Einstein's Mistake

by James E. Spinosa

Spinosa Research Institute

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Does Albert Einstein's definition of distant simultaneous events fail to take into account the earth's motion? On pages 25 and 26 of his book **Relativity: The Special and the General Theory**, he describes the method to use when testing whether or not two distant events are simultaneous.

> Lightning has struck the rails on our railway embankment at two places **A** and **B** far distant from each other. I make the additional assertion that these two lightning flashes occurred simultaneously. ...We thus require a definition of simultaneity such that this definition supplies us with the method by means of which, in the present case, we can decide by experiment whether or not both the lightning strikes occur simultaneously.... By measuring along the rails, the connecting line **AB** should be measured up and an observer placed at the mid-point **M** of the distance **AB**. This observer should be supplied with an arrangement (e.g. two mirrors inclined at 90o) which allows him visually to observe both places **A** and **B** at the same time. If the observer perceives the two flashes of lightning at the same time, then they are simultaneous.1

The method Einstein uses to define distant simultaneous events is a straightforward thought experiment. Einstein's thought experiment, though, is encumbered with a difficulty: it doesn't take into account the motion of the earth. The observer stationed at mid-point **M** would not notice the mid-point moving. And, because mid-point **M** moves in concert with points **A** and **B**, the distance between them would never change. Yet, the fact that the points

1Albert Einstein, **Relativity: The Special and the General Theory** 20th ed. (New York: Random House, Inc., 1961)

do move in space is enough to undermine Einstein's experiment. The movements of the points in space would be perceptible to an observer independent of the earth's motion. For instance, an observer in a spaceship that was hovering near mid-point **M** and which was not subject to the earth's gravitational field would perceive its movement. In general terms the mid-point **M** is moving in either one or two directions. It is either moving towards the light ray coming from point **A** and away from the light ray coming from point **B** or vice versa. In either case the simultaneous lightning flashes won't be perceived as occurring simultaneously by the mid-point observer.

Since the earth moves, the mid-point moves along with the earth. The motion of the rays of light are independent of the motions of the earth. If the lightning flashes at points **A** and **B** are simultaneous, then they will arrive at mid-point **M** at the same time, but it will be the mid-point **M** that existed at the exact moment events **A** and **B** occurred. Because the earth moves, by the time the light rays reach the mirror arrangement, it is no longer at the time: initial mid-point that existed at the exact moment events **A** and **B** occurred. The mirror arrangement is at the mid-point of line segment **AB** for time: present, not time: initial. Since the earth moves in space, points **A** and **B** and their mid-point **M** have all changed their positions in space from what they were in the past. Because light rays travel so quickly, as compared to the motion of the earth the mid-point **M** hasn't undergone that great of a shift.

Since the point of origin of the lightning flashes are fixed points in space, the mid-point between two simultaneous lightning flashes must also be a fixed point. Therefore, this fixed point must be independent not only of the earth's motion, but of the solar system's motion(orbiting around the center of the galaxy) and our galaxy's motion, as well.

There are only two circumstances under which an observer will perceive the lightning

flashes as simultaneous. The first circumstance requires an observer stationed at the mid-point between points **A** and **B** when the lightning flashes occur, and who remains at absolute rest, at least until the lightning flashes reach the mid-point. This observer will perceive the flashes as simultaneous. The second circumstance requires an observer moving in the geometric plane consisting of all points equidistant between points **A** and **B** when the lightning flashes occur. This observer will also perceive the flashes as simultaneous. In the second circumstance, however, other factors must be considered to determine if the observer perceives the flashes of light directly, indirectly or if at all. Every other observer will perceive that the flashes are simultaneous.

Einstein's thought experiment correctly assumes the importance of an observer at the mid-point between points **A** and **B** to judge whether lightning flashes are simultaneous. He fails to acknowledge that the observer must be at absolute rest at the mid-point or at least have knowledge of this absolutely resting mid-point from which he can make certain calculations. Both conditions may be impossible to attain.