Yet another thought experiment by Ralph Malcolm Rabbidge

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September 6, 2011

1 Introduction

Ralph Malcolm Rabbidge, who is posting in the usenet-group sci.physics.relativity under the pseudonym Henry Wilson, has presented a thought experiment for which he claims that the predictions of the Lorentz Ether Theory are different from the predictions of the Special Theory of Relativity.

I will show that this is not the case.

Ralph Malcolm Rabbidge's original post

2 The thought experiment

2.1 Definition of the thought experiment

A clock C is moving with the speed u through Lorentz's ether. Two rods, L_1 and L_3, both with length L as measured in their respective rest frames, are moving with the speed v as measured in the rest frame of the clock C. L_1 is moving in the same direction as u, while L_3 is moving in the opposite direction, as observed in the rest frame of the clock.

The clock C measures the time interval between the passings of the two ends of each rod. The question to be answered is: what does Lorentz Ether Theory (hereafter called LET) predict the measured time intervals will be?

Lorentz Ether Theory is defined by the Lorentz transform. Lorentz ether is the ether with properties such that events transform according to said transform. The 'Lorentz interpretation' is that objects moving in the ether with the speed u are physically contracted by the factor $\sqrt{1-\frac{u^2}{c^2}}$, and moving clocks are physically slowed down by the same factor.

2.2 'Straight forward' calculation of the time intervals

Realizing that the Lorentz transform is a group, it is clear that the ether frame is irrelevant, we can transform the events directly between the rest frame of the clock and the rest frames of the rods.

Let T_{R1} be the time interval the clock will measure for the passing of R_1, and let T_{R3} be the interval for the passing of R_3. Let L_1 and L_3 be the lengths of R_1 and R_3 as measured in the rest frame of the clock.

2.2.1 Calculation of T_{R1} and L_1

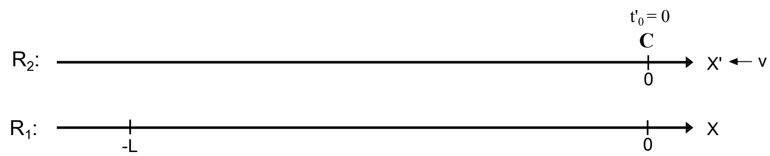

Figure 1: *Rest frame of* R_1 *at* $t = 0$

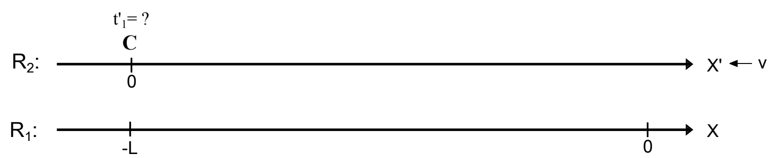

Figure 2: *Rest frame of* R_1 *at* $t = \frac{L}{v}$

We have:

$$
\begin{aligned}
t_0 &= 0 \\
x_0 &= 0 \\
t_1 &= \frac{L}{v} \\
x_1 &= -L \\
t'_0 &= 0 \\
t'_1 &= \frac{t_1 + \frac{x_1 v}{c^2}}{\sqrt{1 - \frac{v^2}{c^2}}} = \frac{\frac{L}{v} - \frac{Lv}{c^2}}{\sqrt{1 - \frac{v^2}{c^2}}} = \frac{L}{v}\sqrt{1 - \frac{v^2}{c^2}}
\end{aligned}
$$

The clock C will measure the interval between the passings of the ends of R_1 to be:

$$T_{R1} = t'_1 - t'_0 = \frac{L}{v}\sqrt{1 - \frac{v^2}{c^2}}$$

Since the relative speed of R_1 is v, C can conclude that the length of R_1 measured in the rest frame of the clock is:

$$L_1 = L\sqrt{1 - \frac{v^2}{c^2}}$$

2.2.2 Calculation of T_{R3} and L_3

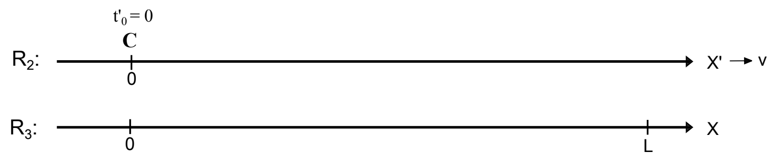

Figure 3: *Rest frame of* R_3 *at* $t = 0$

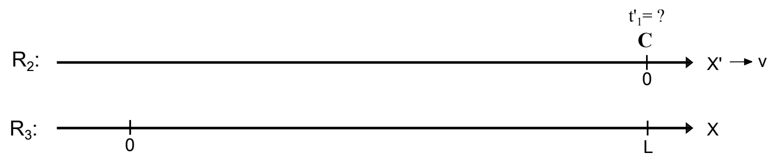

Figure 4: *Rest frame of* R_3 *at* $t = \frac{L}{v}$

We have:

$$\begin{aligned} t_0 &= 0 \\ x_0 &= 0 \\ t_1 &= \frac{L}{v} \\ x_1 &= L \\ t'_0 &= 0 \\ t'_1 &= \frac{t_1 - \frac{x_1 v}{c^2}}{\sqrt{1 - \frac{v^2}{c^2}}} = \frac{\frac{L}{v} - \frac{Lv}{c^2}}{\sqrt{1 - \frac{v^2}{c^2}}} = \frac{L}{v}\sqrt{1 - \frac{v^2}{c^2}} \end{aligned}$$

The clock C will measure the interval between the passings of the ends of R_3 to be:

$$T_{R3} = t'_1 - t'_0 = \frac{L}{v}\sqrt{1 - \frac{v^2}{c^2}}$$

Since the relative speed of R_3 is v, C can conclude that the length of R_3 measured in the rest frame of the clock is:

$$L_3 = L\sqrt{1 - \frac{v^2}{c^2}}$$

We see that LET predicts that C will measure the same interval for the passing of both rods, and since both rods are moving with the same speed, the measured lengths must be equal.

2.3 The calculations made in the ether frame

It may be claimed that according to Lorentz's interpretation, the Lorentz transform is a transformation between the ether frame and a frame which is moving relative to the ether, that is we should not use the group properties of the transform.

2.3.1 How velocities transform according to LET

Let K_C be a frame of reference moving at u in the ether. In this frame, an object is moving at the speed v in the same direction as u. What is the speed of the object in the ether frame?

At some event E_0, the object is at the coordinates $t'_0 = 0$ and $x'_0 = 0$ in K_C. At another event E_1, the object will be at the coordinates $t'_1 = \frac{d}{v}$ and $x'_1 = d$ in K_C, where d is an arbitrary distance.

Transforming these coordinates to the ether frame yields:

$$
\begin{aligned}
t_0 &= 0 \\
x_0 &= 0 \\
t_1 &= \frac{t' + \frac{x'u}{c^2}}{\sqrt{1-\frac{u^2}{c^2}}} = \frac{\frac{d}{v} + \frac{du}{c^2}}{\sqrt{1-\frac{u^2}{c^2}}} = \frac{d}{v}\left(\frac{1+\frac{uv}{c^2}}{\sqrt{1-\frac{u^2}{c^2}}}\right) \\
x_1 &= \frac{x'_1 + ut'_1}{\sqrt{1-\frac{u^2}{c^2}}} = \frac{d + u\frac{d}{v}}{\sqrt{1-\frac{u^2}{c^2}}} = \frac{d}{v}\left(\frac{u+v}{\sqrt{1-\frac{u^2}{c^2}}}\right)
\end{aligned}
$$

The speed w_1 of the object through the ether is thus:

$$
w_1 = \frac{x_1 - x_0}{t_1 - t_0} = \frac{\frac{d}{v}\left(\frac{u+v}{\sqrt{1-\frac{u^2}{c^2}}}\right)}{\frac{d}{v}\left(\frac{1+\frac{uv}{c^2}}{\sqrt{1-\frac{u^2}{c^2}}}\right)} = \frac{u+v}{1+\frac{uv}{c^2}}
$$

Equivalently will the speed of an object moving in K_C at the speed v in the opposite direction of u have the speed w_3 through the ether be:

$$
w_3 = \frac{u-v}{1-\frac{uv}{c^2}}
$$

So according to LET, velocities transform in the same way as in the Special Theory of Relativity.

2.3.2 Calculation of the 'absolute length' of R_1 and T_{R1}

The speed of the clock in the ether is u.

The speed of R_1 in the ether is:

$$v_1 = \frac{u+v}{1+\frac{uv}{c^2}} = \frac{c^2\left(u+v\right)}{c^2+uv}$$

The absolute length of R_1 is:

$$L_{A1} = L\sqrt{1-\frac{v_1^2}{c^2}} = L\sqrt{1-\frac{\left(\frac{c^2(u+v)}{c^2+uv}\right)^2}{c^2}} = L\frac{\sqrt{\left(c^2-u^2\right)\left(c^2-v^2\right)}}{c^2+uv}$$

Observed in the ether frame, R_1 will pass by the clock with the 'overtake speed' (or 'closing speed'):

$$V_{O1} = v_1 - u = \frac{c^2\left(u+v\right)}{c^2+uv} - u = \frac{v\left(c^2-u^2\right)}{c^2+uv}$$

The time between the passings of the ends of R_1, as measured by stationary clocks in the ether frame, will be:

$$t_1 = \frac{L_{A1}}{V_{O1}} = \frac{L\frac{\sqrt{(c^2-u^2)(c^2-v^2)}}{c^2+uv}}{\frac{v(c^2-u^2)}{c^2+uv}} = \frac{L}{v}\sqrt{\frac{\left(c^2-v^2\right)}{\left(c^2-u^2\right)}}$$

Since the clock, as observed in the ether frame, is running slow by $\sqrt{1-\frac{u^2}{c^2}}$, it will measure the duration to be:

$$T_{R1} = t_1\sqrt{1-\frac{u^2}{c^2}} = \frac{L}{v}\sqrt{\frac{\left(c^2-v^2\right)}{\left(c^2-u^2\right)}}\sqrt{1-\frac{u^2}{c^2}} = \frac{L}{v}\sqrt{1-\frac{v^2}{c^2}}$$

2.3.3 Calculation of the 'absolute length' of R_3 and T_{R3}

The speed of the clock in the ether is u.

The speed of R_3 in the ether is:

$$v_3 = \frac{u-v}{1-\frac{uv}{c^2}} = \frac{c^2\left(u-v\right)}{c^2-uv}$$

The absolute length of R_3 is:

$$L_{A3} = L\sqrt{1-\frac{v_3^2}{c^2}} = L\sqrt{1-\frac{\left(\frac{c^2(u-v)}{c^2-uv}\right)^2}{c^2}} = L\frac{\sqrt{\left(c^2-u^2\right)\left(c^2-v^2\right)}}{c^2-uv}$$

Observed in the ether frame, the clock will pass by R_3 with the 'overtake speed'(or 'closing speed'):

$$V_{O1} = u - v_3 = u - \frac{c^2\left(u-v\right)}{c^2-uv} = \frac{v\left(c^2-u^2\right)}{c^2-uv}$$

The time between the passings of the ends of R_3, as measured by stationary clocks in the ether frame, will be:

$$t_3 = \frac{L_{A3}}{V_{O1}} = \frac{L\frac{\sqrt{(c^2-u^2)(c^2-v^2)}}{c^2+uv}}{\frac{v(c^2-u^2)}{c^2+uv}} = \frac{L}{v}\sqrt{\frac{\left(c^2-v^2\right)}{\left(c^2-u^2\right)}}$$

Since the clock, as observed in the ether frame, is running slow by $\sqrt{1-\frac{u^2}{c^2}}$, it will measure the duration to be:

$$T_{R3} = t_3\sqrt{1-\frac{u^2}{c^2}} = \frac{L}{v}\sqrt{\frac{\left(c^2-v^2\right)}{\left(c^2-u^2\right)}}\sqrt{1-\frac{u^2}{c^2}} = \frac{L}{v}\sqrt{1-\frac{v^2}{c^2}}$$

3 Conclusion

We can see from the above that the speed through Lorentz's ether has no consequence whatsoever for what the Lorentz Ether theory will predict for any experiment.

LET and the Special Theory of Relativity will always predict exactly the same for any experiment.

This will, of course, not surprise any reasonably knowledgeable person.