Challenge to the Special Theory of Relativity

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ABSTRACT

This paper finds that the time of the Special Theory of Relativity (STR) is no longer the physical time measured by physical clocks. In fact, a clock can never measure time directly; it can only record the status of a physical process during a period of time, such as the number of cycles of an oscillatory mechanism, which is the product of time and oscillation frequency. After a Lorentz transformation from a moving inertial reference frame to a stationary inertial reference frame, the time in the moving frame is dilated by a factor γ , but the frequency of a clock in the moving frame decreases by the same factor γ , leaving the resulting product (i.e., the time displayed by the moving clock) unchanged. In other words, the time displayed by any physical clock is invariant with respect to Lorentz transformation, unlike the time of the STR. It is a mistake to use the properties of time in the STR to predict time dilation for physical clocks or any other physical process. Based on the Lorentz invariance of clock time, we can prove that within the framework of the STR, our Earth-based standard physical time is absolute, universal and independent of the inertial reference frame. The existence of such an absolute and universal clock time is confirmed by the universal synchronization of all ground and satellite clocks of the Global Positioning System and by the theoretical existence of the absolute and universal Galilean time within the framework of the STR. We can further prove that in the STR, the time dilation and length contraction of a moving inertial reference frame observed from a stationary inertial reference frame are pure illusions. Moreover, in the STR, the real speed of light still exists and follows Newton's velocity-addition formula, which directly falsifies the postulate of the STR that the speed of light is constant in all inertial reference frames. All these findings lead us to question the validity of the STR as a theory of physics.

Key words: Relativity, Lorentz Transformation, Spacetime, Clock Time, Physical Time, Time Dilation, Length Contraction, Inertial Reference Frame, Speed of Light, Universal Synchronization

At present, mainstream physicists seem to have fully accepted Einstein's Special Theory of Relativity (STR) [1] and to take it as the foundation of modern physics because the theory appears perfect logical and its predictions seem to be supported by numerous experiments and observations. However, if one re-examines these experiments carefully and with an open mind, serious problems may emerge, as shown in this manuscript.

The Hafele-Keating experiment [2] demonstrated that atomic clocks that had travelled different paths (a stationary location on Earth, an eastward airline route around the Earth and a westward airline route around the Earth) displayed different times. After the trips, these clocks could be placed in the same spatial location and the differences in their times would remain unchanged regardless of the inertial reference frame from which they were observed. What does this mean? It means that the time differences between the clocks, excluding gravitational effects, were not relative as predicted by the STR but, rather, absolute. That is, the time differences between the clocks were determined not by the relative speeds of the inertial reference frames but by the velocities of the clocks relative to only one medium in space. The behaviours of clocks moving through this medium appear very similar to the behaviour of a mechanical clock with its balance wheel exposed to the air: the faster the clock moves through the air, the more retarded its displayed time will be because the motion of its balance wheel will be slowed down by the wind. Therefore, the Hafele-Keating experiment is a confirmation of the existence of some medium in space rather than a proof of time dilation in the STR relative to an inertial reference frame, although this medium may not be the same medium of light (called the aether) whose existence is indicated by the Fizeau experiment, discussed below, because different media may co-exist in the "vacuum" of space just as air and aether can co-exist in the atmosphere.

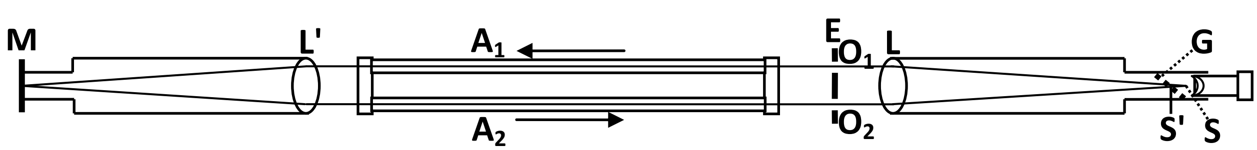

Figure 1. Set-up of the Fizeau Experiment

Figure 1 depicts the set-up of the Fizeau experiment [4]. A light ray emanating from a source **S'** is reflected by a beam splitter **G** and is collimated into a parallel beam by a lens **L**. After passing through slits $\mathbf{O_1}$ and $\mathbf{O_2}$, two rays of light travel through tubes **A_1** and **A_2**, through which water is streaming back and forth as indicated by the arrows. The rays reflect off a mirror **M** at the focus of lens **L'**, such that one ray always propagates in the same direction as the water stream and the other ray propagates in the direction opposite to that of the water stream. After passing back and forth through the tubes, both rays reunite at **S**, where they produce interference fringes that can be visualized through the illustrated eyepiece.

In the Fizeau experiment, Fizeau committed two errors in his calculations: 1) he used the mean velocities instead of the central velocities of the water flows in the tubes for his calculations, and 2) he used a constant speed of light instead of the relative speeds of light in the reference frames of the water flows to calculate the results based on Newton's velocity-addition formula. We know that the light rays in the experiment were propagating along the central line of each tube. The central velocity v was twice as great as the mean velocity V_m because a laminar flow in a tube has a parabolic velocity distribution. Moreover, as the Michelson-Morlay experiment [3] tells us that the speed of light is nearly isotropic on the Earth's surface, the speeds of the light rays relative to the experimental set-up in all directions can be regarded as constant and equal to c . Therefore, the speeds of the incoming light rays in the reference frames of the water flows in the Fizeau experiment, based on Newton's velocity-addition formula, should not be constant but should rather be $c-v$ in the frame of the water flowing in the same direction as the light and $c+v$ in the frame of the water flowing against the direction of the light. As a result, the speeds of the light beams travelling through the water flows should take the forms $(c-v)/n$ and $(c+v)/n$, respectively (where n is the refractive index of water), relative to the water frames, or the forms $(c-v)/n+v$ and $(c+v)/n-v$, respectively, relative to the frame of the experimental set-up, whereas Fizeau used $c/n+v$ and $c/n-v$, respectively. Thus, the displacement of the bands based on Newton's formula should be

$$\begin{aligned} \Delta/\lambda &= \{2Lc/[c/n-v(1-1/n)]-2Lc/[c/n+v(1-1/n)]\}/\lambda \\ &= \{4Lcv(1-1/n)/[c^2/n^2-v^2(1-1/n)^2]\}/\lambda \\ &\approx \left[4Ln^2\left(1-1/n\right)v/c\right]/\lambda = 0.236 \end{aligned} \quad (1)$$

where the length of the tubes is $L = 1.4875$ meters, the refractive index of water is $n = 1.333$, the velocity of the water at the centre of the tubes is $v = 2V_m = 14.118$ meters/second, the wavelength of the light is $\lambda = 0.000000526$ meters, the isotropic speed of light is $c = 299,792,485$ meters/second, and the second-order term (v^2 / c^2) is omitted, which is very different from the result of Fizeau's inaccurate calculation based on Newton's formula: $\Delta / \lambda \;=\; \left[4Ln^2V_m / c\right] / \lambda \;=\; 0.4597$. Compared with the result of 0.4044 that is obtained using the STR's velocity-addition formula (identical to Fresnel's result, as shown in Fizeau's calculation), the result of 0.236 that is correctly obtained based on Newton's formula is much closer to the experimental measurement of 0.23. Therefore, the Fizeau experiment actually disproves the STR's velocity-addition formula and confirms Newton's velocity-addition formula.

Moreover, the corrected calculation for the results of the Fizeau experiment implies the existence of the aether because the isotropic speed of light in Newton's mechanics can only be valid in one inertial reference frame. Because there is no absolutely stationary aether in nature (Michelson-Morlay [3]), the only possibility appears to be that this frame with an isotropic speed of light is the reference frame of the local aether, which should be a kind of fluid. As light can exist everywhere, the aether must fill all space in our visible universe.

The return paths of the light rays in the Fizeau experiment were designed to create exactly symmetric paths for both rays to eliminate any path differences caused by the unavoidable difference in the tube lengths; however, the return paths also cancelled the differences in the speeds of light travelling in opposite directions. If we replace the mirror in Fizeau’s experimental set-up with an interferometer to eliminate the return paths of the light rays, then the resulting modified experimental set-up (see Figure 2) can be used to measure the one-way speed of light in any direction. Using Eq. (1) with half the path length, we can obtain the speed of light in the single direction of the modified experimental set-up as follows:

$$c = 2Ln^2(1 - 1/n)v / [(\Delta / \lambda)\lambda] \tag{2}$$

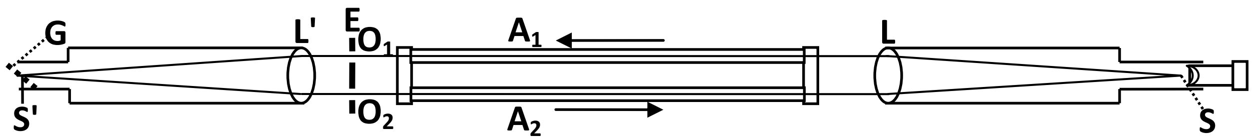

Figure 2. Modified Fizeau Experiment Set-up

Figure 2 depicts the modified Fizeau experiment set-up. A light ray emanating from a source **S'** is reflected by a beam splitter **G** and is collimated into a parallel beam by a lens **L'**. After passing through slits $\mathbf{O_1}$ and $\mathbf{O_2}$, two rays of light travel through tubes $\mathbf{A_1}$ and $\mathbf{A_2}$, through which water is streaming back and forth as indicated by the arrows. After passing through a lens **L**, both rays reunite at **S**, where they produce interference fringes that can be visualized through the illustrated eyepiece.

As the difference in the lengths of the tubes in the set-up illustrated in Figure 2 can never be completely eliminated, this experimental set-up requires measurements to be recorded in all directions at any given location. The displacement of the bands in any given direction used in Eq. (2) should be corrected by subtracting the mean displacement in all directions. The direction with the maximal band displacement will be the direction of the aether wind, and the measured speed of light in that direction minus the mean speed of light in all directions will be the speed of the aether at the location of the experimental set-up. Using this modified version of the set-up of the Fizeau experiment, we should be able to measure the speed of the aether wind at any location in our reachable universe.

NASA scientist Gezari performed a comprehensive literature search and found that none of the five photonic effects predicted by the STR have ever been observed in nature [5]. If one were to investigate other so-called experimental evidence of the STR in greater depth, one might find that these pieces of evidence are either null effects or the results of incorrect interpretations or calculations, just as in the Hafele-Keating experiment and the Fizeau experiment. At the same time, vast numbers of experimental findings disproving the STR are ignored by mainstream physicists. For example, Gezari's lunar laser test [6] revealed that the speed of light is not a constant but instead follows Newton's velocity-addition formula; Prof. Gift of the University of the West Indies reported that anisotropy in the speed of light could successfully explain the Sagnac effect where the STR fails [7]; the designers of the Global Positioning System confirmed that all ground and satellite clocks of the Global Positioning System, once synchronized, will remain synchronized relative to all inertial reference frames [8]; and Prof. Roychoudhuri of the University of Connecticut found that there are no physical objects for which time is one of their real physical parameters [9].

Now, let us consider Einstein's postulates regarding the STR. His first postulate states that all laws of physics should be invariant with respect to different inertial reference frames. Based on this premise, he proposed that electromagnetic equations are laws of physics and therefore should also be invariant in all inertial reference frames. In fact, however, this postulate should be valid only for the fundamental laws of physics, not for all laws of physics. For example, the acoustic wave equation is not invariant in all inertial reference frames; it is valid only in the inertial reference frame that is moving with the local air. Similarly, if electromagnetic waves are simply waves of aether, as the Fizeau experiment indicates, then the electromagnetic equations should be valid only in the inertial reference frame that is moving with the local aether rather than invariant in all inertial reference frames. Einstein’s second postulate states that the speed of light is constant in all inertial reference frames. However, if light is a wave of aether, similar to sound, which is a wave of air, then there is really no reason why the speed of light should be constant in all inertial reference frames whereas the speed of sound is constant only in the reference frame of the local air. Therefore, both of these postulates of the STR are questionable, as noted by Roychoudhuri: "That the foundational hypotheses behind the working theories of physics need to be re-visited is obvious from a large number of recent books and papers" [9].

In nature, only physical processes exist. We use one physical process as a standard for comparison with other physical processes to assess how fast or slow the observed processes are. Throughout human history, we have used many different physical processes, such as the motion of the Sun, the dripping of water, the flow of sand, the oscillations of a pendulum, and the electronic transitions of atoms, as time keepers; in short, there is no natural standard of time in nature, and time is merely the quantity that clocks measure [10]. Indeed, one could use any physical process as a measure of time, even the height of a tree, which could lead to the interesting conclusion that time in a tropical region flows faster than that in an arctic region. One could also assume that all lives had the same life expectancy if time were measured using each organism’s own biological clock, which could lead to the conclusion that the time of a life starts when that life is born and ends when it dies. Although time can be defined in different ways, it must always be defined based on a physical process because we need to use a physical process to measure time in the real world. Without being founded on a physical process, any theoretically defined time could never be used in the real world and would therefore be meaningless. Moreover, although time could be defined based on any physical process, an inappropriate definition of time would lead to difficulties in exchanging descriptions of events among people. The reason we choose specific physical processes as our standard time keepers is because the chosen processes offer the best synchronization among all available processes, which allows the measurements of time used in the descriptions of events to be as consistent, repeatable, predictable, exchangeable and manageable as possible. The times defined by our continuously improving time keepers seem to be approaching an ideal, stable standard of measurement. This ideal stable standard of measurement, which is currently approximated by atomic clocks, is what we call "physical time" or "time" in physics and our daily lives. Therefore, we must always be aware that all of our descriptions of physical phenomena are measured by these physical clocks and make sense only to these clocks.

Currently, almost every clock records the number of cycles of an oscillatory process, which is then divided by a constant (i.e., its frequency), called a calibration constant, to generate the time displayed by that clock to ensure that it is comparable to the times displayed by other clocks. We call this calibrated time the "clock time" or "physical time" and call the time used in a physics theory the "abstract time" or simply "time". In classical mechanics, the clock time is equivalent to the abstract time because the frequency of a clock is invariant with respect to Galilean transformations, i.e., invariant in all inertial reference frames, and can be calibrated away from the recorded number of oscillations, which is the product of the abstract time and the oscillation frequency, to obtain the abstract time. Therefore, the abstract time of classical mechanics is the same as the clock time, i.e., the physical time. However, in the STR, the frequency of a clock is no longer invariant in different inertial reference frames and cannot be calibrated away to cause the clock to produce the abstract time. Thus, the abstract time of the STR is no longer the physical time defined by the physical clocks that are used to observe all physical phenomena. This makes the STR irrelevant to all physical phenomena that we are considering.

The introduction of Lorentz transformations to replace Galilean transformations in physics is equivalent to redefining time and space. In principle, redefining time and space is just like redefining other mathematical variables in that it cannot lead to the discovery of anything new in nature but merely changes the forms of formulae. The critical error of the STR is that it still uses physical clocks as measurement devices for its newly defined time. Interestingly, it is exactly this error that leads to its so-called "new discoveries": time dilation, length contraction, mass increase, etc.

Here is presented a detailed illustration of the Lorentz invariance of the clock time. Consider a clock moving at a constant speed v along the x direction of an inertial reference frame called Frame A, whereas the frame attached to the clock is called Frame B. In the following, all variables of Frame B carry an apostrophe (') to distinguish them from those of Frame A. To represent its displayed time, the clock uses the angle of its arm, which rotates at a constant speed ω' in a plane perpendicular to the direction of the clock's motion.

At the event in which the clock passes the origin of Frame A, the location of the clock is

$$x_1 = x'_1 = 0 \tag{3}$$

where x_1 and x'_1 are the coordinates of the clock in Frame A and Frame B, respectively, and the arm of the clock is oriented at 0 degrees relative to both frames,

$$\alpha_1 = \alpha'_1 = 0 \tag{4}$$

which represents a time of zero in both Frame A and Frame B:

$$t_1 = t'_1 = 0 \tag{5}$$

Consider a new event in Frame A:

$$t_2 = \tau \tag{6}$$

$$x_2 = v\tau \tag{7}$$

$$\alpha_2 = \omega\tau \tag{8}$$

After Lorentz transformation, the corresponding variables for this event in Frame B are as follows:

$$x'_2 = \gamma(x_2 - vt_2) = 0 \tag{9}$$

$$t'_2 = \gamma(t_2 - vx_2 / c^2) = \tau / \lambda \quad \text{or} \quad t_2 = \gamma t'_2 \tag{10}$$

$$y'_2 = y_2 \tag{11}$$

$$z'_2 = z_2 \tag{12}$$

where $\gamma = 1/\sqrt{1-v^2/c^2}$ and where (y_2, z_2) and (y'_2, z'_2) are the coordinates of the tip of the arm in Frames A and B, respectively. The relationships between the angle and the coordinates are as follows:

$$\tan(\alpha_2) = y_2 / z_2 \tag{13}$$

$$\tan(\alpha'_2) = y'_2 / z'_2 \tag{14}$$

From Eq. (11-14), we have

$$\alpha'_2 = \alpha_2 \tag{15}$$

Because the time displayed by the clock has been calibrated with respect to the angle of its arm, Eq. (15) tells us that the time displayed by a rotating clock is invariant with respect to Lorentz transformations.

Because

$$\alpha'_2 = \omega' t'_2 \tag{16}$$

from Eq. (6), (8), (10), (15) and (16), we obtain

$$\omega\tau = \omega'\tau / \gamma \tag{17}$$

Stated otherwise,

$$\omega' = \gamma\omega \qquad \text{or} \qquad \omega = \omega' / \gamma \tag{18}$$

Eq. (10) shows that a time dilation occurs after the Lorentz transformation from Frame B to Frame A, but Eq. (18) indicates that there is also a slowdown of the rotation speed of the arm of the clock upon the transformation from Frame B to Frame A, leaving the angle of the arm (i.e., the product of time and the rotation speed) unchanged after Lorentz transformation. Because the angle of the arm of the clock represents the time displayed by the clock, the time displayed by the clock remains unchanged after Lorentz transformation.

Because any clock can display its time as the angle of an arm rotating in a plane perpendicular to the motion of the clock by means of mechanical gears or digital converters to convert the number of cycles of oscillation of the clock into the angle of the arm, the above derivation can be logically extended to any physical clock, including an atomic clock. In other words, the time displayed by any physical clock must remain unchanged after Lorentz transformation because the dilation of time is cancelled by the slowdown of the frequency (similar to the transverse Doppler effect) in the product. Therefore, we have the following theorem:

Theorem 1. The clock time is an invariant quantity with respect to Lorentz transformation, i.e., an invariant quantity in all inertial reference frames.

Using **Theorem 1**, the twin paradox can be easily solved even in the framework of the STR. The reason it is a paradox is simply because of the mistaken belief that the biological age of a person is a measure of abstract time, whereas in reality, biological age, like the time displayed by a clock, is always the product of abstract time and ageing rate. When the travelling twin is observed in the Earth reference frame, although the abstract time of the moving frame transformed into the Earth frame will dilate by a factor γ , the ageing rate of the travelling twin as observed on Earth will also decrease by the same factor γ , leaving the biological age (i.e., the product) unchanged. In other words, the travelling twin's biological age will be the same when observed in both the moving frame and the Earth frame, as will the biological age of the twin on the Earth. Because twin siblings are the same biological age when they are born, their biological ages will also remain the same thereafter regardless of the reference frame from which they are observed, in the same manner as the times displayed by clocks on both reference frames. This is because the physical time we use is the time shown on clocks rather than the abstract time of the STR, which can never appear in the real world. Therefore, there will be no age difference between twins observed in any inertial reference frame regardless of how fast they have departed from each other.

As any small change in the status of any physical process (i.e., the change in abstract time multiplied by its rate of progression) is always invariant with respect to different inertial reference frames, we should never expect any physical process to exhibit effects of time dilation caused by the relative speeds of different reference frames, as predicted by the STR. It may be argued that time dilation does indeed manifest in the extended lives of muons flying through the atmosphere compared with those created in laboratories. However, careful examination of this phenomenon will reveal that the extension of the lives of flying muons is absolute and will be the same observed in any inertial reference frame rather than dependent on a specific inertial reference frame, as predicted by the STR. The extension of the lives of muons should instead be understood as the result of the enhanced stability brought about by the high speeds with which they travel through their surrounding media (air, aether and/or other possible media), just like riding a bike at high speed, as analogized by Roychoudhuri [9]. Therefore, the extension of the lives of muons also is not evidence of the time dilation of the STR.

Given the Lorentz invariance of the clock time, it is straightforward to reach the conclusion that clock time is absolute and universal. Therefore, even in the framework of the STR, we can establish a standard, absolute and universal physical time as demonstrated below.

If we set all clocks, including clocks moving at constant speeds, to the same displayed time and the same frequency of oscillation in an inertial reference frame with a constant speed of light in all directions, these clocks will all have the same displayed time as observed in this inertial reference frame at all times.

To set all clocks to the same displayed time, one can broadcast the displayed time from a single standard clock. Each other clock can use its position to calculate the time required for the message to travel from the standard clock to that clock and then add that time to the time of the received message to obtain the time that it should display as observed from the inertial reference frame of the standard clock, just as in the synchronization of orbiting GPS clocks with the standard clock on the Earth.

To set all clocks to the same frequency, the above procedure can simply be repeated to adjust the frequency of each receiving clock such that it will show the same displayed time as the standard clock at all times as observed from the inertial reference frame of the standard clock.

Once all clocks have been well synchronized in the inertial reference frame of the standard clock, according to **Theorem 1**, these clocks will also display the same time as observed in all other inertial reference frames. Thus, we obtain the following theorem:

Theorem 2. In the STR, a standard physical time can be established that is absolute, universal, and independent of any inertial reference frame and can be measured by any moving or stationary clock.

It may be argued that clocks that are synchronized in one inertial reference frame will no longer be synchronized in other inertial reference frames. This would be true if synchronization were defined in terms of the abstract time of the STR, but in the physical world, synchronization is defined by the times of physical clocks rather than the abstract time because abstract time is invisible in the real physical world.

With this universal physical time, any event recorded at a certain value of the universal physical time in one inertial reference frame will always be observed at the same universal time in all inertial reference frames. Multiple events recorded simultaneously with the same universal physical time in any inertial reference frame will appear simultaneous in all inertial reference frames.

The existence of an absolute and universal clock time has already disproved the claim of the STR that clocks in different locations can never be synchronized in multiple inertial reference frames [1].

The discovery of the invariance of clock time can be further illustrated in the following mathematical derivation. Even in the STR, Galilean time and Galilean space still exist, which follow Galilean transformation.

In an inertial reference frame with an experimentally confirmed constant speed of light in all directions (called a stationary frame), although this frame may exist only in a small neighbourhood, the Galilean time T and space X can be defined as equivalent to the STR time t and space x :

$$T = t \tag{19}$$

$$X = x \tag{20}$$

Now, let us see how this time t and space x transform into the time t' and space x' of a new inertial reference frame moving at a constant speed v along the x axis of this frame through Lorentz transformation:

$$t' = \gamma(t - vx / c^2) \tag{21}$$

$$x' = \gamma(x - vt) \tag{22}$$

In the moving frame, we can define the Galilean time T' and the Galilean space X' as follows:

$$T' = \gamma(t' + vx'/c^2) \tag{23}$$

$$X' = x'/\gamma \tag{24}$$

From Eq. (19-24), we have

$$T' = \gamma(t' + vx'/c^2) = \gamma[\gamma(t - vx/c^2) + v\gamma(x - vt)/c^2] = \gamma(\gamma t - \gamma t v^2/c^2) = \gamma^2(1 - v^2/c^2)t = t = T \tag{25}$$

$$X' = x'/\gamma = \gamma(x - vt)/\gamma = x - vt = X - vT \tag{26}$$

Stated otherwise,

$$T' = T \tag{27}$$

$$X' = X - vT \tag{28}$$

which proves that in the framework of the STR, we still have Galilean time and Galilean space satisfying Galilean transformation, i.e., Galilean time is invariant with respect to Lorentz transformation, absolute and universal, and Galilean space will never experience length contraction. The Lorentz invariance of Galilean time is analogous to the Lorentz invariance of clock time. Therefore, even in the STR, all physical clocks can be calibrated to measure Galilean time, and these measurements are equivalent. The one-dimensional Galilean time is our physical time, which is independent of Galilean space.

The speed v of the moving frame is always the same regardless of whether it is defined as x/t or X/T because of Eq. (19) and (20). Eq. (21) and (22) can further prove that the speed of the stationary frame relative to the moving frame is always $-v$ regardless of whether it is defined as $X'/T' = (X - vT)/T = -v$ or $x'/t' = \gamma(x - vt)/[\gamma(t - vx/c^2)] = -v$, where $X = x = 0$. In other words, inertial reference frames are always the same regardless of whether their relative speeds are defined in terms of STR time and space or Galilean time and space.

Moreover, we can see that Newton's velocity-addition formula still holds for the speed of light in the STR if we use Galilean time and space to define it:

$$C' = X'/T' = (x'/\gamma)/[\gamma(t' + vx'/c^2)] = [(x'/t')/\gamma^2]/[1 + (v/c^2)(x'/t')] \tag{29}$$

where C' is the Galilean speed of light in the moving frame. Because the speed of light defined in terms of STR space and time is a universal constant,

$$x'/t' = c \tag{30}$$

we have

$$C' = (c/\gamma^2)/(1 + v/c) = c(1 - v^2/c^2)/(1 + v/c) = c(1 - v/c) = c - v \tag{31}$$

Eq. (31) tells us that even in the STR, the speed of light defined in terms of Galilean time and space is not a constant but depends on the speed of the reference frame. Because the real speed of light in the physical world is defined and measured using physical clocks, i.e., Galilean time, not the abstract time of the STR, the real speed of light is the Galilean speed of light and Eq. (31) directly denies the postulate of the STR that the speed of light is constant, as confirmed by Gezari's lunar laser test [6].

From Eq. (23) and (24), we can obtain expressions for STR time and space as functions of Galilean time and space:

$$t' = (1/\gamma)T' - (\gamma v/c^2)X' \quad (32)$$

$$x' = \gamma X' \quad (33)$$

which can be used in combination with the Galilean transformations (i.e., Eq. (27) and (28)) to derive the Lorentz transformations. This implies that the only function of the STR is to redefine time and space to produce an artificially constant speed of light in all inertial reference frames, which has no real physical meaning.

Eq. (32) tells us that in a moving frame, STR time not only scales down the unit of Galilean time (i.e., our physical time) but also adds an asymmetric term to Galilean space to compensate for the asymmetric nature of the real speed of light in a moving inertial reference frame, which is different in the positive and negative directions along the x' axis. In other words, the STR not only needs to calibrate clocks to the speed of the frame but also needs to calibrate clocks according to their locations, which is impossible to achieve.

It may be argued that a stationary clock in an inertial reference frame can measure STR time. If STR time were to be measured by a stationary clock, then that clock could be observed with the same displayed time in all inertial reference frames by virtue of the Lorentz invariance of clock time, and no time dilation of the clock could be observed in any inertial reference frame, contradictory to Lorentz transformation. Therefore, STR time can never be measured by any physical clock. Thus, STR time is not our physical time but rather an artificial time, and consequently, STR space is also an artificial space.

Eq. (23), (24), (32) and (33) tell us that in the STR, Galilean time and space can be defined as functions of STR time and space and the speed of the moving frame and that in classical mechanics, STR time and space can be defined as functions of Galilean time and space and the speed of the moving frame. In other words, all inertial reference frames in both the STR and classical mechanics are the same. The fundamental differences between the STR and classical mechanics lie simply in their different definitions of time and space.

Eq. (32) shows that the STR time at the origin of a moving frame is the Galilean time artificially compressed by a factor γ. The STR claims that the time of a moving frame will dilate by the factor γ as observed in a stationary frame, but the reality is that this dilation is simply the recovery of the Galilean time (i.e., the clock time) because the γ factors cancel each other in the formulation:

$$t = \gamma t' = \gamma[(1/\gamma)T' - (\gamma v/c^2)X'] = \gamma(T'/\gamma) = T' = T \text{ where } X' = 0 \tag{34}$$

Thus, the STR time of a moving frame observed in a stationary frame is always the same as the STR time of the stationary frame, both of which are simply the Galilean time. Therefore, in the STR, the time dilation of a moving frame as observed in a stationary frame is merely an illusion.

Eq. (33) shows that the STR spatial coordinate of a moving frame is the Galilean spatial coordinate artificially enlarged by a factor γ. The STR claims that the length of a moving frame will contract by the factor γ as observed in a stationary frame. However, the reality is that the length of a moving frame as observed in a stationary frame is always the same as the Galilean length without any contraction at all because the γ factors cancel each other in the formulation:

$$\Delta x = \Delta x'/\gamma = (\gamma \Delta X')/\gamma = \Delta X' = \Delta X \tag{35}$$

Thus, a length in a moving frame as observed in a stationary frame is always equal to that same length in the stationary frame. Therefore, in the STR, the length contraction of a moving frame as observed in a stationary frame is also an illusion.

All these findings lead us to the following conclusions:

1. The physical time defined by clocks is invariant with respect to different inertial reference frames, absolute and universal.
2. The time of the STR is not equivalent to the physical time and thus can never be measured by any clock. It is merely an artificial variable introduced solely to produce an artificially constant speed of light.

3. Time dilation is merely a property of the time of the STR and cannot appear on physical clocks or in other physical processes.
4. In the STR, there still exist an absolute and universal Galilean time and a rigid Galilean space that follow Galilean transformation.
5. In the STR, the real speed of light as defined in terms of Galilean time and Galilean space still follows Newton's velocity-addition formula.
6. In the STR, the time dilation and length contraction of a moving inertial reference frame as observed in a stationary inertial frame are merely illusions.
7. Therefore, the status of STR as a fundamental theory of physics is shown to be questionable.

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