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Illusion of space and the special theory of relativity

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We have reviewed the equation of the Special theory of relativity that describes lengths and spatial distances contractions for the moving body, from the point of view of a notion of a space as an illusion, that appeared in connection to the detachment of the majority of the relations between all the elements of the world that existed in the hot early Universe. We propose to review the distances contraction through the energy characteristics of the moving body.

We have shown that the dependency of the distances from the velocity and energy of material bodies movement, described by the relativity theory, is valid for the change of the distances between the galaxies at the expansion of the Universe in the modified cosmological model that considers the non-zero scale factor differential but not valid in the standard Big Bang model.

1. Introduction

Probably we take the physical notions that we use too literally. If we talk about space and time we treat them as something that really exist. And the questions we ask ourselves and then answer are coming from the same notions that we use. But if we have problems, and, undoubtedly, there are some in the physics [1],[2] – it may mean that we ask wrong questions based on the wrong notions.

That is why during many centuries the best minds of the humankind were struggling over questions "what is space?" and "what is time?". However, the analysis of the existing ideas about the nature of space and time [3] shows that such manner to ask a question can be not effective enough in physics and we should formulate the questions a different way. For example, "what do we mean when we use this notion?" and "can we obtain this notion from some other, more primary notions?". Such approach opens a possibility to review the familiar, classical notions not as basic ones but as derivatives, following from something else, more fundamental.

In the book [4], dedicated to the problems of the modern physics and the search for the fundamental basics of the notions of space and time, the opinion of some modern physicists of the notion of space is phrased the following way: *"We, including myself, believe that the space is an illusion and the real relations that form the world are the dynamic network (almost like Internet or a mobile network). We feel this illusion because the breaking of the majority of the possible connections separate everyone by great distances".*

The view of space as an illusion connected with the shutdown of the previously existing pair connections between all the elements of the material world as the hot universe cooled off allowed the author to describe the hypothetical history of the universe that led to the appearance of our three-dimensional space: *"At first it was very hot , and there was enough energy to turn on most of the connections. Consequently, the early universe was a world in which everything was connected with everything. As the Universe cooled down, the connections began to shut down, until only a few needed to form a three-dimensional lattice were left. Such is probably the way our space appeared".*

However, the history of the hot early Universe with a supposed multidimensional space stayed in a distant past. Today we live in a 3-dimensional world where the characteristics of the space are described by repeatedly verified equations of the special theory of relativity (STR). That is why we think it is timely to review not the hypothetical history of the hot Universe development but a possible relation of the described in [4] approach with this acting at the moment theory that relates the space and time characteristics with the travel speed of reference systems and material objects.

Relevance of this manner of posing a question is confirmed by the fact that it's namely STR that describes [5],[6] such not yet comprehended by us phenomenon as quantum non-locality the veracity of which is confirmed [7] by the results of many physical experiments.

2. Reality of the space and the special theory of relativity

If we admit that the space is a fiction, i.e. it does not exist as a real physical object, and everything that exists is the interacting material bodies, it becomes natural to reject the notion "reference systems" in the Lorentz's transformations. In this case we can think that they describe the transformation of spatial and time values not from the point of view of some reference system that moves at some velocity, but from the point of view of the body moving at the same velocity. I.e. leave the transformations of the values that do not exist in reality for the direct study of the characteristics of the material bodies interactions. Hoping that this transition would allow to ask some new questions.

Let us review the conclusions of STR from the point of view of a material object that possess some velocity in relation to the other material objects taken as a point of reference and, accordingly, some kinetic energy in relation to these objects.

The expressions of STR (Lorentz's transformations) contain the value depending on the velocity

$$(1 - v^2/c^2)^{1/2}; \qquad (1)$$

where v – velocity of the movement, c – light speed.

This value is also included into the expression for the total energy of the moving body Ɛ:

$$\mathcal{E} = mc^2/\,(1 - v^2/c^2)^{1/2}; \qquad (2)$$

Which allows to connect the STR expressions for the spatial and time characteristics of the objet with its energy characteristics. Transforming (2), we obtain

$$(1 - v^2/c^2)^{1/2} = mc^2/\,\mathcal{E}. \qquad (3)$$

This way the value $(1 - v^2/c^2)^{1/2\,t}$ that is included into the STR equation appears to be equal to the relation of the material body rest energy mc^2 to its total energy Ɛ, including the rest energy and the kinetic energy of the movement. Let us see how this value is related to the distance to the objective in own coordinates of the body that moves toward this objective with the velocity v.

In his original work about the relativity theory [9] Einstein describes the physical sense of the equations that he obtained for the moving bodies, the following way: *"solid body that has a form of a ball when resting, becomes an ellipsoid of rotation with semi-axes* $R\sqrt{(1\text{-}(v/V)^2)}$*, R, R, when moving, if you ob-*

serve it from the resting system". Here R is a ball radius, v – its movement velocity, V – light speed. *"At v=V all moving objects, observed from the "resting" system, deflate and become flat figures". ... "It is clear that the same results are obtained for the bodies, resting in the "resting" system, but viewed from the system that moves evenly."*

From here, for the body moving with the velocity v, the distance to objective which, from the point of view of the unmoving observer, is equal to D_0, will be equal to

$$D = D_0 mc^2/\varepsilon; \qquad (4)$$

i.e. will decrease by the factor, equal to the relation of the total body energy to its rest energy. At the zero movement velocity the total energy is equal to the rest energy, this relation transforms into 1 and the contraction of distance does not happen. At the velocity movement of the body going to the light speed, the distance to the objective goes to zero.

As the distance to the objective for the moving object decreases, time that it needs to get to the objective decreases as well. But for the observer, unmoving in relation to the objective, the distance from the object to the objective stays equal to D_0, and the time that the object needs to reach the objective corresponds to this distance. That is why he sees that on the moving object the time stretched – his watch slows down (and if he manages to move with the light speed – it stops at all).

If we take a photon as an object, the distance to any objective and the time that it will need to reach it are always strictly equal to zero. From where it follows [5],[6] the physical effects observed in the experiments, that we call "quantum non-locality".

So, according to STR expressions, the distance to the objective for the moving body depends on the velocity and energy of its movement. Which brings us to the nest question: could the distances between unmoving in relation to each other bodies also depend on some kinetic characteristics?

3. Issue of the distance between the unmoving bodies and the analogy with the movement of the galaxies

Dependency of the distance from the kinetic energy of the moving body described by the expression (4), follows from the dependency from the velocity of the movement (Lorentz's transformation for the spatial distances) [8]:

$$D = D_0(1 - v^2/c^2)^{1/2}. \qquad (5)$$

Let us compare the expression (5) with the dependency of the distance between two galaxies from the velocity of their movement in the process of expansion of the Universe.

At first let us review this dependency in the cosmological model based on the metrics which, as opposed to metrics of the standard Big Bang model, is built with consideration of the non-zero value of the scale factor differential in the expanding Universe [10],[11]. This model (let us call it "modified") describes the Universe closed at any matter density, infinite in time and at the current moment expanding in an accelerated manner.

The cross-section described by this model of the closed Universe (2-dimensional section of the 4-dimensional hypersphere) is shown on the Picture. The angular coordinate χ characterizes the location of the object on the hypersphere in relation to the observer. White spot shows the location of the observer ($\chi = 0$), black spots show the location of the reviewed galaxies.

In this model the radius of the hypersphere (scale factor) is related with the velocity of the expansion by the dependency ([11],(58)):

$$a' = da/cdt = (1-\alpha^2)^{1/2}; \qquad (6)$$

where α – relative value of the scale factor.

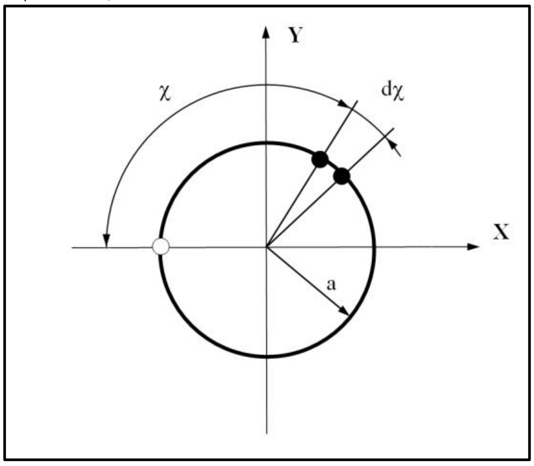
Transforming, we obtain

$$\alpha = (1 - (da/cdt)^2)^{1/2}; \qquad (7)$$

Let us study the distance between two stationary galaxies. Under stationary we understand the galaxies with the constant values of their coordinates on the hypersphere. On the 2-dimensional section shown on the Picture it is a value of the angle χ. Distance D between two stationary galaxies must be proportional to the hypersphere radius – scale factor (α) and constant difference of their angular coordinates on the hypersphere ($d\chi$).

$$D \sim d\chi\alpha = d\chi(1 - (da/cdt)^2)^{1/2}; \qquad (8)$$

At the moment of the maximal expansion of the Universe when $da/cdt = 0$, $\alpha = 1$.



Picture. **A schematic image of the location of the pair of galaxies on the 2-dimensional section of the 4-dimensional hypersphere with radius "a". White spot defines the location of the observer (χ=0).**

Defining the distance between these galaxies at the moment of the maximal expansion as D_0, and considering that da/dt is a velocity of movement of all the objects of the Universe in the 4th dimension (v_4), i.e. in the direction perpendicular to all three dimensions of the 3-dimensional space, we finally obtain the expression

$$D = D_0(1 - v_4^2/c^2)^{1/2}; \qquad (9)$$

different from the STR expression (5) only by the fact that instead of the body movement velocity in the 3-dimensional space there is a velocity of all material bodies – because of the Universe's expansion – moving in the 4th dimension in a direction perpendicular to the dimensions of the 3-dimensional space.

So, the modified model, that considers the non-zero value of the scale factor differential in the expanding Universe, describes the dependency of the spatial distances between the galaxies from the velocity of their movement in the process of the Universe expanding, corresponding to the dependency for the movement of any material body according to STR (5). Obviously, these dependencies will coincide in the energy expression (4), if under the kinetic energy we would understand the energy of the movement in the 4th dimension at the velocity of the expansion of the Universe $v_4 = da/dt$.

4. Checking the correspondence in the standard Big Bang model

Let us compare the obtained results with the expressions of the standard cosmological model of The Big Bang. Such comparison is possible for the option describing, just as the modified model, a closed Universe, i.e. a hypersphere of a finite size. For the option of the open Universe that has infinite size this comparison makes no sense.

The solution of Einstein's equations in The Big Bang theory metrics gives us to equation for the closed Universe ([11],(45)):

$$a'^2 - (8\pi G\varepsilon/3c^4)a^2 + 1 = 0; \quad (10)$$

where G – gravitational constant, a' = da/cdt, ε – average energy density.

Transforming, we obtain

$$2a_0/a = 1 + a'^2; \qquad (11)$$

where

$$a_0 = const. \qquad (12)$$

Introducing the relative value of the scale factor $\alpha = a/2a_0$, for the closed Universe in The Big Bang model we obtain an expression that relates the relative velocity of the hypersphere expansion to its radius:

$$\alpha = 1/(a'^2 + 1). \qquad (13)$$

Expressing the distance between the stationary objects through its value at the moment of the maximal expansion, we finally obtain

$$D = D_0/(v_4^2/c^2 + 1). \qquad (14)$$

The obtained expression shows that the dependency of the spatial distances between galaxies from the velocity of their movement in the process of the Universe expansion in The Big Bang model, as opposed to the reviewed above modified model, does not coincide with the dependency for the movement of the bodies according to STR. At the increase of the velocity of the expansion the distance between the objects does not decrease, according to the Lorentz's transformations, but, quite the opposite, increases.

5. Conclusion

From the point of view of the notion of space as an illusion, existing in the modern world due to the shut-down of the majority of the pair connections between all the elements of the world that existed in the hot Universe, we have reviewed the equation of the special theory of relativity that describes the contraction of the spatial distances for the moving material body.

For the moving body its distance from the objective of the movement depends on the velocity in accordance with the Lorentz's transformation for the spatial intervals. This dependency can be expressed not through the velocity of the body but through its energy characteristics. In this case the distance to the objective is proportional to the relation of its rest energy to the total energy, that includes the kinetic energy of the movement.

Dependency of the distances on the velocity and energy of the bodies movement according to STR exactly coincides with the dependency of the distance between the galaxies on the velocity and energy of their movement in the process of the expansion of the Universe in the modified cosmological model that considers the non-zero scale factor differential. This way, in the modified model the dependency of the distances on the bodies movements on a cosmological scale is described by the same STR law that describes the movement of any other material body.

Coincidence of these dependencies in the standard cosmological model of The Big Bang is lacking, which confirms the insufficiency of The Big Bang model for the adequate description of the expanding Universe.

This way, the thesis about treating the notion of the space as an illusion allows us to see the expressions of the special theory of relativity from the point of view of not the hypothetical coordinates but real material bodies, to compare these expressions with the cosmological models, describing the movement of the matter on the scale of the whole Universe, and to evaluate these models from the point of view of meeting the requirements of STR for the galaxies movement.

At that, the review of STR from the point of view of material bodies movement confirms the validity of the initial thesis about space as an illusion. All the elements of the material world are in relations with one another, which we call distances. The massif of these relations constitutes something we call space. Its fictitiousness (non-absoluteness) manifests in the fact that the distances between the elements of the material world are not absolute and depend not only on their location in relation to each other but also the velocity and energy of their movement.

In the classical absolute space, the body movement would lead to the change of the distances related only to this body, i.e. only distances from it to the other material objects. In the non-absolute (fictional) space the body movement change the distances between other bodies. When the body moves, the whole space contracts for it in the direction of the movement. At that all the distances between all the bodies in the Universe change due it. This is what STR shows us.

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