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Are We Wrong about the Michelson Morley Experiment?

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Abstract

The answer could be yes, because of a small detail that has been overlooked for decades and that was not known in 1905. Applying the Quantum Theory to the Michelson Morley experiment (MME), one can recognize that there are no skewed light paths in the y-arm, perpendicular to the moving x-direction. The MME must be interpreted differently. Therefore, the calculation of the time durations that photons take from the laser to the detector must be changed with the outcome that the null result can only be achieved if there is no length contraction. The time dilation, measured in many experiments, must have another cause. This could be regarded as just another incompatibility between the Special Theory of Relativity and the Quantum Theory, but in this case it goes deeper. A time dilation without a length contraction would have great impacts to the Theories of Relativity, though there are overwhelming confirmations by complex experiments, because the physical basis to the mathematical space-time modelling by the Lorentz transformation would be wrong. Several experiments with the newest technology are proposed to test this alternative view on this fundamental experiment.

Keywords: Michelson morley; Destructive interference; Theories of Relativity; Quantum theory; Lightclock; Lorentz transformation; Reference frames

Introduction

The continuity of the destructive interference (null result) of the two light beams in the Michelson-Morley interferometer at turning the set horizontally is the explicit demand for all theories describing light paths in the Michelson-Morley Experiment (MME) [1].

The Special Theory of Relativity (STR) [2] can explain the null result of MME perfectly, for the rest frame and for the observed moving frame as well. Therefore, most scientists did not think further about this experiment. But the consideration in this article could become crucial for space-time modelling. It would be important and worthwhile to perform the proposed experiments to possibly open another door in physics.

The y-Arm of the Michelson Morley Experiment

We begin with the consideration of what happens if light falls onto a mirror. In this case, the quantum theory is the only theory that can describe the observed phenomena with high accuracy. Here, each atom of the mirror provides a little contribution to the direction of the reflected light beam. And there is an often-forgotten mechanism that was not known to H. A. Lorentz and A. Einstein. If a photon enters the mirror it is not reflected, but the electrons in the mirror absorb it, and if the photon cannot be utilized, the mirror atoms emit a **new** photon!

This means that a mirror behaves like a light source [3]. Now we remember Einstein's well verified second postulate of STR:

'Light is always propagated in empty space with a definite velocity *c* that is independent of the state of motion of the emitting body.'

This means that photons in a moving mirror do not get any momentum to change their speed or their direction, which also would change their frequencies [4]. Photons do not behave like cannonballs. The reflection angle only depends on the geometric configuration of the mirror atoms and not on the movement of the mirror. This can be verified by thousands of observations of spectral binary-stars which did not show any abnormal change of brightness or frequency which then would influence the calculation of orbit-parameters. In all cases, the astronomers got perfect Kepler-orbits [5]. For the case that photons are carried along with a gravitational field one needs an explanation why photons in the vaccum propagate always with the light speed c. From this postulate follows that an incoming laser beam, perpendicular to a sideward moving mirror, is 'reflected' directly without any deflection. And a laser beam on a moving 45°-mirror is not tilted either but 'reflected' perpendicular to the incoming beam-direction.

Therefore, the light beams in the y-arm are not tilted but the beam is broadened backwards and thinned out Figure 2 and the animation. The converging lens on the detector collects all photons, giving the misleading impression that a tilted light beam arrives at the detector. But regarding the straight light paths, the time duration for each photon from the 45°-mirror to the upper mirror at a distance of L and back to the 45°-mirror is

$t_y=2L/c + t_p=n_y\lambda/c$

And the path length

$$s_y=n_y\lambda \qquad (1)$$

Where t_p is the remaining time duration to absorb a whole photon and λ is the wavelength of the photon and n an integer number $n_y > 0$. A new photon can only be emitted if the incoming photon is absorbed completely. There is no continuous time dilation.

There is no time dilation. At high speeds, only a part of the emitted photons can arrive in the detector. The MME-set is crossing the perpendicular paths of photons. Here an example of 10 photons that are emitted serially by one atom and with v=c/4 Figure 2 and animation.

But looking at the drawings of the MME in some textbooks or in the Wikipedia, we often see a skewed line from the semi-transparent 45°-mirror to the upper mirror (in the drawing) and from there a

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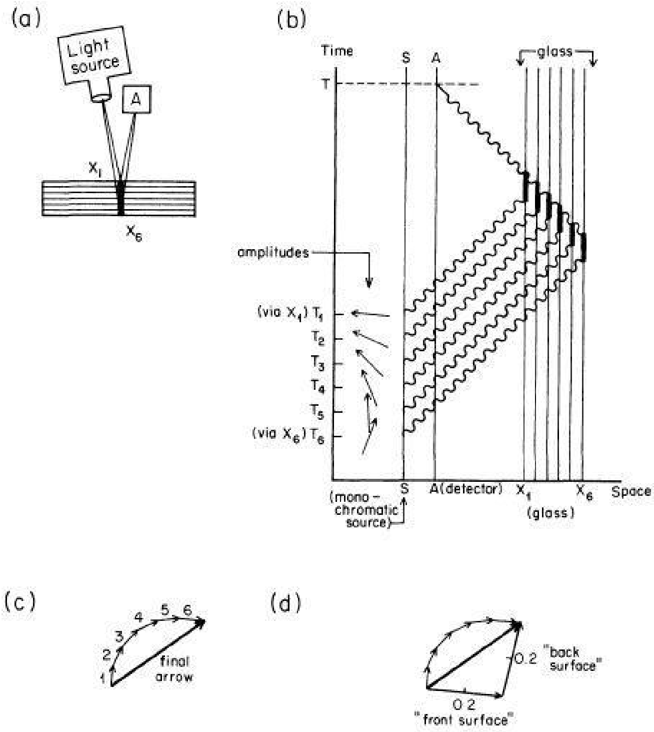

Figure 1: A photon that enters a mirror is not reflected but absorbed by the electron. If it cannot be utilized a new photon is emitted. (Source: QED by R. Feynman).

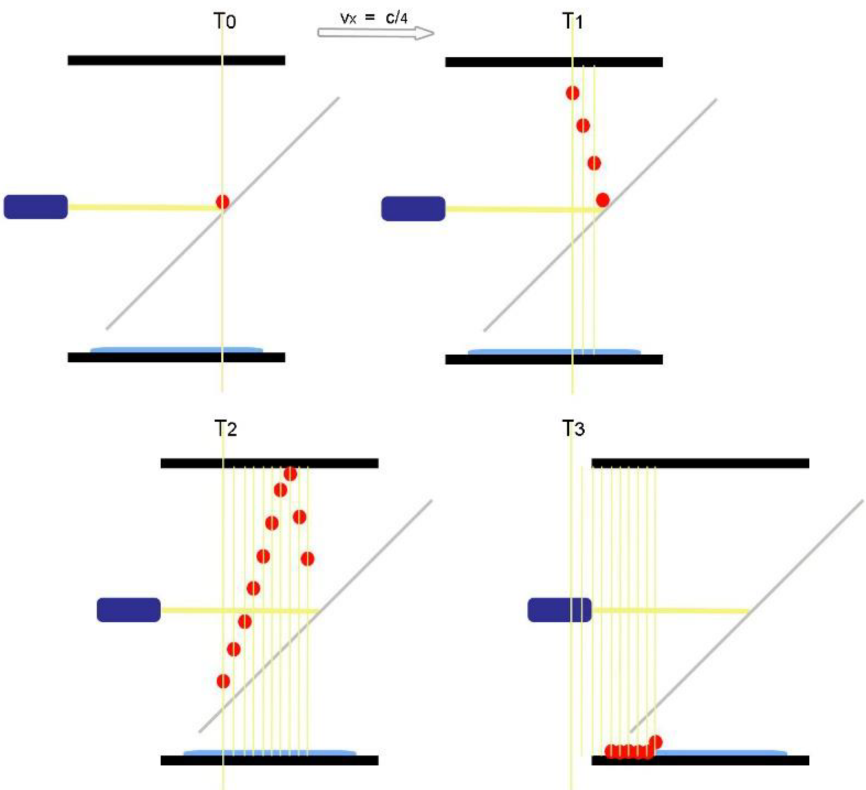

Figure 2: A photon stays on the perpendicular yellow y-line, up and down in the drawing, the laser beam is widened backwards in the left part of the detector and the number of photons is reduced per length unit (animation).

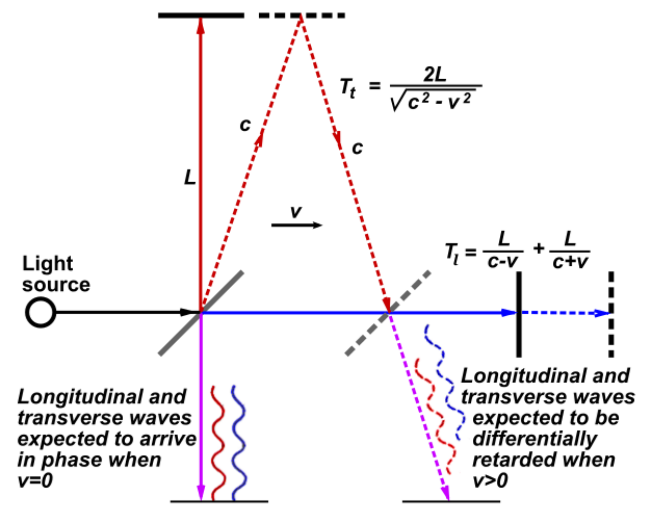

Figure 3: The usual drawing of the Michelson Morley Experiment with skewed light paths in the y-arm that leads to the γ in the y-arm and to the γ² in the x-arm. Source: Wikipedia.

skewed line down to the detector (Figure 3). According to the above considerations, a skewed light path can only be achieved if the upper mirror in the drawing is slightly tilted. But if the arms of the MME are turned by 90° or 180° horizontally, the reflected beams will miss the detector.

Applying the quantum theory to the MME results in vertical light paths in the y-arm, relative to the x-direction. However, the skewed light paths in the y-arm lead to the time dilation

$$t_y = 2L\gamma/c \quad (2)$$

With $\gamma = 1/\sqrt{1-\beta^2}$ and $\beta = v/c$

And from there to the Lorentz-transformation (LT) [6] and finally to the STR. This would have the consequence that the genius space-time modelling proposed by A. Einstein is based on a wrong physical consideration. Einstein's derivation of the LT by comparing a clock in the rest frame with a clock in the moving reference frame is also based on the assumption that the light speed in y direction is c/γ, see page 899 of his 1905-paper [3]. With the assumption that the one-way light speed is always equal to c there must be a time dilation, but this is not the case if the perpendicular 'reflected' photons are independent of the moving light source. The observed time dilation must have another cause. As the interference happens in the 'quantum world' one should apply the quantum theory to this consideration.

The x-Arm of MME from Inside

In the next step, we calculated the time duration that a pulse of photons needs to catch a moving mirror which moves with the velocity v in the x-direction:

$$ct_a = L + vt_a$$

$$t_a = L/(c - v) \quad (3)$$

The time duration from the semi-transparent-45°-mirror to the front mirror, and in the reverse direction:

$$ct_b = L - vt_b$$

$$t_b = L/(c + v) \quad (4)$$

One should be aware that only an observer outside of the MME-set can recognize the additional light paths vt_a and vt_b. An observer in the local reference frame does not know that the lengths of light paths are different due to the movement of this frame. He or she assumes that the length of the light paths is always equal L and v=0. Now there is a fascinating question. Can a local experimenter measure different time durations t_a and t_b due to the movement of this frame? Or are $t_a = t_b$ and hence the one way light speeds the same in both directions also when this frame is moving? In this case the photons are carried along with the local frame which would contradict the second postulate of STR. Or is there a special case if photons are in a gravitational field? In this case the photons propagate similar to a sound pulse within a moving train where the speed of sound is the same as the speed of sound outside of the train. These fundamental questions are not answered yet.

Along the classical physics one also could take the following interpretation:

As the total length of the light path in the x-arm is assumed to be:

$$s_x = c_a t_a + c_b t_b = 2L \quad (5)$$

and the two-way light-speed is ½ $(c_a + c_b) = c$, and the time duration in the x-arm is

$$t_x = 2L/c \quad (6)$$

it follows that

$c_a = c - v$ in the positive x-direction, and in the reverse direction:

$c_b = c + v$

Because the speed of photons is independent of the velocity v of the MME-set. Now the question arises: can these time durations t_a and t_b be measured in the local frame at different times? Or does the light propagate isotropically on the surface of Earth? In this case the photons are carried along with the gravity field of the Earth.

There is a similar situation in the Michelson-Gale-Pearson experiment [7] (Sagnac-effect on Earth) where the distance between two mirrors is the same, but the time durations of a pulse of photons between the mirrors are different due to the rotation of the Earth. Otherwise, there would be no interference in this set. The speed of the Earth around the sun or within the Universe could not been measured by this experiment, which could be hint that the photons are carried along with the gravity field of the Earth and of our galaxy. The surface of Earth is no inertial reference frame. And this is true for the MME on the surface on Earth as well. The one-way time-durations of a light pulse in the x-arm of MME have not been measured yet, because the atomic clocks are not precise enough for an arm-length of 10 m. Anyway, the phase shift is so small that there is no influence on the null result, and in the larger MMEs, there are concave mirrors and lenses to compensate such deviations. But it is principally wrong to apply the Lorentz-transformation to the MME on the surface of Earth, assuming that the null result occurs in an inertial reference frame or in a rest frame.

If we regard the interference in the MME in the local reference frame, the above calculation shows that the path length and the sum of time durations in the local x-arm is independent of v which is in accordance with the STR. But a length-contraction of L would destroy the null result.

With this approach the perpendicular light paths in the y-arm provide the null result of MME for sure.

The x-Arm of MME from Outside

Regarding the moving MME set from a rest-frame, where the light speed c is constant in all directions and the path lengths of light in the x-arm are different, the result is different. In the textbooks the length of the light path in the x-arm is

$$s_x=ct_a + ct_b \quad (7)$$

and

$$t_x=\gamma^2\, 2L/c \quad (8)$$

The addition of the reciprocal local light speeds 1/(c – v) and 1/(c + v) provides the factor γ^2. It leads to a harmonic mean of these local light-speeds rather than to an arithmetic mean of local light speeds which is c, and there is the question whether a mean value can provide an interference [8]. A similar consideration is whether a mean value of different weights on a beam balance can calibrate it to a horizontal state. This is not possible.

Comparing this time duration (8) with the time duration in the y-arm (2) in the view of STR, we can see that there is a γ too much to get the null result. This problem was solved by H. A. Lorentz, who introduced a length contraction by replacing L by L/γ [9]. Together with the time dilation in both arms, the null result was ensured.

However, in the above consideration with perpendicular y-light-paths, the time duration t_x provides a smaller factor γ^2 which also could prevent the null result.

To solve this problem, we replace the time durations by the corresponding frequencies, because frequencies can only be described from a reference frame outside of sender and receiver. Only an observer from outside can recognize that wavelengths are changed if a sender is moving in an isotropic light-field. The frequency is defined by

$$f_a=N_a/t_a \quad (9)$$

with N_a=number of oscillations per time duration t_a and

$$f_b=N_b/t_b \quad (10)$$

with N_b=number of oscillations per time duration t_b

The length of light-path in the x-arm is

$$s_x=cN_a/f_a + cN_b/f_b$$

As sender and receiver are in the same frame, the frequency is not changed.

$f_a=N_a/t_a=f_b=N_b/t_b=f=N_x/T$, with $N_x=N_a + N_b$ and T=the duration for a photon forth and back in the x-arm (distance: 45°- semi-transparent mirror to front mirror)

$$s_x=cN_a/f + cN_b/f=cN_x/f \quad (11)$$

In the outer reference-frame, there is fλ=c constant and therefore, the wavelength λ=constant as well. We get

$$s_x=N_x\lambda \quad (12)$$

The light path in the x-arm can only be increased by one wavelength, dependent on v. In this case, we get the light path as a multiple of the wave-length.

$$s_x=n_x\lambda \quad (13)$$

This consideration is based on the quantum character of photons. Only a whole photon can be absorbed and not a part of a photon before a new photon is emitted. Therefore, the calculated times t_a and t_b in the textbooks are not correct. For t_a one had to add another time duration to accomplish the time until the photon is absorbed. And the same is valid for t_b.

Comparing this light path in the x-direction with the light path in the y-arm we can see that they only differ by a number of wavelengths. Therefore, the null result is ensured here as well. This is also true if the MME set is turned horizontally because the time durations for absorbing a photon are the same in both arms. If the MME-set is adjusted to the null result, this will remain unchanged if the set is turned horizontally. But if there would be a length-contraction in the moving-direction, there would occur a phase shift of both the light beams and the null result could not be maintained. Therefore, a length-contraction in the moving-direction cannot be true.

If these considerations leading to (13) are correct, the total length of the light path in the y-arm must be a multiple of the wave-length λ too, due to the given null result in the MME. Therefore, we have two possibilities to test the MME. If an experiment shows that the time duration in the x-arm is quantized, then the light path in the y-arm cannot be tilted, and vice versa: If an experiment shows that in the y-arm, the light beam is not tilted and widened behind the detector due to a perpendicular 'reflection', then the path length of light in the x-arm is equal $n_x\lambda$ and not $2L\gamma^2$.

From the Hafele-Keating experiments [10] we know that atomic clocks run slower, but this applies to both arms of MME with the same amount. By the way, those experimental results required that an observer is positioned over the North Pole to achieve the accordance with the calculated results by the Lorentz transformation. The design of this experiment was that the observer is located on the surface of Earth. Here we can see an inconsistency between theory and experiment that was ignored.

If the y-light-beam is perpendicular to the movement direction, the light clock [11], a popular aid in the explanation of time dilation, cannot work. The measured time-dilations must have another cause. The application of the Lorentz transformation to the MME would be wrong because this provides a length-contraction in the x-direction. In addition, the space-time modelling, invented by A. Einstein, is only a superficial description of the real but unknown mechanisms and leads automatically to wrong conclusions. Therefore, now is the time to test the above considerations experimentally.

Some Experiments to Find the Truth

The crucial question on the MME is, whether the light paths in y-direction are skewed or not. If not, the widening of a perpendicular laser beam would be different from the widening of a skewed light beam. And: does a continuous γ^2 exist in the local x-arm?

Test of isotropy and quantization: One should measure the time that a light pulse needs in the x-arm with an optical clock [12]. Optical clocks are transportable now and they can measure time duration to 1E-18 precision. The amount of γ^2 for the velocity of the Earth around the sun is $1/[1 – (30/300\,000)^2]=1.000\,000\,01$. The length of the light path in the traditional x-arm is 2L=20 m. With the γ^2 it is 2L=20.000 000 2. And the difference of time durations $\Delta T=2L\gamma^2/c - 2L/c=6.7\ 10^{-16}$. This could not be measured by atomic clocks before, but now it is possible. Is it possible to recognize the γ^2 in the East-West and West-East direction in the four seasons? Is there a time difference to the North-South direction? Is the time duration in the x-arm quantized? One could synchronize four optical clocks positioned in the the four cardinal points by a signal from a satellite or by a central point via glass fibre cables and measure the time durations of a light pulse at 6, 9, 12, 18, 24 o'clock every day during one year.

Test of oblique light paths in the y-arm: Does a light beam in the y-arm from North to South from a squeezed laser [13] arrive directly in the center of the detector or is it widened westwards at 12 or 24 o'clock due to the rotation of Earth or to the movement of Earth around the Sun? (If not, are the photons carried with the gravity field?) Using an aperture of 1mm on the detector, one could measure the brightness or the number of photons that enter the detector at various times, e.g. 6, 12, 18 and 24 o'clock during one year. The detector may not have a converging lens. A circular light spot of a laser should be slightly rectangularly deformed in westerly direction. A divergent lens could magnify this effect.

Test of laser beam widening: Is the reflected laser beam from moon widened 75 km in the East-Western direction? Or do all photons arrive in the receiver-set within the normal circular widening area, because there are retro reflecting mirrors on Moon [14]? Movable receivers on Earth should count the reflected photons in these zones.

Test of light clock: A laser and a photo-sensor mounted opposite on long sun panels of an unaccelerated space probe perpendicular to the direction of motion could reveal whether something will be changed by turning the probe by 180°. Do the photons get a momentum in the direction of movement? If yes, has the frequency changed?

Test of reference frame: local or observed frame? Equation (8) might be valid for sound as well. It should be tested whether the formula for the local reference frame, where the sound path is 2L, or the formula for the reference frame outside of the MME-set with the sound path $2L\gamma^2$ is valid. For more details, please contact the author.

Test of destructive interference: Applying the Quantum Theory on the interference in the MME leads to the question: what happened to all the photons which cannot appear in the detector when the interference is destructive? Are they reflected back to the laser or do they warm up the semi-transparent mirror before the detector? Can this be measured? With this experiment, the above consideration cannot be tested but it would help to understand the quantum mechanism at interference.

Are the photons carried by a gravitational field?: If binary stars are circling around each other e.g. counterclockwise, a star at the position of 7 or 8 o'clock should appear with higher and at the position of 6 o'clock with lower brightness than expected because the photons leave the star with an angle < 90° to the direction of movement. Can this be measured?

Conclusion

If the photons are reflected in the moving mirrors by the rules of Quantum Theory, they are not deflected and if experiments 1-4 show that photons are independent of lateral moving sources and mirrors there is the obvious conclusion:

- The light-clock, a popular way to explain students the time dilation, doesn't work.
- The Theories of Relativity are based on a wrong skewed line in the drawing of the Michelson-Morley experiment.
- This would have so far-reaching consequences that it should be tested as soon as possible.

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