Michelson-Morley Interferometer Experiment of 1887: "Null" Result

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The Michelson-Morley Interferometer Experiment of 1887 is often cited as one of the cornerstones (and perhaps THE cornerstone) upon which Einstein built his theory of special relativity. Allegedly, it "proved" there was no aether. Once Einstein postulated that the speed of light was invariant, the only explanation that became accepted was that time slowed and length contracted due to relative motion according to the Lorentz Transformation formulae, adopted by Einstein as tenets of his special relativity. Despite subsequent experiments contradicting the alleged "null result," reanalysis of the results indicating positive ("non-null") results, and even maintaining the validity of the null result but explaining it via classical physics, the M&M Interferometer Experiment remains a special relativity foundation. However, if the limitation of the invariance of the speed of light is removed, the "null result" can be easily explained without resort to special relativity and its postulates of time dilation and length contraction. Yet this is seldom done.

1. Introduction

As described in "Michelson-Morley (M&M) experiment" (*http://en.wikipedia.org/wiki/Michelson%E2%80%93Morley_experiment*):

> *The Michelson–Morley experiment was published in 1887 by Albert A. Michelson and Edward W. Morley and performed at what is now Case Western Reserve University in Cleveland, Ohio. It compared the speed of light in perpendicular directions, in an attempt to detect the relative motion of matter through the stationary luminiferous aether ("aether wind"). The negative results are generally considered to be the first strong evidence against the then-prevalent aether theory, and initiated a line of research that eventually led to special relativity, in which the stationary aether concept has no role. The experiment has been referred to as "the moving-off point for the theoretical aspects of the Second Scientific Revolution" … Together with the Ives–Stilwell and Kennedy–Thorndike experiments, the Michelson–Morley experiment forms one of the fundamental tests of special relativity theory.*

Subsequent experiments have called into question the need for special relativity to explain the alleged "null result" (e.g., *http://www.anti-relativity.com/daytonmiller.htm;http://www.relativityoflight.com/Chapter9.html;http://www.neoclassicalrelativity.org/;http://www.conspiracyoflight.com/M&M.html;http://www.orgonelab.org/miller.htm*). [1] Even reanalysis of the M&M results has suggested that there was a fringe shift, contrary to the alleged "null" result (*http://relativitychallenge.com/papers/Bryant.CICS.MMX.Analysis.06302006.pdf;* R. Cahill, "The Michelson and Morley 1887 Experiment and the Discovery of Absolute Motion," *Progress in Physics*, October 2005, Volume 3, pp. 25-29).

2. Analysis

Relativistic length contraction (time dilation) is usually cited as the explanation for the "null result of the famous 1887 M&M Interferometer Experiment that reputedly prompted Einstein's Special Relativity. However, if we allow that light can travel at velocities other than c, a much simpler explanation is available.

As shown in Figure 1, the M&M Interferometer Experiment effectively sent two perpendicular light rays from a source (solid mirror) to two target mirrors (shaded and hollow), each a distance L away from the source at time step 0 while the apparatus was translating along one of the ray lines at speed v (presumably that of the Earth tangentially relative to the Sun). Since the source is moving at v, the speeds (black arrows) of the light rays (dashed, dotted and mixed) in the vertical and horizontal directions are vector sums of c and v, i.e., $(c^2+v^2)^{0.5}$ vertically and (c+v) horizontally. The distances (scalars [no arrows]) traveled over time step 1 (at which time "t" the perpendicular ray strikes the shaded mirror and the horizontal ray strikes the hollow mirror) are $(L^2+[vt]^2)^{0.5}$ and (L+vt), respectively.

By symmetry, from time step 1 to 2, the two rays (dashed-dotted and mixed) are reflected back to the source mirror over another time "t." The perpendicular ray covers the same distance at the same speed. However, the horizontal ray now covers a shorter distance (L+vt-2vt = L-vt) at a slower speed (c-v). Since the time "t" is equal in both directions for each time step, we can express it as follows (time = distance/speed):

$$\{(L^2+[vt]^2)^{0.5}\}/\{(c^2+v^2)^{0.5}\} = (L+vt)/(c+v) = (L-vt)/(c-v) = (L^{\pm}vt)/(c^{\pm}v).$$

Squaring both sides yields $(L^2+v^2t^2)/(c^2+v^2) = (L^{2\pm}2vt+v^2t^2)/(c^{2\pm}2cv+v^2)$, which, after "cross-multiplying" and dividing by 2v, simplifies to $L^2c + cv^2t^2 = Lc^2t + Lv^2t$.

[1] Note that the citing of these various websites does not necessarily imply the author's agreement with all material presented on the site. These are cited solely for the portions of their discussions related to the M&M Interferometer Experiment.

This can be more simply expressed as $v^2t(ct - L) = Lc(ct - L)$. Since there is no *a priori* reason for v^2t to equal Lc, the only way this equation can hold is if both sides are zero, i.e., L = ct. But this is precisely the situation governing the relationship for light propagation between the source mirror and each of its target mirrors relative to the three mirrors (and the apparatus as a whole, i.e., the "moving" system). That is, over either time interval "t," the source mirror (or, equivalently, each target mirror) sees the light ray(s) cover the distance L vertically or horizontally at speed c. Therefore, the time elapsed in either the "stationary" (relative to the Sun) or "moving" (relative to the apparatus) reference frame is the same ("t"). There is no time or length dilation, no relativistic effects – therefore, the (in?)famous "null result."

3. Conclusion

Does special relativity, via the Lorentz Transformations, explain the alleged "null result" from the M&M Interferometer Experiment of 1887? Yes. Is that theory and those transformations the only possible explanation? No. Other dissident physicists have offered various non-relativistic explanations of the results, at least one alleging a fringe shift occurred, contradicting the "null result." I too offer a simple classical explanation, based on relaxing the limitation of the invariance of the speed of light, allowing light to acquire the velocity of its source.

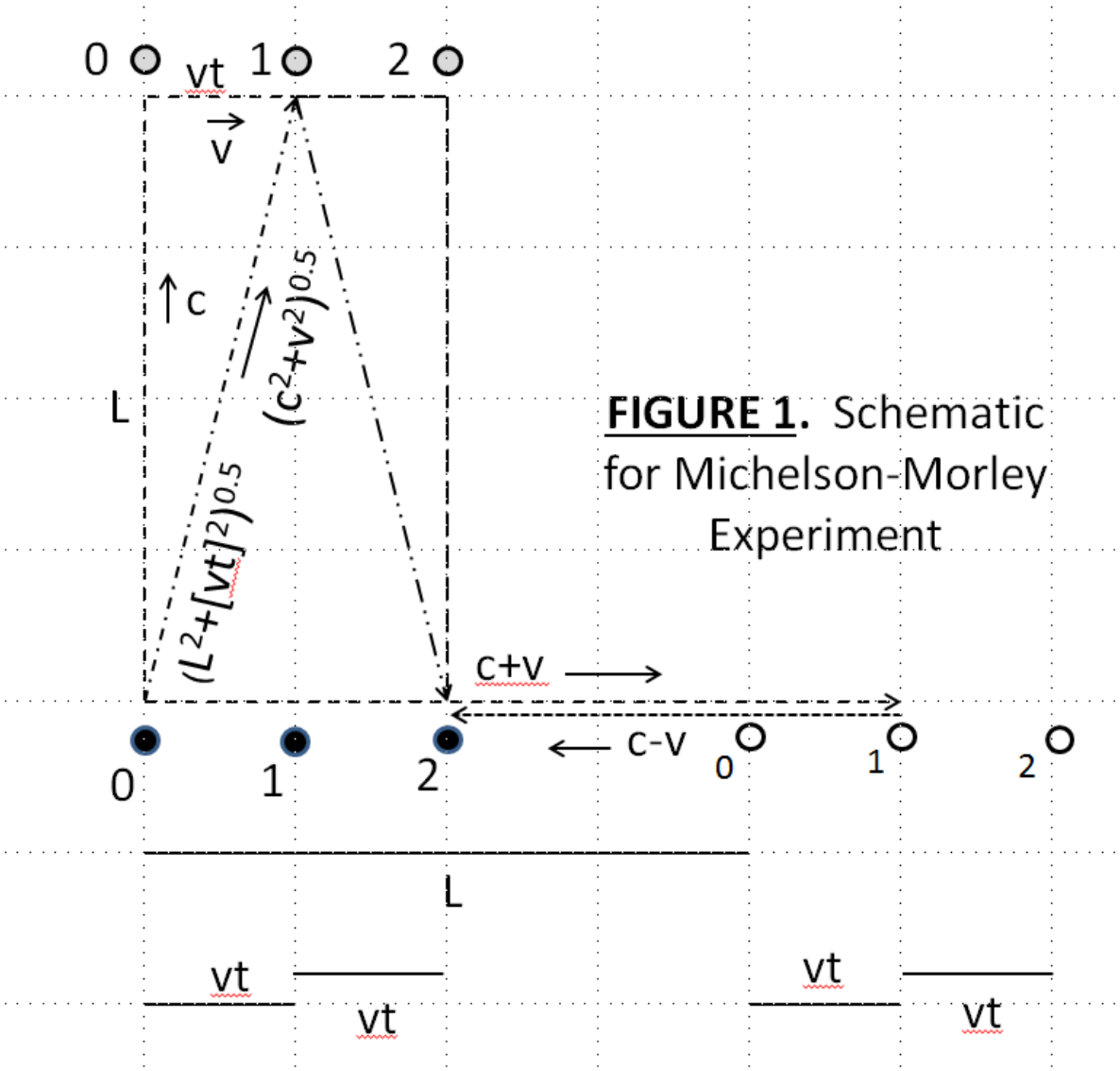

FIGURE 1. Schematic for Michelson-Morley Experiment

MICHELSON-MORLEY EXPERIMENT OF 1887: "NULL" RESULT

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THE EXPERIMENT OF 1887

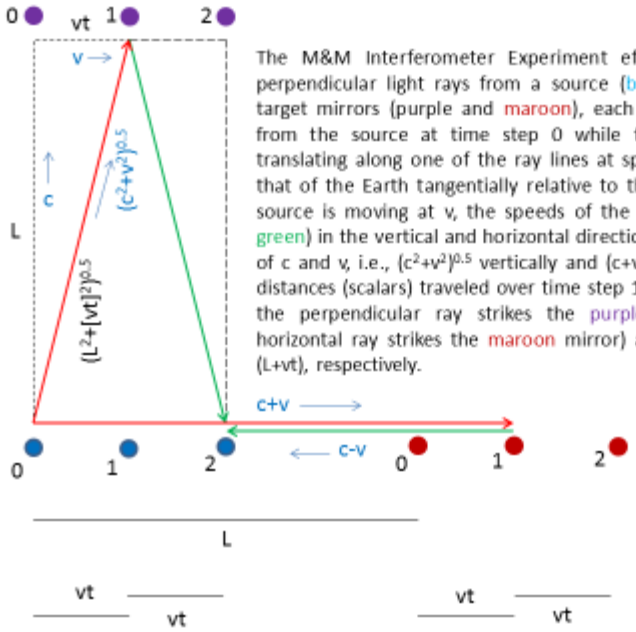
- *The Michelson–Morley* [M&M] *experiment … compared the speed of light in perpendicular directions, in an attempt to detect the relative motion of matter through the stationary luminiferous aether ("aether wind").*
  - *The negative results are generally considered to be the first strong evidence against the then-prevalent aether theory, and … eventually led to special relativity, in which the stationary aether concept has no role.*
  - *The experiment has been referred to as "the moving-off point for the theoretical aspects of the Second Scientific Revolution" …* [and] *forms one of the fundamental tests of special relativity theory.*

QUESTIONING ITS "NULL RESULT"

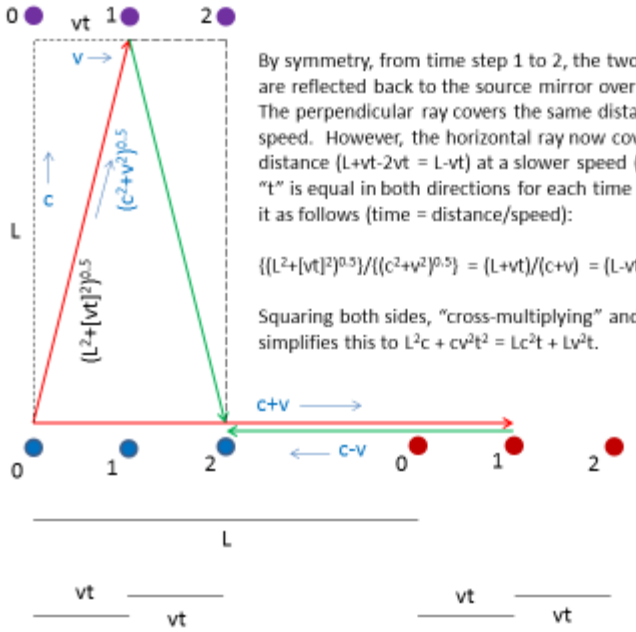
- Subsequent experiments have questioned the need for special relativity to explain the alleged "null result" (e.g., see http://www.
  - *anti-relativity.com/daytonmiller.htm*
  - *relativityoflight.com/Chapter9.html*
  - *neoclassicalrelativity.org*
  - *conspiracyoflight.com/M&M.html*
  - *orgonelab.org/miller.htm*
- Even reanalysis of the has suggested that there was a fringe shift, contrary to the alleged "null" result
  - *http://relativitychallenge.com/papers/Bryant.CICS.MMX.Analysis.06302006.pdf*
  - R. Cahill, "The M&M 1887 Experiment and the Discovery of Absolute Motion," *Progress in Physics,* Oct. 2005, Vol. 3, pp. 25-29)

MAINSTREAM RELATIVISTIC EXPLANATION

- Relativistic length contraction (time dilation) as per the Lorentz Transformations
  - Anchored to Einstein's postulate that light travels at constant speed in a vacuum, regardless of source velocity
- However, if we allow that light can travel at velocities other than c, a much simpler explanation is available.



The M&M Interferometer Experiment effectively sent two perpendicular light rays from a source (blue mirror) to two target mirrors (purple and maroon), each a distance L away from the source at time step 0 while the apparatus was translating along one of the ray lines at speed v (presumably that of the Earth tangentially relative to the Sun). Since the source is moving at v, the speeds of the light rays (red and green) in the vertical and horizontal directions are vector sums of c and v, i.e., $(c^2+v^2)^{0.5}$ vertically and (c+v) horizontally. The distances (scalars) traveled over time step 1 (at which time "t" the perpendicular ray strikes the purple mirror and the horizontal ray strikes the maroon mirror) are $(L^2+[vt]^2)^{0.5}$ and (L+vt), respectively.



By symmetry, from time step 1 to 2, the two rays (red and green) are reflected back to the source mirror over another time "t." The perpendicular ray covers the same distance at the same speed. However, the horizontal ray now covers a shorter distance (L+vt-2vt = L-vt) at a slower speed (c-v). Since the time "t" is equal in both directions for each time step, we can express it as follows (time = distance/speed):

$\{(L^2+[vt]^2)^{0.5}\}/\{(c^2+v^2)^{0.5}\} = (L+vt)/(c+v) = (L-vt)/(c-v) = (L\pm vt)/(c\pm v)$.

Squaring both sides, "cross-multiplying" and dividing by 2v, simplifies this to $L^2c + cv^2t^2 = Lc^2t + Lv^2t$.

WITHOUT RELATIVITY (1)

- The previous expression can be simplified as $v^2t(ct - L) = Lc(ct - L)$
  - Since there is no *a priori* reason for v^2t to equal Lc, the only way this equation can hold is if both sides are zero, i.e., L = ct.
    - But this is precisely the situation governing the relationship for light propagation between the source mirror and each of its target mirrors relative to the three mirrors (and the apparatus as a whole, i.e., the "moving" system).

WITHOUT RELATIVITY (2)

- Over either time interval "t," the source mirror (or, equivalently, each target mirror) sees the light ray(s) cover the distance L vertically or horizontally at speed c.
  - Therefore, the time elapsed in either the "stationary" (relative to the Sun) or "moving" (relative to the apparatus) reference frame is the same ("t").
  - **There is no time or length dilation, no relativistic effects – therefore, the (in?)famous "null result."**

CONCLUSION

- Does special relativity, via the Lorentz Transformations, explain the alleged "null result" from the M&M Interferometer Experiment of 1887? Yes.
- Is that theory with those transformations the only possible explanation? No.
  - Others have offered various non-relativistic explanations, at least one alleging a fringe shift occurred, contradicting the "null result."
  - I too offer a simple classical explanation, by allowing light to acquire the velocity of its source.