The Michelson-Morley Experiment and Classical Analysis of Reflection of Light From a Moving Mirror - Implications for the Lorentz Transformation Equations

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Abstract

This paper presents an argument that the conventional analysis of the Michelson-Morley experiment (MMX) might be only approximately correct but not strictly accurate. Accurate classical analysis would require revision of the Lorentz-Fitzgerald length contraction formula. This new analysis may have even more far reaching consequences: if the new classical analysis results in different length contraction formula for different experimental setups, this would lead to absurdity of the whole concept of length contraction and Lorentz transformation. The standard ether analysis of the MMX implies a law of reflection of light from a moving mirror and this may not agree with the classical analysis, which existed even before the conception of the Michelson-Morley experiment. Accurate ether analysis of MMX should be based on the classical analysis of reflection of light from a moving mirror, which should be derived from fundamental classical wave principles, and not from the requirement that the Michelson-Morley experiment should give a null fringe shift. The significant divergence of the light beam has been neglected (overlooked) in the standard analysis. The fallacy in the standard analysis is that it presumes that the transverse light will not miss the observer/detector, which is possible only if we consider the finite divergence of the beam, but ignores the beam divergence in the analysis and goes on to extraordinary conclusions (length contraction). Michelson's analogy of a man swimming across a river is the original fallacy.

Introduction

The null result of the Michelson-Morley experiment (MMX) is one of the factors that have most influenced the creation of the whole concept of Lorentz's ether theory and Einstein's relativity theories. Since the Lorentz-Fitzgerald contraction and Lorentz transformation equations had been developed before Einstein's 1905 formulation of special relativity, it can be argued that Einstein's derivation of Lorentz transformation may not be independent. Therefore, despite arguments that the Michelson-Morley experiment played little role in the creation of special relativity theory, it can be argued that the MMX played a major role and hence is one of the foundations of special relativity, and any changes in its analysis and interpretation will directly affect the validity of the special theory of relativity. In this paper, a possible error in the standard analysis of the MMX and the implications for the Length contraction hypothesis is presented briefly.

The standard analysis of the Michelson-Morley experiment according to the stationary ether hypothesis

We will first briefly review the standard ether analysis MMX[1]. We assume infinitesimal beam splitter and mirrors for our argument.
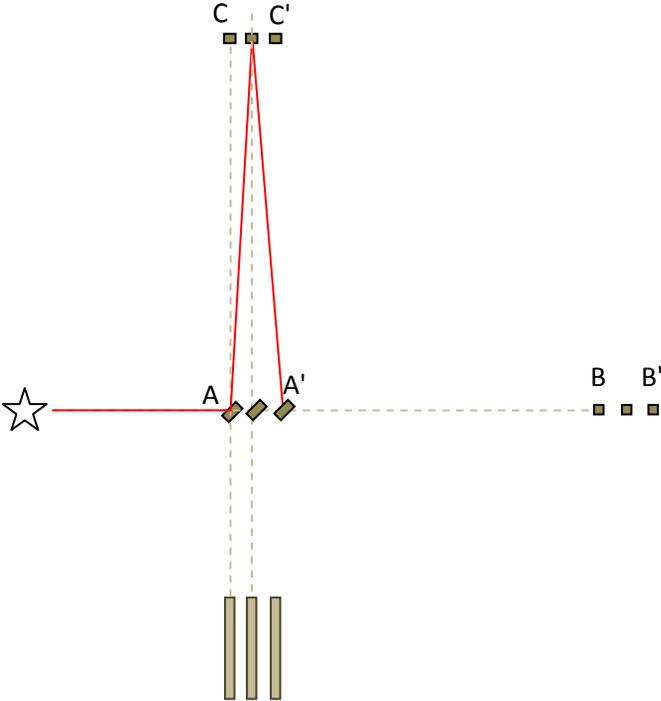
Light from the source hits the beam splitter at point A. The standard analysis starts from the assumption that the transverse light beam will not miss the detector. With this assumption, in the time interval that the beam splitter moves from A to A', the transverse light beam will make round trip time, to meet the beam splitter at point A'.

However, the more accurate analysis would be to use the classical analysis of reflection of light from a mirror moving relative to the ether.

Error in the standard analysis of the Michelson-Morley experiment (MMX) and a new classical analysis

Although the standard analysis of the MMX might be approximately correct, it may not be strictly accurate. This may have serious consequences for the Lorentz-Fitzgerald length contraction hypothesis.

The standard analysis starts from the presumption that the transverse light beam will not miss the observer. I argue that this will be true only if we realize that the light beam from the source has significant divergence. If the beam divergence is infinitely small (or too small), the light reflected from the transverse mirror may miss the observer and hence resulting in loss of interference fringes.

The fallacy in the standard analysis is that it presumes that the transverse light will not miss the observer/detector, which is possible only if we consider the finite divergence of the beam, but ignores the beam divergence in the analysis and goes on to extraordinary conclusions based on such fallacious analysis.

Next we will see a new analysis of reflection from a moving mirror and apply it to the Michelson-Morley experiment.

Consider parallel light rays incident on a mirror that is at absolute rest in the hypothetical ether. Light will reflect from the mirror according to the classical law of reflection: angle of incidence $(90^0 - \alpha)$ equals angle of reflection $(90^0 - \alpha)$.
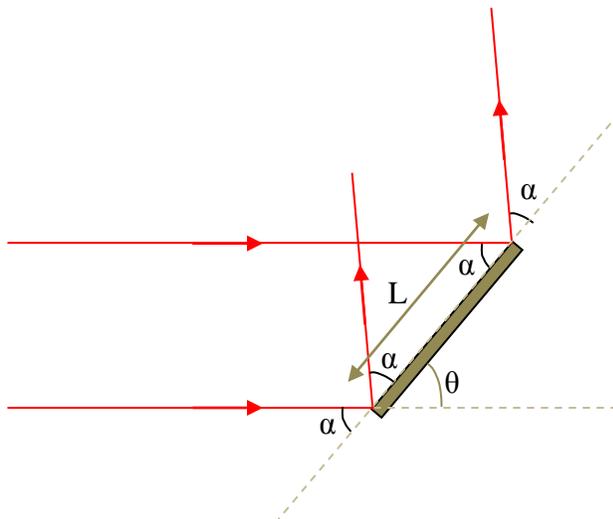
Next consider light reflection from a mirror that is moving to the right with velocity V_{abs} in the ether.
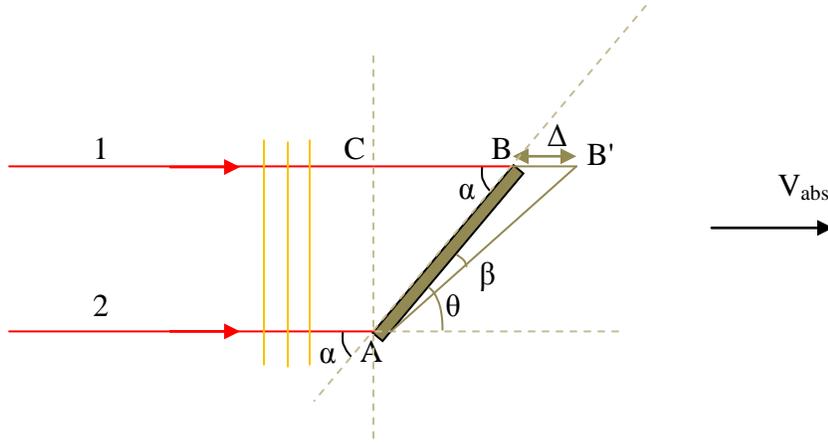

As the wave front is passing through points A and C, it strikes the lower point A of the mirror and gets reflected. However, the wave front will have to travel an extra distance Δ in order to hit the upper point B on the mirror, because the mirror is in motion relative to the ether. Therefore, whereas the wave front will be reflected at points A and B for a stationary mirror, it will be reflected at points A and B' for a mirror moving relative to the ether. We may think of this as if the mirror was inclined forward by an angle β, which will change the effective angle of incidence, and apply the law of reflection to the new apparent position of the mirror.
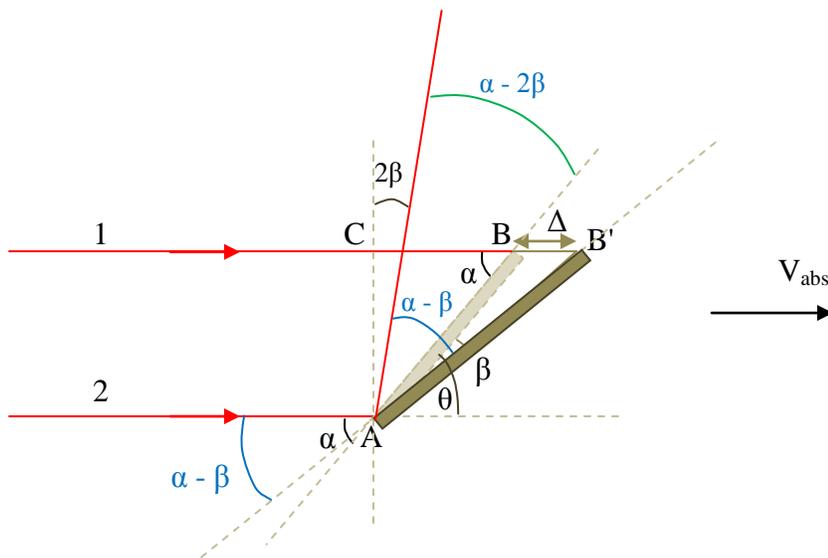
Therefore, the effective angle of incidence is α- β . The angle of reflection should also be α- β . Relative to the actual mirror (in the reference frame of the mirror), the angle of incidence is α and the angle of reflection is α - 2β !

Next we determine the angle β .
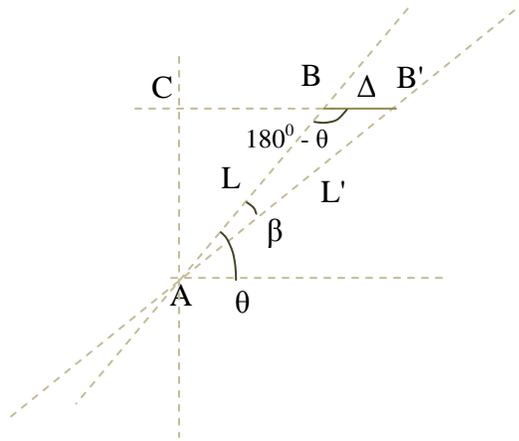
To determine Δ:

During the time interval that the wave front moves from point C to point B', the upper point on the mirror (point B) moves from B to B'.

$$\frac{\frac{L}{\cos\theta} + \Delta}{c} = \frac{\Delta}{V}$$

From which

$$\Delta = \frac{L}{\cos\theta}\frac{cV}{c - V}$$

The length of AB' , which has been denoted by L' , is determined from the cosine rule of the triangle.

Therefore,

$$L' = \sqrt{L^2 + \Delta^2 - 2L\Delta\cos(180^o - \theta)} = \sqrt{L^2 + \Delta^2 + 2L\Delta\,\cos\theta}$$

The angle β is determined from the sine rule.

$$\frac{\sin\beta}{\Delta} = \frac{\sin(180^0 - \theta)}{L'}$$

$$\implies \sin\beta = \Delta\,\frac{\sin(180^0 - \theta)}{L'} = \Delta\,\frac{\sin\theta}{\sqrt{L^2 + \Delta^2 + 2L\Delta\,\cos\theta}}$$

$$\implies \beta = \sin^{-1}\left(\Delta\,\frac{\sin\theta}{\sqrt{L^2 + \Delta^2 + 2L\Delta\,\cos\theta}}\right)$$

Analysis of the Michelson-Morley experiment

In the above analysis, we have seen that the light ray will bend forward by angle 2β for a moving mirror, in the reference frame of the mirror.
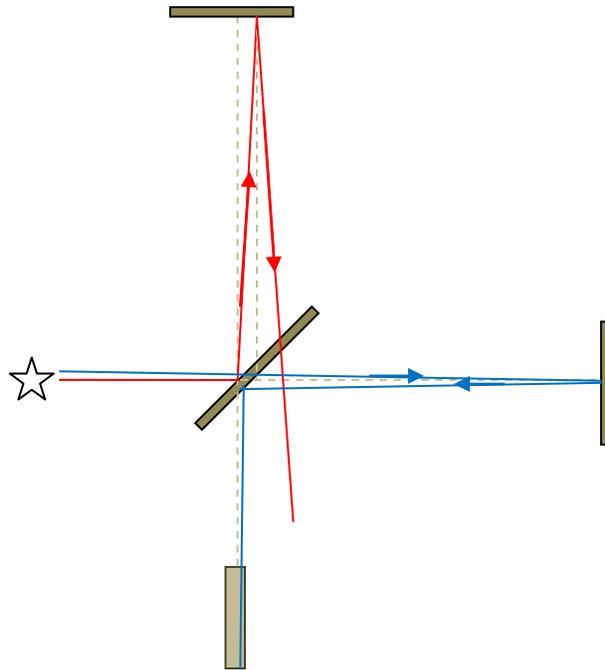

We can see from the above diagram that, even in the reference frame of the MMX apparatus, the transverse light beam (red line) will be bent forward on reflection from the beam splitter due to

motion of the apparatus relative to the ether and there would be no interference pattern because the two light beams will not meet at the point of detection. The transverse light beam will miss the detector.

The question arises: does absolute motion result in loss of interference fringes rather than fringe shift ?

In the above analysis we have assumed a light beam with infinitely small divergence, which was not the case for the Michelson-Morley apparatus. The photons emitted by the source always have significant angular spread.

If the ether existed, the actual situation would be as follows. The analysis is based on the same principle as the previous analysis. The analysis and the final result (the change in difference in path lengths of the two light beams due to motion relative to the ether) will be more complicated, and we will not undertake that in this paper.
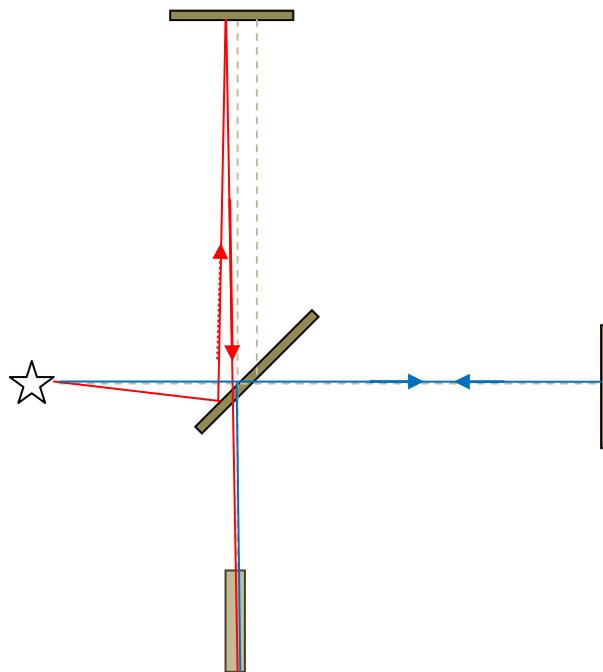
The question is :

- Will this analysis prove the stationary ether hypothesis ?

- What is the implication of this for the Lorentz contraction hypothesis ?

With regard to the first question, this analysis should be completed to see the fringe shift predicted by the new analysis and compare it with the experimental result. However, there are other experiments that seem to disprove the ether theory. Some of these are the lunar laser ranging experiment and the Bryan G Wallace experiment. Other experiments include the Ives-Stilwell experiment, the Arago experiment, etc.

Regarding the question of Lorentz contraction, this analysis may complicate the Lorentz-Fitzgerald length contraction formula, resulting in invalidation of the whole concept of length contraction.

Other authors have also pointed out the error in the standard analysis of the Michelson-Morley experiment, which omits the effect of classical reflection of light from a moving source[2].

Alternative explanation

I have already proposed a new alternative explanation (Apparent Source theory) of the Michelson-Morley experiment [3].

Conclusion

In this paper we have seen the error in the standard analysis of the Michelson-Morley experiment and the implications for the Lorentz-Fitzgerald contraction hypothesis and the Lorenz transformation. Michelson's analogy of a man swimming across a stream is the original fallacy.

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

References

1. Michelson-Morley experiment, Wikipedia

2. The overlooked Phenomena in the Michelson-Morley Experiment, Paul Marmet

3. Intrinsic Absolute Motion Paradigm and Apparent Source Theory – Distinction Between Translational and Rotational Motions, Henok Tadesse, Vixra