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Research Article

The speed of the body at the moment of transition to a massless state is a new world constant

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Abstract

Based on the kinetic theory of gases, the minimum temperature and critical velocity of a body necessary for its transition to a massless state are estimated. The value of this speed ω = 235696.8871 km/s is a new world constant, since it is the same for a body, regardless of its size, mass, density, and chemical composition. For the first time, the masses of X, and Y - bosons, as well as the zeroing temperatures of the mass of elementary particles have been calculated.

Introduction

According to the Grand Unified Theories (GUT), which considers theoretical approaches that at very high energies, all types of fundamental interactions – weak, electromagnetic, strong, including the Higgs, and gravitational ones, are combined into one universal interaction. Such a combination is possible because the effective constants of these interactions show a tendency to approach each other as the transferred momentum increases so that all interactions are characterized by a single coupling constant [1-4]. GUTs predict that a system of particles heated to Grand Unification temperatures becomes a system of massless particles. As it cools, it will pass through special temperature points at which its system will experience phase transitions due to spontaneous symmetry breaking, and some of the particles in each of these transitions will acquire mass. In the original theory, fundamental particles are *massless*. Their masses appear as a result of interaction with the space-filling homogeneous *Higgs field*. This field, which provides the fundamental particles with mass, is the same in all spaces. The mass of a particle is determined by the intensity of its interaction with the Higgs field in such a way that the mass of particles at certain high temperatures is nullified.

The purpose of this work is to estimate the temperatures, as well as the velocities of bodies at which their mass is lost.

Former research

In [5], the fact of the existence of a critical velocity of bodies, at which a transition to a massless state occurs, is proved on the basis of E.L. Feinberg's ideas about relativistic changes in the length scales in the direction of motion of the body, time, mass and acceleration of a moving body as a result of the action of some forces [6].

The composition of the force acting on the body, which is spent on changing the parameters of the movement of a physical object in the direction of this force, can be written as the sum of the corresponding forces:

$$F = F_v + F_m + F_l + F_\tau, \qquad (1)$$

Where F_v, F_m, F_l, F_τ - the cost of force F to change the speed

v, mass m, length l and the rate of time τ of the object. After substituting the appropriate formulas for the cost of force to change the parameters of the body's motion and carrying out simple transformations [5], the dependence on the body's acceleration a_v on its speed at the current moment of time (c is the speed of light) is obtained: the cost of force F to change the speed v, mass m, length l and time rate τ of the object. This addiction has the form:

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

From formula (2) and Table 1 it can be seen that the acceleration of the body will decrease with increasing body speed, and at some critical speed, $v = w$ will be equal to zero. To find w, we solve the equation

$$\sqrt{1-v^2/c^2} - v^2/c^2 = 0 \quad (3)$$

Where

$$v = \omega = c\sqrt{\frac{\sqrt{5}-1}{2}} \approx 0.7862c = 235696.8871\ km/c$$

When squaring equality (4)

$$v^2 = \omega^2 = \frac{\sqrt{5}-1}{2}c^2 \approx 0.6180c^2 = \frac{1}{\Phi}c^2 \quad (5)$$

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 literary sources, the reciprocal value of $\Phi = 1.618034$ is taken as the value of the golden section [7].

When the speed of the object is greater than the critical one, the acceleration of 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 by S.I. Syrovatsky [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, an abrupt phase transition occurs, as a result of which the body mass becomes negative, the body acceleration is positive, and the body continues moving in the same direction (Table 1).

In this table, m_0 is the rest mass of the particle, and

$$m_v = \frac{m_0}{\sqrt{1-v^2/c^2}} \quad (6)$$

– is the mass of a particle moving with speed v; m_r and a_r – mass and acceleration of the body, changed in accordance with the principle of reinterpretation.

In [9-11], the possible properties, application [12], and mechanics of the interaction of particles with a negative mass between themselves and particles with positive mass are considered [13-16], and it is also shown that no fundamental physical laws contradict the existence of substances with negative mass. Reference [17] gives a general overview of the literature on negative masses.

Kinetic theory for determining the critical speed

If the research system is a set of particles in free motion and experiencing their collisions with each other, then it can be considered as a gas consisting of these particles for which the average kinetic energy of the translational motion of particles is written as

$$w = \frac{\overline{mv^2}}{2} = \frac{3}{2}kT, \quad (7)$$

where k = 1,3807.10−16 erg/K is the Boltzmann's constant, and T is the absolute temperature K. As shown in [18], the Maxwell and Boltzmann functional equations have not one, but two solutions: one solution corresponds to the Maxwell distribution, and the other corresponds to the uniform velocity distribution. In a real gas in an isolated system, due to dissipation of the first kind, associated with a change in the angular momentum of molecules during a collision, evolution goes towards a universal distribution in velocities and angular momentum, and due to dissipation of the second kind (overcoming the resistance of the medium), it leads to equalization of the velocities of gas molecules and reducing these speeds to zero values, i.e. to gas degradation. The uniform velocity distribution is thus one of the states of a gas, which can also be characterized by the corresponding temperature. Specifically, for the critical velocity ω, equality (7), taking into account (6), can be written

$$\frac{m_0\omega^2}{\sqrt{1-\omega^2/c^2}} = 3kT \quad (8)$$

Noticing that

$$\sqrt{1-\omega^2/c^2} = \frac{1}{\Phi} \quad (9)$$

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

v	m_v	m_r	$a_v(2)$	a_r
0	m_0	m_0	a_0	a_0
0.5c	1.155m_0	1.155m_0	0,616a_0	0,616a_0
0.75c	1.512m_0	1.512m_0	0,099a_0	0,099 a_0
$\omega = \sqrt{\frac{\sqrt{5}-1}{2}}c$	Φm_0	$\pm\Phi m_0$	0	0
0.8c	1.666m_0	-1.666m_0	-0.040a_0	0.040a_0
0.9c	2.294m_0	–2.294m_0	– 0.374a_0	0.374a_0
$\sqrt{2\left(\sqrt{2}-1\right)}c = 0,912c$	2.385m_0	-2.385 m_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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find

$$m_0 = \frac{3kT}{\omega^2 \Phi} \qquad (10)$$

$$T = \frac{m_0 \omega^2 \Phi}{3k} \qquad (11)$$

$$\omega = \sqrt{\frac{3kT}{m_0 \Phi}} \qquad (12)$$

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 body mass is equal to zero, which means that formula (10) makes it possible to find the rest mass of a particle if the temperature at which the particle, in accordance with the Higgs theory [19-21], loses mass is known, and formula (11) makes it possible to determine the corresponding transition temperature to the massless state if the mass of the particle is known. Accordingly, formula (12) makes it possible to find the critical velocity itself, if the mass of the particle and the temperature of its transition to the massless state are known.

Results

At $T \approx 10^{28}$K, the Grand Unification of fundamental interactions ends, the strong interaction is separated from the electroweak one, and the carriers of the Grand Unification X- and Y-bosons acquire masses $\approx 10^{15}$-10^{16} GeV/c^2 (according to other data $\approx 10^{14}$ GeV/c^2). Choosing the average of these values equal to 10^{15} GeV/c^2 by formula (12), we find the value of the critical velocity equal to ~232453 *km/s*, which is close enough to the exact value of the critical velocity. The mass of these bosons calculated by the formula (10) turned out to be $1.781.10^{-9}$*g*.

The carriers of the Superunification forces of all four fundamental interactions, including gravity, are Planck particles with a mass of $1.222.10^{19}$ GeV/c^2 and the temperature of their transition to the massless state is approximately considered equal to 10^{31}-10^{32}*K*. Choosing the average temperature equal to 5.10^{31}*K* according to formula (12) for the critical velocity, we obtain ~242419 *km/s*. The resulting value is less satisfactory, but this is due to the fact that the temperature of the Superunification taken for the calculation is also not accurate enough. What is important is the revealed fact of the existence of a critical velocity. Substituting in formula (11) the exact value of the critical velocity 235696.8871 *km/s*, we get that the Planck particles should become massless at a temperature of $4.723.10^{31}$K.

Table. 2 shows the values of the rest mass m_0 and the temperature of transition to the massless state *T* for a number of elementary particles calculated by formulas (10,11).

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

Particle name	$m_0 g$	$m_0 c^2$	*TK*
Particle conditionally minimum mass	$1.375.10^{-34}$	0.078 эВ	300
Electronic neutrino	$3.56.10^{-32}$	<2 эВ	77185
Muon neutrino	$<3.38.10^{-28}$	<0.19МэВ	7328246
Electron	$9.109.10^{-28}$	0.511 МэВ	197396000
τ - neutrino	$<3.24.10^{-26}$	< 18.2 МэВ	$7.02.10^{10}$
Muon	$1.8807.10^{-25}$	105.66 МэВ	$4.08.10^{11}$
Proton	$1.6726.10^{-24}$	938.272 МэВ	$3.62.10^{12}$
τ-lepton	$3.163.10^{-24}$	1.777 ГэВ	$6.86.10^{12}$
W^+, W^- bosons	$1.4278.10^{-22}$	80,15 ГэВ	$3.09.10^{14}$
Z^0 - boson	$1.632.10^{-22}$	91.188 ГэВ	$3.51.10^{14}$
Higgs boson	$2.228.10^{-22}$	125.18 ГэВ	$4.84.10^{14}$
X, Y – boson	$1.781.10^{-9}$	$\approx 10^{15}$ГэВ	$\approx 10^{28}$
Planck particle	$2.1767.10^{-5}$	$1.222.10^{19}$ ГэВ	$4.726.10^{31}$

The discussion of the results

From the data in Table 1 shows 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*, the internal structure of the body is rearranged, and the body mass becomes negative. With a further increase in the speed of the body, 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, on other reasons, can be both positive, as well as negative.

Let's consider 3 scenarios for the development of events that may occur after the body reaches a critical speed.

Variant of appearance of substance with negative mass

In accordance with [13], particles of a substance with a negative mass, depending on the choice for the analysis of the principle of equivalence of inertial and gravitational masses, either, repel each other and particles with a positive mass, scatter in the universe, or, conversely, being attracted to each other, unite in huge colonies and move away from ordinary matter with a positive mass. In both cases, they become an integral part of dark matter.

In the mass generation model, S.N. Golubev [22] defines a quasicrystal as a non-periodic structure of virtual particles that fill space, which determines the structure of a vacuum. Real particles are a complex consisting of a central particle, called a *cern*, and its surrounding shell, consisting of virtual particles with the corresponding structure, which form the mass of elementary particles and the masses of atomic nuclei. The mass of particles is generated by the number of pairwise interactions that occur between the virtual particles of the complex that make up the particle. Thus, the essence of mass, its carrier, is not virtual particles, but pair interactions between them! Such pairwise interactions are very similar in meaning to strings. S.N. Golubev found an algorithm that allows a

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simple calculation of the number *n* (*n*+1)/2 of combinatorially possible pair interactions in a system of (*n*+1)) particles with high accuracy to calculate the masses of chemical elements and elementary particles. It turned out that the masses of vector boson cores have a negative mass. This gives grounds to assume that the cores located in the center of elementary particles can contain a substance with a negative mass and represent dark matter.

The spacecraft in this variant, after the transition to a massless state and gaining a negative mass, will begin to accelerate. When the speed of light is reached, the magnitude of its acceleration becomes the same as it was at the beginning of the movement. Formally, it could move faster than the speed of light if its mass could be imaginary.

Variant of the impossibility of the appearance of bodies with negative mass

If the principle of reinterpretation is not applicable in this case, then the mass of the body with increasing speed would increase indefinitely, and the acceleration of the body after reaching the critical speed would become negative. This would mean that the body would first stop and then, under the action of the same external force, would move in the opposite direction, and with acceleration. After the body reaches the speed of light, its speed of movement (in the opposite direction) could become greater than the speed of light if the body could exist in a state with an imaginary mass.

The variant of the emergence of bodies with zero rest mass

Despite the fact that the phase transition of bodies to a state with a negative mass seems to us the most convincing variant of the development of events when the body reaches a critical speed, in reality, it may turn out that a substance with a negative mass still does not exist, and instead of it a body, even with an increase in velocity above the critical one will continue to remain in a massless state and have, accordingly, zero mass. In this version, it immediately follows from Newton's second law that acceleration of the body, depending on the characteristics of a particular situation, the acceleration of the body can be as large as desired. If this body is a spaceship, then, having reached the critical speed, and acting on the ship with only an insignificant external force, the speed of the ship can almost instantly, sharply increase and quickly reach the speed of light. But what is most important in this phenomenon is that the relativistic increase in the mass of the ship to infinity cannot prevent the increase in the speed of the ship to the speed of light, since the rest mass of the ship, due to the fact that the ship is in a massless state, is equal to zero. This option relatively easily allows you to move the ship at the speed of light.

Conclusion

Based on the kinetic theory of gases, the transition temperatures of bodies to a massless state are estimated. It is shown that the transition of bodies to a massless state occurs when someone reaches the same critical speed of 235696.8871 km/s, which is a new world constant.

For the first time, the masses of X, Y - bosons and the transition temperatures of elementary particles to the massless state have been calculated.

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