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On the validity of special relativity

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Abstract

The formulae of length contraction and time dilation, which are derived from the special Lorentz transformation in special relativity, do not agree with common sense. The relativity of space and time deduced from the above formulae is controversial. In this work the problem of a description of the physical reality of length contraction and time dilation is solved. From the Galilean transformation it is deduced that space is relative and time absolute.

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1 Introduction

Special relativity has a few problems in spite of its success. The problems were discussed after publication of the theory but rarely mentioned nowadays because of the discovery of the rest energy. It is believed that the theory is valid for systems moving at high speeds. However, this statement seems to be wrong if we consider the theory more deeply.

A physical theory can be accepted as a correct theory if the theory is in complete agreement with experimental results. The validity of length contraction and time dilation derived from the special Lorentz transformation cannot be precisely tested. Thus these two formulae have to be in coincidence with common sense. However they do not agree. Therefore they are the unsolved problems of the laws of nature. The problems are subtle, since length contraction and time dilation, according to Einstein, are connected with the relativity of space and time, i.e., the fundamental philosophy of special relativity.

Einstein believed that space and time are relative for systems moving at high speeds, since length contraction and time dilation can be derived from the Lorentz transformation. However, the relativity of space has nothing to do with the length contraction of a rod but depends on whether space can be divided into subspaces. The relativity of time also depends on whether time can be divded.

In this work the problem of describing the physical reality of length contraction and time dilation is solved, and the theory of the relativity of space and time is newly formulated on the basis of the Galilean transformation.

2 The special Lorentz transformation

The Lorentz transformation is a linear transformation of the space-time coordinate x^n that leaves the quadratic form invariant

$$x^2 = (x^0)^2 - (x^1)^2 - (x^2)^2 - (x^3)^2. \tag{1}$$

The transformation includes translation, rotation, and the operation of space inversion and time reversal, which play an important role in field theory. In this work we consider the special transformation.

When a frame S' moves in the x-direction with constant high speed v close to the speed of light, relative to a reference frame S, the coordinates x, y, z, t of the frame S are related to the coordinates x', y', z', t' of the frame S' as follows;

$$x' = \frac{x - vt}{\sqrt{1 - \frac{v^2}{c^2}}}, y' = y, z' = z, t' = \frac{t - \frac{vx}{c^2}}{\sqrt{1 - \frac{v^2}{c^2}}}, \tag{2}$$

where $\sqrt{1 - \frac{v^2}{c^2}}$ is a constant of proportionality. This is the well known special Lorentz transformation. The quadratic form (1) is invariant under this transformation only if the time coordinate x^0 has the dimension of length, i.e., $x^0 = ct$. If the time coordinate has the dimension of time, i.e., $x^0 = t$, the transformation (2) does not leave the form invariant.

The special Lorentz transformation is significant only when a system moves relative to another system at speeds approaching the speed of light. It is noted that the systems do not mean particles but frames in which an obserber can observe or measure a physical event. However, there is no such system in the real world or in macrosystems, i.e., planet and galaxy.

3 Length contraction and time dilation

In this section we deal with the problem of a description of the physical reality of two fomulae, length contraction and time dilation, derived from the special Lorentz or the inverse Lorentz transformation.

Let us suppose a rod lies along the x-axis in the frame S' moving relative to a frame of reference S at a high speed v. An observer A measures the unchangeable proper length $L_0 = x'_2 - x'_1$ of the rod in the frame S' with the coordinates x', y', z', t'. According to the special Lorentz transformation, the length of the rod is measured as $L = x_2 - x_1 = L_0\sqrt{1 - \frac{v^2}{c^2}}$ by another observer B in the frame S. That is, the observer B measures a length shorter than the proper length L_0 of the rod with the coordinates x, y, z, t, while the observer A always measures the proper length L_0 of the rod with the coordinates x', y', z', t'.

Let us consider another case to make the situation clear. If the frame S' is first at rest relative to S, the observer B measures the length of the rod as $L = L_0$. If the frame S' travels for 10 minutes at a high speed and returns to its original position at a low speed, then the observer B should measure the length of the rod as $L = L_0$, since the observer A always measures the proper length L_0 of the rod in the frame S' regardless of the speed of the frame S'. That is, the proper length L_0 was not changed. Therefore, the length L of the rod as measured in the frame S during the journey time of the frame S' is not a real length but the length of the picture of the rod, similar to the picture of an object transformed by a lens. The effect of high speed corresponds to that of a lens in optics [Fig.1].

The real length L_0 of the rod cannot be changed in spite of the high speed of the frame S'. If the rod itself moves at high speeds, then the real length of the rod can be changed. It is noted that the length contraction of the picture of an object occurs only in the direction of the relative motion.

Let us suppose an observer A observes an event at the time t'_1 in the frame S' moving at a high speed v and another event after 5 seconds, i.e., at the time $t'_2 = t'_1 + 5$. The proper time interval t_0 measured with the clock of A in the frame S' is $t_0 = t'_2 - t'_1 = 5$ seconds. According to the Lorentz transformation, the time interval measured by the other observer B in the frame S is $t = t_2 - t_1 = \frac{t_0}{\sqrt{1-\frac{v^2}{c^2}}}$, that is, the observer B measures a longer time interval than t_0 with the coordinates x, y, z, t.

This is not a realistic phenomenon. If the frame S' is at rest, the observer A measures the proper time interval t_0 in the frame S' and the observer B measures the interval as $t = t_0$ in the frame S with their own clocks. Although the frame S' moves at a high speed, the observer B should measure the time interval as $t = t_0$, since the observer A always measures the proper time interval t_0 in the frame S' regardless of the speed of the frame S' and two clocks go at the same speed. Therefore, the time interval t between two events derived from the special Lorentz transformation is not realistic, that is, the time interval $t = \frac{t_0}{\sqrt{1-\frac{v^2}{c^2}}}$ is not a real interval but only an interval of the transformed picture of the proper time interval t_0.

4 Are space and time relative ?

According to Newton[1], space and time are absolute. Leibnitz[2] regards space and time as relative. Einstein[3,4] also deduces from length contraction and time dilation that space and time are relative. Since length contraction and time dilation derived from the special Lorentz transformation are nonrealistic phenomena, the relativity of space and time should be reviewed.

For the world we experience the Galilean transformation is valid. According to the transformation, for a frame S' moving in the x-direction with the constant speed v relative to a frame of reference S the coordinates x, y, z, t of the frame S are related to the coordinates x', y', z', t' of the frame S' as follows;

$$x' = x - vt, (a) \qquad y' = y, (b) \qquad z' = z, (c) \qquad t' = t.(d) \quad (3)$$

Space can be divided into subspaces, and the relation between two subspaces is established in the Galilean transformation (a-c). The difference ($x \neq x'$) in the x coordinate means that space is relative. If space is absolute, x is equal to x', that is, space cannot be divided. A space can be considered as a volume. Therefore we can divide the space.

Einstein believed that space is absolute in the case of the Galilean transformation, since length contraction does not occur in the transformation. He concluded that space is relative in the case of the special Lorentz transformation, since length contraction occurs in the transformation. However, his conclusion may be wrong because the relativity of space has nothing to do with the change of the length of a rod, and the length contraction derived from the Lorentz transformation is not realistic.

Let us suppose an event happens at the time t' in the frame S'. An observer A measures the time t' in the frame S' and another observer B measures the time t in the frame S with their own clocks. As we see in the transformation (d), the time t' measured by the observer A is equal to the time t measured by the observer B. This is valid regardless of the speed and the direction of the frame S'. Time cannot be divided. If time can be divided, the time t' is not equal to t. This fact means that time is absolute.

Time has different properties from space. Time is abstract and invisible which is perceived due to the fact that matter alters its position

and form. A clock is an instrument for concrete measurement of time and minutes, seconds etc are not divisions but precise indications of time. We cannot arbitrarily change time and are powerless against time. We can move from a space to another space, but we cannot go back to the past or go into the future.
Time itself is absolute. However, the product of the light speed c and the time t is relative like the space coordinates, since ct has the dimension of length. Therefore we have to use ct instead of t as a component of the quadratic form (1) and of the four-dimensional line element ($ds^2 = g_{ik}dx^i dx^k$) in general relativity. We then can describe the relativistic motion of a system to another system with the line element.
The absoluteness of time cannot be violated in the case of the special Lorentz transformation, since time dilation derived from the transformation is not a realistic phenomenon. Einstein believed that time is absolute in the case of the Galilean transformation, since time dilation does not occur. He concluded that time is relative in the case of the Lorentz tranformation. However his conclsion may be wrong. The properties of space and time cannot be changed through the speed of a frame.

5 Relativity of mass

The formula, $m = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}}$, cannot be derived from the special Lorentz transformation. To explain time dilation and length contraction we have to construct a frame of reference and another frame. However, we do not need the frames to explain the relativity of mass. In this case mass itself is accelerated. The speed v in the formula is not constant since the speed v is varied from zero to v in the process of deriving the rest energy, while the speed v in the Lorentz transformation should be a constant. Mass can be divided and change with time. Therefore, the relativity of mass may be realistic.

6 Conclusions

Special relativity is based on the special Lorentz transformation. The formulae of length contraction and time dilation, which are derived from the transformation, are not realistic, since the high speed effect corresponds to the effect of a lens in optics. Einstein's conclusion on the relativity of space and time deduced from the above two formulae may be wrong. The realtivity depends on whether space and time can be divided or not.

For the real world we experience the Galilean tranformation is valid. From the transformation it was deduced that space is relative and time absolute.

References

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3. A. Einstein, Ueber die spezielle und die allgemeine Relativitaetstheorie (Vieweg, Braunschweig, 1917).

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Figure Captions

Fig. 1 The frame S' moves in the x-direction with constant high speed v relative to the frame of reference S.

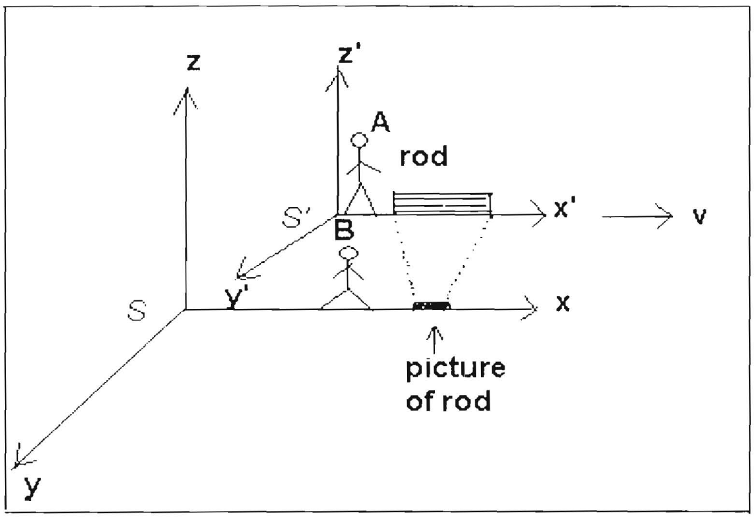

Fig. 1