A critical and thorough re-analysis of the null result of the Michelson and Morley experiment

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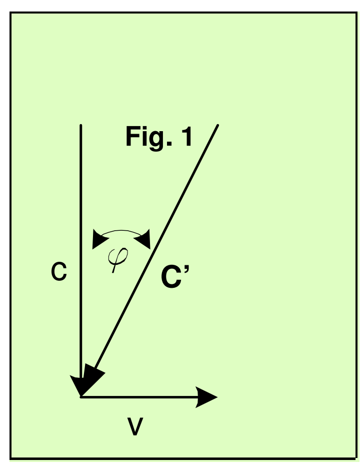
Abstract:

It has happened sometimes in the history of scientific development, that a misinterpretation of a phenomenon or an experiment by a renowned scientist, will spread thereafter under the mantle of his authority without anyone bothering to verify the veracity of those arguments and check for its correctness. With time it becomes so settled that any attempt to deny it will meet with strong opposition. The word of this or that distinguished scientist is irrefutable and only a fool would dare to question it.
This kind of attitude has caused serious harm to the scientific development over the centuries and led research in many areas astray. The last century has not been different.
I'm coming back again and again to this issue, always in a somewhat different and more explicit mode because this is an emblematic case of what has been said above.
In two previous papers[1] we got to demystify the phenomenon of stellar aberration and show that there is nothing magic with light and, as has been demonstrated, there is no violation of the constancy of the speed of light in applying Eddington's rain drops analogy. Since there is a straight correlation, as will be readily shown, between the phenomenon of light aberration and the M/M experiment, we shall start making a rapid pass through it.

It has been previously demonstrated[1] that, for the case of a star in the observer's zenith Fig.(1), the correct aberration angle is given by

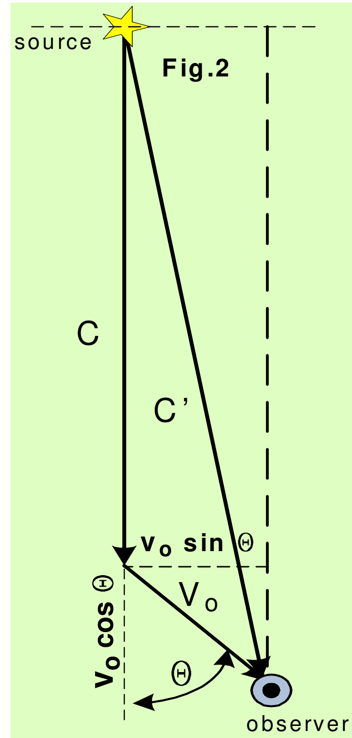
$$\varphi = \operatorname{atan}\left(\frac{v}{c}\right) \qquad (1)$$



In the general case Fig(2) when the star is situated at an angle θ in relation to the observer's speed vector $\mathbf{v_o}$ we have

$$\varphi = \operatorname{asin}\left(\frac{v_o \cdot \sin(\theta)}{\sqrt{c^2 + v_o^2 - 2 \cdot c \cdot v_o \cdot \cos(\theta)}}\right) \qquad (2)$$

the denominator in Eq.(2) is **c'**, the virtual light speed (Fig.2) as perceived by the observer.

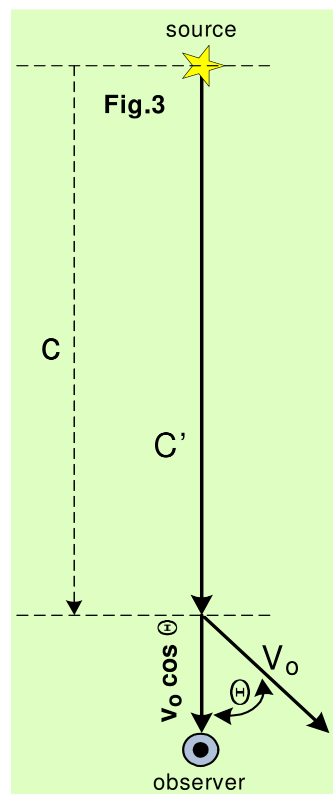


$$c' = \sqrt{c^2 + v_o^2 - 2 \cdot c \cdot v_o \cdot \cos(\theta)} \qquad \textbf{(3)}$$

Eq.(3) expands to

$$c' = c - v_o \cdot \cos(\theta) + \frac{v_o^2}{2 \cdot c} \cdot \sin(\theta)^2 + \frac{v_o^3}{2 \cdot c^2} \cdot \cos(\theta) \cdot \sin(\theta)^2 \ldots \qquad \textbf{(4)}$$

The speed vector **c'** may be decomposed into its co-linear and transverse components and Eq.(3) transforms accordingly



$c - v_o \cdot \cos(\theta)$ co-linear speed component

$v_o \cdot \sin(\theta)$ orthogonal speed component

and $c' = \sqrt{c^2 + v_o^2 - 2 \cdot c \cdot v_o \cdot \cos(\theta)}$

may be written as

$$\longrightarrow \quad c' = \sqrt{\left(c - v_o \cdot \cos(\theta)\right)^2 + \left(v_o \cdot \sin(\theta)\right)^2} \qquad \textbf{(5)}$$

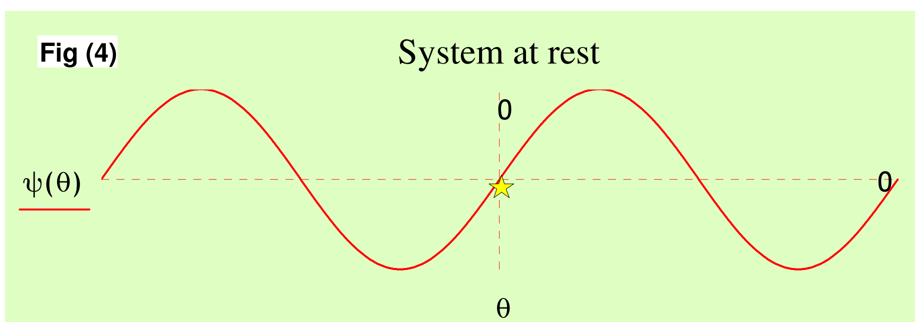
As is already well known there is no light aberration in co-moving systems. The light source, being an integral part of the observer's inertial frame of reference, follows the observer with the same speed and direction forming a closed ensemble. The orthogonal speed component is absent and that means that the transverse speed component, ($v_o \sin\theta$) in Equations (2) and (5) will be equal to zero end thence **φ** in Eq.(2) reduces also to zero; there is no light aberration and **c'** in Eq.(5) becomes

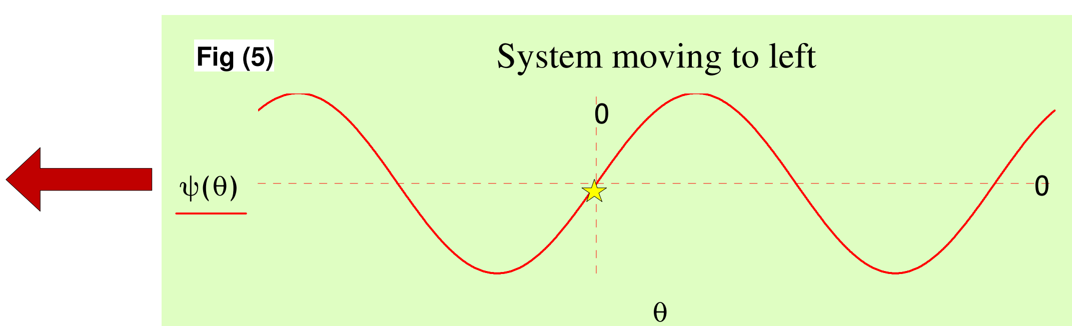
$$c' = c - v_o \cdot \cos(\theta) \qquad \textbf{(6)}$$

Which is (Eq.4) stripped of its higher order terms and, as so, is a first order effect. Eq.(6) is the key to deciphering the riddle presented by the null result of the M/M experiment.

Phase relation:

Wavelength, as seen by the observer, suffers no change in a co-moving systems contrary to what happens to phase Figs.(4, 5).





A free propagating electromagnetic wave has a phase given by

$$\psi_0 = 2\cdot\pi\cdot f\cdot t \qquad \psi_0 = \frac{2\cdot\pi}{\lambda}\cdot c\cdot t$$

making $c\cdot t = L$ then

$$\psi_0 = \frac{2\cdot\pi}{\lambda}\cdot L \qquad (7)$$

Where L is the distance separating the source from the detector (earlier referred to as an "observer").
In a co-moving system the distance **L'** traveled by light, as seen above, depends on the system speed and direction

$$L' = c'\cdot t \longrightarrow \psi = \frac{2\cdot\pi}{\lambda}\cdot c'\cdot t \quad \text{and} \quad t = \frac{L}{c}$$

In that co-moving system,applying Eq.(6), the phase is given by

$$\psi = \frac{2\cdot\pi}{\lambda}\cdot c'\cdot\frac{L}{c} = \frac{2\cdot\pi\cdot L}{\lambda}\cdot\frac{c'}{c} = \psi_0\cdot\frac{c + v\cdot\cos(\theta)}{c}$$

and the phase difference is

$$\Delta\psi = \psi - \psi_0 \qquad \Delta\psi = \frac{2\cdot\pi\cdot L}{\lambda}\cdot\frac{v}{c}\cdot\cos(\theta) \qquad (8)$$

The phenomenon underlying the well proven Sagnac effect has been largely neglected in its straight relation with the many interferometer experiments. A simple Sagnac device takes advantage of the phase difference given by Eq, (9) between two light rays racing in opposite directions in a circular track around a disk and is very sensitive to rotations taking place in the disk. As equation 9 shows, it is absolutely insensitive to orthogonal displacements, as expected.

As has already been shown experimentaly[2], nothing precludes the same effect from happening in a linear arrangement of such a device.

$$\left(\frac{2\cdot\pi\cdot L}{\lambda}\cdot\cos(\theta)\cdot\frac{v}{c}\right)-\left(\frac{2\cdot\pi\cdot L}{\lambda}\cdot\cos(\theta+\pi)\cdot\frac{v}{c}\right)=\frac{4\cdot\pi\cdot L}{\lambda}\cdot\frac{v}{c} \quad \text{(9)} \quad \text{linear Sagnac}$$

Interferometers of the type used by Michelson and Morley, on the other hand, compare the phase of an emitted wave with the phase of same wave as reflected back by a mirror. In other words, it is comparing a delayed phase with the same now advanced phase and the result is shown by Eq.(10)

$$\left(\frac{2\cdot\pi\cdot L}{\lambda}\cdot\cos(\theta)\cdot\frac{v}{c}\right)+\left(\frac{2\cdot\pi\cdot L}{\lambda}\cdot\cos(\theta+\pi)\cdot\frac{v}{c}\right)=0 \quad \text{(10)} \quad \text{M/M}$$

It becomes clear that experiments of the M/M type are bound to give an absolute null result for any angle **θ** to which the device may eventually be pointed. People who insist in getting positive results out of the M/M experiment by applying several odd mathematical gimmicks are certainly trying to squeeze water out of stone.That being firmly established, one question remains: Do we still need the length contraction once proposed by Lorentz to explain the M/M null result? Besides that, length contraction has not even been proven experimentally until now.

1) **Somme Remarks About Starlight Aberration**
Roald C. Maximo
The General Science Journal, April 2010
A Brief Comment About Airy's Experiment
Roald C. Maximo
The General Science Journal, October 2010

2) **Generalized Sagnac Effect**
Ruyong Wang, Yi Zheng and Aiping Yao
Physical Review Letters 93 (2004) 143901