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On the Theory of High-Velocity Particles

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The equations of mechanics and electrodynamics are presented in a form which is covariant for Galileo transformations in Euclidean space. The author shows that Galileo transformations in the Euclidean space are valid for particles with velocities approaching that of light.

1. INTRODUCTION

In Gordeyev (1974) we demonstrated that all attempts to find a logical inconsistency in the special theory of relativity proved to be untenable. In the present paper attention is drawn to the fact that a logically noncontradictory theory can be developed for neutral and charged particles with a velocity approaching that of light, this theory differing from the special theory of relativity but being in agreement with all the experiments on which the latter is based.

The special theory of relativity is based on the notion that light velocity is independent of that or any other inertial reference system. In a three-dimensional space this notion is incompatible with the principle of relativity which states that there is no experiment which could prove whether a closed system of bodies is at rest or in a state of constant motion. Therefore Einstein introduced the notion of relativity of simultaneity of dissociated events and has integrated space and time in a four-dimensional continuum in which the classical transformations which relate the two inertial reference systems, i.e., Galileo transformations

$$x^* = x + wt, \qquad y^* = y, \qquad z^* = z, \qquad t^* = t \tag{1.1}$$

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are substituted by new Lorentz transformations:

$$x^* = \frac{x + wt}{(1 - w^2/c^2)^{1/2}}, \quad y^* = y, \quad z^* = z, \quad t^* = \frac{t + wx/c^2}{(1 - w^2/c^2)^{1/2}} \tag{1.2}$$

where w is the reference system velocity $K^*(x^*, y^*, z^*)$ in relation to reference system $K(x, y, z)$, t^* and t are time measured respectively, in K^* and K, and c is the velocity of light in vacuum.

Transformations (1.1) and (1.2) are written in a Cartesian system in the Euclidean and non-Euclidean spaces, respectively. The special theory of relativity can be rewritten in arbitrary coordinates. We can, in particular, introduce the "Galileo coordinates" in which Galileo transformations will be achieved (Kadomtsev, 1972). But this will change the space metric, and Lorentz transformations (1.2)—which are valid for the pseudo-Euclidean space—will pass to Galileo transformations, but for a new non-Euclidean space. The appearance of the mathematical formulas will be changed, the physical nature of the special theory of relativity remaining, however, unaltered.

Our concern with Galileo transformations in Euclidean space (1.1) lies in the fact that any theory of particle notion which is based on them will differ from the special theory of relativity by its physical nature.

Galileo transformations in a Euclidean space are usually considered valid only for reference systems with slow motion in relation to each other, when $w \ll c$. We intend to demonstrate here that Galileo transformations in a Euclidean space do not lose their sense for reference systems which move in relation to each other with any speed, and that it is possible to develop mechanics of high-velocity particles based on Galileo transformations in a Euclidean space, which will differ both from Einsteinian and from Newtonian mechanics.

2. INTERRELATION BETWEEN ENERGY AND MASS AND MASS–VELOCITY DEPENDENCE

The interrelation between energy and mass and the mass–velocity dependence—which are usually related to Lorentz transformations—can be derived without making assumptions on the transformational properties of space–time. Let us consider a closed system of particles. Take a reference system in which the system center of inertia is at rest. This system will be further termed a "privileged system." According to de Broglie's concept each particle with energy E, mass m, and momentum $\mathbf{p} = m\mathbf{v}$ ($\mathbf{v}$ = particle velocity) can be correlated with de Broglie wave with frequency ν and wavelength λ found from the relations

$$E = h\nu, \qquad \mathbf{p} = h\mathbf{k}, \qquad k = \frac{1}{\lambda} \tag{2.1}$$

where h is Planck's constant and $\mathbf{k}$ the wave vector. Group velocity of waves $\mathbf{v}_g = d\nu / d\mathbf{k}$ coincides with particle velocity $\mathbf{v}$; thus we can write

$$\mathbf{v}_g = \frac{dE}{d\mathbf{p}} = \mathbf{v} \tag{2.2}$$

From relations (2.1) and (2.2) we can easily derive

$$E = m\mathbf{v}_g\mathbf{v}_f \tag{2.3}$$

which is valid for all de Broglie waves.

For photons in vacuum where there is no wave dispersion $v_f = v_g = c_0$ (c_0 is the light velocity in vacuum in the privileged reference system), and consequently

$$E = mc_0^2 \tag{2.4}$$

In principle, de Broglie waves for all other particles do not differ from de Broglie waves corresponding to photons. Therefore we can postulate that relation (2.4) is valid for all particles.

Lewis demonstrated that the relationship between particle mass and speed can be deduced from the law of energy–mass relationship. If the energy–mass relationship law is written in a different form as

$$dE = c_0^2\, dm \tag{2.5}$$

and if we compare (2.2) and (2.5), we derive

$$c_0^2\, dm = \mathbf{v}\, d(m\mathbf{v}) \tag{2.6}$$

By multiplying the two parts of (2.6) by m and integrating the result we derive

$$m = \frac{m_0}{\left(1 - v^2/c_0^2\right)^{1/2}} \tag{2.7}$$

where m_0 is an integration constant equal to the mass of the particle at rest.

In deriving (2.4) and (2.7) neither Lorentz (1.2) nor Galileo (1.1) transformations were used, as the particles were considered in one privileged reference system. Consequently the derivation of the laws of energy–mass relationship and particle-mass–velocity dependence does not require the knowledge of transformational properties of space–time.

3. EINSTEIN'S VELOCITY ADDITION THEOREM

Prior to developing new mechanics let us consider the way of deriving the Einstein velocity addition theorem from the energy–mass interrelation law. Let us take a complex particle of mass $\mathfrak{M}_1$ which is at rest in the privileged reference system. Assume that at a certain moment of time the particle spontaneously emits a particle of mass m and velocity v, while the first particle has now a velocity w and a mass $\mathfrak{M}$ (recoil nucleus). The laws of conservation of energy (mass) and momentum in the privileged reference system will be written as

$$\mathfrak{M}_1 = \mathfrak{M} + m \tag{3.1}$$

$$\mathfrak{M} w = m v \tag{3.2}$$

where w and v are the absolute values of oppositely directed velocities $\mathbf{w}$ and $\mathbf{v}$, and, according to (2.7),

$$\mathfrak{M}_1 = \mathfrak{M}_{10}, \qquad \mathfrak{M} = \frac{\mathfrak{M}_0}{\left(1 - w^2/c_0^2\right)^{1/2}}, \qquad m = \frac{m_0}{\left(1 - v^2/c_0^2\right)^{1/2}} \tag{3.3}$$

Now let us direct our attention to the reference system which moves with the recoil nucleus. Masses and velocities of particles will be denoted in this system by the same letters but with an asterisk. The laws of mass and momentum conservation will be rewritten as

$$\mathfrak{M}_1^* = \mathfrak{M}^* + m^* \tag{3.4}$$

$$\mathfrak{M}_1^* w = m v^* \tag{3.5}$$

In writing down (3.5) we took into account the fact that the velocity of $\mathfrak{M}_1^*$ particle will be equal in value and opposed in direction to that of the recoil nucleus in the privileged reference system $\mathbf{w}^* = -\mathbf{w}$. Obviously the masses of particles at rest are invariant, i.e., are independent of the choice of inertial reference system. Now let us assume that the mass–energy proportionality is also invariant. The fact that c_0^2 coincides with squared light velocity in the privileged reference system does not necessarily mean that the light velocity is an invariant value (see below). Next let us assume that in the new reference system (2.6) and (2.7) maintain their form but velocity $\mathbf{v}$ is changed for velocity $\mathbf{v}^*$. Then

$$\mathfrak{M}_1^* = \frac{\mathfrak{M}_{01}}{\left(1 - w^2/c_0^2\right)^{1/2}}, \qquad \mathfrak{M}^* = \mathfrak{M}_0, \qquad m = \frac{m_0}{\left(1 - v^{*2}/c_0^2\right)^{1/2}} \tag{3.6}$$

Using (3.1)–(3.3) we derive

$$\frac{\mathfrak{M}_{01}}{\mathfrak{M}_0} = \frac{1 + w/v}{\left(1 - w^2/c_0^2\right)^{1/2}} \tag{3.7}$$

From (3.4)–(3.6) we have

$$\frac{\mathfrak{M}_{01}}{\mathfrak{M}_0} = \frac{\left(1 - w^2/c_0^2\right)^{1/2}}{1 - w/v^*} \tag{3.8}$$

By eliminating $\mathfrak{M}_{01}/\mathfrak{M}_0$ from (3.7)–(3.8) and by solving the derived equation for v^* we derive the Einstein theorem of velocity addition,

$$v^* = \frac{v + w}{1 + wv/c_0^2} \tag{3.9}$$

In the case of light emission in vacuum $v = c_0$, and as seen from (3.9), $v^* = c_0$. Thus light velocity is invariant. Using the invariance of light velocity we can derive Lorentz transformations (Bergman, 1942).

Thus by using the law of energy–mass relationship, mass–velocity dependence, and the laws of energy and momentum conservation we can derive Einstein's theorem of velocity addition and all the special theory of relativity, if only we assume that the energy and mass proportionality factor is an invariant value, and that the velocity of a particle, which is inherent to the latter for the given inertial reference system, enters all the equations.

4. NEW MECHANICS OF HIGH-VELOCITY PARTICLES

Einstein's mechanics pays no attention to the difference between the velocity of a particle in relation to the inertia center of a closed system of particles and the velocity of the center of inertia itself. These velocities, however, differ considerably from one another. The first depends on the force of particle interaction and is independent of the chosen reference system (invariant). The second is independent of the particle interaction forces but depends on the chosen inertial reference system. If we take into account the difference between the velocity of a particle in relation to the inertia center of a closed particle system and that of the center of inertia itself we can derive new mechanics of high-velocity particles which will differ both from Einstein and Newtonian mechanics.

Let us consider this problem more thoroughly. First let us derive the equation of particle motion in the privileged reference system. Energy variation E is always related to the work of force $\mathcal{F}$ which acts onto the particle; therefore we can write

$$dE = \mathcal{F}\mathbf{v}\,dt \tag{4.1}$$

From (4.1) and (2.2) follows

$$\frac{d(mv)}{dt} = \mathcal{F} \tag{4.2}$$

(4.2) is the equation of particle motion in the privileged reference system.

When we pass to another inertial reference system which is moving in relation to the privileged one with velocity **w**, velocity **v** in Einstein mechanics in (4.2) will be substituted by velocity **v***, the value of which follows Einstein's law of velocity addition. But as the motion of an inertia center of a closed particle system is not related to the action of the force, we shall consider velocity **v** of (4.2) in the new mechanics as the invariant particle velocity in relation to the inertia center of the system. It will not be changed if we pass to another inertial reference system and will always coincide with the particle velocity in the privileged reference system. This applies to all particles comprising the photons.

Therefore, independently of that, whether light velocity is or is not changed in passing from one inertial reference system to another, light velocity in relation to the inertia center of the system will be invariant, coinciding with light velocity c_0 in the privileged reference system.

Equation (2.6) and formula (2.7) are derived from (2.5), (4.1), and (4.2). Aside from invariant masses of particles at rest m_0 and squared light velocity in relation to inertia center of system c_0^2, (2.7) involves an invariant value, squared particle velocity in relation to inertia center of system v^2. Therefore particle mass m, and together with it energy E, also become invariant.

In the above-considered example of spontaneous emission of a particle of mass m we have

$$\mathcal{M}_1^* = \mathcal{M}_1, \qquad \mathcal{M}^* = \mathcal{M}, \qquad m^* = m \tag{4.3}$$

Using (3.1) we can now rewrite (3.5) as

$$(\mathfrak{M}+m)w=mv^{*} \tag{4.4}$$

Substituting in (4.4) for $\mathfrak{M}w$ its expression in mv from (3.2) and canceling by m we derive the Galileo theorem of velocity addition

$$v^{*}=v+w \tag{4.5}$$

When deriving the Galileo theorem of velocity addition there has been no assumption that velocities v and w are significantly below light velocity c_0. The same is valid also for particles with velocities approaching that of light in vacuum and also for photons. Light velocity c^{*} in a preset inertial reference system which moves in relation to the privileged reference system with velocity $\mathbf{w}$ obeys the Galileo theorem of velocity addition at $w \neq 0$ and $c^{*} \neq c_0$ as well.

The covariance of equation of motion (4.2) for Galileo transformations (1.1) is most easily proved if we consider the case when the energy of particle interaction depends only on the distance between them:

$$\mathfrak{U}=\sum_{\substack{i,k\\ i\neq k}} \mathfrak{U}_{ik}(r_{ik}) \tag{4.6}$$

where r_{ik} is the distance between the i particle and the k particle, and $\mathfrak{U}_{ik}$ is the potential energy of interaction between particles. The force which acts on the k particle from the direction of all the other particles will be

$$\mathfrak{F}_k=-\sum_{\substack{i\\ i\neq k}} \nabla \mathfrak{U}_{ik}(r_{ik})=\sum \frac{\partial \mathfrak{U}_{ik}}{\partial r_{ik}}\cdot\frac{(\mathbf{r}_i-\mathbf{r}_k)}{r_{ik}} \tag{4.7}$$

As seen from (4.7), for Galileo transformations $\mathfrak{F}_k$ will be an invariant. Since $m_k\mathbf{v}_k$ and t are also invariants for Galileo transformations, (4.2) will be covariant.

5. INTERACTION OF CHARGED PARTICLES

It will not be difficult now to write down the equations of electrodynamics in a form which will be covariant for Galileo transformations. Let us consider a closed system of charged particles. Take the k particle. As usual, we will introduce a scalar potential

$$\varphi_k=\sum_{i\neq k}\frac{e_i}{r_{ik}}\rightarrow\int\frac{\rho\, dV}{r} \tag{5.1}$$

where e_i is the i-particle charge and ρ the volume charge density. In contrast to the common definition of the vector potential we shall formulate it as follows:

$$\mathcal{A}_k = \sum_{i \neq k} \frac{e_i \mathbf{v}_i}{r_{ik}} \to \int \frac{\mathbf{j}\, dV}{r} \tag{5.2}$$

where $\mathbf{j}$ is the current density. The difference between (5.2) and the common definition is as follows: the invariant charge velocity $\mathbf{v}_i$ in relation to the inertia center of the system is introduced in it, substituting charge velocity $\mathbf{v}_i^*$, which depends on the choice of inertial reference system, thus making the vector potential invariant for Galileo transformations.

The intensity of electric and magnetic fields,

$$\mathcal{E} = -\nabla\varphi - \frac{1}{c_0}\frac{\partial \mathcal{A}}{\partial t}, \qquad \mathcal{H} = \operatorname{rot} \mathcal{A} \tag{5.3}$$

will also be invariant for Galileo transformations (subscript k is here omitted). The Maxwell equation will have the usual form,

$$\begin{aligned} &\operatorname{rot} \mathcal{E} + \frac{1}{c_0}\frac{\partial \mathcal{H}}{\partial t} = 0, \qquad \operatorname{div} \mathcal{E} = 4\pi\rho \\ &\operatorname{rot} \mathcal{H} - \frac{1}{c_0}\frac{\partial \mathcal{E}}{\partial t} = \frac{4\pi}{c_0}\mathbf{j}, \qquad \operatorname{div} \mathcal{H} = 0 \end{aligned} \tag{5.4}$$

The Lagrangian function

$$\mathcal{L} = -m_0 c_0^2 (1 - v^2/c_0^2)^{1/2} + \frac{e\mathbf{v}\mathcal{A}}{c_0} - e\varphi \tag{5.5}$$

generalized impulse

$$\mathcal{P} = \frac{\partial \mathcal{L}}{\partial \mathbf{v}} = m\mathbf{v} + \frac{e\mathcal{A}}{c_0} \tag{5.6}$$

and equations of motion

$$\frac{d(m\mathbf{v})}{dt} = e\mathcal{E} + \frac{e}{c_0}[\mathbf{v}\mathcal{H}] \tag{5.7}$$

differ from the usual only by the fact that instead of the charge velocity depending on the choice of inertial reference system, the velocity in relation to the inertia center of the system is introduced.

The covariance of equations (5.4) to (5.7) for Galileo transformations (1.1) is quite obvious.

6. GRAVITATIONAL INTERACTION OF PARTICLES

Consider now a closed system of neutral particles. By analogy to electrodynamics let us introduce scalar and vector potentials of the gravitational field, which are invariant for Galileo transformations:

$$\varphi_k^g = -\gamma \sum_{i \neq k} \frac{m_{i0}}{r_{ik}} \to -\gamma \int \frac{\rho^g \, dV}{r} \tag{6.1}$$

$$\mathcal{A}_k^g = -\gamma \sum_{i \neq k} \frac{m_{i0} \mathbf{v}_i}{r_{ik}} \to -\gamma \int \frac{\mathbf{j}^g \, dV}{r} \tag{6.2}$$

where γ is the gravity constant, ρ^g the matter density, and $\mathbf{j}^g$ the matter flux density.

Let us introduce now the gravitational field intensity

$$\mathcal{E}^g = -\nabla \varphi^g - \frac{1}{c_0} \frac{\partial \mathcal{A}^g}{\partial t}, \qquad \mathcal{H}^g = \operatorname{rot} \mathcal{A}^g \tag{6.3}$$

D'Alambert equations can be derived in the usual way (Tamm, 1946),

$$\begin{aligned} \nabla^2 \varphi^g - \frac{1}{c_0^2} \frac{\partial^2 \varphi^g}{\partial t^2} &= -4\pi\rho^g \\ \nabla^2 \mathcal{A}^g - \frac{1}{c_0^2} \frac{\partial^2 \mathcal{A}^g}{\partial t^2} &= -4\pi \mathbf{j}^g \end{aligned} \tag{6.4}$$

as well as equations similar to Maxwell equations,

$$\begin{aligned} \operatorname{rot} \mathcal{E}^g &= -\frac{1}{c_0} \frac{\partial \mathcal{H}^g}{\partial t}, \qquad \operatorname{div} \mathcal{E}^g = 4\pi\rho^g \\ \operatorname{rot} \mathcal{H}^g - \frac{1}{c_0} \frac{\partial \mathcal{E}^g}{\partial t} &= \frac{4\pi}{c_0} \mathbf{j}^g, \qquad \operatorname{div} \mathcal{H}^g = 0 \end{aligned} \tag{6.5}$$

for gravitational field potentials and intensities.

The covariance of equations (6.3)–(6.5) for Galileo transformations is easily checked.

The Lagrangian function

$$\mathfrak{L}^g = -m_0c_0^2\left(1-v^2/c_0^2\right)^{1/2} - \frac{m_0\mathbf{v}\mathcal{Q}^g}{c_0} - m_0\varphi^g \tag{6.6}$$

and the generalized impulse

$$\mathcal{P} = m\mathbf{v} - \frac{m_0\mathcal{Q}^g}{c_0} \tag{6.7}$$

will be covariant values for Galileo transformations.

Using (6.3) we can write the Lagrangian equation as

$$\frac{d(m\mathbf{v})}{dt} = m_0\mathcal{E}^g + \frac{m_0}{c_0}\left[\mathbf{v}\mathcal{H}^g\right] \tag{6.8}$$

(6.8) differs from (5.7) only in that the charge in it is substituted by the mass of particle at rest.

7. RELATION BETWEEN THEORY AND EXPERIMENT

The new mechanics can explain all the presently available experiments which form the basis of the special theory of relativity and are considered indisputable. The limits of the present paper prevent us from discussing all the relativistic effects, the majority of which can be explained by other theories, e.g., the emission theory.

So we shall dwell only on a few experiments which are adequately reliable and up to now are considered in agreement only with the special theory of relativity. As proved by experiment (Frish, 1963), the meson half-life period is proportional to energy

$$\tau = \tau_0\frac{E}{m_0c_0^2} \tag{7.1}$$

where τ_0 is the meson half-life period for a meson at rest, which equals the half-life period experimentally found for slow mesons. Since energy is proportional to mass (2.4) and mass depends on velocity (2.7), it follows that

$$\tau = \frac{\tau_0}{\left(1-v^2/c_0^2\right)^{1/2}} \tag{7.2}$$

where $\mathbf{v}$ is the meson velocity in the laboratory reference system. Half-life periods τ and τ_0 are measured in the same laboratory system which may be taken as a privileged system. Therefore the experiment gives no data on transformational properties of space–time. It can be explained both by the special theory of relativity and by the new mechanics based on Galileo transformations. For both the theories (2.4) and (2.7), and consequently (7.2) in the privileged reference system are similar.

It should be noted that the reasoning cited to prove that this experiment confirms the validity of Lorentz transformations should be considered noncorrect. In the special theory of relativity the proper time interval τ_0 between events as measured with a clock which moves together with a body is always less than the time interval τ between the same events as measured with a clock in another interval reference system (laboratory system) in relation to which the body has a velocity **v**. The relation between τ_0 and τ is given in the same formula (7.2). But in the special theory of relativity (7.2) gives the relationship between the times of one and the same process (e.g., half-time period of the same particle) measured with different clocks, while in the above considered experiment the same formula gives the relation between the times of different processes (half-life period of two particles moving with different velocities) but measured with the same (laboratory) clock. Therefore it cannot be affirmed that the above-considered experiment proves the Lorentz transformation.

To demonstrate the validity of the special theory of relativity experimental facts are cited which are related to collisions of high-velocity particles (Fox, 1965). For example, at elastic proton–proton collisions the angle of divergence after collision is 83° if a proton of 435 MeV collides with a proton at rest (in the laboratory system), and their path after collision is symmetrical to the direction of motion of an incident proton. But if the proton velocity is substantially lower than that of light, the divergence angle will be 90°. This experimental fact is explained by the special theory of relativity.

It can, however, find its explanation in the new mechanics. And, indeed, by using the mass–velocity relationship (2.7) and the laws of energy and momentum conservation expressed as

$$m + m_0 = 2m_1, \qquad mv = 2m_1 v_1 \cos\frac{\varphi}{2} \tag{7.3}$$

where v is the value of incident proton velocity, v_1 the velocity value of diverging protons in the laboratory (privileged) system, we find the relationship

$$\cos\frac{\varphi}{2} = \frac{v}{c_0\left\{2\left[\left(1 - v^2/c_0^2\right)^{1/2} - 1\right] + 3v^2/c_0^2\right\}^{1/2}} \tag{7.4}$$

which correlates the divergence angle φ with the incident proton velocity v. It is easy to prove that at $v \ll c_0$ we derive from (7.4) $\varphi = 90°$, and at proton energy of 435 MeV, $\varphi = 83°$. In this experiment the divergence angle and proton velocities are determined only in one laboratory system, so the experiment is not adequate for being an argument in judging which of the theories is true—the special theory of relativity or the new mechanics.

An interesting experiment has been carried out by Hafele and Kieting (1972). They both started a round-the-world flight from the same airport, one of them traveling eastward and the other westward. Both traveled with the same speed in relation to the Earth surface and then landed at the same airport. The atomic clock of the traveler who flew eastward lagged as compared to the atomic clock at the airport, while the atomic clock of the traveler who flew westward was fast.

This experiment is explainable both in the special theory of relativity and in the new mechanics. The readings of atomic clocks are related to the half-life period, which in both theories is governed by the same expression (7.2), in which $\mathbf{v}$ is speed of the clock in the reference system (privileged system) which is related to the fixed axis of Earth radiation. Because of the Earth's rotation, clock speed when flying eastward will be higher than that of the clock at the airport, and this latter speed will be in its turn higher than that of the clock flying westward. Clock reading derived in accordance with (7.2) qualitatively agree with the readings in experiment. For precise quantitative agreement the gravitational field of the Earth and its motion around the Sun should be taken into account. The clock readings were considered only in one reference system which is related to the fixed axis of the Earth's rotation, and thus it gives no data on any transformational properties of space–time. Therefore this experiment as well cannot be considered as a proof of the validity of Lorentz transformations.

We shall not dwell here on other experiments which are usually considered as a base of the special theory of relativity (Michelson experiment, Fizeau experiment, etc.). They are explained by various alternative theories. All of these experiments can be explained by the new mechanics.

Neither shall we discuss gravitational effects. These require detailed discussion and experimental checking. We shall only note that gravitational waves are found from the solution of the D'Alambert equation (6.4); the invariant part of their propagation is equal to light velocity in vacuum and in the privileged reference system. Mercury perihelium motion can be subjected to the influence of precession in the "magnetic" gravitational field $\mathcal{H}^g$ which is generated by the Sun's rotation around the inertia center of the solar system.

There are some experiments which do not seem trustworthy, e.g., all of the experiments on second-order Doppler effect (Kantor, 1971). More carefully conducted experiments on this effect could record the difference between the new theory and the special theory of relativity.

8. CONCLUSION

In the special theory of relativity the particle mass and energy depend on the choice of inertial reference system. This theory pays no attention to the difference between particle velocity in relation to the inertia center of a closed system of bodies and the velocity of the center of inertia itself. In the new mechanics the difference between these velocities is emphasized. The first velocity depends on the forces of interaction between particles and is independent of the choice of inertial reference system. The second is independent of the particle interaction forces but depends on the chosen inertial reference system. Particle mass and energy in the new mechanics become invariant.

The new mechanics does not reject the results of the special theory of relativity, just as calculations with actual values do not eliminate the introduction of a complex variable. It is a different method for investigating the same processes. Both theories are logically noncontradictory. Only the practice—which is the criterion of truth—can solve the problem: which of the two is in better agreement with reality? But what about the philosophical essence of each theory? These are different because the real space metrics are different for each theory.

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