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The existence of a universal frame of reference, in which it propagates light, is still an unresolved problem of physics

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Abstract:

This article shows that the existence of a universal frame of reference, in which light propagates, is still an unresolved problem of physics. The analyzed articles show that the rejection of the idea of ether due to Michelson-Morley's and Kennedy-Thorndike's experiments was too hasty. The zero results of these experiments can be explained by the theory with a universal frame of reference, in which light propagates. The fact that one-way speed of light has never been accurately measured and that there is a well-documented effect showing the anisotropy of space from the perspective of our frame of reference, which is the dipolar anisotropy of cosmic microwave background radiation, further substantiates theories with a universal frame of reference.

The article shows that the null result of the Michelson-Morley and Kennedy-Thorndike experiments does not determine the Lorentz symmetry.

Keywords: Lorentz transformation, coordinate and time transformation, universal frame of reference, anisotropy of cosmic microwave background radiation, one-way speed of light

1. Introduction

In 1887, an experiment was conducted by Michelson-Morley [11], while in 1932, an improved version of it was carried out; i.e., Kennedy-Thorndike's experiment [7]. In these experiments, the light flow times along the two interferometer arms were compared with great accuracy. The aim of these experiments was to detect the motion of Earth in relation to hypothetical universal frame of reference (UFR, ether), in which light propagates. Relying on classical kinematics based on Galileo's transformation, which was then the only available theory describing the properties of time and space, the results of these experiments were predicted. From a simple geometric analysis, it follows that the time of light flow along the interferometer arm (back and forth) must depend on the angle between the arm and the direction of Earth's velocity in relation to ether [29, 30].

The results of these experiments did not show such a relation and therefore, they were read as an evidence that a universal frame of reference in which light is propagated does not exist and that one-way speed of light in vacuum (in a homogeneous gravitational field) is constant in all inertial frames of reference. Such views on the interpretation of these experiments have become established in physics. They are provided in textbooks and lectures on physics [29, 30].

The zero results of the Michelson-Morley's and Kennedy-Thorndike's experiments have shown that an average speed of light on the path to mirror and back is the same in every direction and in every inertial frame of reference. This is contrary to predictions of the classical kinematics with distinguished frame of reference, in which light is propagated. However, this is not an evidence that a universal frame of reference does not exist and that one-way speed of light in vacuum is constant in all inertial systems. These experiments have shown that ether does not exist in such a meaning, in which classical kinematics described it. After all, predictions of these experiments were calculated on the basis of classical kinematics. The experiment results showed that these forecasts were incorrect. The mistake in the interpretation of these experiments consisted in the fact that these conclusions were generalized in such a way that since ether cannot exist in a meaning in which classical mechanics described it, ether cannot exist in any other meaning.

This article provides an overview of publications in which is returned to UFR idea. These publications have shown that Michelson-Morley's and Kennedy-Thorndike's experiments have been misinterpreted for over 100 years, because in fact these experiments have not shown that ether does not exist. These experiments also did not show that the one-way speed of light in vacuum is constant. Michelson-Morley's and Kennedy-Thorndike's experiments can be explained by the theory with a universal frame of reference [19, 20, 21]. What is more, there are an infinite number of such theories [22]. Each of these theories models a reality with different physical properties.

These studies show that the Lorentz violation transformations are acceptable according to the zero result of the Michelson-Morley and Kennedy-Thorndike experiments.

2. One-way speed of light

In [32], an analysis of numerous experiments was carried out, in which the speed of light was measured. This analysis shows that the exact one-way speed of light has never been measured. The problem of measuring this speed results from that it is unknown how distant clocks can be synchronized without the use of an electromagnetic signal, where the speed must be measured with these clocks. In one-way speed of light measurement, it is also impossible to rely on clocks that were next to each other at the time of synchronization and then were separated from each other as out-of-synchronization clocks in relative motion. For these reasons, in all precise laboratory measurements of the speed of light, only an average speed of light covering the path along closed trajectory was measured. In such experiments, light always returns to the starting point. The same applies to Michelson-Morley's and Kennedy-Thorndike's experiments.

The speed of light measurement shows that an average speed of light in vacuum on the path back and forth is always constant. Due to the local nature of such measurements, caused by the small dimensions of measuring devices, it is considered to be the speed of light in a homogeneous gravitational field.

Despite the fact that there is no precise measurement of one-way speed of light, it is widely believed that the constancy of one-way speed of light in vacuum (in a constant gravitational field) is an experimental fact.

3. Modifications of the Lorentz transformation

In 1905, Albert Einstein announced the Special Theory of Relativity [5]. It was widely recognized as a theory explaining the results of experiments with light. The Special Theory of Relativity was derived from three assumptions:

A. Coordinate and time transformation «inertial frame of reference – inertial frame of reference» is linear.

B. All inertial systems are equivalent.
This assumption means that there is no such a physical phenomenon which distinguishes the inertial system. It means that there is no such phenomenon for which the absolute rest is needed to explain. It also means that there is no physical phenomenon that allows a direction in space to be distinguished; that is, for each observer, space is isotropic. Mathematically, it results from this assumption that each coordinate and time transformation has coefficients with exactly the same numerical values as inverse transformation (with the accuracy to the sign resulting from the velocity direction between the systems).

C. Speed of light c in vacuum is the same in every direction and in all inertial systems.

The most important property of the Special Theory of Relativity is that the space is isotropic for an observer from any inertial system. According to this theory, there is no experiment that distinguishes a certain direction in space. Therefore, any experiment that distinguishes a certain direction in space will prove the incorrectness of this theory.

Since then, attempts have been made to return to the idea of ether by modifying Lorentz's transformation, on which the Special Theory of Relativity is based. This approach is described in articles [10, 15, 16, 17, 28].

In [28], the author described transformation from any inertial frame of reference U' to system U related with UFR in the form of:

$$t = \frac{1}{\sqrt{1-(v/c)^2}}t' \tag{1}$$

$$x = \frac{1}{\sqrt{1-(v/c)^2}}vt' + \sqrt{1-(v/c)^2}\cdot x' \tag{2}$$

The speed v is a speed of the inertial system U' relative to UFR. Reverse transformation from system U related with UFR to any inertial system U' has the form of

$$t' = \sqrt{1-(v/c)^2}\cdot t \tag{3}$$

$$x' = \frac{1}{\sqrt{1-(v/c)^2}}(-vt + x) \tag{4}$$

In [10], the authors presented a derivation of transformation (3)-(4). They received this transformation from the Lorentz's transformation after changing the way of synchronizing clocks in inertial frames of reference.

These studies were developed by Selleri in [16] and [17]. In his work, he gave a formula for one-way speed of light in vacuum, resulting from transformation (3)-(4), which can be written in the form of

$$c'_{\alpha'} = \frac{c^2}{c + v\cos\alpha'} \tag{5}$$

Angle α' is the angle, measured by the observer, between the vector of its speed v in relation to the UFR and the vector of the speed c of light.

In [10], [16] and [17], as well as in [15], other transformations and discussions on this subject are presented.

Actually, in all works on Lorentz's transformation modification, new transformations were treated only as a different mathematical record of the Special Theory of Relativity. Most of the authors did not comment on this, but in [10], it was written directly: "*In this case any reference frame ... can be chosen to be the ether system*" and "*thus the much debated question concerning the empirical equivalence of special relativity and an ether theory taking into account time dilatation and length contraction but maintaining absolute simultaneity can be answered affirmatively*".

4. Special Theory of Ether

4.1. Assumptions of the Special Theory of Ether

A different approach to derivation of kinematics with a universal frame of reference is presented in [19]-[23]. In this case, the reasoning is based on an analysis of Michelson-Morley's and Kennedy-Thorndike's experiments with different assumptions than those underlying the Special Theory of Relativity. In this way, the Special Theory of Ether was derived. Michelson-Morley's and Kennedy-Thorndike's experiments have been analyzed in these works with the following assumptions:

I. Coordinate and time transformation «inertial frame of reference – inertial frame of reference» is linear.
II. For each motionless observer in relation to the universal frame of reference, the space is isotropic; i.e., it has the same properties in each direction.
III. There is at least one inertial frame of reference in which the speed of light in a vacuum is the same in each direction. This system is called a universal frame of reference. This one-way speed of light constant is indicated by the symbol $c = constant$.
IV. The average speed of light in the vacuum flowing way back and forth is constant for each observer from the inertial frame of reference. This average speed does not depend on the observer's velocity in relation to the universal frame of reference, nor on the direction of light propagation. This average speed is also indicated by the symbol $c = constant$ (this results from the Michelson-Morley and Kennedy-Thorndike experiments).

According to these assumptions, there are infinitely many Special Theories of Ether with different physical properties. These theories differ, for example, in how bodies moving in relation to the universal frame of reference undergo transverse contraction or transverse elongation (i.e., in the direction perpendicular to the velocity v at which the body moves in relation to the universal frame of reference). If in the inertial system the body has the width D'_y, then for the observer who is stationary in relation to the universal frame of reference, it is $\psi(v)$ times wider; i.e., it has the width

$$D_y = \psi(v) D'_y \tag{6}$$

4.2. Transformations of the Special Theory of Ether

In [19], [20], [21], a transformation of the Special Theory of Ether was derived, in which there is no transverse elongation (i.e., when $\psi(v) = 1$). This transformation is as identical as the Tangherlini's transformation (1)-(4) presented in the article [28].

Due to assumption that $\psi(v) = 1$ there are also

$$y' = y \quad \text{and} \quad z' = z \tag{7}$$

In this new approach, the Lorentz's transformation was not modified by changing the method of clock synchronization, but the transformation was derived from the basics through analysis of experiments. Thanks to explicit assumptions of the new theory, it was possible to generalize the transformation (1)-(4) and show that there are infinitely many theories with a universal frame of reference, which are according to Michelson-Morley's and Kennedy-Thorndike's experiments [22].

In [22], a general form of transformation was derived for any function $\psi(v)$. Coordinate and time transformations from any inertial system U' to U system related with UFR have a form of

$$\begin{cases} t = \dfrac{\psi(v)}{\sqrt{1-(v/c)^2}} t' \\ x = \dfrac{\psi(v)}{\sqrt{1-(v/c)^2}} vt' + \psi(v)\sqrt{1-(v/c)^2} \cdot x' \\ y = \psi(v) y' \\ z = \psi(v) z' \end{cases} \tag{8}$$

Reverse transformations from U system related with UFR to any inertial system U' have the form of

$$\begin{cases} t' = \dfrac{\sqrt{1-(v/c)^2}}{\psi(v)} t \\ x' = \dfrac{1}{\psi(v)\sqrt{1-(v/c)^2}} (-vt + x) \\ y' = \dfrac{y}{\psi(v)} \\ z' = \dfrac{z}{\psi(v)} \end{cases} \tag{9}$$

In order for a function $\psi(v)$ to have a natural physical interpretation, it should be continuous and meet the following conditions

$$\psi(0) = 1 \tag{10}$$

$$\psi(v) \ge 0 \tag{11}$$

If the space is supposed to be isotropic (for an observer immobile relative to the ether), it must additionally occur that

$$\psi(v) = \psi(-v) \tag{12}$$

Each of transverse elongation functions $\psi(v)$ defines a different theory of kinematics. It suffices to note that on the basis of (8) or (9) time dilatation between the inertial system U' and U

system related with UFR depends on the transverse elongation function $\psi(v)$, as expressed by the formula

$$dt' = \frac{\sqrt{1-(v/c)^2}}{\psi(v)}dt \tag{13}$$

Time dilatation depends to the function $\psi(v)$; i.e., if kinematics differs in the function $\psi(v)$, there is a different time dilatation. Time dilatation is an effect that can be measured experimentally and therefore, if models differ in time dilatation, they describe other kinematics. In addition, it results that time dilatation can be a basis for falsification of various theories described in transformations (8)-(9).

Ref. [22] presents three special cases of transformation (8). One of the special cases of these transformations is Tangherlini's transformation (1)-(4), which is obtained when

$$\psi(v) = 1 \tag{14}$$

Then, transformation (8) assumes the form (1)-(2). For such a transformation, the kinematic and dynamics of bodies analyzed in [19] are obtained. In this case of the Special Theory of Ether, transverse contraction or elongation does not occur. The Special Theory of Ether without transverse contraction is closely linked to the Special Theory of Relativity by Einstein, because in both of these theories, there is neither a transverse contraction nor an elongation.

If it is assumed that

$$\psi(v) = \frac{1}{\sqrt{1-(v/c)^2}} \geq 1 \tag{15}$$

then transformation (8) takes the form of

$$\begin{cases} t = \dfrac{1}{1-(v/c)^2}t' \\ x = \dfrac{1}{1-(v/c)^2}vt' + x' = vt + x' \\ y = \dfrac{1}{\sqrt{1-(v/c)^2}}y' \\ z = \dfrac{1}{\sqrt{1-(v/c)^2}}z' \end{cases} \tag{16}$$

For such transformation, we obtain kinematics in which there is no longitudinal contraction; i.e., in the direction parallel to v velocity and x axis (FitzGerald-Lorentz contraction). At the same time, there is a lateral elongation (in a direction perpendicular to v velocity).

If it is assumed that

$$\psi(v) = \sqrt{1-(v/c)^2} \leq 1 \tag{17}$$

then transformation (8) takes the form of

$$\begin{cases} t = t' \\ x = vt' + (1-(v/c)^2)x' \\ y = \sqrt{1-(v/c)^2} \cdot y' \\ z = \sqrt{1-(v/c)^2} \cdot z' \end{cases} \tag{18}$$

For such a transformation, we obtain kinematics in which time is absolute. It is very interesting that there is a possible theory with an absolute time that meets the conditions of Michelson-Morley's and Kennedy-Thorndike's experiments.

If two inertial systems U_1 and U_2 move relative to UFR along one straight with v_1 and v_2 velocities respectively, then the transformation between these systems is a complex of transformations (8) and (9). This transformation takes the form of

$$\begin{cases} t_1 = \dfrac{\psi(v_2)}{\psi(v_1)} \dfrac{\sqrt{1-(v_1/c)^2}}{\sqrt{1-(v_2/c)^2}} t_2 \\ x_1 = \dfrac{\psi(v_2)}{\psi(v_1)} \dfrac{v_2 - v_1}{\sqrt{1-(v_1/c)^2}\sqrt{1-(v_2/c)^2}} t_2 + \dfrac{\psi(v_2)}{\psi(v_1)} \dfrac{\sqrt{1-(v_2/c)^2}}{\sqrt{1-(v_1/c)^2}} x_2 \\ y_1 = \dfrac{\psi(v_2)}{\psi(v_1)} y_2 \\ z_1 = \dfrac{\psi(v_2)}{\psi(v_1)} z_2 \end{cases} \tag{19}$$

4.3. Properties of the Special Theories of Ether

The Special Theory of Relativity and Special Theories of Ether are alternative models of kinematics.

If in STE without transverse contraction ($\psi(v) = 1$) the observer is motionless with regard to ether, then predictions of this theory are as identical as predictions for any observer in STR (Figure 1).

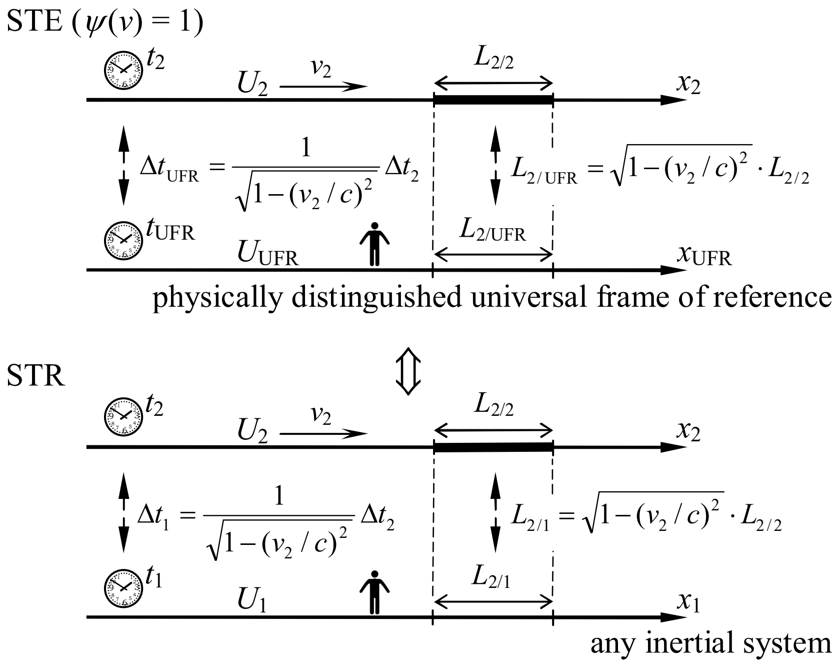

Figure 1. Similarities between STR and STE ($\psi(v) = 1$) [source [21]].

Differences between theories occur when in STE without transverse contraction the observer moves with regard to ether. In STR, all inertial systems are equivalent; i.e., there is no universal frame of reference. For this reason, according to STR, it is not possible to measure the absolute speed using local measurement. This means that for each observer, the space is completely isotropic (has the same properties in each direction). However, according to STE without transverse contraction, the observer can use a local measurement (i.e., when being entirely isolated from the environment) to determine the direction of its movement in relation to UFR. This means that for observers moving in relation to UFR, the space is not isotropic (has different properties in different directions). This is the most important difference between the Special Theory of Relativity and the Special Theory of Ether without transverse contraction.

With reference to the above, if predictions of the Special Theory of Ether without transverse contraction were to be real, then in astronomical observations, some anisotropy should be visible. It turns out that such a phenomenon exists and it is very well studied. This is the dipolar anisotropy of cosmic microwave background [18].

From the perspective of our frame of reference, which is associated with the Solar System, the cosmic microwave background is heterogeneous. The strongest heterogeneity of cosmic microwave background has a dipole form, as shown in Figure 2. From the direction of Leo constellation reaches us microwave of a slightly higher frequency (higher temperature), while from the direction of Aquarius constellation reaches us microwave of a slightly lower frequency (lower temperature).

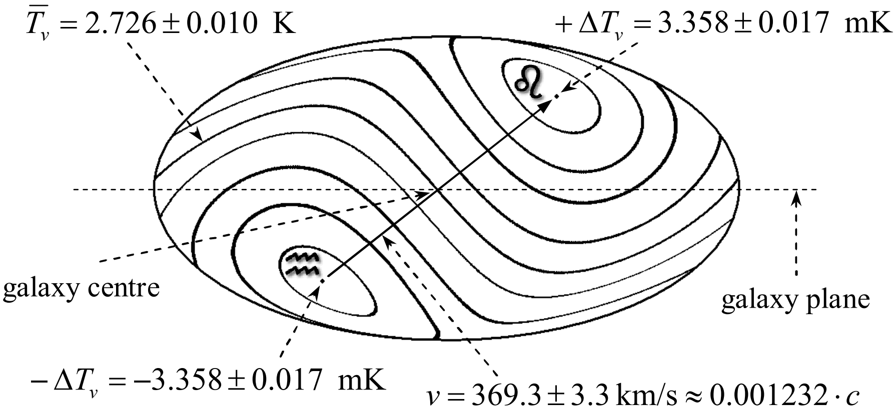

Figure 2. Dipolar anisotropy of cosmic microwave background shown in Hammer-Aitoff projection [source [23]].

In the Special Theory of Ether, the cosmic microwave background can be an electromagnetic thermal radiation of ether (black-body radiation). In fact, satellite measurements have shown that cosmic microwave background has a black-body radiation distribution of temperature 2.726 ± 0.010 K [18]. If the cosmic microwave background is the thermal radiation of ether, it is produced at all times, throughout the space, including in our immediate vicinity. Therefore, in this radiation, the distribution of galaxies is very poorly visible. So, cosmic microwave background did not arise in the early universe as is commonly believed today.

If the universe is homogeneous and filled with homogeneous ether, the cosmic microwave background should be homogeneous in the ether system. The dipolar anisotropy of this radiation as measured in our reference frame is caused by the Doppler Effect that results from the movement of the Solar System relative to ether.

In such an interpretation, the dipolar anisotropy of cosmic microwave background can be used to determine the velocity at which the solar system moves in relation to UFR. This velocity is specified in [22]. Its value is 369.3 km/s = $0.0012 \cdot c$ and it is directed towards the Leo constellation (Figure 3). This corresponds to galactic coordinates (source [18])

$$\begin{aligned} l &= 264.31^\circ \pm 0.16^\circ \\ b &= 48.05^\circ \pm 0.10^\circ \end{aligned} \tag{20}$$

Experimental falsification of STE is not easy due to the low speed of the Solar System relative to ether. For a speed of 369.3 km/s, the anisotropy effects of space predicted by STE are very slight. Therefore, falsification of this theory requires especially designed experiments and their completion with a sufficiently high accuracy [21].

In [22], on the basis of transformation (8) and (9), a formula for one-way speed of light in vacuum $c'_{\alpha'}$ running in any direction in a form identical to that of formula (5) has been derived. It shows that one-way speed of light (5) does not depend on the transverse-elongation function $\psi(v)$. Functional diagrams (5) are shown in Figure 4.

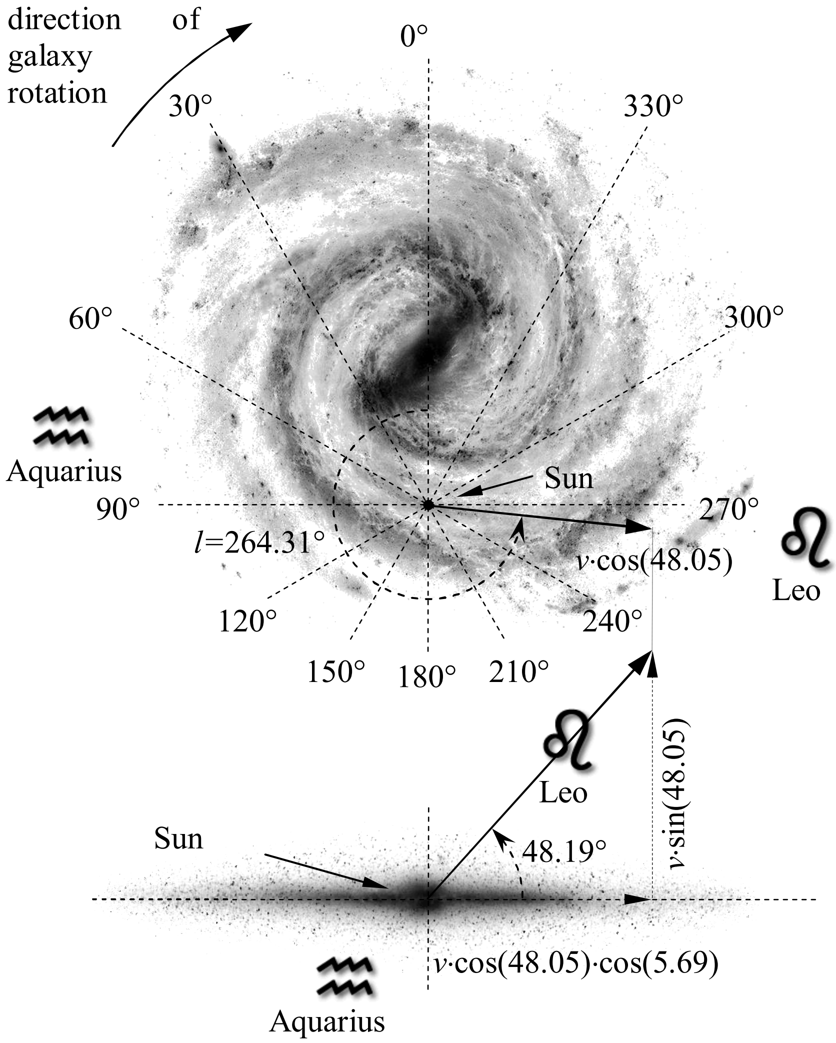

Figure 3. The velocity of the Solar System in relation to the ether.
The projection is on the plane of the galaxy and on the plane perpendicular to the plane of the galaxy (90°-270°). The top view of the Milky Way galaxy (with marked galactic coordinates) and side view [source [22]].

In the monograph shown in [19], on the basis of transformations (8) and (9), a more general formula for one-way speed of light was derived, for the light that flows through a medium. If the observer is motionless in relation to this medium, then the one-way speed of light for the observer is expressed by the formula

$$c'_{s\alpha'} = \frac{c^2 c_s}{c^2 + c_s v \cos\alpha'} \tag{21}$$

The symbols α', v and c have the same meaning as in formula (5). The speed c_s is the light speed in a medium in relation to UFR as seen by the motionless observer relative to UFR.

The formula (21) comes down to formula (5) if only place $c_s = c$. According to this relation, an average speed of light on the path of L-length to the mirror and back is as follows

$$c'_{sr} = \frac{2L'}{t'_{s\alpha'} + t'_{s(\pi+\alpha')}} = \frac{2L'}{\dfrac{L'}{\dfrac{c^2 c_s}{c^2 + c_s v \cos\alpha'}} + \dfrac{L'}{\dfrac{c^2 c_s}{c^2 + c_s v \cos(\pi+\alpha')}}} \tag{22}$$

$$c'_{sr} = \frac{2}{\frac{c^2 + c_s v \cos\alpha'}{c^2 c_s} + \frac{c^2 - c_s v \cos\alpha'}{c^2 c_s}} = \frac{2}{\frac{2c^2}{c^2 c_s}} = c_s \tag{23}$$

From relation (23), it results that c_s is also an average speed of light on the path to mirror and back in the motionless medium relative to a movable observer.

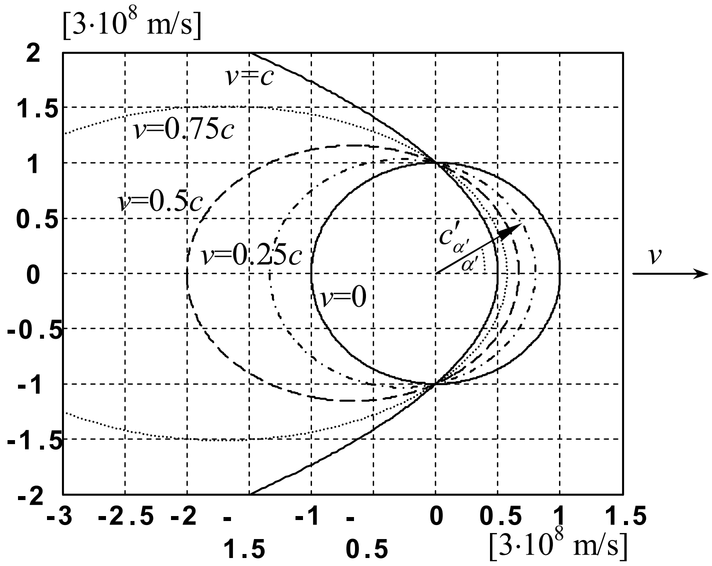

Figure 4. One-way speed of light $c'_{\alpha'}$ predicted by STE in the inertial system for v = 0, 0.25c, 0.5c, 0.75c, c [source [22]].

Although the one-way speed of light expressed by formula (21) depends on angle α' and speed v, the average speed of light on the path to mirror and back is always constant and it is c_s. If the speed of light has the properties described by formula (21), then Michelson-Morley's and Kennedy-Thorndike's experiments are unable to detect a universal frame of reference in which light is propagated.

From the above results, the widely accepted view of Michelson-Morley's and Kennedy-Thorndike's experiments proving that there is no universal frame of reference in which light is propagated and that the one-way speed of light in vacuum is the same for every observer, is false [20]. What is more, there are infinitely many theories with a universal frame of reference, which are according to the results of Michelson-Morley's and Kennedy-Thorndike's experiments (theories included in transformations (8)-(9)) [22].

From the above results, it also follows that Michelson-Morley's and Kennedy-Thorndike's experiments are not sufficient to justify the Special Theory of Relativity and Lorentz symmetry [21].

In the monograph in [19] it is shown that if one-way speed of light is expressed in formula (5) or formula (21), then the average speed of light flowing along closed trajectory is always constant, even if various sections of this trajectory lead through various media. Therefore, Michelson-Morley's and Kennedy-Thorndike's experiments cannot detect UFR, even for very complex configurations of these experiments.

Proposals of measurement systems, which may allow to measure one-way speed of light and falsification of various kinematics theories, are presented in patents [27] and [33]. In these systems, remote clocks are synchronized with a rotating rod, which is a diameter of the rotating wheel. These systems probably will not allow for a very precise measurement of the one-way speed of light. Their aim is precise enough measurement to reveal the anisotropy of this speed. In the monograph in [19], the minimal requirements were designated for the device from patent [27], at which the anisotropy of one-way speed of light resulting from the Special Theory of Ether should be visible; formula (5).

Adopting that one-way speed of light can depend on a direction of its emission does not distinguish any direction in space. It is about the speed of light measured by a movable observer. The speed at which the observer moves in relation to ether distinguishes the characteristic direction in space, but only for this observer. For the motionless observer in relation to ether, the speed of light is always constant and does not depend on a direction of its emission. If the observer moves in relation to ether, then the space is not symmetrical. In this case, it will be like for an observer sailing on water and measuring the speed of waves on water. Although the waves propagate at a constant speed in each direction, the wave speed of the sailing observer will vary in different directions. For this reason, the presented theory based on assumptions I-IV, in a simple way explains the dipolar anisotropy of cosmic microwave background. Within the presented theory, this anisotropy is caused by the Doppler effect, which results from the Solar System motion relative to a universal frame of reference in which light is distributed (i.e., also cosmic microwave background) [22].

5. Final conclusions

The Special Theory of Relativity has numerous experimental grounds. Michelson-Morley's and Kennedy-Thorndike's experiments are also consistent with it, but are not sufficient in order to demonstrate its correctness [22, 23]. These experiments can be explained with the use of various theories, in which a physically distinguished universal frame of reference occurs.

Lorentz's transformation, on which kinematics of the Special Theory of Relativity are based, can be recorded in various ways, after changing the method of clock synchronization in inertial systems. If, as a result of the changed synchronization of clocks, an inertial frame of reference is distinguished, it can be any inertial system. New transformations obtained in this way are treated as a different model of the same Special Theory of Relativity. The interpretation of such models is such that the distinguished inertial system does not have any unique physical features, but is distinguished artificially.

Transformations of the Special Theory of Ether were not created by modifying the transformations previously known, but were derived from the basics (assumptions I-IV). Thanks to this, it was possible to derive completely new transformations (8)-(9) according to Michelson-Morley's and Kennedy-Thorndike's experiments. In the Special Theory of Ether, the universal frame of reference is a real system, not a freely chosen inertial frame of reference. According to the Special Theory of Ether, a universal frame of reference is distinguished from all inertial frames of reference by its physical properties. It is an only frame of reference in which the space is isotropic. From the perspective of any other inertial system, the space is not isotropic. However, related effects are very minor in inertial systems moving with low velocities relative to ether (non-relativistic speeds) [21]. In this case, it is similar to any other relativistic effect.

There is a very well documented astronomical observation, which shows that from the perspective of our frame of reference, the space is not isotropic [18]. This is the dipolar anisotropy of cosmic microwave background (Figure 2). There is a frame of reference in which the cosmic microwave background is isotropic. According to the Special Theory of Relativity, space should be isotropic for each observer; therefore, the dipolar anisotropy of the cosmic microwave background requires a special explanation within this theory. The existence of such a universal frame of reference is an argument in favour of the Special Theory of Ether and shows Lorentz symmetry breaking [21].

In theories with any space-filling medium, there may be an anisotropy for an observer moving in relation to this medium (even if such medium is isotropic). This property of the theory with the distinguished medium is consistent with the measurement of dipolar anisotropy of cosmic microwave background (CMB) discussed in Noble Lecture by G. Smoot [18]. If the cosmic microwave background is the thermal radiation of the distinguished isotropic medium (radiation of the black body), then the cosmic microwave background is isotropic in the reference frame associated with this medium, but shows dipolar anisotropy in the reference frames of reference moving in relation to the medium. In the Special Theory of Relativity, such an effect does not occur, because this theory is based on the assumption that physically, the space is isotropic and homogeneous for each observer from an inertial frame of reference.

For each kinematics it is possible to derive many dynamics. Examples for Special Theory of Ether were derived in monograph [19]. The examples for Special Theory of Relativity were derived in [25].

In [23], it was shown that the Lorentz transformations should be given a different interpretation than the one adopted in the Special Theory of Relativity. It has been shown that the commonly adopted interpretation of STR mathematics is incorrect, as it is a theory with desynchronized clocks that cause the unreal time to elapse measurements in inertial systems moving in relation to the observer. Incorrectly calibrated clocks are the cause of numerous paradoxes of STR.

The problem that mathematical formulas can be assigned different physical interpretations is not just about the Lorentz transformation. For example, in [26], it was shown that gravitational waves should be interpreted as an ordinary modulation of gravitational field intensities. The modulation resulting from the General Theory of Relativity is a property of a system of rotating bodies, not a property of the gravitational interaction, as is commonly believed today.

Ref. [24] explains what time is in physical theories and presents a proof that the mathematics of kinematics of the Special Theory of Relativity does not indicate that the speed of light in a vacuum is the maximum speed in nature. The notion that the speed of light in a vacuum is an impassable speed results from the overinterpretation of the mathematics on which the kinematics of STR is based. Ref. [24] shows that because in the Special Theory of Relativity and Special Theory of Ether kinematics a light signal is used to synchronize the clocks, a light clock is automatically introduced in these theories as a time standard. In other words, STR and STE are theories in which time is measured by the light clock. These are theories that describe the practical aspects of using such clocks. Therefore, in these theories, there is a time dilation phenomenon which is a natural property of the light clock.

Ref. [8] presents the original definition of acceleration in the Special Theory of Relativity, while Ref. [9] develops the formalism for three-vector and four-vector relative velocity. Refs. [12] and [13] relate to important insights into time dilation in relativity, while Ref. [14] presents alternative ideas for relativity. Numerous works discussed the zero result of the Michelson-Morley experiment, from which time dilation and the Lorentz-FitzGerald contraction results [1, 31]. Ref. [3] presents an analysis of various problems related to the Special Theory of Relativity, while the article [2] analyzes the generalized Sagnac effect in inertial frames as well as rotating frames. There are also published papers showing the paradoxes of the Special Theory of Relativity concerning rotating frames of reference [6]. Ref. [4] is investigating the subject of relativistic velocity addition. There are many papers on relativistic mechanics with significant theoretical results.

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