Applied Physics Research; Vol. 8, No. 6; 2016
ISSN 1916-9639 E-ISSN 1916-9647
Published by Canadian Center of Science and Education

Thought Experiment Revealing a Contradiction in the Special Theory of Relativity

Koshun Suto[1]

[1] Chudaiji Buddhist Temple, Isesaki, Japan

Correspondence: Koshun Suto, Chudaiji Buddhist Temple, 5-24, Oote-Town, Isesaki, 372-0048, Japan. Tel: 81-270-23-9980. E-mail: koshun_suto129@mbr.nifty.com

Received: November 21, 2016 Accepted: November 25, 2016 Online Published: November 28, 2016

doi:10.5539/apr.v8n6p70 URL: http://dx.doi.org/10.5539/apr.v8n6p70

Abstract

In the thought experiment in this paper, we considered inertial frames M and A moving at a constant velocity relative to each other. A light signal emitted from inertial frame A, when time of a clock in inertial frame A was 1(s), arrived at inertial frame M when time of a clock in inertial frame M was 2(s). In this paper, the time in inertial frame A when the time in inertial frame M was 2(s) was predicted by observers in inertial frames M and A by applying the special theory of relativity (STR). Predictions of the two observers did not match. Einstein regarded all inertial frames as equivalent, but there are cases where a velocity vector is attached to some inertial frame. Einstein overlooked this fact, and thus a discrepancy appeared in the values predicted by the two observers. It is not the case that all inertial frames are equivalent. This paper concludes that the STR is a theory incorporating a contradiction which must be corrected.

Keywords: Special Theory of Relativity, Minkowski Diagram, Velocity Vector

1. Introduction

STR is not just a single theoretical system. It is composed of two theories of different types. The first is a theory derived from Lorentz transformations which has full symmetry, and the second is Einstein's energy-momentum relationship which holds in free space.

Consider a rod A (inertial frame A) and rod B (inertial frame B) moving at constant velocity relative to each other. First, let us regard inertial frame A as a stationary system, and treat inertial frame B as a moving system in motion at constant velocity $\boldsymbol{v}$ in the x-axis direction of inertial frame A.

According to the STR, when length in the direction of motion of rod B, moving at constant velocity, is measured from inertial frame A, the rod contracts in the direction of motion. Also, the time which elapses on clock B in inertial frame B is delayed compared to the time which elapses on clock A in inertial frame A.

If, conversely, inertial frame A is measured from inertial frame B, rod A contracts in the direction of motion, and the time which elapses on clock A is delayed.

According to Einstein's "principle of relativity," the two inertial frames are equivalent, and thus the same results are obtained no matter which inertial frame measurement is carried out from. The essence of STR is the symmetry of the theory.

Theoretically, there is no problem with the STR, as indicated below:

1) It is mathematically complete.
2) It can be explained using Minkowski diagrams.

It is also thought that the correctness of the STR has been demonstrated based on the following two types of experiments:

1) Extended life of elementary particles.
2) When the velocity of a moving object increases, the mass (or energy) of the object increases.

Experiment (1) is recognized even by physicists who have doubts about the STR. However, to demonstrate the correctness of the STR, one must observe lengthening of the life of stationary elementary particles from a moving system. Experiments carried out thus far have not demonstrated the symmetry of time delay.

Next is Einstein's energy-momentum relationship, which holds in free space.

$$\left(mc^2\right)^2 = \boldsymbol{p}^2c^2 + \left(m_0c^2\right)^2. \quad (1)$$

Here, m_0c^2 is the rest mass energy of a particle or object, mc^2 is the relativistic energy, and p is the momentum. According to Equation (1), when the velocity of a moving object increases, the mass (or energy) of the object also increases. However, even if physical quantities of a stationary system are measured from a moving system, the STR does not assert that the same results are obtained. That is, there is no symmetry in Equation (1). Even if we assume that an increase in the mass of a moving object has been detected, that does nothing more than demonstrate the correctness of Equation (1).

Incidentally, Equation (1) is not applicable in the atom where potential energy exists (Suto, 2011: Suto, 2014: Suto, 2015). However, the equation definitely holds in free space. The STR which this paper views as a problem is the former theory which has perfect Lorentz symmetry.

2. Thought Experiment Indicating a Contradiction in the Special Theory of Relativity

Thought experiment: Rocket A is moving at a constant velocity of 3*c*/5 in the *x*-axis direction of "Stationary system." (In the following, "Stationary system may be indicated as S, and the coordinate system of rocket A as S'_{A}.)

There is an observer M at the origin O of the *x*-axis of S, and M has a stopwatch W. In addition, there is an observer A at the origin O'_{A} of the x'_{A}-axis of S'_{A}, and A has a stopwatch $\mathrm{W_A}$. (In the following "stopwatch W" may be abbreviated as W, and "stopwatch $\mathrm{W_A}$" as $\mathrm{W_A}$.)

Now, when rocket A passes in front of observer M in S, observer M starts W, and observer A starts $\mathrm{W_A}$.

According to the STR, an observer in S, finds the following relationship between the time *t* which elapses on W and the time t'_{A} which elapses on $\mathrm{W_A}$.

$$t'_{\mathrm{A}} = \frac{t}{\gamma} = t\left(1-\frac{v^2}{c^2}\right)^{1/2}. \quad (2)$$

Here, when 1(s) is substituted for *t*,

$$t'_{\mathrm{A}} = \frac{4}{5}\ \text{(s)}. \quad (3)$$

Here, this thought experiment is explained using Minkowski diagram 1 (see Figure 1).

Point O indicates both origins: $x=0$, $t=0$ and $x'_{\mathrm{A}}=0$, $t'_{\mathrm{A}}=0$. The point event $\mathrm{M_0}$ of the point light source O and the point event $\mathrm{A_0}$ of the point light source O'_{A} are at the origin O. (Here, the subscripts "$_0$" of the point events $\mathrm{M_0}$ and $\mathrm{A_0}$ mean, respectively, $t=0$ and $t'_{\mathrm{A}}=0$.)

The *x*-axis indicates the *x*-axis of the inertial frame S when $t=0$. In addition, the x'_{A}-axis indicates the x'_{A}-axis of the inertial frame S'_{A} when $t'_{\mathrm{A}}=0$.

The *ct*-axis is the path for $x=0$. Put another way, it is the world line of the origin of S. The ct'_{A}-axis is the world line of the origin of S'_{A}.

In addition, the straight line extending at a 45° angle from the origin O indicates the light signal emitted from the two light sources at the instant that O and O'_{A} pass by each other.

OE is the distance over which the light signal emitted from O propagates in the *x*-axis direction while 1(s) elapses on the stopwatch W in S.

OE′ is the distance over which the light signal emitted from O'_{A} propagates in the x'_{A}-axis direction while 1(s) elapses on the stopwatch $\mathrm{W_A}$ in S'_{A}.

Oe is the value when an observer in S measures the distance OE′, and Oe′ is the value when the distance OE is measured by an observer in S'_{A}. However, Ee′ is parallel to the *ct*-axis, and eE′ is parallel to the ct'_{A}-axis. Therefore, the relationship between OE, OE′, Oe and Oe′ is as follows.

$$\frac{\mathrm{Oe}}{\mathrm{OE}} = \frac{\mathrm{Oe}'}{\mathrm{OE}'} = \frac{1}{\gamma}, \qquad \gamma = \left(1-\frac{v^2}{c^2}\right)^{-1/2}. \quad (4)$$

Here, when the position of the point E is determined, it is possible to determine the positions of the points e′, e and E′ based on the relationship in Equation (4).

Furthermore, if a point is plotted on the *ct*-axis at a distance equal to OE from O, that is the point event M_1 for O at $t = 1(s)$.

Also, if a point is plotted on the ct'_A -axis at a distance equal to OE′ from O, that is the point event A_1 for O'_A at $t'_A = 1(s)$.

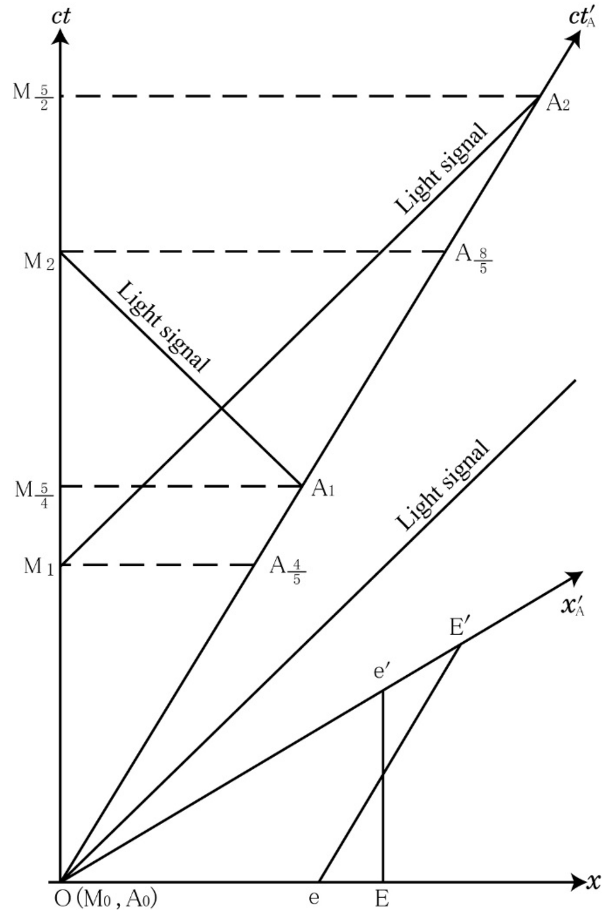

Figure 1. Minkowski diagram 1: This diagram corresponds to thought experiment

Now, how should we find the relationship between the times which elapse in the stationary system and in the coordinate system of rocket A?

To find that, it is enough to compare the times when the straight line parallel to the *x*-axis intersects with the *ct*-axis and ct'_A -axis.

For example, among the lines which pass through M_1, the straight line parallel with the *x*-axis intersects the ct'_A -axis at point $A_{4/5}$, and this is the point event of W_A when $t = 1(s)$. Therefore t'_A matches with Equation (3).

Now when W in S is at 1(s), a light signal is emitted from O to O'_A in S'_A. That light propagates isotropically with respect to O. Then it arrives at O'_A when W_A on rocket A is 2(s). (This light signal corresponds to the world line M_1A_2.)

In the inverse case, when W_A on rocket A is 1(s), a light signal is emitted from O'_A to O. That light arrives at O when W of the stationary system is 2(s). (This light signal corresponds to the world line A_1M_2.)

These results also seem to show there is symmetry between the two inertial systems. In this paper, the propagation situation of the two light signals (M_1A_2 and A_1M_2) is expressed as follows.

$$t = 1\ (s) \rightarrow t'_A = 2\ (s), \tag{5a}$$

$$t' = 2\ (s) \leftarrow t_A = 1\ (s). \tag{5b}$$

Now, are the two inertial systems truly equivalent, as claimed by the STR? Next let's try having observer M and A predict the time of W_A on rocket A when W is 2(s).

3. Discussion

A. Prediction of observer M (prediction based on the STR) (see Figure 2 (a))

In this paper, the moving object is taken to be rocket A, which has passed through an acceleration stage. Therefore, the time t'_A of W_A can be found from Equation (2).

To find t'_A when $t = 2(\mathrm{s})$, it is enough to substitute 2(s) for *t* and 3*c*/5 for *v* in Equation (2). This yields:

$$t'_A = \frac{t}{\gamma} = 2\left[1 - \frac{(3c/5)}{c^2}\right]^{1/2} = 1.6\ (\mathrm{s}). \tag{6}$$

The observer in S concludes that the time t'_A of W_A when the time of W is 2(s) is 1.6(s).

B. Prediction of observer A (prediction based on the STR) (see Figure 2 (b))

The observer in rocket A regards his own coordinate system as the stationary system. With the STR, the observer in S_A predicts the value of the time t_A of W_A as follows when the time of W in S' is 2(s).

$$t_A = \gamma t' = 2\left[1 - \frac{(3c/5)}{c^2}\right]^{-1/2} = 2.5\ (\mathrm{s}). \tag{7}$$

The observer in S_A concludes that the time t_A of W_A when the time of W is 2(s) is 2.5(s).

In the end, if observers M and A predict the time of W_A at a certain instant by applying the STR, different values are obtained.

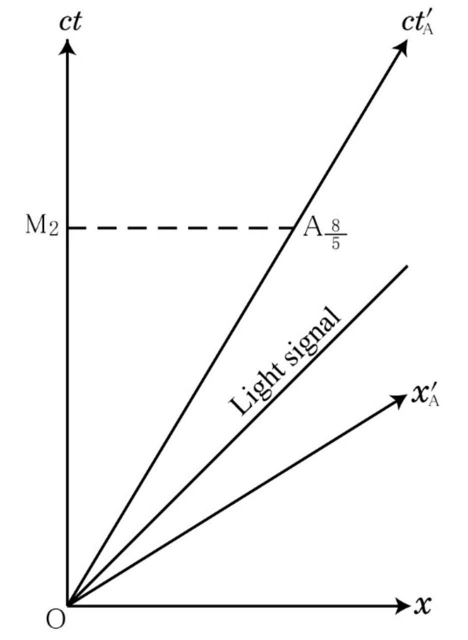

Figure 2(a). Minkowski diagram 2: Prediction of observer M applying the STR, $t = 2\ (\mathrm{s}) \leftrightarrow t'_A = 1.6\ (\mathrm{s})$

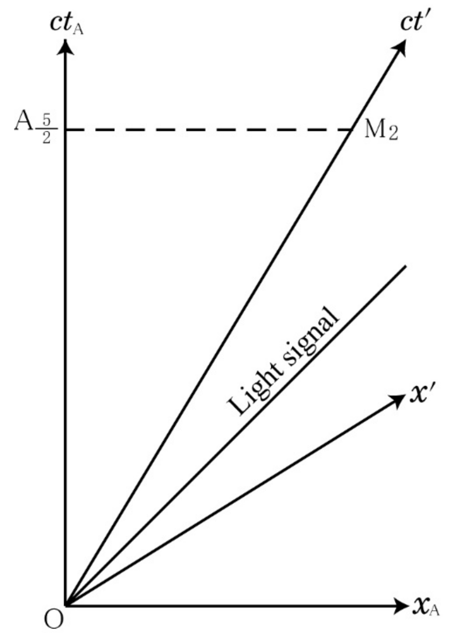

Figure 2(b). Minkowski diagram 3: Prediction of observer A applying the STR, $t' = 2\ (\mathrm{s}) \leftrightarrow t_A = 2.5\ (\mathrm{s})$

4. Conclusion

In the thought experiments in this paper, the light signal emitted from O'_A of rocket A when the time of W_A was 1(s) arrived at O of S when the time of W was 2(s). In this paper, the observer M in S and observer A on rocket A predicted the time of W_A in rocket A when the light signal arrived at O.

(1) Prediction of observer M applying the STR

Observer M predicts 1.6(s) as the time t'_A of W_A when $t = 2$ (s). That is,

$$t = 2 \text{ (s)} \leftrightarrow t'_A = \underline{1.6 \text{ (s)}}. \tag{8}$$

(2) Prediction of observer A applying the STR

Observer A predicts 2.5(s) as the time t_A of W_A when $t' = 2$ (s). That is,

$$t' = 2 \text{ (s)} \leftrightarrow t_A = \underline{2.5 \text{ (s)}}. \tag{9}$$

If STR is applied, there is no match between the times of W_A predicted by observers M and A. This means that at least one of these predictions is wrong.

However, in the thought experiment in this paper, it is not possible to determine the correctness of the predictions of the two observers. If a conclusion based on experiment is required, a more complex thought experiment will be necessary (Suto, 2010, 2015).

Einstein regarded all inertial frames as equivalent, but there are cases where a velocity vector is attached to some inertial frame (Suto, 2010: Suto, 2015). Einstein overlooked this fact, and thus a discrepancy appeared in the values predicted by the two observers. It is not the case that all inertial frames are equivalent. This paper concludes that the STR is a theory incorporating a contradiction which must be corrected.

Acknowledgments

I would like to express my thanks to the staff at ACN Translation Services for their translation assistance. Also, I wish to express my gratitude to Mr. H. Shimada for drawing figures.

References

Suto, K. (2010). Violation of the special theory of relativity as proven by synchronization of clocks. *Physics Essays, 23*(3), 511-519. http://dx.doi.org/10.4006/1.3474836

Suto K. (2011). An energy-momentum relationship for a bound electron inside a hydrogen atom. *Physics Essays, 24*(2), 301-307. http://dx.doi.org/10.4006/1.3583810

Suto K. (2014). Previously unknown ultra-low energy level of the hydrogen atom whose existence can be predicted. *Applied Physics Research, 6*(5), 109-115. http://dx.doi.org/10.5539/apr.v6n5p64

Suto K. (2015). Demonstration of the existence of a velocity vector missing from the special theory of relativity. *Physics Essays, 28*(3), 345-351. http://dx.doi.org/10.4006/0836-1398-28.3.345

Suto K. (2015). Presentation of strong candidates for dark matter. *Global Journal of science frontier research: A, 15*(7), 1.0, 1-6.