THOUGHT EXPERIMENTS WHOSE RESULTS DO NOT AGREE WITH THE PREDICTION OF SPECIAL RELATIVITY

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Abstract

Einstein changed the problem of ether from the discussion of whether or not it exists to that of whether or not it is necessary as a concept or a hypothesis.

It is true that if we give the vacuum the property as a medium that transmits light, it becomes unnecessary to search for ether as substance.

Even so, we have to search for an experiment to decide whether the spread of light emitted from the light source is isotropic or anisotropic relative to the light source.

An experiment like that was formerly considered inexistent, but this paper will show it is existent.

In the process of thought experiments of this paper, we will find different results from the prediction by special relativity. As the cause of that, we will show the existence of an unknown velocity vector Einstein denied.

I. Introduction

At the end of the 19th century, a lot of physicists were convinced of the existence of ether as a medium that transmits light. Further, they considered ether was "absolutely at rest".

Michelson and Morley tried to detect the earth's movement relative to ether, i.e. the absolute velocity.

Nevertheless, they failed to obtain the result they had expected.

Michelson concluded ether was at rest relative to the earth in motion(i.e., it accompanied the earth) in order to explain why they failed to detect the effect they had expected.

On the other hand, Lorentz was convinced of the earth's movement relative to "the absolute rest system". He made a temporary solution by proposing a hypothesis that the object moving at the velocity $\boldsymbol{v}$ relative to ether contracted at the rate of $(1-\beta^2)^{1/2}$ in the moving direction. $(\beta=v/c)$

However, in his thesis on special relativity published in 1905, Einstein stated as follows:

The introduction of a "luminiferous ether" will prove to be superfluous inasmuch as the view here to be developed will not require an "absolutely stationary space" provided with special properties, nor assign a velocity-vector to a point of the empty space in which electromagnetic processes take place[1].

Afterwards he also stated as follows:

According to this theory there is no such thing as a "specially favoured" (unique) co-ordinate system to occasion the introduction of the ether-idea, and hence there can be no ether-drift, nor any experiment with which to demonstrate it[2].

Einstein insisted physics not require an "absolutely stationary space" provided with special properties, and that there be no such things as "specially-favored" coordinate system to occasion the introduction of the ether-idea.

Let us ascertain the two typical interpretations as to Michelson-Morley experiment.

Support of ether:

If the "absolute rest ether" can not be found in spite of the existence of it, the earth is thought to contract at the rate of $(1-\beta^2)^{1/2}$ in the moving direction on Lorentz contraction hypothesis. Provided that everything including the observer contracts uniformly, the observer in the system has no means to distinguish stationary and moving. (At present, it is thought there are no experiments to examine the spread of light. If an experiment like that exists, the spread of light is thought to be anisotropic relative to the light source.)

Denial of ether:

If the vacuum is given the property as a medium that transmits light, the concept of the "absolute rest ether" becomes unnecessary. It becomes a mere product of imagination. If ether does not exist, light emitted from the source ought to spread isotropically. Therefore, it is natural that the effect expected in Michelson-Morley experiment is not detected.

When ether in "support of ether" is replaced from imaginary matter to the vacuum according to contemporary physics, it becomes unnecessary to discuss whether ether exists or not.

In addition, we ascertain that an experiment to demonstrate ether-drift is the same as the one to decide whether the spread of light emitted from the light source is isotropic relative to the light source.

In special relativity, the clock settings of the stopwatches on the front end and the rear end in the train are done operationally by using light signals by the observer in the train[3]. (Relativity of simultaneity)

For that reason, Einstein did not refer to an experiment to give an answer to the problem whether the spread of light in the space is isotropic or not.

It seems Einstein changed the problem of ether from the discussion of whether it exists to that of whether it is necessary as a concept or a hypothesis.

In thought experiments below, however, this paper proposes that there is a way to examine whether the spread of light in a system of coordinates is isotropic.

II. Thought experiments whose results do not agree with the prediction of special relativity

Let us explain the equipment before thought experiments.

1. There are two trains at rest on the railroad running parallel to the platform of the station on the earth. The two trains are tentatively called A and B, which are of the same kind.
2. Along the platform is the x-axis that stretches parallel to the railroad. From the origin of it, the y-axis stretches vertically. Further, on the origin of the x-axis, the light source p is equipped and an observer is standing.
3. At the points $x=\pm L$, two stopwatches are placed. The one in the minus direction is called the stopwatch 1(SW1), and the other in the plus direction the stopwatch 2(SW2).
4. Along the floor of the train A, the x'-axis stretches parallel to the x-axis. The origin of the x'-axis is at the center of the floor, where the light source a is placed. At the points $x'=\pm L$, two stopwatches are placed. The one in the minus direction is called the stopwatch 3(SW3), and the other in the plus direction the stopwatch 4(SW4).
5. Along the floor of the train B, the x''-axis stretches parallel to the x-axis. The origin of the x''-axis is at the center of the floor, where the light source b is placed. At the points $x''=\pm L$, two stopwatches are placed. The one in the minus direction is called the stopwatch 5(SW5), and the other in the plus direction the stopwatch 6(SW6).
6. All the stopwatches used in the experiments are of the same kind. They work at the same tempo when at rest.

Notice that predictions of the observational values in thought experiments are made on the basis of special relativity.

Now let us consider this situation: in front of the observer standing on the origin of the platform, the train A passes at the velocity $\boldsymbol{v}$ and the train B passes at the velocity $\boldsymbol{V}$. (See Fig. 1)

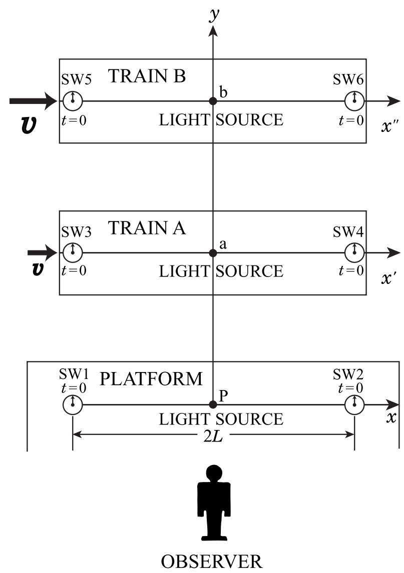

Fig.1 When the light source a (the train A) and b (the train B) reach the y-axis, the three light sources p (the platform), a and b emit the light. In this figure, the contraction of the train A and B in the moving direction is not shown.

The velocity $\boldsymbol{V}$ is defined as follows: when observed from the train A, the velocity of the train B is $\boldsymbol{w}$. (See Fig. 2)

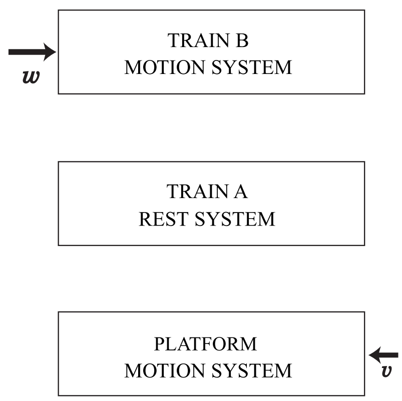

Fig.2 The relations between the velocity of the platform and that of the coordinate system of the train B. They are seen from the train A.

These velocities are not those of normal trains, but the high velocities to which special relativity needs to be applied.

According to the addition theorem for velocities of special relativity,

$$V=(v+w)(1+vw/c^2)^{-1} \tag{II.1}$$

Suppose that light spreads isotropically relative to the source p, when light emitted from the source p arrives at SW1 and SW2(equally distant from the source p), it is absolutely simultaneous. (Here, the spread of light is that of the case where “the denial of ether” is supposed.)

The two stopwatches SW1 and SW2 start to work the moment light arrive at them.

Next let us consider light that is emitted from the source a.

According to the principle of constancy of light speed, light in the vacuum spreads at the constant speed c irrelevantly to the motion state of the light source.

Also, according to special relativity, the train A contracts $(1-\beta^2)^{1/2}$ times in the moving direction when it is seen by the observer on the platform.

Suppose the distance between the light source a and SW3 is $L'$from the measurement by the observer on the platform,

$$L'=L(1-\beta^2)^{1/2} \tag{II.2}$$

By the observer's stopwatch, the time required for light emitted from the light source a to reach SW3 is t'_3;

$$t'_3=L'/(c+v)$$
$$=L(1-\beta^2)^{1/2}/(c+v) \text{ (sec.)} \tag{II.3}$$

In the same way, the time required for light to reach SW4 is t'_4;

$$t'_4=L'/(c-v)$$
$$=L(1-\beta^2)^{1/2}/(c-v) \text{ (sec.)} \tag{II.4}$$

The moment light reach SW3 and SW4, each stopwatch begins to work.

When seen by the observer on the platform, the stopwatches in the train work slowly. While one second passes by the stopwatch of the observer on the platform, $(1-\beta^2)^{1/2}$ second passes by the stopwatches in the train A, and $(1-\beta'^2)^{1/2}$ second passes by the stopwatches in the train B. ($\beta'=U/c$)

Let us consider the time difference between SW3 and SW4 ($t_{3\cdot4}$). The former starts earlier than the latter. Thus, the observer on the platform predicts the time difference as follows;

$$t_{3\cdot4}=(1-\beta^2)^{1/2}(t'_4-t'_3)$$
$$=2Lv/c^2 \text{ (sec.)} \tag{II.5}$$

However, from the observation in the train A, the time difference between SW3 and SW4 can not be detected. That is because the two stopwatches are set by the operational method Einstein introduced.

Next, let us consider the system of coordinates in the train B.

The moment light emitted from the light source b reach SW5 and SW6, each stopwatch begins to work.

By the observer's stopwatch, the time required for light emitted from the light source b to reach SW5 is t'_5 , and the time required for light to reach SW6 is t'_6. From the observation on the platform, SW5 starts earlier than SW6.

When the observer on the platform predicts the time difference between SW5 and SW6($t_{5\cdot6}$), he obtains;

$$t_{5\cdot6}=(1-\beta'^2)^{1/2}(t'_6-t'_5)$$
$$=2LU/c^2 \text{ (sec.)} \tag{II.6}$$

The two trains A and B stop afterwards. In the end, they come back to the point where they first were and stop.

During the deceleration and acceleration, the tempos of the stopwatches change when seen by the observer on the platform.

However, the change of tempos is common to the two stopwatches in each train. Thus it is concluded that the time differences $t_{3\cdot4}$ and $t_{5\cdot6}$ do not change.

Next, let us do time adjustment of SW2, SW4 and SW6; these stopwatches are on the straight line parallel to the y-axis.(See Fig.3)

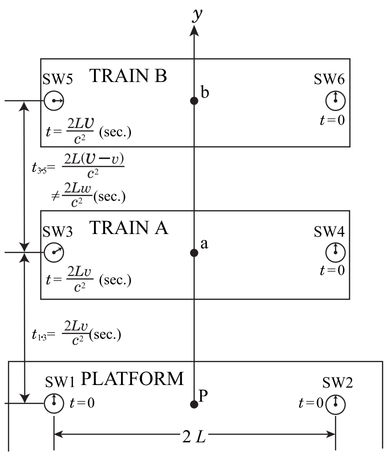

Fig.3 The relations between the six stopwatches.

Properly speaking, the time by SW1, SW2, SW4 and SW6 are not t=0. However, what is important in this paper is the time difference between the six stopwatches. Therefore, the time adjustment was done so that the time by the four stopwatches are t=0.

It is defined that the adjustment to make SW4 agree with SW2 as Δt, and the adjustment to make SW6 agree with SW2 as $\Delta t'$. (Note that this time adjustment does not need to be actually made. Calculative adjustment is enough.)

Next the time adjustment Δt is applied to SW3, and the time adjustment$\Delta t'$ is applied to SW5.

After that, the observer on the platform confirms the time difference between SW1 and SW3($t_{1\cdot3}$), and the time difference between SW1 and SW5($t_{1\cdot5}$).

The time by SW1 agrees with that of SW2, SW4 and SW6 in the absolute sense.

Thus, the time difference $t_{1\cdot3}$ agrees with $t_{3\cdot4}$ in the equation (II.5). Further, the time difference $t_{1\cdot5}$ agrees with $t_{5\cdot6}$ in the equation (II.6).

That is,

$$t_{1\cdot3}= t_{3\cdot4} =2Lv/c^2 \text{ (sec.)} \tag{II.7}$$

$$t_{1\cdot5}= t_{5\cdot6} =2LU/c^2 \text{ (sec.)} \tag{II.8}$$

From those, the time difference $t_{3\cdot5}$ between SW3 and SW5 is as follows;

$$\begin{aligned} t_{3\cdot5} &= t_{1\cdot5} - t_{1\cdot3} \\ &=2L(U\text{-}v)/c^2 \\ &=2Lw(c^2\text{-}v^2)/c^2(c^2+vw) \\ &=2\alpha Lw/ c^2 \text{ (sec.)} \quad [\alpha=(c^2\text{-}v^2)/(c^2+vw),\ \alpha \text{ is scalar}] \end{aligned} \tag{II.9}$$

According to special relativity, the only important velocity in the systems of coordinates that move relatively is the relative velocity. Accordingly, the observer on the train A can regard his system of coordinates as "the rest system".

The relative velocity between the train A and the train B is $\boldsymbol{w}$. Thus, when the observer in the train A applies special relativity, he predicts $t_{3\cdot5}$ from the equation (II . 7) as follows;

$$t_{3\cdot5} = 2Lw/c^2 \text{ (sec.)} \tag{II . 10}$$

The result of thought experiments in this paper [Eq.II . 9] does not agree with the prediction by the observer in the train A [Eq.II . 10].

What is the cause of that disagreement? Is that because the isotropic spread of light is supposed? No, it is not.

Let us ascertain the correspondences between the systems of coordinates. In each correspondence, the former supposes "the denial of ether" and the latter "the support of ether". (See Table 1)

	coordinate system in denial of ether	coordinate system in support of ether
rest system	platform	ether
motion system	train A	platform
motion system	train B	train A

Table 1. The correspondence of coordinate systems in "denial of ether" and "support of ether"

The system of coordinates of the train A corresponds to that of the earth (i.e., the platform). Further, the system of coordinates of the platform corresponds to that of ether. The system of coordinates of the train B corresponds to that of the train A.

When the spread of light in the space around the earth is isotropic relative to the light source on the platform, the time difference $t_{3\cdot5}$[Eq. (II . 9)] does not agree with the prediction of special relativity.

On the other hand, when the spread of light is anisotropic relative to the light source on the platform, the time differences $t_{3\cdot5}$ and $t_{1\cdot3}$ do not agree with the prediction of special relativity.

After all, the prediction of special relativity does not agree with the results of thought experiments in this paper, whether the spread of light is isotropic (in connection with "the denial of ether") or anisotropic (in connection with "the support of ether").

The conclusion is that, if $t_{1\cdot3}$ agrees with the equation (II . 7), the spread of light is isotropic relative to the light source; if not, the spread of light is anisotropic.

Moreover, it is evident from the observations above that, for the actual experiment, four stopwatches are enough: two stopwatches on the platform and two stopwatches in a train.

It is appropriate to say that thought experiments in this paper are the contemporary version of Michelson-Morley experiment.

By the way, does this disagreement mean that special relativity is wrong? This paper does not deny special relativity but regards it as an imperfect theory.

We have to admit that there are cases where an unknown velocity $\boldsymbol{v}$ Einstein denied participates in the system of coordinates.

Apart from its physical significance, the value of $\boldsymbol{v}$ can be obtained easily.

First, from the equation (II . 9),

$$\alpha=(c^2-v^2)/(c^2+vw) \qquad \text{(II . 11)}$$

From this,

$$v^2+\alpha wv-(1-\alpha)c^2=0 \qquad \text{(II . 12)}$$

The case we deal with here is $v>0$. Therefore, the minus solution should be deleted.

$$v=[-\alpha w+\{\alpha^2w^2+4(1-\alpha)c^2\}^{1/2}]/2 \qquad \text{(II . 13)}$$

This value is the component in the direction of x-axis of an unknown velocity.

Ⅲ. Conclusion

The purpose of the thought experiments in this paper is not to ascertain whether ether exists, but to prove that there is an experiment by which we can ascertain whether light emitted from the light source spreads isotropically relative to the light source.

Further, from the thought experiments it has been shown that we can obtain results that disagree with the prediction of special relativity.

From the results, this paper concludes that, in the two systems of coordinates moving relatively, the important velocity is not only relative velocity. The existence of an unknown velocity vector, which Einstein denied, should be considered.

Suppose several systems of coordinates moving relatively. Among these, an unknown velocity vector participates in some systems, while in other systems it does not.

Moreover, if the velocity vector does exist, the magnitude and direction of it differs from one system of coordinates to another.

Therefore, Einstein's "principle of relativity", which claims without consideration of the existence of this velocity vector that all systems of coordinates moving relatively are equal, may hold true visually, but not in a strict sense.

What is this velocity vector? Let us define it as follows.

According to quantum electrodynamics, it is thought the vacuum that transmits electric force is filled with virtual particles, i.e. pairs of particles and antiparticles.

According to uncertainty principle, these virtual particles are constantly fluctuating without being at rest, even in the state of the lowest energy.

Therefore, there are countless relative velocities between the coordinate system of a point in the physical space and the coordinate system of virtual particles in the vacuum that occupy the same coordinates as the point.

It is defined that an unknown velocity vector is the mean value of relative velocities at a certain moment between the coordinate system of a point in the physical space and countless coordinate systems of virtual particles in the vacuum that occupy the same coordinates as the point. (Note that this velocity vector is defined as the one that is in opposite direction against velocity seen from the coordinate system in the space.)

In other words, it is defined this velocity vector has its origin (i.e. "the rest system") on a virtual point (i.e. the coordinate system) in the vacuum which occupies the same coordinates as the point in the physical space, and its end on a point in the physical space.

Therefore, "the rest system" in this case does not exist in the real physical space. (In the coordinate system of a point in the space without a velocity vector, a point in the space can be regarded as "the rest system".)

From this definition, we can regard this velocity vector as the real velocity of the coordinate system.

This paper gives the position of "the ether rest system" to the virtual point in the vacuum, which is filled with virtual particles that can not be observed in reality.

Further, this paper names these virtual points—the origins of the velocity vector—**"the depth rest system"**. ("Depth" means that the origin and the end of this velocity vector occupy the same coordinates in the physical space. "The depth rest system" is a virtual concept. It does not really exist.)

We name this velocity vector **"a depth velocity vector"** in order to distinguish it from a velocity vector in the real physical space.

The following table shows relations between the depth velocity vector and each coordinate system in thought experiments of this paper. (See Table 2)

	coordinate system in denial of ether	coordinate system in support of ether	depth velocity vector
rest system	platform	ether	does not exist
motion system	train A (velocity $\boldsymbol{v}$)	platform (apparent rest system)	exists depth velocity vector $\boldsymbol{v}$
motion system	train B (velocity $\boldsymbol{V}$)	train (velocity $\boldsymbol{w}$ relative to the platform)	exists depth velocity vector $\boldsymbol{V}$

Table 2. The relations between each coordinate system and the depth velocity vector in "denial of ether" and "support of ether"

If "the extent of the space dragging effect by mass" is expressed with a vector, that vector and the depth velocity vector are the same magnitude, but they are opposite in direction.

Next, let us consider the two systems of coordinates where a depth velocity vector does not exist.

On one system of coordinates is the light source A, and on the other the light source B. The two light sources are astronomically distant, and they are moving away from each other at a high speed.

It is appropriate to consider the situation like this: a system of coordinates with large mass (e.g. a heavenly body) is dragging virtual particles corresponding to its mass.

Within the area of ether (i.e. virtual particles) accompanying this system of coordinates, light emitted from the distant light source B spreads isotropically relative to the light source.

Therefore, when the observer on the point A is able to carry out telemetry of the light speed around the light source B, he observes a value that differs from light speed as physical constant. (We are to observe light speed as physical constant in a situation where no virtual particles accompany the system of coordinates of the light source B and relative velocities among "the depth rest systems" of each point in the space can be considered approximately zero.)

That is, the speed of the light emitted away from the light source A is superluminal, while the speed of the light emitted toward the observer is slower than light speed as physical constant. [See Appendix]

However, that does not mean the speed of light depends on the velocity of the light source (the system of coordinates), nor does it mean there is any object that surpasses light. In this situation, the velocity of the object relative to “Lorentz’ rest system” around the object is less than light speed c.

When light gets out of the area of the ether of today that accompanies the coordinate system of the light source B, light spreads at the speed c relative to “Lorentz’ rest system” (“the depth rest system”) of each point in the space, even if the different value from light speed as physical constant is observed in the telemetry of light speed.

When light spreads to the light source A, the observer at A measures light speed as physical constant. Thus, such situation as contradicts “the principle of constancy of light speed” does not occur.

At present there is no theory to set the upper limit on the relative velocity between two “Lorentz’ rest systems” that are astronomically distant from each other. In other words, there is no theory that refers to the upper limit of the relative velocity between virtual particles that constitute the vacuum when those particles exist at a distance.

What special relativity demands is that the upper limit of the velocities between a moving object and Lorentz’ “rest system” around it is less than light speed.

The consideration above shows that countless “depth rest systems” existing at a distance can not be regarded as “the absolute rest system” whose existence Newton was convinced of, because it is possible those systems have certain relative velocities to one another.

However, we can consider “the depth rest system” to be “the ether rest system” of today in Lorentz’ sense. Thus, it is appropriate to give it an apparently contradictory name: **“a relative absolute system of reference”**.

Acknowledgments

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References

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Appendix

This prediction does not deny the addition theorem for velocities of special relativity but discusses an exception on the addition theorem. The case where the addition theorem for velocities of special relativity holds true is: when the masses of the coordinate systems of the train A and B are smaller than that of the platform(the earth), and the virtual particles that the coordinate systems of the train A and B drag are ignorable.

In other words, this addition theorem holds true in the case where we can consider that “the depth rest systems” of all the points in the vacuum are at rest relative to the coordinate system of the platform.

When the mass of the coordinate system of the light source B is large and the area of the virtual particles accompanying this system is unignorable, the observer on the light source A can not apply the addition theorem for velocities of special relativity to the velocity of the object emitted from the coordinate system of the light source B.