Explanation of what time in kinematics is and dispelling myths allegedly stemming from the Special Theory of Relativity

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Abstract:

The paper explains the time dilation phenomenon and the Lorentz-FitzGeralda contraction phenomenon on the basis of Special Theory of Ether. Presented explanations are based on the construction of innovative technical models of these phenomena, and not only on their classical description. Time dilation is a natural property of time measured by the light clock.

The paper shows that time dilation phenomenon is a proof of the existence of universal frame of reference, in which the electromagnetic interaction propagates.

It has been shown that there are no theoretical grounds to argue that the velocity of light in a vacuum is the maximum velocity. The adoption of such a doctrine in modern physics results from an overinterpretation of the mathematics on which Special Theory of Relativity is based.

The model presented here shows how the atomic clocks can be used to determine the motion relative to the universal frame of reference in which electromagnetic signals propagate. The presented model also shows how Michelson-Morley's experiment can be modified to be able to detect movement with respect to ether.

The paper explains what time is in kinematics theories.

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

Key words: light clock, time dilation, time, Lorentz-FitzGeralda contraction, velocity of light, maximum velocity

1. Introduction

The content of this paper refers to articles [11] and [12], and therefore it is advisable to know them in advance, although it is not necessary. We will rely on three assumptions I-III that are identical to those of the paper [12].

Time dilation is a phenomenon manifested by the fact that the duration of the same processes may be different in different reference systems. This means that the duration of process depends on the velocity at which the reference system moves, in which the process takes place.

Time dilation is described by kinematics models, in which the passage of time on clocks depends on the velocity at which the clocks move.

In classical kinematics there is no time dilation phenomenon, because in this theory all clocks measure time in the same way.

In Special Theory of Relativity (STR) there is no universal frame of reference, thus inertial systems cannot be attributed to absolute velocities. In STR, the duration of any process measured by the own clock (i.e. motionless clock in relation to the place where the process takes place) is shorter than the duration of this process measured by clocks from other inertial systems (i.e. clocks moving in relation to the place where the process takes place). According to the commonly adopted interpretation of mathematics, on which STR is based, time dilation is relative in this theory, i.e. it depends on which observer measures it. For example, for one observer the process A is shorter than the process B, while for another observer the process B is shorter than the process A. Therefore, in STR two observers can draw completely different conclusions about the relative duration of two processes, if these processes take place in other inertial systems.

In Special Theories of Ether (STE), there is a universal frame of reference in relation to which it is possible to measure the velocities of inertial systems [8-11]. In STE without transverse contraction, motionless clocks in relation to ether are measuring time the fastest. Clocks moving in relation to ether are measuring time slower. The faster clocks move, the slower they measure time. Therefore, in STE without transverse contraction the time elapse depends on the velocity of moving in relation to ether. In STE all observers evaluate the relative time elapse of any two processes in the same way.

Time dilation in Special Theory of Ether has different properties than in Special Theory of Relativity. In Special Theory of Ether, the velocity of physical process (time elapse) depends on the velocity in relation to the universal frame of reference at which the inertial system moves, in which the process takes place. The time elapse in STE is objective, i.e. each observer evaluates the proper time of a specific process in the same way. In Special Theory of Relativity, the proper time elapse is not objective, because it depends on the relative velocity at which the observer evaluating the process velocity moves.

In [8] and [12] it has been shown that the mathematics on which STR is based can be interpreted differently than it is nowadays accepted in physics. Two other interpretations have been shown. Then STR becomes a theory with universal frame of reference, i.e. it becomes STE without transverse contraction [12]. With these other interpretations the time dilation occurring in STR becomes time dilation occurring in STE without transverse contraction.

It is believed that time dilation is confirmed experimentally. For example, in the particles of lithium ions accelerated to $c/3$ velocity, the frequency of transitions between different energy levels is less than in the same lithium ions that rest motionless in the laboratory [1]. It is concluded that the same processes in accelerated particles are slower than in motionless particles in relation to the laboratory. Another experiment confirming the time dilation was the Hafele and Keating experiment, in which the passage of clocks time remaining motionless on Earth and those sent on a trip around the Earth were compared [2], [3].

Indirect evidence for the existence of time dilation is the Michelson-Morley experiment and its improved version, i.e. the Kennedy-Thorndike experiment. In order to explain these experiments within the Special Theory of Relativity and Special Theory of Ether, it was necessary to introduce time dilation into these theories. However, these experiments are not unquestionable proofs of the existence of time dilation phenomenon, because it is possible to explain them without time dilation, with the use of Ritz's emission theory (ballistic theory of light), according to which light has a constant velocity only in relation to its source [5].

2. Light clock

2.1. Principle of light clock operation

Figure 1 shows a clock, which we will call a signal clock. This clock uses a signal that propagates at a constant velocity v_0 in a homogeneous medium. The universal frame of reference *U* is connected with the medium in which the signal propagates. The clock can move relative to the medium in which the signal is propagated (at *v* velocity). The clock is connected to the inertial system *U′*.

The clock consists of a signal source and a mirror that can reflect such a signal. The signal source and the mirror are rigidly connected at *D′* distance, and form the arm of a clock. The signal is sent from the source and travels a distance of *D′* length. Then it is reflected by the mirror and returns to the source along the same path. When the signal returns to the source, another signal is sent immediately. This means that the signal clock continuously generates further signals. The total time of one signal passing to the mirror and back is a time standard for an observer in the same inertial system *U′* in which the clock is located. The duration of one cycle of a signal clock is the smallest unit of time that a signal clock can measure.

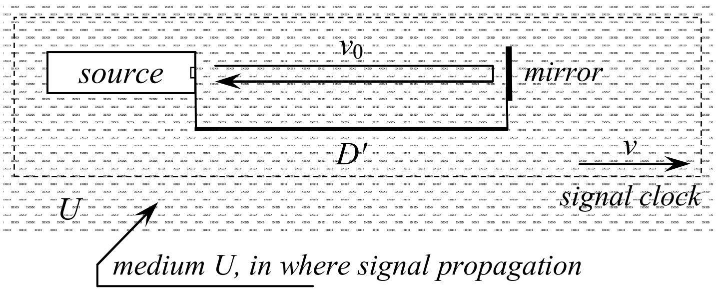

Fig. 1. The signal clock is based on the signal propagating in the distinguished reference system.

If the signal used in a signal clock is a light impulse (or any other electromagnetic impulse), then the clock will be called a light clock. In this paper we will analyze the properties of a light clock assuming that light propagates in the universal frame of reference (ether), i.e. according to the Special Theory of Ether [8-11]. On this basis, conclusions will also be drawn on the Special Theory of Relativity.

Every observer measures his time (proper time) with own light clock, which is motionless in his inertial reference system.

2.2. Light synchronization of clocks means using light clocks

The theorem **on the signal clock (light clock):**

Assumption: The clocks in inertial systems are synchronized with the signal (light).
Conclusion: Time measurement is based on signal clocks (light clocks).

Proof:

Synchronization of two clocks with light is shown in Figure 2.

The two clocks are located in the inertial system *U′*. The distance between clocks is $D' = constants$. When clock *A* indicates value t'_{A1}, a light impulse is sent from it to clock *B*. If the one-way speed of light in this direction is c^+, then when the light impulse reaches the clock *B* the following value must be set on it

$$t'_B = t'_{A1} + D'/c^+ \tag{1}$$

Synchronization of clocks must also operate in opposite side. The light impulse is reflected immediately by the clock *B* and returned to the clock *A*. If the one-way speed of light on the way back has a value of c^-, then when the light impulse returns to the clock *A* it indicates the value

$$t'_{A2} = t'_B + D'/c^- \tag{2}$$

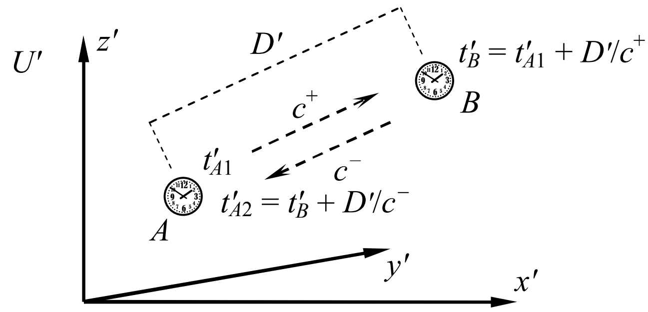

Fig. 2. Synchronization of clocks with light means that time is measured by light clocks.

On this basis we can see that the time elapse on the clock *A* is exactly the same as the total time flow of light back and forth and it is

$$t'_{A2} - t'_{A1} = D'/c^+ + D'/c^- \tag{3}$$

The time required for the light signal to travel *A*→*B*→*A* is used as a standard for the adjustment of clock *A*. This means that the time required for the light to travel back and forth along *D'* arm is exactly the same as the time elapse on clock *A*. This means that clock *A* measures the time in the same way as a light clock. **This proves the conclusion**.

Dependence (3) can be transformed into another form

$$t'_{A2} - t'_{A1} = D'\left(\frac{1}{c^+} + \frac{1}{c^-}\right) = \frac{2D'}{\dfrac{2}{\dfrac{1}{c^+} + \dfrac{1}{c^-}}} = \frac{2D'}{c_{sr}} \tag{4}$$

The time lapse on clock *A* in one cycle depends on the arm length along which the light flows and the average velocity of light c_{sr} on the way back and forth. It is worth noting that the time lapse on clock *A* does not depend on one-way speed of light c^+ and c^- if $c_{sr} = constants$ (assumption III).

Synchronization of *A* and *B* clocks depends on one-way speed of light c^+, and therefore synchronization depends on what theory this process is based on (classical kinematics, Special Theory of Relativity or any of the Special Theory of Ether). But the clock *B* does not affect the velocity at which the clock *A* measures time. Although in the synchronization process the light impulse was sent to clock *B*, but the speed at which clock *A* measures the time depends only on the total time it takes for the light impulse to go back and forth. This means that clock *A* measures the time exactly like a light clock. Since the requests received for clock *A* apply to every clock, all light synchronized clocks measure the time exactly the same as a light clock.

Thanks to the claim about a signal clock, it is known that in all kinematics the standard of time is a signal clock (a light clock). Therefore all properties of time in kinematics result from properties of signal clocks.

2.3. Time measurement in own clock system (in inertial frame of reference)

The light clock rests in the inertial system *U'*, which moves relative to the universal frame of reference *U* at velocity *v*. We consider the case when the clock arm is parallel to the vector of velocity *v*. For an observer from *U'* system, the clock is always a standard (etalon) of the same time unit. The same for observer from *U'* system, the length of clock arm D'_x always has the same value, because the clock arm is the same as the standard length.

For an observer with universal system *U*, the length of clock arm may depend on the velocity at which the clock moves relative to it. We will mark this length with a symbol $D_x(v)$. If $v = 0$, then the length of clock arm is the same for observers from *U'* and *U* systems, and therefore $D'_x = D_x(0)$.

If the clock is motionless in relation to the medium in which the light propagates (universal frame of reference *U*, ether) then the time *t'*, in which the light passes the way to the mirror and back is

$$t' = \frac{2D_x(0)}{c} = \frac{2D'_x}{c} \tag{5}$$

One operation cycle of such a light clock is, for motionless observer in relation to the clock, a time standard with value (5). It should be noted that if a clock follows one cycle, the motionless observer in relation to that clock always evaluates it as a time elapse of time of the same value (5), regardless of whether they move relative to the universal system *U* or not.

It is not known what values have one-way speed of light c^+ (when the light moves in the mirror direction) and c^- (when the light moves on its way back to the light source) [11]. As one-way speed c^+ and c^- may depend on the direction of light propagation or velocity *v*, the one-way light clock, in which the signal flows in only one direction, may not be a good time standard (time etalon). But if the average velocity of light flowing along the way to the mirror and back is constant (assumption III), then the bi-directional clock is a stable time unit standard. Such a unit the time will not depend on the direction of light emission, i.e. the way the light clock is set, nor on velocity *v*. Therefore, in this paper we will use a two-way light clock.

2.4. Time measurement from universal frame of reference

Let us consider the situation as shown in Figure 3.

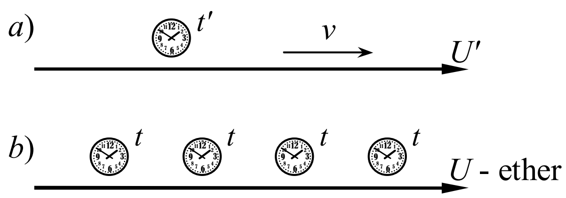

Fig. 3. Comparison of time elapse:
a) clock moving in relation to ether, *b*) motionless clocks in relation to ether.

We have several identical light clocks. One of these clocks is placed in the inertial system *U'*, while the other clocks are placed in the universal system *U*. The clocks in the universal system *U* are synchronized with the light, which in the universal system *U* has a velocity of known one-way value *c* (assumption II). The clock from *U'* system passes by the clocks from *U* system, thus their indications can be compared. It will be shown below that although all clocks are identical, at the time when the clock from *U'* system follows one cycle, the clocks from *U* system will follow other number of cycles. This is the phenomenon of time dilation.

For this purpose, we will analyze the distance covered by the light of clock in U' system from the observer's perspective in U system (Figure 4). We consider the case when the arm of clock is parallel to vector of velocity v with which the clock moves. Dimensions parallel to velocity v will be marked with index x, so in this case the length of the clock arm is $D_x(0) = D'_x$ in U' and $D_x(v)$ in U.

Figure 4 in part A shows the moment when a light impulse is emitted from a source (S). Part B shows the moment when the light impulse is reflected by the mirror (M). Part C shows the moment when the light impulse returns to the source (S).

From the perspective of U' system, the light travels a distance to the mirror of length $D_x(0) = D'_x$ at time t'_1, at a velocity c^+_x. Returning to the source, the light follows a path of the same length $D_x(0) = D'_x$, at time t'_2, at a velocity c^-_x. If the clock follows one cycle, then according to the observer in the same inertial system U' the time elapse $t' = t'_1 + t'_2$ with value (5).

As the dimensions of bodies moving in relation to the universal frame of reference can change, hence from the perspective of U system the distance between the light source and the mirror will be marked by $D_x(v)$.

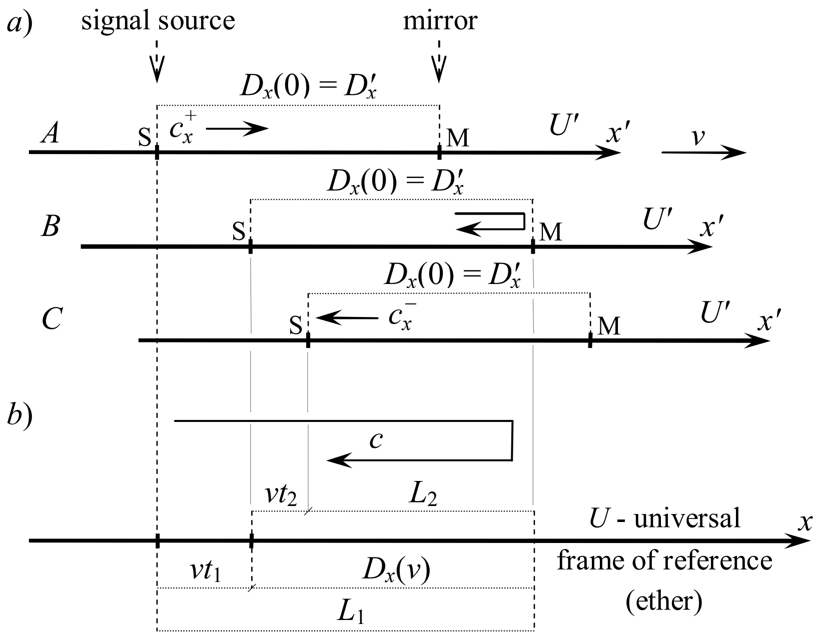

Fig. 4. Light clock:
a) the path of light impulse seen from U' system in which the clock is located,
b) the path of light impulse seen from U system in which the light propagates.

From the perspective of U system, light travels a distance to a mirror of L_1 length, at time t_1, at a velocity c. Returning to the source, the light travels a distance of L_2, at time t_2, at the same velocity c. From Figure 4 (part b) we obtain

$$L_1 = D_x(v) + v \cdot t_1, \qquad L_2 = D_x(v) - v \cdot t_2 \tag{6}$$

$$t_1 = \frac{L_1}{c} = \frac{D_x(v) + v \cdot t_1}{c}, \qquad t_2 = \frac{L_2}{c} = \frac{D_x(v) - v \cdot t_2}{c} \tag{7}$$

Relations (7) must be resolved in respect of t_1 and t_2. Then we obtain the time and the path of light flow in the system U in a form of

$$t_1 = \frac{D_x(v)}{c - v}, \qquad t_2 = \frac{D_x(v)}{c + v} \tag{8}$$

$$L_1 = c \cdot t_1 = D_x(v)\frac{c}{c-v}, \qquad L_2 = c \cdot t_2 = D_x(v)\frac{c}{c+v} \tag{9}$$

When the light pulse follows one cycle, then the light signal for the observer from U system travels a distance of $L_1 + L_2$. Therefore, for the observer from U system, the time t elapses, which the light needs in this system to cover a distance of $L_1 + L_2$.

$$t = t_1 + t_2 = \frac{L_1}{c} + \frac{L_2}{c} = \frac{D_x(v)}{c-v} + \frac{D_x(v)}{c+v} = D_x(v)\frac{(c+v)+(c-v)}{(c-v)(c+v)} = \frac{2c\,D_x(v)}{c^2 - v^2} \tag{10}$$

$$t = \frac{2\,D_x(v)}{c}\frac{1}{1-(v/c)^2} \tag{11}$$

During one cycle of the light clock for the observer from U' system the time elapses given by the equation (5) and for the observer from universal frame of reference U the time elapses given by the equation (11). Therefore, these observers evaluate the time elapse differently. When we divide the pages of equation (11) by equation (5), then we obtain the formula for time dilation in a form of

$$t = t'\frac{D_x(v)}{D_x(0)}\frac{1}{1-(v/c)^2} = t'\frac{D_x(v)}{D'_x}\frac{1}{1-(v/c)^2} \tag{12}$$

Time dilation depends on velocity v with which the clock moves (i.e. on the velocity of U' system in relation to U system) and on how the longitudinal dimensions of bodies moving in relation to the light propagation medium contract (i.e. on value of $D_x(v)/D'_x$). Time dilation also depends on the velocity c with which the signal moves.

From the derived equation (12) it follows that

$$\frac{\text{number of clock cycles in } U}{\text{number of clock cycles in } U'} = \frac{D_x(v)}{D_x(0)}\frac{1}{1-(v/c)^2} = \frac{D_x(v)}{D'_x}\frac{1}{1-(v/c)^2} \tag{13}$$

This means that if the same light clock in U' system is seen by two observers, one is motionless in relation to the clock (inertial system U'), the other is motionless in relation to ether (universal frame of reference U), then for them this clock measures the time differently. It results from the fact that for the observer from U' system the considered clock is a time standard, while for the observer from U system the time standard is the motionless clocks in his U system. As the velocity v with which the clock moves in relation to the universal frame of reference influences the velocity of its ticking, the time standard of these two observers work differently.

It results that time dilation is a natural property of a light clock.

The value c appearing in equations (12) and (13) does not have to be the velocity of light in a vacuum, but it can be the velocity of any signal propagating in a medium, e.g. the velocity of sound in air or water.

2.5. Time measured by a moving clock with a freely set arm

The important question is whether the way the light clock measures time depends on its position in the inertial system U', i.e. on the angle of inclination of the clock arm in relation to the vector of velocity v at which the clock moves in relation to ether. In chapters 2.3 and 2.4 only the case when the clock arm is parallel to the velocity vector v is analyzed (Figure 4). If the way in which the light clock measures time is dependent on the inclination angle, then for the clock to be stable, it cannot be rotated. In such a case, the practical application of a light clock would be difficult.

The experiments of Michelson-Mrley and Kennedy-Thorndike essentially consist in comparing the indications of two light clocks, the arms of which are inclined towards each other. The officially recognized results of these experiments show that the average velocity of light in vacuum is always constant in inertial systems available for experiments. This proves that, under real conditions, a light clock measures time independently of the angle of arm inclination. However, if it turned out that Michael-Morley's and Kennedy-Thorndike's experiments provide some insignificant positive results [6, 7], then the way the time is measured by the light clock would depend to some extent on the inclination angle of this clock in relation to velocity v.

In papers [11] and [12] all linear transformations (without revolutions) are derived, for which the average velocity of light on the way back and forth is always constant. Each of these transformations is consistent with the results of Michelson-Mrley's and Kennedy-Thorndike's experiments. In kinematics based on such transformations the time of light flow along the arm of light clock (on the way back and forth) does not depend on the inclination angle of this arm to the vector of velocity v. Therefore in these kinematics the time measured using a light clock does not depend on the position of light clock in the inertial system. Such kinematics are Special Theory of Relativity and Special Theories of Ether.

In the further part of this paper, we will assume that there is a kinematics based on one of the numerous transformations derived from the paper [11]. In each of these kinematics, the light clock measures the time independently of the inclination of clock arm. Therefore, in all such kinematics the time dilation equation (11) and (12) is valid regardless of how the clock is set.

3. Time dilation w different kinematics

3.1. Classical kinematics

In classical kinematics (Galilean) there is no length contraction, and therefore $D(v) = D'$ (for each inclination angle). A light clock without contractions will be called a classic light clock. In this case, the time dilation (12) takes the form of

$$t = t' \frac{1}{1-(v/c)^2} \tag{14}$$

Equation (14) applies only if the clock arm and vector of velocity v are parallel. Therefore, the symbol t is accompanied by the designation ||.

Initially it was believed that the universal frame of reference, in which light (ether) propagates, occurs within the classical kinematics. For this reason Michelson and Morley planned their experiment on the basis of predictions resulting from classical kinematics, into which the ether was introduced. Equation (14) shows that if in such a model clocks are synchronized with the help of light, there will be time dilation described by this equation.

As in classical kinematics with ether, the average velocity of light depends on the direction of emission (§1.3 [4]), that is why in this theory the time dilation depends on the inclination of arm of the light clock in relation to the vector of velocity v. It was precisely to detect this effect, although they probably understood it differently, that they counted in their experiment Michelson and Morley.

Time dilation in classical kinematics with ether will not only be when the velocity $c = \infty$, or equivalently when $v \ll c$ because then time dilation is immeasurable. Then equation (14) is simplified to $t = t'$. Therefore, in the introduction of this paper it is written that there is no time dilation in classical kinematics.

3.2. Kinematics of the Special Theory of Ether

In the paper [11] the whole class of kinematics (transformation) of the Special Theory of Ether was derived, which are in accordance with the results of the Michelson-Morley experiment. In these kinematics in every inertial system the average velocity of light is constant (assumption III is fulfilled). Therefore, the light clocks measure time independently of their inclination in relation to the velocity v with which they move in relation to the ether.

Longitudinal contraction (i.e. in the direction parallel to velocity v) in STE is expressed by the equation derived from the paper [11] in the form of

$$D_x(v) = D_x(0)\psi(v)\sqrt{1-(v/c)^2} = D'_x\psi(v)\sqrt{1-(v/c)^2} \tag{15}$$

Parameter $\psi(v)$ describes transverse contraction (i.e. perpendicular to velocity v), which the kinematics of the Special Theory of Ether are differ between each other. In these kinematics the transverse contraction is closely related to longitudinal contraction. This is forced by the fact that in every frame of reference the average velocity of light is always constant (assumption III). The dimensions of body in motion are shown in Figure 5.

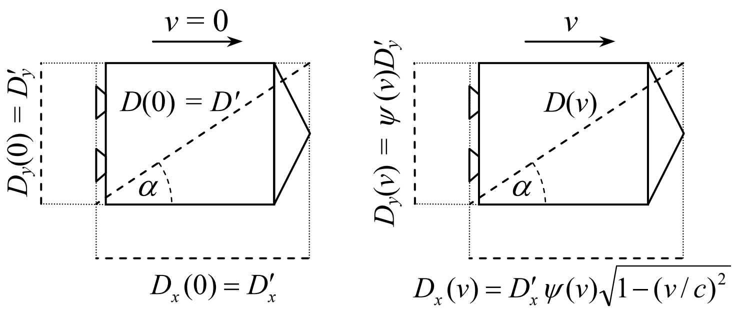

Fig. 5. Body dimensions in STE observed by a motionless observer in relation to ether.

Based on (15), the dilatation of time (12) takes in STE the form of

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

Time t is always measured by motionless clocks in relation to the ether, while time t' is measured by motionless clocks in relation to the inertial system moving in the ether at velocity v. From equation (16) it follows that each kinematics of the STE has a different time dilation.

In Special Theory of Ether without transverse contraction $\psi(v) = 1$. In this theory, the time dilation is expressed by the same equation as in Special Theory of Relativity, i.e.

$$\psi(v) = 1 \overset{\text{STE}}{\Leftrightarrow} t = t'\frac{1}{\sqrt{1-(v/c)^2}} \tag{17}$$

There is STE in which there is no time dilation. This is a theory in which transverse contraction is expressed by the equation

$$\psi(v) = \sqrt{1-(v/c)^2} \tag{18}$$

Then all clocks measure the time in the same way regardless of their motion state. This is due to the fact that on the basis of (18) equation (16) takes the form of

$$\psi(v) = \sqrt{1-(v/c)^2} \overset{\text{STE}}{\Leftrightarrow} t = t' \tag{19}$$

Figure 6 shows the time dilation diagrams for the four examples of Special Theory of Ether.

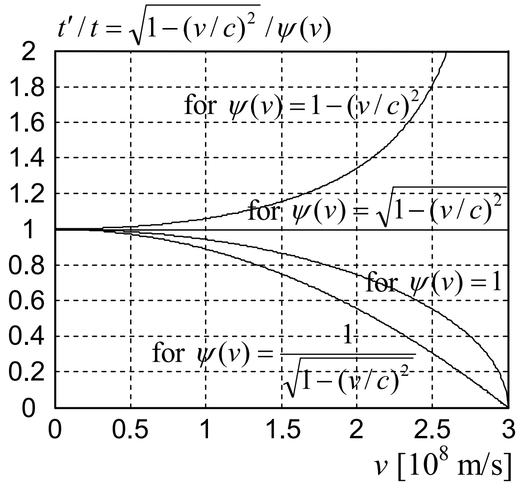

Fig. 6. Time dilation for four kinematics of the Special Theory of Ether. The graphs show the ratio of time t' measured in the inertial system to time t measured in the universal frame of reference.

Now we will determine some additional equations that we will be needed in the next part of the paper.

Body size measured at any angle to the direction of velocity v is indicated by $D(0) = D'$ and $D(v)$, i.e. without indexes x and y. If the angle α' is measured in the body's own system, then according to the equations given in Figure 5 there is

$$D(v)=\sqrt{D_x^2(v)+D_y^2(v)}=\sqrt{(D'_x\psi(v)\sqrt{1-(v/c)^2})^2+(D'_y\psi(v))^2} \tag{20}$$

$$D(v)=\sqrt{(D'\psi(v)\sqrt{1-(v/c)^2}\cos\alpha')^2+(D'\psi(v)\sin\alpha')^2} \tag{21}$$

$$D(v)=\sqrt{(D'\psi(v)\cos\alpha')^2(1-(v/c)^2)+(D'\psi(v)\sin\alpha')^2} \tag{22}$$

$$D(v)=\sqrt{(D'\psi(v))^2-(D'\psi(v)\cos\alpha')^2(v/c)^2} \tag{23}$$

Finally, the dependence for contraction from any angle α' is obtained in the form of

$$D(v)=D'\psi(v)\sqrt{1-(v/c)^2\cos^2\alpha'} \tag{24}$$

As in STE, the bodies in motion are deformed in a different way in the longitudinal and transverse direction (Figure 5), and therefore in inertial systems the angles are not preserved. Let the angle measured in the resting system of body as α' has a value α in the ether system. Acting in a symmetrical way as in the case of equations (20)-(24) it is possible to derive the relation to contraction at any angle α in the form of

$$D(v)=\frac{D'\psi(v)\sqrt{1-(v/c)^2}}{\sqrt{1-(v/c)^2\sin^2\alpha}} \tag{25}$$

Based on (24)-(25) the equation is obtained, which binds the angle α and α' in the form of

$$\sqrt{1-(v/c)^2\cos^2\alpha'}=\frac{\sqrt{1-(v/c)^2}}{\sqrt{1-(v/c)^2\sin^2\alpha}} \tag{26}$$

After the transformation of equation (26) the other equations are obtained, which bind the angle α and α' in the form of

$$\cos^2\alpha' = \frac{1-\sin^2\alpha}{1-(v/c)^2\sin^2\alpha} \quad \wedge \quad \sin^2\alpha = \frac{1-\cos^2\alpha'}{1-(v/c)^2\cos^2\alpha'} \tag{27}$$

The duration of one light clock cycle is described in equation (11) by the length of clock arm, but only when the arm is parallel to the vector of velocity v. We will now determine a more general equation for STE, in which the duration of one cycle will be described by the length of arm forming any angle α with the vector of velocity v. If the light clock is motionless in relation to the ether, then the length of its arm, regardless of the angle of its inclination, is the same for the observer from ether. Therefore, for the arms of identical clocks it is possible to write

$$D(0) = D' = D_x(0) = D_y(0) \tag{28}$$

If identical light clocks move in relation to the ether at velocity v, then for an observer from the ether, the arm parallel to velocity v is $D_x(v)$ long and the arm inclined at an angle α to velocity v is $D(v)$ long (Figure 5). In STE, these clocks measure time identically, but their arm lengths for an ether observer are not equal in general. In order to determine the relation between the arm lengths of these two clocks, the equation (25) will be divided by (15) and (28) will be considered. Then the following will be obtained

$$D_x(0) = D(0) \quad \Rightarrow \quad D_x(v) = D(v)\sqrt{1-(v/c)^2\sin^2\alpha} \tag{29}$$

The searched equation describing the time t, measured in the ether system, of one light clock cycle, based on the length of arm $D(v)$ of any inclination, is obtained by taking into account the equation (29) in equation (11)

$$t = \frac{2D(v)}{c}\frac{\sqrt{1-(v/c)^2\sin^2\alpha}}{1-(v/c)^2} \tag{30}$$

If to add an equation (25) to this equation, a different version will be obtained in the form of

$$t = \frac{2D(0)}{c}\frac{\psi(v)}{\sqrt{1-(v/c)^2}} = \frac{2D'}{c}\frac{\psi(v)}{\sqrt{1-(v/c)^2}} \tag{31}$$

Equation (30) is expressed from the length of moving arm that is measured from the ether system. However, equation (31) is expressed from length the arm would have in the ether if it did not move. It is worth noting that in the second case, in order to calculate the time t of one light clock cycle, it is not necessary to know the angle α or α', but the transverse contraction function $\psi(v)$ is needed.

3.3. Kinematics of the Special Theory of Relativity

In modern physics it is widely believed that time dilation is a property of space-time. This paper shows that it is the property of a light clock. The important thing is the mechanism of light clock, not the space-time. The idea of space-time with strange properties was introduced into physics probably because of difficulties in interpreting the mathematics on which the Special Theory of Relativity is based and space-time diagrams proposed by Hermann Minkowski.

In the paper [12] it was shown that mathematics, on which STR is based, can be interpreted differently. According to this interpretation, clocks in inertial systems are in STR desynchronized in relation to motionless clocks in relation to ether. If they are synchronized (which comes down to the assumption that the parameter $e(v) = 0$), then STR transforms into STE without transverse contraction. Therefore, in STR the time dilation equation is identical to the equation (17) for STE without transverse contraction.

In STR, the desynchronization of clocks is exactly such that the difference between inertial system and universal frame of reference is blurred [12]. The measurements of each observer based on such desynchronized clock are the same as the measurements of the observer from the universal frame of reference. Therefore every observer on the basis of own clocks determines the dilation according to equation (17), i.e. as if was in the universal frame of reference. In this way all inertial systems become indistinguishable.

4. There is no reason to claim that the velocity of light in a vacuum is the maximum velocity

Based on (16), we conclude that in kinematics, where the following condition is met

$$\lim_{v\to c}\frac{\sqrt{1-(v/c)^2}}{\psi(v)}=0 \tag{32}$$

if the time lapse in ether $t<\infty$, then the time lapse in inertial system has the value

$$\lim_{v\to c} t'=0 \tag{33}$$

It follows that in kinematics meeting the condition (32), light clocks moving at velocities $v\approx c$ cease to function. If, in such kinematics, the light clock moves at light velocities or higher, then it does not measure time ($t'=0$). This is due to the fact that a light impulse moving slower in relation to the ether than the clock cannot catch up with the mirror or source (depending on the direction in which the light clock arm is positioned).

In kinematics, which meet condition (32), it is not possible to describe processes in inertial systems that move at light velocities or higher. In such inertial systems, light clocks do not operate, i.e. it is not possible to measure the time lapse. In the mathematical notation it is expressed in such a way that when $v\to c$, then peculiarities appear in the time transformations. However, this does not mean that there are any physical reasons for forbidding bodies to reach the velocity of light in a vacuum, or a velocity higher than the velocity of light in a vacuum.

Kinematics can be based on light clocks using light impulses that propagate in a medium at a velocity of $c_s<c$. This could be done by a civilization that would live in a material medium that slows down light, for which vacuum would be unavailable. In their atmosphere, the velocity of light would always be, e.g. $c_s=c/2$. In their transformations, there would always be the velocity c_s, not the velocity c. Their transformations would stop functioning for inertial systems moving with the velocity of c_s. If they interpreted it in the same way as the value c is interpreted according to our contemporary physics, they would claim that c_s is the maximum velocity that cannot be exceeded. This is not the case, of course, and their transformations would stop functioning for the velocity of c_s or higher, only because for such velocities the light clock based on the signal propagating with the velocity of c_s does not function.

If the signal clock uses a signal moving at $c_s>c$ velocity, then the transformations based on the signal clock will function, also for velocities higher than the light velocity in a vacuum. In the extreme case, when $c_s=\infty$, the signal clock functions correctly in all inertial systems, regardless of their velocity. Therefore, in this case, the transformations act for inertial systems moving at any high velocity. This is the way it is in classical kinematics.

In a similar way, if in classical kinematics a signal clock using an air propagating sound signal (about 340 m/s) were to be used, then the corresponding transformations would no longer function for velocities such as the velocity of sound. However, this does not mean that the velocity of sound in the air is an impassable velocity.

While in all kinematics that do not meet the condition (32), the dimensions of bodies moving at velocity $v \to c$ tend for the motionless observer to zero values. This is because

$$\lim_{v\to c}\frac{\sqrt{1-(v/c)^2}}{\psi(v)}>0 \quad \Rightarrow \quad \lim_{v\to c}\psi(v)\le \lim_{v\to c}\sqrt{1-(v/c)^2}=0 \tag{34}$$

In kinematics, where condition (32) is not met, the length of a clock arm is contracted due to motion (Figure 5) more than it slows down the classic light clock (equation (14)). If the classic light clock moves in relation to the ether then for the motionless observer the light travels back and forth more slowly. In kinematics that do not meet the condition (32), the arm is contracted so much that it compensates for the slowing down effect of classical light clock. If the clock arm is contracted enough, the clock in motion can measure the time faster than the motionless clock (this is shown in one example in Figure 6, where $t' > t$).

Also in kinematics, which do not meet the condition (32), the transformations cease to function for inertial systems moving at velocities above c. For these kinematics, the reason is that the dimensions of length standards decrease to zero values when $v \to c$ (the arm lengths of light clocks become zero). Therefore, the transformations do not describe the dimensions of bodies moving at velocities $v > c$, and consequently do not describe the operation of light clocks, but this does not mean that the velocity of light in a vacuum is an absolute velocity. The theory simply does not say anything about what happens to the dimensions of bodies after passing through a peculiarity when their dimensions were zero.

The analysis presented in this chapter shows that there are no theoretical reasons to argue that the velocity of light in a vacuum is impassable. If coordinate and time transformations cease to function in inertial systems moving at velocities of $v = c$, or at higher velocities, it is only because light clocks cannot be time standard in such inertial systems.

Of course, it is not known whether the velocity of light in vacuum is the maximum velocity or not. The paper only shows that if the actual velocity of light in a vacuum is physically impassable, this is not derived from the Special Theory of Relativity, nor from the Special Theory of Ether. The dogma prevailing in modern physics that the velocity of light in a vacuum is impassable is that there is currently no theoretical basis for it.

5. Longitudinal contraction (Lorentz-FitzGerald) and transverse contraction

This chapter proposes a model explaining the contraction (or elongation) mechanism of bodies moving in relation to the universal frame of reference, in which light propagates. According to the explanation given, the contraction of bodies in motion is caused by the influence of this motion on the state of equilibrium of atoms in a solid body. At least two opposite interactions affect atoms. The average distance of atoms results from the state of equilibrium between these interactions. One of these interactions is related to the light clock.

Figure 7 shows two atoms of a solid body that are in thermal equilibrium. The considered atoms are at average distance $D(v)$ and move in relation to the ether at velocity v. The angle between the direction determined by atoms and the direction of velocity v has a value α (this is the angle measured in the ether system).

Each atom is under the influence of two interactions. One of them transmits momentum Δp_v to atoms and causes the atoms to repel each other. The other one acts on the atoms with force F_m and causes the atoms to attract each other. Figure 8 shows examples of the values of these interactions for a fixed value of velocity v. Only the distance D_s between atoms is stable. If this distance increases slightly, then the attraction force is greater than the repulsive force. If this distance decreases, then the repulsive force is greater than the attraction force. If the distance of atoms increases above the distance D_n, then the intermolecular bond is permanently broken because the repulsive force becomes greater than the attraction force.

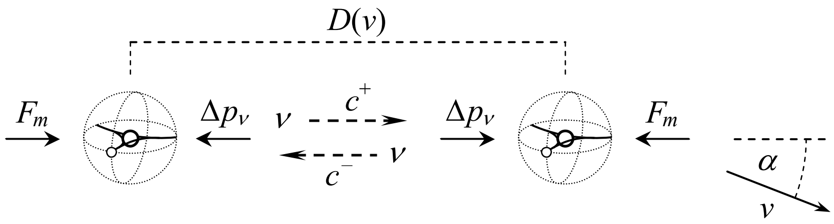

Fig. 7. There are two opposite interactions on atoms.
The average distance of atoms is the result of balance state between these interactions.

Now we will describe the repulsive effect. Atoms emit and absorb photons with frequencies ν that propagate in the ether. In the state of thermal equilibrium between atoms, n photons pass back and forth at time $\Delta t(v)$. For simplicity it is assumed that these photons reflect elastically from atoms. Atoms and photons that pass between them form a light clock. Each time when a photon reflects from an atom it transmits to it a momentum of the following value

$$\Delta p_\nu = 2\frac{h}{\lambda} = 2\frac{\nu h}{c} \tag{35}$$

where: λ is the wavelength attributed to the photon, ν is the frequency of this wave, h is the Planck constant, while c is the velocity of light in vacuum (average on the way back and forth).

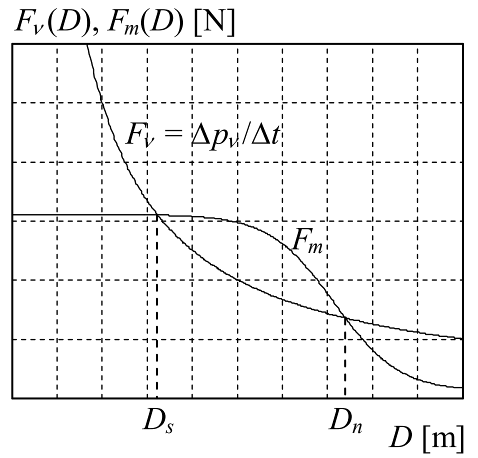

Fig. 8. Example of the values of interactions between atoms of solid body for a fixed value of velocity v.
$F_\nu(D)$ is repulsive force, $F_m(D)$ is an attraction force.

That is, photons passing between atoms push them and create internal pressure (we will call them the photons pressure).

Force is the momentum change in time. Therefore, the average force with which n photons act on one atom is

$$F_\nu = \frac{n\,\Delta p_\nu}{\Delta t(v)} = 2\frac{n\,\nu\,h}{c\,\Delta t(v)} \tag{36}$$

It is assumed that the number of n photons does not depend on the distance of atoms $D(v)$. The time $\Delta t(v)$ that a photon needs to travel between atoms, back and forth is described by the equation (30) and (31). After substituting these equations to (36) the following is obtained

$$F_\nu = \frac{n\,\nu\,h}{D}\frac{1-(v/c)^2}{\sqrt{1-(v/c)^2\sin^2\alpha}} \tag{37}$$

$$F_v = \frac{n\,\nu\,h}{D'} \frac{\sqrt{1-(v/c)^2}}{\psi(v)} \tag{38}$$

The repulsive force (37) of atoms is inversely proportional to their distance $D(v)$, as shown in Figure 8. This is due to the properties of light clock, which slows down the timing when the length of its arm increases.

Now we will describe the attraction effect. The atoms shown in Figure 7 are compressed by the intermolecular force (F_m). In this paper we do not discuss the nature of this interaction. We want to select the values of force F_m so that the atoms remain in equilibrium when they are at a distance D_s. We also want the distance between the atoms to depend on the velocity v in accordance with equation (25). For such a force F_m, the dimensions of body will change if its velocity in relation to the ether changes, as predicted by relativism.

Atoms will be in equilibrium at a distance of D_s if the equilibrium of attraction and repulsive forces occurs.

$$F_m(v, D_s, \alpha) = F_v(v, D_s, \alpha) \tag{39}$$

After substitution of the equation (37) the following is obtained

$$F_m(v, D_s, \alpha) = \frac{n_s\,\nu_s\,h}{D_s} \frac{1-(v/c)^2}{\sqrt{1-(v/c)^2 \sin^2\alpha}} \tag{40}$$

Based on the relation (38), the equation for the attraction force F_m can be written in another form

$$F_m(v, D'_s) = \frac{n_s\,\nu_s\,h}{D'_s} \frac{\sqrt{1-(v/c)^2}}{\psi(v)} \tag{41}$$

Equations (40) and (41) represent the value of intermolecular bond force only at the stable point D_s or D'_s, shown in Figure 8. For the remaining values D, the function F_m can have different values. This means that in general we can save the following dependencies on the function F_m

$$\begin{cases} F_m(v, D, \alpha) = \dfrac{n_s\,\nu_s\,h}{D_s} \dfrac{1-(v/c)^2}{\sqrt{1-(v/c)^2 \sin^2\alpha}} f_m(v, D, \alpha) \\ f_m\left(v, D_s = \dfrac{D'_s\,\psi(v)\sqrt{1-(v/c)^2}}{\sqrt{1-(v/c)^2 \sin^2\alpha}}, \alpha\right) = 1 \end{cases} \tag{42}$$

$$\begin{cases} F_m(v, D') = \dfrac{n_s\,\nu_s\,h}{D'_s} \dfrac{\sqrt{1-(v/c)^2}}{\psi(v)} f_m(v, D') \\ f_m(v, D'_s) = 1 \end{cases} \tag{43}$$

The function fm appearing in equations (42) and (43) is any positive and continuous function that only has to fulfill one the conditions specified in (42) or (43). For a fixed value of velocity v and angle α, the values of this function depend only on the distance D or D' of atoms. It was the function f_m that decided about the exemplary shape of the force diagram F_m in Figure 8.

The model presented in this chapter can be used to interpret the known physical properties of bodies. For example, Figure 9 shows examples of differences between a hard body and a soft body. The harder is the body for which deformation of the distance D_s causes greater differences in values of forces F_m and F_v (i.e. for which the inclination of function F_v is greater in point D_s).

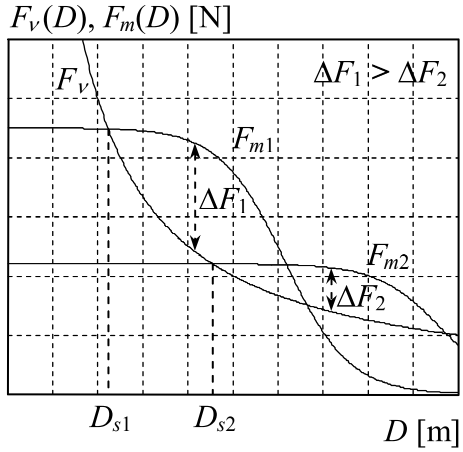

Fig. 9. Example of hard (F_{m1}) and soft body (F_{m2}).

Figure 10 shows examples of differences between a fragile body and a plastic body. The fragile body is the one for which smaller changes ΔD cause permanent breaking of intermolecular bond, i.e. reaching the point D_n.

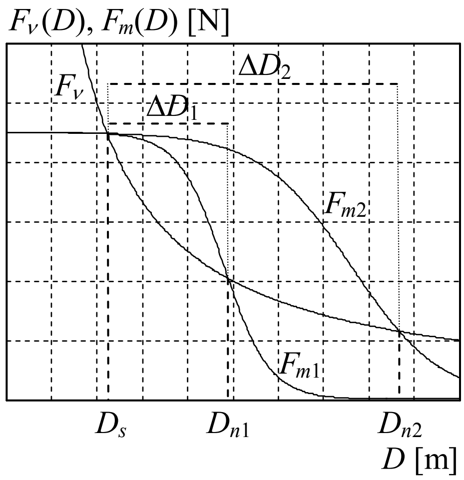

Fig. 10. Example of friable (F_{m1}) and plastic body (F_{m2}).

Figure 11 shows examples of differences between a cooler body and a warmer body. In a warmer body, the frequency of photons v is higher. This makes the repulsion force F_v in the equations (37)-(38) is greater and the diagram of this repulsion force rises upwards. If the diagram F_v is raised so that it no longer has any shared points with the diagram F_m, the body becomes liquid or gaseous. If the force diagrams F_v and F_m do not intersect, then there is no distance D_s of atoms for which the forces remain in equilibrium and form a rigid bond. Whether the body is liquid or gaseous depends on the external pressure and thus indirectly on the force of gravity. This is consistent with phase diagrams of equilibrium states.

The factor $n_s v_s / D_s$ occurring in equations (42) and (43) for the force F_m must be treated as a constant. That is, the force F_m does not depend on the number of photons and their frequency as the force F_v depends on them. If the body temperature changes, the frequency v of photons causing the repulsive force changes (then it will be shown that their number n changes as well), but the values of n_s, v_s and D_s do not change, which in equations (42) and (43) are constant (they are a reference point).

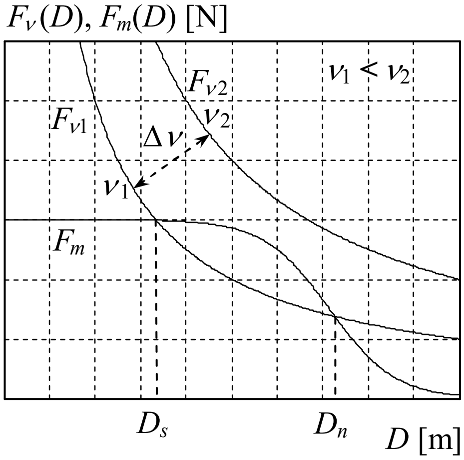

Fig. 11. Example of a body in solid state ($F_{\nu 1}$) and a body in liquid or gaseous state ($F_{\nu 2}$).

The presented model also explains the mechanism of thermal expansion. For a warmer body, the graph of F_ν function moves upwards (Figures 8-11). Then the stability point D_s moves to the right, i.e. the distance between atoms and the dimensions of solid body increases.

In the presented model atoms emit and absorb photons (electromagnetic radiation). It is expected that part of photons oscillating between atoms escapes from the body area. Such prediction is in accordance with the fact that each body emits electromagnetic thermal radiation called the radiation of a black body. The distribution of black body radiation was described by Max Planck, who postulated that it originated from the vibrations of harmonic oscillators that emit and absorb this radiation. Therefore, the model presented here is consistent with the analysis based on which Max Planck derived an equation for the distribution of black body radiation.

The model is in accordance with Wien's law, according to which the main wavelength of thermal radiation emitted by the body decreases proportionally with the increase in body temperature. Wiena's law enables to calculate the frequency of photons for which the distribution of all photons in the black body radiation has a maximum value. That is

$$\nu_{\max} = \frac{c}{\lambda_{\max}} = \frac{c}{b/T} = \frac{c}{b} T \quad [1/\mathrm{s}] \tag{44}$$

The photon energy has a value of

$$E_f = \nu\, h \quad [\mathrm{J}] \tag{45}$$

Symbol N [1/m^3] designates the number of photons of thermal radiation that are inside the body in a volume of 1 m^3. These photons have different frequencies described in the Planck distribution. For the purpose of this paper, for simplicity it is assumed that the frequency of all photons has a value (44). Then the energy of all photons in this volume is obtained after placing (44) to (45) and multiplying by $N/6$. Factor 6 is due to the fact that the photons of thermal radiation leave the body in six directions. Therefore, there are 6 times more photons inside a cube than it results from the thermal radiation of one cube wall. Then the following is obtained

$$E_{f/m^3}(T) \approx \frac{N}{6} \frac{c}{b} T\, h \quad [\mathrm{J/m^3}] \tag{46}$$

The energy of photons of thermal radiation, which escapes to the outside through its unit surface per second, is described by the law of Stefan-Boltzmann radiation in the form of

$$E_{f/m^2}(T) = \sigma T^4 \quad [\mathrm{J/(s\,m^2)}] \tag{47}$$

Since photons move at an average velocity of c, thus in the unit volume of body there are photons with the energy that is obtained by dividing (47) by c

$$E_{f/m^3}(T) = \frac{E_{f/m^2}(T)}{c} = \frac{\sigma T^4}{c} \quad [\mathrm{J/m^3}] \tag{48}$$

After comparing the equations (46) and (48), the following is obtained

$$\frac{N}{6}\frac{c}{b}T\,h \approx \frac{\sigma T^4}{c} \tag{49}$$

On this basis, an estimation of the number of photons in the unit volume of a black body is obtained

$$N \approx 6\frac{\sigma b}{h c^2}T^3 = N_S\,T^3 \quad [1/\mathrm{m^3}] \tag{50}$$

For constant values

$$\begin{aligned} \sigma &= 5{,}670400\cdot 10^{-8} && [\mathrm{J/(s\,m^2\,K^4)}] \\ b &= 2{,}897768\cdot 10^{-3} && [\mathrm{m\,K}] \\ h &= 6{,}6260693\cdot 10^{-34} && [\mathrm{J\,s}] \\ c &= 2{,}99792458\cdot 10^{8} && [\mathrm{m/s}] \end{aligned} \tag{51}$$

equation (50) takes the form of

$$N \approx N_S\,T^3 = 16\,555\,076\cdot T^3 \quad [1/\mathrm{m^3}] \tag{52}$$

For example, at room temperature (293°K) in one cubic meter of matter there are about $4{,}16\cdot 10^{14}$ photons of thermal radiation. These photons, reflecting between atoms, act on them with the force (37)-(38) and create internal pressure. These photons, which escape to the outside, create thermal radiation.

If the actual change in body dimensions in motion is due to stresses in solid bodies, it is very likely that different substances will contract slightly in a different way. It may be that each substance has its own individual function $\psi(v)$. Then if both arms of the interferometer in the Michelson-Morley experiment are made of the same material, they will shorten proportionally as shown in Figure 5. This makes the experiment unable to detect motion relative to the ether. But if the arms are made of different substances, then perhaps the Michels-Morleay experiment will be able to detect motion relative to the hypothetical universal frame of reference in which light propagates.

Therefore, Michelson-Morley's experiment should be carried out, in which each arm is made of a different material. It is necessary to investigate which materials give the greatest effect.

According to the Lorentz transformation and some STE transformations, the dimensions of bodies accelerated to velocity c will be zero. It is to be expected that in reality this will not be the case. Each theory acts only to some limited extent. Theoretical predictions for inertial systems unavailable for experiments are the outcome of extrapolation results obtained in experiments in inertial systems available for experiment. It is expected that during the acceleration of body the new mechanisms will appear (e.g. repulsive force of atoms will increase very much) and the body will stop contraction according to the patterns. Sufficiently densely packed atoms will not come close together even if the photons pressure does not act on them. However, in modern physics it is common that the results of extrapolation are treated literally and, for example, it is claimed that the Lorentz transformation shows that in the real world bodies accelerated to velocity c will shorten to zero dimensions.

According to equations (46) and (52), the energy and number of photons forming photons pressure decreases to zero when the body temperature drops to absolute zero. This means that in bodies cooled to low temperatures, the photon pressure stops functioning. However, it is known that the dimensions of such bodies do not decrease to zero, as could be deduced from the presented model. It follows that at low temperatures, when the atoms are already close enough, another mechanism is revealed which does not allow the atoms to come any closer. This is the same mechanism as that referred to in the previous paragraph. This conclusion from the presented model can be very useful in planning an experiment that would enable to detect our motion in relation to a hypothetical ether. That is, the arms of interferometer should be cooled down to low temperatures. Perhaps the temperature of liquid nitrogen will be sufficient. At low temperatures, the interferometer arms should not undergo the Lorentz-FitzGerald contractions, which compensated for the differences in time dilatation of the classical light clock. If there is indeed an ether in which light propagates, such an experiment with the interferometer should give a positive result. Perhaps the better effect will be obtained when one arm of the interferometer is cooled to low temperatures and the other is heated to freely undergo contractions.

6. Atomic clock, time dilation and absolute velocity determination

As the atomic clocks are subject to time dilation ([2], [3]) it results from the fact that they realize the signal clock. It should be suspected that atomic clocks use a signal that propagates in a distinguished medium (e.g. an electromagnetic signal propagating in the ether). It is very possible that this mechanism is associated with atoms used as oscillators, but it is also possible that with other elements of the clock such as microwave cavities.

There is a large number of atomic clocks, that is why there is no place in this paper to analyze their structure and to search for relations with signal clocks.

Longitudinal and transverse contraction in STE are shown in Figure 5. In the paper [11] it was shown that these contraction must be exactly such if the average velocity of light in a vacuum is to have in every inertial system a value c.

It is very likely that the actual contraction of the signal clock arms in the atomic clocks are not as ideal as those shown in Figure 5. It is enough for longitudinal contraction to be slightly different, or transverse contraction to be slightly different from that shown in Figure 5. This is very likely if contractions are related to stresses in the matter discussed in Chapter 5. Then the timing of such clocks will depend slightly on the way they are inclined in relation to the speed of motion relative to the universal frame of reference. If this effect is very insignificant in our frame of reference, it can be immeasurable using the Michelson-Morley experiment, but it can be measured using atomic clocks.

In order to determine the velocity in relation to the universal frame of reference, an atomic clock should be used, in which the arm of signal clock contained in it has a strictly defined one direction, if such a clock can be constructed. For this purpose, several atomic clocks must be placed at different angles to one another on a rotating platform. The rotating platform must be capable of maintaining a constant position of the clocks in relation to space. In order to determine the absolute velocity, it is necessary to look for correlations between the speed at which the clocks operate and the directions in which their arms are positioned in space.

7. Coordinate and time transformations

We will derive time transformations and position coordinates parameterized by two parameters: longitudinal contraction $\xi(v)$ and transverse contraction $\psi(v)$. These parameters meet the dependencies already given in equation (15) and in figure 5, i.e.

$$D_x(v) = D_x(0)\xi(v) \tag{53}$$

$$D_y(v) = D_y(0)\psi(v) \tag{54}$$

We accept the markings shown in Figure 12.

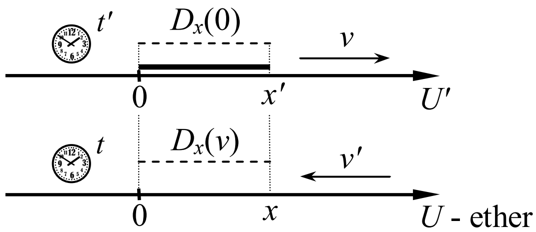

Fig. 12. Inertial system moves in relation to the ether with velocity v,
while the ether moves in relation to the inertial system with velocity v' ($v \cdot v' \le 0$).

We want the body moving relative to the universal frame of reference to be contracted according to patterns (53) and (54). At the same time, we want the time dilation to be in line with the equation (12) when the arm of light clock is parallel to velocity v. On the basis of (53) dilation (12) we can save it in the form of

$$t_{\|} = t'_{\|}\frac{\xi(v)}{1-(v/c)^2} \tag{55}$$

The symbol || indicates that the equation refers to time, measured by clocks, which arms are parallel to velocity v. On the basis of accepted requirements, the following equations are obtained

$$x = \xi(v)x' + vt_{\|} = \xi(v)x' + v\frac{\xi(v)}{1-(v/c)^2}t'_{\|} \tag{56}$$

$$x' = \frac{1}{\xi(v)}x + v't'_{\|} = \frac{1}{\xi(v)}x + v'\frac{1-(v/c)^2}{\xi(v)}t_{\|} \tag{57}$$

Based on (56) we obtain

$$\xi(v)x' = x - v\frac{\xi(v)}{1-(v/c)^2}t'_{\|} \tag{58}$$

$$x' = \frac{1}{\xi(v)}x - v\frac{1}{1-(v/c)^2}t'_{\|} \tag{59}$$

If to compare (59) and equation (57) the relation between velocities v and v' is obtained in the form of

$$v' = -v\frac{1}{1-(v/c)^2} \tag{60}$$

On the basis of (54)-(60) it is possible to save the transformations from the inertial system U' to the ether U

$$\begin{cases} t_{\|} = \dfrac{\xi(v)}{1-(v/c)^2} t'_{\|} \\ x = \xi(v) x' + v \dfrac{\xi(v)}{1-(v/c)^2} t'_{\|} \\ y = \psi(v) y' \\ z = \psi(v) z' \end{cases} \tag{61}$$

Transformation from ether U to inertial system U' has the following form

$$\begin{cases} t'_{\|} = \dfrac{1-(v/c)^2}{\xi(v)} t_{\|} \\ x' = \dfrac{1}{\xi(v)}(x - v t_{\|}) \\ y' = \dfrac{1}{\psi(v)} y \\ z' = \dfrac{1}{\psi(v)} z \end{cases} \tag{62}$$

In the paper [12], all linear transformations (without revolutions) have been derived for which the average velocity of light in vacuum on the road back and forth is always c. Those transformations are parameterized by two parameters $e(v)$ and $\psi(v)$. The paper [12] shows that parameter $e(v)$ does not create new kinematics, but desynchronizes the clocks in inertial systems. Therefore, all kinematics with a constant average velocity of light are parameterized with one transverse contraction $\psi(v)$ parameter. In the paper [11] all such transformations were derived using a different method, based on a geometric analysis of Michelson-Morley's experiment.

Transformations (61)-(62) derived in this paper are more general than those parametrized only by parameter $\psi(v)$. The additional parameter $\xi(v)$ creates new kinematics for which longitudinal contraction can be independent from transverse contraction. In these kinematics it is possible to model clocks for which the ticking speed depends on the inclination angle of their arms.

Based on the transformation (61)-(62) it can be shown (calculations are omitted) that the average velocity of light in the inertial system U' depends on the direction of emission. If the light propagates in a direction parallel to v (i.e. parallel to x-axis), then in the system U', the value of average velocity of light on the road back and forth is

$$c'_{av\_x}(v) = c \tag{63}$$

If the light propagates perpendicular to v, then in the system U' the one-way speed of light is

$$c'_y(v) = \frac{\xi(v)}{\psi(v)\sqrt{1-(v/c)^2}} c \tag{64}$$

The average velocity of light in each propagation direction has a value c only in those kinematics (61)-(62) where

$$\xi(v) = \psi(v)\sqrt{1-(v/c)^2} \tag{65}$$

These are kinematics derived from the paper [11].

8. Final conclusions

Maximum velocity in relativistics is not a physically impassable velocity, but a velocity at which the light clock used to measure time stops operating.

The paper explains the phenomenon of time dilation. Time dilation is a natural property of light clock. The paper has been shown that the time dilation occurring in the relativistic theories of Special Theory of Relativity (STR) and Special Theories of Ether (STE) is identical to the one that results from the operation of light clock.

If in the STR and STE kinematics a light signal is used to synchronize the clocks, then the 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, time dilation occurs in these theories.

The paper explains why STR transformation (Lorentz transformation) and STE transformations cease to operate when the velocity of inertial systems reaches the value c that occurs in these transformations. The presented analysis shows that velocity c occurring in transformations is not a limit velocity in the physical sense, but a velocity at which the light clock stops operating. In systems moving at velocities c or above, the light clocks stop measuring time. Therefore, it is not possible to describe the processes taking place in such systems with light clocks. However, from STE and STW not results that speed c is the limiting speed.

The existence of time dilation phenomenon is an indirect proof of the existence of universal frame of reference (ether), in which the light propagates. If atomic clocks are subject to this phenomenon, it results from the fact that they use in their operation a propagating signal in a distinguished medium (it is very possible that it is an electromagnetic signal).

It has been shown that if the classical kinematics is introduced to the measurement of time by means of a light clock, based on a signal with a finite speed, then also in this theory will appear the time dilation phenomenon. In order for the time dilation phenomenon not to occur, the velocity of signal used by the clock must be infinite (or equivalent $v << c$). This is how it is in the classical approach to classical kinematics, so there is no time dilatation in it.

Presented analysis shows that one of the ways of testing the movement in relation to ether can be the measurement of time with atomic clocks inclined at different angles to the direction of movement in relation to ether. Comparison of time measured with such clocks will enable to measure the velocity in relation to ether if longitudinal or transverse contraction does not compensate the differences in time dilatation in an ideal way.

The paper [11] shows that Michelson-Morley's and Kennedy-Thorndike's experiments are not able to detect movement with respect to ether in case of infinite number of different kinematics with ether. In case of these kinematics, the measurement with atomic clocks will not be effective either. However, if longitudinal or transverse contraction does not compensate the differences in time dilatation in an ideal way, then the measurement with atomic clocks can be more effective due to the very high accuracy of modern atomic clocks.

Another way to measure the movement in relation to the ether is to conduct Michelson-Morley experiment using an interferometer, the arms of which are made of two different substances, or an interferometer which arms (or one arm) are cooled to low temperatures.

Time is what we measure by some kind of physical process. Only cyclic processes, e.g. seasons, pendulum fluctuations (pendulum clocks), quartz crystal vibrations (quartz clocks), atomic oscillations (atomic clocks), or even the reigning periods of successive emperors, are of practical importance. Different physical processes have different sensitivity to changing environmental conditions. Therefore, different ways of measuring time have different, individual properties. For example, the time lapse measured by a pendulum clock is sensitive to gravity field intensity, while the time lapse measured by biological cycles is sensitive to different conditions determining life expectancy.

The paper shows that time measurement in kinematics is based on signal clocks and therefore is sensitive to the velocity at which the inertial system moves relative to medium in which it propagates the signal. In modern relativistic, the time dilation, which is the property of signal clocks, has been automatically transferred to all other physical processes without proper justification. In this way, the idea of universal time was created, which is a space-time dimension, which is not related to any specific physical processes. However, there is no reason to argue with certainty that the velocity of inertial system affects in the same way the frequency of all physical processes, according to time dilation. If the physical process has no relation to the signal clock, the duration of this process may not be subject to time dilation. For example, the life expectancy of a person may depend on the velocity of movement in a different way than the velocity of ticking (i.e. the period of ticking) of the atomic clock. For this reason, it is not known whether conventional twins, from the paradox of twins, will be subject to time dilation resulting from kinematics. Everything depends on whether the speed of life processes is correlated with the velocity of signal clock. Time dilation refers to signal clocks and physical processes that are related to the signal clock. In the case of other physical processes, the determination of whether they are subject to time dilation requires in each case experimental confirmation or some theoretical justification.

From the analysis presented it follows that time dilation is not owned by space-time, as is now believed in the Special Theory of Relativity, only properties of a light clock.

The paper also explains the phenomenon of longitudinal contraction (Lorentz-FitzGerald) and transverse contraction. Contraction results from the electromagnetic interaction between atoms of a solid body. In the presented model the balance of position between atoms is affected by the velocity at which the body moves in relation to the ether. Therefore, the dimensions of solids depend on their velocity and are closely related to time dilation. The model presented here combines the properties of relativity theory and physics of a solid body.

For each kinematics it is possible to derive many dynamics. Examples for Special Theory of Ether were derived in monograph [8]. The examples for Special Theory of Relativity were derived in the article [14].

The article [13] presents the original method of deriving kinematics, which meets the results of Michelson-Morley's and Kennedy-Thorndike's experiments only in selected inertial systems, e.g. moving with relatively low velocities in relation to the ether. It is for such kinematics that experiments with atomic clocks, referred to in chapter 6, can detect motion in relation to ether.

The mistaken belief is that the velocity of light in vacuum is certainly the maximum velocity in nature. It should be noted that scientific methods do not allow to prove that something is impossible. Something may be impossible under some theory, or under how this theory is interpreted at any given time. However, no theory is absolutely certain, because perhaps in the future a phenomenon will be discovered which will undermine it. Science can only prove that something is possible if it is done in a practical way. But the criticism of c as a maximum velocity presented in this paper is not based on this property of science. The paper shows that even under the Special Theory of Relativity, there are no grounds for treating c as a maximum velocity. Even if c is the maximum velocity in nature, it does not follow from the Special Theory of Relativity as it is widely believed today. The velocity of c is only the velocity at which the light clock used in transformations to measure time stops operating.

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