Properties of Kinematics with the Universal Frame of Reference

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Abstract:

In this article, we derive the properties of kinematics of bodies from the universal frame of reference (UFR, ether), which we called the Special Theory of Ether.

The article explains why Michelson-Morley and Kennedy-Thorndike experiments could not detect the universal frame of reference.

In article, a different transformation of time and position than the Lorentz transformation is derived on the basis of the geometric analysis of the Michelson-Morley and Kennedy-Thorndike experiments. The transformation is derived based on the assumption that the universal frame of reference exists. UFR is a frame of reference in which the velocity of light is constant in every direction. In inertial frames of reference moving in the UFR, the one-way velocity of light may be different.

Formulas for summation for absolute speed and relative speeds has been derived. The formulas for length contraction and dilatation of time were also derived.

The entire article contains only original research conducted by its authors.

Keywords: kinematics of bodies, universal frame of reference, coordinate and time transformation, the speed of light in one direction, length contraction, dilatation of time

PACS: 02.90.+p , 03.30.+p

1. Introduction

It is commonly thought that the Michelson-Morley experiment from 1887 and Kennedy-Thorndike experiment from 1932 demonstrated that the universal frame of reference does not exist and that the velocity of light in vacuum is absolutely constant. The analysis of this experiment led to the creation of the Special Theory of Relativity (STR).

The article an explanation the results of the Michelson-Morley [3] and Kennedy-Thorndike [1] experiments, assuming the existence of the universal frame of reference (UFR), in which the velocity of light is constant, is presented. In inertial frames of reference moving in the UFR, the one-way velocity of light may be different. The transformations from the inertial system to the UFR and from the UFR to the inertial system was derived by the geometric method.

The velocity of light in one direction has never been accurately measured. In all accurate laboratory experiments, as in the Michelson-Morley experiment, only the average velocity of light, travelling on a closed trajectory, was measured. In these experiments, light always comes back to the source point. Therefore, the assumption about the constant velocity of light (instantaneous velocity) adopted in the Special Theory of Relativity is not experimentally justified. The derivation presented in this article is based on the assumption resulting from these experiments, that is for every observer, the average velocity of light travelling the way to and back is constant.

The transformation «UFR - inertial system» (27)-(28) derived in this article by the geometric method was already derived in articles [2] and [12] by other method. In article [2] the author obtained this transformation from the Lorentz transformation thanks to the synchronization of clocks in inertial frames by the external method. The transformation obtained in the work [2] is the Lorentz transformation differently written down after a change in the manner of time measurement in the inertial frame of reference, this is why the properties of the Special Theory of Relativity were attributed to this transformation. The transformation (27)-(28) has a different physical meaning than the Lorentz transformation, because according to the theory outlined in this article, it is possible to determine the speed with respect to a universal frame of reference by local measurement. So the universal reference system is real, and this is not a freely chosen inertial system.

2. The Assumptions

In the presented analysis of the Michelson-Morley and Kennedy-Thorndike experiments, the following assumptions are adopted:

I. There is a universal frame of reference (UFR) with respect to which the velocity of light in vacuum is the same in every direction.
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 UFR. This results from the Kennedy-Thorndike experiment.
IV. In the direction perpendicular to the direction of the velocity of the body, moving in relation to the UFR, there is no contraction or elongation of its length.
V. The transformation «UFR - inertial system» is linear.

The transformation derivation presented in this article differs from the derivation by the geometric method of the Lorentz transformation which is the basis for the STR. In STR in the derivation of the Lorentz transformation, it is assumed that the reverse transformation has the same form as the original transformation. Such an assumption stems from the belief that all inertial frames are equivalent. In the derivation presented in this article, we do not assume what form the reverse transformation has.

Assumptions concerning the velocity of light adopted in this article are also weaker than those adopted in the STR. In the STR, it is assumed that the velocity of light is absolutely constant, despite the fact that it has not been proven by any experiment. In this article, the assumption resulting from experiments is adopted, i.e. the average velocity of light on the way to the mirror and back is constant (assumption II and III). In the presented considerations, the velocity of light by assumption is constant only in one highlighted frame of reference - the UFR (assumption I).

Assumptions IV and V are identical to those on which the STR is based.

In works [6] and [7], identical transformations were derived as in this article, but with the adopted additional assumption. For this, it was necessary to conduct the full analysis of the Michelson-Morley experiment in which also the second stream of light, parallel to velocity v, is taken into account. In that case, only one stream of light was analyzed.

3. Time and way of the light flow in the UFR

Let us consider inertial system U', which moves in relation to system U related with the UFR at velocity v (Figure 1). In system U', there is a mirror at distance D' from the beginning of the system. Light in the system U moves at constant velocity c. From system U', from point $x'=0$ in time $t=0$, a stream of light was sent in the direction of the mirror. Having reached the mirror, the reflected light moves in the system U in the opposite direction at velocity with the negative value $-c$.

We assume the following symbols for the observer from the system U: t_1 is the time of the light flow to the mirror, t_2 is the time of the light return to the starting point. L_1 and L_2 are ways which were travelled by light in the system U in one direction and in another.

When light moves in the direction of the mirror, then the mirror runs away from it at velocity v. When light comes back to point $x'=0$ after the reflection from the mirror, then this point runs towards it at velocity v. For an observer from system U, distance D' parallel to velocity vector v is seen as D. We obtain

$$L_1 = D + v \cdot t_1, \qquad L_2 = D - v \cdot t_2 \tag{1}$$

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

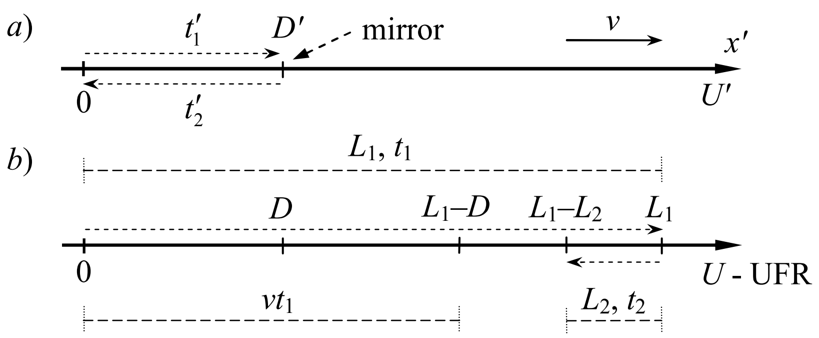

Fig. 1. The time and the flow path of light to the mirror and back:
a) the way of light seen from the inertial system U',
b) the way of light seen from the UFR.

Dependencies (2) should be solved due to t_1 and t_2. We then obtain time and way of flow in the UFR

$$t_1 = \frac{D}{c-v}, \qquad t_2 = \frac{D}{c+v} \tag{3}$$

$$L_1 = c \cdot t_1 = D\frac{c}{c-v}, \qquad L_2 = c \cdot t_2 = D\frac{c}{c+v} \tag{4}$$

4. The Geometrical Derivation of the Transformation

We analyze the results of the Michelson-Morley experiment, as shown in Figure 2. The inertial system U' move sat a relative velocity v to the inertial system U, associated with the UFR, parallel to the axis x. Axes x and x' lie on one straight line.

At the moment when origins of systems overlap, clocks in both systems are synchronized. Clocks in system U related to the UFR are synchronized by the internal method [2]. Clocks in system U' are synchronized by the external method in such a manner that if the clock of system U indicates time t=0, then the clock of system U' next to it is also reset, that is t'=0.

In the system U', an experiment measuring the velocity of light in vacuum perpendicular and parallel to the direction of movement of the system U' in relation to the UFR was conducted. In each of these directions, light travels to the mirror and back. Figure 2 presents in part *a*) the flow path of light seen by the observer from the system U', while in part *b*) the path seen by the observer from the system U.

In system U light has always constant velocity c (assumption I). Considerations concern the flow of light in vacuum.

In accordance with conclusions resulting from the Michelson-Morley experiment it has been assumed that the average velocity of light c_p on the way to the mirror and back in system U' is the same in every direction, in particular in the parallel direction to the axis y' (assumption II). It has also been assumed that the average velocity of light c_p on the way to the mirror and back does not depend on the velocity of an observer in relation to the UFR (assumption III).

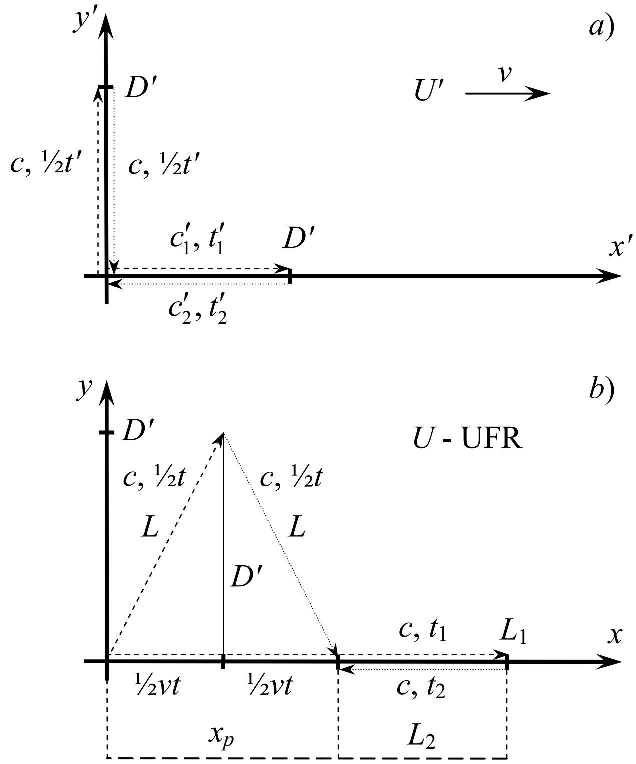

Fig. 2. Paths of two streams of light:
a) seen by an observer from the system U',
b) seen by an observer from the system U (UFR).

From assumption II and III it follows that the average velocity of light c_p in the inertial frame of reference is the same as the velocity of light c in the system U. If we allow that the average velocity of light c_p in the system U' is a function of the velocity of light c in the system U dependent on the velocity v, we can write

$$c_p = f(v)c \tag{5}$$

From assumption III the average velocity of light is the same for different velocities of the Earth relative to the UFR, so $f(v_1)=f(v_2)$. Since $f(0)=1$, therefore $f(v)=1$ for every velocity v. It follows that $c=c_p$.

The mirrors are associated with the system U' and placed at distance D' from the origin. One mirror is located on the axis x', the second one on the axis y'. We assume that the distance D', which is perpendicular to the velocity v is the same for observers from both systems (assumption IV). Therefore, in Figure 2, there is the same length D' in part *a*) and part *b*).

The flow time of light in the system U, along the axis x, in the direction to the mirror is marked as t_1. The flow time back is marked as t_2.

The flow time of light in the system U', along the axis x', in the direction to the mirror is marked as t'_1. The flow time back to the source is marked t'_2.

Total time is marked respectively as t and t' ($t = t_1+t_2$ and $t' = t'_1+t'_2$).

The light stream, moving parallel to the axis y', from the point of view of the system U moves along the arms of an isosceles triangle of side length L. Since the velocity of light is constant in the system U, therefore, the time of movement along both arms is the same and is equal to $t/2$.

In the system U, the light stream parallel to the axis x, in the direction of the mirror overcomes distance L_1 during time t_1. On the way back, it travels distance L_2 during time t_2. These distances are different due to the movement of the mirror and the source point of light in the UFR.

In the experiment, both light streams come back to the source point at the same time, both in system U and system U'. It results from assumption II and from the mirrors' setting at the same distance from the point of light emission.

For an observer of U' and U, the velocity of light can be written as

$$\frac{2D'}{t'_1+t'_2}=\frac{2D'}{t'}=c=\frac{2L}{t}=\frac{L_1+L_2}{t_1+t_2} \tag{6}$$

From equation (6) light paths L and D' as a function of the velocity of light c and the light flow times t, t' respectively in the systems U and U' can be determined

$$L=\frac{ct}{2};\quad D'=\frac{ct'}{2} \tag{7}$$

The velocity of the system U' relative to the absolute frame of reference U, i.e. the UFR is marked by v. Since x_p is the path that the system U' travelled in time t, of the light flow, we have

$$v=\frac{x_p}{t};\quad x_p=vt \tag{8}$$

Using the geometry of Figure 2, the length L can be expressed as

$$L=\sqrt{(x_p/2)^2+D'^2}=\sqrt{(vt/2)^2+D'^2} \tag{9}$$

Having squared equation (9) and taken (7) into account, we obtain

$$(ct/2)^2=(vt/2)^2+(ct'/2)^2 \tag{10}$$

After arranging we obtain

$$t^2(c^2-v^2)=(ct')^2 \tag{11}$$

$$t=t'\frac{1}{\sqrt{1-(v/c)^2}}\quad \text{for}\quad x'=0 \tag{12}$$

The above relation describes only times t and t' that involve the full light flow to the mirror and back. It should be noted that these are times measured in point x'=0. However, if we assume that the length D' can be chosen so that time flow of light is any time, so the relationship (12) is true for any time.

Length D' associated with the system U' that is parallel to the axis x, and is seen from the system U as D. If light flows in the absolute frame of reference U to the mirror, is chasing the mirror, which is away from it at length D. After reflection, light returns to the source point, which runs against him. Using equations (4), we obtain the equations for light flow paths in both directions along the axis x' in the system U

$$L_1 = ct_1 = D\frac{c}{c-v}; \qquad L_2 = ct_2 = D\frac{c}{c+v} \tag{13}$$

From equations (13) the sum and difference in length the L_1 and L_2, which light travelled in the system U, can be determined

$$\begin{aligned} L_1 + L_2 &= D\frac{c}{c-v} + D\frac{c}{c+v} = 2D\frac{1}{1-(v/c)^2}, \\ L_1 - L_2 &= D\frac{c}{c-v} - D\frac{c}{c+v} = 2D\frac{v}{c}\cdot\frac{1}{1-(v/c)^2} \end{aligned} \tag{14}$$

From the second equation, the distance that the system U' travelled in half of the light flow time $t/2$ can be determined, so we have

$$\frac{x_p}{2} = \frac{vt}{2} = \frac{L_1 - L_2}{2} = D\frac{v}{c}\frac{1}{1-(v/c)^2} \tag{15}$$

Since it was assumed that in the system U the velocity of light c is constant, therefore both distances, which are travelled by light $2L$ and L_1+L_2 are the same

$$2L = L_1 + L_2 \tag{16}$$

After substituting (9) and the first equation (14) we obtain

$$2\sqrt{(vt/2)^2 + D'^2} = 2D\frac{1}{1-(v/c)^2} \tag{17}$$

After reducing by two, raising to the square and taking (15) into account we can write

$$\left(D\frac{v}{c}\cdot\frac{1}{1-(v/c)^2}\right)^2 + D'^2 = D^2\left(\frac{1}{1-(v/c)^2}\right)^2 \tag{18}$$

From equation (18) a dependence for the length contraction can be determined

$$\begin{aligned} D'^2 &= D^2\left(\frac{1}{1-(v/c)^2}\right)^2(1-(v/c)^2) \\ D' &= D\left(\frac{1}{1-(v/c)^2}\right)\sqrt{1-(v/c)^2} = D\frac{1}{\sqrt{1-(v/c)^2}} \end{aligned} \tag{19}$$

$$D = D'\sqrt{1-(v/c)^2} \tag{20}$$

Lengths D and D' which are distances between mirrors and the point of light emission occur in the above dependence. Since length D' can be selected on a voluntary basis; therefore, dependence (20) is true for any value of D'.

Having introduced (12) to (8), we have

$$x_p = vt'\frac{1}{\sqrt{1-(v/c)^2}} \quad \text{for} \quad x' = 0 \tag{21}$$

We assume that the transformation from the inertial system U' to the system U is linear (assumption V). If linear factors dependent on x' are added to the transformation of time and position (12), (21), transformations with unknown coefficients a, b can be obtained

$$\begin{aligned} t &= t'\frac{1}{\sqrt{1-(v/c)^2}} + ax' \\ x &= vt'\frac{1}{\sqrt{1-(v/c)^2}} + bx' \end{aligned} \tag{22}$$

Transformation (22) should be valid for any time and position. In a particular case, it is valid at the moment of clocks' synchronization, that is when $t=t'=0$ for the point with coordinates D' in system U'. In this connection, we introduce $t=t'=0$, $x'=D'$ and $x=D$ into (22). At this point it has been applied external synchronization of clocks in a U' on the basis of clocks in the ether. Having taken (20) into account, we obtain

$$\begin{aligned} &0 = aD' \\ &\sqrt{1-(v/c)^2}\,D' = bD' \end{aligned} \tag{23}$$

We obtain coefficients a and b

$$\begin{aligned} a &= 0 \\ b &= \sqrt{1-(v/c)^2} \end{aligned} \tag{24}$$

Finally, the transformation from any inertial system U' to the system U, associated with the UFR takes the form

$$t = \frac{1}{\sqrt{1-(v/c)^2}}\,t' \tag{25}$$

$$x = \frac{1}{\sqrt{1-(v/c)^2}}\,vt' + \sqrt{1-(v/c)^2}\cdot x' \tag{26}$$

After transformations of the above equations, we obtain the inverse transformation, that is the transformation from the system U, associated with the UFR to the inertial system U'

$$t' = \sqrt{1-(v/c)^2}\cdot t \tag{27}$$

$$x' = \frac{1}{\sqrt{1-(v/c)^2}}(-vt + x) \tag{28}$$

The velocity v is the velocity of the inertial system relative to the universal reference system.

5. 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 (25)-(26). The transformation from the system U connected with the ether to the inertial system U_1 can be written down based on (27)-(28). 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

$$\begin{cases} t = \dfrac{1}{\sqrt{1-(v_2/c)^2}} t_2 \\ x = \dfrac{1}{\sqrt{1-(v_2/c)^2}} v_2 t_2 + \sqrt{1-(v_2/c)^2} \cdot x_2 \\ y = y_2 \\ z = z_2 \end{cases} \tag{29}$$

and

$$\begin{cases} t_1 = \sqrt{1-(v_1/c)^2} \cdot t \\ x_1 = \dfrac{1}{\sqrt{1-(v_1/c)^2}} (-v_1 t + x) \\ y_1 = y \\ z_1 = z \end{cases} \tag{30}$$

Let us consider only the simplest case in which velocities v_1 and v_2 are parallel to each other. We place equations (29) to equations (30). 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

$$\begin{cases} t_1 = \dfrac{\sqrt{1-(v_1/c)^2}}{\sqrt{1-(v_2/c)^2}} t_2 \\ x_1 = \dfrac{v_2 - v_1}{\sqrt{1-(v_1/c)^2}\sqrt{1-(v_2/c)^2}} t_2 + \dfrac{\sqrt{1-(v_2/c)^2}}{\sqrt{1-(v_1/c)^2}} x_2 \\ y_1 = y_2 \\ z_1 = z_2 \end{cases} \tag{31}$$

6. Speeds in STE

6.1. The speed of light in the inertial system

In works [5] and [11], based on the transformation (25)-(28), a general formula for the velocity of light running in any direction in vacuum is derived. It has the form of (Figure 3)

$$c'_{\alpha'} = \frac{c^2}{c + v\cos\alpha'} \tag{32}$$

For light moving in a material medium motionless in relation to the observer, it has the form of ([11])

$$c'_{s\alpha'} = \frac{c^2 c_s}{c^2 + c_s v\cos\alpha'} \tag{33}$$

In these two dependencies, angle α' is the angle, measured by the observer, between the vector of its velocity in relation to the UFR and the vector of the velocity of light. Velocity c_s is the velocity of light in the material medium motionless in relation to the UFR seen by the observer motionless in relation to the UFR. Formula (33) come down to formula (32), if we substitute c_s=c.

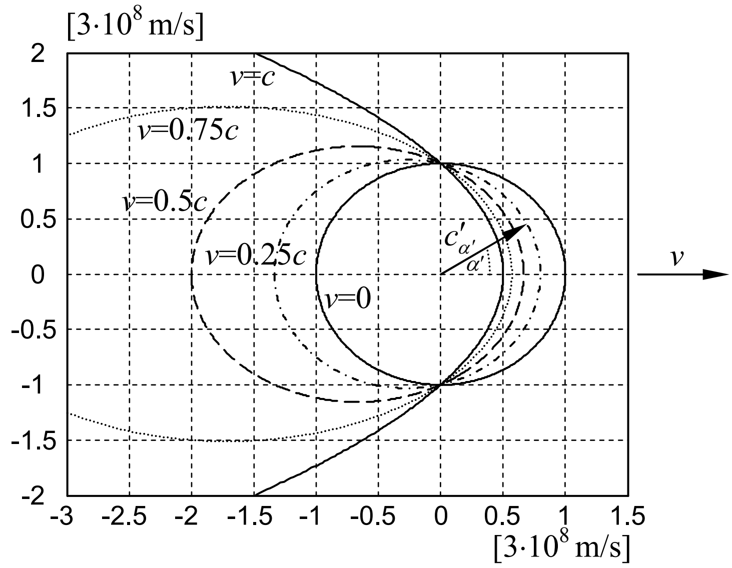

Fig. 3. The one-way speed of light $c'_{\alpha'}$ in inertial system for v=0, 0.25c, 0.5c, 0.75c, c.

In the system U_1, let light run in parallel to velocity v_1 of the system U_1 relative to the UFR (Figure 4). Just as in the Michelson-Morley experiment, light runs along the way L over time t'. At the end of the way, light is reflected in the mirror and goes back along the same way L over time t''. Then, the average velocity of light in inertial system U_1 can be described on the basis of (33) and is equal to

$$c'_{sr} = \frac{2L}{t'_{s\alpha'} + t'_{s(\pi-\alpha')}} = \frac{2L}{\dfrac{L}{\dfrac{c^2 c_s}{c^2 + c_s v \cos\alpha'}} + \dfrac{L}{\dfrac{c^2 c_s}{c^2 + c_s v \cos(\pi-\alpha')}}} \tag{34}$$

$$c'_{sr} = \frac{2}{\dfrac{c^2 + c_s v \cos\alpha'}{c^2 c_s} + \dfrac{c^2 - c_s v \cos\alpha'}{c^2 c_s}} = \frac{2}{\dfrac{2c^2}{c^2 c_s}} = c_s \tag{35}$$

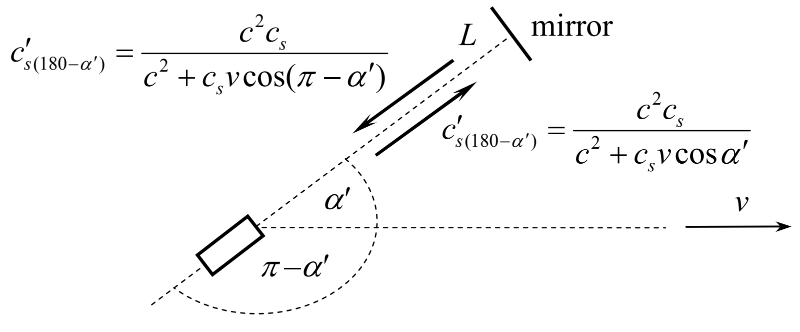

Fig. 4. The velocity of light in the Michelson-Morley experiment.

From dependence (35) it follows that c_s is also the average velocity of light on the way to the mirror and back in the material medium motionless in relation to the a moving observer. Despite the fact that the velocity of light expressed by formula (33) depends on angle α' and velocity v, the average velocity of light on the way to the mirror and back is always constant and is equal to c_s. This velocity agrees with the results of the Michelson-Morley and Kennedy-Thorndike experiments, which shows that the average velocity of light is constant and is equal to c in vacuum or c_s in a material medium (the average velocity, not instantaneous). We have shown that the Michelson-

Morley experiment does not imply that the current velocity of light is constant in every direction. Stating that the Michelson-Morley experiment proved that there is no universal frame of reference in which light propagates and moves at a constant velocity is also untrue.

6.2. Relative velocity and adding absolute speed

On the basis of (31) we get the differentials

$$\begin{cases} dt_1 = \dfrac{\sqrt{1-(v_1/c)^2}}{\sqrt{1-(v_2/c)^2}}dt_2 \\ dx_1 = \dfrac{v_2 - v_1}{\sqrt{1-(v_1/c)^2}\sqrt{1-(v_2/c)^2}}dt_2 + \dfrac{\sqrt{1-(v_2/c)^2}}{\sqrt{1-(v_1/c)^2}}dx_2 \end{cases} \tag{36}$$

The relative velocity of the inertial system U_2 relative to the inertial system U_1 is equal to the velocity of any point x_2 from the system U_2 relative to the system U_1. It is therefore

$$v_{2/1} = \frac{dx_1}{dt_1} = \frac{\dfrac{v_2 - v_1}{\sqrt{1-(v_1/c)^2}\sqrt{1-(v_2/c)^2}}dt_2 + \dfrac{\sqrt{1-(v_2/c)^2}}{\sqrt{1-(v_1/c)^2}}dx_2}{\dfrac{\sqrt{1-(v_1/c)^2}}{\sqrt{1-(v_2/c)^2}}dt_2}, \quad \text{gdzie} \quad dx_2 = 0 \tag{37}$$

So the relative velocity of the two inertial systems that are moving relative to UFR in the same direction is

$$v_{2/1} = \frac{\dfrac{v_2 - v_1}{\sqrt{1-(v_1/c)^2}\sqrt{1-(v_2/c)^2}}}{\dfrac{\sqrt{1-(v_1/c)^2}}{\sqrt{1-(v_2/c)^2}}} = \frac{v_2 - v_1}{1-(v_1/c)^2} \tag{38}$$

On the basis of (38) we obtain the formula for summing absolute velocities

$$v_2 = v_1 + v_{2/1}(1-(v_1/c)^2) \tag{39}$$

6.3. Adding relative speeds

Figure 5 shows there three inertial systems U_1, U_2, U_3. Relative velocities between the systems are shown.

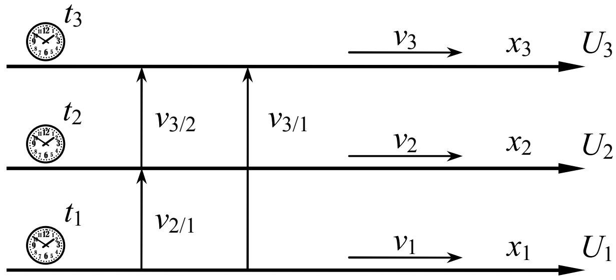

Fig. 5. Inertial systems U_1, U_2, U_3 moving in the UFR at velocities v_1, v_2, v_3.

On the bases (38) and (39) can be write

$$v_{3/1} = (v_3 - v_1)\frac{1}{1-(v_1/c)^2} \tag{40}$$

$$v_1 = v_2 - v_{2/1}(1-(v_1/c)^2) \tag{41}$$

$$v_3 = v_2 + v_{3/2}(1-(v_2/c)^2) \tag{42}$$

By putting (41) and (42) them into the equation (40) we obtain

$$v_{3/1} = (v_2 + v_{3/2}(1-(v_2/c)^2) - v_2 + v_{2/1}(1-(v_1/c)^2))\frac{1}{1-(v_1/c)^2} \tag{43}$$

Finally, we get the formula for summing relative speeds

$$v_{3/1} = v_{3/2}\frac{1-(v_2/c)^2}{1-(v_1/c)^2} + v_{2/1} \tag{44}$$

On the base of (38) occurs

$$1-(v_1/c)^2 = \frac{v_2 - v_1}{v_{2/1}} \quad \text{oraz} \quad 1-(v_2/c)^2 = \frac{v_1 - v_2}{v_{1/2}} \tag{45}$$

On this basis, the formula for summing of relative speeds (44) takes the form

$$v_{3/1} = -v_{3/2}\frac{v_{2/1}}{v_{1/2}} + v_{2/1} \tag{46}$$

7. Contractions in STE

7.1. The length contraction

Consider two systems U_1 and U_2 moving in the ether in the same direction, respectively at velocities v_1 and v_2. Within these systems, two identical lines with length $L_0=L_{1/1}=L_{2/2}$ are fixedly arranged in parallel to the direction of movement. The ends of the fixed line in the system U_2 are in the system in the position x_2^A and x_2^B. On the basis of (31), for every time t_2, the ends of the lines have coordinates in the system U_1

$$x_{2/1}^A = \frac{v_2 - v_1}{\sqrt{1-(v_1/c)^2}\cdot\sqrt{1-(v_2/c)^2}}t_2 + \frac{\sqrt{1-(v_2/c)^2}}{\sqrt{1-(v_1/c)^2}}x_2^A \tag{47}$$

$$x_{2/1}^B = \frac{v_2 - v_1}{\sqrt{1-(v_1/c)^2}\cdot\sqrt{1-(v_2/c)^2}}t_2 + \frac{\sqrt{1-(v_2/c)^2}}{\sqrt{1-(v_1/c)^2}}x_2^B \tag{48}$$

Having subtracted by sides (48) and (47), we obtain $L_{2/1}$, that is the length of a line from the system U_2 seen in the system U_1

$$L_{2/1} = x_{2/1}^B - x_{2/1}^A = \frac{\sqrt{1-(v_2/c)^2}}{\sqrt{1-(v_1/c)^2}}(x_2^B - x_2^A) \tag{49}$$

Because

$$L_0 = x_2^B - x_2^A \tag{50}$$

we calculated the formula for reducing the length expressed by the absolute velocity

$$L_{2/1} = \frac{\sqrt{c^2 - v_2^2}}{\sqrt{c^2 - v_1^2}} L_0 \tag{51}$$

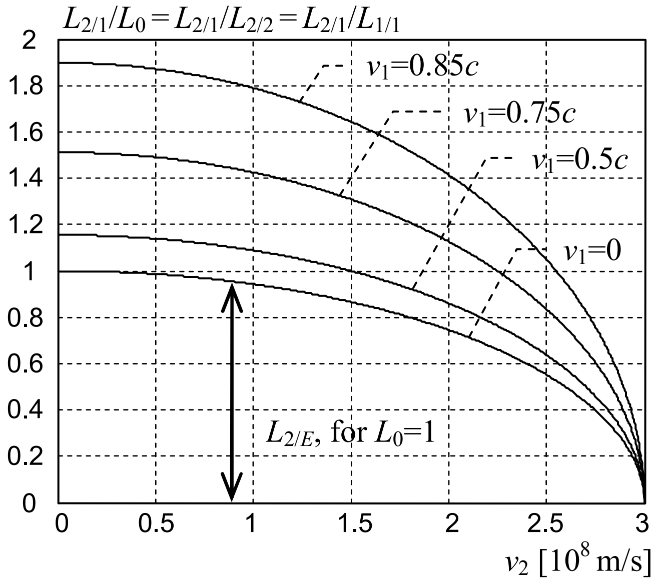

Fig. 6. The length contraction in the system U_2, seen in the system U_1, at set constant velocity v_1.

Figure 6 presents the length contraction (51), where the system U_1 has constant velocity v_1, in the function of variable velocity v_2.

On the basis of (45), the length contraction can be expressed by the relative velocities

$$L_{2/1} = \sqrt{-\frac{v_{2/1}}{v_{1/2}}} \cdot L_0 \tag{52}$$

7.2. The dilatation of time

We consider two systems U_1 and U_2 moving in the ether in the same direction, respectively at velocities v_1 and v_2. In the system U_2, two events occur, respectively, at times t_2^A and t_2^B. In the system U_1, in accordance with (31), times of occurrence of these events can be written as

$$t_1^A = \frac{\sqrt{1-(v_1/c)^2}}{\sqrt{1-(v_2/c)^2}} t_2^A \tag{53}$$

$$t_1^B = \frac{\sqrt{1-(v_1/c)^2}}{\sqrt{1-(v_2/c)^2}} t_2^B \tag{54}$$

Having subtracted by sides (54) and (53), we obtain Δt_1, the interval between events seen from the system U_1

$$\Delta t_1 = t_1^B - t_1^A = \frac{\sqrt{1-(v_1/c)^2}}{\sqrt{1-(v_2/c)^2}}(t_2^B - t_2^A) \tag{55}$$

Because

$$\Delta t_2 = t_2^B - t_2^A \tag{56}$$

we obtain the formula for the dilatation of time expressed by the absolute velocity in the form of

$$\Delta t_1 = \frac{\sqrt{c^2 - v_1^2}}{\sqrt{c^2 - v_2^2}}\Delta t_2 \tag{57}$$

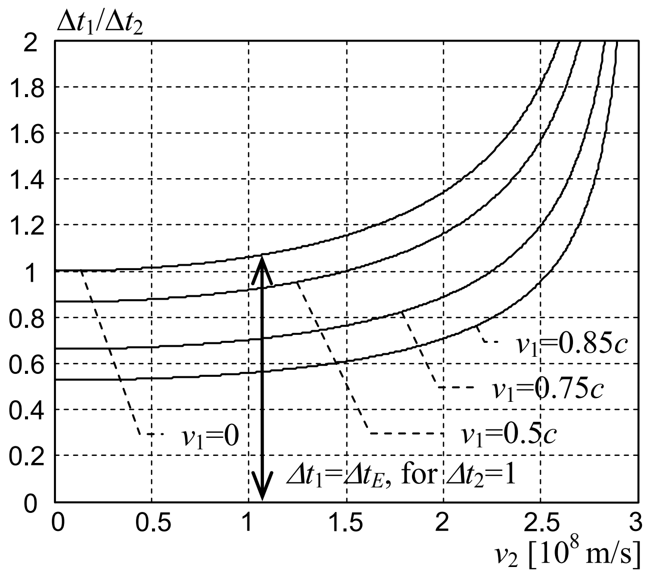

Fig. 7. The time contraction in the system U_2, seen in the system U_1 at constant velocity v_1.

Figure 7 shows the time contraction (57), where the system U_1 has constant velocity v_1, in the function of variable velocity v_2.

On the basis of (45), the dilatation of time can be expressed by the relative velocities

$$\Delta t_1 = \sqrt{-\frac{v_{1/2}}{v_{2/1}}} \cdot \Delta t_2 \tag{58}$$

8. Anisotropy of cosmic microwave background

Light is a special case of electromagnetic radiation, however, the above considerations concern not only light, but each electromagnetic radiation.

The outer space is filled with the microwave background radiation. Numerous studies on this subject were discussed in the work [4]. 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

$$\overline{T}_v = 2.726 \pm 0.010 \ \text{K} \tag{59}$$

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

$$\Delta T_v = 3.358 \pm 0.017 \text{ mK} \tag{60}$$

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 [4] 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 filling the space; 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. 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 [5] demonstrates that based on transformation (25)-(28) 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

$$f_v = f_0 \frac{c - v\cos\alpha_E}{\sqrt{c^2 - v^2}} \quad \text{for} \quad \alpha_E \in (0 \div \pi) \tag{61}$$

where f_0 is the frequency of light in relation to the ether, while f_v 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 $\alpha_E=0$ the equation (61) comes down to

$$f_v^{\min} = f_0\sqrt{\frac{(c-v)^2}{(c+v)(c-v)}} = f_0\sqrt{\frac{c-v}{c+v}} \quad \text{for} \quad \alpha_E = 0 \tag{62}$$

For $\alpha_E=\pi$ the equation (61) comes down to

$$f_v^{\max} = f_0\sqrt{\frac{(c+v)^2}{(c+v)(c-v)}} = f_0\sqrt{\frac{c+v}{c-v}} \quad \text{for} \quad \alpha_E = \pi \tag{63}$$

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

$$\frac{1}{\lambda_{\max}} = \frac{T}{0.00290\,[\mathrm{m\cdot K}]} \quad \Rightarrow \quad f = \frac{c}{\lambda_{\max}} = \frac{cT}{0.00290} \tag{64}$$

For the frequency seen in the ether system we get

$$f_0 = \frac{cT_0}{0.00290} \tag{65}$$

For the frequency seen by the moving observer

$$f_v^{\min} = \frac{cT_v^{\min}}{0.00290} = \frac{c(\overline{T}_v - \Delta T_v)}{0.00290} \quad \wedge \quad f_v^{\max} = \frac{cT_v^{\max}}{0.00290} = \frac{c(\overline{T}_v + \Delta T_v)}{0.00290} \tag{66}$$

After substituting (65) and (66) to (62) we receive

$$T_v^{\min} = \overline{T}_v - \Delta T_v = T_0\sqrt{\frac{c-v}{c+v}} \tag{67}$$

After substituting (65) and (66) to (63) we receive

$$T_v^{\max} = \overline{T}_v + \Delta T_v = T_0\sqrt{\frac{c+v}{c-v}} \tag{68}$$

Having divided by sides (67) by (68), we obtain dependence

$$\frac{T_v^{\min}}{T_v^{\max}} = \frac{\overline{T}_v - \Delta T_v}{\overline{T}_v + \Delta T_v} = \frac{c-v}{c+v} \tag{69}$$

Hence, after minor transformations, we obtain

$$v = \frac{T_v^{\max} - T_v^{\min}}{T_v^{\max} + T_v^{\min}}c = \frac{(\overline{T}_v + \Delta T_v) - (\overline{T}_v - \Delta T_v)}{(\overline{T}_v + \Delta T_v) + (\overline{T}_v - \Delta T_v)}c = \frac{\Delta T_v}{\overline{T}_v}c \tag{70}$$

On the basis of (59) and (60) we receive (c = 299792.458 km/s)

$$v = \frac{\Delta T_v}{\overline{T}_v}c = \frac{3.358\cdot 10^{-3}}{2.726}\cdot 299792.458 = 369.30\ \mathrm{km/s} \tag{71}$$

$$v_{\max} = \frac{(\Delta T_v)_{\max}}{(\overline{T}_v)_{\min}}c = \frac{(3.358+0.017)\cdot 10^{-3}}{2.726-0.01}\cdot 299792.458 = 372.53\ \mathrm{km/s} \tag{72}$$

$$v_{\min} = \frac{(\Delta T_v)_{\min}}{(\bar{T}_v)_{\max}} c = \frac{(3.358 - 0.017)\cdot 10^{-3}}{2.726 + 0.01} \cdot 299792.458 = 366.08 \text{ km/s} \tag{73}$$

$$\Delta v = v - v_{\min} = 3.24 \text{ km/s} \quad \text{or} \quad \Delta v = v_{\max} - v = 3.22 \text{ km/s} \tag{74}$$

Finally, on the basis of (71) and (74) we receive the velocity of the Solar System in relation to the ether (its value is roughly the same as in [4] but has a different interpretation)

$$v = 369.3 \pm 3.3 \text{ km/s} \approx 0.001232 \cdot c \tag{75}$$

This velocity is turned in the direction of the Lion constellation, which corresponds to direction of the galactic coordinates (figure 8)

$$\begin{aligned} l &= 264.31° \pm 0.16° \\ b &= 48.05° \pm 0.10° \end{aligned} \tag{76}$$

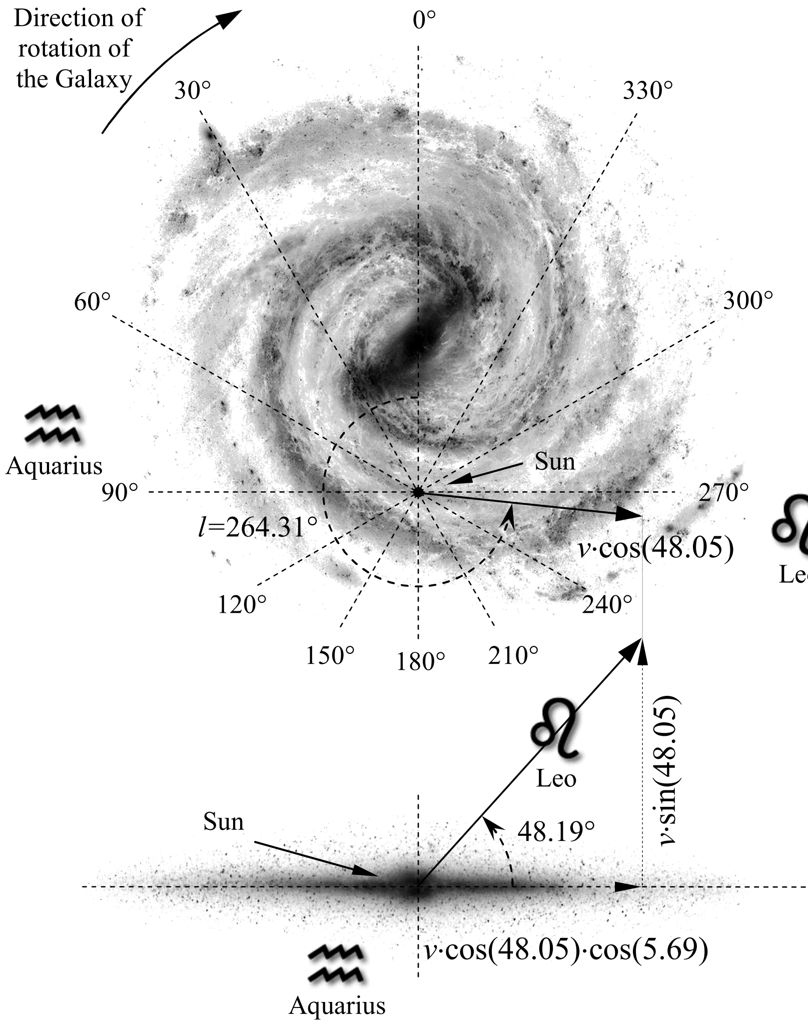

Fig. 8. The velocity of the Solar System in relation to the ether.
The projection on the plane of the Galaxy and the projection on the plane perpendicular to the plane of the Galaxy (90°-270°). The top view of the Milky Way galaxy (with marked galactic coordinates) and side view.

In the work [5], 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.

Now we will derived the temperature T_0 of microwave background radiation as seen from the ether system. For this purpose we multiply by sides (67) and (68). We obtain

$$T_0 = \sqrt{T_v^{\min} \cdot T_v^{\max}} = \sqrt{(\overline{T}_v - \Delta T_v)(\overline{T}_v + \Delta T_v)} \tag{77}$$

After taking into account (71) and (74) we obtain

$$T_0 = 2.72599793\,\mathrm{K} \tag{78}$$

Due to the low velocity of the Solar System relative to ether, this temperature is only slightly lower than the average temperature (71) measured in the Solar System.

9. Conclusion

Derived transformations (25)-(26) and (27)-(28) are consistent with the Michelson-Morley and Kennedy-Thorndike experiments. From the above transformations it follows that the measurement of the velocity of light in vacuum by means of the previously applied methods will always give the average value equal to *c*. This happens despite the fact that for the moving observer the velocity of light has a different value in different directions. The average velocity of light is always constant and independent of the velocity of the inertial frame of reference. Due to this property of the velocity of light, the Michelson-Morley and Kennedy-Thorndike experiments could not detect the universal frame of reference.

It follows from the conducted analysis that the explanation of the results of the Michelson-Morley experiment on the basis of the universal frame of reference is possible. Stating that the Michelson-Morley experiment proved that the velocity of light is absolutely constant is untrue. Stating that the Michelson-Morley experiment proved that there is no universal frame of reference in which light propagates and moves at a constant velocity is also untrue.

Admitting that the velocity of light may depend on the direction of its emission does not differentiate any direction in space. The velocity of light which is measured by the moving observer is significant here. It is the velocity at which the observer moves in relation to the universal frame of reference that differentiates the characteristic direction in space, but only for this observer. For the observer motionless in relation to the universal frame of reference, 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 universal frame of reference, then from his perspective space is not symmetrical. The case of this observer will be similar to the case of the observer moving on water and measuring the velocity of the wave on water. Despite that the wave propagates on water at the constant velocity in every direction, from the perspective of the observer moving on water, the velocity of the wave will be different in different directions.

At present, it is believed that the STR is the only theory explaining the Michelson-Morley and Kennedy-Thorndike experiments. This article proved that different theories in accordance with these experiments are possible. In works [5]-[10] a new physical theory of kinematics and dynamics of bodies based on the transformation determined here, called by the authors the Special Theory of Ether, was derived. In work [11] it has been shown that it is possible to weaken the assumption IV and derive a more general form of transformation (25)-(28). Thus many kinematics can be derived in accordance with the Michelson-Morley and Kennedy-Thorndike experiments. In the work [5] has been shown that within each such kinematics can derive infinitely many dynamics. In order to derive dynamics, it is necessary to adopt the additional assumption, which will allow for introduction into theory of the concept of mass, kinetic energy, and momentum.

Based on this kinematics can naturally explain the anisotropy of the microwave background radiation, which was discussed at work [4]. This allows determine the speed at which the solar system is moving relative to a universal reference system, that is 369.3 km/s. This has been also shown in [7], [8] and [11].

The Michelson-Morley experiment and Kennedy-Thorndike experiment were conducted many times by different teams. Each of the experiments only confirmed that the average velocity of light is constant. Therefore, assumptions, on which the presented derivation is based, are experimentally justified.

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