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An Update of the Explanation of the Michelson-Morley Experiment by Abolishing the Second Postulate of Relativity

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Abstract **– In a recent research, a function was presented that, in the context of a privileged inertial system, could explain the result of the Michelson-Morley experiment by abolishing the second postulate of relativity and thus disregarding the length contraction. This paper briefly explores this hypothesis and discusses its application, which unfortunately appears inaccurate in one place. A more appropriate configuration that the above function should assume is then indicated and some consequences of its application are analyzed. Since in the case of the existence of a privileged inertial system the slowing down of processes in a moving body is absolute and real, a consideration on the twin paradox is presented.**

Keywords **– Privileged Inertial System, Length Contraction, Light Speed, Wavelength, Frequency as a Constant, Twin Paradox, Consciousness.**

I. Introduction

The Michelson-Morley experiment [1] did not detect any ether wind. One possible explanation of this result, the contraction of the lengths of moving bodies, was provided by FitzGerald [2] and formalized by Lorentz [3]. Einstein's theory of special relativity [4] incorporated the formulas of Lorentz transformations, but assuming the nonexistence of the aether. However, some scholars disagree with some aspects and results of the theory of relativity, especially regarding the isotropy of the speed of light and the relativity of simultaneity. In what follows, this debate will be briefly summarized. Special attention will be paid to a new function [5] that could explain the result of the Michelson-Morley experiment by abolishing the second postulate of relativity and without taking into account the contraction of lengths, in the context of a privileged inertial system. A brief explanation of the hypothesis underlying this function is presented, and after noting that its application appears partially inaccurate, a more appropriate configuration is indicated. Next, discussing the consequences of the application of the function, it is shown that photons emitted by a moving light source have in the latter's inertial system the same frequency in each direction, which is also identical to the frequency they would have if the light source were stationary in the privileged inertial system. Furthermore, considering that if there is a privileged inertial system the slowing down of processes in a moving body is absolute and real, a brief paragraph on the twin paradox and on the possible effects on those traveling at relativistic speeds is also proposed.

II. From Strong Relativity to the Abolition of Length Contraction

In the well known twin paradox, one of the twins, who travels almost at the speed of light to a distant star and returns to earth, finds his brother older than himself. This is in contrast with the principle of strong relativity for which no inertial system is privileged and therefore the brother who remains on earth can be considered, along with the earth and even the entire universe, to be in motion with respect to the brother who travels, thus assumed to be at rest. To solve this problem, but contravening the principle of strong relativity, it was noted that only the twin moving away from the earth is subject to acceleration [6]. Selleri [7], on the contrary, observed that muons rotating in a cyclotron, subjected to very strong accelerations, decay at the same time as muons traveling at the same speed from the stratosphere to the earth's surface, following a straight trajectory without accelerations. Selleri, whose analysis also takes into account phenomena he believed were not well explained by relativity, such as the Sagnac effect and the aberration of light, developed a theory, "Weak Relativity" [7], based on the assumption of the existence of a privileged inertial system (the hypothesis of the existence of a privileged system is followed not only by Selleri: see Burde [8]; among the hypotheses about its nature: Xian Xiang [9]).

More recently [10], following Selleri, it was noted that, according to the experiment of Hafele and Keating [11] [12], time for moving bodies can slow down but can also accelerate, and in a more recent paper [5] the hypothesis of the abolition of the second postulate of relativity was put forward, thus making the length contraction unnecessary for the explanation of the Michelson-Morley Experiment.

Some equivalent versions of a function were presented in the cited paper [5], of which the most intuitive is the following:

$$C_{\theta,S_0} = \sqrt{c^2 - |\sin\theta|\, v^2 (c^2 \text{-} v^2)/c^2} \qquad (1)$$

In (1) c is the speed of a photon emitted by a light source at rest in the privileged inertial system S_0, θ is the angle between the trajectory of the light source (at rest in the inertial system S_1 and in motion with velocity v with respect to S_0) and the trajectory of the emitted photon. C_{θ,S_0} is the speed of the photon measured in the privileged inertial system S_0. Assuming $c = 1$, (1) is simplified as follows [5]:

$$C_{\theta,S_0} = \sqrt{1 - |\sin\theta|\, v^2 (1\text{-}v^2)} \qquad (2)$$

Applying (1) (or (2)), if $v > 0$ and if θ is different from 0° or 180°, the light speed in S_0 is less than c. In addition, according to the scholar [5], the speed of the light pulse calculated by means of this function is such that it satisfies the results of the Michelson-Morley experiment: photons directed in various directions towards equidistant mirrors should travel equivalent round-trip paths in S_1 to return to the light source in the same time, whatever the motion of S_1 with respect to S_0.

The explanation for this lies in the fact that the photon whose trajectory has an angle with the source trajectory other than *0°* or *180°* undergoes traction during emission and its trajectory undergoes translation. If the photon does not undergo a translation, in vacuum its nature is to move at speed c with respect to the emission point (in S_0): the photon experiences only its natural motion with respect to the emission point and no internal time advances for it and it never decays. If, on the other hand, the trajectory of the photon is translated at a velocity v, the internal time of the photon remains stationary due to the fact that time can not have negative variations [13] but the motion of the photon with respect to S_1 slows down according to the Lorentz factor as it happens for anything else in the universe (its motion with respect to S_0 is instead given by (1) and, as v increases, is a combination of decreasing motion in S_1 and increasing translation in S_0).

Incidentally, if we imagine the photon not as a point particle but as having a length (two waves, magnetic and electric, with a train of nodes and antinodes giving rise to its frequency), we can see that it does not hit a target at rest in S_0 at a single point, but along a line.

III. Review of the Light Speed Function

As already mentioned above, (1) (and (2)) need to be revised. In fact, the function gives equal times of light round trips only if the value of θ is $0°$, $90°$, $180°$ or $270°$. The reason of this partial failure of the function lies in its factor: $|sin\ \theta|$. According to it, as θ changes, the photon speed should change more rapidly when the value of θ is close to $0°$ or $180°$.

The next section will show that this is not borne by the calculations. It is therefore necessary to propose a more realistic factor. The modification, although very small, will take into account the fact that the curve describing the relationship between θ and the intensity of the pull on photons must have an inflection point. The presence of an inflection point is due to the fact that the variation of the photon path reaches its highest values when the angle is $45°$, $135°$, $225°$ or $315°$.

The revised function is the following:

$$C_{\theta,S_0} = \sqrt{1 - sin^2\theta v^2 (1\text{-}v^2)} \quad (3)$$

In (3) $sin^2\ \theta$ takes the place of $|sin\ \theta|$ and this obviously occurs in all the forms assumed by the formula. In this way, (3) takes into account the fact that when the trajectory of the photons begins to diverge from that of the light source, the pull on the photons initially grows faster and faster and then, having passed the inflection point, grows slower and slower (the inverse from $90°$ or $270°$ to $0°$ or $180°$).

The modified factor will allow the output function to adhere more closely to the result of the Michelson-Morley experiment. In what follows we will verify it.

IV. Verification of Functions

Let us compare (3) with (2).

For simplicity, from now on, we will always assume $c = 1$. Let us now calculate the speed of photons emitted towards a target from a light source, both at rest in the inertial system S_1 but moving at the velocity v with respect to the privileged inertial system S_0. We will calculate the velocity in S_0 and S_1.

Assume that the light source emits a photon whose trajectory has an angle θ (in S_1) with the trajectory of the light source. Therefore, the photon has the speed $c_{\theta,S0}$ in S_0. The speed of the photon in S_1 between the light source and the target can be calculated in S_1, taking into account the time of S_1, and thus say it $c_{\theta,S1,S1}$ or taking into account the time of S_0, and in this case say it $c_{\theta,S1,S0}$. As it has been shown graphically [5], in S_0 the angle between the trajectory of the photon and the trajectory of the light source is less than θ if $0 < \theta < 180°$ (for $180 < \theta < 360°$ the opposite occurs), due to the translation of the photon in the same direction as the light source.

Let us assume for simplicity that the distance between the light source and the targets is exactly 1. In this case $sin\ \theta$ is the distance between the trajectory of the target and the trajectory of the light source and $cos\ \theta$ is the projection of the photon trajectory onto the trajectory of the light source in S_1 (see Figure 1A). As the photon moves towards the target, employing time $t_{\theta,S0}$ in S_0, the target moves in the same direction as the light source and therefore the trajectory of the photon will not be in S_0 the same as in S_1, as already mentioned above (unless

θ is $0°$).

$Cos\ \theta + v\ t_{\theta,S0}$ (that is $0C$) will be the projection of the photon's trajectory (in S_0) onto the trajectory of the light source (see Figure 1A and Figure 1B).

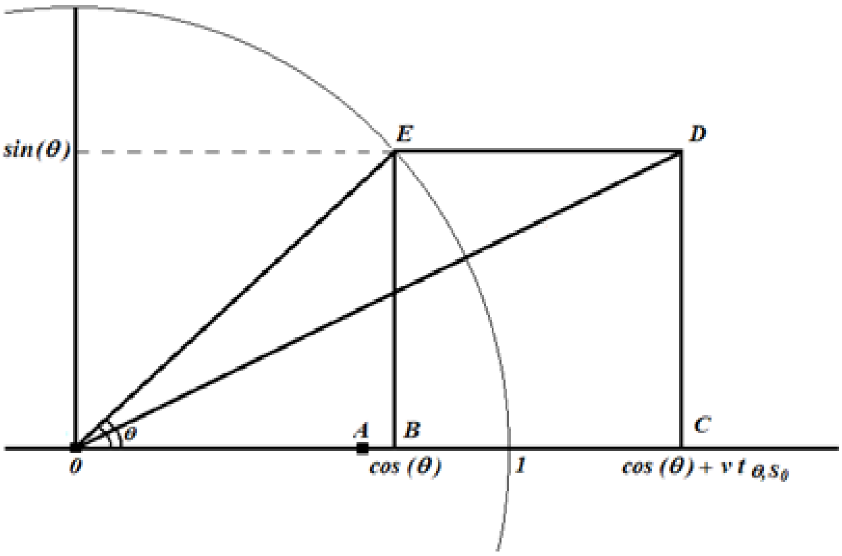

Fig. 1A. When the photon starts from the light source, the light source is in *0*. The light source is in *A* after traveling *0A*, that is $v\ t_{\theta,S0}$. *E* is the target of the photon when the light source is in *0*, and *0E* is the apparent trajectory of the photon in S_1. The target is in *D* when it is reached by the photon. $0B = cos(\theta)$, $0C = cos(\theta) + v\ t_{\theta,S0}$, $CD = BE = sin(\theta)$, $0D = c_{\theta,S0}\ t_{\theta,S0}$, that is the path of the photon in S_0.

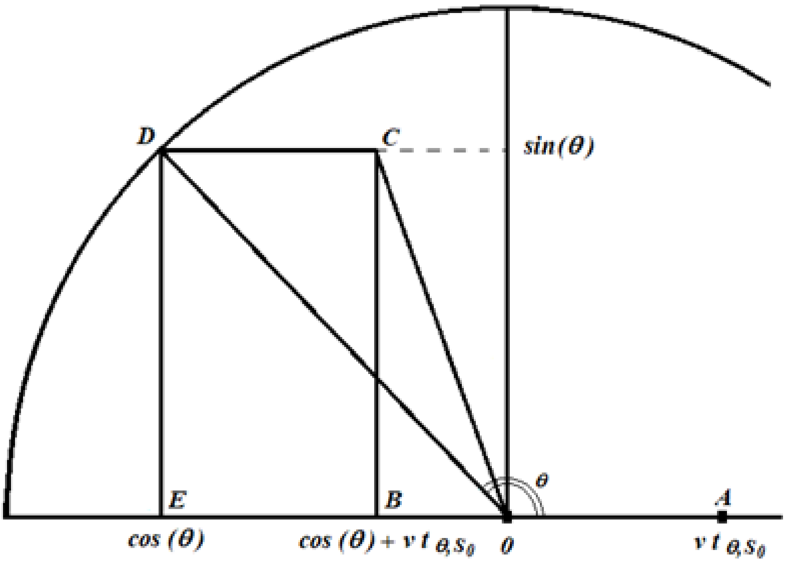

Fig. 1B. Here, when the photon starts from the light source (in *0*), the target is in *D*, to the left of the light source and therefore *cos(θ)* has a negative value (*0E*) and *0D* is the apparent trajectory of the photon in S_1. When the photon reaches the target, the light source is in *A* and the target is in *C*. Note that *0A* (the path of the light source) is equal to the distance between *E* and *B*. $0C = c_{\theta,S0}\ t_{\theta,S0}$ is the path of the photon in S_0, $BC = ED$ is $sin(\theta)$.

Applying the Pythagorean theorem:

$$(c_{\theta,S_0} t_{\theta,S_0})^2 - sin^2\theta = (v\ t_{\theta,S_0} + cos\theta)^2 \qquad (4)$$

we can obtain the value of $t_{\theta,S0}$ (note that $v\ t_{\theta,S0} + cos\ \theta$ can have a negative value as in Figure 1B but it is squared and therefore its sign is irrelevant for our purposes):

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$$t_{\theta,S_0} = [v\ cos\theta + \sqrt{c_{\theta,s_0}{}^2 sin^2\theta + c_{\theta,s_0}{}^2 cos^2\theta - v^2\ sin^2\theta}]\ /(c_{\theta,S_0}{}^2 - v^2) \quad (5)$$

The term inside the round brackets in the numerator can also be subtracted, giving negative values for $t_{\theta,S0}$, but only the positive value of this term will be considered, as it is written in (5). Taking into account that $sin^2\theta + cos^2\theta = 1$, (5) can be simplified:

$$t_{\theta,S_0} = [v\ cos\theta + \sqrt{c_{\theta,s_0}{}^2 - v^2\ sin^2\theta}]\ /(c_{\theta,S_0}{}^2 - v^2) \quad (6)$$

Note that the time taken by the photon to return to the light source, if it is reflected by a mirror placed in the target, is the same as the one-way trip for $180° - \theta$(if $0° < \theta < 180°$). We can then calculate the total time taken by the photon to make a round-trip and thus its speed. Adding the second term of (6) to the analogous term calculated for $180° - \theta$ and equating the sum to the time taken by a photon for $\theta = 0°$ or $\theta = 180°$ (which travels at the speed c, that is 1, in S_0) we can obtain the value of $cos^2\theta$. The time taken is $2\ d\ /\ (1 - v^2)$, where d is the distance between the light source and the target; since we have assumed $c = 1$, the time taken is $2\ /\ (1 - v^2)$.

Figure 2 shows the speed of light in S_0 calculated by means of (6), according to the procedure just described, assuming $v = 0.5$. Figure 3 and Figure 4, on the other hand, show the speed of light in S_0 calculated by means of (2) and (3), respectively, again assuming $v = 0.5$. It is easy to see that the curve plotted by (3), unlike the one plotted by (2), is superimposable on that in Figure 2 (the curve plotted by (2) gives the same result as (6) only for $0°$, $90°$ and $180°$). However, this super impossibility seems to be less good for very high values of v. This could simply be due to the approximations of the calculation. Otherwise, this could denote a residual insufficiency of the proposed function in describing the studied phenomenon, and in any case this insufficiency could be detected only under extreme conditions. If we accept Xian Xiang's approach [9], according to which the speed variations of the processes (local time) are essentially due to motion with respect to the local gravitational field (solar and terrestrial), the speeds involved in the Michelson-Morley's experiment are much lower.

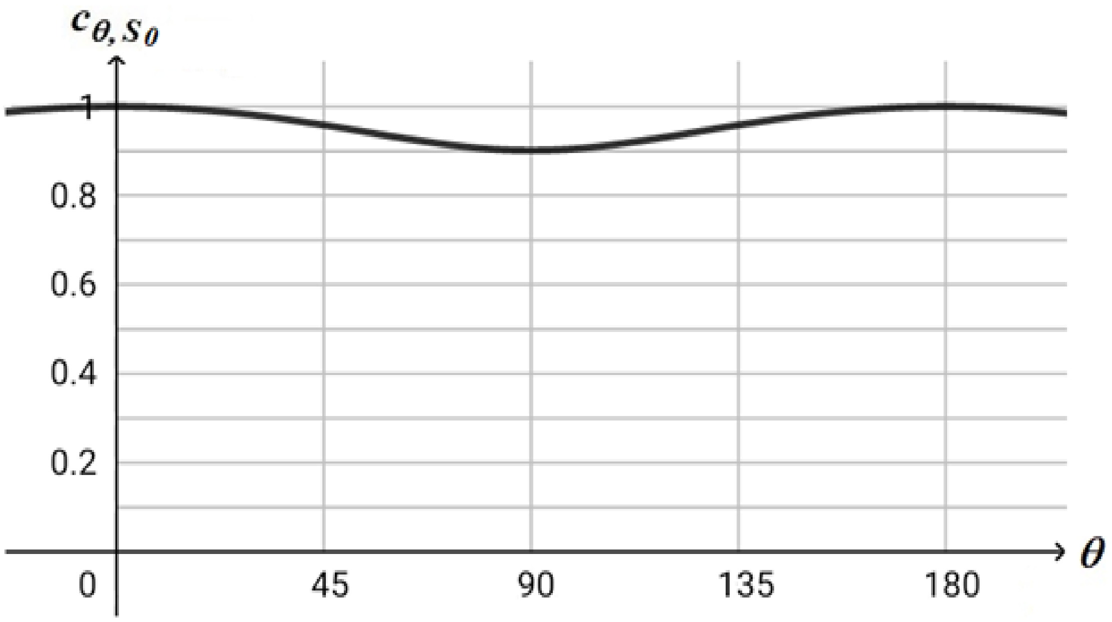

Fig. 2. The curve shows the relationship between the speed of light as a function of the angle θ, for $v=0.5$, calculated by means of (6) applied to the angles θ and $180 - \theta$ and equating the sum of its results to the time taken for the round-trip of a photon whose speed is 1.

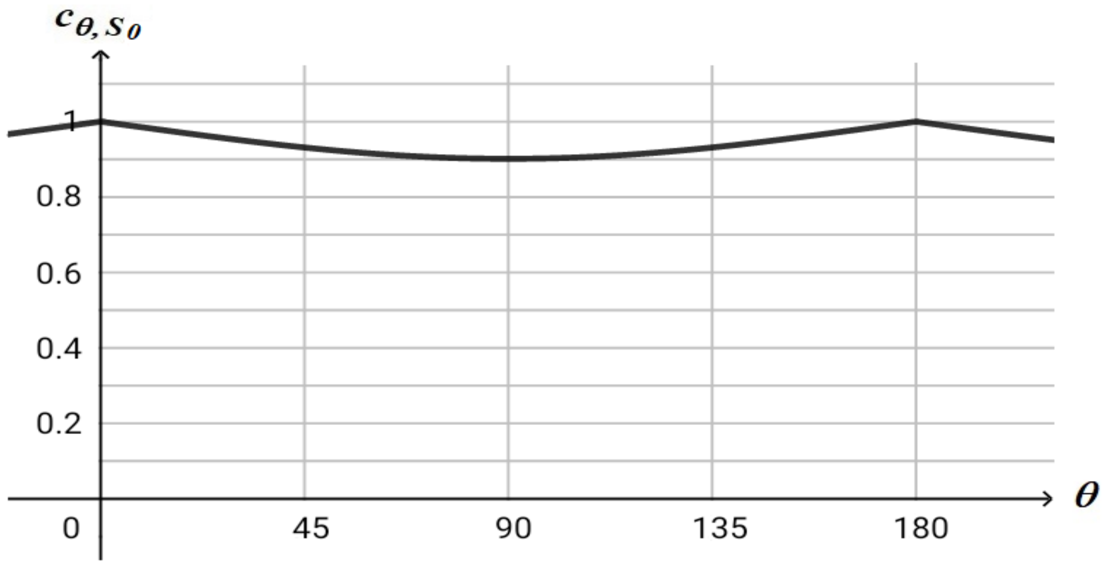

Fig. 3. The curve shows the relationship between the speed of light as a function of the angle θ calculated by means of (2), for $v = 0.5$.

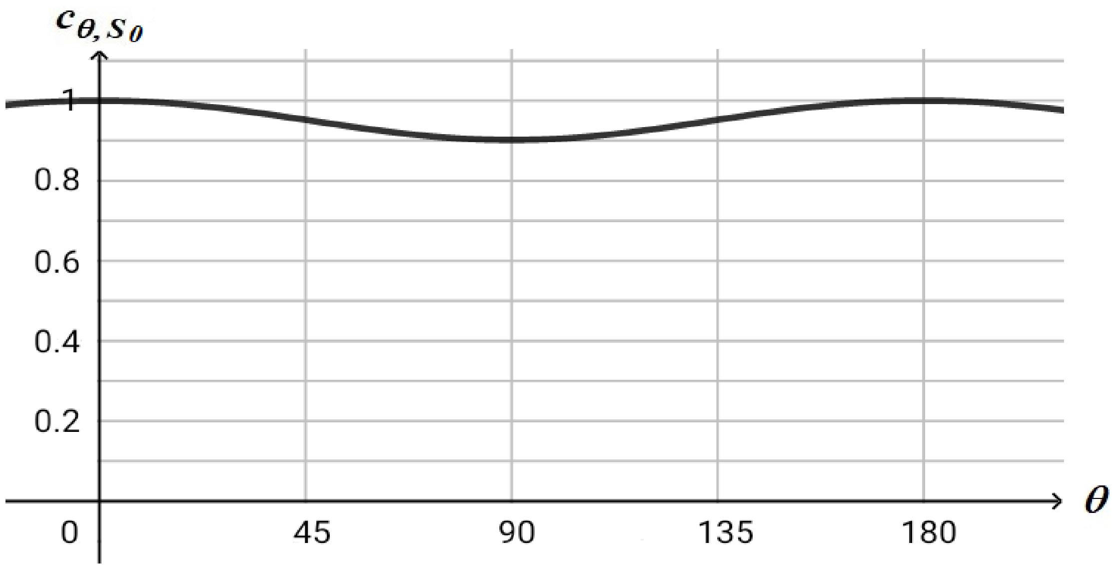

Fig. 4. The curve shows the relationship between the speed of light on dependence of the angle θ calculated by the revised function (3), for $v = 0.5$.

V. Speed, Wavelength, Frequency of the Electromagnetic Wave for a Moving Light Source

Time in S_1, increasing the absolute value of v, slows down and therefore, if we want know it, it is necessary to divide (6) by the Lorentz's factor γ:

$$t_{\theta,S1} = t_{\theta,S0} / \gamma \qquad (7)$$

that is: $t_{\theta,S1} = t_{\theta,S0}\sqrt{1 - v^2}$.

(7) returns the travel time of the photon to its target in S_1.

Since we assumed that the path of the photon to the target in S_1 is 1 light second and $c = 1$, the unidirectional speed of light calculated according to the time of S_1 is (say it $C_{\theta,S1,S1}$):

$C_{\theta,S1,S1} = 1 / t_{\theta,S1}$ (8)

Regarding the wavelength of photons emitted by a moving light source, we must take into account that for a moving light source, time slows down and therefore photons should be emitted more slowly, increasing their wavelength. Therefore, the wavelength $\lambda_{\theta,S1}$ should be $\gamma\ \lambda_{v=0}\ C_{\theta,S1,S1}/ c$, where $\lambda_{V=0}$ is the wavelength if the light source is at rest in S_0 and $C_{\theta,S1,S0}$ is the speed of light with respect to the light source in S_1, but measured in S_0, according to the time of S_0. Given $c = 1$ we will have $\lambda_{\theta,S1} = \gamma\ \lambda_{v=0}\ C_{\theta,S1,S0}$. However, $C_{\theta,S1,S0}\ \gamma = C_{\theta,S1,S1}$ and thus we can write:

$$\lambda_{\theta,S1} = \lambda_{v=0}\ C_{\theta,S1,S1} \tag{9}$$

The wavelength is the same in S_0 and in S_1 because we have assumed that there is no length contraction. It is evident from (9) that there is a direct proportionality between $\lambda_{\theta,S1}$ and $C_{\theta,S1,S1}$ and therefore assuming $\lambda_{v=0} = 1$, $\lambda_{\theta,S1}$ and $C_{\theta,S1,S1}$ could be described graphically by the same curve.

One consequence of the fact that there is a direct proportionality between $\lambda_{\theta,S1}$ and $C_{\theta,S1,S1}$ is that the frequency of photons emitted by a moving light source (with respect to the privileged inertial system S_0) is the same in S_1 in any direction around the light source and is also the same, for the time measured in S_1, as it would be if the light source were at rest in S_0. In fact, the frequency (called *f* in this paper) is calculated by dividing the wave speed by the wavelength and thus in S_1 is:

$$f_{\theta,S1} = C_{\theta,S1,S1} / \lambda_{\theta,S1} \tag{10}$$

where $f_{\theta,S1}$ is the frequency of photons in S_1 as a function of θ. It is easy to see that due to the direct proportionality between $\lambda_{\theta,S1}$ and $C_{\theta,S1,S1}$, $f_{\theta,S1}$ is a constant for any angle θ. Fu Furthermore, taking (9) into account, (10) becomes: $f_{\theta,S1} = C_{\theta,S1,S1} / (\lambda_{v=0}\ C_{\theta,S1,S1})$. Simplifying:

$$f_{\theta,S1} = 1 / \lambda_{v=0} \tag{11}$$

which is the same frequency detectable in S_0 if the light source were stationary in it.

What appears red or blue to an observer at rest with the light source in S_0 appears red or blue even if both are in S_1, and this happens even if the unidirectional speed of light changes as the direction changes (obviously this does not happen if the observer is at rest in S_0 and the light source is moving).

VI. A Hypothesis on the Twin Paradox

Hafele and Keating's experiment [11] [12] and the experiments with muons [7] showed that relativity of time is real (but on the nature of time: [13]). However, the question is: are sequences of events in different inertial systems equivalent? In other words, if we assume the existence of a privileged inertial system, it is likely that in a context such as the twin paradox, the sequences of events of each of the two observers (the twins) are not really comparable. As noted by Selleri [7] and pointed out by Paolilli [10], assuming the existence of a privileged inertial system, local time can slow down but it can also speed up, and thus the twin paradox in the case of relativistic velocities should imply a scenario like the following: the twin who remains at rest lives as usual, while the other sees, from his reference system, everything else in the universe going very fast. However, it is important to note that in the context of a privileged inertial system all components of a moving body experience an actual slowing down of time. Here we hypothesize that if local time slows down too much, consciousness can not be sustained. The debate about consciousness is developing rapidly, although the central problem of its origin and nature still appears to be a "hard problem" [14]. However, what appears relevant in our context is that neural oscillations of 35-70 hz in the neural cortex [15] could be fundamental to the functioning of consciousness, as well as the temporal extension of neural activity [16].

In a moving inertial system time slows down as near a strong gravitational field, and according to the hypothesis of the existence of a privileged inertial system, this slowdown is absolute. Therefore, the number of neural oscillations could, at certain speeds, become insufficient to sustain a consciousness. In addition, the structure of matter could change for velocities above a certain value, as is already the case in a neutron star (where the escape velocity is $1 / 3\ c$). For velocities close to that of light, the traveling twin will not come back younger, but rather dead. So interstellar travel could only be possible if it were possible to neutralize the effects of the gravitational and inertial field on moving bodies.

VII. Conclusion

In a recent paper [5] a function was presented which could explain the Michelson-Morley experiment by abolishing the second postulate of relativity, without taking into account the length contraction. This paper discusses some implications of the application of this function and, more generally, of the hypothesis of the existence of a privileged inertial system. It is explained why photons can slow down in vacuum.

Most importantly, a review of the function presented in the cited paper is indicated.

Furthermore, it is shown that there are no detectable differences in the frequency of photons around a moving light source and that this frequency is the same if the light source were stationary in the privileged inertial system and that this does not imply the validity of the second postulate of relativity. Furthermore, it is observed that in a context of a privileged inertial system the slowing down of all processes in a moving body is absolute. This opens up alternative scenarios for future interstellar travel to take into account the effects that very high velocities could have on travelers.

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