Article: **Light is not the best means to study relativity**

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Abstract

In 1905, A. Einstein published his paper "On the Electrodynamics of Moving Bodies"[1]. In Section 1, the equation " t_B - t_A = t'_A - t_B " was provided; it describes a method for confirming the synchronization of two clocks by using a ray of light that makes a round trip between the clocks. Based on this method, Einstein established the Special Theory of Relativity (STR). In other words, his STR does not hold without the concept of light. The approach of employing a light ray is also useful for measuring distance; therefore, it is applied in many modern technological fields. However, there are other approaches, such as SONAR, that can be employed to achieve the same of purpose. In thought experiments aimed at confirming the above synchronization, another method that does not cause a time lag between the two clocks can be used. Using this method, STR becomes very simple and even non-scientists can easily confirm the synchronization of the clocks without any need for calculations. From the above, we can say that light is not the best means to study relativity.

1. Background

In 1905, A. Einstein published his first work, a paper entitled "*On the Electrodynamics of Moving Bodies*" [1]. In this paper[1], he introduced his perspective on relativity using thought experiments and the theories that he expounded on in Sections 2, 3, 4, and 5 are referred to as "the Special Theory of Relativity" (STR).

In Section 1 of his paper [1], the major premise of Einstein's theory is described; he defined the concept of "time", then he provided the following equation:

$$tB - tA = t'A - tB \qquad (1)$$

Equation (1) shows a simple formalism that can be applied to confirm the synchronization of two clocks placed at points *A* (where the light source is placed at) and *B* (where the mirror is placed at); this approach uses a ray of light that makes the round trip between *A* and *B*.

Based on this method, Einstein introduced the following set of equations as a part of conclusion of Section 2 of his paper [1]:

$$t_B - t_A = \frac{\gamma_{AB}}{c - v} \quad \text{and} \quad t'_A - t_B = \frac{\gamma_{AB}}{c + v} \qquad (2)$$

The form of both equations corresponds to the universal equation "time = distance / speed"; considering a round trip of light performed on a moving system with uniform velocity, as viewed from a stationary system set up as a reference frame by a parallel translation to the moving system, the left equation denotes "go" (from point *A* to point *B*), the right equation denotes "return" (from point *B* to point *A*)

Furthermore, in Section 3 of his paper [1], Einstein included the following equation at the beginning of the development process of the Lorentz factor $\beta = \dfrac{1}{\sqrt{1-v^2/c^2}}$:

$$\frac{1}{2}(\tau_0+\tau_2) = \tau_1 \qquad (3)$$

This equation denotes the time interval of one way of a round trip of light in a moving system, as viewed from the moving system. The symbol τ denote "time" in the moving system, τ_0 denotes the point in time when the light source emitted the ray of light, τ_1 denotes the point in time when the ray of light reflected by the mirror and τ_2 that when the ray returns to the position of the light source.

This method, which uses the round trip of a light signal between two points, as described by Eqs. (1), (2), and (3), is useful not only for confirming the synchronization of the clocks, but also for measuring the distance between them.

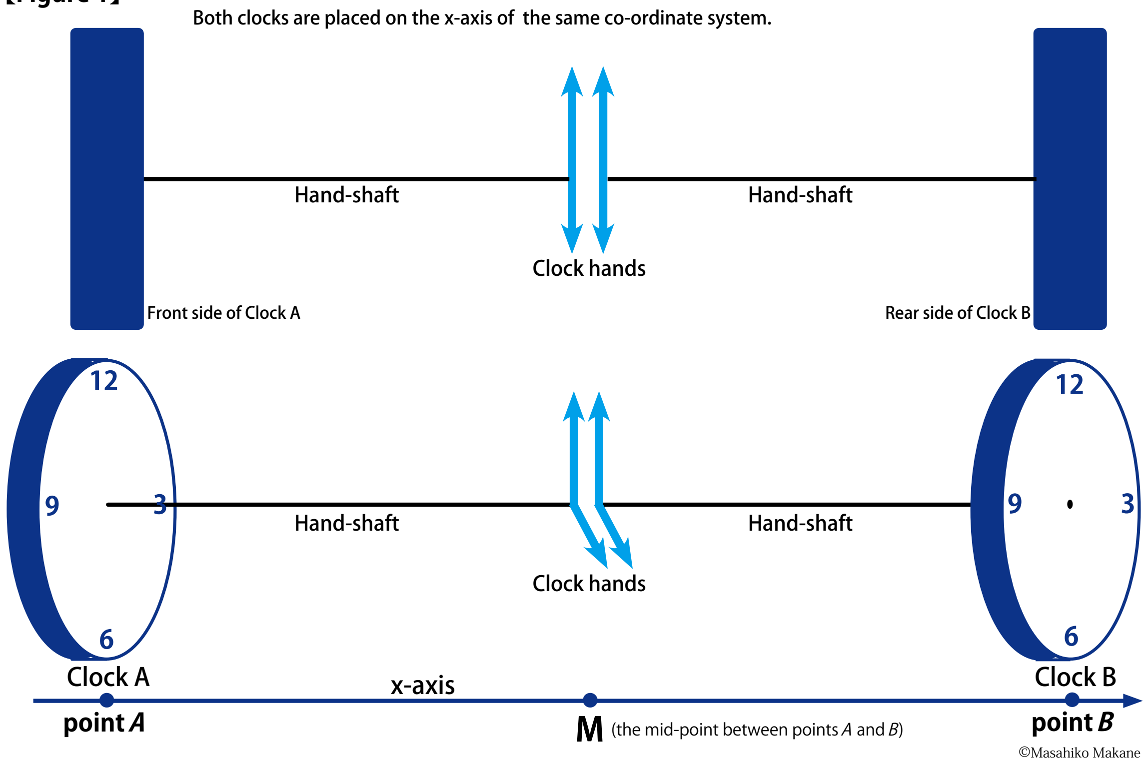
However, other methods exist that may be applied for the above purposes. For example, SONAR, which is used in several practical applications, can be employed for use in water and conditions in which light cannot be implemented. Animals, such as bats and whales, also use similar systems for navigation.

In order to confirm the synchronization of the clocks, we can apply an approach that does not cause a time lag between two clocks A and B. The assumptions made in this thought experiment are as follows: <Figure 1>

- Two clocks A and B are placed at two points *A* and *B* of the x-axis of the co-ordinate system.
- The hand-shafts of both the clocks are extended to the mid-point between the two points along the x-axis of the co-ordinate system in which the clocks are placed.
- The hand-shaft of clock B juts from the rear end of the clock.
- The clock hands are attached to the end of each hand-shaft.
- If both hands of the clocks rotate together at same time, the synchronization is satisfied.

[Note] Texts with blue underline are new contents that I added by major revise 22th of March 2016.

【Figure 1】



As a part of the thought experiment, we can expand the above concept while considering the motion of the moving system by using the reference stationary system.

Assuming that the two clocks, which have a similar structure as shown in Figure (1), are placed at any arbitrary points on the x-axis of the reference stationary system, we can confirm their synchronization without any calculations that can be viewed within the reference stationary system.

Assuming that the two clocks, which have the similar structure shown in Figure (1), are placed at any arbitrary points of the x-axis of the moving system, we can confirm their synchronization without any calculations. This can be viewed within the moving system or viewed from the reference stationary system, regardless of whether the reference stationary system and the moving system are connected by a parallel translation and even if the moving system accelerates or decelerates.

In the above assumptions, the Einstein's method that uses the round trip of light between the two clocks in order to confirm their synchronization is unnecessary, also the time lag between the two clocks does not arise always by using the method shown in Figure (1), while

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considering STR. This indicates that the method shown in Figure (1) is more inclusive than the method that uses the round trip of light between the two clocks as the thought experiment.

[Note] Texts with blue underline are new contents that I added by major revise 22th of March 2016.

2. Conjecturing the main reason that Einstein used light in his STR

Light is certainly a superior means of measurement, as its motion can be characterized as very fast, straight, and with a uniform velocity in vacuum. At a glance, using light to confirm the synchronization of clocks or to measure a distance appears to be the only suitable approach, even in thought experiments. However, Einstein's main reason for using light may be different: this can be inferred from "*the principle of relativity*" and "*the principle of the constancy of the velocity of light*" that are defined in Section 2 of his paper [1] and his instruction written in the middle of the development process of the Lorentz factor in Section 3 of the paper [1].

These two principles state:

The principle of relativity: "*The laws by which the states of physical systems undergo change are not affected, whether these changes of state be referred to the one or the other of two systems of co-ordinates in uniform translatory motion*."

The principle of the constancy of the velocity of light: "*Any ray of light moves in the 'stationary' system of co-ordinates with the determined velocity c, whether the ray be emitted by a stationary or by a moving body*."

The instruction is:

"*We now have to prove that any ray of light, measured in the moving system, is propagated with the velocity c, if, as we have assumed, this is the case in the stationary system; for we have not as yet furnished the proof that the principle of the constancy of the velocity of light is compatible with the principle of relativity*."

Regarding the principle of relativity, developed according to the conventional approach of Galilean/Newton mechanics, maintains that the same theory of mechanics holds true in any co-ordinate system as an absolute theory. We can assert that this principle is an established theory, because it had been validated directly by everyone in everyday life from way back.

Regarding the principle of the constancy of the velocity of light, it may be better to say that this principle is not an established theory yet; because, the number of persons who directly validated this principle are not so many. In any case, under this principle, if a light source is at rest in a moving system, (i.e., the light source is in motion when viewed from a reference stationary system) the emitted light advances with the same velocity c when observed from the moving system and also from the stationary system. In other words, the same light obeys the principle of relativity in both systems, even when considering the two systems together. Thus, it seems that light is a convenient means for considering the relationship between the moving system and the stationary system, and light can be used as the mediation between the moving system and the stationary system. That may be the main reason why Einstein used light as the means to study STR.

On the other hand; if we use a rocket that can move with uniform velocity in a straight orbit instead of light, we must consider adding (or subtracting) the value of the velocity of the moving system to (or from) the speed of the projectile. Thus, the principle of relativity cannot be maintained in both systems by the rocket, when we considering the two systems together. It will make the study complicated. Therefore, light is better than the rocket or any other massive object in order to confirm the synchronization of clocks, if we employ the principle of the constancy of the velocity of speed of light.

If my conjecture is incorrect, or if the principle of the constancy of the velocity of light is incorrect, using light and the above rocket are the same except the value of velocity; thus the necessity of using light becomes less persuasive in order to confirm the synchronization of clocks.

3. Confirming the fundamental perspective and equations in the premise of Einstein's STR

In Section 1 of his paper, Einstein defined the concept of "time" for the position where the watch is located as follows:

"*It might appear possible to overcome all the difficulties attending the definition of 'time' by substituting 'the position of the small hand of my watch' for 'time'. And in fact such a definition is satisfactory when we are concerned with defining a time exclusively for the place where the watch is located*." **< Statement (I) >**

This statement explains how the method describes time through the readings of a watch, but does not define "time" itself. Therefore, for convenience, let us hereafter assume that "time" and the indication of time displayed on the face of clock are the same, according to Einstein's definition of “time” for the place where the watch (i.e. clock) is located.

Subsequently, Einstein stated:

“*…but it is no longer satisfactory when we have to.connect in time series of events occurring at different places, or—what comes to the same thing—to evaluate the times of events occurring at places remote from the watch.*” **<Statement (II)>**

Then, he provided the equation:

$$t_B - t_A = t'_A - t_B \qquad (1)$$

t_A is the time when the light departs from point A, t_B is the time when the light is reflected by a mirror from point B, and t'_A the time when the light returns to point A. The left-hand side of Eq. (1) represents the time required for the ray of light to “go”, and the right-hand side represents the time required for the ray of light to “return.” Based on the premise that the speed of light is constant, both values are equal. Using this method, the requirement of Statement (II) is satisfied.

Based on Eq. (1), Einstein introduced the equation:

$$t_B - t_A = \frac{\gamma_{AB}}{c - v} \quad \text{and} \quad t'_A - t_B = \frac{\gamma_{AB}}{c + v} \qquad (2)$$

Both equations of (2) are expressions of the form: time = distance / speed. Einstein’s premises regarding Eq. (2) are as follows:

• Two co-ordinate systems: one is the moving system where the rigid rod is placed, and the other is the stationary system as the reference frame.

• The moving system moves with a uniform velocity (i.e. the rigid rod moves with a uniform velocity) along the positive direction of the x-axis, undergoing a parallel translation with respect to the stationary system.

• Points B and A correspond to the front and the back of the rod, respectively.

• A light source is placed at A and a mirror is placed at B to reflect the incident light to the opposite direction.

• A clock is placed at each of the points A and B.

• The round trip of a ray of light between points A and B is performed according to the formalism described by Eq. (1).

• v is the velocity of the moving rigid rod.

• c is the velocity of light. ([Note] In the original German text of the paper [1], it was described as "V".)

• γ_{AB} denotes the length of the moving rigid rod, measured in the stationary system.

Considering Eq. (2), Einstein implied that an event occurring in a moving system, viewed from that moving system, differs from the same event viewed from a stationary system. This perspective became the fundamental basis of his STR.

Regarding Eq. (3) $\frac{1}{2}(\tau_0+\tau_2) = \tau_1$, which was provided in Section 3 of the paper [1], the symbol τ corresponds to t of Eq. (1); i.e., τ_0 corresponds to t_A , τ_1 corresponds to t_B , and τ_2 corresponds to t'_A . Thus, for the round trip occurring from τ_0 to τ_1 and from τ_1 to τ_2, if referring to the form of Eq. (1), we can transpose Eq. (3) to:

$$\tau_1 - \tau_0 = \tau_2 - \tau_1 \qquad (4)$$

For consistency with the form of Eq. (2), which corresponds to time = distance/speed, we can write Eq. (1) as:

$$t_B - t_A = \frac{\text{distance } A\rightarrow B}{c} \quad \text{and} \quad t'_A - t_B = \frac{\text{distance } B\rightarrow A}{c} \qquad (5)$$

Furthermore, we can write Eqs. (3) and (4) as:

$$\tau_1 - \tau_0 = \frac{\text{distance } 0\rightarrow 1}{c} \quad \text{and} \quad \tau_2 - \tau_1 = \frac{\text{distance } 1\rightarrow 2}{c} \qquad (6)$$

All the above equations consider a round trip of light. Specifically, Eqs. (5) and (6) denote;

"the time in which the light signal moves between two points"

is equal to

"the distance that the light signal moves between the two points"

divided by

"the speed with which the light signal moves between the two points."

In other words, if we consider the equation time = distance / speed as it is used for an object that moves from a certain point to another, each element contained in this equation should be associated with the motion of the object; from this viewpoint, we can call the speed in this equation "mobile speed."

Regarding Eq. (2), the left-hand side of the equations (i.e., $t_B - t_A$ and $t'_A - t_B$) corresponds to the time in which the light signal moves from one point to another point. However, the term $c-v$ and $c+v$, which denotes speed in Eq. (2), are the relative speed between the ray of light and the moving system. They are not mobile speed. From this perspective, we can say that employing $c-v$ and $c+v$ as the speed is inconsistent with $t_B - t_A$ and $t'_A - t_B$.

In the case of Eq (5) and (6), the light signal transfers the information that the light was emitted or reflected. Of course, we can provide time data to each event by reading a clock placed at position where the light is emitted or reflected. Therefore, we can say that the light signal transfers the data (of time) from one position to another, and Eq (5) (6) express that:

"the time required for transferring the data"

is equal to

"the distance along which the data were transferred"

divided by

"the speed with which the data were transferred".

4. Confirming a better means than light

In the latter half of Section 1 of this paper, as a thought experiment, I assumed the method that does not cause time lag between two clocks. <**Figure 1** (On page 3 of this paper) >

It must be very easy for every one to understand this method, because this uses the same mechanism of the conventional mechanical clock, except the length of hand-shafts. If we do not trust time data provided by the clocks hands in this method, it is effectively the same as refusing the conventional mechanical clock.

If we use this method, the value of "the time required for transferring the data" becomes zero. Therefore, we can say that in Eqs. (5) and (6) the "speed with which the data were transferred" becomes infinite; because, if we denote "the time required for transferring the data" as "t" and "the distance along which the data were transferred" as "d", we can calculate

$\lim_{t \to +0} \frac{d}{t} = \infty$.

In the Lorentz factor $\beta = \frac{1}{\sqrt{1-v^2/c^2}}$, the term "c", which was described as "V" in the original German text of the paper [1], corresponds to the "speed with which the data were transferred." If considering the Lorentz factor with the method above, and if denoting the velocity of the moving system as the term "v" and denoting "speed with which the data were transferred" as the term "V", we can calculate $\lim_{V \to \infty} \frac{v^2}{V^2} = 0$, therefore $\beta = \frac{1}{\sqrt{1-v^2/c^2}}$ becomes $\beta = \frac{1}{\sqrt{1-0}}$, $\beta = \frac{1}{1}$.

It is very simple to consider STR with $\beta = \frac{1}{1}$; therefore, the means of the above assumption is better than light, in order to study relativity.

5. The other reason that light is not the best means

Under the principle of the constancy of the velocity of light, the light emitted from the source in the moving system advances with velocity c, when viewed from both the moving and the stationary system. However, if we thoroughly consider the motion of light, we cannot assert that this principle holds always in thought experiments, as the following discussion shows.

First, let us imagine that a very long and big straight steel pipe, whose edges are capped perfectly, is at rest along the x-axis of the moving system, similarly to Einstein's rigid rod. Accordingly, we can say that there is a closed space in the steel pipe that is not affected from the outside space. Then, we place a light source in this pipe and emit a ray of light in the positive direction of the x-axis of the moving system. Under these conditions, observers at rest in the pipe can observe the light and measure its velocity as "c"; however, observers in the stationary system cannot observe and measure the motion of the light ray in the pipe because the steel of the pipe obstructs the view of the interior of the pipe. In this case, the light in the steel pipe does not adhere to the principle of the constancy of the velocity of light for the stationary system, if viewed from the stationary system.

On the other hand, if we place the light source on the exterior of the steel pipe, this condition is the same as that of the light source on Einstein's rigid rod. Therefore, the observers in the moving system and in the stationary system can both observe the light, and they can measure the velocity of light as "c", if we employ the principle of the constancy of the velocity of light.

The above considerations are probably very clear for everyone; however, if we change the steel pipe to a glass pipe and place the light source in the glass pipe, it is difficult to assess whether this condition applies to the principle of the constancy of the velocity of light, because:

• The glass does not obstruct the view of the interior of the pipe; therefore, the observers in the stationary system can observe the motion of the light in the pipe.

• However, the light is enclosed; thus, the light physically belongs to the closed space inside the pipe.

• From these two conditions, we can say that the light in the glass pipe is visually open and physically closed.

• If the principle of the constancy of the velocity of light requires only the visual condition, the light in the glass pipe is consistent with the principle of the constancy of the velocity of light; because the observers in the stationary system can observe the motion of the light, from when the light source emits the light until when the light reaches to a destination, and the result that measured the velocity of light will indicate “c”.

• However, if the principle of the constancy of the velocity of light requires physical conditions, the light in the glass pipe does not adhere to the principle of the constancy of the velocity of light, same as the light in the steel pipe.

In reality, we cannot see a motion of ray of light directly, because light itself is invisible except the case looking at the light source or reflections of light directly. However, if assuming as a thought experiment that a gas is enclosed in the pipe that reflects the ray of the light, we can have an image that the ray advances in the glass pipe with a speed near c. However, we cannot expect that, the observers in the stationary system can see the motion of the ray in the steel pipe, and comprehend the relationship between the closed space in the steel pipe and the open space that the steel pipe and the reference stationary system both belong to.

From the above, I conclude that the results of the observations are different depending on whether the light source is placed in the steel pipe or in the glass pipe, or on the exterior of the pipe. This implies that if we want to consider STR as a universal theory, using light is not appropriate.

6. Attention when using light as the means to study relativity

Considering the above, we found that using light is preferable to using the rocket or any other massive object, but light is not the best means when studying relativity. However, light still has merits, as its motion in vacuum is very fast and straight, and has a uniform velocity. Nevertheless, we must pay attention to the following, when using light.

As a very important premise, when using the universal equation “time=distance/speed” to describe an object that moves from a certain point to another, each element of this equation (i.e., time, distance, and speed) should be associated with the motion of the object.

However, Einstein did not compose this equation using only such elements. For example, in Eq.(2), Einstein inserted the relative speed in the place where the mobile speed should be used. In the same equations, Einstein used γ_{AB}, which denotes “*the length of the moving rigid rod - measured in the stationary system*”, as “distance”. As a result, Eq. (2) becomes the equation which denotes:

“the time interval of the motion of light between points *A* and *B*”

is equal to

“the length of rod measured in the reference stationary system”

divided by

“the relative speed between the speed of light and the speed of the moving system.”

This structure does not have logical consistency.

It is not clear whether it is possible to assume the concepts of “relative time” and “relative distance” in the universal equation “time=distance/speed”; but, if we want to provide the relative speed into “time=distance/speed” at all cost, this “time” should be “relative time” and this “distance” should be “relative distance”. In any case, we must always maintain logical consistency.

7. Confirming the case precluding inconsistency in Eq. (2)

From the above analysis, we confirm that; if we hold logical consistent, light can be used for studying relativity, except the cases shown in Section 5 of this paper (i.e. the cases “light in pipe”). However, we have already confirmed that the relative speed (i.e., “$c-v$” “$c+v$”) and “γ_{AB}” are not appropriate for use in Eq. (2). Based on this, I demonstrate a method to denote the round trip of light in a moving system, measured from a stationary system without inconsistency, by modifying Eq. (2) in the following way:

$$t_B - t_A = \frac{\gamma_{AB}}{c-v} \quad \text{and} \quad t'_A - t_B = \frac{\gamma_{AB}}{c+v} \qquad (2)$$

First, we have to understand the purpose of Eq. (2). Eq. (2) is based on the premise of Eq. (1), given by $t_B - t_A = t'_A - t_B$. Eq. (1) confirms the synchronization of two clocks, by calculating the time intervals of "go" and "return" in the round trip of light. Eq. (1) itself cannot be used to confirm or calculate the length of the rod or the value of the speed of light.

Eq. (2) was in order to confirm the synchronization of two clocks placed in a moving system by applying the same round trip of light technique used in Eq.(1), as viewed from a stationary reference system. In fact, Einstein used Eq. (2) to emphasize the following statement in a conclusion of Section 2 of his paper [1],

"*Observers moving with the moving rod would thus find that the two clocks were not synchronous, while observers in the stationary system would declare the clocks to be synchronous.*"

Therefore, even though the two equations have two different observers, one that is in the stationary system and the other that is in the moving system, their purpose is the same, i.e., confirming the synchronization of two clocks. In order to attain the above purpose, we have to calculate time intervals of "go" and "return" in the round trip of light. In other words, the eventual purpose of Eq. (2) is confirming the synchronization of two clocks, and the purpose for attaining the confirmation is the calculation of the time intervals.

We already confirmed that the quantities $c-v$, $c+v$ and γ_{AB} are not appropriate to use in Eq. (2); therefore, we need to identify appropriate elements to use in Eq. (2), instead of $c-v$, $c+v$ and γ_{AB}.

Regarding the speed, we can use the mobile speed of light (i.e., just "c"), instead of the relative speeds $c-v$ and $c+v$.

Instead of "γ_{AB}", we can use the "*light path*" which was provided by Einstein in Section 1 of his paper [1]. To precisely express the light path from a viewpoint of time sequence:

In the left equation $t_B - t_A = \frac{\gamma_{AB}}{c-v}$, "the light path from point A at the time when light departed to point B at the time when the light reached the point B (i.e., reflected by the mirror), viewed from the stationary system".

In the right equation $t'_A - t_B = \frac{\gamma_{AB}}{c+v}$, "the light path from the point B at the time when the light reflected by the mirror to the point A at the time when the light arrived the point A, viewed from the stationary system."

Thus, according to the above perspective, if we denote the positions of points A and B, as viewed from the stationary system when A is at t_A as At_A, B at t_B as Bt_B, A at t'_A as At'_A, respectively, Eq. (2) can be modified as:

$$t_B - t_A = \frac{Bt_B - At_A}{c} \quad \text{and} \quad t'_A - t_B = \frac{-(At'_A - Bt_A)}{c} \qquad (7)$$

Kindly note that the numerator on the right-hand side of the right equation of Eq. (7) expresses the light path in the negative direction of the x-axis. Therefore, we must multiply the term $At'_A - Bt_B$ with minus one.

For validating Eq. (7), let us substitute the numerical value below in Eq. (7). For this, let us assume the following conditions: <**Figure 2, 3** (On page 15,16 of this paper)>

- The distance between points A and B is the distance that light can travel in 1s in the moving system, denoted as "l ". In other words, this distance corresponds to the length of Einstein's rigid rod, which is placed on the moving system.
- The moving system moves at a uniform velocity "v", which is half the speed of light (i.e., $c\times0.5$).
- When t = 00 s, the position of the light source placed at point A of the moving system accords to the origin of the stationary system along x-axis, and the light source emits light in the positive direction of the x-axis.

Under these conditions, an observer in the stationary will observe the following:

- Go interval (from At_A to Bt_B): $l \times 2$
- Return interval (from Bt_B to At'_A): $l \times 2/3$
- t_A (the time when light was emitted by the light source): 00 s
- t_B (the time when light was reflected by the mirror): 02 s
- t'_A (the time when light returned to A): 2/3 s after 02 s

Among the time points listed above, t'_A has a fractional value of 2/3 s, i.e., less than 1 s. This value is obtained as follows. At 02 s, the point A, which is at a distance of $l \times 1$ from the origin of the stationary system, advances along the positive direction of the x-axis at a speed of $c \times 0.5$. At the same instant, light is reflected by the mirror, which is at a distance of $l \times 2$ from the origin of the stationary system. This light moves toward the point A at a speed $c\times1$. As a result, the point A meets the reflected light at a time 2/3 s after 02 s.

The time taken by traveling light, as viewed from the stationary system, is as follows:

- Go interval (from t_A to t_B): 02 s

- Return interval (from t_B to t'_A): 2/3 s

As described above, we can confirm the velocity using the formula: distance ÷ time = speed. The results are as follows:

- Go interval: $l \times 2 \div 2$ s $= c$
- Return interval: $l \times 2/3 \div 2/3$ s $= c$

Substituting these numerical values into Eq. (7),

$$2t - 0t = \frac{l \times 2 - l \times 0}{c} \quad \text{and} \quad (2t + 2/3\,t) - 2t = \frac{-\{(l \times 1 + l \times 1/3) - l \times 2\}}{c} \qquad (8)$$

This gives us the following expressions:

$$2t = \frac{l \times 2}{c} \quad \text{and} \quad 2/3\,t = \frac{l \times 2/3}{c} \qquad (9)$$

To obtain the equation in the form: speed = distance ÷ time, we re-arrange Eq. (9) to give,

$$c = \frac{l \times 2}{2t} \quad \text{and} \quad c = \frac{l \times 2/3}{2/3t} \qquad (10)$$

This gives us the following result for each equation:

$$c = 1 \quad \text{and} \quad c = 1. \qquad (11)$$

From the above analysis, we also confirm that the velocity of the moving system, "v", does not affect to relativity, if we employ the principle of the constancy of the velocity of light as means to study relativity. If we assume that the meaning of "v does not affect to relativity" is the same as "the value of v in relativity is effectively always zero", we can express the term "v^2/c^2" in the Lorentz factor as $\lim_{v \to +0} \frac{v^2}{c^2} = 0$. Therefore, the Lorentz factor $\beta = \frac{1}{\sqrt{1 - v^2/c^2}}$ becomes $\beta = \frac{1}{\sqrt{1-0}}$, $\beta = \frac{1}{1}$. The result $\beta = \frac{1}{1}$ is the same as the result of considering the Lorentz factor with the method which does not cause a time lag between the two clocks, outlined in Section 4 of this paper.

8. Overview

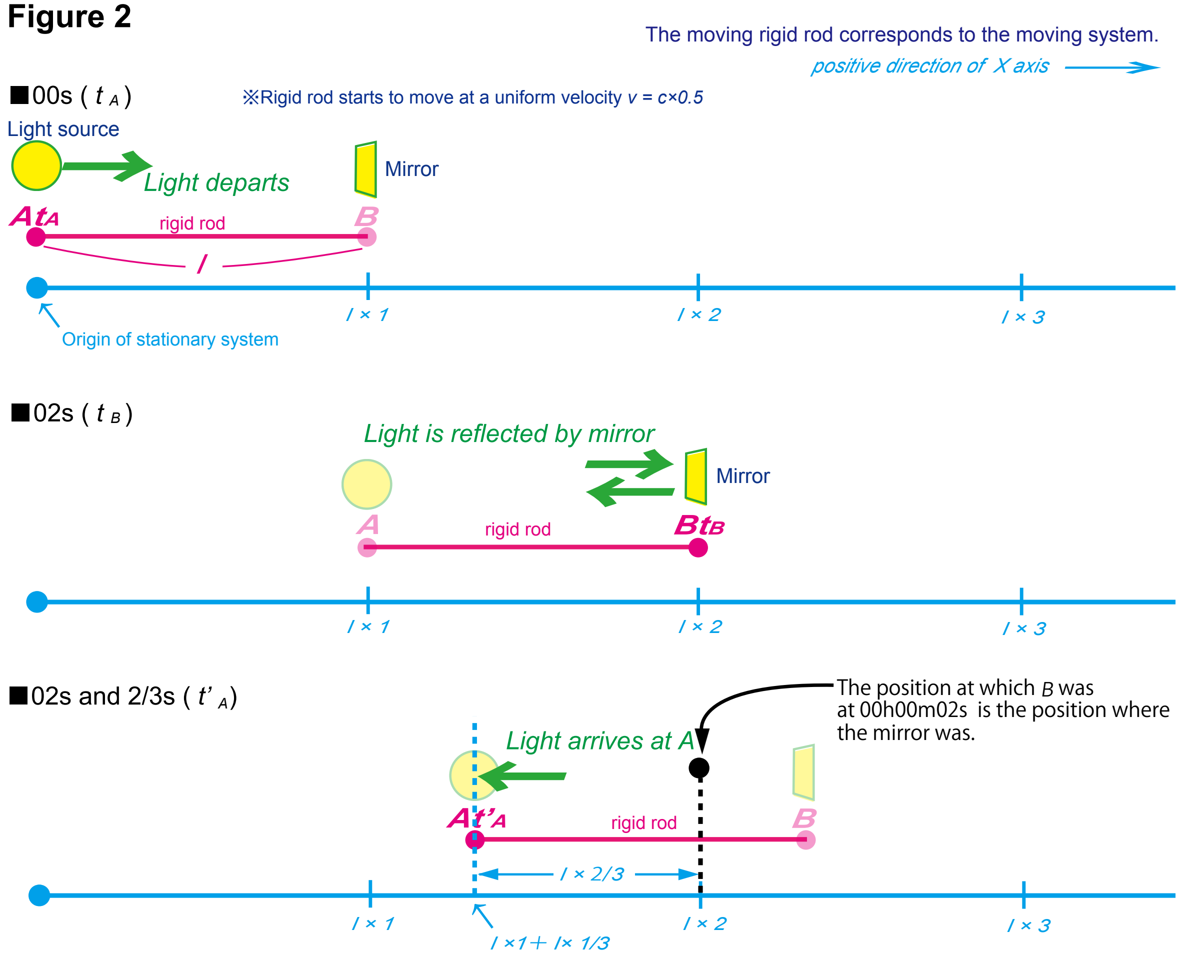
In Section 2 of this paper, we confirmed that light is a better alternative to a rocket or any other massive object in order to confirm the synchronization of clocks, because the former can be a mediation between the moving system and the stationary system, if we employ the principle of constancy of the velocity of light. For using light as a mediation, it is necessary to always maintain logical consistency in the universal equation, time = distance/speed. Thus, we need to exclude $c-v$, $c+v$, and γ_{AB} from the equation. If we do so, we obtain $\beta = \frac{1}{1}$, yielding the same results as obtained using the method that does not cause a time lag between the two clocks. Moreover, this method does not require any equations beyond elementary mathematics.

However, in the development process of the Lorentz factor, Einstein used higher mathematics, but could not ensure the consistency of time = distance/speed. The only possible reason for this is the suitability of denoting the relative speed $c–v$ as physics or mathematics. Einstein persisted in using the relative speed $c–v$. This is why the Lorentz factor includes the terms v, not only c, though employing the principle of the constancy of the velocity of light.

Even if we use light as a means for confirming the synchronization of clocks, and ensure the consistency of the equation time = distance/speed, the issue of the motion of light in the steel pipe and the glass pipe, as shown in Section 5 of this paper, will arise.

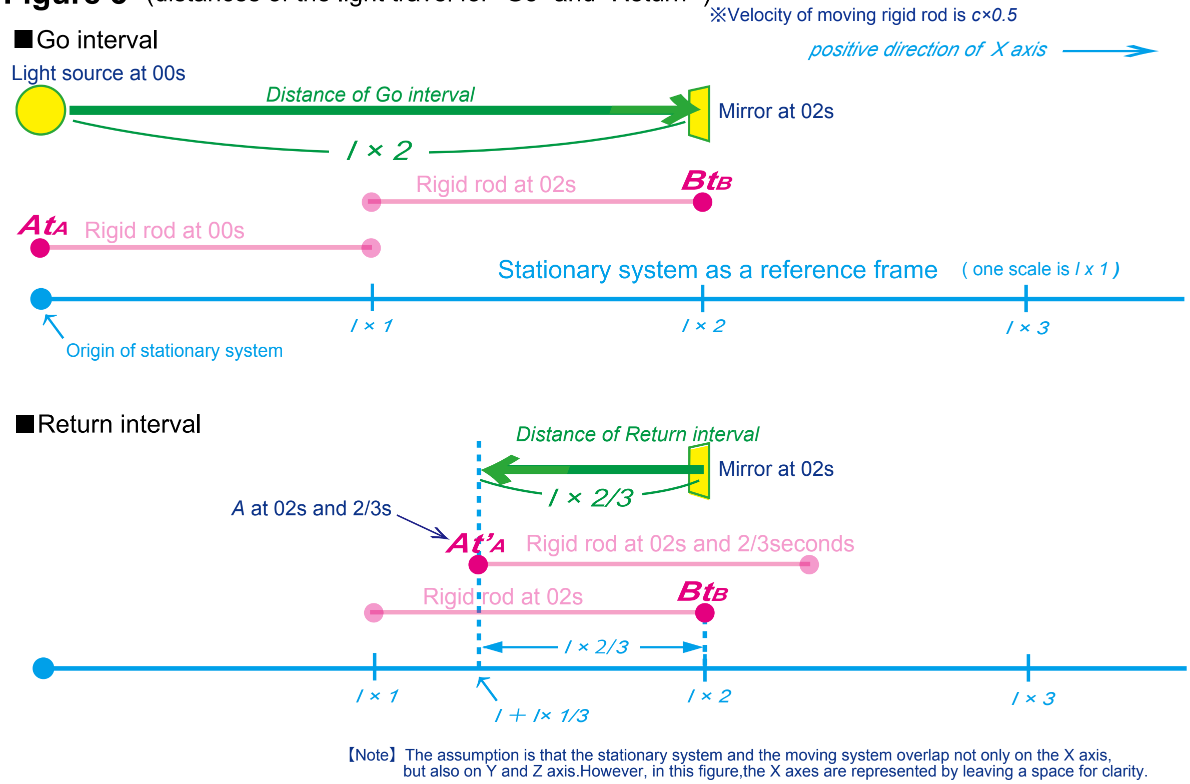
If our purpose is to unravel the mechanism behind the principle of the constancy of the velocity of light or characteristic of light, naturally we must use light in order to unravel it. Since this purpose is undoubtedly attractive and significant, we should continue to study the above mechanism. However, it is not appropriate to continue using light only, in order to confirm the synchronization of clocks. Henceforth, we should also use the means that does not cause a time lag between two clocks to study relativity.

Figure 2



【Note】 The assumption is that the stationary system and the moving system overlap not only on the X axis, but also on Y and Z axis.However, in this figure,the X axes are represented by leaving a space for clarity.

Figure 3 (distances of the light travel for “Go” and “Return”)



Reference

[1] Perrett,W., Jeffery, G.B., On the Electrodynamics of Moving Bodies, English translation of “Zur Elektrodynamik bewegter Körper”, German Das Relativatsprinzip, [4th ed] Tuebner, 1922. Einstein, A. Zur Elektrodynamik bewegter Körper. Annalen der Physik. 17:891, (1905). This version of Einstein’s paper appeared in the book “The Principle of Relativity”, published in 1923 by Methuen and Company, Ltd. of London. All of these sources are now in the public domain.

[2] Masahiko Makane, Unnecessary Equations in §2 of “On the Electrodynamics of Moving Bodies”, the General Science Journal, on March 11, 2015.

[3] Masahiko Makane, *c–v* is not usable for dividing the “*light path*”, the General Science Journal, on May 7, 2015, the minor revised version on June 16, 2015.

[4] Masahiko Makane, γ_{AB} *is not appropriate as the distance contained in “time=distance/ speed*, the General Science Journal, on March 17, 2015.

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