

# Measuring the Own Velocity of Material Bodies in a Vacuum Using A Light Clock

Tadeusz Wajda

## ABSTRACT

The article presents the principle of light clock operation in terms of the values of the time intervals it generates. The time intervals generated by the light clock are different and depend on the velocity of the clock movement in the vacuum and its orientation in relation to the direction of its movement. The stationary clock will set the shortest time intervals. A clock in motion, oriented transversely, will calculate time intervals longer than the stationary clock. The same light clock in motion, oriented longitudinally, will determine the longest time intervals. In this orientation, the light clock will run at its slowest pace.

Formulas for the values of K coefficients determining mutual relations of time intervals generated by the light clock were derived. These relationships were determined based on the principles of classical physics without referring to the theory of relativity and, in particular, its postulates, which are incorrect. It is not time that dilates, but the light clock in motion sets time intervals longer than the stationary clock.

The novelty is the discovery that the values of the K coefficients depend not only on the velocity of the clock's movement but also on its orientation in relation to the direction of its movement.

Based on these analyzes and findings, a technical way of measuring the own velocity, e.g. a rocket moving in a vacuum with respect to this vacuum, has been submitted, without the need to refer to other material bodies and local reference systems.

**Keywords:** absolute velocity in vacuum, light clock properties, Lorentz theory, time dilation, relativity theory.

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## I. INTRODUCTION

In the article [1] published in 2017, the construction and analysis of the operation of a light clock was presented by author of this paper. The clock sends short light pulses that are reflected by the mirror and returned to it, triggering the next light pulse. In this article, the author referred to the works of H. Lorentz [2], [3], from whom the concept of “gamma” was borrowed. This concept is in fact a factor of slowing down the walking velocity of the clock, which was predicted by H. Lorentz. This phenomenon was later misinterpreted by A. Einstein [4] and identified with time dilation in the theory relativity invented by him. The Lorentzian gamma has become a universal false key to relativize movement-related phenomena. These problems were discussed also in [7]-[12]. According to the author of this article, time does not undergo dilation. Light clocks in motion have the physically justified right to tick slower, but time in the universe is passing by at a steady and unchanging pace. Identification of slowing down of clock pace with slowing down of time passage is, in my opinion, the biggest mistake in 20th century physics. In order to facilitate the explanation of the developed method of measuring the own velocity  $v$  of the rocket in relation to the vacuum, the necessary assumptions and concepts were

presented, and the findings on the basis of which this method was developed.

## II. ASSUMPTIONS

1. Universal Reference System (URS) I define as a three-dimensional intergalactic, immaterial, unlimited and stationary space, forming one URS. This system is characterized by the fact that in and with it, all movement of material bodies can occur. The parameters of the motion of these bodies can be clearly defined, without the need to refer to other bodies or artificially created local reference systems. URS has the property that electromagnetic waves (EM), including light, propagate in it and in relation to it, with constant velocity  $c$ . This velocity, according to Maxwell's discovery is determined by the magnetic and electric permeability ( $\mu$  and  $\xi$ ) of vacuum, which this System fills, and which creates it [5].

2. I define time as an immaterial physical constant that determines the velocity of the processes in the Universe. Time in the Universe is passing by its independent and unchanging pace.

3. In the proposed Universal Reference System (URS) there are no time dilatations or any of its derivatives, including ruler. These phenomena have no physical basis for

their existence and have never been confirmed experimentally.

4. The velocities of material bodies in a vacuum are not limited. Everybody in motion can move in the URS lossless at any velocity and in any direction.

The assumptions mentioned above are sufficient to achieve the stated goal, which is to develop a method of measuring own velocity, e.g. a rocket in relation to the URS and the interplanetary vacuum filling it.

Below there are the values of time intervals generated by both stationary and moving clock [1]. Based on these values, a method for measuring the velocity of the rocket and other material bodies in a vacuum using a light clock, will be provided.

The concept of own velocity  $v$  of material bodies in a vacuum has been tightened to the concept of the velocity of material objects moving in a vacuum, in the sense in relation to this vacuum. In determining the value of this velocity, I use the light velocity constant  $c$ , also understood as a constant velocity in relation to the vacuum.

The rocket's own velocity  $v$  will be defined as the fraction of constant velocity  $c$  of light propagating through the vacuum.

### III. BRIEF DESCRIPTION AND OPERATION OF THE LIGHT CLOCK

The design of the light clock was extended at work (8). Below there are the main concepts and a list of their values generated by the light clock.

The light clock has a base a fixed-length base  $L$ . The length of the light clock base (rail) cannot be any. Its length is limited by the strength parameters of the material from which it can be made. The clock base design should be mechanically stable, rigid and insensitive to changes in external factors, mainly temperature.

The light clock has no moving mechanical parts. At one end of this bus there is mounted a generator of single short light pulses (GLP) and their detector (DLP). At the other end of the rail there is mounted a mirror perpendicular to the rail.

The light pulse generated by the GLP is sent towards the mirror, bounces off it and returns back to the place from which it was sent. There, it is picked up by a photodiode of the detector and in the form of an electrical pulse, given on trigger a GLP that triggers the next light pulse.

The described construction used and tested in terrestrial conditions must be placed in the pipe from which the air was pumped out.

### IV. BASIC OPERATING PARAMETERS OF THE LIGHT CLOCK

The light clock will determine (generate) time intervals that will determine the pace of its gait. The values of these time intervals will depend on the state of motion (velocity) of the clock in the vacuum and its orientation in relation to the direction of its movement.

#### A. Stationary clock

The time intervals generated by the stationary clock in reference to URS, marked as  $T_s$  (stationary) will be equal:

$$T_s = \frac{2L}{c} \tag{1}$$

These will be the time intervals for the given clock base constant length  $L$ , because the light pulse will run to the mirror and back along the shortest possible path (Fig. 1). In reality, there are no immovable objects in relation to the URS.

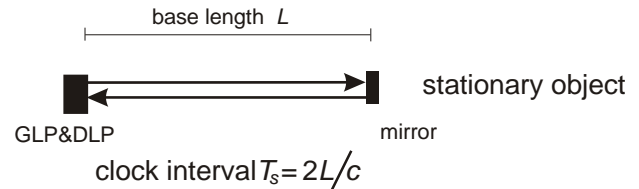


Fig. 1. The stationary clock in relation to the URS.

#### B. Transversely carried light clock

The notion of a “transversely transported light clock” should be understood as the movement of a clock whose base is oriented perpendicular to the direction of its movement. A clock oriented in this way, moving in a vacuum with a velocity  $v$ , will generate longer than the time intervals  $T_s$ , the time intervals marked as  $T_t$  (transversal). The values for these intervals will be equal:

$$T_t = T_s \cdot K_t \tag{2}$$

where  $K_t$  is the value of the coefficient determining how many times, time intervals  $T_t$  generated by the moving and transversely oriented clock, will be greater than the time intervals  $T_s$  generated by the stationary clock (Fig. 2).

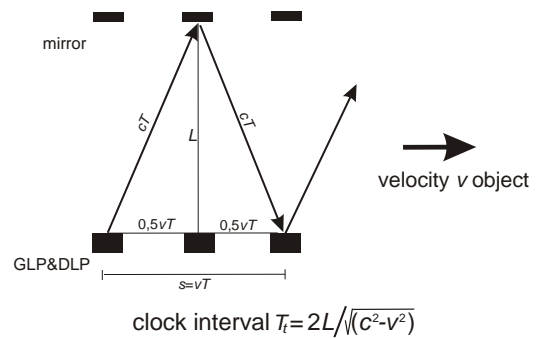


Fig. 2. The clock oriented transversely to the direction of his movement.

The formula for the value denoted here  $K_t$  was derived in the years around 1894-1904 H. Lorentz who tried to explain the reason for the lack of phase shift of light in two mutually perpendicular arms of the Michelson interferometer [6].

This formula is known under the name  $\gamma$  (gamma). Its value depends on the ratio of the velocity  $v$  of the arm motion of the perpendicular arm Michelson interferometer in the ether to the constant velocity  $c$  of light ( $v/c$ ).

$$y = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{3}$$

The above formula is widely used in relativism as a factor determining the value of (non-existent) time dilation and physically non-existent so-called shortening (contracting) of the length of moving bodies. This pattern in relativism has become a universal false key relativizing many phenomena related to movement and often misinterpreted as relativistic phenomena. Therefore, in the considerations presented here, instead of the concept of gamma, concepts of  $K$  coefficients defining the relationship between the time intervals determined by the light clock have been introduced, which were designated  $T_s$ ,  $T_t$  and  $T_l$ . These are actual real and not imaginary time intervals, which can only be seen by an undefined observer from the second reference system.

Analysis of the operation of the light clock based on the laws of classical physics showed that the working light beam in a clock in motion, in a transverse orientation, will run along a “zigzag” line, therefore, at sections longer than the path of the light pulse in the stationary clock. Therefore, the time intervals  $T_t$ , determined by the clock in motion in the transverse orientation, will be longer than the time intervals  $T_s$  generated by the stationary clock. No time dilation or other relativistic phenomena [4] occur here, which is why they were not included in the analysis of the light clock and were not used.

C. Light clock transported longitudinally

Under this concept is understood a clock in motion, oriented parallel to the direction of its movement. The clock oriented in this way will generate even longer time intervals  $T_l$  than time intervals  $T_t$ , equal:

$$T_l = T_t \cdot K_l \tag{3}$$

where  $K_l$  is the coefficient determining how many times the time interval  $T_l$  generated by the longitudinally oriented clock will be larger than the time interval  $T_t$  generated by the transversely oriented clock (Fig. 3). On the clock oriented longitudinally, the working light pulse will run along the longer path than the path in clock oriented transversally. This path will be line parallel to the clock moving direction. During the flight of the light to the mirror, it will “run away” and on the way back the impulse detector to the impulse reflected from the mirror, DLP will approach. The phenomenon is not symmetrical, as a result of which the sum of the flight time of the light pulse back and forth in this clock orientation, will reach the highest value. A light clock moving in a vacuum in longitudinal orientation will be “ticking” the slowest and generates the longest possible time intervals  $T_l$ .

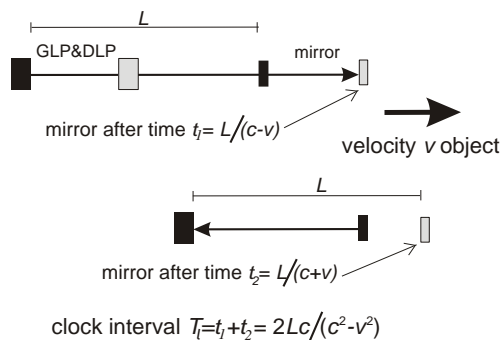


Fig. 3. The clock oriented longitudinally to the direction of his movement.

D. Summary and analysis of time intervals generated by the light clock

Algebraic relationships determining the values of the time intervals generated by the clock [1] are listed below. A stationary clock, motionless relative to a vacuum, will generate time intervals  $T_s$  equal:

$$T_s = \frac{2L}{c}$$

The clock in motion is oriented transversely, will generate time intervals  $T_t$ , equal:

$$T_t = \frac{2L}{\sqrt{c^2 - v^2}}$$

The clock in motion in longitudinal orientation will generate time intervals  $T_l$ , equal:

$$T_l = \frac{2L c}{c^2 - v^2}$$

Calculation of the values of  $K_t$  and  $K_l$

The value of the factor  $K_t$ , which determines the ratio of the time interval  $T_t$ , generated by a transversely oriented light clock, to the value of the stationary time interval  $T_s$ , will be equal:

$$K_t = \frac{T_t}{T_s} = \frac{\frac{2Lc}{c^2 - v^2}}{\frac{2L}{\sqrt{c^2 - v^2}}} = \frac{c}{\sqrt{c^2 - v^2}} \tag{4}$$

The value of the coefficient  $K_l$ , which determines the ratio of the time interval  $T_l$  generated by the longitudinally transported clock, to the time interval  $T_t$  generated by the same transversely oriented clock, will be equal:

$$K_l = \frac{T_l}{T_t} = \frac{\frac{2Lc}{c^2 - v^2}}{\frac{2L}{\sqrt{c^2 - v^2}}} = \frac{c}{\sqrt{c^2 - v^2}} \tag{5}$$

Both the value of  $K_t$  and  $K_l$  reduces to the same expression:

$$\frac{c}{\sqrt{c^2 - v^2}}$$

The above comparison shows that the values of  $K_t$  and  $K_l$  coefficients are the same for a given velocity  $v$  of clock movement.

This unexpected and proven equality of these values is a peculiar foundation on which the proposed method of determining the own velocity in clock in relation to the vacuum is based.

I note these equality as:

$$K_t = K_l \quad (6)$$

Using the form of the notation made by H. Lorentz, who introduced the gamma coefficient to the state of knowledge, the formula  $\frac{c}{\sqrt{c^2 - v^2}}$  is transformed into the classical form of the expression

$$\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$$

Equation (6) records as:

$$K_t = K_l = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} \quad (7)$$

where  $v$  is the velocity of the clock movement in relation to the vacuum,  $c$  is the constant value of the velocity of light in the vacuum in the sense of this vacuum as an immaterial medium in which light is propagated.

#### E. Determination and measurement of the $K$ factor value

The  $K$  factor (without markings) is defined as the ratio of the time intervals determined by the light clock in motion in longitudinal orientation to the time interval determined by the stationary clock.

Based on my theses derived in article [1], I conclude that the value of  $K$  is equal to the square of the value of  $K_t$  and  $K_l$ . Evidence is provided below.

The value of the time interval determined by the light clock transported parallel to its direction of movement is equal:

$$T_l = \frac{2Lc}{c^2 - v^2}$$

The value of the time interval measured by the stationary clock is equal to:

$$T_s = \frac{2L}{c}$$

The value of the ratio of these two time intervals  $T_l$  and  $T_s$  was defined as the  $K$  factor.

Its value is equal to:

$$K = \frac{\frac{2Lc}{c^2 - v^2}}{\frac{2L}{c}} = \frac{c^2}{c^2 - v^2} \quad (8)$$

The reader will notice that the value of  $\frac{c^2}{c^2 - v^2}$  is the square of the value of  $\frac{c}{\sqrt{c^2 - v^2}}$ .

This is identical to the values of the  $K_t$  and  $K_l$  coefficients. So

$$K = K_t^2 \quad (9)$$

and

$$K = K_l^2 \quad (10)$$

It has been proved that the value of the  $K$  coefficient defined as the ratio of the time interval  $T_l$  generated by a longitudinally oriented light clock to the time interval  $T_s$  which is generated by a stationary clock, is equal to the square of the coefficient  $K_l$ .

The above also shows:

$$K = K_l \cdot K_t \quad (11)$$

An unexpected phenomenon and property of a light clock is the discovery that the values of proportionality coefficients, which are  $K_t = T_l / T_s$  and  $K_l = T_l / T_t$ , are equal.

The above-mentioned dependencies on the characteristics of a small physical discovery regarding the operation of a moving light clock enable measurement of the own velocity  $v$  of its light clock in a vacuum.

The formula determining the value of  $K$  in trigonometric form has the form:

$$K = K_l^2 = \frac{1}{1 - \frac{v^2}{c^2}} = \frac{c^2}{c^2 - v^2}$$

The above formula is identical to equation (8).

After transforming this formula with respect to  $v$ , we get a formula for the value of the own velocity  $v$  of the light clock movement in a vacuum:

$$v = c \sqrt{1 - \frac{1}{K}} \quad (12)$$

To calculate the clock velocity, only the value of the dimensionless  $K$  factor is needed. This value can be measured with a light clock. Practically, the value of this factor can be defined as the square of the value of the factor  $K_l$ . The factor  $K_l$  is obtained from the quotient of the measured values generated by the light clock of the time intervals  $T_l$  and  $T_t$ . Without the need to use the  $T_s$  time interval that the stationary clock would generate.

Due to the discovery of the  $K_l$  factor, which is the equivalent of the second, longitudinal Lorentz gamma, which Lorentz did not derive, this discovery enables the technical measurement of the  $K$  factor value, so determination of the  $v$  velocity of the clock in a vacuum is

possible. This velocity, according to J. Maxwell [6], was interpreted as the absolute velocity  $v$ , determined in relation to the vacuum.

Having experimentally measured the numerical value of the  $K_l$  coefficient, at any moment of the rocket's movement, it is possible to calculate the  $K$  coefficient from its value and the velocity  $v$  of it, at each stage of its motion, also in variable movement.

Measuring your own velocity in the following way will be made in a few minutes.

A direct measurement of the value of the coefficient would not be possible because in real conditions we cannot directly measure the value of the time interval  $T_s$ . It is not possible to specify this value because everybody in the URS, including a light clock, is in motion whose parameters we do not know.

The submitted method will also be able to determine the direction of the Earth's movement with the Solar System in URS. This direction will be the direction in which the clock longitudinally oriented, will go at its slowest pace. This direction will be determined in relation to this boundless three-dimensional space that has been defined and called the Universal Reference System.

#### F. Description of technology and hypothetical numerical example of measuring the velocity $v$ , rocket in a vacuum

We must have a light clock on the rocket equipment. We will measure the pace of his walk with an impulse counter which is its integral part. The clock must be mounted on the outside of the rocket shell, because its proper operation will be possible only in a vacuum and not inside a rocket in which there may be air. The light in the air is propagating with slowest velocity than the vacuum by about 80 km/s and in relation to this air and not interplanetary vacuum.

I built a light clock with a base length of 7 feet or 2.135 m. I assume that this clock works according to the assumptions and will measure time intervals of approximately 14 ns. Then the pace of his walk or frequency of his work, which I denote  $f$ , will be around 70 MHz.

We set our clock transversely, i.e. perpendicularly to the direction of flight of the rocket. On the pulse counter we read the clock frequency  $ft$  in this orientation. We obtain a result, let us say of equal  $ft = 70.000000$  MHz.

The rocket flies with a constant velocity  $v$ , whose value we do not know and which value we want to measure. We switch and strictly change the clock orientation to longitudinal in relation to the direction of flight of the rocket. We make a second reading of the walking rate  $fl$  of light clock in this orientation. This frequency will be slightly lower than the  $ft$  frequency that the clock had during its operation in transverse orientation. Let this reading be equal:

$$fl=69.99999965\text{MHz}$$

From these example two measurements, we calculate the time intervals  $T_l$  and  $T_t$  determined by this clock in two orientations. Longitudinal "l" and transverse "t" orientation.

These intervals will be equal:

$$T_t = ft^{-1} = 1/70.00000000 \text{ MHz} = 1.428571428571 \cdot 10^{-8} \text{ s}$$

$$T_l = fl^{-1} = 1/69.99999965 \text{ MHz} = 1.428571435714 \cdot 10^{-8} \text{ s}$$

The quotient of these times according to formula (5) will give us the value of the coefficient  $K_l = T_l / T_t$ .

After inserting the value and performing the division, we get the value of dimensionless factor  $K_l$  equal  $K_l=1.000000005$ .

This value squared (10) gives the value of the coefficient  $K$ .

$$K = 1.0000000052 = 1.00000001.$$

I calculate the velocity  $v$  of a rocket from the value  $K = K_l$  2. The  $K$  value was defined and calculated as the ratio of time intervals  $T_l / T_s$ .  $T_l$  are time intervals generated by the longitudinally oriented clock.  $T_s$  time intervals, would generate a stationary clock. Since it is practically impossible to measure the value of time interval  $T_s$ , the derived dependencies are used formula (10).

Having the numerical value of  $K$ , using the formula (12), we calculate the value of the own velocity of the rocket in vacuum.

This velocity will be expressed as a fraction of the constant value of the light velocity  $c$  in a vacuum:

$$v = c \sqrt{1 - \frac{1}{K}}$$

After inserting the  $K$  value and performing the actions, we get the desired velocity  $v$  of the clock installed on the given object:

$$v = c \sqrt{1 - \frac{1}{1.00000001}} = c \cdot 0.00009999.$$

Assuming a constant value of the velocity of light in a vacuum equal to  $c=300000$  km/s, measured with the described way, velocity  $v$  the rocket, will be equal to:

$$v \approx 30 \text{ km/s.}$$

This will be the velocity determined in relation to the URS or absolute velocity  $v$ , of the rocket in relation to the boundless vacuum.

## V. SUMMARY

The presented method of measuring of the own velocity of material bodies in a vacuum was not known until now, and even because of the theses resulting from the being in force theory of relativity, it was forbidden, In the opinion of most relativists, measuring the own velocity against "nothing" would be unthinkable at all.

Based on the adopted calculations, it can be assumed that the presented method of measuring the own velocity is technically feasible. This method will be possible for practical use, provided that we have a suitably rigid clock and a stable pulse counter. The design of the light clock must be stable enough that for small velocity of its movement, in the order of hundreds of meters per second, at

a clock frequency of several dozen megahertz, ensured measurement of changes in this frequency, which will appear in the range of only a few decimal Hz. This can be a technical challenge, requiring the implementation of a suitably stable mechanical and electro-optical construction of such a clock.

And also, a stable counter enabling reliable measurement of frequencies in the range up to several hundred MHz with a resolution 0,001 Hz. This is technically possible by extending the measurement time. Frequency measurement will require the meter time gate to open up to 10s and even 100 s. In this way, the instability timing gate of the pulse counter will be relatively smaller.

Here a small additional assumption or remark. In the calculation example, it was assumed that the light clock works lossless in the sense that the times of flight of light pulses from the generator to the mirror and back will be “clean” working times in the sense that they will not be burdened with the time necessary for the processing of electrical signals, in “clock electronics” which appear in practical solutions of such a clock. These times, which can sometimes be called “bias” or sometimes “silicon”, will be constant and independent of the state of motion and clock orientation. Therefore, it will be possible to take them into account and eliminate their burdensome measurements of velocity and influence.

Measurement of the time intervals generated by the clock will require optimization of its dimensions. For example, you can extend twice the optical path of light without increasing the length of the clock base [1]. This is possible by inserting an additional mirror next to the pulse generator. Then the path of light will be doubled while maintaining the rigidity of the clock's mechanical structure. The clock frequency will decrease twice.

This problem will be the subject of a report on research activities related to light clock which are being continued.

The method described in this article should be treated as the theoretical justification of the 'possibility' of measuring of own velocity  $v$ , rocket in vacuum This method was developed entirely on the basis of the laws of classical physics. Without having to refer to the second reference system and use the services of relativistic “observers”.

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After graduating in 1966 at the Cracow University of Technology, for 10 years he studied electrical and electroosmotic phenomena occurring in porous media. In 1977 he defended his doctoral dissertation on the influence of electric potentials on the laminar flow of water in soils and related phenomena. He also proved the formation of landslides resulting from the formation of water pressures at the interface between two layers of soil differing in mineralogical

composition.

He made a dozen exert opinions related to landslides and slope stability of reservoirs of waste materials deposited on the ground. He was participant in the international conference in Nuernberg (Germany 1986).

After retiring in 2005, he dealt with the phenomena of atmospheric vortices and metrology of velocity measurements of objects moving in a vacuum. His article “Dilation of time dilation” published in the Apliance Physics Researche in 2019, in which he discovered the K factor, an extension of H. Lorentz's ether theory, is of increasing interest to scientists all over the world.