

# Explanation of Michelson-Morley Experiment

**Michael Tzoumpas**

Mechanical and Electrical Engineer  
National Technical University of Athens  
Irinis 2, 15234 Athens, Greece

E-mail: [m.tzoumpas@gmail.com](mailto:m.tzoumpas@gmail.com)

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**Abstract.** The unified theory of dynamic space has been conceived and written by Professor Physicist Naoum Gosdas, inspired from the principle of antithesis (opposition), because of which all natural phenomena are created. These phenomena are derived from the unique absolute dynamic space. So, the explanation of Michelson-Morley experiment is based on the above theory, namely on both actual and the known apparent reduction of light speed, without the second postulate of relativity. The actual reduction of light speed happens only when the light is transmitted on moving material systems, on which the cohesive pressure of the proximal space is reduced.

*Keywords:* Second postulate of relativity; light speed; Lorentz factor; moving clock; cohesive pressure.

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## 1. General Appearance

The explanation of Michelson-Morley experiment is based on both actual and apparent reduction of light speed. The actual reduction of light speed happens only when the light is transmitted on moving material systems, on which the cohesive pressure<sup>1,2</sup> of the proximal space is reduced. The apparent reduction of light speed happens due to the aberration of light, which can be used as a detection criterion of the absolute motion. Lorentz factor of special relativity is the tool for the mathematical expression of the problem that had arisen from the Michelson-Morley experiment. Of course, the time dilation was an ingenious and pioneering idea, which has been accepted, ignoring, though, the real cause of the slowing of the moving clock, i.e. the phenomenon of motion.<sup>3,4</sup> However, this same reduction factor appears as well in the unified theory of dynamic space<sup>1,2</sup> with the Galilean transformations, by calculating the actual reduction of the light speed on moving material systems, not based on the second postulate of relativity.

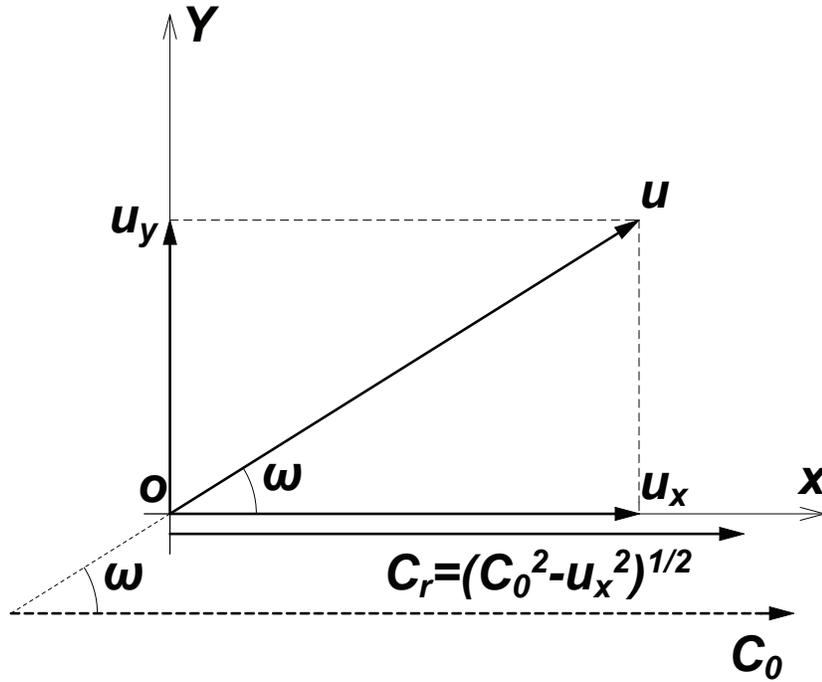
## 2. Michelson-Morley Experiment

### 2.1. Relative and absolute speed of light

The motion of charged<sup>3</sup> and uncharged particles<sup>4</sup> takes place by accumulation of forces on pairs of vertical meridians of the particle spherical zone as a result of pressure difference, which is placed in front of and behind the particle. Therefore, on the moving material systems the residual cohesive pressure will be then

$$P = P_0 - \Delta P, \quad (1)$$

where  $\Delta P$  the pressure difference as a motion arrow<sup>3,4</sup> of the particle and  $P_0$  the cohesive pressure<sup>1,2</sup> of the dynamic space far from the moving system.



**Figure 1.** Component  $u_x$  causes an actual reduction of light speed

The speed of light<sup>5</sup> far from the the moving system is

$$C_0 = \sqrt{\frac{P_0}{d_m}} \Rightarrow C_0^2 = \frac{P_0}{d_m}, \quad (2)$$

while the speed  $u$  of the particle<sup>6</sup> is

$$u = \sqrt{\frac{\Delta P}{d_m}} \Rightarrow u^2 = \frac{\Delta P}{d_m}, \quad (3)$$

where  $d_m$  the constant mass density<sup>7</sup> of space. The relative speed of light on the moving material system, due to Eqs 2 and 1, will be then

$$C_r = \sqrt{\frac{P}{d_m}} \Rightarrow C_r^2 = \frac{P}{d_m} = \frac{P_0 - \Delta P}{d_m} \Rightarrow C_r^2 = \frac{P_0}{d_m} - \frac{\Delta P}{d_m} \quad (4)$$

and, due to Eqs 2 and 3, the Eq. 4 becomes

$$C_r^2 = C_0^2 - u^2 \Rightarrow C_r = \sqrt{C_0^2 - u^2} \Rightarrow C_r = C_0 \sqrt{1 - \frac{u^2}{C_0^2}}. \quad (5)$$

Hence, the speed of light on a moving material system is reduced, irrespective of the direction of motion, according to the reduction factor  $\sqrt{1 - u^2/C_0^2}$  (Eq. 5).

Of course, if  $\omega$  is the angle between  $C_0$  and speed  $u$  of a moving system, then the relative speed of light (Fig. 1) is  $C_r = \sqrt{C_0^2 - u_x^2}$  (Eq. 5), where  $u_x = u \cos \omega$ . Namely, only the component  $u_x$ , parallel to the speed of light  $C_0$ , causes an actual reduction of light speed, due to reduction of the cohesive pressure (Eq. 1), while the component  $u_y$ , vertical to the speed of light  $C_0$ , causes an apparent reduction of light speed, due to the aberration of light, as it will be described in the following subsection 2.2.

Given that, the relative speed of light  $C_r = \sqrt{C_0^2 - u^2}$  (Eq. 5) is a function of speed  $u$  (that imposes the motion arrow) of the moving system, it is expected the absolute speed of light  $C$  to be the algebraic sum of  $u$  and  $C_r$ , namely it is

$$C = C_r \pm u \Rightarrow C = \sqrt{C_0^2 - u^2} \pm u. \quad (6)$$

So, as it concerns light, there is no need to apply the Lorentz transformations (since it is  $C_r < C_0$ ), but the Galilean transformations, exactly as they apply at the motion of material bodies on moving systems.

## 2.2. Aberration of light - Apparent speed of light

When light moves far from dynamic fields (e.g. electrical or gravitational fields) or in regions where the Cosmic change of cohesive pressure<sup>1,2</sup> of dynamic space is negligible, then it moves in straight line and any aberrance from this straight line determines the so called phenomenon of aberration of light. This phenomenon is caused by the apparent aberration and the change of light speed, due to the absolute motions of either the observer, or the light source, or both. In Fig. 2a, where observer and light source are stationary, observer at point O observes the E/M waves from light source S transmitted by the laser device.

In Fig. 2b light source and observer are moving in parallel at speed  $u$ , vertically to the emitted laser beam, resulting the footprint of the beam to be left behind the observer, since the motion of the light source does not affect the autonomous motion of the E/M waves.<sup>8,9</sup> Therefore, the aberration of light can be used as a detection criterion of the absolute motion.

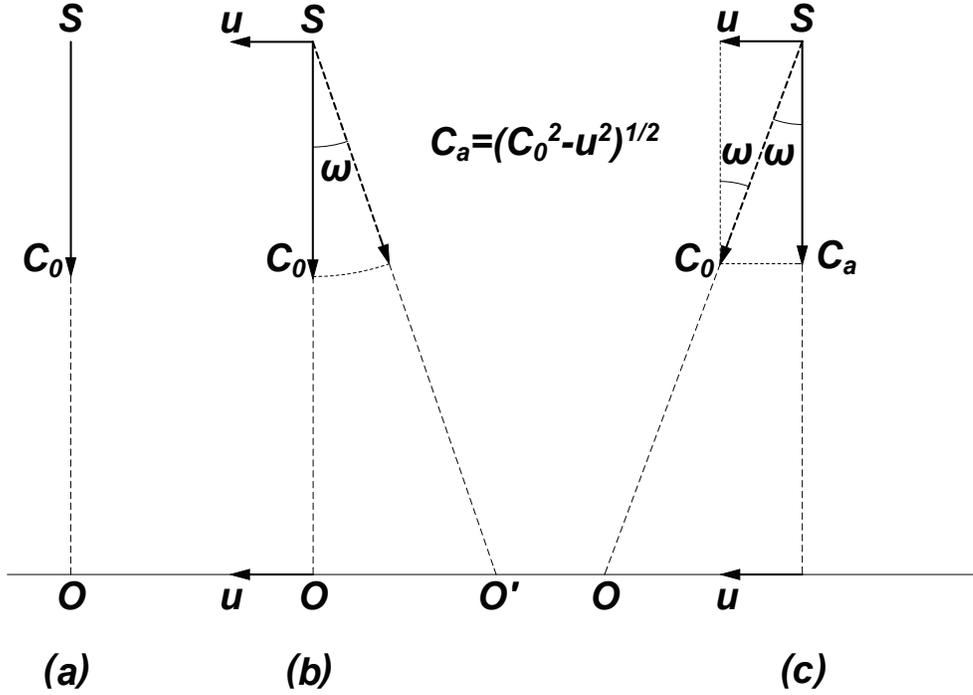
However, the laser beam must turn clockwise at an angle  $\omega$  (Fig. 2c), so that the component  $C_a$  be

$$C_a = C_0 \cos \omega \Rightarrow C_a = \sqrt{C_0^2 - u^2} \Rightarrow C_a = C_0 \sqrt{1 - \frac{u^2}{C_0^2}}. \quad (7)$$

Then, the moving observer can see the light with the so called apparent light speed  $C_a$ .

It is noted that, the apparent change of light speed is reduced by the same reduction factor  $\sqrt{1 - u^2/C_0^2}$  (Eq. 7) as in the actual reduction of light speed (Eq. 5), namely when

light moves to the direction of the moving system. In this cases, the vertical motion of the moving system does not cause an actual change of light speed, but an apparent change due to the aberration of light.



**Figure 2.** The aberration of light causes an apparent reduction of light speed

Therefore, in case light moves to the direction of or opposite to the moving system, an actual reduction of light speed occurs, due to reduction of the cohesive pressure on the moving material system, while in case light moves to the vertical direction of the moving system, an apparent reduction of light speed occurs by the same reduction factor  $\sqrt{1 - u^2/C_0^2}$ , but here due to the aberration of light, that is

$$C_r = C_a = C_0 \sqrt{1 - \frac{u^2}{C_0^2}}. \quad (8)$$

Consequently, the explanation of Michelson-Morley experiment can be based on both actual and apparent reduction of light speed.

### 2.3. Explanation of Michelson-Morley experiment not based on the second postulate of relativity

It was expected the differential phase shift between light traveling the longitudinal versus the transverse arms of the Michelson interferometer. For a stationary observer the total time  $T_1$  on arm  $(KK_1) = \beta$  (indicatively see Fig. 3), where occurs an aberration of light (Eq. 7), is

$$T_1 = \frac{2\beta}{C_a} \Rightarrow T_1 = \frac{2\beta}{\sqrt{C_0^2 - u^2}} \quad (9)$$

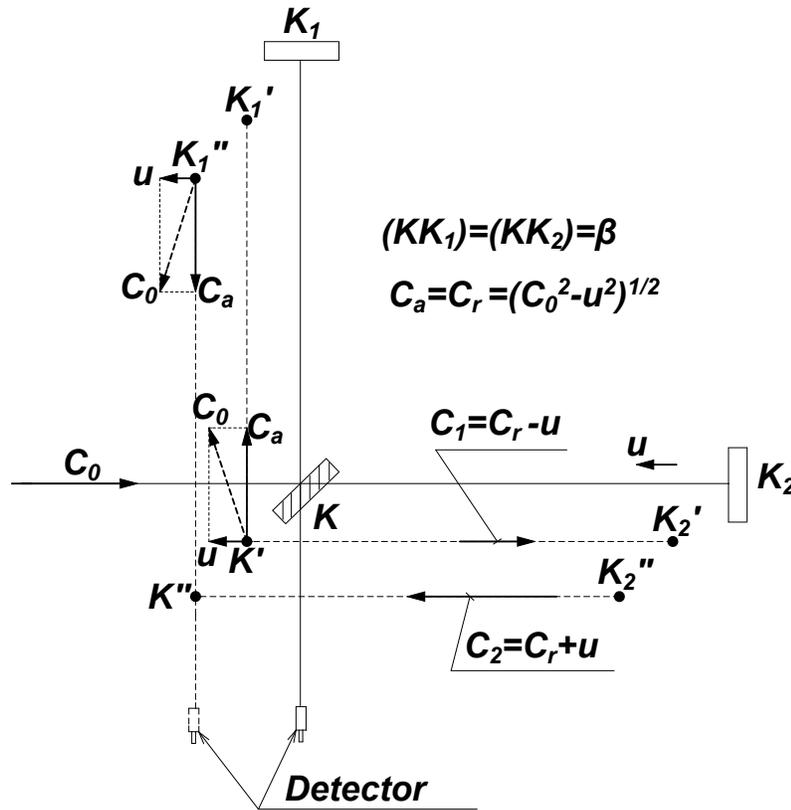
and the total time  $T_2$  on arm  $(KK_2) = \beta$ , using the Galilean transformations, is

$$T_2 = \frac{2\beta C_0}{C_0^2 - u^2}. \quad (10)$$

Dividing by parts Eqs 9 and 10, it is

$$\frac{T_1}{T_2} = \sqrt{1 - \frac{u^2}{C_0^2}} < 1 \Rightarrow T_1 < T_2. \quad (11)$$

This theoretical result is not verified by the experiment, since the superposition of the two parts of monochromatic light is maintained, which happens only, if  $T_1 = T_2$ . Therefore, something is wrong with the behavior of light.



**Figure 3.** Schematic representation of Michelson interferometer. For the stationary observer  $C_1 = C_r - u$  and  $C_2 = C_r + u$  (Eq. 6) are the absolute light speeds on arm  $(KK_2) = \beta$  and  $C_a = \sqrt{C_0^2 - u^2}$  (Eq. 7) is the apparent light speed on arm  $(KK_1) = \beta$ , due to the apparent reduction of light speed, where  $C_r = \sqrt{C_0^2 - u^2}$  (Eq. 5) is the relative light speed on arm  $(KK_2) = \beta$ , due to the actual reduction of light speed and  $u$  is the speed of interferometer (Earth)

This experimental result was the cause for the creation of the relativity theory and the acceptance of Lorentz transformations for light. The time dilation and the definition of time as a physical entity in the space-time continuum are the two consequences of the above creation. The time dilation (first consequence), of course, was a very great and correct idea, ignoring, though, the real cause of the slowing of the moving clock, i.e.

the phenomenon of motion.<sup>3,4</sup> In the second consequence, however, time<sup>10</sup> is defined (oppositely to relativity) as the motion of the electrically opposite elementary units<sup>11</sup> at speed of light, according to the unified theory of dynamic space.<sup>1,2</sup> These elementary units construct matter and motion as the unique phenomena of Nature.

We shall now explain the Michelson-Morley experiment, as a result of both actual and apparent reduction of light speed in the moving material systems:

The stationary observer calculates that (Fig. 3), the absolute speed of light  $C_1$  (Eq. 6) on arm  $(KK_2) = \beta$ , is

$$C_1 = C_r - u \quad (12)$$

and

$$(KK'_2) = C_1 t_1, \quad (13)$$

where  $t_1$  the motion time of the interferometer at speed  $u$ , covering the distance  $KK'_2 = ut_1$ . Substituting in Eq. 13, the Eq. 12 and  $(KK'_2) = (KK_2) - (K_2K'_2) = \beta - ut_1$ , it is

$$\beta - ut_1 = (C_r - u)t_1, \quad (14)$$

where  $C_r = \sqrt{C_0^2 - u^2}$  (Eq. 5) the relative speed of light on arm  $KK_2$ , due to the actual reduction of light speed, thus Eq. 14, due to Eq. 5, becomes

$$t_1 = \frac{\beta}{C_r} \Rightarrow t_1 = \frac{\beta}{\sqrt{C_0^2 - u^2}}. \quad (15)$$

The time on arm  $(KK_1) = \beta$ , due to Eq. 8, is

$$t'_1 = \frac{\beta}{C_a} = \frac{\beta}{C_r}, \quad (16)$$

as it is  $t_1$  (Eq. 15) on arm  $KK_2$ , namely

$$t'_1 = t_1 = \frac{\beta}{\sqrt{C_0^2 - u^2}}, \quad (17)$$

due to the apparent reduction of light speed (Eq. 7) and  $t'_2$  the return time on arm  $K_1K$  with an apparent reduction of light speed, that is

$$t'_2 = \frac{\beta}{\sqrt{C_0^2 - u^2}}. \quad (18)$$

At the return of light (on arm  $K_2K$ ), covering the distance  $C_2 t_2 = (K'_2K'') = (K'_2K''_2) + (K''_2K'')$  at time  $t_2$  of interferometer motion, when covering the distance  $(K'_2K''_2) = ut_2$  with speed  $u$ , where  $C_2$  (Eq. 6) the absolute light speed and  $(K''_2K'') = \beta$ , then

$$C_2 t_2 = ut_2 + \beta, \quad (19)$$

and for  $C_2 = C_r + u$  (Eq. 6) the Eq. 19, due to Eq. 15, becomes

$$C_r t_2 + ut_2 = ut_2 + \beta \Rightarrow t_2 = \frac{\beta}{C_r} \Rightarrow t_2 = \frac{\beta}{\sqrt{C_0^2 - u^2}} = t_1, \quad (20)$$

where  $C_r = \sqrt{C_0^2 - u^2}$  (Eq. 5) the actual reduction of light speed. Accordingly,  $t_2 = t_1 = \beta/\sqrt{C_0^2 - u^2}$  (Eq. 20), due to Eq. 18, becomes

$$t_2 = t_1 = \frac{\beta}{\sqrt{C_0^2 - u^2}} = t'_2, \quad (21)$$

where  $t'_2$  the return time on arm  $K_1K$  with an apparent reduction of light speed. Therefore, it is

$$t_1 = t'_1 = t_2 = t'_2 = \frac{\beta}{\sqrt{C_0^2 - u^2}}, \quad (22)$$

namely time is same on arms  $KK_1$  and  $KK_2$  of interferometer. The total time on arm  $KK_1$ , and due to Eq. 22, is

$$T_1 = t'_1 + t'_2 = \frac{2\beta}{\sqrt{C_0^2 - u^2}} \Rightarrow T_1 = \frac{2\beta}{\sqrt{C_0^2 - u^2}} \quad (23)$$

and the total time on arm  $KK_2$ , due to Eq. 22, is

$$T_2 = t_1 + t_2 = \frac{2\beta}{\sqrt{C_0^2 - u^2}} \Rightarrow T_2 = \frac{2\beta}{\sqrt{C_0^2 - u^2}}, \quad (24)$$

namely as much as on arm  $KK_1$  and due to Eqs 23 and 24, we have

$$T_1 = T_2 = \frac{2\beta}{\sqrt{C_0^2 - u^2}} \Rightarrow T_1 = T_2. \quad (25)$$

Hence, for this reason the superposition of the two parts of the monochromatic light is maintained.

A similar explanation of Michelson-Morley experiment applies if the observer is on the moving system, i.e. on the Earth. Consequently, the Michelson-Morley experiment has been explained on the basis of both actual and apparent reduction of light speed.

Therefore, in case light moves to the direction of or opposite to the moving system, an actual reduction of light speed occurs, due to the reduction of the cohesive pressure.

However, in case light moves to the vertical direction of the moving system, an apparent reduction of light speed occurs by the same reduction factor, but here due to the aberration of light.

#### 2.4. The slowing of moving clocks

Assuming a clock on a moving material system, with a time period  $T = 2\pi\sqrt{m/k}$  in a linear oscillation or with a time period  $T = 2\pi\sqrt{I/\mu}$  in a rotational oscillation, where  $k$  the string constant,  $m$  the mass,  $I$  the moment of inertial and  $\mu$  the torsion constant, then the following relationships applie

$$\frac{T_0}{T} = \sqrt{\frac{k}{k_0}} = \sqrt{\frac{\mu}{\mu_0}} = \sqrt{\frac{P}{P_0}} \Rightarrow \frac{T_0}{T} = \sqrt{\frac{P}{P_0}}, \quad (26)$$

since the reduction of elastic forces<sup>2</sup> of oscillations in material bodies takes place to each direction, due to the residual cohesive pressure  $P = P_0 - \Delta P$  (Eq. 1), where  $T_0$  the time

period of a stationary clock,  $P_0$  the cohesive pressure<sup>1,2</sup> of the dynamic space far for the moving system and  $\Delta P$  the motion arrow<sup>3,4</sup> of the moving system.

Timeless speed<sup>6</sup> of the moving system, with linear speed  $u$ , is

$$u_a = \frac{u}{C_0} = \sqrt{\frac{\Delta P}{P_0}} \Rightarrow \frac{u^2}{C_0^2} = \frac{\Delta P}{P_0}. \quad (27)$$

So, due to Eqs 5, 27 and 1, we have

$$\frac{C_r}{C_0} = \sqrt{1 - \frac{u^2}{C_0^2}} = \sqrt{1 - \frac{\Delta P}{P_0}} = \sqrt{\frac{P_0 - \Delta P}{P_0}} = \sqrt{\frac{P}{P_0}}, \quad (28)$$

namely it is

$$\sqrt{\frac{P}{P_0}} = \sqrt{1 - \frac{u^2}{C_0^2}}. \quad (29)$$

Therefore,  $T_0/T = \sqrt{P/P_0}$  (Eq. 26), due to Eq. 29, becomes

$$\frac{T_0}{T} = \sqrt{1 - \frac{u^2}{C_0^2}} = \frac{1}{\gamma} \Rightarrow \frac{T}{T_0} = \gamma > 1 \Rightarrow T > T_0, \quad (30)$$

where

$$\gamma = 1/\sqrt{1 - \frac{u^2}{C_0^2}}, \quad (31)$$

as symbolized in special theory of relativity.

So, the moving clock, with the longest time period  $T$ , slows down, compared to stationary clock with time period  $T_0$  (Eq. 30).

### 2.5. Consequences due to slowing of the moving clocks

The time measured by a clock on the moving system of Earth, according to the theory of relativity, is reduced as

$$t = t_0 \sqrt{1 - \frac{u^2}{C_0^2}}, \quad (32)$$

where  $t_0$  is the time measured by a stationary clock on reference system of Ether (Michelson-Morley experiment). For  $\gamma = 1/\sqrt{1 - u^2/C_0^2} > 1$  (Eq. 31) the Eq. 32 becomes

$$\frac{t}{t_0} = \sqrt{1 - \frac{u^2}{C_0^2}} = \frac{1}{\gamma} \Rightarrow t = \frac{t_0}{\gamma} \Rightarrow t < t_0. \quad (33)$$

On Ether the light has traveled a distance  $L_0$ , while on Earth light has traveled a distance  $L$  (according to the theory of relativity), so it is ‡

$$L = L_0 \sqrt{1 - \frac{u^2}{C_0^2}}, \quad (34)$$

‡ Also, the relationship  $L/L_0 = \sqrt{P/P_0}$  (Eq. 26) applies (according to the theory of dynamic space), given that the reduction of elastic deformations<sup>2</sup> takes place due to residual cohesive pressure  $P = P_0 - \Delta P$  (Eq. 1) and due to  $\sqrt{P/P_0} = \sqrt{1 - u^2/C_0^2}$  (Eq. 29), we have  $L = L_0 \sqrt{1 - u^2/C_0^2}$  (not based on the second postulate of special relativity).

because the distance is also reduced by the known reduction factor  $\sqrt{1 - u^2/C_0^2} = 1/\gamma$  (Eq. 31) and substituting this in Eq. 34, it is

$$L = \frac{L_0}{\gamma}. \quad (35)$$

Also, light speed  $C$ , measured by an observer on the moving system (Earth), is

$$C = \frac{L}{t} \quad (36)$$

and substituting therein  $L = L_0/\gamma$  (Eq. 35) and  $t = t_0/\gamma$  (Eq. 33), it is

$$C = \frac{L_0/\gamma}{t_0/\gamma} = \frac{L_0}{t_0} \Rightarrow C = \frac{L_0}{t_0}. \quad (37)$$

However,  $C_0 = L_0/t_0$  is the speed of light measured by an observer on Ether. Therefore

$$C = C_0, \quad (38)$$

namely the speed of light looks as a constant (seemingly) on the moving system (second postulate of relativity), but in reality it has been reduced.

This equality of light speeds arose, because the speed of light, reduced by the factor  $\sqrt{1 - u^2/C_0^2}$  (Eq. 5), is measured by a clock that slows down, due to the longest time period  $T$  (with  $T > T_0$ ) by the same factor  $\sqrt{1 - u^2/C_0^2}$ , according to Eq. 30.

### 3. Epilogue of Michelson-Morley experiment

The interpretation of the Michelson-Morley experiment, as based on the second postulate of relativity, has since remained without a physical explanation, but has now been proved in subsection 2.3. In the special relativity, the time dilation has been accepted, ignoring, though, the real cause of the slowing of the moving clock, i.e. the phenomenon of motion.<sup>3,4</sup> In the general relativity, time is defined as a physical entity (as a fourth dimension) in the space-time continuum, while in the dynamic space,<sup>1,2</sup> time<sup>10</sup> is the motion phenomenon itself, i.e. the motion of the elementary units.<sup>11</sup> In addition, the experimental result of increased life of fast moving muons is used as a proof of relativity theory. However, the unified theory of dynamic space clearly outlines the structure of particles and their motion,<sup>4</sup> which decreases the cohesive pressure of the proximal space. So, the cortex of muon<sup>12</sup> resists easier to the reduced attraction of cohesive pressure, thus slowing their decay and prolonging their life.

In the question “Why theory of relativity has correct applicable results?”, the following answer is given:

The reduction factor  $\gamma = 1/\sqrt{1 - u^2/C_0^2}$  (Eq. 31), the so called Lorentz factor, is the tool for the mathematical expression of the problem that had arisen from the Michelson-Morley experiment. This same reduction factor appears also in the unified theory of dynamic space with the Galilean transformations, by calculating the actual reduction of the light speed on moving material systems. So, Lorentz transformations prove correct, but not based on the second postulate of relativity and thus, the relativity theory

has correct applicable results. However, the application of Galilean transformations is preferable, at calculating the relative speed of light on the moving material systems. Moreover, the application of the Lorentz transformations on imaginary (non-material) systems can lead to unreasonable results. The actual reduction of light speed happens only when the light is transmitted on moving material systems, on which the cohesive pressure of the proximal space is reduced.

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