The GPS Sagnac Correction Disproves Isotropy and Constancy of the Speed of Light and the Relativistic Clock Synchronization Procedure

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Abstract

Light speed experiments involving moving detectors/observers have been some of the controversial topics in the Special Relativity Theory. The relativistic arguments are inconsistent and are usually ad hoc mixtures of relativistic and classical views. Researchers trying to use such experiments to disprove relativity haven't been particularly successful either because the arguments usually left room for (not always consistent) relativistic counter-arguments. In this paper, I present a decisive disproof of special relativity by applying the assumption of isotropy of the speed of light to a thought experiment. The result is in direct conflict with experience and well-known facts.

Introduction

Light speed experiments involving moving detectors/observers are rightly perceived as a promising way to disprove the Special Theory of Relativity (STR) among researchers looking for alternatives to the STR. One such experiment is the GPS and the GPS Sagnac correction. There have been numerous papers, articles and debates on this over the decades. The relativistic arguments are inconsistent and are ad hoc mixtures of relativistic and classical views as usual. But researchers seeking to disprove relativity by using moving source experiments haven't been particularly successful either, as the arguments usually leave room for (not usually consistent) relativistic counter-arguments. In this paper, I present a new argument against the theory and the principle of relativity by applying the relativistic procedure of clock synchronization to a thought experiment. The result is in direct conflict with experience and facts.

A Disproof of the Principle and Theory of Relativity

<u>Galileo's ship thought experiment:</u>

Consider a light source emitting a light pulse from some point in the Earth's frame, at $t = 0$. The velocity of the source is irrelevant. At the instant of light emission, an observer is at distance D from the source and is moving away from the source with velocity v, in the Earth's frame.

We know that the light will catch up with the observer at $t = D/ (c - v)$. This is a well-known and accepted fact even in the Special Relativity Theory SRT and has been confirmed by experiments. Now I will use this in my argument against the principle of relativity.

Consider Galileo's ship thought experiment (Fig.1). An observer in a closed room of the ship is doing a physics experiment. There are two light sources S_1 and S_2, with the distance between

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them equal to*2D*. The line connecting the sources is parallel to the longitudinal axis of the ship, and hence to the velocity *v* of the ship. S_2 is in front of S_1. There are clocks C_1 and C_2 at the same location as S_1 and S_2, respectively. A detector is placed at the midpoint between the sources, at distance *D* from each source. The light sources each emit a short light pulse simultaneously every second. The detector detects the time difference between the pulses. If the time difference is zero, then we may conclude that the isotropy of the speed of light is proved. Otherwise, both the principle and theory of relativity are disproved.

For this, the clocks C_1 and C_2 need to be synchronized first. For this, a short light pulse is emitted from S_1 towards S_2. Suppose that S_1 emits the light pulse at $t = 0$. The observer in the closed room (a relativist) synchronizes the clocks based on the principle of isotropy of the speed of light, because according to SRT the speed of light is isotropic in Galileo's ship! However, unknown to him/her, we know that the clocks 'synchronized' by this procedure will be out of synch by an amount:

$$\frac{2D}{c-v} - \frac{2D}{c} = 2D\frac{v}{c(c-v)}$$

Actually the clock C_2 will be behind the clock C_1 by this amount.

It should be noted that, according to special relativity, the clocks synchronized by this procedure will be in synch. However, from experience we know that the clocks will be out of synch. I think even relativists implicitly accept this (i.e. the clocks being out of synch); they only claim that this does not contradict SRT, using inconsistent arguments as usual. Physicists usually describe SRT by using thought experiments in deep space, claiming that SRT is a correct theory of the universe. However, when it comes to terrestrial experiments, they usually switch their interpretation of SRT to a one that agrees with experimental outcomes. Note that in the above Galileo's thought experiment, we assumed a terrestrial experiment. However, if a relativist was given the same problem, except that the experiment is done in deep space, he/she would say that the clocks will be in synch. Therefore, we know that the relativistic procedure is wrong, based on experience and inconsistency in the analysis of SRT. Therefore we analyze the experiment classically as follows.

The sources each emit a short light pulse 'simultaneously' (quoted because the clocks are not actually in synch), every second. The observer in the ship expects the pulses to arrive simultaneously, which they will not.

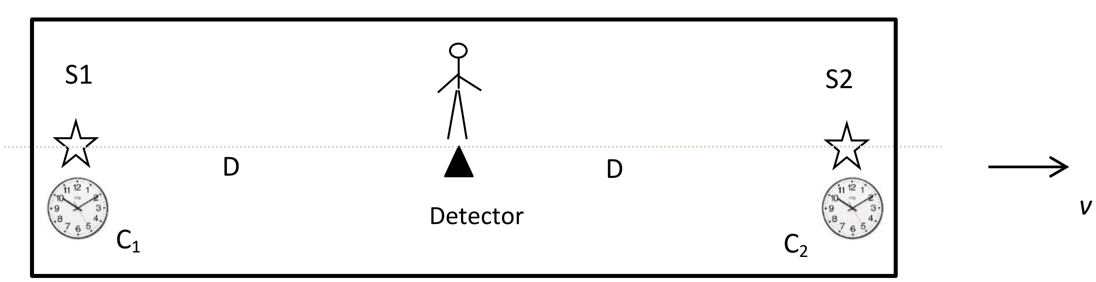

Fig. 1

Let S_1 emit the light pulse at $t = t_0$. Then S_2 will emit 'simultaneously' at the time,

$$t_0 + 2D\frac{v}{c(c-v)}$$

The light from S_1 arrives at the detector at the time

$$t_1 = t_0 + \frac{D}{c-v}$$

The light from S_2 arrives at the detector at time

$$t_2 = [\ t_0 + 2D\frac{v}{c(c-v)}\ ] + \frac{D}{c+v}$$

The difference in the time of arrival of the two pulses at the detector will be:

$$t_2 - t_1 = \Delta = \left[t_0 + 2D\frac{v}{c(c-v)} + \frac{D}{c+v}\right] - \left[t_0 + \frac{D}{c-v}\right]$$

$$\Rightarrow \Delta = \frac{2D}{c}\frac{v^2}{c^2}\frac{1}{1-\frac{v^2}{c^2}} \quad . \quad . \quad . \quad (1)$$

The relativist observer synchronized the clocks by assuming isotropy of the speed of light, placed the detector at the midpoint between the sources and made the sources emit light pulses 'simultaneously'. He/she would expect the light pulses to arrive simultaneously at the detector, which they didn't. The light pulses always arrive with a time difference of Δ that depends on velocity v. The observer would have no way to explain this. To any one rejecting this argument, my response is this: let an actual experiment be done to test it. We know that the origin of the problem lies in the observer assuming isotropy of the speed of light while synchronizing the clocks. This disproves the principle and theory of relativity.

Let me make the difference between the new synchronization procedure I am proposing and the standard synchronization procedure more clear.

In the standard clock synchronization procedure, synchronization light pulses would be sent from the mid-point to the clocks C_1 and C_2, which, on receiving the pulses, are immediately set to $t = 0$ and start counting.

In the new procedure, clock C_1 is set to $t = 0$ and at the same time sends a synchronization pulse to the clock C_2. The clock C_2 , upon receiving the pulse, is set to $t = 2D/c$, assuming isotropy of the speed of light , and starts counting from there.

If absolute motion doesn't exist, then both procedures are equivalent in principle and both clocks will be in synch, and therefore $t_2 - t_1 = 0$.

However, if absolute motion exists, both procedures will result in out of synch clocks. However, in the standard procedure, this effect will be exactly canceled out as the sources emit the ‘simultaneous’ pulses to the detector, so that $t_2 - t_1 = 0$.

In the newly proposed procedure, the clocks will be out of synch and this will manifest in non-simultaneous arrival of 'simultaneously' emitted pulses from S_1 and S_2. That is, the unsynchronized clocks will manifest as: $t_2 - t_1 \neq 0$

GPS Sagnac correction as evidence for anisotropy of the speed of light

How does the GPS Sagnac correction support my argument that the pulses from S_1 and S_2 will not arrive simultaneously at the detector ?

Consider both the proposed thought experiment and the GPS in the ECI frame. In both cases, the source and the observer are moving in the ECI frame. In both cases the clocks are synchronized by assuming light speed isotropy. In the GPS , the point of signal emission is fixed in the ECI frame and the motion of the observer in the ECI frame is considered. (so called GPS Sagnac correction). Therefore, in the thought experiment also the point of signal emission is fixed in the ECI frame and the motion of the observer needs to be considered, and therefore we conclude that the pulses will not arrive simultaneously at the detector.

At this point one might invoke ‘relativity of simultaneity’ , ‘length contraction’ , ‘time dilation’ etc. as a counter-argument. However, we know that the special relativity theory is based on the two postulates:

1. The principle of relativity.
2. The constancy and isotropy of the speed of light

Everything else in SRT is a consequence of these two postulates: Lorentz transformations, relativity of simultaneity, length contraction, time dilation, etc. Therefore, these two postulates need to be tested and established experimentally before accepting their consequences, such as relativity of simultaneity, as facts.

If one or both of the two postulates is shown to be wrong, then we can conclude that the consequences (relativity of simultaneity, etc.) cannot be correct. If somehow it can be shown experimentally that the speed of light is not constant, one cannot bring, for example, relativity of simultaneity into the argument because the latter is a consequence of the former, and not the other way round.

However, the predicted time difference of the two pulses is extremely small for terrestrial experiments in which the distance D can only be tens of kilometers at most. Such time difference would be difficult or impossible to measure by current technology.

Testing the relativistic clock synchronization procedure by transmitting time signals between an Earth clock and a satellite clock

Yet another opportunity to test the prediction is by exchange of clock signals between an Earth clock and a satellite clock[1]. The big distance involved is a great advantage to test and detect the predicted effect. The experiment is described as follows.

Consider an atomic clock (C_1) on Earth and another atomic clock (C_2) on a satellite (a GPS satellite, for example), (Fig.2).

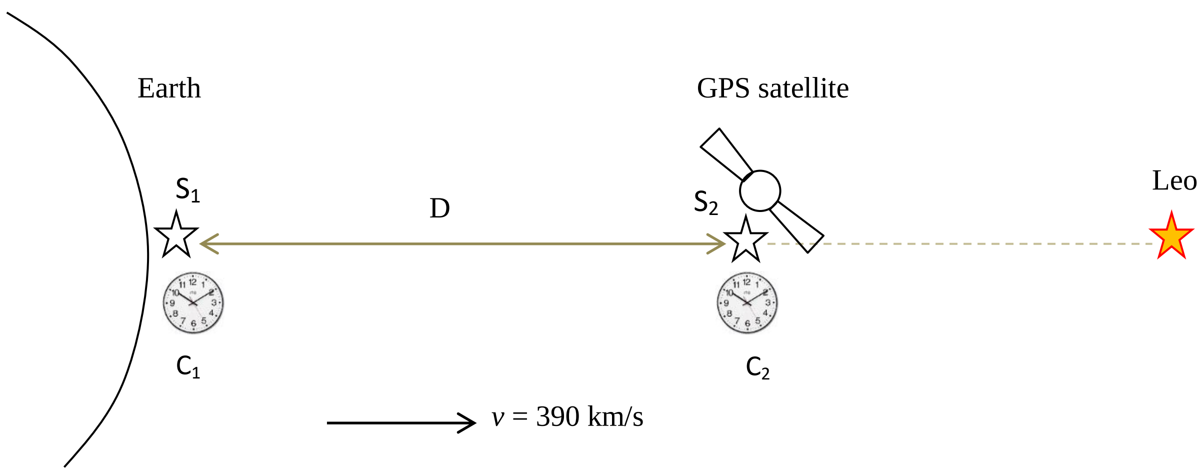

Fig. 2

The experiment is done when the Earth, the GPS satellite and Leo are aligned, as shown (Fig.1). However, alignment would be preferable but not a necessity, so a GPS satellite out of alignment but close enough to the Earth-Leo line can be used, with a component of the absolute velocity along this line calculated and used.

The distance D needs to be measured as precisely as possible, by radar ranging, that is by reflecting radar signal from the satellite (not by interrogation!). For this, the radial velocity of the GPS satellite relative to the Earth needs to be near zero to accurately compute the distance D from the radar round trip time (τ). In this case:

$$\tau = \frac{2D}{c}$$

If there is relative radial velocity between the Earth and the GPS satellite, using the above equation leads to erroneous distance *D*. (the Brian G. Wallace effect)

At time $t = 0$, the Earth clock (C_1) transmits a synch pulse to the GPS satellite clock (C_2). The satellite clock actually receives the synch signal at $t = D/(c-v)$, that is when the time of the Earth clock is $t = D/(c-v)$. However, due to the assumption of isotropy of the speed of light, the satellite clock is set to $t = D/c$. Therefore, the GPS satellite clock will be behind the Earth clock by an amount:

$$\delta = \frac{D}{c-v} - \frac{D}{c}$$

The (c - v) is because the satellite clock (C_2) is moving away from the synch signal (Fig.2).

Now, let the GPS satellite clock (C_2) transmit the time signal to Earth later at some time $t = t_0$.

At this instant, the clock on Earth (C_1) will be ahead of the satellite (C_2) clock by an amount δ. That is, the time of the Earth clock when the satellite transmits the time signal will be:

$$t_0 + \delta$$

Therefore, the GPS satellite time signal arrives on Earth when the time of the Earth clock is:

$$(t_0 + \delta) + \frac{D}{c+v} = (t_0 + \frac{D}{c-v} - \frac{D}{c}) + \frac{D}{c+v}$$

The $c + v$ is because the Earth clock is moving towards the GPS time signal.

However, due to the assumption of isotropy of light speed, the GPS receiver on Earth *calculates* the 'correct' time to be:

$$t_0 + \frac{D}{c}$$

Therefore, the difference between the *actual time* of the Earth clock and the *calculated time* (using GPS signal) will be:

$$(t_0 + \frac{D}{c-v} - \frac{D}{c}) + \frac{D}{c+v} - (t_0 + \frac{D}{c}) = \frac{D}{c-v} + \frac{D}{c+v} - \frac{2D}{c} = \frac{2D}{c} \frac{\frac{v^2}{c^2}}{1 - \frac{v^2}{c^2}}$$

Substituting $D = 22000$ Km, $v = 390$ km/s we get about 0.248 micro seconds.

This discrepancy can be easily detected.

Conclusion

In this paper, we applied the relativistic procedure of clock synchronization, that is by assuming isotropy of the speed of light, to a thought experiment. In the thought experiment, a detector is placed at the mid-point between two sources S_1 and S_2 in an inertial lab, a Galileo's ship moving with velocity *v* relative to the sea. Therefore, the lab is moving at least relative to the sea. Clocks C_1 and C_2 are co-located with S_1 and S_2, respectively. The two clocks are synchronized by emitting a synch pulse from S_1 towards S_2 and by assuming isotropy of the speed of light. We argued that, in reality, the two clocks will not be *actually* synchronized by this procedure because the clock C_2 is moving away from the synch pulse, which will take more time to reach C_2 than if C_2 was not moving. Despite this, let the clock C_2 , upon receiving the synch pulse, set its time to D/c, instead of $D/(c-v)$. Next we will see how this out-of-synch condition of the clocks will manifest. After some time, each clock 'simultaneously' emits a light pulse towards the detector. If the clocks are really in synch and if the speed of light is really isotropic, then the pulses will arrive simultaneously at the detector. The question is: will the pulses arrive at the detector simultaneously or not? One way to test this is to do an actual/physical experiment. However, we can also use past experience to determine whether the time difference of the two pulses will be zero or not. One such experience is the GPS Sagnac correction. Consider the thought experiment described and the GPS system in the ECI frame. In both cases, both the source and the detector are moving. In both cases, the point where signal is emitted is fixed in the ECI frame. In both cases, isotropy of the speed of light is assumed to synchronize the clocks. We know that motion of the detector/receiver is considered in the GPS (so called GPS Sagnac correction) to account for the change in position of the receiver during the GPS time signal transit time. We conclude that motion of the detector needs to be considered in the thought experiment also and, therefore, the 'simultaneously' transmitted pulses will not arrive at the detector simultaneously, despite the fact that the sources are at equal distances from the detector. This disproves the isotropy of the speed of light and thereby the theory and principle of relativity.

Glory be to God and His Mother, Our Lady Saint Virgin Mary

Notes and references

1. I have discussed this experiment on internet forum:

https://www.scienceforums.net/topic/132749-a-disproof-of-the-principle-and-theory-of-relativity/page/4/#comments