Correct Physical Interpretation of Einstein's Special Relativity Theory

Mamaev A.V., candidate of engineering sciences, associated professor

Independent Scientific Researcher, Moscow, Russia

Abstract: An alternative interpretation of Special Relativity Theory is offered, according to which light clocks of identical design (with aboslutely identical distance between parallel mirrors of light clocks), moving each with respect the other uniformly and rectilinearly, may be synchronised each with other because they have equal time measurement units and do not retard each from other, retardation of a moving clock with respect a stationary one is absent and superlight speeds of motion are not forbidden.

Key words: special relativity theory, light clock, time measurement unit, theory interpretation.

1. Galiley's Principle of Relativity

It is well known that when we study physics, we must use Newtonian or inertial reference frames (IRF), that is coordinate systems, which do not rotate, and are either fixed in three-dimensional space or move in a straight line at constant velocity (with zero acceleration) and comprise in addition some quantity of clocks synchronized each with others.

In physics all clocks, that are at rest in some IRF, are called as "synchronized clocks", if all these clocks at any moment of time of that IRF have identical readings. For clocks synchronization in any IRF a procedure is used offered by Einstein in the 1905 article [1].

It is also well known, that in the 1905 article [1] Einstein used two postulates:

1. A relativity principle: "The laws, by which the states of physical systems undergo change, are not affected, whether these changes of state be referred to the one or the other of two systems of co-ordinates in uniform translatory motion".

2. A postulate of light speed independence on the speed of a light source motion: "Any ray of light moves in the "stationary" system of co-ordinates with the determined velocity $\boldsymbol{c_0}$, whether the ray be emitted by a stationary or by a moving body".

In his 1922 article [2] Einstein declared:

"The purpose of theoretical physics consists in creating the system of concepts based on possibly smallest number of logically independent hypotheses, which would allow establishing causal interrelation of all complex of physical processes".

This statement is one of possible versions of Occam's methodological recommendation to any scientific researcher known as Occam's sickle (razor). But in the article [1] the number of postulates is not equal to minimal quantity. In order to decrease a quantity of independent postulates used for defining the purpose of theoretical physics it is possible to apply a formulation of Galiley's relativity postulate "The state of uniform translational motion is completely equivalent to the state of resting" and to refuse from Einstein's second principle, having used instead of it some consequence from the Galiley's relativity principle. Such consequence from Galiley's relativity principle, that can be used instead of Einstein's second postulate, is the following statement: "Time measurement units of two identical light clocks, moving each with respect the other uniformly and rectilinearly, are absolutely accurately equal to each other". This statement is true because for two light clocks of identical design, moving uniformly and rectilinearly each with respect the other, each of these clocks can be considered with equal foundation as being at rest, and the other – as moving uniformly and translationally. And namely under such condition the state of uniform and translational motion can be considered as completely equivalent to the state of resting.

2. Proof of a very important theorem

Now let us prove such a theorem: "If the speed c_u of light propagation in a moving inertial reference frame (IRF) depends on light source speed motion $\boldsymbol{u}$ according to an equation (2.1)

$$c_u = c_0\sqrt{1+u^2/c_0^2} = c_0\gamma \text{, (2.1)}$$

where c_0=299 792 458 m/s is the speed of light propagation in a stationary IRF, and if the length L of a moving body depends upon the speed $\boldsymbol{u}$ of the body motion according to the equation (2.2)

$$L = L_0/\gamma = L_0/\sqrt{1+u^2/c_0^2} \text{, (2.2)}$$

then the unit of time measurement by a light clock, moving at the constant speed $\boldsymbol{u}$ along a line perpendicular to planes of this light clock mirrors with distance equal to L_0 between the mirrors in the rest condition, is equal to the unit of time measurement by an immovable light clock and is determined by the equation (2.3)

$$T_0 = \frac{2L_0}{c_0} \text{". (2.3)}$$

For the light clock moving in such a manner the time measurement unit must according to modern mathematics be calculated according to the equation (2.4)

$$T = \frac{L}{c_u - u} + \frac{L}{c_u + u} \text{. (2.4)}$$

Indeed, let us consider a light clock consisting of two parallel plane mirrors 1 and 2 fastened each with another by means of four rods of equal length L_0, as it is shown in fig. 1. In this figure a straight line OX is perpendicular to planes of both mirrors 1 and 2. Let the vector ***u*** of light clock motion velocity be parallel to the line OX.

The first term in the right part of the equation (2.4) is the time interval, during which the light pulse moving at the speed c_u in a moving at speed ***u*** IRF from a moment of light pulse reflection from mirror 1 till a moment when light pulse will reach the light clock mirror 2, which tries to run away from the light pulse, as it is shown in fig.1 below. The second term in the right part of the equation (2.4) is the time interval, during which the light pulse moves from the moment of its reflection by the mirror 2 to the next reflection of light pulse from the mirror 1. The sum of these two terms from the right part of the equation (2.4) constitutes the time measurement unit T of the moving light clock from the left part of the equation (2.4)

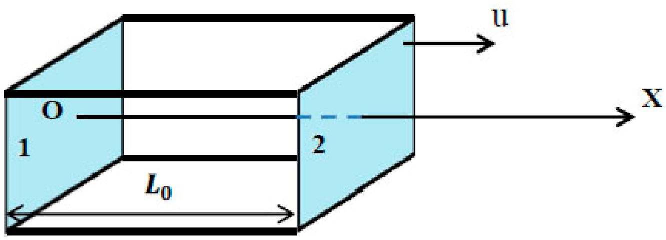

Fig. 1. Light clock consisting of two plane mirrors 1 and 2 (L_0 ***is the distance between two plane mirrors of the stationary light clock, OX is a line perpendicular to planes of both mirrors, u is the velocity vector of light clock motion parallel to the line OX).***

Then, substituting equations (2.1) and (2.2) into the equation (2.4) we obtain consequently the following results (after each equality sign)

$$T = \frac{L}{c_u - u} + \frac{L}{c_u + u} = \frac{L_0}{\gamma} \frac{c_u + u + c_u - u}{c_u^2 - u^2} = \frac{2L_0}{c_0} = T_0 . \quad (2.5)$$

Thus, as in the most left part of the equation (2.5) we see time measurement unit of the moving light clock and in the most right part of the equation (2.5) we see time measurement unit of the stationary light clock of the same design, the above theorem is proven.

3. Dependence of light speed on the speed of light source

At that we must confirm that in the equation (2.5) we made replacement under the equation (3.1)

$$c_u^2 - u^2 = c_0^2 , \quad (3.1)$$

because in accordance with the equation (3.1) the equation (3.2) must be true

$$c_u^2 = c_0^2 + u^2 . \quad (3.2)$$

It is evident that equation (3.2) is obtained from equation (3.1) by adding the value ($+u^2$) to the both parts of the equation (3.1).

In the equation (2.5) we also used the equation (3.3)

$$c_u = c_0\gamma \,, \tag{3.3}$$

which is obtained by excluding the middle component $c_0\sqrt{1+u^2/c_0^2}$ from the equation (2.1).

Now we must show, how we derived the equations (2.1) and (2.2).

How can we practically perform measurement of the "light speed in vacuum of a moving IRF" defined by the equation (2.1)? We can perform such measurement in accordance with figure 2.

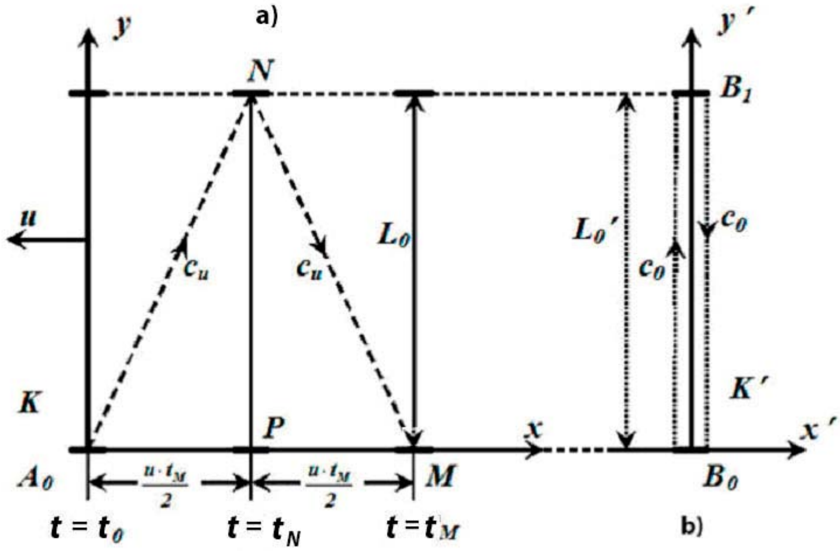

Fig. 2. Propagation of light in a light clock in two IRFs moving each with respect the other at the speed u.

a) propagation of light in the unprimed IRF from a source being at rest in the primed IRF K' from a point of view of an observer resting in the unprimed IRF K, light propagates in the «moving" IRF K along straight lines A_0N, NM at the light speed $\mathbf{c_u}$*;*

b) propagation of light in a «stationary» IRF K′ from a point of view of an observer resting in the «stationary» IRF K′, light propagates in the "stationary" IRF K′ at the light speed c_0 = 299 792 458 *m/s along axis* y'.

Let us consider two IRF K′ (x′, y′) and K (x, y) moving each with respect to another one at the velocity $\boldsymbol{u}$ (see fig. 2). In all points of the unprimed IRF K named with letters (points A_0, N, M) there are technological timers that are synchronized (show the same time at any time moment of the IRF K). The primed IRF K′ in figure 2 is a stationary IRF. That means that an arbitrary light clock with stationary mirrors in points B_0 and B_1 of the primed IRF K′ is at rest in this primed IRF K′ and the moving unprimed IRF K is moving in a direction, that is parallel to planes of mirrors B_0 and B_1.

Let at a time moment, when the **y** axis of the unprimed IRF K moving at a constant speed **u** in negative direction of the axis x' of the primed IRF K′ and points B_0 and A_0 of the both unprimed IRF K and primed IRF K′ coinside each with other, a source in point B_0 radiates simultaneously two light pulses in two directions. One pulse is sent into the direction of the mirror B_1 (that pulse will move along the streight line A_0N) and the second pulse is sent from point B_0 along a perpendicular to the plane $x'y'$ of the primed IRF K′ to point A_0, where this pulse stops a technological timer resting in point A_0 of the unprimed IRF K, that timer was earlier syncronised with timers in points N and M of the moving unprimed IRF.

When the light pulse radiated in the point B_0 arrives to the point B_1**,** a light source in the point B_1 radiates a light pulse that puts a spot mark in a point N and stops a timer (that timer was earlier synchronised with timers in points A_0, N and M of the unprimed IRF K) in point N of the IRF K**.** Simultaneously a pulse arrived from the point B_0 is reflected by the mirror in the point B_1 and moves back to the point B_0**.**

When the pulse reflected from the point B_1 arrives back to the point B_0 a light source in the point B_0 puts a spot mark in the point *M* of the IRF *K* and stops a timer situated in the point *M* (at a time moment t_M). The timer in point M was earlier also synchronised with timers in points A_0 and N.

Then an observer being at rest in the “moving” IRF *K* measures the optical length of light ray path $S = A_0N + NM$ in the moving IRF *K* and makes read out of the indications t_N and t_M of the timers being at rest in the points *N* and *M* of the IRF *K* and which were stopped by the light pulse at a moment, when the light pulse emitted from point A_0 arrived to point N and when the light pulse reflected from point B_1 returns back to the point B_0 after reflection from the mirror in the point B_1. Then the “light speed in vacuum of the moving IRF” may be calculated using the equation (3.4)

$$c_u = \frac{S}{t_M - t_0}. \quad (3.4)$$

So the value “light speed in vacuum of the moving IRF” calculated by means of the equation (3.4) can be rather simply measured and calculated according to equation (3.4) in the experiment, if the light in figure 2 propagates in vacuum.

By the way, as the time moment t_M of the light pulse arriving to the point *M* of the IRF *K* coincides with a time moment of the light pulse returning back to the point B_0 in the IRF *K′***,** and the optical length of light pulse path $S = A_0N + NM$ in the IRF *K* is greater than optical length of the light pulse path $S' = 2L_0$ in the stationary IRF K', the value of “light speed in a moving IRF” c_u exceeds the value of “light speed in the stationary IRF” c_0 determined by equation (3.5)

$$c_0 = \frac{S'}{t_M - t_0}, (3.5)$$

that means that $c_u > c_0$. Thus, during the time travel of the light pulse from the point B_0 to the point B_1 and back from the point B_1 to the point B_0 at the speed c_0 in the stationary IRF K' the same light pulse performs in the moving IRF K a travel from the point A_0 through the point N to the point M at the greater speed c_u. So, considering a rectangular triangle A_0NP in the fig. 2, we have an equation (3.6)

$$c_u^2 = c_0^2 + u^2, (3.6)$$

or an equation (3.7)

$$c_u = \sqrt{c_0^2 + u^2}, (3.7)$$

or removing a factor c_0 from the radical sign according to the equation (3.8)

$$c_u = c_0\sqrt{1 + u^2/c_0^2}. (3.8)$$

Thus, having introduced the concept “light speed in a moving IRF” by equation (2.1) we have shown above how this “light speed in the moving IRF” K can be measured experimentally using fig. 2.

4. Derivation of new transformation instead of Lorentz transformation

Now we must derive instead of Lorentz transformation a new transformation of space-time coordinates basing upon the only Galiley’s relativity principle using Logunov’s method [4].

Let the primed inertial reference frame (IRF) X', Y', Z', T' be an IRF moving at a constant speed V in a direction of positive values of the X coordinate of the unprimed IRF X, Y, Z, T.

Let all the clocks being at rest in the primed IRF be synchronized each with other using Einstein’s method by means of light sources being at rest in the same primed IRF and all clocks being at rest in the unprimed IRF be synchronized each with other using Einstein’s method by means of light sources being at rest in the same unprimed IRF.

Let the IRF *B* with primed coordinates (X', Y', Z', T') be a stationary IRF and the IRF *A* with unprimed coordinates (X, Y, Z, T) be an IRF moving at the speed V in negative direction of the axis X' of the stationary unprimed IRF *B*.

Then the expression for square of interval in the primed Cartesian coordinates of IRF *B* will be determined by an expression (4.1)

$$dS^2 = c_0^2(dT')^2 - d(X')^2 - d(Y')^2 - d(Z'). (4.1)$$

Let us perform over equation (4.1) the Galilean transformation comprising equations (4.2)

$$t = T', \quad x = X' + VT', \quad y = Y', \quad z = Z'. \ (4.2)$$

For that purpose let us write a transformation inverse to transformation (4.2) that comprises equations (4.3)

$$T' = t, \quad X' = x - Vt, \quad Y' = y, \quad Z' = z. \ (4.3)$$

Having taken differentials from the both parts of equations (4.3) and having substituted this differentials into the expression (4.1), we shall have the equation (4.4)

$$dS^2 = c_0^2 \left(1 - \frac{V^2}{c_0^2}\right) dt^2 + 2Vdxdt - dx^2 - dy^2 - dz^2. \ (4.4)$$

In order to dispose in the right part of the equation (4.4) from a cross term 2Vdxdt, let us separate a perfect square in it. In the result of this operation the interval (4.4) acquires the form of equation (4.5)

$$dS^2 = \frac{c_0^2}{1 - \frac{V^2}{c_0^2}} \left[\left(1 - \frac{V^2}{c_0^2}\right) dt + \frac{V}{c_0^2} dx \right]^2 - \frac{dx^2}{1 - \frac{V^2}{c_0^2}} - dy^2 - dz^2. \ (4.5)$$

Now let us introduce a new speed determined by the equation (4.6)

$$u = \frac{V}{\sqrt{1 - \frac{V^2}{c_0^2}}}, \ (4.6)$$

as well as new time and space coordinates determined by equations (4.7)

$$T = t\left(1 - \frac{V^2}{c_0^2}\right) + \frac{V\,x}{c_0^2}, \quad X = \frac{x}{\sqrt{1 - \frac{V^2}{c_0^2}}}, \quad Y = y, \quad Z = z. \ (4.7)$$

Then the interval (4.5) for these variables will have the form of equation (4.8)

$$dS^2 = \frac{c_o^2}{1 - \frac{V^2}{c_0^2}} dT^2 - dX^2 - dY^2 - dZ^2. \ (4.8)$$

In order to have invariant expression for the interval the equation (4.8) should have the form of equation (4.9)

$$dS^2 = c_u^2\, dT^2 - dX^2 - dY^2 - dZ^2, \ (4.9)$$

where c_u is some new speed of light determined in accordance with the formula (4.10)

$$c_u = \frac{c_0}{\sqrt{1 - \beta^2}} = c_0 \gamma. \ (4.10)$$

Thus, having applied consequently transformation (4.2) and transformations (4.5) – (4.7) we passed from the interval (4.1) in the primed IRF to the interval (4.9) in the unprimed IRF. That means that after substitution of the transformation (4.2) into the transformation (4.7) we shall obtain the following transformation (4.11) of coordinates and time from one IRF to another IRF

$$T = T'\left(1-\frac{V^2}{c_0^2}\right)+\frac{V}{c_0^2}(X'+VT'),\quad X=\frac{X'+VT'}{\sqrt{1-\frac{V^2}{c_0^2}}},\quad Y=Y',\quad Z=Z'. \quad (4.11)$$

Now let us change groups in the right parts of first two expressions in (4.11) to the form of equation (4.12)

$$T = T'+\frac{VX'}{c_0^2},\quad X=\frac{X'+(V/c_0)c_0T'}{\sqrt{1-\frac{V^2}{c_0^2}}},\quad Y=Y',\quad Z=Z'. \quad (4.12)$$

And now let us multiply left and right parts of the first equation in (4.12) by a multiplier γc_0. We obtain the transformation (4.13)

$$\gamma c_0 T = \gamma c_0\left(T'+\frac{VX'}{c_0^2}\right),\quad X=\gamma\left(X'+\frac{V}{c_0}c_0T'\right),\quad Y=Y',\quad Z=Z'. \quad (4.13)$$

And now let us bring the constant $\boldsymbol{c_0}$ inside the brackets in the right part of the first equation in transformation (4.13). We obtain the transformation (4.14)

$$\gamma c_0 T = \gamma\left(c_0T'+\frac{VX'}{c_0}\right),\quad X=\gamma\left(X'+\frac{V}{c_0}c_0T'\right),\quad Y=Y',\quad Z=Z'. \quad (4.14)$$

Now let us introduce in transformation (4.14) the following designations

$$c_u = c_0\gamma\,, \quad (4.15)$$

$$\beta = \frac{V}{c_0}. \quad (4.16)$$

Then the transformation (4.14) will take the form of transformation (4.17)

$$c_uT = \gamma(c_0T'+\beta X'),\quad X=\gamma\left(X'+\beta c_0T'\right),\quad Y=Y',\quad Z=Z'. \quad (4.17)$$

Having substituted in transformation (4.17) the large Latin letters with small letters, the transformation (4.17) may be written in the form of transformation (4.18)

$$c_ut = \gamma(c_0t'+\beta x'),\quad x=\gamma\left(x'+\beta c_0t'\right),\quad y=y',\quad z=z'. \quad (4.18)$$

Having resolved transformation (4.18) with respect the primed space-time coordinates, we obtain the transformation (4.19)

$$c_0t' = \gamma(c_ut-\beta x),\quad x'=\gamma(x-\beta c_ut),\quad y'=y,\quad z'=z. \quad (4.19)$$

The formulas (4.18) and (4.19) are direct and inverse transformations of space-time coordinates of the new relativistic space-time theory.

From transformations (4.18) and (4.19) of coordinates of the new space-time theory it is seen that whatever large the speed u of IRF movement should be, the speed $c_u = \sqrt{c_0^2 + u^2}$ of light in vacuum of a moving IRF will be greater and no imaginary numbers in the new theory does not appear. Consequently, the prohibition on existence of superlight speeds, existing in the SRT, in the new space-time theory does not exist.

As a consequence of the second formula from the transformation (4.19) the transformation of length in the new space-time theory has the form of equation (4.20)

$$x'_2 - x'_1 = \gamma\left[(x_2 - x_1) - u(t_2 - t_1)\right]. \quad (4.20)$$

In order to obtain the length of a moving body in the unprimed IRF, we should mark two coordinates at the same moment of time $t_2 = t_1$. In the result we shall have the formula (4.21) for transformation of length

$$x'_2 - x'_1 = \gamma(x_2 - x_1). \quad (4.21)$$

In case if $L_0 = x'_2 - x'_1$ and $L = x_2 - x_1$ from the formula (4.21) we shall have the formula (4.22)

$$L = L_0 / \gamma = L_0 / \sqrt{1 + u^2 / c_0^2}. \quad (4.22)$$

Thus, the formula (2.2) coincides with the formula (4.22) and really it is a consequence from the space-time transformation (4.19) of the new theory.

As a consequence of the first formula in (4.19) transformation of a time interval in the new space-time theory has the form of equation (4.23):

$$c_0(t_2' - t_1') = \frac{c_u(t_2 - t_1) - \beta(x_2 - x_1)}{\sqrt{1 - \beta^2}}. \quad (4.23)$$

As we consider here inertial reference frames, then their relative speed u of motion is a constant value and for motion only along axis x the following formula (4.24) is valid

$$(x_2 - x_1) = u\,(t_2 - t_1). \quad (4.24)$$

Then substituting equation (4.24) into the right part of equation (4.23), we obtain the equation (4.25)

$$c_0(t_2' - t_1') = \frac{[c_u(t_2 - t_1) - \beta\, u\,(t_2 - t_1)]}{\sqrt{1 - \beta^2}}. \quad (4.25)$$

Bringing in the right part of the equation (4.25) the multiplier $c_u(t_2 - t_1)$ behind the square bracket, we have the equation (4.26)

$$c_0\left(t_2' - t_1'\right) = c_u\left(t_2 - t_1\right)\frac{[1-\beta^2]}{\sqrt{1-\beta^2}}. \quad (4.26)$$

Performing in the right part of equation (4.26) reduction by $\sqrt{1-\beta^2}$, we have the equation (4.27)

$$c_0(t_2' - t_1') = c_u\sqrt{1-\beta^2}(t_2 - t_1). \quad (4.27)$$

Because of equation (4.10) validity, the equation (4.27) acquires the form of equation (4.28)

$$t_2' - t_1' = t_2 - t_1. \quad (4.28)$$

Consequently, whatever large the speed of movement u of one IRF with respect the other IRF will be, in the new theory not in the single IRF the consequence can not happen earlier than the cause. Because the time coordinate with index 1 is the coordinate of the event, which is the cause in the both IRF, and the time coordinate with the index 2 is the coordinate of the consequence in the both IRF. Namely because of this the causality principle in the new theory does not contradict the existence of superlight speeds.

5. Conclusions

1. Thus, it is possible to create a relativistic space-time theory (RSTT) based upon only one relativity principle in Galiley's formulation "The state of uniform translational motion is completely equivalent to the state of resting". In this RSTT a concept "light speed in a moving inertial reference frame" may be introduced, which is equal to the light speed in a stationary IRF from a moving source and is determined according to the equation $c_u = c_0\sqrt{1+u^2/c_0^2}$ (2.1), where ***u*** is the physically measured speed of a source (or IRF) motion determined according to the equation $u = \dfrac{V}{\sqrt{1-V^2/c_0^2}}$, where V is the speed of motion from Lorentzian transformation of Einstein's special relativity theory (SRT).

2. In this RSTT the length of a moving body in a direction of its motion is determined under the equation $L = L_0/\sqrt{1+u^2/c_0^2}$ (2.2), where L_0 is the proper length of a body, .

3. In this RSTT the time measurement unit (TMU) of a light (and any other) clock moving at the speed ***u*** is equal to the time measurement unit of the clock of the same design being at rest and is equal to the value $T = \dfrac{2L_0}{c_0}$ (2.5).

4. In this RSTT the known Lorentz transformation from Einstein's SRT is replaced with the new one having the form $c_0 t' = \gamma(c_u t - \beta x)$, $x' = \gamma(x - \beta c_u t)$, $y' = y$, $z' = z$, where c_u is determined by equation (1.2), $\beta = u / c_u$, $\gamma = \sqrt{1 + u^2 / c_0^2}$.

5. New transformation of the RSTT does not forbid superlight speeds of particle motion, which are not also forbidden by the known causality principle (see equation (4.28).

6. All other consequences from new transformation of the new RSTT are discussed in papers [4], [5], [6], [7] and [8].

References

1. Einstein A., On Electrodynamics of Moving Bodies, June 30, 1905, [url]http://www.fourmilab.ch/etexts/einstein/specrel/www/[/url].
2. Einstein A. About Modern Crisis in Theoretical Physics. Collection of papers, v. 4. – Moscow, Nauka, 1967. p. 55, in Russian.
3. Logunov A.A. Lectures on theory of relativity and gravitation. Modern analysis of the problem. Moscow, Nauka, 1987, p. 33 – 35. In Russian
4. Mamaev A.V. Astronomical Phenomena Disprove Einstein's Special Relativity Theory, International Journal "The Way of Science", 2014, No.5, (5), p.p. (10-19).
5. Mamaev A.V., "New Relativistic Space-Time Theory", Transactions of International Congress–2016 "Fundamental problems of Natural Sciences " (Sanct-Petersburg, 25–30.07.2016), No. 37-2, pp. 91–122 , in Russian [url]http://scicom.ru/files/journal/v37/N2/12.pdf[/url]
6. Mamaev A. V., "Replacement of Einstein.s Relativity Theory with a New One: Why the Second Postulate is Superfluous?", International Journal of Physics, 4:5 (2016), 140–145 http://www.sciepub.com/ijp/content/4/5[/url].
7. Mamaev A.V., "Cutting-off Einstein's Special Relativity Theory by Occam's Sickle (How the mountain (Large Hadron Collider) has Brought Forth a Mouse)"/"Global Journal of Science Frontier Research - A: Physics and Space Science" vol. 16, issue No. 6, (2016): p.p. 55 - 67. URL: https://globaljournals.org/GJSFR_Volume16/E-Journal_GJSFR_(A)_Vol_16_Issue_6.pdf
8. Mamaev A.V., New Relativistic Space-Time Theory. Physics with dependence of charge value upon particle speed, without prohibition of superlight speeds and without time dilation, LAP Lambert Academic Publishing, Saarbrucken, Germany, 2013, 328 c. in Russian http://www.acmephysics.narod.ru/mamaev-nrtpv.pdf