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Mini Review

A substance with negative mass

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Abstract

The conditions for the formation of a substance with a negative mass are investigated. The critical velocity of a body ω = 235696.8871 *km/s*, necessary for its transition to a massless state, was determined by two independent methods. Zeroing of the mass of matter also occurs at a temperature T =2.17 $\cdot$ $10^{36} m_o$ (m_o is the rest mass of the particle in grams). At higher temperatures or speeds of movement, the mass of bodies becomes negative. The resulting formulas made it possible to calculate the masses of X,Y-bosons equal to 4.606 $\cdot$ 10^{-9} *g*. The temperature of the Superunification of the four fundamental interactions, including gravity, is estimated to be 4.72 $\cdot$ 10^{31} K.

Introduction

Possible properties and mechanics of the interaction between a particle with a negative mass and a particle with a positive mass were considered in studies [1-5], in which it was shown that no fundamental physical laws contradict the existence of substances with a negative mass. The theory of the emergence of a substance with a negative mass is based on the ideas of E.L. Feinberg [7] about relativistic changes in the length scales in the direction of motion of a body, time, mass, and acceleration of a moving body as a result of the action of certain forces is described in [6]. The idea of E.L. Feinberg's decomposition of the force acting on the body into components responsible for changing the dynamic characteristics of the body is hypothetical since there is no evidence of its validity in the literature.

The purpose of this work is to search for other independent evidence of the formation of a substance with a negative mass, which would confirm or refute the conclusions of [6], and at the same time assess the correctness of the approach of E.L. Feinberg.

The possibility of the emergence of matter with negative mass

The composition of the force **F** acting on the body, which is expended on changing the parameters of the motion of a physical object, according to [6,7] can be represented as

$$\mathbf{F} = \mathbf{F}_v + \mathbf{F}_m + \mathbf{F}_l + \mathbf{F}_\tau \, , \qquad (1)$$

Where the cost of force $\mathbf{F}_v$ is directly to change the speed *v* of the object in the direction of Force **F**, F_m is the cost of force **F** to change the mass *m* of the object, $\mathbf{F}_l$ is the cost of force **F** to change the length *l* of the object in the direction of force **F**, **F** is the cost of force $\mathbf{F}_\tau$ to change the rate time $\tau = \Delta t$. There is no change in the length of the object in directions perpendicular to the speed of the object in accordance with SRT. In the future, since all components of the acting force **F**, as well as the length, speed, and acceleration of the object is estimated only in the direction of the force **F**, then in the following formulas, for the convenience of recording and perception of information, their vector nature will not be fixed, and equality (1) can be written:

$$F = F_v + F_m + F_l + F_\tau \;, \tag{2}$$

Where

$$F_v = m_0 \cdot \frac{dv}{dt} = m_0 \cdot a \;, \tag{3}$$

$$F_m = v \cdot \frac{dm}{dt} , \tag{4}$$

$$F_l = \frac{m_0 v}{l_0} \cdot \frac{dl}{dt} , \tag{5}$$

$$F_\tau = -\frac{m_0 v}{\tau_0} \cdot \frac{d\tau}{dt} \;, \tag{6}$$

$$m = \frac{m_0}{\sqrt{1 - v^2 / c^2}} \;, \tag{7}$$

$$l = l_0 \sqrt{1 - v^2 / c^2} \;, \tag{8}$$

$$\tau = \frac{\tau_0}{\sqrt{1 - v^2 / c^2}} \;, \tag{9}$$

And m_o, l_o, τ_o are the mass, length, and rate of time of the physical object at rest, c is the speed of light, v,a are the speed and acceleration of the body, respectively, [6]. The minus sign in formula (6) is explained by the fact that the rate of time of a moving body slows down rather than accelerates, i.e. the amount of time, as it were, "accumulated by the body" during movement becomes smaller, in contrast to the mass, the amount of which increases with increasing body speed. The values m_o, l_o, τ_o and v in formulas (3 - 6) play the role of proportionality coefficients, such that the dimensions of the right parts of these equalities in the aggregate have the dimension of force. The coefficient v is independent of the corresponding arguments, so it is not included in formulas (4–6) under the differential sign.

Substituting formulas (7 - 9) into equalities (4 - 6) and differentiating, we get:

$$F_m = m_0 a \cdot \frac{v^2 / c^2}{\left(1 - v^2 / c^2\right)^{1.5}} \;, \tag{10}$$

$$F_l = -m_0 a \cdot \frac{v^2}{c^2 \sqrt{1 - v^2 / c^2}} \;, \tag{11}$$

$$F_\tau = -m_0 a \cdot \frac{v^2 / c^2}{\left(1 - v^2 / c^2\right)^{1.5}} \tag{12}$$

Substituting expressions (3, 10 - 12) into equality (2), we obtain:

$$F = m_0 a \left(1 - \frac{v^2}{c^2 \sqrt{1 - v^2 / c^2}} \right) . \tag{13}$$

Formula (13) shows that the costs of the acting force for increasing the body mass and slowing down time are mutually compensated. This indirectly indicates the dependence of the time rate on the object on the body mass.

Since the mass depends on the speed of the body according to the formula (7), then, in order to note this circumstance, we write the formula (13) in the form:

$$F = \frac{m_0}{\sqrt{1 - v^2 / c^2}} \cdot a \left(\sqrt{1 - v^2 / c^2} - v^2 / c^2 \right) . \tag{14}$$

$$F = m_0 a_0 \,. \tag{15}$$

Where

$$a_0 = a = \frac{F}{m_0} . \tag{16}$$

Substituting (16) into (14), we get:

$$F = \frac{m_0}{+\sqrt{1 - v^2 / c^2}} \cdot a_0 \left(+\sqrt{1 - v^2 / c^2} - v^2 / c^2 \right) . \tag{17}$$

The formula for the dependence of the acceleration of the body a_v on its speed, at the current time, will look like this:

$$a_v = a_0 \left(\sqrt{1 - v^2 / c^2} - v^2 / c^2 \right) . \tag{18}$$

Table 1 presents the characteristics of a body moving with acceleration, calculated by formulas (7, 18), as well as the magnitude of the mass defect

$$\Delta m_r = m_r - m_0 \;, \tag{19}$$

Acceleration a_r, and mass m_r, which the body must have as a result of applying the principle of reinterpretation.

From formula (18) and Table 1, it can be seen that the acceleration of the body will decrease with increasing body

Table 1: Characteristics of a body moving with acceleration based on dynamic interpretation of relativistic effects.

v	m (7)	m_r	m_r (19)	a_v (18)	a_r
0	m_0	m_0	0	a_0	a_0
0.5c	155m_0	1.155m_0	0,155m_0	0,616a_0	0,616a_0
0.75c	1.512m_0	1.512m_0	0,512m_0	0,099a_0	0,099a_0
$\omega = \sqrt{\frac{\sqrt{5}-1}{2}} c$	Φm_0	$\pm\Phi m_0$	+0.618m_0 -0.718m_0	0	0
0.8c	1.666m_0	-1.666m_0	-2.666m_0	-0.040a_0	0.040a_0
0.9c	2.294m_0	-2.294m_0	-3.294m_0	-0.374a_0	0.374a_0
$\sqrt{2\left(\sqrt{2}-1\right)}c = 0,912c$	2.385m_0	-2.385m_0	-3.385m_0	$\left(\sqrt{2}-1\right)a_0 = -0.414a_0$	$\left(\sqrt{2}-1\right)a_0 = -0.414a_0$
c	∞	-∞	−∞	$-a_0$	a_0

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speed, and at some critical speed, $v = \omega$ will be equal to zero. To find ω, we solve the equation

$$\sqrt{1-v^2/c^2} - v^2/c^2 = 0 \quad (20)$$

Where

$$v = \omega = c\sqrt{\frac{\sqrt{5}-1}{2}} \approx 0.7862c \approx 235696.8871\ km/s \quad (21)$$

When squaring equality (21)

$$v^2 = \omega^2 = \frac{\sqrt{5}-1}{2}c^2 \approx 0.61803c^2 = \frac{1}{\Phi}c^2 \quad (22)$$

We obtain that the square of the critical velocity ω is the golden ratio of the squares of velocities not exceeding the speed of light, i.e. he divides the range of squares of these speeds in the extreme and average ratio into two parts so that the boundary of this section is the geometric mean between these parts. However, in most literature sources, the reciprocal value Φ = 1.618034 is taken as the value of the golden section [9].

When the speed of the object is greater than the critical one, the acceleration of the body, defined by formula (18), formally becomes negative. If this were the case, then the bodies that have reached such a speed should turn back. In reality, we know that elementary particles, for example, in hadron colliders, reach speeds close to the speed of light, and no negative accelerations are observed. However, if we apply the principle of reinterpretation [8], and replace the negative value of the body acceleration with a negative value of the mass, then from such a transformation it follows that after the body reaches the critical speed ω, the internal structure of the body is rearranged in such a way that the body mass becomes negative, the acceleration of the body positive, and the body continues to move in the same direction.

Formation of matter with negative mass

The acceleration of a physical body is determined through the differentiation of its speed

$$v = \frac{dx}{dt}, \quad (23)$$

Where dx is the distance traveled by the body in time dt. Any movement of the body is due to the forced interactions of this body with the surrounding matter and its characteristics. Thus, the interval dx and the time interval dt, included with equality (23), are external, depending on the speed of the body, parameters by which, in this case, the speed is found. In the process of motion, the quantities dx and dt do not change the speed of the point, but, on the contrary, they themselves change depending on the change in speed, so that

$$dx = df(v,\tau), \quad (24)$$

$$dt = df(\tau), \quad (25)$$

Where τ is the proper time of the moving body.

Relations (24, 25) show that in formula (23) the differential dt of the argument t in this case does not depend on t. In this regard, the second differential of the function $f(\tau)$ is equal to the differential of its first differential:

$$d\left[df(\tau)\right] = d^2 f(\tau) \quad (26)$$

Using the well-known formula for the second derivative in terms of differentials [10]

$$\frac{d^2y}{dx^2} = \frac{dx \cdot d^2y - dy \cdot d^2x}{dx^3}, \quad (27)$$

Body acceleration can be defined as

$$\frac{dv}{dt} = \frac{d^2x}{dt^2} - \frac{dx}{dt} \cdot \frac{d^2 f(\tau)}{dt^2}. \quad (28)$$

For $df(\tau) = d\tau$, equality (28) will look like

$$\frac{dv}{dt} = \frac{d^2x}{dt^2} - \frac{dx}{dt} \cdot \frac{d^2\tau}{dt^2} \quad (29)$$

or, taking into account (23), we obtain

$$\frac{dv}{dt} = \frac{d^2x}{dt^2} - v \cdot \frac{d^2\tau}{dt^2}. \quad (30)$$

On the right side of equation (30), both terms are, in essence, partial derivatives of the path and proper time, so equality (30) can be written as:

$$a = \frac{dv}{dt} = \frac{\partial^2 x}{\partial t^2} - v\frac{\partial^2 \tau}{\partial t^2}. \quad (31)$$

Based on the dependence of the body length on its speed according to formula (8), the change in its length will be equal to

$$dl = dl_0\sqrt{1-v^2/c^2} \quad (32)$$

To determine the reduction of the object's proper time (acceleration of the time rate), we consider that the signal moving at the speed of light will cover the distance dl in the time d:

$$\frac{dl}{c} = d\tau = \frac{dl_0\sqrt{1-v^2/c^2}}{c} = dt\sqrt{1-v^2/c^2}, \quad (33)$$

Where

$$\frac{\partial \tau}{\partial t} = \frac{d\tau}{dt} = \sqrt{1-v^2/c^2}, \quad (34)$$

$$\frac{\partial^2 \tau}{\partial t^2} = \frac{\partial\sqrt{1-v^2/c^2}}{\partial t} = \frac{\partial\sqrt{1-v^2/c^2}}{\partial v} \cdot \frac{\partial v}{\partial t} \quad (35)$$

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$$\frac{\partial^2 \tau}{\partial t^2} = -\frac{v}{c^2\sqrt{1-v^2/c^2}} \cdot \frac{\partial v}{\partial t} \tag{36}$$

The second derivative of the path with respect to time at the moment of starting is equal to

$$\frac{d^2 x}{dt^2} = \frac{\partial v}{\partial t} = a_0 \ , \tag{37}$$

Where a_o is determined by the formula (16). Substituting formulas (36, 37) into (31), we obtain

$$a_v = \frac{dv}{dt} = \frac{\partial v}{\partial t}\left(1 - \frac{v^2}{c^2\sqrt{1-v^2/c^2}}\right) = a_0\left(1 - \frac{v^2}{c^2\sqrt{1-v^2/c^2}}\right) \tag{38}$$

Newton's second law in accordance with (38) will have the form:

$$F = m_0 a = m_0 a_0\left(1 - \frac{v^2}{c^2\sqrt{1-v^2/c^2}}\right). \tag{39}$$

And since the mass of the body depends on its speed according to the formula (7), it is rational to represent the formula (39) in the form:

$$F = m_v a_v = \frac{m_0}{+\sqrt{1-v^2/c^2}} \cdot a_0\left(+\sqrt{1-v^2/c^2} - v^2/c^2\right). \tag{40}$$

Formula (40) coincides with formula (17), and the dependence of the acceleration a_v on the body velocity (38) is determined by the formula (18). Thus, in this section, we obtained the same results as in [6], but without using the idea of E.L. Feinberg on the admissibility of expanding the action of a force on a change in the dynamic characteristics of a body, which confirms his hypothesis.

Discussion of results

From the data in Table 1 it follows that the body mass should increase with increasing body speed, but at a speed equal to $\omega \approx 0.7862c \approx 235696.8871$ *km/s* due to the principle of reinterpretation at this speed, the internal structure of the body is restructured in such a way that the body mass becomes negative. With a further increase in the speed of the body in absolute value, the absolute value of the body mass will continue to increase. Such a dependence of the body mass on its speed suggests that the mass of the body, in itself, does not determine the amount of matter in the body, but the amount of matter can be determined by the modulus of the mass value. The existence of bodies with negative mass suggests that, in addition to the amount of matter contained in them, material bodies also have a gravitational charge, which, depending on their speed, and, possibly, for other reasons, can be both positive and negative. And negative. Curious is the fact that, as follows from Table 1, the acceleration of the body a_r with increasing body speed the value ω decreases from the initial value a_o to 0, and then increases with increasing speed, reaching the same value a_o when the body speed is equal to the speed of light. This testifies in favor of the fact that the body did not turn into radiation but was preserved as matter, and, accelerating, begins to move at a superluminal speed. In accordance with formula (16), the mass of such a body must be imaginary, which hints at the possibility of the existence of bodies with imaginary masses and superluminal velocities for such bodies. The mechanics of hypothetical particles with an imaginary mass among themselves and their interaction with particles of positive and negative mass are described in [11]. These conclusions do not contradict SRT, since the postulates of SRT refer to the dynamics of bodies with positive mass [12].

Diagnostics of particles with negative mass

Numerous experiments at Hadron colliders have not yet made it possible to fix the formation of substances with a negative mass. If the idea of changing the parameters of a moving body from its speed is correct, the fact that bodies with a negative mass were not detected would indicate that the transformation of bodies with a positive mass into bodies with a negative mass either does not take place, or the transformation does not affect the instruments for monitoring the course of the experiment. In an appreciable way, or to the fact that, externally, with respect to observation instruments, the behavior of a substance with a negative mass is the same as with a positive mass.

From the Equivalence Principle (EPE) of inert m_i, active m_a and passive m_p of Einstein's gravitational masses follows:

$$F = m_i a \tag{41}$$

$$F = m_i a = -G\frac{m_p m_a}{r^2} \ , \tag{42}$$

Where the minus sign in formula (42) indicates the attraction of interacting bodies to each other [13]. Consider the interaction of two bodies of positive mass:

As follows from formula (42), if the masses of both bodies are positive, then the bodies are attracted (Figure 1). Formula (41) indicates that the accelerations of both bodies are positive, i.e. coincide with the direction of the acting forces. Therefore, the bodies move towards each other. Now consider the case when the masses of both bodies are negative (Figure 2):

Substituting the values of the masses into formula (42), we obtain that bodies with negative mass must also attract. Let us consider the case when two bodies have masses of different signs (Figure 3)

When the masses are substituted into formula (42), the result will be positive. Therefore, the bodies must repel. However, on closer examination, we will stumble upon "pitfalls". If the mass is negative, then the acceleration is also negative, which follows Newton's second law (41). Therefore, the body will move in the opposite direction to the acting force. Let's review the previous examples with this conclusion in mind. As can be seen from Figure 4, bodies with negative

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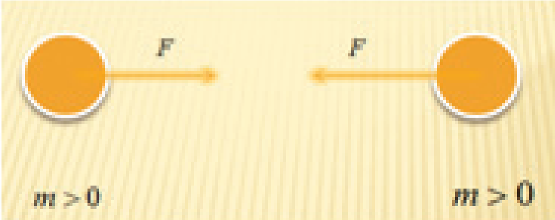

Figure 1: Attraction of bodies with positive mass.

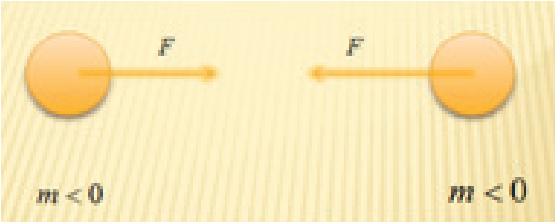

Figure 2: Formal attraction of bodies with negative mass.

Figure 3: Formal repulsion of bodies with masses of different signs.

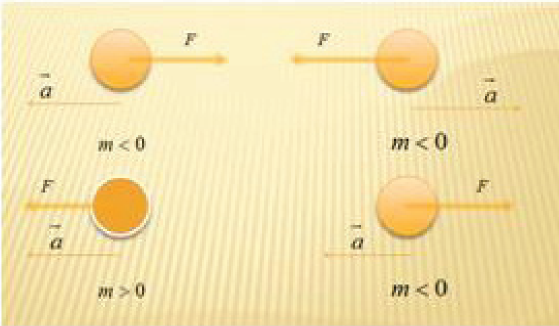

Figure 4: Interaction of bodies with negative mass and with masses of different sign.

mass will repel, and bodies with masses of different signs will move in the same direction in the direction of motion of a body with positive mass, and with additional acceleration, since in addition to the external force acting on the bodies, there is also the force of their gravitational influence Each other.

In accordance with the above, if the EPE is correct, then the formed particles with negative mass should repel each other, which will lead to the expansion of the beam of moving particles.

In the direction of motion of the particle beam, there will be a stratification of particles into avant-garde particles repelled from behind the flying particles, and particles lagging behind. But since an external accelerating force F still acts on all particles of the beam, then in general, all particles of the beam will move with acceleration.

If the principle of reinterpretation is not applied, i.e. consider it erroneous, then, as can be seen from Table 1, the mass of the body would remain positive, and the acceleration of the body a_v, when the body speed $v = \omega$ would be reached, would become equal to zero, and a further increase in the body speed would be impossible. The acceleration of the body would formally become negative, which would correspond to the movement in the opposite direction. However, in Hadron colliders, it is possible to accelerate particles to speeds greater than the critical velocity, close to the speed of light. This would not be possible if the principle of reinterpretation were not valid.

In [13], the New Equivalence Principle (NPE) is substantiated, taking into account the possibility of the existence of particles of negative mass:

$$|m_i| = |m_a| = |m_p| \ , \qquad (43)$$

From which it follows that the amount of matter in the body is determined by the modulus of its mass:

$$|m_i| = |-m_a| = |-m_p| = +m \qquad (44)$$

It is easy to see that, on the basis of NPE, two bodies with both positive and negative masses will be attracted to each other, and two bodies with different masses will repel each other. Obviously, a substance with a negative mass will move away with acceleration from a substance with a positive mass and form colonies. In hadron colliders, when particles reach a velocity above the critical velocity $v = \omega$, their mass (Table 1) becomes negative. But they will be attracted to each other in the same way as particles with positive mass.

Therefore, they cannot be distinguished from particles with a positive mass. However, at speeds slightly exceeding the critical speed, particles of both signs will be present in the beam of moving particles. They will repel each other, which will lead to some expansion of the beam. Thus, one of the signs of the formation of matter with a negative mass can be the expansion of a beam of moving particles in hadron colliders. Another sign of the existence of matter with a negative mass, if the NPE is correct, is the presence in our Universe of huge islands of matter with a negative mass remote from our part of the Universe. If EPE is correct, then matter with negative mass should be scattered throughout the Universe. In both cases, matter with negative mass will manifest itself as one of the types of "dark matter", the need for the existence of which has already been explained [14].

Predictions

As is known [14], the average kinetic energy of the translational motion of particles is written as

$$w = \frac{\overline{mv^2}}{2} = \frac{3}{2}kT \ , \qquad (45)$$

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Where k = $1,3807 \cdot 10^{-16}$ erg/K – Boltzmann's constant, T – absolute temperature K. Specifically, for the critical velocity ω, equality (45), taking into account (7), can be written

$$\frac{m_0 \omega^2}{\sqrt{1-\omega^2/c^2}} = 3kT \quad (46)$$

Noticing that

$$\sqrt{1-\omega^2/c^2} = \frac{1}{\Phi}\ , \quad (47)$$

Find

$$m_0 = \frac{3kT}{\omega^2 \Phi} \quad (48)$$

$$T = \frac{m_0 \omega^2 \Phi}{3k} \quad (49)$$

After substituting the numerical values of the constants k, ω, Φ into equality (49), we obtain a simple formula for calculating the transition temperature of a substance to a massless state:

$$T = 2.17 \cdot 10^{36} m_0\ K\ , \quad (50)$$

where m_o is the rest mass of the particle in grams.

Grand Unification theories predict that a system of particles heated to the temperatures of the Grand Unification becomes a system of massless particles and, upon subsequent cooling, will pass through special temperature points at which this system will experience phase transitions due to spontaneous symmetry breaking, and some of the particles in each of these transitions will gain mass. On the other hand, from Table 1 it can be seen that the dependence of the body mass on its velocity at the critical velocity of the body ω undergoes a transition from positive to negative values. This indicates that at this speed the value of the mass of the body is zero. It follows from this that formula (48) allows one to find the rest mass of a particle if the temperature at which the particle, in accordance with the Higgs theory [14,15], loses mass is known, and formula (49) makes it possible to determine the corresponding transition temperature to the massless state if the mass of the particle is known. Table 2 shows the values of m_o Mand T calculated by formulas (48, 49) for a number of elementary particles.

At T ≈ 10^{28}K, the Grand Unification of fundamental interactions ends [14,15], the strong interaction is separated from the electroweak one, and the carriers of the Grand Unification X- and Y-bosons acquire masses ≈10^{15}–10^{16} GeV/c^2 [14] (according to [14] ≈10^{14} GeV /c^2). The rest of the particles remain massless. The mass of these bosons calculated by the formula [48] turned out to be $2.586 \cdot 10^{15}$ GeV/c^2 and is more accurate.

The carriers of the Superunification forces of all four fundamental interactions, including gravity [14], are Planck particles with a mass of $1.222 \cdot 10^{19}$ GeV/c^2. According to formula (49), we find that the Planck particles should become massless at a temperature of $4.732 \cdot 10^{31}$K.

Table 2: Transition temperatures of elementary particles to the massless state.

Particle Name	m_0 (g)	m_0c^2	T K
Particle conditionally minimum mass	$1.375 \cdot 10^{-34}$	0.078 эВ	300
Electronic neutrino	$3.56 \cdot 10^{-32}$	< 2 э В	77185
Muon neutrino	< $3.38 \cdot 10^{-28}$	< 0.19 МэВ	7328246
Electron	$9.109 \cdot 10^{-28}$	0.511 МэВ	197396000
τ - neutrino	< $3.24\ 10^{-26}$	< 18.2 МэВ	$7.02 \cdot 10^{10}$
Muon	$1.8807 \cdot 10^{-25}$	105.66 МэВ	$4.08 \cdot 10^{11}$
Proton	$1.6726 \cdot 10^{-24}$	938.272 МэВ	$3.62 \cdot 10^{12}$
τ- lepton	$3.163 \cdot 10^{-24}$	1.777 ГэВ	$6.86 \cdot 10^{12}$
W^+,W^- - bosons	$1.4278 \cdot 10^{-22}$	80,15 ГэВ	$3.09\ 10^{14}$
Z^0-boson	$1.623 \cdot 10^{-22}$	91.188 ГэВ	$3.51 \cdot 10^{14}$
Higgs boson	$2.228 \cdot 10^{-22}$	125.18 ГэВ	$4.84\ 10^{14}$
X, Y- bosons	$4.606 \cdot 10^{-9}$	$2.586 \cdot 10^{15}$ ГэВ	10^{28}
Planck particle	$2.1767 \cdot 10^{-5}$	$1.222 \cdot 10^{15}$ ГэВ	$4.723 \cdot 10^{31}$

Black holes are formed as a result of gravitational contraction and accretion of matter. The speed of particles falling towards the center of the Black Hole increases as it approaches the center and eventually reaches the critical speed ω, after which the mass of the falling particles becomes negative. In accordance with the EPE, such particles should repel each other, and then the Black holes should fly apart, but this is not observed. On the contrary, NPE requires the attraction of negative particles to each other, their merging with the formation of a nucleus with a negative mass, which makes the Black Hole a stable formation and a candidate for the role of a type of "dark matter".

Conclusion

It is proved that the force acting on the body can be decomposed into components responsible for relativistic effects. Formulas for calculating the mass and transition temperature of an elementary particle to a massless state are derived. It has been established that as the body speed increases to the critical speed ω ≈ 235696.8871 $km/$, the body mass increases to the value Φ≈$1.618034 m_o$, and upon reaching the critical speed, the body undergoes an internal restructuring, as a result of which the body mass becomes negative. A substance with a negative mass can be obtained by increasing the body temperature, which depends, in accordance with formula (49), on the rest mass of the original substance. From what has been said, it follows that the minimum speed of the body movement necessary for the transition of the mass of the substance to a state with zero or negative mass for all bodies is the same and equal to ω, and the transition temperature is different and depends on the chemical composition of the substance. This conclusion opens up opportunities for understanding the essence, theoretical and experimental study of non-substance. One of the signs of the formation of non-matter can be the expansion of a beam of moving particles in hadron colliders, and the study of collisions of non-matter with each other and with ordinary particles with positive mass will make it possible to verify the validity of the interaction mechanics described above, taking into account the corresponding principles of equivalence.

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References

1. Bondi H. Negative Mass in General Relativity. Reviews of Modern Physics. 1957; 29: 423–428.

2. Bonnor WB. Negative Mass in General Relativity. General Relativity and Gravitation. 1989; 24: 1143–1157.

3. Forward R. Rocket engine on the substance of negative mass. J of Propulsion and Power. 1989; 28–37.

4. Serga EV. Physical vacuum as a form of matter: a new look at the structure and properties. Space exploration. 2017; 2: 85100. DOI: 10.7256/2453-8817.2017.2.23245.

5. Golovkin BG. Negative mass is a component of the Universe. Noosphere Society Person. 2019. URL: http://noocivil.esrae.ru/259-1903.

6. Golovkin BG. Newton's Second Law in Special Theory of Relativity. Journal of Physics & Optics Sciences. 2022; 173. SRC/JPSOS/199. DOI: doi.org/10.47363/JPSOS/2022(4)173.

7. Feinberg EL. Is it possible to consider the relativistic change in the scales of length and time as a result of the action of some forces? // Einstein collection (1975-1976). M. Science. 1978; 43–77.

8. Syrovatsky SI. On the question of the "delay" of the relativistic contraction of moving bodies. Einstein collection (1975-1976). M Science. 1978; 78– 81.

9. Corbalan F. The Golden Ratio. The Beautiful Language of Mathematics. Deagostini. 2010.

10. Vygodsky MYa. Handbook of higher mathematics. M. Fizmatlit. 1973; 872. With. 425.

11. Golovkin BG. Gravitational interactions of bodies from the point of view of different principles of equivalence. World Scientific News. 2020; 141: 48–65.

12. Golovkin BG. Proof of Einstein`s postulates. Ann Math Phis. 2022; 5: 13–20. DOI: https://dx.doi.org/10.17352/amp. 000035.

13. Golovkin BG. New Particle Mechanics with Negative Mass. World Scientific News. 2019; 126: 283–290.

14. Ishkhanov BS, Kapitonov IM, Yudin NP. Particles and atomic nuclei. M. Lenand. 2019; 548, 551, 605. 672.

15. Okun LB. Leptons and quarks. M "Science". The main edition of Physical and Mathematical literature.1990. 346.

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