

On a new wave explanation to Michelson-Morley Experiment

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1 Abstract

Using as null hypothesis the existence of classical Luminous Ether as preferred reference frame and considering all its consequences within a wave analysis in an absolute time framework, it is theoretically proved that a two way interference experiment do not demonstrate the inexistence of an eventual absolute space, as it is considered until now. In this sense Michelson-Morley experiment, and others of the same nature, may all of them be inconclusive.

Keywords: Michelson-Morley Experiment, Ether, Special Relativity

2 Introduction

The Michelson Morley Experiment (MME)[1], just like other experiments of the same nature (two way interferometry) as Kennedy-Thorndike's [2] and Hammar's [3], and many others, are considered as an irrefutable proof of the non-existence of a privileged reference frame (PRF), or Luminous Ether (LE).

The present article demonstrates how from a null hypothesis, as the existence of an absolute space and time, and using Newton's dynamics and Doppler effect the same 'negative' result is obtained in any two way interference experiments. Understanding by 'negative' the null detection of that absolute PRF, even if it effectively existed. This obviously does not mean that, in this way, the null hypothesis results validated.

For the purpose of this article it is necessary then to make that starting null hypothesis: The assumptions of the validity of Newton's dynamics on space and time and their characteristics as a privileged reference frame where the speed of light c is fixed only with respect to it, as the classical LE was considered.

These are not completely new assumptions. Many authors have already postulated as the best theory of physics of space and time the one based on absolute simultaneity and absolute space. Representative of them are F. Selleri [4] or V. Guerra and R. Abreu [5][6].

3 Reinterpreting Michelson-Morley's type of experiments.

3.1 Reviewing the Classical Michelson-Morley's Experiment.

Michelson-Morley experiment [1] use a light interferometer, which is a device that measures for comparison the difference between two optical paths over the instrument's two arms along light's journey outward and backwards in two different directions.

Michelson interferometer, as it is conceived, does not measure directly any time or speed difference but an

optical path difference. This is achieved comparing the difference between the total number of wave-fronts along the perceived light path of both arms.

The number and width of interference fringes observed is related to the difference between the lengths of the arms, the wavelength, and a multiple of an integer m . That one and other relationships such as the intensity of the observed fringes are perfectly well known and it is not considered necessary to go into any detail of that for the purpose of this article.

There are a couple of important considerations about Michelson's classical analysis that have to be epistemologically revisited to check if that analysis matches the experimental facts. These are:

1. The classical analysis is based on physical lengths comparison between both arms, go and return, and therefore the "metric distance" travelled by a photon over the two arms. This analysis is neglecting an important experimental fact: The interferometer measures optical path no physical lengths. They are not the same.
2. Since the experiment and its results are all carried out and analysed from a reference frame moving through the supposed luminous ether, as it is the case of an experiment placed at a laboratory over the earth, the Michelson's analysis must be carried out from that same moving reference frame point of view, not from the still ether point of view as it is classically accomplished.

3.2 A new perspective analysis

Let us then analyse Michelson's interferometer from a point of view placed on itself, which we call reference frame \mathbf{O}' , moving at velocity \vec{v} with respect to a static medium, which we call the PRF \mathbf{O} in absolute stillness.

When a moving wave source emits its monochromatic natural frequency ω_A it primarily transmits that frequency to the medium. Is here where a first Doppler effect occurs and so this equation have to be applied to calculate the frequency transmitted through the medium.

On reception a second time Doppler effect has to be taken into account. No frequency change is in this way detected

in a comobile detectot but the 'in between' optical path does change depending on wave direction vector \vec{k} .

Let us consider a standard Michelson interferometer setup as represented in *Figure 2*.

Let us call arm 1 to the interferometer's arm that moves longitudinally to speed \vec{v} , and arm 2 the one that moves transversally to \vec{v} . From \mathbf{O}' point of view the optical path observed on both arms would be:

A.- ARM 1

ARM 1, GO: Number of wave fronts over the go path.

When frequency ω_A is transmitted from the beamsplitter to arm 1 direction it will be 'observed', from a near point of the static medium \mathbf{O} in that direction (the \vec{v} direction), as ω_{og} . According to the Doppler effect formula for a moving emitter approaching a receiver (medium) at the same direction of \vec{v} , and module v , will be:

$$\omega_{og} = \omega_A \cdot \frac{c}{c - v}$$

Being its perceived wave number in that fixed direction over time:

$$\tilde{\omega}_{og} = \frac{\omega_A}{c - v}$$

And the total number of perceived wave fronts (Optical Path) of arm 1 go trip will be the wave number times the length of that travel. Due to from the \mathbf{O}' reference frame point of view the length of the travel is exactly L , the number of wave fronts observed from \mathbf{O}' will be then:

$$nwg_1 = \frac{L \cdot \omega_A}{c - v}$$

ARM 1, RETURN: Number of wave fronts over the return path.

When the light beam reaches the mirror at the end of arm 1 and bounces back, now according again to the Doppler effect formula for a moving emitter A (mirror) getting away from a receiver \mathbf{O} (medium) will be:

$$\omega_{or} = \omega_A \cdot \frac{c}{c + v}$$

Being its wave number in that direction:

$$\tilde{\omega}_{or} = \frac{\omega_A}{c + v}$$

And the total number of wave fronts (optical path) observed from \mathbf{O}' over the return travel of arm will be now:

$$nwr_1 = \frac{L \cdot \omega_A}{c + v}$$

Total number of waves fronts over arm 1.

The total number of wave fronts over arm 1 as seen from the beam splitter (\mathbf{O}') will be the total number of wave front in the go way path, plus the total number of wave fronts in the return path.

$$tnw_1 = nwg_1 + nwr_1 = \frac{L \cdot \omega_A}{c - v} + \frac{L \cdot \omega_A}{c + v} = \frac{2L \cdot \omega_A \cdot c}{c^2 - v^2}$$

B.- ARM 2

This case is the very spirit of this article and has its physical meaning has to be well understood. Transverse Doppler effect in the case of a co-mobile emitter-receiver must to be taken into account.

Because it is the medium that transmits the wave the object at \mathbf{A} , as seen from every point of arm 2, \mathbf{C} , \mathbf{D} , \mathbf{E} in Figure 1, is not measured at \mathbf{A} but at \mathbf{A}' , \mathbf{A}'' , \mathbf{A}''' position respectively, although the emitter is effectively placed at \mathbf{A} . The measured speed from \mathbf{C} point of view would not be $|\vec{c}|$, it would be $|\vec{c}|$ minus the projection of \vec{v} along the direction of perception $\mathbf{A}'\mathbf{C}$, $\mathbf{A}''\mathbf{D}$, $\mathbf{A}'''\mathbf{E}$ at every moment i.e. $|\vec{c}| - |\vec{v}_p|$ as represented in Figure 1.

This is the main point of the epistemological foundation of this article and it has to be analysed carefully. It is important to distinguish between the actual emitter's position and the measured one. Any given experiment does not actually measure any 'real' or 'actual' quantity, but an 'observed' one.

The result of this effect is an 'observed' projection of the velocity \vec{v} in the direction of perception $\mathbf{A}'\mathbf{C}$ that affects the speed perceived by \mathbf{C} in its movement and so is affected the obtained equation of the Doppler effect.

According to Figure 1, we obtain:

$$\cos \alpha = \frac{|\vec{v}| \cdot t}{c \cdot t} = \frac{|\vec{v}_p|}{v}$$

Hence, speed \vec{v} projected onto the line of perception $\mathbf{A}'\mathbf{C}$ in this setup will be:

$$|\vec{v}_p| = \frac{|\vec{v}|^2}{|\vec{c}|} \quad (1)$$

And the transmitted Doppler frequency ω_A to the medium would be in this case ω_{ot} :

$$\omega_{ot} = \omega_A \cdot \left(\frac{c}{c - \frac{v^2}{c}} \right) = \omega_A \cdot \frac{c^2}{c^2 - v^2} \quad (2)$$

ARM 2, GO: Number of wave fronts over the go path.

In the case of arm 2 the observer in \mathbf{C} is the mirror at the end of the arm, the transmitted frequency to the medium \mathbf{O} in the direction of perception $\mathbf{A}'\mathbf{C}$ will be the ω_{ot} as seen, the frequency then will be:

$$\omega_{ot} = \omega_A \cdot \frac{c^2}{c^2 - v^2}$$

And its wave number:

$$\tilde{\omega}_{ot} = \omega_A \cdot \frac{c}{c^2 - v^2}$$

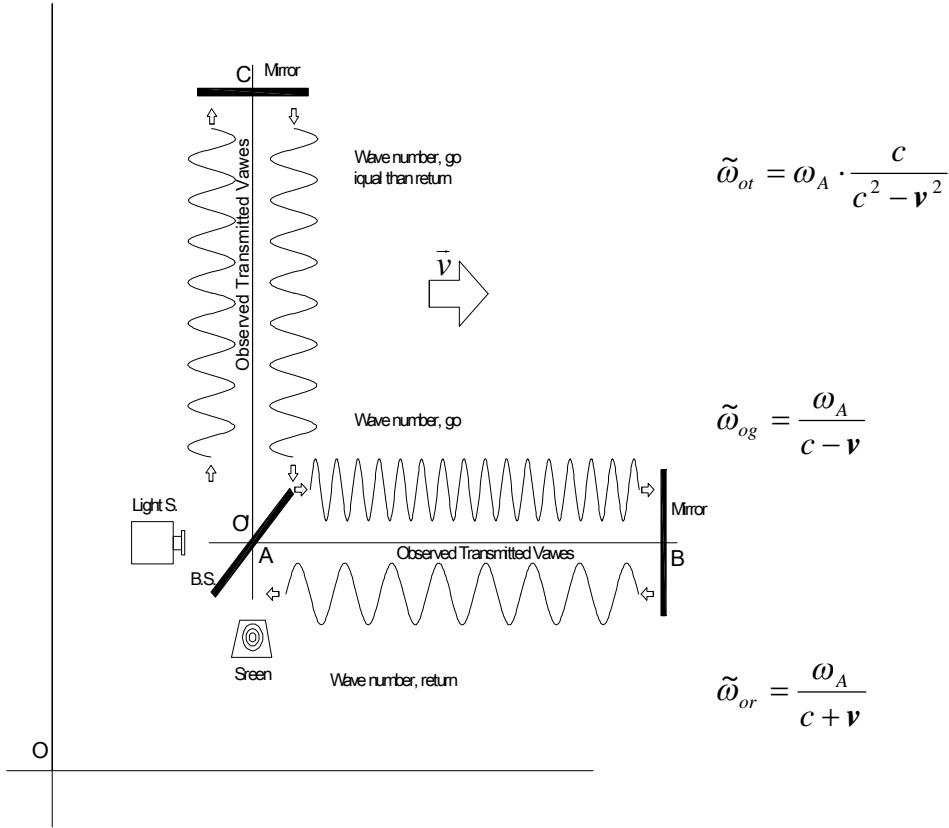


Figure 2: Michelson-Morley experimental setup and representation of observed transmitted wave number in each of two light path.

Also an apparently similar experiment trying to exploit this same idea was the one carried out by Stefan Marinov in his “coupled shutter experiment” [10] where, the presumable results obtained are in reality caused by the setup of his experiment, being a Sagnac type of interferometer.

As demonstrated in section 3 for a Michelson interferometer the optical path, or number of wave fronts, does not change along both arms of the interferometer. This has the consequence that one split pulse is going to behave similarly than a single wave front, point to point, in each arm and consequently, because the number of wave fronts does not change, both pulses will arrive at the exactly the same instant to the beamsplitter with no phase shift at all.

3.4 The Kennedy-Thorndike’s experiment

The Kennedy-Thorndike [2] experiment is a variation of the MME with two arms of different lengths, L_1 and L_2 . The difference between the number of wave fronts in both arms will give as a result the order of the fringes that appear in the interference pattern but, even if the length of the arms of the interferometer are different, the difference in the number of wave fronts of both trajectories when they turn in relation to the motionless system O does not change.

Using the same relationships that those exposed in section 3 the total of wave fronts, in the two way trip, over the arm of length L_1 of the interferometer is:

$$tnw_1 = \frac{2L_1 \cdot \omega_A \cdot c}{c^2 - v^2}$$

And the total number of wave fronts, over the two way trip of arm of length L_2 , similarly:

$$tnw_2 = \frac{2L_2 \cdot \omega_A \cdot c}{c^2 - v^2}$$

The difference between the total number of wave fronts between both arms measured by the interferometer will be:

$$Dtnw_1 = \frac{2\omega_A \cdot c}{c^2 - v^2} \cdot (|L_1 - L_2|)$$

Evidently the absolute value of the formula represents the difference in distance of L_1 and L_2 .

If we now turn the interferometer 90° that difference of wave fronts will be:

$$Dtnw_2 = \frac{2\omega_A \cdot c}{c^2 - v^2} \cdot (|L_2 - L_1|)$$

That is the same as the previous one and, thus, no phase shift observed when rotating the interferometer.

4 Conclusions

Neither Michelson’s type of experiments nor any other using two way interference seems to be adequate to check for the existence of an absolute space or Preferred Reference Frame because the same result may be obtained in both cases (existence or not of a PRF) using such an experiments.

New type of experiment must to be carried out. Those using two beam (sources) interferometrical setup are previewed to be specially adequate to that objective.

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