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TO THE QUESTION ON THE PHYSICAL SPACE-TIME

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Abstrakt

The initial axioms of Einstein's *Special Relativity Theory* (SRT) are analyzed. It is shown that wrong interpretation of initial principles in this theory deprives it of the status of the physical theory of space-time, i.e. that novel element that has been introduced by Einstein into the electrodynamics of Lorentz.

1. About kinematic and dynamic relativity principles [1]

Let's clarify concept ***"relativity principle"***. There are two relativity principles in classical mechanics - dynamic and kinematic. Both these principles - not by the title, but in essence - were known already for Newton. And it is possible to say with confidence, that nothing gave to him so much obstruction, as demarcation of absolute and relative, dynamic and kinematic concepts. And these obstructions were brilliantly overcome by Newton [2]. The negligence by theoretical physics of XX century of this genius philosophic-methodological and natural-scientific achievement of Newton has resulted in deepest aberrations.

Let in each of physical laboratories, which are moving each relative to the other translationally, uniformly and rectilinearly, identical experiments for ascertainment of law of some physical process are conducted. In this case we deal with the Galileo dynamical relativity principle, which is the statement of the following experimental fact: identical processes in different physical laboratories, which are moving each relative to the other translationally, uniformly and rectilinearly, proceed and are described in the same way.

Let in those laboratories some physical law for the same, common for all of them, process is ascertained. In this case we deal with the kinematic relativity principle of Copernicus, which is the statement of such experimental fact: the flow of some process does not depend on what from laboratories, driving relatively each other, it is considered, but this process will thus be esteemed and described in each of laboratories differently.

Distinctive feature of the kinematic relativity principle is the capability of transition from the description of some process in one of the reference system to its description in another system of reference with the aid of a formal-mathematical transformations of space-time coordinates. For example, in the classical mechanics of Newton such linear transformations are applied

$$\bar{r} = \bar{r}_{o'} + \bar{r}'; \qquad t = t' \qquad (1)$$

where $\bar{r}$ and $\bar{r}'$ are radius-vectors of the same point in the fixed and moving reference systems; t and t' - time in these reference systems; $\bar{r}_{o'}$ - radius-vector of the origin of the moving reference system relative to the fixed one. Just in connection with such transformations the concept of invariance and covariance of equations of motion was introduced.

If the equations of motion at some transformations of systems of reference retain their appearance, but does not retain the expressions for functions, constituent to them, it is said, that these equations of motion are *covariant* relative to the given transformations. If the equations of motion at some transformations retain not only appearance, but also expressions for functions, included in them, it is said, that they are *invariant* relative to the given transformations.

Being the formal-mathematical transformations, bound only with the form of notation of equations of motion, invariance and covariance of equations of motion are not subject to experimental verification. The mathematical formulation of the same law can be given both in invariant (covariant), and in the non-invariant (non-covariant) form concerning that or diverse transformations. Thus, mathematical notation of the Newton law of universal gravitation for two material particles A and B will not be invariant concerning Galileo transformations

$$\bar{r} = \bar{r}' + \bar{v}t'; \qquad t = t' \tag{2}$$

if this law is stated in the reference system with the origin in one of these particles, e.g. in the A point

$$F = \gamma \frac{m_A m_B}{r_B^2} \tag{3}$$

and invariant relative to these very transformations, should the origin be concurrent to some third point C

$$F = \gamma \frac{m_A m_B}{(\bar{r}_A - \bar{r}_B)^2} \tag{4}$$

It is absurdly to assert that the experiment can prove a correctness of the law of universal gravitation in the invariant form (4) and irregularity in the form (3).

As the dynamic relativity principles is referred to different, though identical, processes in each of the reference systems, then it is impossible to link the description of these processes by transformations of a type (1), (2). Therefore, for a dynamic relativity principle the concepts of invariance and covariance are inapplicable.

2. About the velocity of light

2.1. Velocity of light in Galileo transformations.

a) The point source of light is located at the origin of the absolute (in the sense of classical mechanics of Newton) system of reference Oxy - Fig.1. The center of each of fronts of the light wave, emitted in the fixed time moment t_*, is positioned at the origin of this reference system. The reference system $O'x'y'$ moves translationally with the velocity $\bar{v} = const$ in the positive direction of x-axis. At the moment $t = 0$ origins of these reference systems coincide.

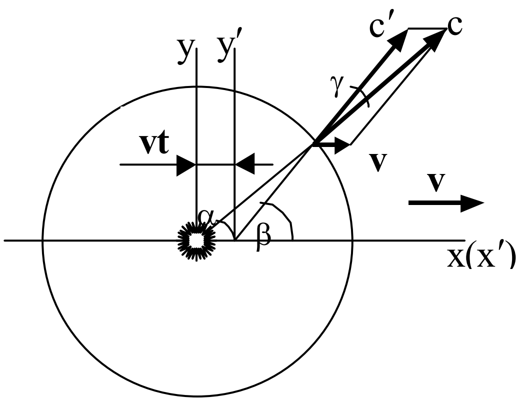

Fig.1. The source, resting at the origin of the Oxy reference system, emits the front of concentric light waves, one of which, emitted at the moment t_*, is shown on the figure.

Equation of the light wave front, emitted at the moment t_*, has the following appearance in the reference system Oxy

$$x^2 + y^2 = c^2(t - t_*)^2, \qquad t \geq t_* \tag{5}$$

The absolute velocity $\bar{c}$ of an arbitrary point of the light wave front and transport velocity $\bar{v}$ uniquely determine the relative velocity of light $\bar{c}'$ of this point of the wave in the dashed system of reference

$$\bar{c} = \bar{v} + \bar{c}' \tag{6}$$

From the corresponding triangle we have

$$c'^2 = c^2 + v^2 - 2cv\cos\alpha \tag{7}$$

Taking into consideration, that

$$\cos\alpha = \frac{x}{c(t - t_*)} \tag{8}$$

we get from (7)

$$c^2 = c'^2 - v^2 + 2\frac{vx}{(t - t_*)} \tag{9}$$

With account of (9) and Galileo transformations

$$x = x' + vt', \qquad y = y', \qquad t = t', \tag{10}$$

equation (5) of the light wave front in the dashed reference system takes the appearance

$$(x' + vt'_*)^2 + y'^2 = c'^2(t' - t'_*)^2 \tag{11}$$

If one consider the absolute speed of light c as a global constant, not subject to transform at transition from one reference system to another, then application of Galileo transformations (10) leads the equation of the light wave front (5) to the form

$$(x' + vt')^2 + y'^2 = c^2(t' - t'_*)^2 \tag{12}$$

Thus, relative to the reference system $O'x'y'$, moving with the speed v to the right, equations (5) of any of the light wave fronts moving away of it with the speed v to the left, may be written down both in the form (11) and in the form (12). However if the equation (11) describes the wave fronts via the velocity of light c' relative to the dashed system of reference, the value of which is determined according to (7), then the equation (12) describes the wave fronts via the global constant c, which is no longer the velocity of light for the dashed reference system.

Comparison with (5) shows, that in the form (11) the equation of the light front, emitted at the moment $t_* = t'_* = 0$, is covariant relative to Galileo transformations, whilst in the form (12) - not.

b) The point source of light is placed permanently at the origin of the reference system $O'x'y'$, moving with the velocity $\bar{v} = const$ to the right along x-axis, and emits the light wave fronts – Fig.2. The centers of these waves remain unmovable in the absolute reference system Oxy since the moment of their appearance.

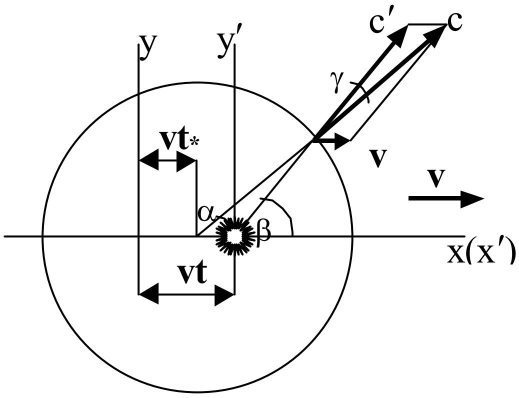

Fig. 2. The source, moving together with the origin of the reference system $O'x'y'$, emits fronts of the light waves, one of them, emitted at the moment t_*, is shown on the figure.

Let's consider one of the light wave front, emitted at the moment t_*, equation of which in the system Oxy has the form

$$(x - vt_*)^2 + y^2 = c^2(t - t_*)^2, \qquad t \geq t_* \qquad (13)$$

In this case relations (6), (7) remain, but (8) and (9) take the form

$$\cos\alpha = \frac{x - vt_*}{c(t - t_*)} \qquad (14)$$

$$c^2 = c'^2 - v^2 + 2\frac{v(x - vt_*)}{(t - t_*)} \qquad (15)$$

With account of (15) and Galileo transformations (10), equation (13) of the light wave front in the dashed system of reference takes the form

$$x'^2 + y'^2 = c'^2 (t' - t'_*)^2 \qquad (16)$$

Via the global constant c the same front (13) of the light is described by form

$$[x' + v(t' - t'_*)]^2 + y'^2 = c^2(t' - t'_*)^2 \qquad (17)$$

Thus, the source of light, moving with the speed v to the right, remains to the left behind it the light wave fronts. These waves in the reference system Oxy are described by the equation (13), while in the reference system $O'x'y'$ these very wave fronts can be described by equations both in the form of (16) – via relative velocity of light c', and in the form of (17) – via the global constant c. Comparison with (13) indicates, that in the form (16) equation of the front of the light wave, emitted at the moment $t_* = t'_* = 0$, is covariant relative to Galileo transformations, whilst in the form (17) – not.

2.2. Velocity of light in kinematic Lorentz transformations

a) The source of light is unmovable in the absolute reference system.

With account of Lorentz transformations

$$x = \frac{x' + vt'}{\sqrt{1 - (v/c)^2}}, \qquad y = y', \qquad t = \frac{t' + (v/c^2)x'}{\sqrt{1 - (v/c)^2}}, \qquad (18)$$

equation (5) of the light wave front in the dashed reference system, taking into consideration, that

$$t_* = \frac{t'_* + (v/c^2)\,x'}{\sqrt{1 - (v/c)^2}}, \qquad (19)$$

has appearance

$$(x' + vt')^2 + y'^2\left(1 - (v/c)^2\right) = c^2(t' - t'_*)^2 \qquad (20)$$

From comparison of (5) and (20) it follows, contrary to the statement of SRT, that equations of the light wave fronts are non-invariant and even non-covariant relative to Lorentz transformations. Equation of the unique light wave front, emitted at the initial moment $t_* = 0$, is invariant relative to Lorentz transformations. Thus it is necessary to take into account, when $t_* = 0$, then, pursuant to (19),

$$t'_* = -\frac{vx'}{c^2} \qquad (21)$$

By limiting transition $\left(v/c\right) \to 0$ from the equation of the light wave front (20) we get not the equation (11), as one could expect according to the SRT of Einstein, but equation (12). This corresponds to that at such limiting transition Lorentz transformations (18) pass into the transformations of Galileo (10), according to which later from (5) we obtain (12). Therefore, the constant c, contained in Lorentz transformations and electromagnetic equations of Maxwell, is not the speed of light relative to each inertial reference systems, as stated in the SRT of Einstein, but the global constant – velocity of light in the absolute system of reference.

b) The light source is moving in the absolute reference system.

With account of Lorentz transformations (18) and relation (19), equation (13) of the light wave front in the dashed reference system has the form

$$\left[\left(1-(v/c)^2\right)x'+v(t'-t'_*)\right]^2+y'^2\left(1-(v/c)^2\right)=c^2(t'-t'_*)^2 \quad (22)$$

By limiting transition $\left(v/c\right)\to 0$ from (22) we get, again, not the light wave front equation (16), as one might expect according to the SRT, but equation (17).

From comparison of (13) and (22) follows, with account of (21), that only equation of the unique light wave front, emitted at the initial moment $t_* = 0$, is invariant relative to Lorentz transformations

3. About optical experiment of Michelson-Morley

At the theoretical substantiation of the optical experiment of Michelson-Morley the principle mistake has been allowed: the time of passage of the longitudinal ray was determined according to Galileo transformations, and the time of passage of the transverse ray – contrary to these transformations. In this connection the following remark of Lorentz is curious: *"Could it happen so, that some moment in the theory of Mr. Michelson experiment was omitted from consideration?"* [3, p.109].

Let's consider correct calculation.

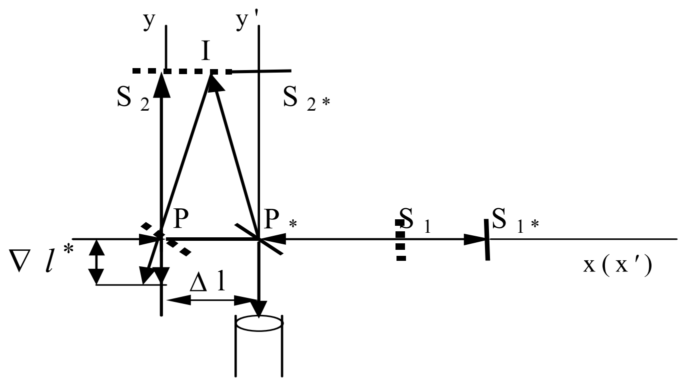

Fig.3. The calculation scheme of rays propagation,
PS_1S_2 and $P_*S_{1*}S_{2*}$ – initial and final position of the apparatus

As in the experiment the light source is moving together with the apparatus, mounted on the surface of the Earth, relative to the absolute system of reference, then the case 2.1b, considered above, is realized. From the velocity triangle - Fig. 2 we find, that the light ray, inclined by the angle α in the absolute reference system, is seen in the movable reference system by the angle β

$$\beta = \alpha + \gamma \quad (23)$$

where angle of aberration γ is found from the same velocity triangle

$$tg\gamma = \frac{v\sin\alpha}{c - v\cos\alpha} \quad (24)$$

With account of (7), (23) and (24) we get

$$if:\quad \alpha = 0, \quad then \quad c' = c - v, \qquad \gamma = 0, \quad \beta = 0; \qquad (25)$$

$$\alpha = \pi, \quad then \quad c' = c + v, \qquad \gamma = 0, \quad \beta = \pi; \qquad (26)$$

$$\alpha = \frac{\pi}{2}, \quad c' = \sqrt{c^2 + v^2}, \quad tg\gamma = \frac{v}{c}, \quad \beta = \frac{\pi}{2} + arctg\frac{v}{c}. \qquad (27)$$

The propagation time for a longitudinal ray "forward and back" both in absolute, and in relative motions, according to (25) and (26), coincides with the generally accepted

$$t_1 = 2\frac{l}{c} \cdot (1 - \frac{v^2}{c^2})^{-1} \qquad (28)$$

The transverse ray in absolute movement passes the distance $PS_2 + S_2P = 2l$ by trajectory PS_2P with the velocity c - Fig. 3, for the time

$$t_2 = 2\frac{l}{c} \qquad (29)$$

The same ray in the relative movement covers the distance $P_*I + IP$ following trajectory P_*IP with the velocity c' pursuant to (27) for the time

$$t_2 = \frac{2\sqrt{l^2 + (v\frac{t_2}{2})^2}}{\sqrt{v^2 + c^2}} \qquad (30)$$

this is coinciding with (29), as it should be.

Time t_1 of propagation of the longitudinal ray exceeds time t_2 of propagation of the transverse ray by the value

$$\Delta t = t_1 - t_2 = 2\frac{l}{c}\frac{v^2}{c^2}(1 - \frac{v^2}{c^2})^{-1} \approx 2\frac{l}{c}\frac{v^2}{c^2} \qquad (31)$$

thus, the transverse ray passes the eyepiece apart by the distance

$$\Delta l = vt_2 = 2l\frac{v}{c} \qquad (32)$$

The purpose of optical experiment of Michelson-Morley was the measurement of displacement of interference fringes, the value of which is the second order of magnitude by aberration. However, divergence of rays Δl is the value of first order of magnitude by aberration. Thus, neither in the absolute, nor in the relative movements the transverse ray propagates with the velocity c following trajectory PIP_* in the direction of movement of the apparatus, contrary to the accepted in the scientific literature. Therefore statement that the transversal ray will get in the eyepiece of an interferometer, is wrong. The observed interference pattern is conditioned by errors of experiment, first of all by that the ray is not ideally acute, but has the finite dimensions of cross-section and definite conicity of divergence.

4.About the initial axioms of Einstein's SRT

4.1. The initial axioms of the fundamental physical theory should be generalization of the experimental facts. Let's analyze, whether the axioms of Einstein's SRT comply with these requirements. Let's refer to the basic article of this theory, published in 1905.

"Further considerations,- Einstein writes,- *are based on the relativity principle and on the constancy of speed of light. We'll formulate both principles in the following way.*

The laws, governing changes of state of physical systems, do not depend on to which one of two coordinate systems, driving one relative to another uniformly and rectilinearly, these changes of state concern.

Each light ray is moving in the "reposing" coordinate system with the definite speed, irrespective of whether this light ray is emitted by a reposing or driving body" [4,p. 10].

4.2 The formulation of the first of these principles, the relativity principle, is correct provided that it is deemed as the dynamic relativity principle of Galileo. This principle is confirmed by all the set of physical experiments. However, each time, when Einstein in his conclusions, both like in this article, and in all subsequent, refers to the given principle, he applies it not as the dynamic one, but as a kinematic relativity principle, moreover, as the requirement of the invariant form of writing down of the equations, considered by him. Such comprehension of the first principle of his theory repeatedly confirms also Einstein himself. *"Should one convert the basic equations of mechanics of Newton, written for the unaccelerated system of reference, with the aid of relations*

$$t = t', \qquad x' = x - vt, \qquad y' == y, \qquad z' = z \qquad (33)$$

to the new system of reference, being in the rectilinear and uniform movement relative to the first one, then new equations in the variables t', x', y', z', *will be obtained, identical to the initial equations in variables* t, x, y, z. *Or else, at transition from one system of reference to another, driving uniformly and rectilinearly in relation to the first one, the Newtonian laws of motion will be converted to the laws of the same kind. Just this* (!? – A. P.) *is kept in mind when speaking that in the classical mechanics the relativity principle is observed ... Should the basic equations of Lorentz theory be transformed with the aid of relations (33), then equations of another kind will be obtained, thus the values* x', y', z' *are constituent to them already asymmetrically. Thus, the Ether-based theory of Lorentz does not comply* (!? –A. P.) *with the relativity principle"* [4, p. 144].

The beginning of such erroneous identification of a dynamic relativity principle with the formal-mathematical requirement of invariance of equations of motion relative that or diverse transformations of reference systems ascends to A. Poincare. According to Poincare,*"the relativity principle should be esteemed as the conditional agreement"* [5, p.428]. *"What the revolution which took place under influence of the recent successes of physics consists of?"*, - asks Poincare. And responds: *"The relativity principle in its former shape should be disclaimed, it is interchanged with the relativity principle of Lorentz. Just the transformations of Lorentz group do not change differential equations of dynamics"* [5, p. 429]. But the invariability of equations relative to some transformations is the formal-mathematical requirement of the invariant form of writing-down of these equations concerning the given transformations.

Thus, according to Poincare and Einstein, the relativity principle of Galileo consists in the invariance of equations of motions concerning transformations of Galileo, and the relativity principle of Lorentz consists in the invariance of these equations concerning Lorentz transformation. It is the wrong point of view on the nature of that dynamic relativity principle itself, which for the first time was formulated by Galileo and what serves as the basis for the first law of classical mechanics of Newton - law of inertia [2]. And this erroneous point of view remained unnoticed during the entire XX century. For example, in the classical course of *Theoretical physics* of Landau and Lifshitz, there is asserted: *"The experiments demonstrates, that the so-called relativity principle is true. According to this principle all laws of nature are identical in all inertial systems of reference. That is to say* (!?– A. P.), *the equations expressing laws of nature, are invariant in relation to transformations of coordinates and time from one inertial system of reference to another. It means, that the equation describing some law of nature, being expressed through coordinates and time in different inertial systems of reference, are of the same kind"* [6, p. 13].

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4.3. The formulation of the second principle, principle of constancy of speed of light, also is correct, provided that it under the "fixed" coordinate system one perceives the "absolute" coordinate system, bound to the sphere of remote stars, that is in the sense of Newton-Maxwell-Lorentz. In such comprehension, really, all the set of experimental facts and astronomical observations confirms that the speed of light only relative to this unique coordinate system does not depend *"on whether this light ray is emitted by a reposing or driving body"*. In such comprehension we shall call this principle further "The Lorentz Principle of a constancy of speed of light". *"We, really, can not envisage anything other, as that the Ether is quiescent and that light waves, escaping a light source or mirror, are diffused with once and for all established speed, at absolutely independent on motion of a light source and a mirror"*, - writes Lorentz [7, p. 129]. With this, apparently, Einstein agrees as well: *"According to experiments, we assume, that the value* c *is a universal constant (speed of light in vacuum)"* [4, p. 10]. However, already several pages later in the same article, Einstein in his conclusions uses ***"****that circumstance, that light at measurement in the moving system is also diffused with the speed (as demanded by the principle of a constancy of speed of light in combination (*!? – A. P.) *with the relativity principle)"* [4, p. 15]. This consequent we shall call hereinafter “A false Einstein principle of a constancy of speed of light”. For Einstein it was sufficient that experimental fact, that the speed of light in one of system of reference, the “absolute”, does not depend on the running speed of its source. And then, having identified the invariance of the light wave front concerning Lorentz transformations (only for the initial moment - ref. above) with the dynamic relativity principle of Galileo, he identifies the speed of light relative to the moving system of reference with the speed of light concerning the “reposing” reference system. On this false Einstein’s principle of a constancy of speed of light is based all the evidences of necessity of revision of our representations about the physical space and time. For example: *“Let the signals are sent from some point A on the x'-axis in two mutually opposite directions. As the speed of propagation of the signal in the system K', as well as in any system* (!? - A. P.)*, is equal in (both directions) c, then the signals will reach the points B and C, equidistant from A, at the same moment of time (in the system K'). However, it can be easily seen, that these very two events (coming of the signal into B and C) will be rather not simultaneous for the spectator in the K. Really, the speed of signals relative to the system K pursuant to* (!?- A. P.) *the relativity principle equals to that very c, and as the point B moves (relative to the system K) towards the signal, sent to it, while the point C - away from the signal (sent from A* ***into*** *C), then in the system K the signal will come into the point B earlier, than into the point C ”* [6, p. 16].

Einstein in his first article of 1905 comes to a conclusion, that *“it is not necessary to give an absolute value to the concept of a simultaneity”* [4, p. 13]., comparing the passage time of the light signal back and forth along the restful bar AB in the reference system K', moving with the speed v

$$t_B - t_A = \frac{r_{AB}}{c - v} \quad \text{and} \quad t_A^* - t_B = \frac{r_{AB}}{c + v} \tag{34}$$

with the passage time of the light signal back and forth along the “instantaneous snapshot” of this bar on the film, resting in the “fixed” system of reference

$$t_B - t_A = \frac{r_{AB}}{c} \quad \text{and} \quad t_A^* - t_B = \frac{r_{AB}}{c} \tag{35}$$

this, naturally, leading to different results. *“Thus*, - makes conclusion Einstein, - *the spectators, moving together with the rod, will find that clocks in the points A and B are not going synchronously, while the spectators located in a reposing system, would pronounce these hours are synchronic”* [4, p. 13]. However, this concluding is erroneous. It is necessary to take into account, that while light is gone along the rod, the rod itself passes relative to the fixed system of reference some spacing interval. With the account of this we find

$$t_B - t_A = \frac{r_{AB} + v(t_B - t_A)}{c}, \qquad t_A^* - t_B = \frac{r_{AB} - v(t_A^* - t_B)}{c} \tag{36}$$

The outcomes (34) and (36) coincide, as it should be, as the reasoning are conducted by Einstein within the framework of concepts of classical mechanics of Newton, the axioms of which are consistent and based on the experimental practice.

Such inconsistency in comparing the values, obtained according to transformations of Galileo, with the values obtained contrary to these transformations, makes the basis of all the similar “evidences” of a new look of the theory of Einstein on space and time.

5. Conclusions

1. The Einstein’s *Special Relativity Theory* bases on erroneous identification *of the*: a) dynamic relativity principle of Galileo with invariance of equations of motion concerning transformations of reference systems; b) principle of Lorentz of a constancy of speed of light with a false principle of Einstein of a constancy of speed of light. Therefore conclusion of SRT about change of physical space and time in each of inertial systems of reference is wrong.

2. The concepts of *"absolute time"* and of *"absolute space"* of Newton are scientific abstraction from the *"relative, apparent or ordinary"* [2] time and space. To refute these concepts is as senseless as how to refute the concepts of "absolute solids", "perfect fluid", "ideal gas», etc.

3. The kinematic Lorentz transformations, as well as transformations of Galileo, allow reformulating the mathematical description of some physical process from one inertial system of reference into another, remaining within the framework of classical representations of "absolute space" and "absolute time". *"Anyway, but the theory of a fixed Ether is sufficiently reliable and quite fits me, wherefore does not force to go on any radical revision of our representations. Being based on it, we, for example, can prolong talk about an true time and true simultaneity"* [7, p. 134].

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