A Possible Exception to a Basic Principle of Special Relativity

Peter Schorer
peteschorer@gmail.com

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Preliminaries

I will assume that the reader is familiar with Einstein's moving-train model to show the relativity of simultaneity, that is, the fact that two events may appear to occur simultaneously to one observer, but not to another. This model is described in virtually all popularizations and also in more in-depth treatises of Special Relativity. A translation of Einstein's description of his model can be found on pp. 25-26 of his book, *Relativity*[1].

To quickly review: in the model, a lightning bolt strikes at a distance d in front of a train moving in a straight line on a level track at constant speed v, at the same moment as another lightning bolt at a distance d behind the train also strikes. "At the same moment" means relative to an external observer on a nearby embankment who is sitting on a line perpendicular to the center of the train at the moment the bolts strike. This observer sees the bolts as occurring simultaneously because the speed of light is constant, and the distance from each bolt to the observer is the same.

However, an observer sitting in the middle of the train sees the bolt in front as occurring before the bolt behind. The reason for this difference is that because the photons from the front of the train are moving toward the middle of the train, and the middle of the train is moving toward the photons from the front, the time for the photons to reach the middle of the train is less than the time for the photons from behind the train to reach the middle.

Some readers have trouble understanding this difference in arrival times at the middle of the train, so let me express it in terms of closing speeds. In the case of Einstein's train model, the closing speed of the photons from the front of the train, and the middle of the train, is $c + v$, where c is the speed of light. But the closing speed of the photons from behind the train, and the middle of the train, is $c - v$. Since the distance to be traveled by the photons in each case, is the same, namely, $d + (½)r$, where r is the length of the train, the photons from the front of the train will reach the middle, hence reach the observer, before the photons from behind the train.

1. translation by Robert W. Lawson, Prometheus Books, Amherst, N.Y., 1995 (originally published 1916).

Several years ago I began asking myself, Suppose that instead of the two lightning flashes, there had been simultaneous flashes of light from lightsources at the end of each of two metal rods projecting equal distances *d* from the front and rear of the train. (It is a well-known fact that clocks (timers) can be synchronized within an inertial frame — in this case, to set off the flashes simultaneously.[1]) What would the observer in the middle of the train have seen?

It seemed to me clear that the observer would have seen exactly what he saw in Einstein's original model.

But I realized that *that implied that it is possible, from within an inertial frame (the train), to determine if the frame is moving (at a constant speed), which is an exception to one of the basic principles of Special Relativity, which asserts that such a determination is impossible!*

I devised a possible proof of my Conjecture. Its present form is as follows.

Possible Proof of Conjecture

1. Assume an inertial frame has a lightsource in front of it and a lightsource in the rear.

2. Assume there are light detectors in the middle of the frame, one to detect light from the front lightsource, one to detect light from the rear one.

3. Assume the lightsources are programmed to emit light at the same time, and that timers in the light detectors are programmed to record when the light from each source reaches the detector.

4. If the detector for the front lightsource receives light before the detector for the rear lightsource, then the frame is moving (in a line in the forward direction). If not, the frame is not moving.

Remark: The argument that the speed of the photons might be changed if they are released from within the inertial frame, as opposed to from lightning flashes, contradicts another principle of Special Relativity, namely, that the speed of light is a constant.

I will welcome comments. – Peter Schorer.

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1. *Proof*:
Assume there are two identical timing devices, *A* and *B* — identical in parts, assembled in one and the same shop.
Assume that in that same shop, the starting time in each device is set at 0 min..
Assume that the Start button on each device is simultaneously pressed. The devices are observed ticking at the same rate, and are observed to reach the successive time figures (e.g., 1 min., 2 min., 3 min., …) at the same time.
One of those running timing devices is then placed next to and connected to the front lightsource, and the other running timing device is placed next to and connected to the rear lightsource.
The same time figure on each device can then be set to cause the lightsources to flash simultaneously at that time.