A Simple Challenge to Relativity

Henok Tadesse
Email: *entkidmt@yahoo.com*

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Abstract

There are long standing confusions and arguments about the application of special relativity theory to such problems as the Global Positioning System, Sagnac effect and moving observer experiments. The arguments in many cases are intuitive, lacking mathematical rigor, lacking mathematical treatment strictly according to Lorentz transformation equations. Even relativists are usually seen to be confused regarding, for example, the time delay of a short light pulse for an observer moving at non-relativistic speeds relative to the light source, according to the theory of special relativity. In this paper, I present a simple challenge that probes into the understanding of the application of special relativity to these problems by physicists.

Introduction

There are longstanding confusions and arguments about the application of special relativity to the Global Positioning System (GPS), the Sagnac effect, stellar aberration and moving observer experiments. The arguments so far are mostly intuitive, lacking mathematical rigor. Here I present a simple problem[1] that probes the understanding of the application of special relativity to these problems by relativists and others.

A moving observer experiment

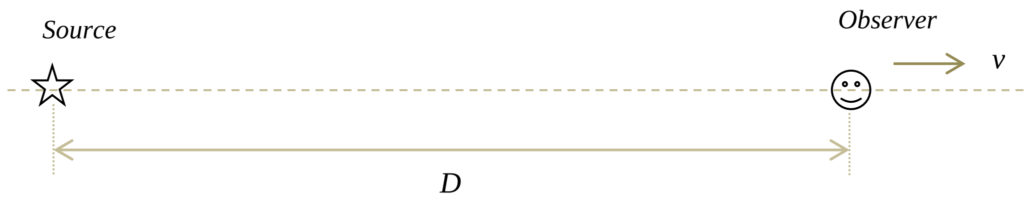
Consider a hypothetical terrestrial light speed experiment. Assume that the speed of light is constant c in the reference frame of the Earth. For a relativist, it is an inertial reference frame and for a supporter of absolute motion it is an absolute reference frame.

There is a stationary light source at some point on the Earth. A distant observer is moving directly away from the source with velocity v, along the line connecting the light source and the observer.

We have synchronized clocks both at the source and at (moving together with) the observer. We assume that $v << c$, so that the gamma factor (γ) of special relativity is almost equal to one. So we can ignore length contraction and time dilation. Because this is a non-relativistic experiment, we can assume that the clocks, once synchronized, will remain synchronized.

Electrical engineer, BSc, Debrezeit, Ethiopia Mobile: +251 910 751339
or +251 912 228639 Alternate email: *wchmar@gmail.com*

The light source emits a very short light pulse. *At the instant of light emission*, the distance between the source and the observer is *D*, as shown below.



The question is, according to special relativity theory, what is the time interval (Δt) between emission and detection of the light pulse?

Is it :

$$\Delta t = \frac{D}{c}$$

or:

$$\Delta t = \frac{D}{c - v}$$

?

If your answer is the first one or the second one, do you think it is supported by experiments?

This is a non-relativistic experiment, so I haven't presented it in terms of reference frames and haven't discussed about clock synchronization. To avoid possible confusions related to clock synchronization and reference frames, I restate the problem as follows.

Consider an inertial reference frame S. A light source is at rest at the origin of S, together with clock A. An observer is at the origin of another inertial reference frame S' which is moving with velocity $v << c$ relative to S in the $+x$ direction. The observer has clock B with him/her. The coordinates of S are (x , t) and those of S' are (x', t'). Clocks A and B are synchronized when the origins of S and S' coincide, at $t = t' = 0$.

The light source emits a short light pulse. *At the instant of light emission*, the observer is at point $x = D$, both relative to S, moving away from the light source with velocity v , in the $+x$ direction.

My questions are:

What is the time interval between emission and detection of the light pulse as *measured* by clock A and by clock B, or as *measured* in S and in S', according to special relativity ?

Are there experiments done so far to record the time *instant* of emission by clock A and the time *instant* of detection by clock B?

Has any attempt ever been made to *measure* the time *interval* between emission and detection, relative to reference frame S and relative to reference frame S' ?

Conclusion

The moving observer problem presented in this paper is supposed to be one of the easiest problems in relativity theory, yet it is one of the most confusing and debated problems of special relativity. This simple problem embodies the confusions regarding the application of special relativity to GPS, the Sagnac effect and stellar aberration.

Thanks to Almighty God Jesus Christ and His Mother Our Lady Saint Virgin Mary

References

1. Was the Light Speed Problem Really Solved by Einstein in 1905, by Henok Tadesse, user name Hal

https://www.thenakedscientists.com/forum/index.php?topic=77760.140