A Moving Rod Does Not Shrink

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Contrary to the orthodox interpretation of the length contraction equation in special relativity, a simple argument is given to prove that a moving rod does not actually shrink or contract.

In the NPA 2009 conference, I showed [1] that the so-called time dilation equation in special relativity is fully compatible with the view that a moving clock (clock in a moving inertial frame) and a stationary clock (clock in a rest frame) keep the same time. In other words, contrary to orthodoxy, the time dilation equation does not imply a moving clock runs slower compared to a stationary clock. This implies that the Hafele-Keating [2] and other similar experiments did not actually confirm the purported difference in rhythm between a moving clock and a stationary clock due to special relativistic effect. The Hafele-Keating experiment can indeed be [3,4] accounted for entirely by general relativity.

The so-called length contraction equation in special relativity is [5-7] conventionally interpreted to mean that a moving rod actually shrinks or contracts. Here, my intention is not to prove that the length contraction equation is wrong. Instead, I will show that the equation, like the time dilation equation, is also misinterpreted. In particular, I will prove that a moving rod does not actually shrink or contract, contrary to the orthodox view.

Consider an inertial reference frame S' with its x'-axis moving uniformly with velocity $+v$ parallel to the x-axis of a rest frame S.

Suppose there is a rod at rest in the moving frame S', lying parallel to the x'-axis. To measure the length of the rod, Jill, an observer in the S' frame, does not have to measure the coordinates, x'_1 and x'_2, of the two end points of the rod simultaneously.

The rod is moving at speed v relative to the rest frame S. To measure the length of the rod, Jack, an observer in the S frame, must measure the coordinates, x_1 and x_2, of the two end points of the rod simultaneously, i.e., $\Delta t = t_2 - t_1 = 0$.

The length of the rod measured by Jill is

$$\Delta x' = x'_2 - x'_1 \tag{1}$$

and the length of the rod measured by Jack is

$$\Delta x = x_2 - x_1 \tag{2}$$

The Lorentz transformation equations in special relativity imply that the length of the rod $\Delta x'$ measured by Jill and the length of the rod Δx measured by Jack are related through

$$\Delta x' = \gamma\left(\Delta x - v\Delta t\right) = \gamma \Delta x \tag{3}$$

where $\gamma = 1\Big/\sqrt{1-\left(v/c\right)^2}$ is the Lorentz factor. Eq. (3) is called the length contraction equation because $\Delta x < \Delta x'$ since $\gamma > 1$.

The rod is at rest in the moving frame S', which moves at speed v relative to the rest frame S. Eq. (3) shows that the length of the rod Δx measured by Jack in the S frame is shorter than the length of the rod $\Delta x'$ measured by Jill in the S' frame. However, the two different lengths measured by Jack and Jill cannot both be the *actual* (real) length of the rod simply because the actual length of the rod cannot possibly be two different values.

Which of the two different measured lengths, one by Jack and the other by Jill, is the actual length of the rod? The rod is at rest relative to Jill, but moving relative to Jack. The actual length of the rod is the length measured by Jill. The shorter length measured by Jack is not the actual length of the rod. In other words, the rod, which is moving relative to Jack, does not physically shrink or contract. The rod only seems shorter to Jack.

In short, the orthodox interpretation of the length contraction equation in special relativity is wrong. Whether the equation itself, which relates the length of a uniformly moving rod measured by an observer in a rest frame with the length measured by another observer moving together with the rod, is correct empirically is a different issue altogether.

References

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