The derivation of the general form of kinematics with the universal reference system

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Summary

In the article, the whole class of time and position transformations was derived. These transformations were derived based on the analysis of the Michelson-Morley experiment [2] and its improved version, that is the Kennedy-Thorndike experiment [1]. It is possible to derive a different kinematics of bodies based on each of these transformations. In this way, we demonstrated that the Special Theory of Relativity is not the only theory explaining the results of experiments with light. There is the whole continuum of the theories of kinematics of bodies which correctly explain the Michelson-Morley experiment and other experiments in which the velocity of light is measured.

Based on the derived transformations, we derive the general formula for the velocity of light in vacuum measured in any inertial reference system. We explain why the Michelson-Morley and Kennedy-Thorndike experiments could not detect the ether. We present and discuss three examples of specific transformations. Finally, we explain the phenomenon of anisotropy of the cosmic microwave background radiation by means of the presented theory.

The theory derived in this work is called the Special Theory of Ether - with any transverse contraction.

Keywords: kinematics of bodies, universal frame of reference, transformation of time and position, one-way speed of light, anisotropy of cosmic microwave background

1. Introduction

It is a common belief in the contemporary physics that the Michelson-Morley experiment proved that the velocity of light is absolutely constant and that there is no universal reference system called the ether. Based on the analysis of these experiments, the Lorentz transformation, on which the Special Theory of Relativity is based, was derived. It is currently considered that the Special Theory of Relativity is the only theory of kinematics of bodies which correctly explains the Michelson-Morley experiment and all other experiments in which the velocity of light is measured.

It was assumed in considerations which led to the Special Theory of Relativity that all inertial systems are equivalent and that for every observer the velocity of light has constant value.

However, these assumptions are not justified by experiments. The assumptions that all inertial systems are equivalent was adopted because explaining the Michelson-Morley experiment by means of the theory with the universal reference system was too difficult. In this article, we show how to do it and that such theories are endless. It turns out that the velocity of light in one direction (momentary) has never been accurately measured. In all measurements of the velocity of light, only the average velocity of light traveling the path along the closed trajectory was measured. In order to measure the velocity of light, light had to return to the measuring device. In the simplest case, light was sent to a mirror and back as was done in experiments by Armand Fizeau in 1849 and by Jean Foucault in 1850. The same happens in Michelson-Morley and Kennedy-Thorndike experiments in which sources of light after being reflected by mirrors return to the source point. From these experiments, it is clear that the average velocity of light traveling the path to and back is constant, and not that the velocity of light in one direction (momentary) is constant.

We conducted the analysis of Michelson-Morley and Kennedy-Thorndike experiments with different assumptions than it was done in the Special Theory of Relativity.

2. The assumptions of kinematics of bodies

The following assumptions are adopted:

I. There is a universal frame of reference with respect to which the velocity of light in vacuum is the same in every direction. We call it the universal reference system or the ether.
II. The average velocity of light on its way to and back is for every observer independent of the direction of light propagation. This results from the Michelson-Morley experiment.
III. The average velocity of light on its way to and back does not depend on the velocity of the observer in relation to the universal frame of reference. This results from the Kennedy-Thorndike experiment.
IV. In the direction perpendicular to the direction of the body's velocity in relation to the universal reference system, its $\psi(v)$ - fold contraction occurs, where $\psi(v)>0$ is the function of transverse contraction dependent on the velocity v of the body in relation to the ether.
V. The transformation between universal frame of reference and inertial system is linear.

In works [4], [5], [6] and [7], we derived kinematics and dynamics of bodies for the above assumptions, but only for the case, when $\psi(v)=1$. In this work, we present kinematics with any transverse contraction, in which assumption IV was generalized and the function $\psi(v)>0$ can have a more complex form (Figure 1) [8].

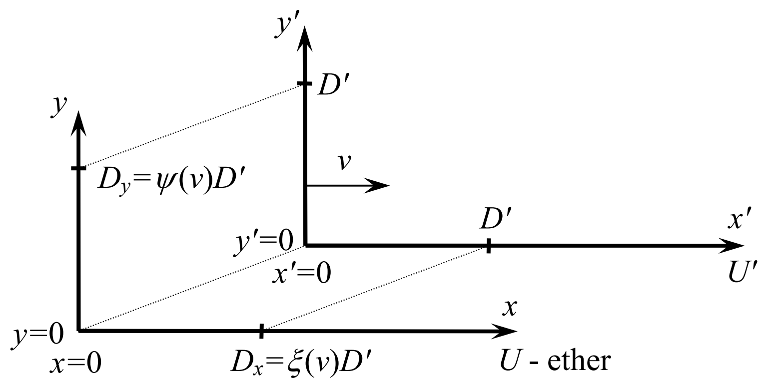

Fig. 1. The significance of a parameter of transverse contraction $\psi(v)$ and longitudinal contraction $\xi(v)$

The length perpendicular to the axis x and x' seen from the system U' as D', is seen from the system U as $\psi(v)D'$. If $\psi(v)=1$, then transverse contraction does not occur, that is all lengths perpendicular to the velocity v, the inertial system U' in relation to the ether U, have the same value for the observer from the inertial system U' and for the observer from the ether U.

The length parallel to x and x' seen from the system U' as D', is seen from the system U as $\xi(v)D'$. It will later turn out that for the adopted assumptions, the function of longitudinal contraction $\xi(v)$ depends on the function of transverse contraction $\psi(v)$ and the velocity v. Therefore, we do not adopt any assumptions for longitudinal contraction.

If the velocity v=0, then measurements from the system U' must be identical as those from the system U. Then $D'=D_y=\psi(0)D'$ occurs. On this basis, we obtain the important property of the function of transverse contraction

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

3. The light flow time and path in the ether

Let us consider the inertial system U', which moves in relation to the system U connected with the ether at the velocity v (Figure 2). There is a mirror in the system U' at the distance D' from the origin of the system. Light in the ether travels at the constant velocity c. When origins of systems overlap, a light stream is sent from the point x'=0 in the time t=0, in the direction of the mirror. After reaching the mirror, light reflects itself and moves in the ether in the opposite direction at the velocity with negative value, that is $-c$.

We assume the following symbols for the observer form the ether: t_1 is the time of light flow to the mirror, t_2 is the time of light return to the source point. L_1 and L_2 are paths which light traveled in the ether in one and the other direction.

When light goes in the direction of the mirror, then the mirror runs away from it at the velocity v. When light after being reflected from the mirror returns to the point x'=0, then this point runs toward it at the velocity v. For the observer from the system U, the distance D' parallel to the vector of the velocity v is seen as D_x. We obtain

$$L_1 = D_x + v \cdot t_1, \qquad L_2 = D_x - v \cdot t_2 \tag{2}$$

$$t_1 = \frac{L_1}{c} = \frac{D_x + v \cdot t_1}{c}, \qquad t_2 = \frac{L_2}{c} = \frac{D_x - v \cdot t_2}{c} \tag{3}$$

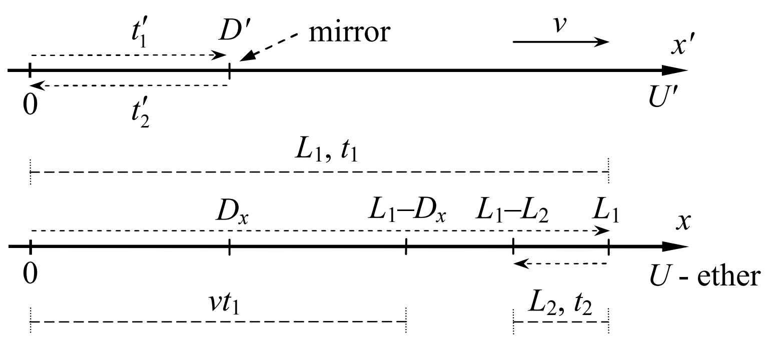

Fig. 2. The light flow time and path to the mirror and back

Dependencies (3) should be solved due to t_1 and t_2. Then, we obtain the light flow time and path in the ether

$$t_1 = \frac{D_x}{c-v}, \qquad t_2 = \frac{D_x}{c+v} \tag{4}$$

$$L_1 = c \cdot t_1 = D_x \frac{c}{c-v}, \qquad L_2 = c \cdot t_2 = D_x \frac{c}{c+v} \tag{5}$$

4. The geometric derivation of the general transformation

In this chapter, the transformation system-ether was derived by the geometric method. The complete geometric analysis of the Michelson-Morley experiment, which takes the light flow perpendicular and parallel to the direction of the movement of the system *U'* into account, was conducted.

We adopt assumptions from I to V listed in the introduction.

Figure 3 shows two systems. The system *U* rests in the ether, while the system *U'* moves in relation to the ether at the constant velocity *v*. Axes *x* and *x'* lie on one line. At the moment, when origins of systems overlapped, clocks were synchronized and set to zero in both systems. Clocks in the system *U* connected with the ether are synchronized by the internal method, that is based on distances of clocks and the known velocity of light which in the system *U* is constant. Clocks in the system *U'* are synchronized by the external method in such a way that the clock of the system *U* indicates the time t=0, then the clock of the system *U'* next to it is also set to zero, that is t'=0.

In the system *U'*, an experiment of measuring the velocity of light in vacuum perpendicularly and in parallel to the direction of the movement of the system *U'* in relation to the ether is conducted. In every of these directions, light travels the path to the mirror and back. In figure 3 in part *a*), light flow paths seen by the observer from the system *U'* are presented, while in part *b*), those seen by the observer from the system *U* are presented.

We denote the average velocity of light in the system *U'* by c_p.

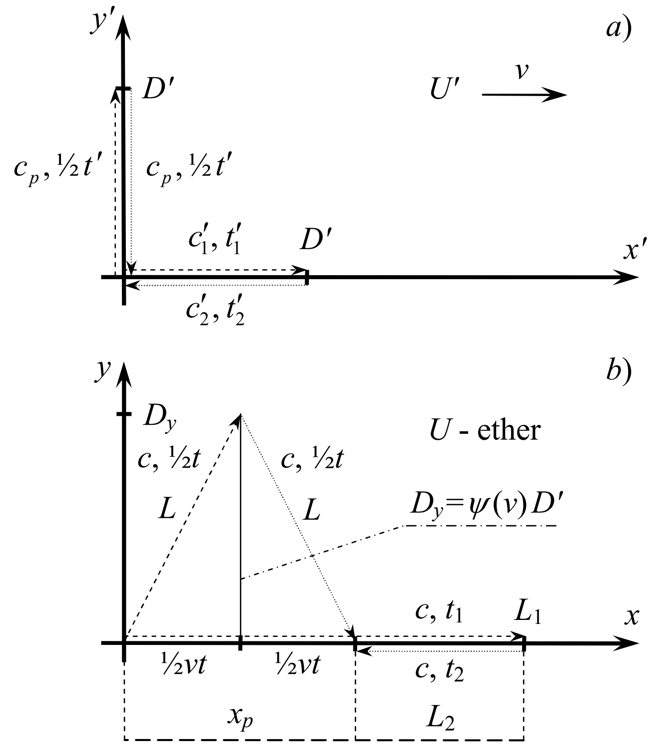

Fig. 3. Paths of two light streams
a) seen by the observer from the system *U'*, b) seen by the observer from the system *U* (the ether)

Mirrors are connected with the system *U'* and placed at the distance *D'* from the origin of the coordinate system. One mirror is on the axis *x'*, the other one on the axis *y'*.

In accordance with assumption IV, the distance D' in the system U' perpendicular to the velocity v has for the observer from the ether U value (transverse contraction)

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

The light flow time in the system U, along the axis x, to the mirror is denoted by t_1. The back-flow time is denoted by t_2.

The light flow time in the system U', along the axis x', to the mirror is denoted by t'_1. The back-flow time is denoted by t'_2.

The total time is denoted accordingly as t and t' ($t=t_1+t_2$ and $t'=t'_1+t'_2$).

Both light streams return to the source point at the same time, both in the system U and system U'. This results from assumption II and from the mirrors' setting at the same distance D' from the point of light emission.

A light stream, moving in parallel to the axis y', from the point of view of the system U moves along the arms of a triangle. Since the velocity of light in the system U is constant (assumption I), this triangle is isosceles. The length of its arm is denoted by L. Due to the constant velocity of light in the system U, the flow time along every arm is the same and is equal to $1/2t$.

In the system U, light stream running in parallel to the axis x in the direction of the mirror travels the distance L_1 in the time t_1. On the way back, it travels the distance L_2 in the time t_2. These distances are different due to the movement of the mirror and point, from which light is sent, in the ether.

If we allow that the average velocity of light c_p in the system U', is some function of the velocity of light c in the system U dependent on the velocity v, then

$$c_p(v) = f(v)c \tag{7}$$

Due to assumption III we have that $f(v_1)=f(v_2)$. Since $f(0)=1$, then $f(v)=1$ for every velocity v. As a result, the average velocity of light in the inertial system is equal to the velocity of light in one direction in the ether, that is

$$c_p = c \tag{8}$$

For the observer from the ether U, the following occurs

$$c = \frac{2L}{t} = \frac{L_1 + L_2}{t_1 + t_2} \tag{9}$$

For the observer from the inertial system U' after taking (8) into account, the following occurs

$$c = c_p = \frac{2D'}{t'_1 + t'_2} = \frac{2D'}{t'} \tag{10}$$

It is possible to determine the path L from equation (9), while it is possible to determine the path D' from equation (10). We obtain

$$L = \frac{ct}{2}; \quad D' = \frac{ct'}{2} \tag{11}$$

The velocity of the system U' in relation to the absolute reference system U is denoted by v. Because x_p is the path which the system U' will travel in the time t of the light flow, hence

$$v = \frac{x_p}{t}; \quad x_p = vt \tag{12}$$

Using the geometry presented in Figures 3, (6) and (12), the path L can be expressed as

$$L=\sqrt{(1/2x_p)^2+D_y^2}=\sqrt{(1/2vt)^2+(\psi(v)D')^2} \tag{13}$$

The equation (13) after having been squared and taking the dependence (11) into account has the form

$$(1/2ct)^2=(1/2vt)^2+(1/2\psi(v)ct')^2 \tag{14}$$

After arranging, we obtain

$$t^2(c^2-v^2)=(\psi(v)ct')^2 \tag{15}$$

$$t=t'\frac{\psi(v)}{\sqrt{1-(v/c)^2}} \quad \text{for} \quad x'=0 \tag{16}$$

In the above dependence, there are only times t and t' which concern the complete light flow to the mirror and back. It should be noted that these are times measured at the point x'=0. Since the length D' can be selected in such a way that the light flow time was unrestricted; therefore, dependence (16) is true for any time t' and time t corresponding to it.

The length D' connected with the system U' parallel to the axis x is seen as D_x from the point of view of the system U. Equations (5) express light flow paths in the system U in both directions along the axis x'

$$L_1=ct_1=D_x\frac{c}{c-v}; \qquad L_2=ct_2=D_x\frac{c}{c+v} \tag{17}$$

From equations (17), the sum and difference in paths L_1 and L_2, which light traveled in the ether, can be determined

$$\begin{aligned} L_1+L_2&=D_x\frac{c}{c-v}+D_x\frac{c}{c+v}=2D_x\frac{1}{1-(v/c)^2}, \\ L_1-L_2&=D_x\frac{c}{c-v}+D_x\frac{c}{c+v}=2D_x\frac{v}{c}\cdot\frac{1}{1-(v/c)^2} \end{aligned} \tag{18}$$

From the second equation, the distance that the system U' traveled in half of the light flow time $1/2t$ can be determined, that is

$$1/2x_p=1/2vt=\frac{L_1-L_2}{2}=D_x\frac{v}{c}\cdot\frac{1}{1-(v/c)^2} \tag{19}$$

Since it was assumed that in the system U (i.e. the ether), the velocity of light c is constant (assumption I); therefore, both paths which are traveled by light $2L$ and L_1+L_2 are the same

$$2L=L_1+L_2 \tag{20}$$

After substituting (13) and the first equation (18), we obtain

$$2\sqrt{(1/2vt)^2+(\psi(v)D')^2}=2D_x\frac{1}{1-(v/c)^2} \tag{21}$$

After reducing by 2 and squaring and taking (19) into account, we obtain

$$\left(D_x\frac{v}{c}\cdot\frac{1}{1-(v/c)^2}\right)^2+\psi^2(v)D'^2=D_x^2\left(\frac{1}{1-(v/c)^2}\right)^2 \tag{22}$$

That is

$$\psi^2(v)D'^2 = D_x^2\left(\frac{1}{1-(v/c)^2}\right)^2(1-(v/c)^2) \tag{23}$$

$$D' = D_x\left(\frac{1}{1-(v/c)^2}\right)\frac{\sqrt{1-(v/c)^2}}{\psi(v)} = D_x\frac{1}{\psi(v)\sqrt{1-(v/c)^2}} \tag{24}$$

We obtain a dependence for the length contraction in the form of (longitudinal contraction)

$$D_x = \xi(v)D' = \psi(v)\sqrt{1-(v/c)^2}\,D' \tag{25}$$

In the above dependence, lengths D_x and D', which are distances between mirrors and points of light emission, occur. Since the length D' can be selected freely; therefore, dependence (25) is true for any value D'.

Having introduced (16) into (12), we obtain

$$x = vt'\frac{\psi(v)}{\sqrt{1-(v/c)^2}} \quad \text{for} \quad x' = 0 \tag{26}$$

We assume that the transformation from the inertial system U' to the ether U is linear (assumption V). If linear factors dependent on x' are added to the transformation of time and position (16), (26), then we obtain the transformation with unknown coefficients *a, b*

$$\begin{aligned} t &= t'\frac{\psi(v)}{\sqrt{1-(v/c)^2}} + ax' \\ x &= vt'\frac{\psi(v)}{\sqrt{1-(v/c)^2}} + bx' \end{aligned} \tag{27}$$

The transformation (27) should be valid for any time and position. In the specific case, it is valid at the moment of clock synchronization, that is when $t=t'=0$ for the point with coordinates of D' in the system U'. In this respect, we introduce $t=t'=0$, $x'=D'$ and $x=D_x$ into the transformation (27). Having taken (25) into account, we obtain

$$\begin{aligned} &0 = aD' \\ &\psi(v)\sqrt{1-(v/c)^2}\,D' = bD' \end{aligned} \tag{28}$$

From here we obtain coefficients *a* and *b*

$$\begin{aligned} &a = 0 \\ &b = \psi(v)\sqrt{1-(v/c)^2} \end{aligned} \tag{29}$$

Finally, having introduced (29) into (27), the general form of the transformation from any inertial system U' to the system U connected with the ether will assume the form

$$\begin{cases} t = \dfrac{\psi(v)}{\sqrt{1-(v/c)^2}}t' \\ x = \dfrac{\psi(v)}{\sqrt{1-(v/c)^2}}vt' + \psi(v)\sqrt{1-(v/c)^2}\cdot x' \\ y = \psi(v)y' \\ z = \psi(v)z' \end{cases} \tag{30}$$

After transformation, we obtain the general form of the reverse transformation, that is the transformation from the system U connected with the ether to the inertial system U'

$$\begin{cases} t' = \dfrac{\sqrt{1-(v/c)^2}}{\psi(v)}t \\ x' = \dfrac{1}{\psi(v)\sqrt{1-(v/c)^2}}(-vt+x) \\ y' = \dfrac{y}{\psi(v)} \\ z' = \dfrac{z}{\psi(v)} \end{cases} \tag{31}$$

The determined transformations (30) and (31) are consistent with Michelson-Morley and Kennedy-Thorndike experiments. We will later prove that the above transformations show that the measurement of the velocity of light in vacuum by means of previously applied methods will always the average value equal to c. This is despite the fact that the velocity of light has a different value in different directions.

5. The transformation of velocity

Axes of the inertial system U' and the system U connected with the ether were determined in such a way that they were parallel to each other (Figure 4). The inertial system moves at the velocity v in parallel to the axis x and x'.

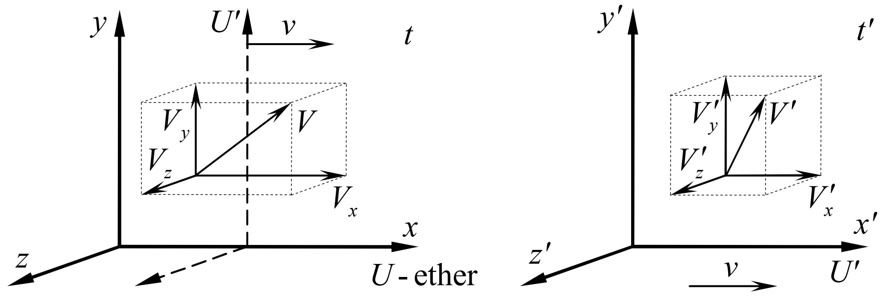

Fig. 4. The movement seen from the ether and the inertial system

Differentials from the transformation (31) have the form

$$\begin{cases} dt' = \dfrac{\sqrt{1-(v/c)^2}}{\psi(v)}dt \\ dx' = \dfrac{1}{\psi(v)\sqrt{1-(v/c)^2}}(-vdt+dx) \\ dy' = \dfrac{1}{\psi(v)}dy \\ dz' = \dfrac{1}{\psi(v)}dz \end{cases} \tag{32}$$

A moving body is observed from the ether U and the inertial system U'. In the ether, it moves at the velocity V, while in the inertial system, it moves at the velocity V'. Components of these velocities are presented in Figure 4.

The velocity of the body in the system of the ether U can be written in the form

$$V_x = \frac{dx}{dt}, \qquad V_y = \frac{dy}{dt}, \qquad V_z = \frac{dz}{dt} \tag{33}$$

The velocity of the body in the inertial system U' can be written in the form

$$V'_x = \frac{dx'}{dt'}, \qquad V'_y = \frac{dy'}{dt'}, \qquad V'_z = \frac{dz'}{dt'} \tag{34}$$

We introduce differentials (32) into equations (34). We obtain

$$\begin{cases} V'_x = \dfrac{\dfrac{1}{\psi(v)\sqrt{1-(v/c)^2}}(-vdt+dx)}{\dfrac{\sqrt{1-(v/c)^2}}{\psi(v)}dt} \\ V'_y = \dfrac{1}{\psi(v)}\dfrac{dy}{\dfrac{\sqrt{1-(v/c)^2}}{\psi(v)}dt} \\ V'_z = \dfrac{1}{\psi(v)}\dfrac{dz}{\dfrac{\sqrt{1-(v/c)^2}}{\psi(v)}dt} \end{cases} \tag{35}$$

That is

$$\begin{cases} V'_x = \dfrac{-v}{1-(v/c)^2} + \dfrac{1}{1-(v/c)^2}\dfrac{dx}{dt} \\ V'_y = \dfrac{1}{\sqrt{1-(v/c)^2}}\dfrac{dy}{dt} \\ V'_z = \dfrac{1}{\sqrt{1-(v/c)^2}}\dfrac{dz}{dt} \end{cases} \tag{36}$$

Based on (33), we obtain the searched transformation of velocity

$$\begin{cases} V'_x = \dfrac{V_x - v}{1-(v/c)^2} \\ V'_y = \dfrac{V_y}{\sqrt{1-(v/c)^2}} \\ V'_z = \dfrac{V_z}{\sqrt{1-(v/c)^2}} \end{cases} \tag{37}$$

It is interesting that the obtained transformation of velocity does not depend on the function of transverse contraction $\psi(v)$.

6. The velocity of light in vacuum for a moving observer

Generally, the light flow occurs along paths presented in Figure 5. Axes of coordinate systems are set in such a way that

$$c_z = c'_z = 0 \tag{38}$$

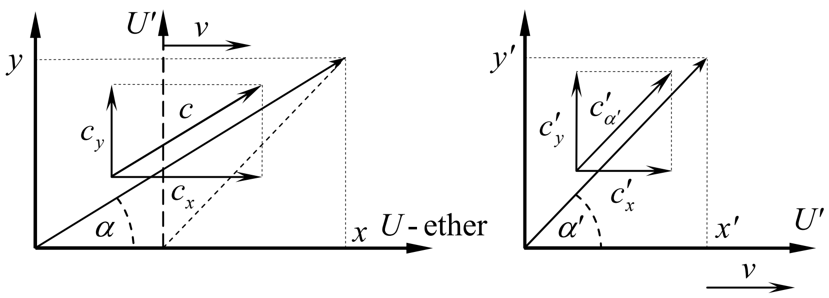

Fig. 5. The light flow at any angle

In accordance with the Figure based on the Pythagorean theorem, we obtain

$$c'^2_{\alpha'} = c'^2_x + c'^2_y \tag{39}$$

$$c^2 = c_x^2 + c_y^2 \tag{40}$$

The following also occurs

$$\cos\alpha' = \frac{c'_x}{c'_{\alpha'}} \tag{41}$$

When $V_x=c_x$ and $V'_x=c'_x$, then in accordance with (37) the following occurs

$$c'_x = \frac{c_x - v}{1-(v/c)^2} \tag{42}$$

$$c'_y = \frac{c_y}{\sqrt{1-(v/c)^2}} \tag{43}$$

6.1. The first dependence for the velocity of light

Having introduced dependencies (42) and (43) into (39), we obtain

$$c'^2_{\alpha'} = \left(\frac{c_x - v}{1-(v/c)^2}\right)^2 + \left(\frac{c_y}{\sqrt{1-(v/c)^2}}\right)^2 \tag{44}$$

$$c'^2_{\alpha'} = c^4\,\frac{(c_x - v)^2}{(c^2 - v^2)^2} + c^2\,\frac{c_y^2}{c^2 - v^2} \tag{45}$$

$$c'^2_{\alpha'} = \frac{c^2}{(c^2 - v^2)^2}[c^2(c_x - v)^2 + (c^2 - v^2)c_y^2] \tag{46}$$

Having taken (40) into account, we obtain

$$c'^2_{\alpha'} = \frac{c^2}{(c^2 - v^2)^2}[c^2(c_x^2 - 2vc_x + v^2) + (c^2 - v^2)(c^2 - c_x^2)] \tag{47}$$

$$c'^2_{\alpha'} = \frac{c^2}{(c^2 - v^2)^2}(c^2c_x^2 - 2vc^2c_x + v^2c^2 + c^4 - c^2c_x^2 - v^2c^2 + v^2c_x^2) \tag{48}$$

$$c'^2_{\alpha'} = \frac{c^2}{(c^2 - v^2)^2}(-2vc^2c_x + c^4 + v^2c_x^2) \tag{49}$$

$$c'^2_{\alpha'} = \frac{c^2}{(c^2 - v^2)^2}(c^2 - vc_x)^2 \tag{50}$$

On this basis, we obtain the first dependence for the velocity of light in the inertial system expressed from c_x

$$c'_{\alpha'} = \frac{c}{c^2 - v^2}(c^2 - vc_x) \tag{51}$$

6.2. The second dependence for the velocity of light

Based on (42) we obtain

$$c_x = v + (1 - (v/c)^2)c'_x = v + \frac{c^2 - v^2}{c^2}c'_x \tag{52}$$

After introducing it into (51), we obtain

$$c'_{\alpha} = \frac{c}{c^2 - v^2}\left[c^2 - v\left(v + \frac{c^2 - v^2}{c^2}c'_x\right)\right] \tag{53}$$

$$c'_{\alpha'} = \frac{c}{c^2 - v^2}\left[c^2 - v^2 - v\frac{c^2 - v^2}{c^2}c'_x\right] \tag{54}$$

$$c'_{\alpha'} = c - \frac{vc'_x}{c} \tag{55}$$

On this basis we obtain the second dependence for the velocity of light in the inertial system, expressed from c'_x

$$c'_{\alpha'} = \frac{c^2 - vc'_x}{c} \tag{56}$$

6.3. The third dependence for the velocity of light

Based on (56) we obtain

$$cc'_{\alpha'} = c^2 - vc'_x \tag{57}$$

$$cc'_{\alpha'} + vc'_x = c^2 \tag{58}$$

$$1 = \frac{c^2}{cc'_{\alpha'} + vc'_x} \tag{59}$$

$$c'_{\alpha'} = \frac{c^2 c'_{\alpha'}}{cc'_{\alpha'} + vc'_x} \tag{60}$$

$$c'_{\alpha'} = \frac{c^2}{c + v\dfrac{c'_x}{c'_{\alpha'}}} \tag{61}$$

From this equation based on (41) we obtain the third dependence for the velocity of light in the inertial system, expressed from α' (Figure 6)

$$c'_{\alpha'} = \frac{c^2}{c + v\cos\alpha'} \tag{62}$$

This formula is identical to formula (377) derived by the geometric method in the work [4]. It is interesting that the velocity of light in vacuum does not depend on the function of transverse contraction $\psi(v)$. It follows that this function cannot be determined based on the experiment of the measurement of the velocity of light in one direction.

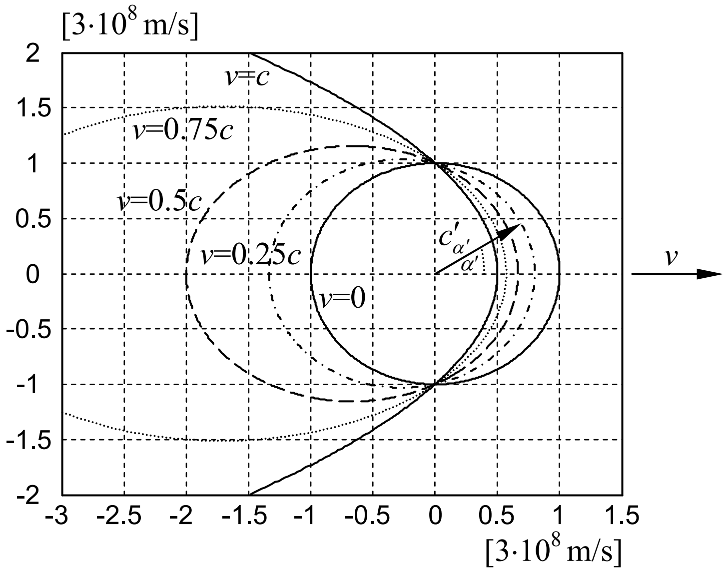

Fig. 6. The velocity of light $c'_{\alpha'}$ in the inertial system for v=0, 0.25c, 0.5c, 0.75c, c

We will now determine the average velocity of light which in any inertial system travels the path with the length L', is reflected from the mirror and returns along the same path to the source point. If t'_1 is the time needed for light to travel the path L' in one direction, while t'_2 is the time needed for light to travel the same path in the other direction, then the average velocity of light along the path back and forth is equal to

$$c'_{sr} = \frac{2L'}{t'_1 + t'_2} = \frac{2L'}{\dfrac{L'}{\dfrac{c^2}{c + v\cos\alpha'}} + \dfrac{L'}{\dfrac{c^2}{c + c\cos(180 - \alpha')}}} \tag{63}$$

$$c'_{sr} = \frac{2}{\dfrac{c + v\cos\alpha'}{c^2} + \dfrac{c - v\cos\alpha'}{c^2}} = \frac{2}{\dfrac{2c}{c^2}} = c \tag{64}$$

It follows that the average velocity of light is constant and equal to the velocity of light c seen from the ether. This average velocity does not depend on the angle α' nor the velocity v. For this reason, the rotation of the interferometer in Michelson-Morley and Kennedy-Thorndike experiments does not influence interference fringes. Therefore, these experiments could not detect the ether.

7. Examples of Special Theories of Ether

Below are presented three examples of transformations ether-system obtained for three different functions $\psi(v)$. Every such transformation contains the complete information on kinematics of bodies and can be the basis for the derivation of a separate theory of kinematics of bodies. Within each of these kinematics it is possible to derive numerous dynamics of bodies in a way analogous to the one presented in the work [4]. In order to derive dynamics, it is necessary to adopt the additional assumption.

The function of transverse contraction $\psi(v)$ must meet dependence (1) and assume unsigned values.

7.1. The Special Theory of Ether without transverse contraction

In the simplest case, it can be assumed that for any value of the velocity v

$$\psi(v)=1 \tag{65}$$

Then transformation (30) assumes the form

$$\begin{cases} t=\dfrac{1}{\sqrt{1-(v/c)^2}}t' \\ x=\dfrac{1}{\sqrt{1-(v/c)^2}}vt'+\sqrt{1-(v/c)^2}\cdot x' \\ y=y' \\ z=z' \end{cases} \tag{66}$$

Kinematics and dynamics of bodies which were derived in the work [4] are obtained for such a transformation. In this case of the Special Theory of Ether, transverse contraction does not occur. The Special Theory of Ether derived based on transformation (66) is closely linked to the Special Theory of Relativity by Einstein. This was proven in the work [4].

7.2. The Special Theory of Ether with the absolute time

If we assume that

$$\psi(v)=\sqrt{1-(v/c)^2}\leq 1 \tag{67}$$

then transformation (30) assumes the form

$$\begin{cases} t=t' \\ x=vt'+(1-(v/c)^2)\,x' \\ y=\sqrt{1-(v/c)^2}\cdot y' \\ z=\sqrt{1-(v/c)^2}\cdot z' \end{cases} \tag{68}$$

Based on this transformation, it is possible to derive STE with the absolute time. It is very interesting that the theory with the absolute time which meets the conditions of Michelson-Morley and Kennedy-Thorndike experiments is possible.

7.3. The Special Theory of Ether without longitudinal contraction

If we assume that

$$\psi(v) = \frac{1}{\sqrt{1-(v/c)^2}} \geq 1 \tag{69}$$

then transformation (30) assumes the form

$$\begin{cases} t = \dfrac{1}{1-(v/c)^2} t' \\ x = \dfrac{1}{1-(v/c)^2} vt' + x' = vt + x' \\ y = \dfrac{1}{\sqrt{1-(v/c)^2}} y' \\ z = \dfrac{1}{\sqrt{1-(v/c)^2}} z' \end{cases} \tag{70}$$

Kinematics in which there is no longitudinal contraction (in the direction parallel to the velocity v and the axis x) is obtained for such a transformation. At the same time, transverse elongation (in the direction perpendicular to the velocity v) occurs.

8. Anisotropy of cosmic microwave background

The outer space is filled with the microwave background radiation. Numerous studies on this subject were discussed in the work [3]. Accurate measurements of this radiation were conducted by COBE, WMAP and Planck satellites. The spectrum of this radiation is the same as the spectrum of the black-body radiation with a temperature of

$$\overline{T}_v = 2.726 \pm 0.010 \ \text{K} \tag{71}$$

The microwave background radiation is a light with a maximum intensity for the frequency of approximately 300 GHz. The background radiation has an irregularity (anisotropy) with an amplitude of

$$\Delta T_v = 3.358 \pm 0.017 \ \text{mK} \tag{72}$$

The lowest temperature of the background radiation can be observed in the vicinity of the Aquarius constellation, while the highest temperature in the vicinity of the Lion constellation. This means that, from the perspective of the Solar System, the Universe is slightly warmer on one side, while it is slightly cooler on the other side.

In accordance with all currently recognized theories, space is homogeneous (all points of space are equal) and isotropic (all directions in space are equal) and all inertial reference systems are equivalent. With these assumptions, if the cosmic microwave background radiation is to be generated by objects in space, then this radiation reaching the Earth should be the same from every direction. Since it is not the case; therefore, anisotropy of the cosmic microwave background radiation requires special explanation within valid theories.

The work [3] presents the explanation of anisotropy of the cosmic microwave background radiation which refers to the Big Bang theory. This radiation is said to be formed in the initial period of the evolution of the Universe when the whole matter became transparent. Then the radiation, which we observe today as the cosmic microwave background radiation, was released. This radiation is homogeneous in the inertial system in which it was formed. According to this concept, anisotropy of the cosmic microwave background radiation is caused by the Doppler effect for the observer moving in relation the reference system in which this radiation was formed. With such an explanation of this phenomenon, all inertial systems remain physically equivalent. However, such an explanation requires adopting many assumptions which cannot be verified experimentally. For example, the assumption that the whole matter in the universe was stationary in one inertial reference system at the moment when it became transparent is necessary.

Within the presented theory in this work, anisotropy of the cosmic microwave background radiation can be explained in a more natural way. It is known that the cosmic microwave background radiation is very penetrating through the matter; therefore, if its sources are dispersed in homogeneous space, then, it accumulated evenly in the whole space in a long time of existence of the universe. Thus, it can be assumed that the cosmic microwave background radiation is homogeneous in the universal reference system in which light propagates. According to our concept, anisotropy is caused by the Doppler effect seen by the observer moving in relation to the universal reference system in which light spreads. In this model, for the observer moving in relation the universal reference system, the cosmic microwave background radiation is not homogeneous despite the fact that space is homogeneous. Such an explanation of this phenomenon can be verified experimentally because it does not refer to the Big Bang theory. Anisotropy of the cosmic microwave background radiation is a very strong argument in favor of the existence of the reference system in which light propagates.

It is possible to determine the velocity at which the Solar System moves in relation to the ether based on anisotropy of the cosmic microwave background radiation. For this purpose, we will analyze the anisotropy of the cosmic microwave background radiation based on one of all possible kinematics of bodies. We will use the kinematics without transverse contraction described by transformations (66). We assume that the cosmic microwave background radiation is homogeneous in the system of the ether. We assume that it corresponds to temperature T_0 of a black body. The work [4] demonstrates that based on transformation (66) it is possible to derive a formula for the Doppler effect from the ether to the inertial system, the same as in the Special Theory of Relativity, that is

$$f_v = f_0 \frac{c - v\cos\alpha_E}{\sqrt{c^2 - v^2}} \quad \text{for} \quad \alpha_E \in (0 \div \pi) \tag{73}$$

where f_0 is the frequency of light in relation to the ether, while f_R is the frequency of this light in relation to the inertial system moving at the velocity v. While α_E an angle is between the velocity vector v and the vector of the speed of light. The angle α_E is seen from the universal frame of reference.

For α_E=0 the equation (73) comes down to

$$f_v^{\min} = f_0 \sqrt{\frac{(c-v)^2}{(c+v)(c-v)}} = f_0 \sqrt{\frac{c-v}{c+v}} \quad \text{for} \quad \alpha_E = 0 \tag{74}$$

On the basis of the Wien's displacement law, the length of a light wave with a maximum intensity is connected with a temperature of a black body emitting it as presented by this relation

$$\frac{1}{\lambda_{\max}} = \frac{T}{0.0029\,[\mathrm{m}\cdot\mathrm{K}]} \quad \Rightarrow \quad f = \frac{c}{\lambda_{\max}} = \frac{cT}{0.0029} \tag{75}$$

For the frequency seen in the universal frame of reference we get

$$f_0 = \frac{cT_0}{0.0029} \tag{76}$$

For the frequency seen by the moving observer

$$f_v^{\min} = \frac{cT_v^{\min}}{0.0029} = \frac{c(\overline{T}_v - \Delta T_v)}{0.0029} \quad \text{for} \quad \alpha_E = 0 \tag{77}$$

After substituting to (74) we receive

$$T_v^{\min} = \overline{T}_v - \Delta T_v = T_0\sqrt{\frac{c-v}{c+v}} \quad \text{for} \quad \alpha_E = 0 \tag{78}$$

On this basis, after slight transformations, we obtain

$$(T_0 \approx \overline{T}_v \quad \wedge \quad \alpha_E = 0) \quad \Rightarrow \quad v \approx c\frac{\overline{T}_v^2 - (\overline{T}_v - \Delta T_v)^2}{\overline{T}_v^2 + (\overline{T}_v - \Delta T_v)^2} \tag{79}$$

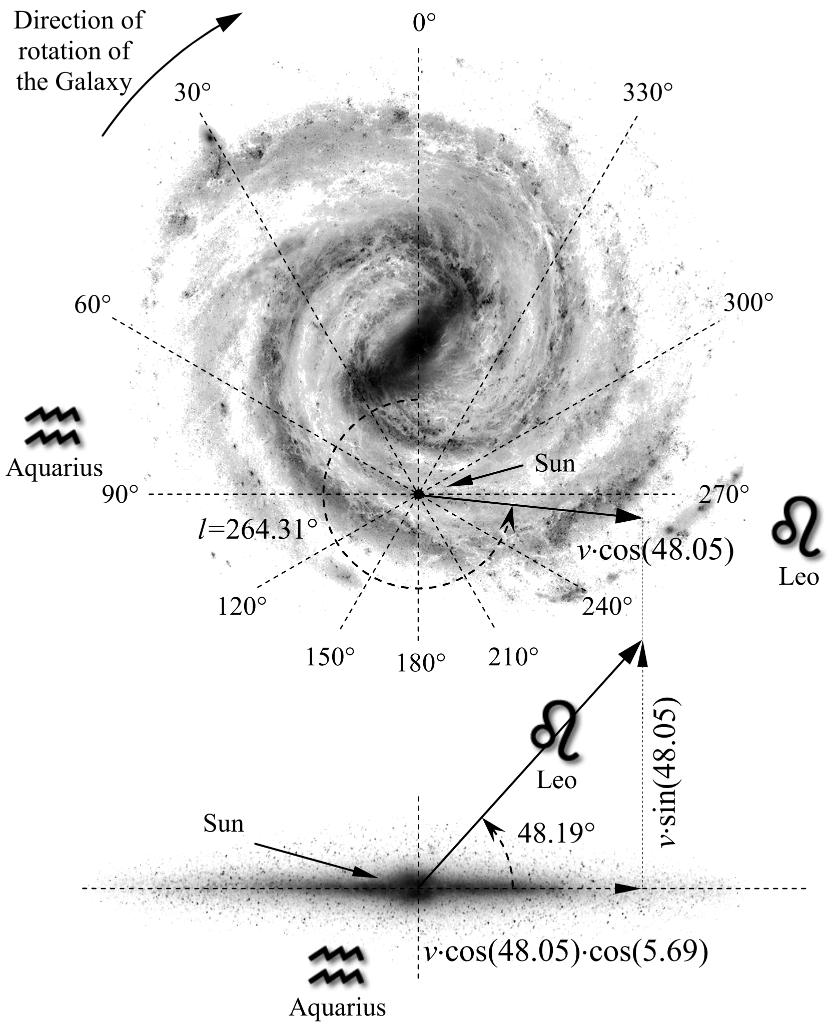

Fig. 7. The velocity of the Solar System in relation to the ether:
the projection on the plane of the Galaxy and the projection on the plane perpendicular to the plane of the Galaxy (90°-270°). The top view of the Milky Way galaxy (with marked galactic coordinates) and side view.

Finally, similarly to the work [3], based (71) and (72) we receive the velocity of the Solar System in relation to the universal frame of reference (c = 299792,458 km/s)

$$v = 369.5 \pm 3 \text{ km/s} \approx 0.001233 \cdot c \tag{80}$$

This velocity is turned in the direction of the Lion constellation, which corresponds to direction of the galactic coordinates (figure 7)

$$\begin{aligned} l &= 264.31° \pm 0.16° \\ b &= 48.05° \pm 0.10° \end{aligned} \tag{81}$$

In the work [4], the velocity of the Solar System in relation to the ether was estimated based on the vague experiment with disintegration of mesons K^+. The value obtained there is of the same order and is equal to 445 km/s.

9. The transformation between two inertial systems

The transformation from the inertial system U_2 to the system U, connected with the ether, can be written based on (30). The transformation from the system U connected with the ether to the inertial system U_1 can be written down based on (31). The velocity v_1 is the velocity of the system U_1 in the system U, while the velocity v_2 is the velocity of the system U_2 in the system U. Hence, we obtain

$$\begin{cases} t = \dfrac{\psi(v_2)}{\sqrt{1-(v_2/c)^2}} t_2 \\ x = \dfrac{\psi(v_2)}{\sqrt{1-(v_2/c)^2}} v_2 t_2 + \psi(v_2)\sqrt{1-(v_2/c)^2} \cdot x_2 \\ y = \psi(v_2) y_2 \\ z = \psi(v_2) z_2 \end{cases} \tag{82}$$

and

$$\begin{cases} t_1 = \dfrac{\sqrt{1-(v_1/c)^2}}{\psi(v_1)} t_2 \\ x_1 = \dfrac{1}{\psi(v_1)\sqrt{1-(v_1/c)^2}} (-v_1 t + x) \\ y_1 = \dfrac{y}{\psi(v_1)} \\ z_1 = \dfrac{z}{\psi(v_1)} \end{cases} \tag{83}$$

Let us consider only the simplest case in which velocities v_1 and v_2 are parallel to each other. We place equations (82) to equations (83). On this basis, after small transformations, we obtain the transformation from the inertial system U_2 to the inertial system U_1 in the form

$$\begin{cases} t_1 = \dfrac{\psi(v_2)}{\psi(v_1)} \dfrac{\sqrt{1-(v_1/c)^2}}{\sqrt{1-(v_2/c)^2}} t_2 \\ x_1 = \dfrac{\psi(v_2)}{\psi(v_1)} \dfrac{v_2 - v_1}{\sqrt{1-(v_1/c)^2}\sqrt{1-(v_2/c)^2}} t_2 + \dfrac{\psi(v_2)}{\psi(v_1)} \dfrac{\sqrt{1-(v_2/c)^2}}{\sqrt{1-(v_1/c)^2}} x_2 \\ y_1 = \dfrac{\psi(v_2)}{\psi(v_1)} y_2 \\ z_1 = \dfrac{\psi(v_2)}{\psi(v_1)} z_2 \end{cases} \tag{84}$$

10. Final conclusions

In this work, we proved that there is the whole class of theories with the universal reference system (the ether) which correctly explain experiments in which the velocity of light was measured. In all such experiments, light traveled a path along the closed trajectory; therefore, only the average velocity of light on this trajectory was measured. The velocity of light in one direction has never been measured accurately. Therefore, the assumption about the absolutely constant velocity of light, adopted by Albert Einstein in the Special Theory of Relativity (STR), has no experimental grounds.

In every theory with the ether presented here, the velocity of light in vacuum is expressed by the same formula (62). Despite the fact that the velocity of light has the value dependent on the direction of its emission and the velocity of the observer in relation to the ether, the average velocity of light on a path back and forth is always constant (63)-(64). Therefore, each of theories of ether is compatible with experiments in which the velocity of light was measured. Due to this property of the velocity of light, Michelson-Morley and Kennedy-Thorndike experiments cannot detect the ether.

Formula (62) for the velocity of light in one direction in vacuum is the same in each of the derived theories of kinematics of bodies. For this reason, it is not possible to resolve which is the correct model of the real kinematics of the derived theories based on the measurement of the velocity of light in one direction.

The currently recognized theory which explains the results of experiments with light is STR by Albert Einstein. It is commonly mistakenly believed that STR is the only theory of kinematics of bodies which explains these experiments.

The Special Theory of Ether built on the transformation ether-system (66) is closely linked to the Special Theory of Relativity by Einstein. Predictions of kinematics of the Special Theory of Relativity are the same as predictions of the Special Theory of Ether described by transformations (66), but only for observers stationary in relation to the ether. We proved this in the work [4].

Certainly, many of possible theories of ether can be discarded in advance because they are not the correct models of kinematics due to the incompatibility with various experiments. For example, it is known that the life time of accelerated basic particles is in our system longer than in the system of these particles; therefore, the model with the absolute time based on transformation (68) will probably be the incorrect model of kinematics. Resolving which of the Special Theories of Ether is the correct model of kinematics of bodies should be one of important tasks of future physics and will probably require resolving through experiments. The example of such an experiment can be the precisely performed Ives-Stillwell experiment in which time dilation is checked based on the Doppler's displacement for light.

Allowing the velocity of light to depend on the direction of its emission does not distinguish any direction in space. It relates, in fact, to the velocity of light which is measured by the moving observer. It is the velocity of light at which the observer moves in relation to the ether that distinguishes the characteristic direction in space, but only for this observer. For the observer stationary in relation to the ether, the velocity of light is always constant and does not depend on the direction of its emission. If the observer moves in relation to the ether, then space is not symmetrical for him. In his case, it will be similar as for the observer swimming in water and measuring the velocity of a wave on water. Despite the fact that the wave propagates on water at the constant velocity in every direction, for the swimming observer, the velocity of the wave will be different in different directions. For this reason, the presented theory based on assumptions I-V, explains anisotropy of the cosmic microwave background radiation in a simple way. Within the presented theory, this anisotropy is caused by the Doppler effect, which results from the movement of the Solar System in relation to the universal reference system, in which light propagates.

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