Empirical falsification of Einstein's special relativity (SR) and general relativity (GR) by an experiment that compares three frames of reference

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Abstract: Einstein defined time as the length of the light path divided by the speed of light. According to this definition, time can only change if either the length of the light path or the speed of light changes. Einstein replaced this objective mathematical truth with his idea that not only is the speed of light constant but also the length of the light path, so Einstein was able to define a constant proper time t_0 in all frames of reference. However, treating distances as constant contradicts the physical definition of motion. Therefore, Einstein's relativity not only violates mathematical and physical rules but also violates logical rules when it claims that the reason why clocks measure different times is that all clocks measure the same time t_0. Einstein's physical half-truth, which makes a false statement about the lengths of light paths, which cannot be constant, leads to contradictions with reality, which Einstein compensated for by mathematical corrections. This inevitably led to a mathematical pseudoreality that is described by theoretical physics according to Einstein's idea. However, Einstein's principle of relativity cannot be mathematically manipulated. If we compare at least three reference frames, we obtain contradictory results for the kinematic and gravitational time dilation. In this case, e.g., the paradox arises that an atomic clock must be able to count forward and backward at the same time. Comparing only two frames of reference, the proper time t_0 can be arbitrarily assigned to each of the two frames of reference without contradictions occurring. However, if an experimental setup is always chosen in such a way that at most two frames of reference are compared, and so Einstein's relativity cannot be falsified, a systematic error is applied, and the experiment is scientifically worthless as far as the confirmation of Einstein's relativistic SR and GR is concerned. © *2024 Physics Essays Publication*. [http://dx.doi.org/10.4006/0836-1398-37.4.281]

Résumé: Einstein a défini le temps comme la longueur du trajet parcouru par la lumière divisée par la vitesse de la lumière. Selon cette définition, le temps ne peut changer que si la longueur du trajet parcouru par la lumière ou la vitesse de la lumière change. À cette vérité mathématique objective, Einstein a substitué l'idée que non seulement la vitesse de la lumière était constante, mais aussi la longueur du trajet parcouru par la lumière, afin d'introduire une constante de temps propre t_0 pour tous les référentiels. Or, le fait de traiter les distances comme une constante contredit la définition physique du mouvement. Ainsi, la théorie de la relativité d'Einstein viole les règles des mathématiques et de la physique, mais également de la logique, en expliquant que la raison pour laquelle les horloges mesurent des temps différents est que toutes les horloges mesurent le même temps t_0. La demi-vérité physique énoncée par Einstein, qui se trompe sur la longueur des trajets parcourus par la lumière puisque celle-ci ne peut être constante, induit des contradictions avec la réalité qu'il a compensées par des corrections mathématiques. Cela a inévitablement conduit à une pseudo-réalité mathématique, décrite par la physique théorique conformément à l'idée d'Einstein. Cependant, le principe de relativité d'Einstein ne peut être manipulé mathématiquement. Si l'on compare au moins trois référentiels, on obtient des résultats incorrects du point de vue de la cinématique et de la dilatation du temps liée à la gravité. Dans ce cas, par exemple, une horloge atomique devrait à la fois avancer et reculer simultanément, ce qui constitue un paradoxe. Si l'on compare uniquement deux référentiels, le temps propre t_0 peut être assigné arbitrairement à n'importe quel de ces référentiels sans contradiction. Toutefois, si le cadre expérimental est invariablement choisi de sorte que le nombre maximal de référentiels ne dépasse pas deux et donc que la théorie de la relativité d'Einstein ne peut pas être réfutée, on applique une erreur systématique et l'expérience n'a plus de valeur scientifique du point de vue de la confirmation ou de l'infirmation de la relativité restreinte et de la relativité générale.

Key words: Principle of Relativity; Special Relativity (SR); Kinematic Time Dilation; General Relativity (GR); Gravitational Time Dilation; Gravitational Frequency Shift; Quantum Gravity; Space–Time Curvature; Michelson–Morley Experiment; Hafele–Keating Experiment.

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I. INTRODUCTION

Many empirical experiments have been carried out to verify a relativistic kinematic or gravitational time dilation, which all compared only two frames of reference. These empirical experiments have confirmed a relative relationship between frames of reference.[1–4] Einstein defined time as path length divided by the speed c of light. According to this definition of time, time can only change if either the path length or the speed of light changes. Einstein replaced this objective mathematical truth with his imagination that not only is the speed c constant, but so is the length of the light path. He justified this idea by the principle of relativity, which enabled him to define a constant proper time t_0 in all frames of reference. Since Einstein's relativity was able to make accurate predictions, the idea that it was physically correct became entrenched and mathematical corrections were developed to resolve contradictions with reality. What cannot be changed mathematically, however, is a physical principle. To confirm a relativistic relationship between frames of reference according to Einstein's relativistic principle of relativity, which excludes a causation between time dilation and gravity, at least three frames of reference are required—this is because if only two frames of reference are compared, the proper time t_0 can be arbitrarily assigned to either of the two frames of reference without contradictions occurring.

II. COMPARING THREE FRAMES OF REFERENCE DISPROVES EINSTEIN'S SR AND GR AND EINSTEIN'S PRINCIPLE OF RELATIVITY

A simple example shows that if more than two reference frames are compared with each other, the principle of relativity, according to which we are able to arbitrarily assign either the proper time t_0 or the time t' to a frame of reference, no longer provides meaningful results. Imagine three spaceships A, B, and C, each of which has an atomic clock on board that is set to zero. They start from the same space base and always fly exactly parallel to each other. After they have reached their different terminal speeds, they fly tangentially at a certain distance past the Earth over a city, with the arrival of the spaceships over the city occurring simultaneously as seen from the city. At this moment, a signal is sent from the city to the three atomic clocks in the spaceships, which now begin to count the time. We can ignore the fact that the signal from Earth does not reach the spaceships at exactly the same time because of the different speeds of the spaceships relative to Earth. Seen from an observer in this city, spaceship A flies at a speed of $0.001c$, spaceship B at a speed of $0.002c$, and spaceship C at a speed of $0.003c$. The spaceships continue to fly parallel in the same direction at the same speeds for two months according to their constant proper times t_0 and then stop their clocks. After they meet at another space base, the clocks are compared. Applying Einstein's principle of relativity, we assign both spaceships A and B the proper time t_0. Thus, the traveler in spaceship A would have to see significantly fewer seconds on the display of the atomic clock of spaceship C than the traveler in spaceship B, because the difference in speed between spaceships A and C was $0.002c$, while the difference in speed between spaceships B and C was only $0.001c$. However, since an atomic clock can only show one time on its display and not two or more times, this is physically impossible.

I found only one empirical experiment carried out in the past that compares more than two frames of reference. It is the famous Hafele–Keating experiment.[1] Hafele and Keating also compared only two of the three frames of reference involved in the experiment and, therefore, could seemingly confirm a relativistic relationship between frames of reference. However, all three frames of reference involved in the experiment were not analyzed in a joint comparison by applying Einstein's principle of relativity, which would be necessary to really exclude causation between time dilation and motion or location within Earth's gravitational field and thus verify or falsify a relativistic relationship between frames of reference. The Hafele–Keating experiment showed that atomic clocks within commercial aircraft are influenced by their distance from the ground and their motion on Earth. The speed of the aircraft with four atomic clocks on board, moving once eastward and once westward, was about 800 km/h on average, with a flight duration of 41.2 h eastward and 48.6 h westward. Eastward the average height of the aircraft was 8900 m and westward 9400 m. The eastward trip began on October 4, 1971; the westward trip began on October 13, 1971. The times measured by atomic clocks in the aircraft were compared with the times measured by atomic clocks on the ground. For the eastward flight, the researchers measured on average a time difference of −59 ns between the atomic clocks in the aircraft and the atomic clocks on the ground, which means that the atomic clocks in the aircraft lost 59 ns in comparison to the atomic clocks on the ground. For the westward flight, the researchers measured on average a time difference of +273 ns between the atomic clocks in the aircraft and the atomic clocks on the ground, which means that the atomic clocks in the aircraft gained 273 ns in comparison to the atomic clocks on the ground. The statement after the Hafele–Keating experiment was and still is that the experiment confirms Einstein's relativistic physics. This has been justified by the fact that the comparison between two frames of reference confirmed a relative relationship between the measured time in the aircraft flying eastward and the time measured on the ground of ±59 ns and a relative relationship between the measured time in the aircraft flying westward and the time measured on the ground of ±273 ns. However, comparing only two frames of reference cannot exclude a causation between time dilation and motion or location within the gravitational field of Earth. In the Hafele–Keating experiment, there are three frames of reference: (1) A frame of reference on the ground. (2) A frame of reference that moved for 41.2 h at an average speed of 800 km/h eastward at an average height of 8900 m. (3) A frame of reference that moved for 48.6 h at an average speed of 800 km/h westward at an average height of 9400 m. We know from the empirical results that after an eastward flight the clocks are behind the atomic clocks on the ground, and after a westward flight they are ahead of the atomic clocks on the ground. Therefore, it is not necessary to repeat the Hafele–Keating experiment with two identical aircraft, one flying eastward and the other flying westward around Earth at the same time, because we know the measurement results of the eastward and westward flights. Since we can assume that the measurement results are reproducible values, comparable values would have been measured if the flights had taken place on other days. In order to compare all three reference frames, it is, therefore, sufficient to imagine that the movements of the two aircraft had taken place on the same day, with two identical aircraft taking off simultaneously or in immediate succession, with one aircraft heading east and the other heading west. Applying Einstein's principle of relativity, which describes a relativistic relationship between frames of reference, we are allowed to arbitrarily assign both aircraft the proper time t_0. In this case, after the flights, the atomic clocks on the ground would have gained 59 ns in comparison to the atomic clocks in the eastbound aircraft, and lost 273 ns in comparison to the atomic clocks in the westbound aircraft. Since, after the flight and the short transportation distance to the atomic clock in the frame of reference on the ground, the time passes equally in all atomic clocks, the times measured by the atomic clocks on the ground and in the two aircraft can be compared at leisure. If we apply Einstein's principle of relativity, which is the basis of SR and GR, the atomic clocks on Earth must display the time $t_{0(\text{east})} + \Delta t' = t_{0(\text{east})} + 59\,\text{ns}$ and $t_{0(\text{west})} - \Delta t' = t_{0(\text{west})} - 273\,\text{ns}$ after the flight of the aircraft,

$$\begin{aligned}\Delta t'_E &= \Delta t_{0(\text{east})} + 59\,\text{ns},\\ \Delta t'_E &= \Delta t_{0(\text{west})} - 273\,\text{ns},\\ \Delta t_{0(\text{east})} = \Delta t_{0(\text{west})} &\rightarrow \Delta t'_E = \Delta t_0 + 59\,\text{ns} = \Delta t_0 - 273\,\text{ns}.\end{aligned} \tag{1}$$

However, physically it is not possible that an atomic clock on the ground simultaneously measures a gain of time ($\Delta t_0 + 59\,\text{ns}$) and a loss of time ($\Delta t_0 - 273\,\text{ns}$). Therefore, comparing all three frames of reference involved in the Hafele–Keating experiment, Einstein's principle of relativity is empirically disproved: In real physics, atomic clocks cannot go simultaneously forward and backward. The measurements of the Hafele–Keating experiment can only make sense if the measured time differences result from a direct influence of an earthbound physical phenomenon on the atomic clocks in different motion and position with respect to Earth, whereby the only possible such phenomenon is the Earth's gravitational field. In this case, we are allowed to assign the proper time t_0 only to the frame of reference on the ground in the sense of an "absolute" frame of reference for the three frames of reference involved—just the opposite of Einstein's relativistic SR and GR, which do not permit this. When we do this, an atomic clock on the ground on Earth no longer has to record simultaneously a gain of $+59\,\text{ns}$ and a loss of $-273\,\text{ns}$; instead, one aircraft measures a loss of $-59\,\text{ns}$ (eastward) and one measures a gain of $+273\,\text{ns}$ (westward). If we violate Einstein's principle of relativity and choose the atomic clocks on the ground as an absolute reference frame for the atomic clocks in the aircraft, the atomic clocks in the aircraft that flew eastward must display the time $t_0 + \Delta t_{(\text{east})} = t_0 + 59$ and the atomic clocks in the aircraft that flew westward must display the time $t_0 - \Delta t_{(\text{west})} = t_0 - 273$ after the flight of the aircraft, so that in this case no contradiction arises. To avoid logical contradictions, we have to violate the principle of relativity and choose Earth's frame of reference as an absolute reference frame for atomic clocks moving on Earth, which is practiced by today's physicists and contradicts Einstein's SR and GR. Today, the Earth-Centered Inertial Frame (ECI frame) in near-Earth clock comparisons is used as an absolute frame of reference that does not rotate, exactly fulfilling the characteristics of the gravitational field of Earth. The necessity to use the absolute ECI frame, e.g., for GPS, can only be justified by a causation between kinematic time dilation and motion and gravitational time dilation and position within Earth's gravitational field. Therefore, the kinematic and gravitational time dilation must be explained by a theory of relativity in dependence of locally absolute strengths of gravitational potentials within predominant gravitational fields.[5,6] Hafele and Keating achieved an apparently verification of Einstein's SR and GR by comparing only two frames of reference. However, a real verification presupposes the possibility of falsification, which is not possible when comparing only two frames of reference, because with two frames of reference Einstein's principle of relativity, which describes a relativistic relation, cannot be falsified. Einstein's SR and GR only make sense as long as only two frames of reference are compared; if we compare more than two frames of reference, Einstein's relativistic physics no longer works.

III. SPECIAL RELATIVITY (SR) THAT IS BASED ON EINSTEIN'S PRINCIPLE OF RELATIVITY LEADS TO PARADOXICAL RESULTS AND DESCRIBES IMPOSSIBLE PHYSICAL PROCESSES

Einstein already recognized that kinematic time dilation can best be derived from thought experiments with light beams.[7] Therefore, we imagine that two physicists on Earth devise a thought experiment with light beams to cross-check Einstein's SR. The two physicists imagine a vertical tube moving sideways on Earth at a certain speed v, with a light beam moving vertically upward in the tube. In this case, the physicists have two inertial frames: The inertial frame of Earth that is at rest relative to them, and the inertial frame of the tube moving on Earth. According to Einstein's relativistic principle of relativity, they must arbitrarily assign the proper time t_0 and the relative time t' to the two inertial frames. Since the physicists are at rest on Earth, at first they assign the oblique light beam the path $c \times t_0$ as it must be seen by an observer at rest on Earth, and they assign the light path $c \times t'$ to the vertical light path. See Fig. 1.

From this, the two physicists calculate for the time t' in the moving tube a slowing down of time for the vertical light path. When time passes more slowly, time units need a longer time to be measured and the number of time units must be lower by the factor $1/\gamma$,

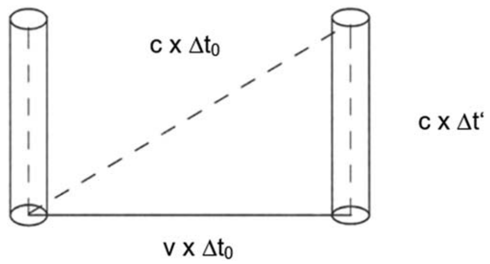

FIG. 1. The situation of a light beam that moves vertically upward in a tube that moves sideways as seen by an observer at rest on Earth.

$$
\begin{aligned}
(\Delta t' \times c)^2 &= (\Delta t_0 \times c)^2 - (\Delta t_0 \times v)^2,\\
\Delta t' &= \sqrt{\frac{(\Delta t_0 \times c)^2 - (\Delta t_0 \times v)^2}{c^2}},\\
\Delta t' &= \sqrt{1-\frac{v^2}{c^2}} \times \Delta t_0.
\end{aligned}
\tag{2}
$$

When the number of time units measured is lower by the factor $1/\gamma$, the time units must be longer by the factor γ in the moving tube, so that a time dilation by the factor γ is expected,

$$
\begin{aligned}
\Delta t' &= \frac{1}{\sqrt{1-\frac{v^2}{c^2}}} \times \Delta t_0,\\
\Delta t' &= \gamma \times \Delta t_0.
\end{aligned}
\tag{3}
$$

However, if they were to apply Einstein's principle of relativity, our two physicists must instead assign the proper time t_0 and the speed c ($t_0 \times c$) to the vertical light path in the moving tube and the relative time t' to the oblique light beam as it must be seen in the inertial frame at rest on Earth. See Fig. 2.

According to Einstein's principle of relativity, our two physicists must also calculate a slowing down of time t' for the oblique light path as seen by our two physicists at rest in the frame of reference of Earth because the time units must be longer by the factor γ in the oblique path length, so that a time dilation by the factor γ is expected for t',

$$
\begin{aligned}
(\Delta t_0 \times c)^2 &= (\Delta t' \times c)^2 - (\Delta t' \times v)^2,\\
\Delta t_0 &= \sqrt{\frac{(\Delta t' \times c)^2 - (\Delta t' \times v)^2}{c^2}},\\
\Delta t_0 &= \sqrt{1-\frac{v^2}{c^2}} \times \Delta t',\\
\Delta t' &= \frac{1}{\sqrt{1-\frac{v^2}{c^2}}} \times \Delta t_0.
\end{aligned}
\tag{4}
$$

According to Eqs. (3) and (4), the principle of relativity, which allows us to arbitrary assign the proper time t_0 to any frame of reference, leads to the contradiction that time passes more slowly in both frames of reference and time passes equally in both frames of reference. If Eqs. (3) and (4) are physically true, this must lead to the paradoxical physical effect that atomic clocks must simultaneously measure time dilation and not measure time dilation—but that is not physically possible! Paradoxes indicate that a theory cannot be correct. If we want to understand nature, we must not violate physical and mathematical rules and impose our ideas on nature by applying mathematical manipulations.

According to the physical definition of movement, distances change when movement happens. We can see that the oblique light path in Figs. 1 and 2 is longer than the straight light path in the tube moving on Earth. Just because it is not necessary to specify the light path directly in the calculations in order to perform the calculations does not justify ignoring this fact. As we always measure the speed of light c for light beams on Earth, we have to assign the speed c to the oblique beam of light. According to this, the speed of the light beam in the moving tube must slow down because the speed of light in the tube cannot become faster than c.

The paradox of Einstein's relativity that atomic clocks must simultaneously measure time dilation and not measure time dilation disappears if we assign the speed of light c only to the frame of reference at rest on Earth, in which we always measure the speed c, and allow the speed of light to slow down by a factor of $1/\gamma$ in the vertical light path of the light source moving on Earth. See Fig. 3.

By Eq. (5), we calculate the slower speed of light v_c to be $1/\gamma \times c$,

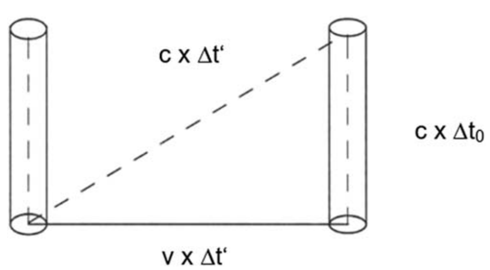

FIG. 2. The situation of a light beam that moves vertically upward in a tube that moves sideways, as seen by an observer moving with the tube.

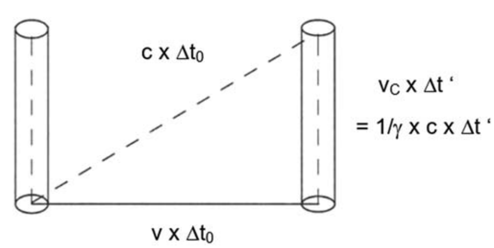

FIG. 3. When we allow the speed of light in the vertical light path to slow down by the factor $1/\gamma$, we obtain the correct time dilation factor γ without detours and without contradiction.

$$
\begin{aligned}
&{v_c}^2 = c^2 - v^2,\\
&v_c = \sqrt{c^2 - v^2},\\
&\frac{v_c}{c} = \frac{\sqrt{c^2 - v^2}}{\sqrt{c^2}},\\
&v_c = \sqrt{1 - \frac{v^2}{c^2}} \times c,\\
&v_c = \frac{1}{\gamma} \times c.
\end{aligned}
\tag{5}
$$

When we calculate using the slower speed of light $1/\gamma \times c$, we obtain the time dilation factor γ directly, without the paradox of Einstein's SR,

$$
\begin{aligned}
&\left(\Delta t' \times \frac{1}{\gamma} \times c\right)^2 = (\Delta t_0 \times c)^2 - (\Delta t_0 \times v)^2,\\
&\Delta t' = \sqrt{\frac{(\Delta t_0 \times c)^2 - (\Delta t_0 \times v)^2}{\left(\frac{1}{\gamma} \times c\right)^2}},\\
&\Delta t' = \sqrt{1 - \frac{v^2}{c^2}} \times \gamma^2 \times \Delta t_0,\\
&\Delta t' = \sqrt{1 - \frac{v^2}{c^2}} \times \frac{1}{1 - \frac{v^2}{c^2}} \times \Delta t_0,\\
&\Delta t' = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} \times \Delta t_0,\\
&\Delta t' = \gamma \times \Delta t_0.
\end{aligned}
\tag{6}
$$

Since time must also be taken into account according to the definition of the speed c of light, we must define the speed of light in distance per time and not just as c, so that for the moving tube, seen from the perspective of the Earth's reference frame, we obtain

$$
\begin{aligned}
&\Delta t' = \frac{\gamma \times \Delta d}{c},\\
&\Delta t' = \gamma \times \frac{\Delta d}{299\,792\,458 \times \frac{m}{\Delta t_0}},\\
&\Delta t' = \frac{\Delta d}{299\,792\,458 \times \frac{m}{\gamma \times \Delta t_0}}.
\end{aligned}
\tag{7}
$$

However, if time is really a physical entity that is independent of the speed of physical processes, then—since, as postulated by Einstein, all processes associated with the speed of light must take place at constant speed in all frames of reference—we can arbitrarily replace $\Delta t'$ with the term $\gamma \times \Delta t_0$ on the left side of Eq. (7) without any further physical justification, which has unexpected consequences. Inserting for $\Delta t'$ the term $\gamma \times \Delta t_0$ on the left side of Eq. (7), we obtain

$$
\begin{aligned}
&\Delta t' = \frac{\Delta d}{299\,792\,458 \times \frac{m}{\gamma \times \Delta t_0}},\\
&\gamma \times \Delta t_0 = \frac{\Delta d}{299\,792\,458 \times \frac{m}{\gamma \times \Delta t_0}},\\
&\Delta t_0 = \frac{\Delta d}{299\,792\,458 \times \frac{m}{\Delta t_0}}.
\end{aligned}
\tag{8}
$$

This means that the kinematic time dilation that we can observe in the frames of reference that move in relation to us would be able to vanish, causing the paradoxical physical effect that an atomic clock would both measure time dilation and measure no time dilation. The only way to ensure that the kinematic time dilation cannot disappear is for the speed of light to change in an object by the factor $1/\gamma$ when the object (light source or atomic clock) moves within the predominant gravitational field of Earth (against locally absolute strengths of gravitational potentials), and furthermore not to consider time as a physical entity independent of the speed of physical processes that happen at the speed of light. In this case, we cannot replace $\Delta t'$ on the left side of Eq. (8) by the term $\gamma \times \Delta t_0$ because no further physical process is involved that justifies the mathematical replacement. This means that the time dilation factor γ is only preserved (can only be physically real) if it is caused by the slowing down of physical processes that take place in objects moving at the speed c of light in relation to the predominant gravitational field of the Earth (in relation to locally absolute strengths of gravitational potentials),

$$
\begin{aligned}
&\Delta t' = \frac{\Delta d}{\frac{1}{\gamma} \times c} = \frac{\Delta d}{\frac{1}{\gamma} \times 299\,792\,458 \times \frac{m}{\Delta t_0}},\\
&\Delta t' = \frac{\Delta d}{299\,792\,458 \times \frac{m}{\gamma \times \Delta t_0}} \rightarrow \Delta t' = \gamma \times \Delta t_0.
\end{aligned}
\tag{9}
$$

Since I consider Einstein's concept of a proper time to be in error because it requires a constant length of the light path and a constant speed of light, in Eq. (9) the time t_0 does not represent Einstein's proper time, but the time that we measure when we are at rest with respect to locally absolute strengths of gravitational potentials within Earth's predominant gravitational field. When we bring physics back to the mathematical reality that time must change if the length of the light path or the speed of light changes, we are able to define the kinematic time dilation that we observe in objects moving on Earth in two ways, where Δd is the distance a light beam or an intra-atomic or an intraelemental particular structure moving with the speed of light has to cover on Earth and the speed c is the speed of light that we measure in Earth's predominant gravitational field,

$$
\Delta t' = \frac{\gamma \times \Delta d}{c} = \gamma \times \Delta t_0 \leftrightarrow \Delta t' = \frac{\Delta d}{\frac{1}{\gamma} \times c} = \gamma \times \Delta t_0. \tag{10}
$$

From Eq. (10), we are now able to see that the time dilation in the moving tube results from an increase in distance by the factor γ in the frame of reference of Earth (left side) and from a slowing down of the speed c by the factor $1/\gamma$ in the frame of reference of the tube (right side). This means that time is relative and depends on the movement in relation to gravitational potentials. There is no place in the universe at which there is not a predominant gravitational field.

IV. COMPARING AT LEAST THREE REFERENCE SYSTEMS CONTRADICTIONS ARISE IF WE APPLY GENERAL RELATIVITY (GR)

Let us place an atomic clock on a mountain and in a valley. The comparison of the two clocks seems to confirm Einstein's principle of relativity, because the clock on the mountain measures the time $\Delta t_0 + \Delta t$ and the clock in the valley measures the time $\Delta t_0 - \Delta t$, whereby time is always interpreted below as the number of measured time units. If you choose an atomic clock at a location that is exactly at the altitude between the valley and the mountain, contradictions arise. According to Einstein, all clocks measure the same proper time t_0. However, as seen from the clock on the mountain, the middle clock must measure $\Delta t_0 - \Delta t$ and as seen from the clock in the valley, the middle clock must measure $\Delta t_0 + \Delta t$, so that the middle clock must be able to measure $\Delta t_0 - \Delta t$ and $\Delta t_0 + \Delta t$ simultaneously for the two frames of reference in the valley and on the mountain, which is not physically possible. This is because the difference in height between the middle frame of reference and the frame of reference in the valley and on the mountain behaves symmetrically because they are the same distance away from the middle frame of reference, while the gravitational field behaves asymmetrically and increases in strength from the middle clock downward toward the valley and decreases in strength upward toward the mountain. The paradox can only be resolved by a causation between gravitational time dilation and the location within gravitational potentials of different strengths. If we assign the time t_0 only to the clock in the valley, the middle clock measures $\Delta t_0 + \Delta t$ compared to the clock in the valley and $(\Delta t_0 + 2\Delta t) - \Delta t = \Delta t_0 + \Delta t$ compared to the clock on the mountain, so that the contradiction to Einstein's relativistic GR, which accepts no influence of gravity on the speed of physical processes, disappears. If we assign the time Δt_0 only to the clock on the mountain, the middle clock measures $\Delta t_0 - \Delta t$ compared to the clock on the mountain and $(\Delta t_0 - 2\Delta t) + \Delta t = \Delta t_0 - \Delta t$ compared to the clock in the valley, so that the contradiction of Einstein's GR also disappears. This means that there must be an objective and absolute deceleration on Earth's surface or on other planets, stars, or moons if the oscillating atoms of the atomic clocks are confronted with locally stronger gravitational potentials.

V. THE CALCULATION OF THE GRAVITATIONAL REDSHIFT BY GR MAKES NO PHYSICAL SENSE AND CANNOT BE EXPLAINED BY EITHER GR OR CLASSICAL PHYSICS

The gravitational redshift observed on stars can be calculated from classical physics or from GR. From classical physics we obtain the gravitational shift in wavelength, where Φ is the gravitational potential,

$$\begin{aligned} \frac{\Delta\lambda}{\lambda} &= \frac{\Phi}{c^2}, \\ \Delta\lambda &= \frac{\mathrm{GM} \times m}{r \times c^2} \times \lambda. \end{aligned} \tag{11}$$

Near the surface of Earth, the following simplified equation can be used,

$$\begin{aligned} \frac{\Delta\lambda}{\lambda} &\approx \frac{g \times \Delta h}{c^2}, \\ \Delta\lambda &\approx \frac{g \times \Delta h}{c^2} \times \lambda. \end{aligned} \tag{12}$$

This was a problem for Einstein's relativity because, according to classical physics, a change in the wavelength of electromagnetic waves must be accompanied by a change in the speed c of light. To prevent a change in the speed of light, Einstein came up with the idea of curved space–time. General relativity introduces space–time curvature to explain the gravitational redshift: The redshift is said to be the result of an apparently longer light path within a stronger gravitational potential, as seen by a distant observer in a weaker gravitational potential. This leads to an apparent gravitational time dilation because a light beam has to cover a longer path in curved space–time seen from a distance than it has to cover locally, while the same proper time t_0 must still be measured locally, independent of the strength of the gravitational potential. Accordingly, space cannot be curved locally, even on the surface of a large mass. Electromagnetic waves arriving at Earth from the star Sirius B (a white dwarf star about the size of Earth, but with a much larger mass) showed a mean relative redshift of the emitted wavelength of $1.0024 \times \lambda_0$, which can be interpreted as time passing more slowly ($\Delta t'$ and $\Delta t_0 =$ time defined by the size of time units),[8]

$$\Delta t'_N = 1.000\,24 \times \Delta t_N = 1.000\,24 \times \frac{\Delta d}{c}. \tag{13}$$

In classical physics, we would have to interpret this result by assuming the frequency to be slower by the factor $0.999\,76 \times \mathrm{f}_0$, caused by a slower speed of light—which Einstein's GR does not allow. Because time defined by the number of measured time units is inversely proportional to time defined by the size of time units, we obtain ($\Delta t'_{\mathrm{N}} =$ time defined by number of measured time units; $\Delta t'$ and $\Delta t_0 =$ time defined by the size of time units)

$$\begin{aligned} 0.999\,76 \times c &\approx 0.999\,76 \times f_0 \\ \rightarrow \Delta t'_N &= 0.999\,76 \times f_0, \\ \Delta t'_N &= 0.999\,76 \times \frac{1}{\Delta t_0}, \\ \frac{1}{\Delta t'_N} &= \frac{1}{0.999\,76 \times \frac{1}{\Delta t_0}}, \\ \Delta t' &= 1.000\,24 \times \Delta t_0. \end{aligned} \tag{14}$$

To avoid a variable speed of light with respect to frames of reference within different gravitational potentials, Einstein had to invent the space–time curvature: The theory that light beams have to move longer distances within stronger gravitational potentials than within weaker gravitational potentials, so that GR obtains the same value ($\Delta t'$ and Δt_0 = time defined by the size of time units),

$$\begin{aligned}\Delta t' &= \frac{1.000\,24 \times \Delta d}{c},\\ \Delta t' &= 1.000\,24 \times \frac{\Delta d}{c},\\ \Delta t' &= 1.000\,24 \times \Delta t_0.\end{aligned} \tag{15}$$

In order not to distract from the core of the problem, I will refrain from using complicated mathematics to illustrate the space–time curvature with longer light paths. The argumentation of GR for our observations of gravitational redshift of electromagnetic waves emitted on Sirius B is illogical. Einstein's GR postulates that locally, at any place in the universe, we measure the constant proper time t_0, which is defined by the constant length of the light path divided by the constant speed of light, from which it follows that space–time is not curved locally by gravitation, but only when viewed from a distance. It is absurd to imagine that we can observe the space–time curvature from a distance, so that distant stars must move on a curved path of space–time around other stars, when at the position of the stars space—time is not curved locally. Therefore, Einstein's argumentation for GR makes no sense at all from a physical point of view. This is because the only purpose of Einstein's GR is to mathematically enforce a constant speed of light independent of the gravitational potential in gravitational fields. Einstein derived the kinematic time dilation factor γ for the longitudinal light path on the basis of back and forth movements that take place at the speed of light. However, we know that photons propagate in a straight line in nature and do not move back and forth. Therefore, we must conclude that the derivation of the kinematic time dilation factor γ calculated by the motion of photons can only be understood as a mathematical model describing another physical process that is responsible for the kinematic time dilation. Since condensed intra-atomic or intraelemental particular structures are also expected to move with the speed c and we know that atoms are always in motion, so that even in solid matter they permanently move back and forth, we have to assume that the kinematic time dilation results from motion of atoms and elemental particles. Indeed, it makes no physical sense for photons moving in a straight line to be able to change the oscillation frequency of atoms that move back and forth in atomic clocks. Photons cannot be the cause for the time dilation factor γ, which is an average value, because photons cannot move with an average speed on the x-axis in moving inertial frames, but only with speed $c - \mathrm{v}$ or with speed $c + \mathrm{v}$. Therefore, the increase in wavelength (in all emission directions) by the factor γ when light sources are in motion on Earth must be the result of a dilated emission process of photons, which causes an increase in wavelength when intra-atomic structures that emit photons move back and forth and, in addition, move in a certain direction in the predominating gravitational field of Earth (against locally absolute strengths of gravitational potentials). The decisive insight that resolves the aforementioned contradictions of GR is the knowledge that our considerations about photons just represent a macroscopic model for the behavior of processes that take place at the speed of light within elemental particles or within atoms. Since "time," defined by the number of measured time units, is inversely proportional to time defined by the size of time units, and since frequencies are also inversely proportional to time defined by the size of time units, a decrease in the frequency of oscillating atoms in atomic clocks within a stronger gravitational potential can be used to measure gravitational time dilation within matter. However, this has nothing to do with the observed redshift of electromagnetic waves emitted from light sources at stronger gravitational potentials, because photons cannot be responsible for the time measured by atomic clocks ($\Delta t'_{\mathrm{N}}$ = time defined by numbers of measured time units; $\Delta t'$ and Δt_0 = time defined by the size of time units),

$$\begin{aligned}\Delta t'_N &= f',\\ \Delta t'_N &= 0.999\,76 \times f_0,\\ \frac{1}{\Delta t'_N} &= \frac{1}{0.999\,76 \times f_0},\\ \Delta t' &= 1.000\,24 \times \frac{1}{f_0},\\ \Delta t' &= 1.000\,24 \times \Delta t_0.\end{aligned} \tag{16}$$

When, using atomic clocks, we measure time passing more slowly near the surface of a mass, and more quickly at high altitude above the surface of this mass, the speed c of photons is nonetheless constant in all frames of reference within the gravitational potentials of the predominant gravitational field—this is because a slower speed of light near the surface of a mass is compensated by time passing more slowly near a mass and a faster speed of light at high altitude above the surface of this mass is compensated by time passing more quickly. According to the theory of relativity in dependence of gravity, the slower speed of light on Sirius B is compensated by time passing more slowly, so that on Sirius B, the speed of light can still be measured as c ($\Delta t'$ and Δt_0 = time defined by the size of time units),

$$\begin{aligned}\Delta t' &= \frac{\Delta d}{0.99976 \times c},\\ 1.000\,24 \times \Delta t_0 &= \frac{\Delta d}{0.999\,76 \times c},\\ 1.000\,24 \times \Delta t_0 &= 1.000\,24 \times \frac{\Delta d}{c},\\ \Delta t_0 &= \frac{\Delta d}{c}.\end{aligned} \tag{17}$$

Since I consider Einstein's concept of a proper time in any frame of reference to be false, in Eq. (17), the time t_0 does not represent Einstein's proper time, but the time that we measure when we are at rest with respect to a locally absolute strength of a gravitational potential within Earth's predominant gravitational field, which means that t_0 varies depending on the strength of the local gravitational potentials. This means that time is relative and depends on the movement and position in relation to gravitational potentials.

The redshift cannot be explained either by a slower speed of light or by GR since it is absurd, given that light is measured at the constant speed c at any gravitational potential, or by GR since it is absurd to imagine that we can observe a space–time curvature from a distance so that distant stars must move on a curved path of space–time around other stars when at the position of the stars space–time is not curved locally. Once again, we must realize that the derivation of gravitational time dilation using photons can only serve as a mathematical model to calculate the deceleration of processes in the condensed matter within stronger or weaker gravitational potentials. The observed redshift of electromagnetic waves arriving at Earth from Sirius B is caused by an increase in wavelength when electromagnetic waves are emitted on Sirius B, which can be attributed to the fact that the emission process of electromagnetic waves from atoms or elemental particles is slower within stronger gravitational potentials so that each pulse of electromagnetic radiation has moved a greater distance on Sirius B than if emitted on Earth before the next pulse can follow, which leads to an increase in wavelength relative to the emission process on Earth.

VI. CONCLUSIONS AND DISCUSSION

Physicists often use the argument of relative motion as proof for the correctness of Einstein's relativity. For example, it is irrelevant whether a conductor moves relative to a magnet or a magnet moves relative to a conductor: In both cases, a current is generated. No one would think of denying relative motion. A fist slamming against my face hurts whether the fist was moved toward my face or whether my face moved toward the fist. However, when we compare at least three frames of reference, paradoxes arise if we apply Einstein's principle of relativity, which does not describe a relative relationship, but rather a relativistic relationship between frames of reference. The Hafele–Keating experiment verifies a causation between time dilation and motion or position within the predominant gravitational field of Earth and falsifies a relativistic relationship between frames of reference if we compare all three frames of reference involved in the Hafele–Keating experiment.[1] A theory of relativity in dependence of locally absolute strengths of gravitational potentials within predominant gravitational fields brings physics back from Einstein's subjective imagination of a constant proper time t_0 to the objective mathematical truth that, according to the definition of time as path length divided by the speed of light, time can only change if either the speed of light changes (=gravitational time dilation) or the length of the light path in the rest frame in a predominant gravitational field changes, which enforces a change in the speed of light in the frame of reference moving in a predominant gravitational field (= kinematic time dilation). Although gravitational time dilation is then caused by a decrease in the speed of light in an object that is located at a stronger gravitational potential within a predominant gravitational field, at any gravitational potential the same speed c of photons can be measured, because a slower speed of light near the surface of a mass at a lower gravitational potential is compensated by time passing more slowly near this mass. The observed redshift of electromagnetic waves arriving at Earth from Sirius B must be caused by an increase in wavelength when electromagnetic waves are emitted on Sirius B because the emission process of electromagnetic waves from atoms or elemental particles is slower within stronger gravitational potentials, so that each pulse of electromagnetic radiation has moved a greater distance on Sirius B than if emitted on Earth before the next pulse can follow, which leads to an increase in wavelength relative to the emission process on Earth. The derivation of the kinematic time dilation factor γ calculated based on the motion of photons just represents a mathematical model to calculate the duration of physical processes in condensed matter that also happen at the speed of light. Kinematic time dilation must be caused by moving structures within atoms or elemental particles having to travel an objectively longer distance within predominant gravitational fields. Similarly, the gravitational time dilation calculated by photons within different strengths of gravitational potentials just represents a mathematical model to calculate the duration of physical processes in condensed matter that also happen at the speed of light. When matter moves within predominant gravitational fields or is located at a stronger gravitational potential, physical processes in condensed matter in atoms or elemental particles, which happen at the speed of light, slow down, so that the frequency of oscillating atoms in atomic clocks becomes lower, which can be interpreted as time dilation. Therefore, the so-called transverse Doppler shift must result from a dilation of the emission process of photons from light sources that move in the predominant gravitational field of Earth. To come to a physically correct interpretation of the Michelson–Morley experiment[9] and experiments with moving interferometers on Earth, we need a theory of relativity in dependence of locally absolute strengths of gravitational potentials within predominant gravitational fields.[5,6] The additional effects of gravitational motion, which Newton's theory of gravity cannot describe, are not caused by electromagnetic radiation but are the result of quantum-physical effects, which also occur at the speed of light. I was able to demonstrate this by correctly predicting the curvature of a light beam at the surface of the Sun, as well as phenomena observed at the binary pulsar PSR B1913 + 16, by just applying Kepler's second law on gravitational quanta, which move with the speed c, in my paper "Newtonian quantum gravity."[10]

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