Proposal for a new light speed anisotropy experiment based on time of flight method

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Abstract

A new light speed anisotropy experiment is proposed that is based on time of flight technique. Two light transceivers A and B are fixed to each end of a rigid rod. A short light pulse initially emitted by A is detected by B, upon which B is triggered to emit a light pulse, which in turn is detected by A, upon which A is triggered to emit another light pulse which will be detected by B, and so on. An electronic counter counts the pulses. Changing the orientation of the rod with respect to Earth's absolute velocity direction will cause a variation of the number of pulses counted in a given period of time (i.e. the frequency). The unique feature of this experiment is that Earth's absolute velocity can be determined with any desired accuracy.

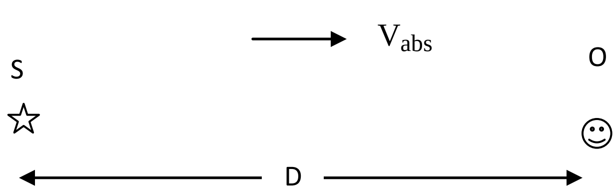
Introduction

Most of the light speed anisotropy experiments use interference techniques which are based on phase differences because of the difficulty associated with time of flight technique. The Michelson-Morley experiments all use interference methods. In this paper we propose a new method based on time of flight.

Apparent Source Theory [1]

According to the new theory already proposed by this author, *the effect of absolute motion of an inertial observer is to create an apparent change in the position (distance and direction) of the point of light emission relative to the observer* [1].

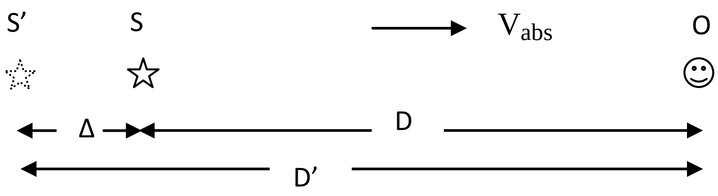
Imagine a light source S and an observer O, both at (absolute) rest, i.e. $V_{abs} = 0$.



A light pulse emitted by S will be detected after a time delay of

$$t_d = \frac{D}{c}$$

Now suppose that the light source and the observer are absolutely co-moving to the right.



The new interpretation proposed here is that the position of the source S changes apparently to S', *as seen by the observer, relative to the observer*.

During the time (t_d) that the source 'moves' from point S' to point S, the light pulse moves from point S' to point O, i.e. the time taken for the source to move from point S' to point S is equal to the time taken for the light pulse to move from point S' to point O.

$$\frac{\Delta}{V_{abs}} = \frac{D'}{c}$$

But

$$D + \Delta = D'$$

From the above two equations:

$$D' = D \frac{c}{c - V_{abs}}$$

and

$$\Delta = D \frac{V_{abs}}{c - V_{abs}}$$

The effect of absolute motion is thus to create an apparent change of position of the light source relative to the observer, in this case by amount Δ .

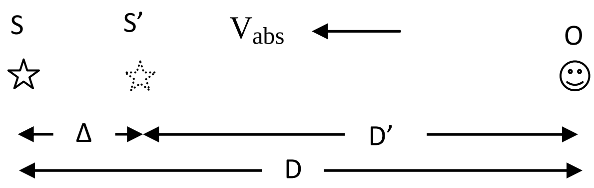
Once we have determined the apparent position of the source as seen by the co-moving observer, we can analyze the experiment by assuming that light was emitted from S' (not from S) and that the speed of light is constant relative to the apparent source.

Therefore, a light pulse emitted by the source is detected at the observer after a time delay of:

$$t_d = \frac{D'}{c} = \frac{D \frac{c}{c - V_{abs}}}{c} = \frac{D}{c - V_{abs}}$$

To the observer, the source S appears to be farther away than it physically is.

In the same way, for absolute velocity directed to the left:



$$\frac{\Delta}{V_{abs}} = \frac{D'}{c} \qquad and \qquad D - \Delta = D'$$

From which

$$D' = D\frac{c}{c\ +\ V_{abs}}$$

and

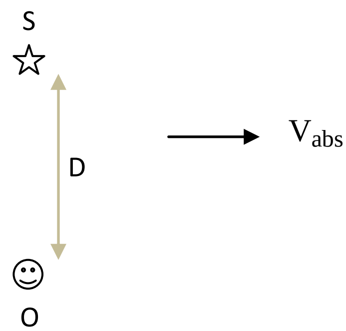
$$\Delta = D\frac{V_{abs}}{c + V_{abs}}$$

In this case, it appears to the observer that the source is nearer than it actually is by amount Δ.

Once we have determined the apparent position (S') of the source as seen by the co-moving observer, we can determine the time delay t_d. Therefore, a light pulse emitted by the source is detected at the observer after a time delay of:

$$t_d = \frac{D'}{c} = \frac{D\frac{c}{c + V_{abs}}}{c} = \frac{D}{c + V_{abs}}$$

Now imagine a light source S and an observer O as shown below, with the relative position of S and O orthogonal to the direction of their common absolute velocity.



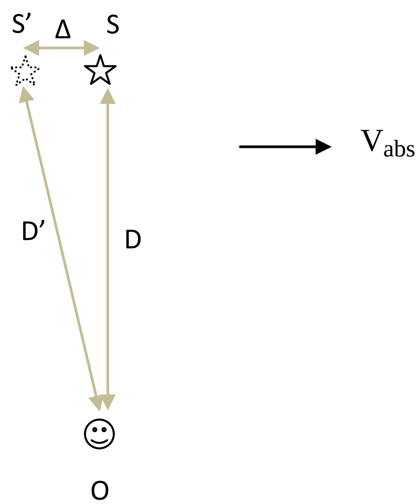
S and O are moving to the right with common absolute velocity V_{abs}.

If V_{abs} is zero, a light pulse emitted from S will be received by O after a time delay t_d

$$t_d = \frac{D}{c}$$

In this case, light arrives at the observer from the direction of the source, S.

If V_{abs} is not zero, then the source position appears to have shifted to the left as seen by the observer O.



In this case also, the effect of absolute velocity is to create an apparent change in the *position*(distance and direction) of the light source relative to the observer.

In the same way as explained previously,

$$\frac{D'}{c} = \frac{\Delta}{V_{abs}}$$

i.e. during the time interval that the light pulse goes from S' to O, the source goes from S' to S.

But,

$$D^2 + \Delta^2 = D'^2$$

From the above two equations

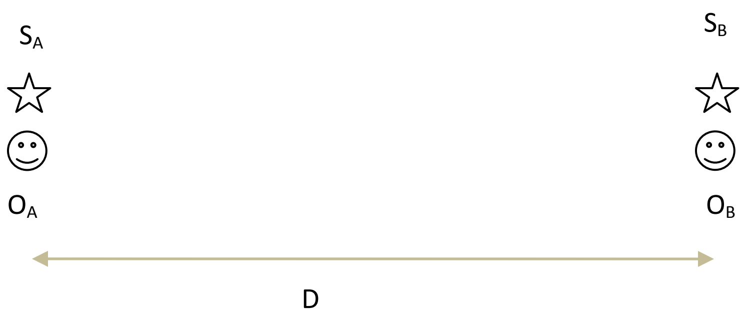
$$D' = D\frac{c}{\sqrt{c^2 - V_{abs}{}^2}} \text{ and } \quad \Delta = D\frac{V_{abs}}{\sqrt{c^2 - V_{abs}{}^2}}$$

Therefore, the time delay t_d between emission and reception of the light pulse in this case will be

$$t_d = \frac{D'}{c} = \frac{D}{\sqrt{c^2 - {V_{abs}}^2}}$$

Proposed experiment

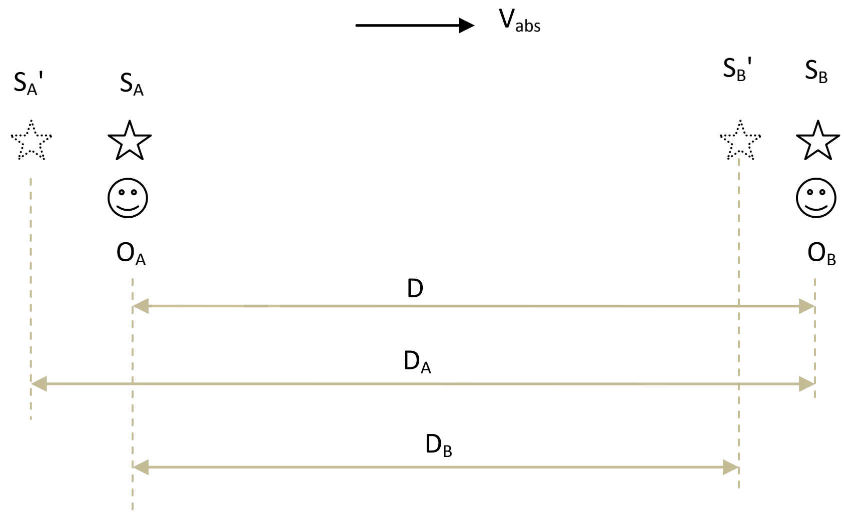
Consider two co-moving light transceivers A and B, each fixed to the two ends of a rigid rod, with the distance between them being D . Each transceiver detects light, upon which it will be triggered to emit a light pulse.



Initially A emits a short light pulse, which will be detected by B, upon which B will be triggered to immediately emit a short light pulse, which will be detected by A, upon which A will be triggered to immediately emit a short light pulse, which will be detected by B, and so on. An electronic counter counts the number of pulses in a given period of time.

If A and B are at absolute rest, the round trip time of light will be 2D/c , hence the frequency of the pulses will be f = 1/ (2D/c) = c / 2D.

If A and B are in absolute motion, say to the right, the apparent positions of each light source as seen by the other detector will be as shown below.



S_A' is the apparent position of S_A as seen by O_B , and S_B' is the apparent position of S_B as seen by O_A , where O_A and O_B are the detectors at A and B, respectively.

In this case, the round trip time of a light pulse emitted by A, re-emitted by B, and detected by A will be:

$$T_d = \frac{D_A}{c} + \frac{D_B}{c}$$

where

$$D_A = D\,\frac{c}{c - V_{abs}} \qquad \text{and} \qquad D_B = D\,\frac{c}{c + V_{abs}}$$

Therefore,

$$T_d = \frac{D_A}{c} + \frac{D_B}{c} = D\,\frac{c}{c - V_{abs}} + D\,\frac{c}{c + V_{abs}} = \frac{2Dc}{c^2 - {V_{abs}}^2}$$

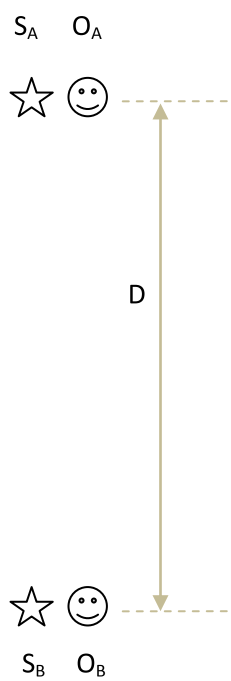
The frequency of the pulses will be:

$$\boxed{f = \frac{1}{T_d} = \frac{c^2 - {V_{abs}}^2}{2Dc}}$$

This is the frequency of the pulses when the rod is oriented towards the direction of absolute velocity, which is towards Leo constellation.

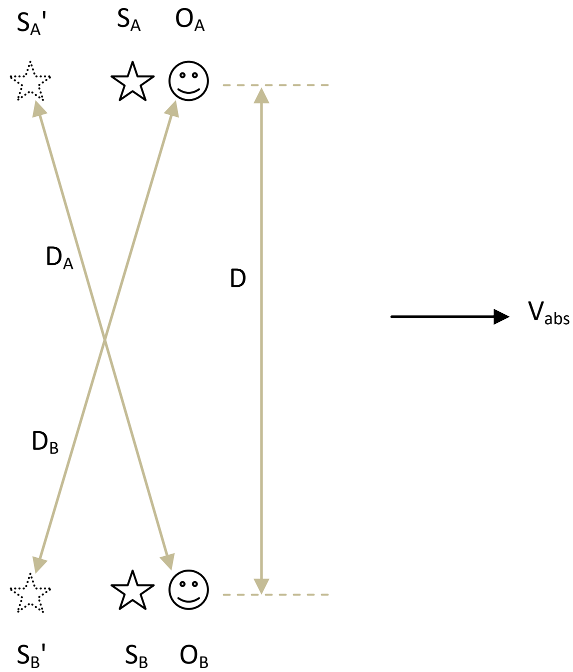
Note that the distance between S_A and O_A (and between S_B and O_B) is assumed to be very small, and much less than D, so that both can be assumed to be at the same point in space.

Now let the rod be oriented perpendicular to Earth's absolute velocity.



As before, if A and B are at absolute rest, the round trip time of light will be 2D/c , hence the frequency of the pulses will be f = 1/ (2D/c) = c / 2D.

If A and B are in absolute motion, say to the right, the apparent positions of each light source as seen by the other detector will be as shown below.



The round trip time of a light pulse emitted by S_A , detected by O_B, which in turn will be emitted by S_B and detected by O_A will be:

$$T_d = \frac{D_A}{c} + \frac{D_B}{c}$$

where

$$D_A = D_B = D \frac{c}{\sqrt{c^2 - V_{abs}{}^2}}$$

Therefore

$$T_d = \frac{D_A}{c} + \frac{D_B}{c} = \frac{2D}{\sqrt{c^2 - V_{abs}{}^2}}$$

The frequency of the pulses in this case will be:

$$f = \frac{1}{T_d} = \frac{1}{\left(\frac{2D}{\sqrt{c^2 - V_{abs}{}^2}}\right)} = \frac{\sqrt{c^2 - V_{abs}{}^2}}{2D}$$

This is the frequency of the pulses when the rod is oriented perpendicular to the direction of absolute velocity.

Thus, the reading of an electronic counter which counts the pulses for a fixed interval of time will change as the orientation of the rod relative to the absolute velocity vector is changed.

For example, let V_{abs} = 390 km/s and D = 3m.

The frequency of the pulses when the rod is parallel with the absolute velocity vector will be:

$$f_{parallel} = \frac{c^2 - V_{abs}{}^2}{2Dc} = \frac{300000^2 - 390^2}{2 * 0.003 * 300000} = 49999915.5000000 Hz$$

The frequency of the pulses when the rod is perpendicular to the absolute velocity vector will be:

$$f_{perpendicular} = \frac{\sqrt{c^2 - V_{abs}{}^2}}{2D} = \frac{\sqrt{300000^2 - 390^2}}{2 * 0.003} = 49999957.7499821 Hz$$

The difference in frequency will be:

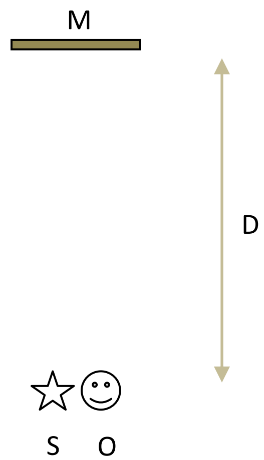
$$f_{perpendicular} - f_{parallel} = 49999957.7499821 - 49999915.5000000 = 42.24998\ Hz$$

Therefore, in one second the difference in the counter readings will be about 42.24998. In 30 minutes, for example, the difference will be 42.24998*30*60 = 76049.964counts.

The actual experimental setup may consist of two identical such systems (each system consisting of two light transceivers connected to each end of a rigid rod) , one oriented parallel to the Earth's absolute velocity and the other perpendicular to it. The two systems are started simultaneously and then, say after 30 minutes, stopped simultaneously, and the readings of the two counters compared.

Note that we have assumed, for simplicity, instantaneous emission of a light pulse by the transceivers upon triggering by a detected pulse. In an actual experiment, the finite delay between detection and re-emission of a light pulse should be taken into account.

To determine this time delay between light detection and re-emission experimentally, the following setup is used. According to Apparent Source Theory [1] , absolute motion does not affect experiments in which the light source and the detector are so close together that they can be considered to be at the same point in space. Also, absolute motion of an observer/detector results in an apparent change in source position, and not mirror position, i.e. the actual/physical position of the mirror is taken in the analysis of the experiment [1].



Initially, a short light pulse is emitted by the source S, which will travel to mirror M, and reflected back to the detector O. Upon detecting the light pulse, detector O immediately triggers source S to emit a short light pulse again, which will travel to the mirror, reflected back and detected by O, which triggers source S and so on. A counter counts the number of pulses emitted. If we don't consider the finite time delay between detection and re-emission, the round trip time will be:

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

To determine the finite delay between detection and re-emission, we let the counter (the system) run for a fixed length of time, say one second, and then stop it. Let the value of the counter be N at the end of one second. The period in this case will be:

$$\tau = \frac{1\, second}{N} = \frac{1}{N}\ seconds$$

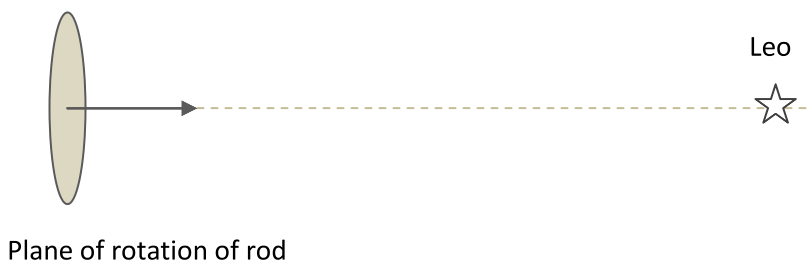
The time delay Δ between detection and re-emission will be the difference between τ and T .

$$\Delta = \tau - T$$

The longer the time the system runs, for example one minute instead of one second, the more accurately the value of Δ can be determined.

Determination of direction and magnitude of absolute velocity

Our discussion so far assumed that we know the direction and magnitude of absolute velocity, which is towards Leo constellation and 390 Km/s , respectively. However, to independently determine Earth's absolute velocity, we follow the following procedure. First the direction of the absolute velocity is determined. To find the direction of absolute velocity, we need to find the plane in which rotation of the rod does not cause any change in the counter value for a fixed period of time. This means that, for any orientation of the rod in this plane, there will always be the same number of counts in a given fixed period of time. The absolute velocity is perpendicular to this plane. Once we find the direction of absolute velocity we can determine the magnitude of absolute velocity by orienting the rod parallel and perpendicular to the absolute velocity and finding the difference in the counter values for a fixed period of time in the two cases, as discussed before.



We can use one of the following equations to determine V_{abs} .

$$f_{parallel} = \frac{c^2 - {V_{abs}}^2}{2Dc} \quad \dots\dots\dots\dots \quad (1)$$

$$f_{perpendicular} = \frac{\sqrt{c^2 - {V_{abs}}^2}}{2D} \quad \dots\dots\dots\dots\dots \quad (2)$$

Conclusion

The new experiment proposed in this paper is basically based on integrating (accumulating) the extremely small differences between the time of flight of light in two directions, which would be difficult to measure by using conventional time of flight methods in which the time elapsed between spatially separated emitter and detector is measured. The new method uses two light 'transceivers' spatially separated, instead of spatially separated emitter and a detector , with the emission, detection and re-emission cycle continuing for as long as desired. This enables determination of the magnitude and direction of Earth's absolute velocity with high accuracy.

Thanks to God and the Mother of God, Our Lady Saint Virgin Mary

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