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The original method of deriving transformations for kinematics with a universal reference system

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Abstract:

The article presents the original derivation method of transformations for kinematics with a universal reference system. This method allows to derive transformations that meet the results of the Michelson-Morley and Kennedy-Thorndike experiments only in some frame of reference, e.g. in laboratories moving in relation to a universal frame of reference with small speeds.

The obtained transformations are the basis for the derivation of the new physical theory, which has been called the Special Theory of Ether (STE).

Based on conclusions of the Michelson-Morley's and Kennedy-Thorndike's experiments, the parameter $\delta(v)$ was determined. The generalized transformations can be expressed by relative speeds (26)-(27) or by the parameter $\delta(v)$ (37)-(38). This allows the transformations to take a special form (81)-(82). These transformations are consistent with experiments in which speed of light is measured.

On the basis of obtained transformations, the formulas for summing speed and relative speed were also determined.

The entire article includes only original research conducted by its author.

Keywords: kinematics, universal frame of reference, one-way speed of light, summing speed, relative speed, coordinate and time transformation

1. Introduction

The article explains results of Michelson-Morley's [11] and Kennedy-Thorndike's experiments [6], assuming that there is a universal frame of reference (ether), in which one-way speed of light has a constant value. In moving inertial frame of reference, the one-way speed of light may be different. Thus it has been shown that it is not true that Michelson-Morley's and Kennedy-Thorndike's experiments prove that there is no universal frame of reference in which light propagates and that one-way speed of light in vacuum is constant.

STE transformations can be derived by various methods. The derivation presented in this article is different from that shown in articles [18] and [22-24]. Derived transformation is a generalization of Galilean transformation, because she becomes Galilean transformation in a particular case.

The reasoning presented in this article is based on observation that one-way speed of light has never been measured accurately. In all accurate laboratory experiments, as in Michelson-Morley's and Kennedy-Thorndike's experiment, the average speed of light on a closed trajectory that returns to its starting point was only measured. Therefore, assumption of a constant one-way speed of light in vacuum (instantaneous speed) adopted in the Special Theory of Relativity (STR) has no strict experimental justification. In works [17]-[21] been shown that Michelson-Morley's and Kennedy-Thorndike's experiments can be explained by the theory with a universal frame of reference. In the work [22] been shown that there is infinite number of such theories. Thus it is not true that these experiments have shown that there is no ether in which light propagates. Derivation presented in this article is based on these findings, i.e. assumptions that for each observer the average speed of light moving forth and back is constant and that there is a universal frame of reference, in which light propagates.

2. Adopted assumptions

In presented analysis, the following assumptions were adopted:

- I. There is a frame of reference in relation to which the speed of light in vacuum has the same value in each direction. This universal frame of reference is called ether.
- II. Average speed of light on the light path forth and back is for every observer independent from the direction of light propagation. This results from Michelson-Morley's experiment.
- III. Average speed of light on the light path forth and back does not depend on the observer's velocity in relation to a universal frame of reference. This results from Kennedy-Thorndike's experiment.
- IV. «Inertial system – inertial system» transformation is linear.
- V. Measurements of observers from different inertial systems are consistent. That is, all observers receive the same conclusions based on the measurements. This assumption implies the natural way of determining coefficients in the reverse transformation, used to determine the formula (3).
- VI. In perpendicular direction to the velocity direction of body in relation to ether, its contraction or extension does not occur.
- VII. Between inertial systems, there is a symmetry of the following form (when inertial systems U_1 and U_2 move in relation to universal frame of reference along their axes x_1 and x_2 , which are parallel to each other).

$$\left. \frac{dx_1}{dt_2} \right|_{\frac{dx_2}{dt_2}=0} = - \left. \frac{dx_2}{dt_1} \right|_{\frac{dx_1}{dt_1}=0} \quad (1)$$

Assumption VII indicates that in coordinate transformation, the module coefficient at t is the same in primary and reverse transformation (coefficient b in transformations (15)). This is a technical assumption made to simplify considerations. It is known from articles [22]-[24] that there are infinitely many different transformations with a universal frame of reference, describing various physical properties. Thanks to assumption VII, we limit ourselves to only one of these transformations, the one without transverse contraction. It follows that the derivation presented in this article can be generalized if the assumption of VII is abandoned. Then it should be possible to derive all the other transformations for the theory with a universal frame of reference. This is a topic for further theoretical research.

Derived transformation presented in this article differs from derivation of Lorentz's transformation using the geometric method on which STR is based. In STR, in derived Lorentz's transformation, it is assumed 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). This assumption is based on a belief that all inertial systems are equivalent (i.e. experimental indistinguishable). In the derivation presented in this article, we do not assume the equivalence of inertial systems, but the assumption V, from which the values of the two coefficients in the inverse transformation result. To simplify the derivation, we additionally adopt assumption VII on the value of the next, third coefficient in the inverse transformation.

Adopted assumptions in this article on the speed of light are weaker than those adopted in STR. The STR assumes that one-way speed of light is absolutely constant, even though no experiment has proved it. In this article, the assumption was made resulting from experiments that the average speed of light on a path forth and back to the mirror is constant (assumption II and III). In presented dissertations, light speed is assumed to be constant in only one universal frame of reference – ether (assumption I).

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

In works [17]-[22] an identical transformation was derived as (83)-(84), but in a different way, using the geometric method.

3. Derived transformation between inertial systems

An aim is to determine coordinate and time transformation between inertial systems U_1 and U_2 , Figure 1. Systems move in relation to each other parallel to axis x . The U_1 system moves relative to U_2 system with speed $v_{1/2}$. The U_2 system moves relative to U_1 system with speed $v_{2/1}$ ($v_{1/2} \cdot v_{2/1} \leq 0$).

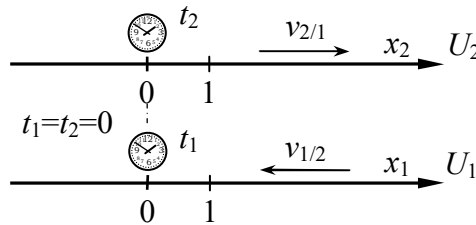


Fig. 1. Two inertial systems U_1 and U_2 move relative to each other with relative speeds $v_{1/2}$ and $v_{2/1}$.

Generalization of transformation is to allow the possibility that modules of velocity value $v_{1/2}$ and $v_{2/1}$ can be different.

In considered inertial systems, clocks are synchronized. Now we are only establishing that in a moment, when beginnings of systems overlap (coordinate $x_1 = 0$ from U_1 system is next to

coordinate $x_2 = 0$ from U_2 system), then clocks found at these coordinates are reset. Thanks to such an establishment, there are no constant terms in transformations (2) and (3).

Assumption IV guarantees that the Newton's first law is applicable in every inertial frame of reference, i.e. if a body moves uniformly in one inertial frame of reference, then its motion observed from another inertial frame of reference will also be uniform. This means that coordinate and time transformation between inertial systems U_1 and U_2 has a form of

$$\begin{aligned} x_1 &= a \cdot x_2 + b' \cdot t_2 \\ t_1 &= e' \cdot x_2 + f \cdot t_2 \end{aligned} \quad (2)$$

Coefficient $f > 0$, because we assume that time cannot flow backwards in any system.

Now we will write the reverse transformation. For this, we rely on the assumption of V. If in U_2 system, the time flows quicker, thus in U_1 system it is slower. Therefore, in reverse transformation, the coefficient f must be replaced by $1/f$. Similarly, if in one system a length contraction occurs, in the second is an extension. Hence in the reverse transformation, it is necessary to replace coefficient a by $1/a$. This method to determine values of two coefficients in reverse transformation on $1/f$ and $1/a$, follows from the assumption of V and we call it the natural way of determining coefficients in the reverse transformation.

There are no assumptions for coefficient e' , and therefore in the reverse transformation any coefficient e'' was accepted.

The reverse transformation has a form of

$$\begin{aligned} x_2 &= \frac{1}{a} x_1 - b'' \cdot t_1 \\ t_2 &= -e'' \cdot x_1 + \frac{1}{f} t_1 \end{aligned} \quad (3)$$

If the speed of U_2 system relative to U_1 is positive, the speed of U_1 system relative to U_2 is negative. Hence coefficients b' and $-b''$ are opposite signs. Assumption VII regards values of these coefficients. It is possible to calculate differentials appearing in this assumption from (2) and (3). They have a form of

$$dx_1 = a dx_2 + b' dt_2 \Rightarrow \frac{dx_1}{dt_2} = a \frac{dx_2}{dt_2} + b' \quad (4)$$

$$dx_2 = \frac{1}{a} dx_1 - b'' dt_1 \Rightarrow \frac{dx_2}{dt_1} = \frac{1}{a} \frac{dx_1}{dt_1} - b'' \quad (5)$$

i.e.

$$\frac{dx_2}{dt_2} = 0 \Rightarrow b' = \frac{dx_1}{dt_2} \quad (6)$$

$$\frac{dx_1}{dt_1} = 0 \Rightarrow b'' = -\frac{dx_2}{dt_1} \quad (7)$$

Due to assumption VII we obtain

$$b' = b'' = b \quad (8)$$

Placing t_2, x_2 from the reverse transformation (3) to transformation (2) we will obtain

$$\begin{aligned} x_1 &= a \left(\frac{1}{a} x_1 - b t_1 \right) + b \left(-e'' x_1 + \frac{1}{f} t_1 \right) = x_1 (1 - b e'') + t_1 \left(-a b + \frac{b}{f} \right) \\ t_1 &= e' \left(\frac{1}{a} x_1 - b t_1 \right) + f \left(-e'' x_1 + \frac{1}{f} t_1 \right) = t_1 (-e' b + 1) + x_1 \left(\frac{e'}{a} - f e'' \right) \end{aligned} \quad (9)$$

Since formulas (9) should be true for all t_1, x_1 , the equations must be fulfilled

$$1 - b e'' = 1 \quad (10)$$

$$\frac{b}{f} = a b \quad (11)$$

$$1 - e' b = 1 \quad (12)$$

$$\frac{e'}{a} = f e'' \quad (13)$$

As from the assumption, systems move in relation to each other, thus $b \neq 0$. On this basis from (10) results that $e'' = 0$. By analogy from (13) results that $e' = 0$. From (11) results

$$a = \frac{1}{f} \quad (14)$$

Searched transformations can be written in a form of

$$\begin{cases} x_1 = \frac{1}{f} x_2 + b t_2 \\ t_1 = f t_2 \end{cases} \quad \begin{cases} x_2 = f x_1 - b t_1 \\ t_2 = \frac{1}{f} t_1 \end{cases} \quad (15)$$

We will determine the differentials from these transformations

$$\begin{cases} dx_1 = \frac{1}{f} dx_2 + b dt_2 \\ dt_1 = f dt_2 \end{cases} \quad \begin{cases} dx_2 = f dx_1 - b dt_1 \\ dt_2 = \frac{1}{f} dt_1 \end{cases} \quad (16)$$

On the basis of these differentials, it is possible to determine relative speeds of U_1 and U_2 systems. If we consider any point with a fixed coordination in U_2 system, then from the first transformation (16) we obtain speed $v_{2/1}$ of U_2 system in relation to U_1 system

$$\frac{dx_2}{dt_2} = 0 \Rightarrow v_{2/1} = \frac{dx_1}{dt_1} = \frac{\frac{1}{f} dx_2 + b dt_2}{f dt_2} = \frac{1}{f^2} \frac{dx_2}{dt_2} + \frac{b}{f} = \frac{b}{f} \quad (17)$$

If we will consider any point with a fixed coordination in U_1 system, then the second transformation (16) we obtain speed of $v_{1/2}$ of U_1 system in relation to U_2 system

$$\frac{dx_1}{dt_1} = 0 \Rightarrow v_{1/2} = \frac{dx_2}{dt_2} = \frac{f dx_1 - b dt_1}{\frac{1}{f} dt_1} = f^2 \frac{dx_1}{dt_1} - b f = -b f \quad (18)$$

We divide the equation (18) by equation (17) and we will obtain

$$\frac{v_{1/2}}{v_{2/1}} = -f^2 \quad (19)$$

From the relation (19) and on the basis of (17) and (18), it is possible to determine unknown coefficients ($f > 0$)

$$f = \sqrt{-\frac{v_{1/2}}{v_{2/1}}} \quad (20)$$

$$b = -v_{1/2} / f = -v_{1/2} \sqrt{-\frac{v_{2/1}}{v_{1/2}}} \quad (21)$$

$$b = v_{2/1} \cdot f = v_{2/1} \sqrt{-\frac{v_{1/2}}{v_{2/1}}} \quad (22)$$

Since speed of $v_{1/2}$ and $v_{2/1}$ have different signs, and therefore it is possible to show that relations (21) and (22) are equivalent (below, in $\pm$, character '+' is appears when $v_{1/2} < 0$, while character '-' appears when $v_{1/2} > 0$)

$$\begin{aligned} b &= -v_{1/2} \sqrt{-\frac{v_{2/1}}{v_{1/2}}} = \pm \sqrt{v_{1/2}^2} \sqrt{-\frac{v_{2/1}}{v_{1/2}}} = \pm \sqrt{-v_{1/2}^2 \frac{v_{2/1}}{v_{1/2}}} = \\ &= \pm \sqrt{-v_{1/2} \cdot v_{2/1}} = \pm \sqrt{-\frac{v_{1/2}}{v_{2/1}} v_{2/1}^2} = \pm \sqrt{v_{2/1}^2} \sqrt{-\frac{v_{1/2}}{v_{2/1}}} = v_{2/1} \sqrt{-\frac{v_{1/2}}{v_{2/1}}} = b \end{aligned} \quad (23)$$

If we multiply (21) and (22), we will obtain

$$b^2 = -v_{1/2} v_{2/1} \quad (24)$$

and thus the same as from (23) we will obtain

$$b = +\sqrt{-v_{1/2} v_{2/1}} \quad \vee \quad b = -\sqrt{-v_{1/2} v_{2/1}} \quad (25)$$

Coefficient b may have a different sign. From (23) results that coefficient $b > 0$, when speed $v_{2/1} > 0$, while $b < 0$, when speed $v_{2/1} < 0$.

On the basis of (20), (21) and (22), transformations (15) can be expressed from relative speeds and can be written in a form of

$$\begin{cases} t_1 = \sqrt{-\frac{v_{1/2}}{v_{2/1}}} \cdot t_2 \\ x_1 = v_{2/1} \sqrt{-\frac{v_{1/2}}{v_{2/1}}} \cdot t_2 + \sqrt{-\frac{v_{2/1}}{v_{1/2}}} \cdot x_2 \end{cases} \quad (26)$$

$$\begin{cases} t_2 = \sqrt{-\frac{v_{2/1}}{v_{1/2}}} \cdot t_1 \\ x_2 = v_{1/2} \sqrt{-\frac{v_{2/1}}{v_{1/2}}} \cdot t_1 + \sqrt{-\frac{v_{1/2}}{v_{2/1}}} \cdot x_1 \end{cases} \quad (27)$$

We have obtained completely symmetrical transformations. In transformation (26), we may just convert indexes 1 into 2 and 2 into 1 in order to obtain transformation (27). This is despite the fact that apparently non-symmetry was introduced in derived transformation (formula (2) and (3)).

Assumptions IV, V and VII were enough to obtain transformation (26)-(27).

Transformation (26)-(27) is a generalized Galilean transformation, expressed from relative speeds. If $v_{2/1} \approx -v_{1/2}$ occurs for U_2 and U_1 systems, then these transformations came down to Galilean transformation.

From time transformation (26)-(27) results that if in some inertial system the clock indicates time $t_2 = 0$, then in every inertial system the clock found by this clock also indicates time $t_1 = 0$. This means that clocks in inertial systems are synchronized with the external method, proposed in the article [9]. It results that this method of clock synchronization is a consequence of assumptions on the basis of which the transformation (26)-(27) was derived (assumptions IV, V and VII).

Synchronization of clocks with the external method consists in setting all clocks on the basis of clocks indications of one distinguished inertial system (let it be U_1 system). Clocks in U_2 system are reset when beginnings of U_1 and U_2 systems overlap. If the clock of U_1 system indicates time $t_1 = 0$, then clock next to it of U_2 system is also reset, i.e. $t_2 = 0$. This way of clocks synchronization enables to synchronize clocks in all inertial systems, if there is a possibility to synchronize clocks in some first inertial system. At this stage we do not resolve how the synchronized clocks in U_1 system have been synchronized. The problem of clocks synchronization in the first system will be solved in Chapter 5.

4. Implementation of a universal frame of reference

To transformation (26) and (27) we will implement a universal frame of reference (ether). By v_1, v_2 were indicated speeds of U_1 and U_2 system relative to universal frame of reference (absolute speeds). Since there is a universal frame of reference, every movement in the space can be described by speeds in relation to that system. We will call these speeds absolute. Therefore relative speeds $v_{1/2}$ and $v_{2/1}$ depend explicitly on absolute speeds v_1, v_2 . We assume that function F combines relative speeds of systems and their absolute speeds in the following way

$$\begin{cases} v_{1/2} = -v_{2/1}F(v_1, v_2) \\ v_{2/1} = -v_{1/2}F(v_2, v_1) \end{cases} \quad (28)$$

From equations (28), after multiplying them by sides, results that function F has a form of

$$F(v_1, v_2) = \frac{1}{F(v_2, v_1)} \quad (29)$$

Trivial solutions of this functional equation are

$$F(v_1, v_2) = 1 \quad (30)$$

and

$$F(v_1, v_2) = -1 \quad (31)$$

The first of these solutions gives Galilean transformation. The second leads to contradiction. Nontrivial solution of this functional equation is function F in a form of

$$F(v_1, v_2) = \frac{G(v_1, v_2)}{G(v_2, v_1)} = \frac{1}{\frac{G(v_2, v_1)}{G(v_1, v_2)}} = \frac{1}{F(v_2, v_1)} \quad (32)$$

We assume that for our needs a function F is sufficient with divided variables, then it is possible to write it with quotient of certain functions M and N

$$F(v_1, v_2) = \frac{G'(v_1) \cdot G''(v_2)}{G'(v_2) \cdot G''(v_1)} = \frac{G'(v_1)/G''(v_1)}{G'(v_2)/G''(v_2)} = \frac{M(v_1)}{N(v_2)} = \frac{1}{\frac{M(v_2)}{N(v_1)}} = \frac{N(v_1)}{M(v_2)} \quad (33)$$

From the equation (33) results that $M(v) = N(v)$. Now it can be written in a form of

$$F(v_1, v_2) = \frac{M(v_1)}{M(v_2)} = \frac{\frac{M(v_1)}{M(0)}}{\frac{M(v_2)}{M(0)}} = \frac{\delta(v_1)}{\delta(v_2)} \quad (34)$$

Function $\delta(v)$ at this stage is unknown. Based on (34), it is known to be dimensionless. Without a loss of generality, it can be assumed that it is a positive function and in zero assumes value one, because

$$\delta(0) = \frac{M(0)}{M(0)} = 1 \quad (35)$$

On the basis of (28) and (34) we will obtain

$$-\frac{v_{2/1}}{v_{1/2}} = \frac{\delta(v_2)}{\delta(v_1)} \quad (36)$$

On this basis, transformation (26)-(27) can be written in the form expressed from parameter $\delta(v)$

$$\begin{cases} t_1 = \sqrt{\frac{\delta(v_1)}{\delta(v_2)}} \cdot t_2 \\ x_1 = v_{2/1} \sqrt{\frac{\delta(v_1)}{\delta(v_2)}} \cdot t_2 + \sqrt{\frac{\delta(v_2)}{\delta(v_1)}} \cdot x_2 \end{cases} \quad (37)$$

$$\begin{cases} t_2 = \sqrt{\frac{\delta(v_2)}{\delta(v_1)}} \cdot t_1 \\ x_2 = v_{1/2} \sqrt{\frac{\delta(v_2)}{\delta(v_1)}} \cdot t_1 + \sqrt{\frac{\delta(v_1)}{\delta(v_2)}} \cdot x_1 \end{cases} \quad (38)$$

This transformation form required one additional assumption in relation to assumptions on which transformations (26) and (27) are based. This is assumption on the existence of a universal frame of reference.

Now we can get an important property of the function $\delta(v)$.

If $v_1 = -v_2 = v$, then there is a full symmetry, for the observer related to ether, between U_1 and U_2 systems. If the space is supposed to be isotropic, i.e. all directions in ether are supposed to be equivalent, then $v_{2/1} = -v_{1/2}$ must occur. On the basis of (37) and (38) we will obtain

$$x_1 = v_{2/1} \sqrt{\frac{\delta(v_1)}{\delta(v_2)}} \cdot \left(\sqrt{\frac{\delta(v_2)}{\delta(v_1)}} \cdot t_1 \right) + \sqrt{\frac{\delta(v_2)}{\delta(v_1)}} \cdot \left(-v_{2/1} \sqrt{\frac{\delta(v_2)}{\delta(v_1)}} \cdot t_1 + \sqrt{\frac{\delta(v_1)}{\delta(v_2)}} \cdot x_1 \right) \quad (39)$$

$$0 = v_{2/1} \cdot t_1 - v_{2/1} \frac{\delta(-v)}{\delta(v)} \cdot t_1 \quad (40)$$

On this basis we will obtain another, after (35), a universal property of function $\delta(v)$

$$\delta(v) = \delta(-v) \quad (41)$$

5. Designation of function $\delta(v)$ based on Michelson-Morley's experiment

Function $\delta(v)$ was determined in subsection, assuming that in every inertial frame of reference the zero results of Michelson-Morley's and Kennedy-Thorndike's experiments are fulfilled. These experiments show that the average speed of light c_{av} , on the path forth and back, is constant in each inertial frame of reference U' (assumption II and III). We assume that in U system, i.e. ether, the speed of light c is constant in each direction (assumption I).

From assumption II and III results that average speed of light c_{av} in inertial frame of reference is the same as speed of light c in ether. It will be sufficient to notice that light signal has the same average speed of light c_{av} in U' system, when U' system does not move in relation to U system (i.e. $v = 0$). Since then speed of light c_{av} is exactly the same as speed c , and therefore for each speed v occurs $c_{av} = c$.

Paths of light flow are shown in Figure 2. U system lies in ether, while U' system moves in relation to ether at a constant speed v . Axes x and x' lie on one straight.

Distance D' which is perpendicular to speed v , is the same from a point of view of both frames of reference (assumption VI). Therefore on Figure is the same length D' in part a) and parts b).

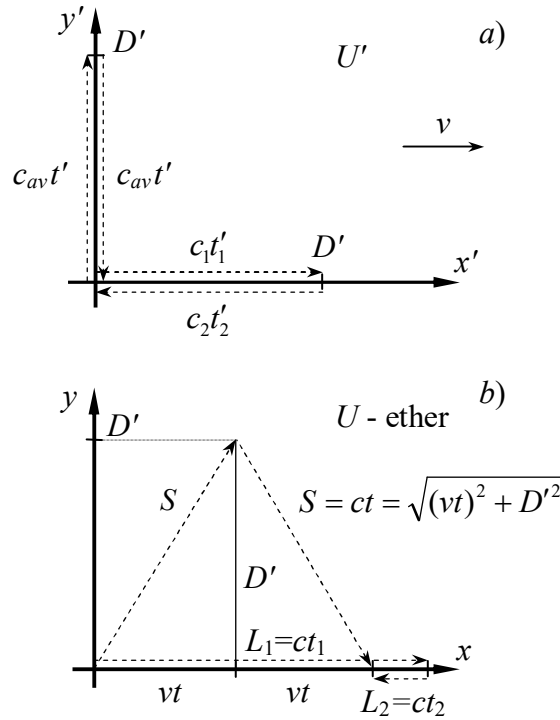


Fig. 2. Light flow paths in two systems moving relative to each other:

- a) inertial system U' the flow parallel to axis x' and y' ,
- b) light flows seen from U system (ether).

Because of the isotropic nature of space, the one-way speed of light moving along the y' axis has a c value in the U' system. This is due to the fact that none of the directions perpendicular to the velocity v is distinguished and the average speed of light is c . Therefore, for the system U' we can write that

$$c_{av} = c = \frac{D'}{t'} = \frac{2D'}{2t'} = \frac{2D'}{t'_1 + t'_2} \quad (42)$$

Similar dependencies can be written for U system (ether)

$$c = \frac{2S}{2t} = \frac{2\sqrt{(vt)^2 + D'^2}}{2t} = \frac{L_1 + L_2}{t_1 + t_2} \quad (43)$$

If for transformation (37), the following new determinations will be adopted: $U_2 \equiv U'$ and $U_1 \equiv U$ (ether), then according to (35)

$$\begin{aligned} v_1 &= 0 \\ v_{2/1} &= v_2 = v \\ \delta(v_1) &= \delta(0) = 1 \end{aligned} \quad (44)$$

Then time transformation (37) will take the form of

$$t = \frac{1}{\sqrt{\delta(v)}} \cdot t' \quad (45)$$

On the basis of equation (42) and equation (43) we will obtain the relation of

$$\frac{2D'}{2t'} = \frac{2\sqrt{(vt)^2 + D'^2}}{2t} \quad (46)$$

After reduction by 2 and applying determined time transformation (45) we will obtain

$$\frac{D'}{t'} = \frac{\sqrt{\left(v \frac{t'}{\sqrt{\delta(v)}}\right)^2 + D'^2}}{\frac{1}{\sqrt{\delta(v)}} \cdot t'} \quad (47)$$

i.e.

$$D' \frac{1}{\sqrt{\delta(v)}} = \sqrt{\frac{v^2 t'^2}{\delta(v)} + D'^2} \quad (48)$$

$$D'^2 \frac{1}{\delta(v)} = \frac{v^2 t'^2}{\delta(v)} + D'^2 \quad (49)$$

$$D'^2 \left(\frac{1}{\delta(v)} - 1 \right) = \frac{v^2 t'^2}{\delta(v)} \quad (50)$$

$$\frac{1 - \delta(v)}{\delta(v)} = \frac{v^2}{\delta(v)} \left(\frac{t'}{D'} \right)^2 \quad (51)$$

$$1 - \delta(v) = v^2 \left(\frac{t'}{D'} \right)^2 \quad (52)$$

On the basis of (42) we will obtain

$$1 - \delta(v) = v^2 \left(\frac{1}{c} \right)^2 \quad (53)$$

Finally, function $\delta(v)$, for which the transformation meets conditions of Michelson-Morley's experiment takes the form of

$$\delta(v) = 1 - (v/c)^2 = \frac{c^2 - v^2}{c^2} \quad (54)$$

Transformations (37) and (38) with a function (54) required additional assumptions I, II, III and VI.

By introducing into the theory of a universal frame of reference, in which one-way speed of light is constant, it is possible to solve mentioned above problem of clocks synchronization. In a universal frame of reference, the clocks can be synchronized by means of light (internal method). It will be a system to which clocks in all inertial systems (external method) will be synchronized.

6. Summing speed and relative speed

6.1. Derivation based on the transformation with function $\delta(v)$

Let us consider a situation presented in Figure 3. All considered velocities are parallel to each other.

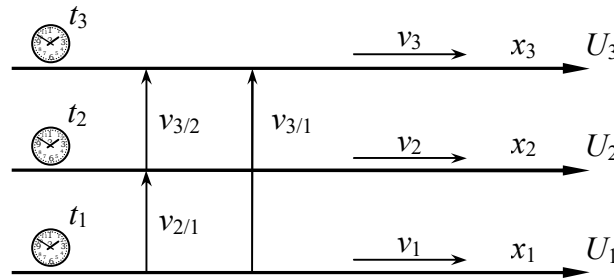


Fig. 3. Inertial systems U_1, U_2, U_3 moving relative to ether with speeds v_1, v_2, v_3 .

On the basis of (37) and (38), transformations from U_2 system to U_3 system and from U_1 system to U_2 system will have a form of

$$\begin{cases} t_3 = \sqrt{\frac{\delta(v_3)}{\delta(v_2)}} \cdot t_2 \\ x_3 = v_{2/3} \sqrt{\frac{\delta(v_3)}{\delta(v_2)}} \cdot t_2 + \sqrt{\frac{\delta(v_2)}{\delta(v_3)}} \cdot x_2 \end{cases} \quad \begin{cases} t_2 = \sqrt{\frac{\delta(v_2)}{\delta(v_1)}} \cdot t_1 \\ x_2 = v_{1/2} \sqrt{\frac{\delta(v_2)}{\delta(v_1)}} \cdot t_1 + \sqrt{\frac{\delta(v_1)}{\delta(v_2)}} \cdot x_1 \end{cases} \quad (55)$$

Combining these two transformations by putting t_2, x_2 from the second to the first one, we will obtain a transformation from U_1 system to U_3 system

$$\begin{cases} t_3 = \sqrt{\frac{\delta(v_3)}{\delta(v_2)}} \sqrt{\frac{\delta(v_2)}{\delta(v_1)}} \cdot t_1 \\ x_3 = v_{2/3} \sqrt{\frac{\delta(v_3)}{\delta(v_2)}} \sqrt{\frac{\delta(v_2)}{\delta(v_1)}} \cdot t_1 + \sqrt{\frac{\delta(v_2)}{\delta(v_3)}} \cdot \left[v_{1/2} \sqrt{\frac{\delta(v_2)}{\delta(v_1)}} \cdot t_1 + \sqrt{\frac{\delta(v_1)}{\delta(v_2)}} \cdot x_1 \right] \end{cases} \quad (56)$$

After reduction we will obtain

$$\begin{cases} t_3 = \sqrt{\frac{\delta(v_3)}{\delta(v_1)}} \cdot t_1 \\ x_3 = \left[v_{2/3} \sqrt{\frac{\delta(v_3)}{\delta(v_1)}} + v_{1/2} \frac{\delta(v_2)}{\sqrt{\delta(v_1)\delta(v_3)}} \right] \cdot t_1 + \sqrt{\frac{\delta(v_1)}{\delta(v_3)}} \cdot x_1 \end{cases} \quad (57)$$

Transformation from U_1 system to U_3 system can also be obtained directly from (38)

$$\begin{cases} t_3 = \sqrt{\frac{\delta(v_3)}{\delta(v_1)}} \cdot t_1 \\ x_3 = v_{1/3} \sqrt{\frac{\delta(v_3)}{\delta(v_1)}} \cdot t_1 + \sqrt{\frac{\delta(v_1)}{\delta(v_3)}} \cdot x_1 \end{cases} \quad (58)$$

Combined transformation presented in (57) must have the same form as transformation (58). Hence we will obtain

$$v_{1/3} \sqrt{\frac{\delta(v_3)}{\delta(v_1)}} = v_{2/3} \sqrt{\frac{\delta(v_3)}{\delta(v_1)}} + v_{1/2} \frac{\delta(v_2)}{\sqrt{\delta(v_1)\delta(v_3)}} \quad (59)$$

After reduction, the equation takes the form of

$$v_{1/3} \delta(v_3) = v_{2/3} \delta(v_3) + v_{1/2} \delta(v_2) \quad (60)$$

On this basis, we obtain the formula for summing parallel relative speeds

$$v_{1/3} = v_{1/2} \frac{\delta(v_2)}{\delta(v_3)} + v_{2/3} \quad (61)$$

An analogous equation as (60) can be written between other systems by changing indexes in (60). For three systems there are six such equations. For example, after replacing indexes $2 \rightarrow 1$ and $1 \rightarrow 2$, we will obtain

$$v_{2/3} \delta(v_3) = v_{1/3} \delta(v_3) + v_{2/1} \delta(v_1) \quad (62)$$

If we will assume that U_3 system is ether (a universal frame of reference), then speed $v_3 = 0$. On this basis we have $v_{2/3} = v_2$, $v_{1/3} = v_1$ and $\delta(v_3) = \delta(0) = 1$. From equations (60) and (62) we will obtain equations

$$\begin{aligned} v_1 &= v_2 + v_{1/2} \cdot \delta(v_2) \\ v_2 &= v_1 + v_{2/1} \cdot \delta(v_1) \end{aligned} \quad (63)$$

After conversion we will obtain relations

$$\begin{aligned} v_{2/1} &= (v_2 - v_1) / \delta(v_1) \\ v_{1/2} &= (v_1 - v_2) / \delta(v_2) \end{aligned} \quad (64)$$

After taking into account (54), formulas (63) for summing parallel speeds take the form of

$$\begin{aligned} v_1 &= v_2 + v_{1/2} \cdot (1 - (v_2/c)^2) \\ v_2 &= v_1 + v_{2/1} \cdot (1 - (v_1/c)^2) \end{aligned} \quad (65)$$

After taking into account (54), formulas (64) for relative speeds take the form of

$$\begin{aligned} v_{2/1} &= \frac{v_2 - v_1}{1 - (v_1 / c)^2} \\ v_{1/2} &= \frac{v_1 - v_2}{1 - (v_2 / c)^2} \end{aligned} \quad (66)$$

6.2. Derivation based on the transformation with relative speeds

In the analogous way, it is possible to put transformations between systems, expressed with relative speeds (26) and (27). Transformations from U_2 system to U_1 system and from U_3 system to U_2 system have a form of

$$\begin{cases} t_1 = \sqrt{-\frac{v_{1/2}}{v_{2/1}}} \cdot t_2 \\ x_1 = v_{2/1} \sqrt{-\frac{v_{1/2}}{v_{2/1}}} \cdot t_2 + \sqrt{-\frac{v_{2/1}}{v_{1/2}}} \cdot x_2 \end{cases} \quad \begin{cases} t_2 = \sqrt{-\frac{v_{2/3}}{v_{3/2}}} \cdot t_3 \\ x_2 = v_{3/2} \sqrt{-\frac{v_{2/3}}{v_{3/2}}} \cdot t_3 + \sqrt{-\frac{v_{3/2}}{v_{2/3}}} \cdot x_3 \end{cases} \quad (67)$$

Making these transformations by putting t_2, x_2 from the second to the first one, we will obtain transformation from U_3 system to U_1 system

$$\begin{cases} t_1 = \sqrt{-\frac{v_{1/2}}{v_{2/1}}} \cdot \sqrt{-\frac{v_{2/3}}{v_{3/2}}} \cdot t_3 \\ x_1 = v_{2/1} \sqrt{-\frac{v_{1/2}}{v_{2/1}}} \cdot \sqrt{-\frac{v_{2/3}}{v_{3/2}}} \cdot t_3 + \sqrt{-\frac{v_{2/1}}{v_{1/2}}} \cdot \left[v_{3/2} \sqrt{-\frac{v_{2/3}}{v_{3/2}}} \cdot t_3 + \sqrt{-\frac{v_{3/2}}{v_{2/3}}} \cdot x_3 \right] \end{cases} \quad (68)$$

On this basis we will obtain

$$\begin{cases} t_1 = \sqrt{-\frac{v_{1/2}}{v_{2/1}}} \cdot \sqrt{-\frac{v_{2/3}}{v_{3/2}}} \cdot t_3 \\ x_1 = \left[v_{3/2} \sqrt{-\frac{v_{2/1}}{v_{1/2}}} \cdot \sqrt{-\frac{v_{2/3}}{v_{3/2}}} + v_{2/1} \sqrt{-\frac{v_{1/2}}{v_{2/1}}} \cdot \sqrt{-\frac{v_{2/3}}{v_{3/2}}} \right] t_3 + \sqrt{-\frac{v_{2/1}}{v_{1/2}}} \sqrt{-\frac{v_{3/2}}{v_{2/3}}} x_3 \end{cases} \quad (69)$$

Transformation from U_3 system to U_1 system can also be obtained directly from (37)

$$\begin{cases} t_1 = \sqrt{-\frac{v_{1/3}}{v_{3/1}}} \cdot t_3 \\ x_1 = v_{3/1} \sqrt{-\frac{v_{1/3}}{v_{3/1}}} \cdot t_3 + \sqrt{-\frac{v_{3/1}}{v_{1/3}}} \cdot x_3 \end{cases} \quad (70)$$

Putting transformation presented in (69) must have the same form as transformation (70). Hence we will obtain

$$\sqrt{-\frac{v_{1/3}}{v_{3/1}}} = \sqrt{-\frac{v_{1/2}}{v_{2/1}}} \cdot \sqrt{-\frac{v_{2/3}}{v_{3/2}}} \quad (71)$$

$$\sqrt{-\frac{v_{3/1}}{v_{1/3}}} = \sqrt{-\frac{v_{2/1}}{v_{1/2}}} \sqrt{-\frac{v_{3/2}}{v_{2/3}}} \quad (72)$$

$$v_{3/1} \sqrt{-\frac{v_{1/3}}{v_{3/1}}} = v_{3/2} \sqrt{-\frac{v_{2/1}}{v_{1/2}}} \cdot \sqrt{-\frac{v_{2/3}}{v_{3/2}}} + v_{2/1} \sqrt{-\frac{v_{1/2}}{v_{2/1}}} \cdot \sqrt{-\frac{v_{2/3}}{v_{3/2}}} \quad (73)$$

From the relation (71) and (72), after increasing to square, an identical equation is obtained

$$-\frac{v_{1/2}}{v_{2/1}} \frac{v_{2/3}}{v_{3/2}} \frac{v_{3/1}}{v_{1/3}} = 1 \quad (74)$$

From the relation (73) after conversion we will obtain

$$v_{3/1} = v_{3/2} \sqrt{-\frac{v_{2/1}}{v_{1/2}}} \sqrt{-\frac{v_{2/3}}{v_{3/2}}} \sqrt{-\frac{v_{3/1}}{v_{1/3}}} + v_{2/1} \sqrt{-\frac{v_{1/2}}{v_{2/1}}} \sqrt{-\frac{v_{2/3}}{v_{3/2}}} \sqrt{-\frac{v_{3/1}}{v_{1/3}}} \quad (75)$$

From the equation (74) it is known that factor at $v_{2/1}$ is equal 1, hence

$$v_{3/1} = v_{3/2} \sqrt{-\frac{v_{2/1}}{v_{1/2}}} \sqrt{-\frac{v_{2/3}}{v_{3/2}}} \sqrt{-\frac{v_{3/1}}{v_{1/3}}} + v_{2/1} \quad (76)$$

i.e.

$$v_{3/1} = v_{3/2} \sqrt{-\frac{v_{1/2}}{v_{2/1}}} \sqrt{-\frac{v_{2/3}}{v_{3/2}}} \sqrt{-\frac{v_{3/1}}{v_{1/3}}} \cdot \left(-\frac{v_{2/1}}{v_{1/2}} \right) + v_{2/1} \quad (77)$$

Using (74) we will obtain the formula for summing relative speeds ($v_{1/2} \cdot v_{2/1} \leq 0$)

$$v_{3/1} = -v_{3/2} \frac{v_{2/1}}{v_{1/2}} + v_{2/1} \quad (78)$$

On the basis of (36) and (54) we will obtain

$$-\frac{v_{2/1}}{v_{1/2}} = \frac{\delta(v_2)}{\delta(v_1)} = \frac{1 - (v_2/c)^2}{1 - (v_1/c)^2} = \frac{c^2 - v_2^2}{c^2 - v_1^2} \quad (79)$$

Now the formula (78) for summing relative speeds has a form of

$$v_{3/1} = v_{3/2} \frac{1 - (v_2/c)^2}{1 - (v_1/c)^2} + v_{2/1} = v_{3/2} \frac{c^2 - v_2^2}{c^2 - v_1^2} + v_{2/1} \quad (80)$$

7. Transformation expressed from absolute speed

On the basis of (54) and (66), transformation (37)-(38) can be expressed from absolute speed v_1 and v_2 . Then a general form (26)-(27) and (37)-(38) is lost, but we will obtain its special form, which is consistent with experiments in which the speed of light was measured.

$$\begin{cases} t_1 = \sqrt{\frac{1 - (v_1/c)^2}{1 - (v_2/c)^2}} \cdot t_2 \\ x_1 = \frac{v_2 - v_1}{\sqrt{1 - (v_1/c)^2} \sqrt{1 - (v_2/c)^2}} \cdot t_2 + \sqrt{\frac{1 - (v_2/c)^2}{1 - (v_1/c)^2}} \cdot x_2 \end{cases} \quad (81)$$

$$\begin{cases} t_2 = \sqrt{\frac{1-(v_2/c)^2}{1-(v_1/c)^2}} \cdot t_1 \\ x_2 = \frac{v_1 - v_2}{\sqrt{1-(v_1/c)^2} \sqrt{1-(v_2/c)^2}} \cdot t_1 + \sqrt{\frac{1-(v_1/c)^2}{1-(v_2/c)^2}} \cdot x_1 \end{cases} \quad (82)$$

8. Transformation between ether and inertial system

We adopt the following determinations: $U_2 \equiv U'$ and $U_1 \equiv U$ (ether). Then relations occur (44). We also adopt the following determinations: $x = x_1$, $t = t_1$, $x' = x_2$ and $t' = t_2$. With such determinations, on the basis of (81) and (82), we obtain transformations from the inertial system U' to ether U and ether U to inertial system U' in a form of

$$\begin{cases} t = \frac{1}{\sqrt{1-(v/c)^2}} \cdot t' \\ x = \frac{v}{\sqrt{1-(v/c)^2}} \cdot t' + \sqrt{1-(v/c)^2} \cdot x' \end{cases} \quad (83)$$

$$\begin{cases} t' = \sqrt{1-(v/c)^2} \cdot t \\ x' = \frac{-v}{\sqrt{1-(v/c)^2}} \cdot t + \frac{1}{\sqrt{1-(v/c)^2}} \cdot x \end{cases} \quad (84)$$

This transformation is identical as transformation derived in works [17]-[22], in which it was derived with other method based on geometrical analysis of Michelson-Morley's and Kennedy-Thorndike's experiment. In monograph [17], on the basis of this transformation, a new theory of kinematics and dynamics of bodies was derived, called the Special Theory of Ether.

Transformation (83)-(84) was also derived, but with other method, in articles [9] and [27]. In work [9], the author obtained this transformation from Lorentz's transformation thanks to clocks synchronization in inertial systems with the external method. The transformation obtained in work [9] is a differently written Lorentz's transformation after the change of the way of measuring time in the inertial frame of reference, and therefore the authors have assigned it the properties of Lorentz's transformation. Transformation derived in this article has a different physical meaning than Lorentz's transformation, because according to the theory presented here, it is possible to determine the velocity in relation to a universal frame of reference by means of local measurement. This means that a universal frame of reference is real, and is not an arbitrarily chosen inertial system.

9. One-way speed of light

In works [17] and [22] based on transformation (83)-(84), a formula for one-way speed of light in vacuum was derived, which is measured by the observer from inertial frame of reference

$$c'_{\alpha'} = \frac{c^2}{c + v \cos \alpha'} \quad (85)$$

In the work [17], a formula for one-way speed of light in the material medium s was derived, which is measured by the observer from inertial frame of reference

$$c'_{s\alpha'} = \frac{c^2 c_s}{c^2 + c_s v \cos \alpha'} \quad (86)$$

In these two relations, angle α' , measured by the observer, is an angle between vector of its velocity in relation to ether and vector of the velocity of light. The speed c_s is a speed of light in the motionless material medium in relation to ether, seen by motionless observer in relation to ether.

Although, the speed of light expressed by formula (86) depends on angle α' and speed v , the average speed of light on the path forth and back to the mirror is always constant. It is sufficient to verify that for the speed of light expressed by formula (86), the average speed on path L' forth and back to the mirror is as follows

$$c'_{sr} = \frac{2L'}{t'_{s\alpha'} + t'_{s(\pi+\alpha')}} = \frac{2L'}{\frac{L'}{\frac{c^2 c_s}{c^2 + c_s v \cos \alpha'}} + \frac{L'}{\frac{c^2 c_s}{c^2 + c_s v \cos(\pi + \alpha')}}} \quad (87)$$

$$c'_{sr} = \frac{2}{\frac{c^2 + c_s v \cos \alpha'}{c^2 c_s} + \frac{c^2 - c_s v \cos \alpha'}{c^2 c_s}} = \frac{2}{\frac{2c^2}{c^2 c_s}} = c_s \quad (88)$$

From the relation (88) results that c_s is also an average speed of light on the path forth and back to the mirror in the motionless material medium relative to the observer.

10. Conclusions

Determined transformations (81)-(82) and (83)-(84) are consistent with the zero result of the Michelson-Morley's and Kennedy-Thorndike's experiments. It results from above transformations that measurement of the speed of light in vacuum will always give an average value equal to c (measurement with so far used methods). The average speed of light is constant and independent from the velocity of an inertial frame of reference, in which it is measured. This is despite the fact that for a moving observer the speed of light has different values in different directions. Because of this property the speed of light, Michelson-Morley's and Kennedy-Thorndike's experiments could not detect ether.

The analysis shows that it is possible to explain the zero result of Michelson-Morley's experiment on the basis of ether. A statement is false that Michelson-Morley's experiment has shown that one-way speed of light is absolutely constant. It is also false that Michelson-Morley's experiment has proved that there is no ether in which light propagates.

Assumption that speed of light can depend on the direction of its emission, does not distinguish any direction in space. It is about the speed of light measured by moving observer. It is a velocity, at which the observer moves in relation to universal frame of reference (ether), that distinguishes in space the characteristic direction, but only for this observer. For motionless observer in relation to universal frame of reference, the one-way speed of light is always constant and does not depend on the direction of its emission. If the observer moves in relation to a universal frame of reference, then the space for observer is not symmetrical. In this case, it will be like for an observer sailing on water and measuring the speed of wave on the water. Despite the fact that the wave propagates at a constant speed in each direction, for sailing observer the wave speed will vary in different directions.

Currently it is believed that STR is the only theory that explains the Michelson-Morley's and Kennedy-Thorndike's experiments. This article shows that other theories are possible according to these experiments. In works [17] and [22], based on determined here transformation, the new

physical theory of kinematics and dynamics of bodies was derived, called by authors the Special Theory of Ether. The work [22] shows that there is infinite number of theories with ether that correctly explain zero result of the Michelson-Morley's and Kennedy-Thorndike's experiments. Even the theory with ether is possible, in which time is absolute.

In the works [17] and [25], it is shown that within each such kinematics, an infinite number of dynamics can be derived. In order to derive dynamics, it is necessary to adopt an additional assumption, which enables to introduce the concept of mass, kinetic energy and momentum in the theory.

All experiments conducted by man were observed with laboratories moving with small speeds relative to universal frame of reference (about $0,0012 c$) [22]. Such experiments do not provide an answer on how the laws of nature look like for observers found in the inertial frames of reference moving with large speeds relative to a universal frame of reference. It is unknown, for example, what will be the results of the Michelson-Morley and Kennedy-Thorndike experiments in laboratories which moves relative to universal reference system with high speeds. Therefore, in physical theories, the results obtained in frames of reference available to the observer are extrapolated to all other inertial frames of reference. But as, they are acceptable as valid models of real processes, kinematics based on transformations that do not meet the II-III assumptions in all inertial frames of reference, but only in inertial frames of reference available for experiments. Such kinematics can be created on the basis of transformations (26)-(27) or (37)-(38) derived in this article. For example, if assumptions II-III are to be fulfilled in any inertial frames of reference, then transformation (81)-(82) is obtained, which can also be written in the form (83)-(84).

In the article [23] it was shown that Lorentz transformations should be assigned a different interpretation than that 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 article [26] it was shown that gravitational waves should be interpreted as a 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.

On the basis of presented kinematics (83)-(84), it is possible in a natural way to explain the dipole anisotropy of cosmic microwave background, which in detail is discussed in the article [16]. This enables to determine the velocity at which the Solar System moves in relation to universal frame of reference, i.e. $369,3 \text{ km/s} = 0,0012 c$. This was presents in works [18] and [22].

In the Special Theory of Ether, the cosmic microwave background can be, for example, electromagnetic thermal radiation of ether (black body radiation). If the microwave background radiation 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 it did not arise in the early universe as is commonly believed today [21].

Predictions of the Special Theory of Ether and Special Theory of Relativity are very similar. However, there are differences which may allow for experimental falsification of these theories in the future. 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 absolute speed using local measurement. This means that for each observer the space is completely isotropic (the same properties in each direction). However, according to STE, the observer can use local measurements to determine the direction of its movement in relation to ether. This means that for observers moving in relation to ether, the space is not isotropic (has different properties in different directions). Confirmation of this by experiment is not easy due to the low speed of the Solar System

relative to ether. For a small speed, the effects of non-isotropic space are very slight. This is the most important difference between the Special Theory of Ether and Special Theory of Relativity [20].

The article [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.

Michelson-Morley's and Kennedy-Thorndike's experiments were conducted repeatedly by different teams. Each of these experiments at most confirmed that the average speed of light is constant. Therefore, assumptions on which presented derivations are based are justified experimentally. However, it should be remembered that there are studies (e.g. [10], [12]) which show that the Michelson-Morley experiment gives a result that is not zero, although much weaker than originally predicted from the kinematics of Galileo Galilei with a luminiferous ether.

In the Special Theory of Relativity and the Special Theory of Ether, it is assumed that the speed of light in a given direction (moving in a straight line one direction) is constant, because there are no experiments to suggest otherwise.

There are numerous articles on the subject of relativistic mechanics with significant theoretical results. The article [7] presents the original definition of acceleration in Special Theory of Relativity, while in article [8] the formalism concerning the three-vector and four-vector relative velocity was been shown. The articles [13] and [14] relate to important insights on time dilation in relativity, while article [15] presents alternative ideas for relativity. Numerous works discuss the zero result of the Michelson-Morley experiment, from which time dilation and the Lorentz-Fitzgerald contraction results [1], [28]. There are also published papers showing the paradoxes of the Special Theory of Relativity concerning rotating frames of reference [5]. Article [4] is investigating the subject of relativistic velocity addition. The article [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.

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