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Einstein's special relativity violates the constancy of the velocity *c* of light under one-way conditions and thus contradicts the behavior of electromagnetic radiation

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Abstract: On Earth, we always measure the constant velocity c of electromagnetic radiation. Einstein assumed the velocity c of light to be constant in all inertial frames and developed his theory of special relativity by considering a light beam that moves back and forth, whereby he derived transformations between the coordinates of two reference frames: A moving reference frame represented by the coordinate system k and the coordinate system K that is at rest with respect to k. However, by applying Einstein's theory of relativity, with its postulates of relativistic time dilation and length contraction, to electromagnetic radiation that moves only in one direction, either in the direction of or in the opposite direction to a moving inertial frame, it is demonstrated that the constancy of the velocity c of light is not compatible with Einstein's theory of special relativity. It becomes obvious that Einstein's relativistic physics must be an unrealistic theory, and consequently, we need an alternative, nonrelativistic, explanation of the constancy of the velocity c of electromagnetic radiation measured on Earth, and for the special and general "relativistic" phenomena. © *2021 Physics Essays Publication*. [http://dx.doi.org/10.4006/0836-1398-34.3.275]

Résumé: Sur la Terre, nous mesurons toujours la vitesse constante c du rayonnement électromagnétique. Einstein pensait que la vitesse de la lumière c était constante dans tous les référentiels galiléens et a développé sa théorie de la relativité restreinte en considérant un faisceau lumineux qui se déplace d'avant en arrière. Il a ensuite déterminé les transformations entre les coordonnées de deux cadres de référence: Un cadre en déplacement, représenté par le système de coordonnées k, et le système de coordonnées K, qui est au repos par rapport au système k. Toutefois, lors de l'application de la théorie de la relativité d'Einstein, avec ses postulats concernant la dilatation relative du temps et la contraction des longueurs, au rayonnement électromagnétique, qui ne se déplace que dans un sens, soit dans le sens d'un référentiel galiléen en mouvement ou dans le sens opposé, il s'avère que la constance de la vitesse de la lumière c n'est pas compatible avec la théorie de la relativité restreinte d'Einstein. Il est évident que la relativité d'Einstein est une théorie qui n'est pas réaliste. Par conséquent, nous avons besoin d'une autre explication non relative à la constance de la vitesse c du rayonnement électromagnétique mesuré sur Terre et à la relativité restreinte et générale.

Key words: Constant Velocity c of Light; Refutation of Einstein's Relativity; Time Dilation; Length Contraction; Lorentz Contraction; Special Relativity; General Relativity; Higgs Mechanism; Standard Model; Quantum Field Theory.

I. INTRODUCTION

Einstein's theory of relativity is one of the most successful physical theories developed in the last century. Nevertheless, Einstein's theory of relativity is also a very controversial theory. This article demonstrates that Einstein's theory of relativity cannot be a realistic physical theory, because it violates the constancy of the velocity c of electromagnetic radiation under one-way conditions, and we therefore need an alternative theory to explain "relativistic" phenomena and the constancy of the speed c of light that we measure on Earth.

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II. EINSTEIN DERIVES RELATIVISTIC LENGTH CONTRACTION AND TIME DILATION BY POSTULATING A CONSTANT VELOCITY *C* OF LIGHT IN ALL INERTIAL FRAMES CONSIDERING A LIGHT BEAM THAT MOVES BACK AND FORTH

In the famous publication "On the Electrodynamics of Moving Bodies" of 1905, Einstein derives transformations between the coordinates of two reference frames.[1] Einstein calculates the time taken by a horizontally moving light beam that moves back and forth in a moving inertial frame represented by the coordinate system k related to an inertial frame represented by the stationary coordinate system K. He states in Section 3: "From the origin of system k let a ray be emitted at the time τ_0 along the X-axis to x', and at the time

τ_1 be reflected thence to the origin of the co-ordinates, arriving there at the time τ_2; we then must have:

$$\frac{1}{2}(\tau_0+\tau_2)=\tau_1''. \tag{1}$$

In the following, I use the Latin letter t for time instead of the Greek letter τ. Einstein considers a light beam that moves horizontally back and forth in a moving inertial frame represented by the coordinate system k. A light beam emitted from the origin of the stationary coordinate system K at time t_0 is supposed to move along the X-axis of this system. The distance in the coordinate system K from the origin of emission to the mirror, or vice versa, is defined by the length L. Expressing the time as the ratio of length to velocity, Eq. (1) yields, for the inertial frame represented by the coordinate system K

$$\begin{aligned}
&\frac{1}{2}\times(t_0+t_2)=t_1,\\
&\frac{1}{2}\times\left(0+\frac{L}{c-v}+\frac{L}{c+v}\right)=t_1,\\
&\frac{1}{2}\times\left(\frac{L\times(c-v)}{c^2-v^2}+\frac{L\times(c+v)}{c^2-v^2}\right)=t_1,\\
&\frac{1}{2}\times\left(\frac{L\times c+L\times v+L\times c-L\times v}{c^2-v^2}\right)=t_1,\\
&\frac{1}{2}\times\left(\frac{L\times c}{c^2-v^2}+\frac{L\times c}{c^2-v^2}\right)=\frac{1}{2}\times\frac{2L\times c}{c^2-v^2}=t_1,\\
&\frac{L\times c}{c^2-v^2}=\frac{L\times c^2}{c\times(c^2-v^2)}=\frac{L}{c\times\frac{c^2-v^2}{c^2}}=\frac{L}{c\times\left(1-\frac{v^2}{c^2}\right)}=t_1.
\end{aligned} \tag{2}$$

Einstein described in Section 4 of his publication "On the Electrodynamics of Moving Bodies" that for the horizontally moving light beam, space must appear shortened.[1] While L is the distance in the coordinate system K from the origin of emission to the mirror, or vice versa, L_0 is the proper length of the distance from the origin of emission to the mirror, or vice versa, in the rest frame of the moving coordinate system k

$$\begin{aligned}
&L=\frac{1}{\gamma}\times L_0=\frac{L_0}{\gamma}=\frac{L_0}{\frac{1}{\sqrt{1-\frac{v^2}{c^2}}}},\\
&L=L_0\times\sqrt{1-\frac{v^2}{c^2}},\\
&L_0=\gamma\times L.
\end{aligned} \tag{3}$$

The length contraction factor is $1/\gamma$

$$\frac{1}{\gamma}=\frac{1}{\frac{1}{\sqrt{1-\frac{v^2}{c^2}}}}. \tag{4}$$

The factor γ is called the Lorentz factor or relativistic time dilation factor

$$\gamma=\frac{1}{\sqrt{1-\frac{v^2}{c^2}}}. \tag{5}$$

If we now consider photons moving perpendicular to this horizontal motion (i.e., vertically), moving to a mirror and back in a moving inertial frame, we can specify the following velocity for both light paths:

$$v=\sqrt{c^2-v^2}. \tag{6}$$

For photons moving vertically first to the mirror and then back to the origin of emission, we can express the time as the ratio of length to velocity. Equation (1) yields, for the inertial frame represented by the coordinate system K,

$$\begin{aligned}
&t_1=\frac{1}{2}\times(t_0+t_2),\\
&\frac{1}{2}\times\left(0+\frac{L}{\sqrt{c^2-v^2}}+\frac{L}{\sqrt{c^2-v^2}}\right)=t_1,\\
&\frac{1}{2}\times\frac{2L}{\sqrt{c^2-v^2}}=\frac{L\times\sqrt{c^2}}{\sqrt{c^2}\times\sqrt{c^2-v^2}}=\frac{L\times\sqrt{c^2}}{c\times\sqrt{c^2-v^2}}=t_1,\\
&\frac{L}{c\times\sqrt{1-\frac{v^2}{c^2}}}=t_1.
\end{aligned} \tag{7}$$

According to Einstein, the length contraction effect does not apply to vertically moving photons and thus $L=L_0$. Replacing L with L_0 and inserting the relativistic "time dilation" factor γ on the right side of Eq. (7), we obtain the time t_1' for a vertically emitted photon in the moving inertial frame represented by the coordinate system k

$$\begin{aligned}
&\frac{L_0}{c\times\sqrt{1-\frac{v^2}{c^2}}}=\gamma\times t_1',\\
&\frac{L_0}{c\times\sqrt{1-\frac{v^2}{c^2}}}=\frac{1}{\sqrt{1-\frac{v^2}{c^2}}}\times t_1',\\
&t_1'=\frac{L_0}{c}.
\end{aligned} \tag{8}$$

Einstein's theory of special relativity is compatible with the constancy of the velocity c of light for photons moving vertically back and forth in moving inertial frames, as there results the so-called proper time L_0/c that must be measured by any observer in his inertial frame and therefore also by an observer at rest in the coordinate system k.

Suppose now that we first apply relativistic "length contraction" to the inertial frame represented by the coordinate system k in Eq. (2) for photons moving horizontally back and forth. We obtain with respect to the moving coordinate system k, as it would be seen by an observer in the coordinate system K

$$\frac{L}{c\times\left(1-\frac{v^2}{c^2}\right)}=t_1\rightarrow\frac{\frac{1}{\gamma}\times L_0}{c\times\left(1-\frac{v^2}{c^2}\right)}=t_1,$$

$$\frac{\sqrt{1-\frac{v^2}{c^2}}\times L_0}{c\times\left(1-\frac{v^2}{c^2}\right)}=t_1. \tag{9}$$

Next, applying relativistic time dilation to the coordinate system k on the right side of Eq. (9) for photons moving horizontally back and forth, we obtain the time t_1' for a horizontally emitted photon in the moving inertial frame represented by the coordinate system k

$$\frac{\sqrt{1-\frac{v^2}{c^2}}\times L_0}{c\times\left(1-\frac{v^2}{c^2}\right)}=\gamma\times t_1',$$

$$\frac{\sqrt{1-\frac{v^2}{c^2}}\times L_0}{c\times\left(1-\frac{v^2}{c^2}\right)}=\frac{1}{\sqrt{1-\frac{v^2}{c^2}}}\times t_1', \tag{10}$$

$$\frac{\sqrt{1-\frac{v^2}{c^2}}\times\sqrt{1-\frac{v^2}{c^2}}\times L_0}{c\times\left(1-\frac{v^2}{c^2}\right)}=\frac{L_0}{c}=t_1'.$$

Einstein's theory of special relativity is compatible with the constancy of the velocity c of light for photons moving horizontally back and forth in moving inertial frames, as there results the so-called proper time L_0/c that must be measured by any observer in his inertial frame and therefore also by an observer at rest in the coordinate system k.

III. EINSTEIN'S THEORY OF RELATIVITY VIOLATES THE CONSTANCY OF THE VELOCITY *C* OF LIGHT WHEN PHOTONS MOVE EITHER IN THE DIRECTION OF OR IN THE OPPOSITE DIRECTION TO A MOVING INERTIAL FRAME

To check whether Einstein's theory of relativity is also compatible with the constancy of the velocity of light c under one-way conditions, we have to examine the two motion directions separately. We still consider photons moving horizontally, but instead of light beams, we now use radio waves, which are also photons. We take a moving inertial frame represented by the coordinate system k—for example, a rocket. Instead of installing a mirror in the inertial frame k of the rocket to reflect the photon, we install a receiver at one side and an emitter at the opposite side. L_0 is defined as the distance between the receiver and the emitter in the moving inertial frame represented by the coordinate system k. We take another inertial frame represented by the coordinate system K, which is stationary with respect to the motion of the system k. An observer at rest in the moving coordinate system k measures the time t' and an observer in the stationary coordinate system K measures the time t. The system k moves uniformly horizontally, exactly parallel to the X-axis of system K, at a certain velocity with respect to the stationary system K. At a certain time t_0, the emitter in the system k (the rocket) will cross the Y-axis of system K. At this time t_0, the emitter in the moving system k (the rocket) emits photons to the receiver, which arrive in the coordinate system K at time t_{1a} at the receiver in the rocket. We assume that the velocity of the photons (radio waves) emitted by the emitter in the moving system k is c and v is the velocity of the inertial frame represented by the coordinate system k with respect to the inertial frame represented by the stationary coordinate system K (see Fig. 1).

We can now calculate the time the photons need to move from the emitter to the receiver in the rocket, as seen from the stationary coordinate system K (L is the distance between the emitter and the receiver, as seen in the inertial frame represented by coordinate system K)

$$t_{1a}=t_0+\frac{L}{c-v},$$

$$t_{1a}=0+\frac{L}{c-v}=\frac{L}{c-v},$$

$$t_{1a}=\frac{L\times c}{c\times(c-v)}=\frac{L}{c}\times\frac{c}{(c-v)}=\frac{L}{c}\times\frac{1}{1-\frac{v}{c}}$$

$$t_{1a}=\frac{L}{c\times\left(1-\frac{v}{c}\right)}. \tag{11}$$

Suppose now that we first apply relativistic length contraction, as defined in Eq. (3), to the inertial frame represented by the coordinate system k on the right side of Eq. (11), as it would be seen by an observer in the coordinate system K (L_0 is the distance between the emitter and the receiver in the coordinate system k)

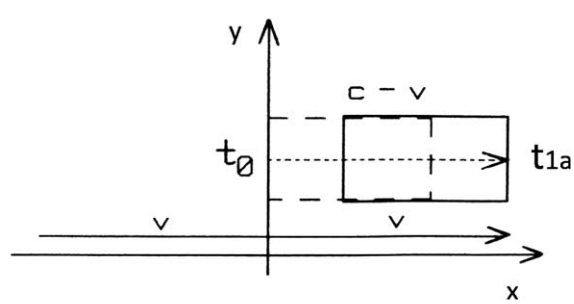

FIG. 1. Photons moving in the same direction as the receiver in the rocket arrive at time t_{1a}, seen from the stationary coordinate system K.

$$t_{1a} = \frac{L}{c \times \left(1 - \frac{v}{c}\right)} \rightarrow t_{1a} = \frac{\frac{L_0}{\gamma}}{c \times \left(1 - \frac{v}{c}\right)} = \frac{\frac{1}{\gamma} \times L_0}{c \times \left(1 - \frac{v}{c}\right)},$$

$$t_{1a} = \frac{\sqrt{1 - \frac{v^2}{c^2}} \times L_0}{c \times \left(1 - \frac{v}{c}\right)}. \tag{12}$$

Next, applying relativistic time dilation to the coordinate system k on the left side of Eq. (12), as it would be seen by an observer in the coordinate system K, we obtain for the coordinate system k

$$\gamma \times t'_{1a} = \frac{\sqrt{1 - \frac{v^2}{c^2}} \times L_0}{c \times \left(1 - \frac{v}{c}\right)},$$

$$\frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} \times t'_{1a} = \frac{\sqrt{1 - \frac{v^2}{c^2}} \times L_0}{c \times \left(1 - \frac{v}{c}\right)},$$

$$t'_{1a} = \frac{\sqrt{1 - \frac{v^2}{c^2}} \times \sqrt{1 - \frac{v^2}{c^2}} \times L_0}{c \times \left(1 - \frac{v}{c}\right)} = \frac{\left(1 - \frac{v^2}{c^2}\right) \times L_0}{c \times \left(1 - \frac{v}{c}\right)},$$

$$t'_{1a} = \frac{\left(1 - \frac{v}{c}\right) \times \left(1 + \frac{v}{c}\right) \times L_0}{c \times \left(1 - \frac{v}{c}\right)} =$$

$$t'_{1a} = \frac{L_0}{c} \times \left(1 + \frac{v}{c}\right) = \frac{L_0}{c} + L_0 \times \frac{v}{c^2} \neq \frac{L_0}{c}. \tag{13}$$

The time t'_{1a} is the time measured in the moving system k, which must have the value L_0/c, according to the constancy of the velocity of light. For photons that do not travel back and forth, but only move in the same direction as a moving inertial frame, there does not result the so-called proper time L_0/c in the inertial frame represented by the coordinate system k. This means that Einstein's theory of relativity is not compatible with the constancy of the velocity c of electromagnetic radiation that we always measure on Earth. We now let the inertial frame represented by the coordinate system k (the rocket) move uniformly horizontally in the opposite direction than before, as shown in Fig. 2 (v is the velocity of the inertial frame represented by the coordinate system k with respect to the inertial frame represented by the stationary coordinate system K).

At a certain time t_0, the emitter in the inertial frame k (the rocket) will cross the Y-axis of the system K in the opposite direction than before. At this time t_0, the emitter in the moving inertial frame (the rocket) emits photons to the receiver, which arrive there at time t_{1b}, seen from the coordinate system K. In this case, the time the photon takes to move from the emitter to the receiver in the rocket, as seen by an observer in the inertial frame represented by the coordinate system K, can be calculated as (L is the distance between the emitter and the receiver in the coordinate system K)

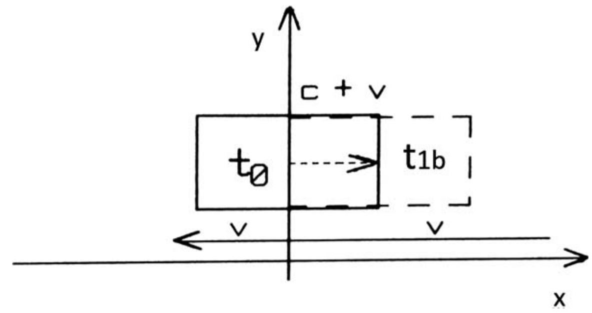

FIG. 2. Photons moving in the opposite direction to the receiver in the rocket arrive at the receiver in the rocket at time t_{1b}, seen from the stationary coordinate system K.

$$t_{1b} = t_0 + \frac{L}{c+v},$$

$$t_{1b} = 0 + \frac{L}{c+v} = \frac{L}{c+v},$$

$$t_{1b} = \frac{L \times c}{c \times (c+v)} = \frac{L}{c} \times \frac{c}{(c+v)} = \frac{L}{c} \times \frac{1}{1+\frac{v}{c}} = \frac{L}{c \times \left(1+\frac{v}{c}\right)}. \tag{14}$$

Suppose now that we first apply relativistic length contraction, as defined in Eq. (3), to the inertial frame represented by the coordinate system k on the right side of Eq. (14), as it would be seen by an observer in the coordinate system K (L_0 is the distance between the emitter and the receiver in the system k)

$$t_{1b} = \frac{L}{c \times \left(1+\frac{v}{c}\right)} \rightarrow t_{1b} = \frac{\frac{L_0}{\gamma}}{c \times \left(1+\frac{v}{c}\right)} = \frac{\frac{1}{\gamma} \times L_0}{c \times \left(1+\frac{v}{c}\right)},$$

$$t_{1b} = \frac{\sqrt{1 - \frac{v^2}{c^2}} \times L_0}{c \times \left(1+\frac{v}{c}\right)}. \tag{15}$$

Next, applying relativistic time dilation on the left side of Eq. (15), as it would be seen by an observer in the coordinate system K for the photons moving in the coordinate system k, we obtain for the coordinate system k

$$\gamma \times t'_{1b} = \frac{\sqrt{1-\frac{v^2}{c^2}} \times L_0}{c \times \left(1+\frac{v}{c}\right)},$$

$$\frac{1}{\sqrt{1-\frac{v^2}{c^2}}} \times t'_{1b} = \frac{\sqrt{1-\frac{v^2}{c^2}} \times L_0}{c \times \left(1+\frac{v}{c}\right)},$$

$$t'_{1b} = \frac{\sqrt{1-\frac{v^2}{c^2}} \times \sqrt{1-\frac{v^2}{c^2}} \times L_0}{c \times \left(1+\frac{v}{c}\right)} = \frac{\left(1-\frac{v^2}{c^2}\right) \times L_0}{c \times \left(1+\frac{v}{c}\right)},$$

$$t'_{1b} = \frac{\left(1-\frac{v}{c}\right) \times \left(1+\frac{v}{c}\right) \times L_0}{c \times \left(1+\frac{v}{c}\right)},$$

$$t'_{1b} = \frac{L_0}{c} \times \left(1-\frac{v}{c}\right) = \frac{L_0}{c} - L_0 \times \frac{v}{c^2} \neq \frac{L_0}{c}. \tag{16}$$

The time t'_{1b} is the time measured in the moving system k, which must have the value L_0/c, according to the constancy of the velocity of light. For photons that do not travel back and forth, but only in the opposite direction to a moving inertial frame, there does not result the so-called proper time L_0/c in the inertial frame represented by the coordinate system k. This means that Einstein's theory of relativity is not compatible with the constancy of the velocity c of electromagnetic radiation that we always measure on Earth.

If we combine the two horizontal motion directions of electromagnetic radiation that are exactly opposite, Einstein's theory of relativity results in a seemingly constant velocity c of light, as only in this case, we obtain in our example for the coordinate system k the correct proper time $t' = L_0/c$, which is the necessary consequence of the constancy of the velocity c of light

$$t' = \frac{t'_{1a} + t'_{1b}}{2} = \frac{\frac{L_0}{c} + L_0 \times \frac{v}{c^2} + \frac{L_0}{c} - L_0 \times \frac{v}{c^2}}{2} = \frac{L_0}{c}. \tag{17}$$

Therefore, experiments using interferometers with electromagnetic radiation that moves back and forth can simulate the compatibility of the constancy of the velocity c of light with Einstein's theory of relativity, but in reality the theory of relativity contradicts the behavior of electromagnetic radiation.

IV. CONCLUSION

On Earth, we always measure the constant velocity c of electromagnetic radiation. Applying Einstein's theory of relativity, with its postulates of relativistic time dilation and length contraction, to electromagnetic radiation that moves only in one direction, either in the direction of or in the opposite direction to a moving inertial frame, it is demonstrated that the constancy of the velocity c of light is not compatible with Einstein's theory of relativity, which means that the theory of relativity is refuted by the natural behavior of light. This yields several logical consequences: 1. Einstein's relativity cannot be the correct explanation for physical phenomena that are currently called "relativistic" phenomena; 2. Because special relativity provides very precise numerical values that can be measured in nature, theories based on special relativity, e.g., Einstein's general relativity and the standard model of physics, must also yield exact values, although they likewise cannot be realistic theories; 3. All experiments that are said to verify Einstein's theory of relativity only seemingly confirm the theory of relativity; 4. We must find an alternative nonrelativistic explanation for these relativistic phenomena and the constancy of the velocity c of electromagnetic radiation that we always measure on Earth; 5. The Lorentz invariance must be explained without using relativistic ideas; quantum field theory (QFT) and the standard model must be based on a new theory that offers an alternative explanation for the constancy of the velocity c of light and so-called relativistic phenomena, using a nonrelativistic concept. 6. Since Einstein's theory of special relativity, not being compatible with the constancy of the velocity c of light that we measure on Earth, must be an unrealistic physical theory. Quantum field theory (QFT) and the standard model with the Higgs mechanism must also be unrealistic theories, as they are based on Einstein's special relativity.

I have published suggestions for a possible nonrelativistic concept that explains the constancy of the velocity c of light that we measure on Earth and so-called relativistic phenomena in earlier articles.[2,3] I presented the main features of my nonrelativistic concept at the international conference "Physics Beyond Relativity" in Prague in October 2019.[4]

[1]A. Einstein, Ann. Phys. **17**, 891 (1905).
[2]R. G. Ziefle, Phys. Essays **33**, 466 (2020).
[3]R. G. Ziefle, Phys. Essays **33**, 99 (2020).
[4]See https://science21.cz/conference/ for detailed information about the international conference in Prague "Physics Beyond Relativity" from October 18–21, 2019.