Einstein's Relativity of Simultaneity Argued Against

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Abstract

By using Einstein's procedure to determine whether or not two spatially separated events occur at the same time, it is shown that simultaneity does not depend on the observer's reference frame, but the assessment of simultaneity does. Thus Einstein's claim of relative simultaneity is unsubstantiated.

I. Introduction

According to the widely accepted concept of the *relativity of simultaneity* (RS), whether or not two spatially separated events are considered to occur simultaneously depends on the observer's reference frame, *i.e.* the observer's motion relative to those events. For Einstein, verbalizing this concept was essential in order to demonstrate a need to relativize time, which then led him to formulate his *Special Theory of Relativity*[1,2].

II. Relativity of simultaneity as defined by Einstein

Einstein, to demonstrate his concept of RS, introduced[2] a thought experiment depicted in Fig. 1. In his example, a single lightning strikes the points A and B (on the embankment) at the same time (according to a clock registering the embankment's time). Then, light is reflected from points A and B towards the point M, which is halfway from A and B. The observer standing on the embankment at location M registers light incoming from A and B at the same time. Thus, the observer concludes that lighting strikes at A and B occurred simultaneously (relative to the embankment).

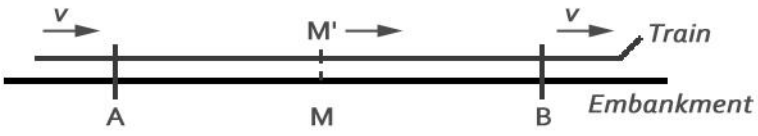

Fig. 1: Train travels with speed *v* relative to the embankment , See text for details (redrawn from ref. 2).

Then, Einstein asks: "*Are two events (e.g. the two strokes of lightning A and B) which are simultaneous with reference to the railway embankment also simultaneous relatively to the train?*". Next, his surprising answer reads: "*We shall show directly that the answer must be in*

the negative". So, he argues that, since M', which is aligned with M at the instant of the lighting strike, moves with speed *v* (away from M) during the time light from A (or B) travels towards M (or M'), the observer at M' will not see the light signals from A and B arriving simultaneously. So, Einstein concludes: "*Events which are simultaneous with reference to the embankment are not simultaneous with respect to the train, and vice versa (relativity of simultaneity)*". Then, he further concludes that time needs to be relative: "*Every* [...] *coordinate system has its own particular time*".

III. Objections to Einstein's above conclusions

Let us first somewhat re-formulate our task: we need to determine whether or not the events at A and B (in the above example) are simultaneous. In order to do that, a light detector is placed on the embankment and another one on the train. The detectors should be designed such a way that they are capable of detecting light signals coming from any direction. If the detectors – in a given period of time – register only a single light pulse (coming from A and B), we conclude that the events at A and B occurred simultaneously (see also *Endnote 1*). Then, it is immediately recognized that both detectors can be placed such a way that they should register only one single pulse. On the embankment, the detector must be placed at M (as Einstein also pointed out), which requires the knowledge of the A-B distance. On the train, however, it should be placed at a certain distance to the left of M'. The proper placement again requires the information about the A-B distance, but also the speed of the train. If ***t*** is the time, during which light travels from A (or B) to M (see also *Endnote 2*), then the detector should be placed at ***vt*** distance left to M (or M'). So, whether or not the detectors successfully registers simultaneity in either case depends on their proper placement in both reference frames (but on the frames).

IV. Discussion

It is thus safe to conclude that Einstein's above procedure can determine simultaneity in both frames, if ***v*** is known (in addition to the known A-B distance). Thereby, one must also conclude that simultaneity is not frame-dependent, but the method how it is assessed definitely is. Consequently, Einstein's argument for the relativity of simultaneity, which thus seems to reflect some voluntarism, cannot substantiate his claim that "*Every* [...] *coordinate system has its own particular time*".

If two events occur at the same time, it is either a coincidence or there is a reason behind the observed simultaneity. In the latter case an obvious task of a scientific venture could likely be to

reveal that reason, which is possible, regardless of the inertial frame the observation is made in or from. On the other hand, the concept of relative simultaneity, as proposed by Eintein[2], would not help much such task and thus pointless.

[1]*Einstein, A.: On the electrodynamics of moving bodies* (English translation, ed. John Walker), Ann. der Physik. 17:891 (1905)
[2]Einstein, A.: *Relativity: The Special and the General Theory*, Reprint of 1920 translation by Robert W. Lawson ed. (2001)

Endnotes

1. Although Einstein's observers are here replaced by light detectors, the present procedure to determine simultaneity is analogous to Einstein's.
2. The calculation to determine the proper placement of the detector in the frame of the train assumes that the speed of light is invariant.