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 propagation 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.

Key words: Special Relativity, Absolute Rest System of Coordinates, Ether-Drift, Depth Rest System of Coordinates, Depth Velocity Vector, Relative Absolute System of Coordinates.

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1. Introduction

At the end of the 19th century, a lot of physicists were convinced of the existence of ether as a medium that propagates light.

Further, they considered ether was "absolutely at rest".

Michelson and Morley attempted to detect earth's motion relative to the luminiferous ether, i.e. the absolute velocity.

Nevertheless, they failed to detect the effect they had expected [1].

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 motion relative to the "absolute rest system of coordinates". He made a temporary solution by proposing a hypothesis that a body moves through space at the velocity v relative to ether contracted at the rate of $(1-\beta^2)^{1/2}$ in the direction of motion. ($\beta=v/c$) [2].

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 [3].

Afterwards he also stated as follows:

According to this theory there is no such thing as a "specially favoured" (unique) coordinate 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 [4].

Einstein insisted physics not require an "absolutely stationary space" provided with special properties, and that there be no such things as "specially-favoured" 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 direction of motion on Lorentz contraction hypothesis. Provided that everything including the observer contracts uniformly, the observer in the coordinate system has no means to distinguish stationary and moving. (At present, it is thought there are no experiments to examine the propagation of light. If an experiment like that exists, the propagation 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 propagates 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 light source ought to propagate isotropic. 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 propagation 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 wall and the back wall inside the train are done operationally by using light signals by the observer inside the train (Relativity of Simultaneity) [5].

For that reason, Einstein did not refer to an experiment to give a reply to the problem whether the propagation 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, this paper proposes that there is a way to examine whether the propagation of light in a system of coordinates is isotropic.

But before that we suppose the "Principle of Constancy of Light Speed", which has two meanings:

Principle of Constancy of Light Speed 1:

The speed of light in the vacuum is not dependent on the speed of the light source. One light does not pass the other.

Principle of Constancy of Light Speed 2:

Light emitted from the light source reaches the reflective mirrors － set in all the directions and equally distant by L from the source－and it is reflected and returns simultaneously. If it takes time t to go to and from the mirrors, light speed can be calculated by $2L/t$, which is one of the universal constants in nature.

Now, standing on the supposition above, we consider Thought experiments below.

2. 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. (See Fig.1)
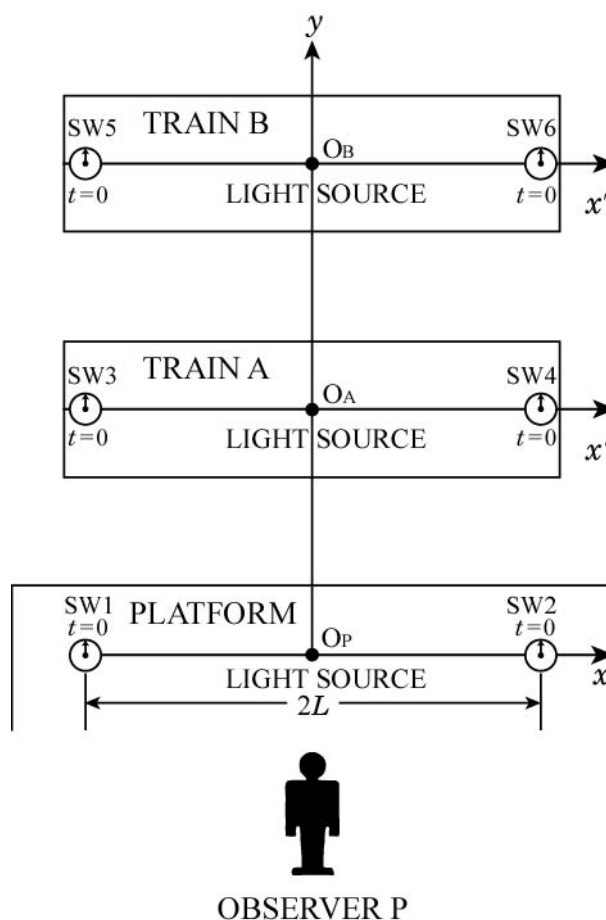

Fig. 1 Light source and two stopwatches are installed in each coordinate system of the platform, train A, and train B.

(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, light source O_P is installed and an observer P is standing.

(3) At the points $x=\pm L$, two stopwatches are installed. The one in the minus direction is called stopwatch 1 (SW1), and the other in the plus direction 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 light source O_A is installed. At the points $x'=\pm L$, two stopwatches are installed. The one in the minus direction is called stopwatch 3 (SW3), and the other in the plus direction stopwatch 4 (SW4).

(5) Along the floor of 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 light source O_B is installed. At the points $x''=\pm L$, two stopwatches are installed. The one in the minus direction is called stopwatch 5 (SW5), and the other in the plus direction 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 P, train A passes at the velocity **v** and train B passes at the velocity **v**. (See Fig.2)
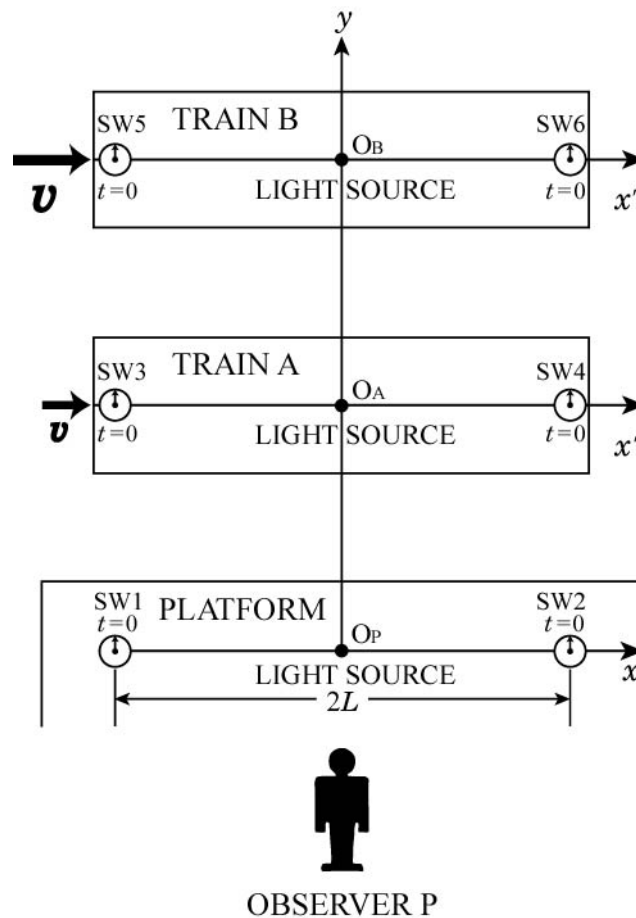

Fig . 2   When light source O_A and O_B reach the y-axis, the three light sources O_P, O_A and

O_B begin emitting light at the same time. In this figure, the contraction of train A and B in the direction of motion is not shown.

The velocity v is defined as follows: when observed from train A, the velocity of train B is w. (See Fig.3)
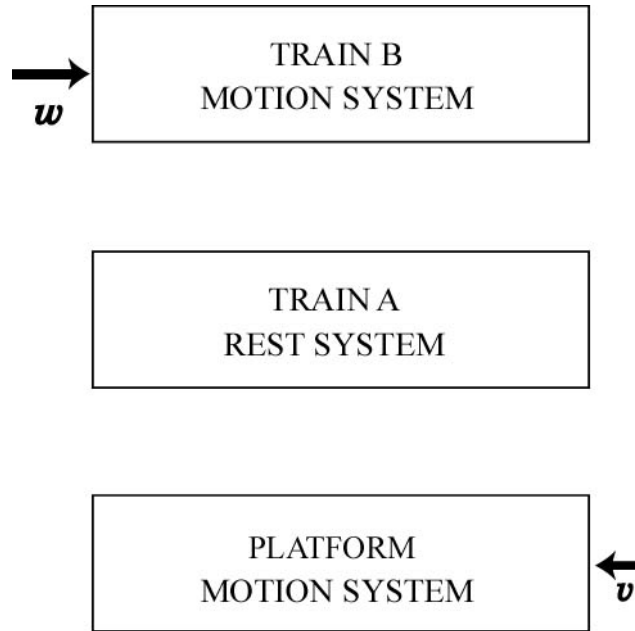

Fig. 3   The relations between the velocity of the platform and that of the coordinate system of train B. They are seen from train A.

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,

$$v = \frac{v + w}{1 + \dfrac{vw}{c^2}}. \qquad\qquad (1)$$

Suppose that the light propagates isotropic relative to O_P, when light emitted from O_P arrives at SW1 and SW2 (equally distant from O_P), it is absolutely simultaneous. (Here, the propagation of light is that of the case where "denial of ether" is supposed.)

Two stopwatches 1 and 2 start to work the moment light arrive at them.

Next let us consider light that is emitted from O_A.

When light sources O_P, O_A and O_B are aligned with on the y-axis in front of observer

P, and the three light sources begin emitting light at the same time, to observer P, those light propagate evenly in all directions.

Furthermore, according to the "Principle of Constancy of Light Speed 1," the speed of light is not dependent on the speed of the light source.

If two trains are stopped, to observer P, it would appear that light arrives at the front train and back train at the same time. However, the trains are moving in this Thought experiment. In the case of light source O_A, while light is propagating from the origin A_0, the back train is moving toward the origin A_0. This origin A_0 is an intersection which the x'-axis and the y-axis cross. (See Fig.4)
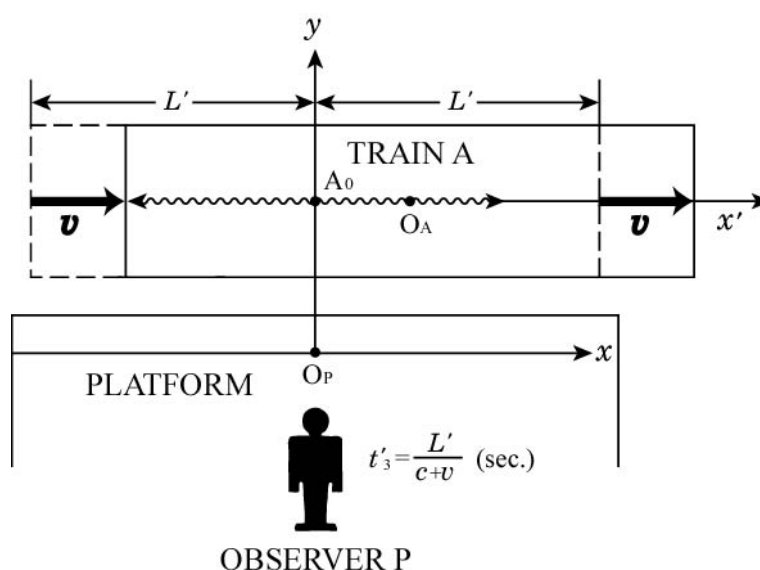

Fig. 4 Light emitted from light source O_A at starting point A_0 arrives at SW3 at the back

wall of the train in t'_3 seconds as measured by observer P's stopwatch.   At this time the

light has not yet reached SW4 at the train's front wall.

Meanwhile, the front train is moving away from the origin A_0.

Observer P would see light arrive first at the back train, not the front train.

From the perspective of the observer P, SW3 on the back train, where light first
   arrives, starts before SW4 on the front train, where light arrives later. (See Fig.5)

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

By the way, according to Special Relativity, train A contracts $(1-\beta^2)^{1/2}$ times in the direction of motion when it is seen by the observer P.

Suppose the distance between O_A and SW3 is L' from the measurement by the observer P,

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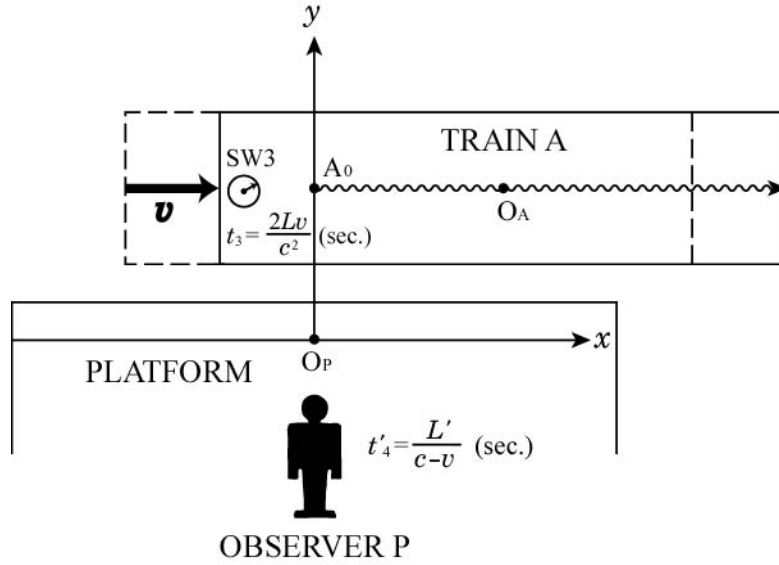$$L' = L\sqrt{1-(v/c)^2}. \qquad\qquad (2)$$

Fig. 5 Light emitted from light source O_A at starting point A_0 arrives at SW4 at the front wall of the train in t'_4 seconds as measured by observer P's stopwatch.

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

$$\begin{aligned} t'_3 &= \frac{L'}{c+v} \\ &= \frac{L\sqrt{1-(v/c)^2}}{c+v} \quad (\text{sec.}). \end{aligned} \qquad (3)$$

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

$$\begin{aligned} t'_4 &= \frac{L'}{c-v} \\ &= \frac{L\sqrt{1-(v/c)^2}}{c-v} \quad (\text{sec.}). \end{aligned} \qquad (4)$$

The terms ($c+v$) from Eq. (2.3) and ($c-v$) from Eq. (2.4) do not imply that the speed of light is affected by the speed of the light source. The speed of light holds as c.

The time difference between light arriving at SW3 and SW4 is ($t'_4-t'_3$) seconds, as measured by observer P's stopwatch.

However, the time has elapsed more slowly at the stopwatch inside the train is than the stopwatch used by the observer. (However, the timekeeping tempo of two stopwatches on the same train would be the same)

While one second passes by the stopwatch of the observer P, $(1-\beta^2)^{1/2}$ second passes by the stopwatches inside train A, and $(1-\beta'^2)^{1/2}$ second passes by the stopwatches inside train B. ($\beta'=v/c$)

Therefore, the time difference $t_{3.4}$ observed by observer P between SW3 and SW4 is the following.

$$t_{3\cdot4} = (t_4' - t_3')\sqrt{1-(v/c)^2}$$
$$= \frac{2Lv}{c^2} \quad (sec.). \tag{5}$$

However, to observers riding on trains A and B, the "Principle of Constancy of Light Speed 2" would apply to their coordinate system, so they would judge the second hands of stopwatches fixed on walls at the front and back of the train they are riding to be in synch. This is Einstein's "Relativity of Simultaneity"[5].

Next, let us consider the coordinate system inside train B.

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

By the observer P's stopwatch, the time required for light emitted from O_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 P predicts the time difference between SW5 and SW6 ($t_{5.6}$), he has;

$$t_{5\cdot6} = (t_6' - t_5')\sqrt{1-(V/c)^2}$$
$$= \frac{2LV}{c^2} \quad (sec.). \tag{6}$$

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 P.

However, the timekeeping tempo of two stopwatches on the same train would be the same.

Thus it is concluded that the time differences $t_{3.4}$ and $t_{5.6}$ 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.6)

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
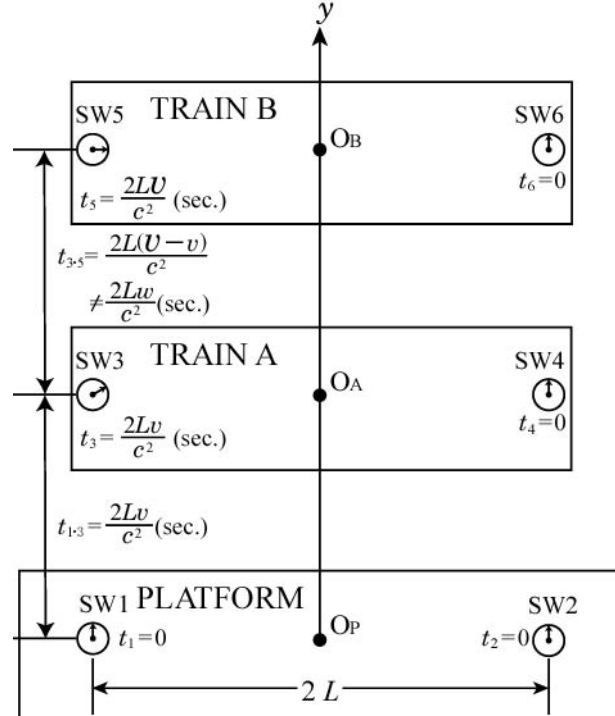
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applied to SW5.

Fig. 6   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 $t=0$.

After that, the observer P 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 Eq. (2.5).

Further, the time difference $t_{1\cdot5}$ agrees with $t_{5\cdot6}$ in Eq. (2.6).

That is,

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

$$t_{1\cdot5} = t_{5\cdot6} = \frac{2LV}{c^2} \quad (\text{sec.}). \tag{8}$$

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

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$$t_{3 \cdot 5} = t_{1 \cdot 5} - t_{1 \cdot 3}$$
$$= \frac{2L(V - v)}{c^2} \quad \text{(sec.)}. \tag{9}$$

According to Special Relativity, the only important velocity in the system of coordinates that move relatively is the relative velocity.

Accordingly, the observer inside train A can regard his system of coordinates as the "rest system of coordinates".

The relative velocity between train A and train B is w.

Thus, when the observer inside train A applies Special Relativity, he predicts $t_{3 \cdot 5}$ from Eq. (2.7) as follows;

$$t_{3 \cdot 5} = \frac{2Lw}{c^2} \quad \text{(sec.)}. \tag{10}$$

The results of the above Thought experiments become as it is shown in the next table. (See Table.1)

Motion system / Rest system	Platform (SW1)	Train A (SW3)	Train B (SW5)
Platform (SW1)		Relative velocity: v Time deference: $t_{1 \cdot 3} = 2Lv/c^2$ (sec.)	Relative velocity: v Time deference: $t_{1 \cdot 5} = 2Lv/c^2$ (sec.)
Train A (SW3)	Relative velocity: v Time deference: $t_{1 \cdot 3} = 2Lv/c^2$ (sec.)		Relative velocity: w Time deference: $t_{3 \cdot 5} = 2L(v-v)/c^2$ $\neq 2Lw/c^2$ (sec.)

Table.1 The relative velocity between two coordinate systems and the relation of time deference $t_{1 \cdot 3}$, $t_{1 \cdot 5}$ and $t_{3 \cdot 5}$.

3. Discussion

The result of Thought experiments in this paper [Eq. (2.9)] does not agree with the prediction by the observer inside train A [Eq. (2.10)].

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

Let us ascertain the correspondences between the coordinate systems.

In each correspondence, the former supposes "denial of ether" and the latter "support of ether". (See Table.2)

Coordinate system	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 (velocity w)

Table. 2 The correspondence of coordinate systems in "denial of ether" and "support of ether".

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

When the propagation of light in the space around the earth is isotropic relative to O_P, the time difference $t_{3.5}$ [Eq. (2.9)] does not agree with the prediction of Special Relativity.

On the other hand, when the propagation of light is anisotropic relative to O_P, the time differences $t_{3.5}$ and $t_{1.3}$ do not agree with the prediction of Special Relativity.

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 v Einstein denied participates in the coordinate system.

Apart from its physical significance, the value of v can be obtained easily.

First, from (2.9),

$$t_{3.5} = \frac{2Lw(c^2 - v^2)}{c^2(c^2 + vw)}$$

$$= \frac{2\alpha Lw}{c^2}, \quad (\text{where}, \alpha = \frac{c^2 - v^2}{c^2 + vw}, \alpha \text{ is scalar}).$$

(1)

From this,

$$v^2 + \alpha wv - (1 - \alpha)c^2 = 0.$$

(2)

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

$$v_x = \frac{-\alpha w + \sqrt{\alpha^2 w^2 + 4(1 - \alpha)c^2}}{2}.$$

(3)

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

4. Conclusion

1. The prediction of Special Relativity does not agree with the results of Thought experiments in this paper, whether the propagation of light is isotropic (in connection with "denial of ether") or anisotropic (in connection with "support of ether").

The conclusion is that, if $t_{1.3}$ agrees with Eq. (2.7), the propagation of light is

isotropic relative to O_P; if not, the propagation of light is anisotropic. (See Table.3)

Time difference $t_{1.3}$	Propagation of light relative to O_P	Ether-drift
$t_{1.3}=2Lv/c^2$ (sec.)	Isotropic propagation	Does not exist
$t_{1.3}\neq2Lv/c^2$ (sec.)	Anisotropic propagation	Exists

Table. 3   The relations between the time difference $t_{1.3}$, the propagation of light relative to O_P and ether-drift.

We have to admit that there are cases where an unknown velocity vector Einstein denied participates in the coordinate system.

Thought experiments in this paper give a final reply to Michelson-Morley experiment.

2. 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.

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.

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—"**Depth Rest System of Coordinates (DRSC)**". "Depth" means that the origin and the end of this velocity vector occupy the same coordinates in the physical space. DRS is a virtual concept. It does not really exist.

We name this velocity vector "**Depth Velocity Vector (DVV)**" *d* in order to distinguish it from a velocity vector in the real physical space.

The following table shows relations between the DVV and each coordinate system in Thought experiments of this paper. (See Table.4)

Coordinate system / Depth Velocity Vector	Coordinate system in "denial of ether"	Coordinate system in "support of ether"
Rest system / Depth Velocity Vector	Platform / Does not exist	Ether / Does not exist
Motion system / Depth Velocity Vector	Train A (velocity *v*) / Exists (Depth Velocity Vector *d*)	Platform(apparent rest system) / Exists

Table. 4   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 DVV are the same magnitude, but they are opposite in direction.

3. Let us consider the two systems of coordinates where a DVV 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 propagates isotropic relative to the light source.

This means that countless DRSC existing at a distance can not be regarded as "absolute rest system of coordinates" whose existence Newton was convinced of, because it is possible those systems have certain relative velocities to one another.

However, we can consider the DRSC to be the "ether rest system" of today in Lorentz' sense.

Thus, it is appropriate to give it an apparently contradictory name: "**Relative Absolute System of Coordinates**".

Acknowledgements

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