Another thought experiment by Ralph Malcolm Rabbidge

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May 30, 2011

1 Introduction

Ralph Malcolm Rabbidge, who is posting in the usenet-group sci.physics.relativity under the pseudonym Henry Wilson, has presented yet another thought experiment for which he claims that the Special Theory of Relativity (hereafter called SR) will give contradictory predictions.

I will show that this is not the case.

2 The thought experiment

2.1 Definition of the thought experiment

Ralph Malcolm Rabbidge's thought experiment

His thought experiment is quoted in extenso below.

Quote begin

Wilson's Rubber Band Paradox

A modification of Bell's Spaceship Paradox, which proves Einstein's SR WRONG.

Two objects are positioned 1 km apart along an axis aligned with Earth. The objects are connected by a rubber band and are at rest wrt Earth.

O1 ——— 1km ——— O2 E

Xo ——— X axis

At a certain instant, both objects are set in motion towards E at speed v. (all quantities measured in the E frame)

O1->v ——— ?km ——— O2 ->v E

Xo ——— X axis

According to SR, the rubber band has contracted to 1/gamma km (in the E frame).
However, according to all theories including SR, the X coordinates of O1 and O2 after time t are Xo-vt and Xo-vt-1 km (in the E frame).
That means the distance between the ends of the rubber remains 1 km in the E frame no matter what its speed is in that frame.
Thus, the rubber band has not changed in and way from its rest state due to its movement. All its atoms are exactly as they were initially.

In Bell's Paradox, two spaceships are connected by a long wire and set in motion in similar fashion to the objects above. In that case, SR claims the wire will contract and break.

However it is clear from the above, that if the rubber band is replaced by a wire, its length will similarly NOT change at all and it will experience no internal stresses (in the E frame). There is no reason why it should break.

The conclusion is that since SR claims that the wire's length will both contract to 1/gamma km and remain 1 km (both measured in the E frame) there exists a clear contradiction that renders SR impossible and therefore WRONG.

Note: the Bell paradox was originally published in 1959 by Messrs Dewan and Beran and was widely acclaimed as a clear refutation of Einstein's theory. However its proponents were quickly silenced by the physics establishment whose reputations were seriously threatened by any such claim. Without the advantages of the internet, they were obliged to remain silent even though they were clearly correct.

Quote end

2.2 What SR predicts

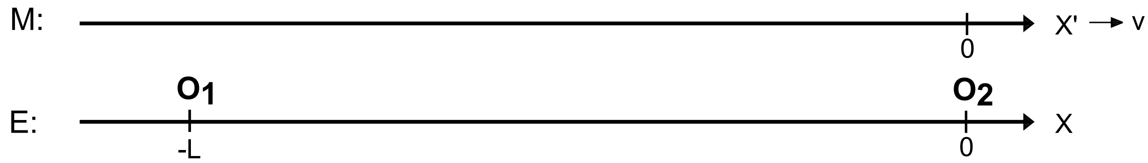

Figure 1: *The frames of reference*

In the inertial frame of reference 'E', with coordinates [x,t], there are two stationary objects, O_1 at the position $-L$, and O_2 at the origin.

A second inertial frame 'M', with coordinates [x',t'], is moving with the speed v along the positive x-axis of 'E' in such a way that $t' = t = 0$ when the origins are aligned.

At the time $t = 0$ in frame 'E', both objects are instantly set in motion with the speed v, such that they thereafter will be stationary in frame 'M'.

Let E_1 be the event that O_1 is set in motion.

Let E_2 be the event that O_2 is set in motion.

In frame 'E' the coordinates of the events will be:

$$\begin{array}{lll} eventE_1: & x_1 = -L, & t_1 = 0 \\ eventE_2: & x_2 = 0, & t_2 = 0 \end{array}$$

Transformed to frame 'M' the coordinates of the events will be:

$$\begin{array}{lll} eventE_1: & x_1' = -\dfrac{L}{\sqrt{1-\frac{v^2}{c^2}}}, & t_1' = \dfrac{vL}{c^2\sqrt{1-\frac{v^2}{c^2}}} \\ eventE_2: & x_2' = 0, & t_2' = 0 \end{array}$$

After O_1 and O_2 are set in motion they will remain stationary in frame 'M' at x_1' and x_2' respectively.

As measured in frame 'M', the distance between the objects after they are set in motion will be: $L' = x_2' - x_1' = \frac{L}{\sqrt{1-\frac{v^2}{c^2}}}$. This is a proper distance.

If the objects are connected by a physical link with length L, which is relaxed with no internal stresses before they are set in motion, then this link will be physically stretched to $\frac{L}{\sqrt{1-\frac{v^2}{c^2}}}$ when the objects are set in motion. There will be internal stresses in the link, and if it can't sustain the stresses, it will break.

After the objects are set in motion, the distance between the objects as measured in frame 'E' will be the proper distance L' transferred to frame 'E': $L'\sqrt{1-\frac{v^2}{c^2}} = L$. So measured in frame 'E', the distance will always remain L. Note, however, that after the objects are set in motion this is no longer a proper distance, it is a Lorentz contracted distance.

2.3 Viewed in frame 'M'

We can see from the above that as viewed in frame 'M', O_2 is set in motion at the time $t' = 0$, and O_2 will thereafter be stationary in frame 'M'. But at the time $t' = 0$ O_1 will still be stationary in frame 'E', and thus be moving at the speed v in frame 'M'.

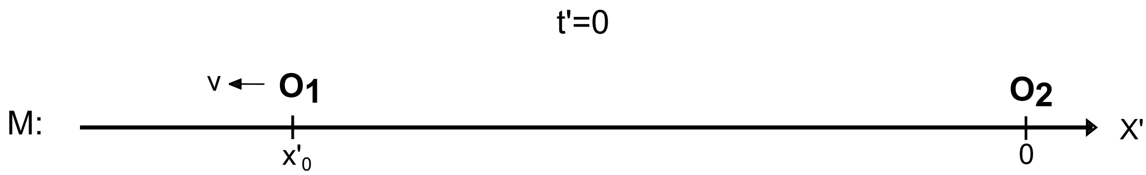

Figure 2: *Frame 'M' at* $t' = 0$

Let x'_0 be the position of O_1 in frame 'M' at $t' = 0$.

Let E_0 be the event with coordinates $[x', t']$=$[x'_0$,0] in frame 'M'.

The spatial coordinate of E_0 in frame 'E' is $x_0 = -L$.

We can thus write:

$$t'_0 = \frac{t_0 - \frac{-Lv}{c^2}}{\sqrt{1 - \frac{v^2}{c^2}}} = 0 \qquad x'_0 = \frac{-L - vt_0}{\sqrt{1 - \frac{v^2}{c^2}}}$$

Solving these, yields:

$$t_0 = -\frac{Lv}{c^2} \qquad x'_0 = -L\sqrt{1 - \frac{v^2}{c^2}}$$

We previously found that O_1 is set in motion and becomes stationary in frame 'M' at the time $t'_1 = \frac{vL}{c^2\sqrt{1 - \frac{v^2}{c^2}}}$. So during the time $t'_1 - t'_0$ O_1 will move with the speed v in frame 'M'.

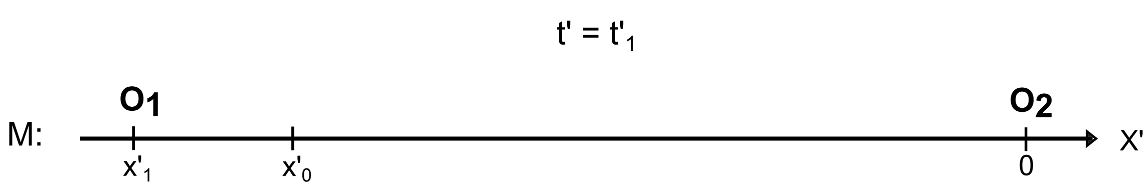

Figure 3: *Frame 'M' at* $t' = t'_1$

So before O_1 becomes stationary in 'M' it will move a distance $\Delta x' = (t'_1 - t'_0)\, v = L\frac{\frac{v^2}{c^2}}{\sqrt{1 - \frac{v^2}{c^2}}}$.

We can find the stationary position x'_1 of O_1:

$$x'_1 = x'_0 - \Delta x' = -L\sqrt{1 - \frac{v^2}{c^2}} - L\frac{\frac{v^2}{c^2}}{\sqrt{1 - \frac{v^2}{c^2}}} = -\frac{L}{\sqrt{1 - \frac{v^2}{c^2}}}$$

Which is the same as previously found.

3 Conclusion

We have shown that the predictions of SR for Ralph Malcolm Rabbidge's thought experiment are:

After the the objects are set in motion the proper distance between them will be: $\frac{L}{\sqrt{1-\frac{v^2}{c^2}}}$ where L is the proper distance between them before they were set in motion.

After the objects are set in motion the distance between them, as measured in frame 'E', will be Lorentz contracted to L.

There is not possible to make SR predict anything else for the thought experiment.

Ralph Malcolm Rabbidge claims (L = 1 km):

> "According to SR the rubber band has contracted to 1/gamma km (in the E frame)."

Ralph Malcolm Rabbidge doesn't seem to be able to calculate what SR predicts, so he is guessing.

The guesses of Ralph Malcolm Rabbidge are proven wrong.

There are no contradictions.

SR is consistent.