Proofs of the Error

in the interpretation of the Michelson-Morley experiment

The ether theory and the Michelson-Morley experiment

Proof #1. A simple experiment to detect the ether could have been performed in Newton's time

Proof #2. When the ether wind changes its magnitude, the vertical light beam cannot change its initial direction

Proof #3. Error in Ohanian vector analysis of the experiment

Proof #4. Feynman's method of graphically explaining the Michelson-Morley experiment *hides an error*

Proof #5. Three distinct mechanical systems require three distinct vector additions in the motion of the vertical light beam of the MM experiment

Proof #6. Three distinct vector interactions require three distinct diagrams of the Michelson-Morley experiment according to

1. Newton's classical mechanics
2. Michelson's theory of the ether
3. Einstein's mechanics

Proof #7. Discrepancies in the Michelson's and Morley's paper of 1887

About the Ether and its Properties

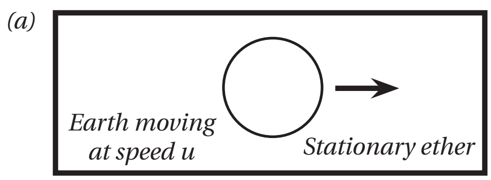
By Boris Milvich • bm@milvich.com • EinsteinsFirstErrors.com

The nature of the ether

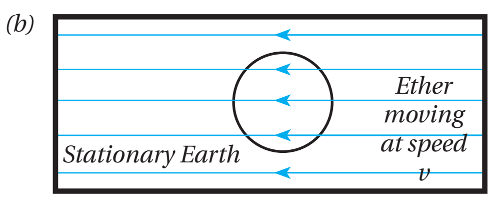
Professor Hans Ohanian:

> *"This analogy between the propagation of light and of sound suggests that there exist some pervasive medium whose oscillations bring about the propagation of light, just like the oscillations of the air bring about the propagation of sound. Presumably this ghostly medium fills all the space, even the interplanetary and interstellar space which is normally regarded as a vacuum. The physicists of the nineteenth century called this hypothetical medium the* **ether**, *and they attempted to describe the light waves as oscillations of the ether."* [1]

It was assumed by 19th century physicists that if the earth moved through the ether, as shown in *Fig. 1a* below, it would be mechanically the same as if the earth were at rest and the ether wind were blowing through the earth and a laboratory on it, as shown in *Fig. 1b*, taken from Ohanian's textbook, *Principles of Physics.* [1]



Earth is moving through the stationary ether



Earth is stationary as the ether wind is blowing through it

Figure 1

Professor Ohanian:

> *"The motion of the ether past the Earth was called the ether wind by the nineteenth century physicists. If the Sun is at rest with the ether, then the ether wind would have velocity opposite of that of the Earth around the Sun — about 30 km/s; if the Sun is in (steady) motion, then the ether wind would vary with the seasons — smaller than 30 km/s during one-half of the year and greater than 30 km/s during the other half."*
>
> *"In the reference frame of the Earth, the ether flows past the Earth, forming the ether wind."* [1]

In other words, the ether wind is created by the motion of the earth through the stationary ether. The faster the speed of the earth, the faster the ether wind. Hence, *if the earth moves at the speed u=30,000 m/s around the sun, the ether wind would have the same speed, v=30,000 m/s, however, in the opposite direction.*

Professor Peter J. Nolan:

> *"If there is a medium called the ether that pervades all of space then the earth must be moving through the ether as it moves in its orbital motion about the sun. From the point of view of an observer on the earth the ether must flow past the earth, that is, it must appear that the earth is afloat in the ether current. The ether current concept allows us to consider an analogy of a boat in a river current." [2]*

Mechanical properties of the ether wind

Mechanical properties of the ether wind and its effect on the light beams is often demonstrated with a vector presentation. One such presentation *(Fig. 2)* was made by professor Hans Ohanian in his college textbook. [3]

In his analysis there are two moving components:

1. The ether wind v acting from right to left
2. Motion of the light beams at different velocities

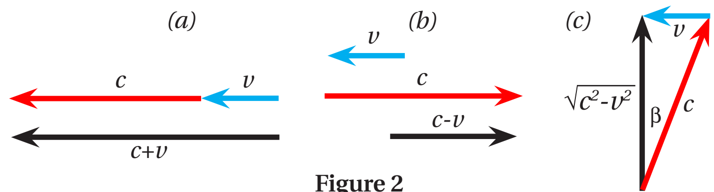


Figure 2

Professor Ohanian:

> *"Experimenters attempted to detect this ether wind by its effects on the propagation of light. A light wave in a laboratory on the Earth would have a greater speed when moving downwind and a smaller speed when moving upwind or across the wind. If the speed of the ether wind 'blowing' through the laboratory is v, then the speed of light in this laboratory is c+v for a light signal with downwind motion, c-v for upwind motion, and* $\sqrt{c^2-v^2}$ *for motion perpendicular to the wind."* [1]

If the initial direction of the beam traveling across the wind is perpendicular to the either wind (shown below in red), then the beam would travel along the hypotenuse shown as black arrow at velocity $\sqrt{c^2+v^2}$.

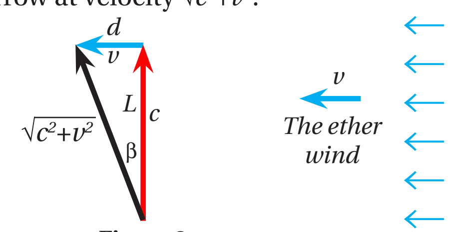


Figure 3

The angle of displacement of the vertical beam (β), due to the ether wind in *Fig. 2c* and *Fig. 3*, is determined by the magnitude of the ether vector v shown in blue.

The displacement d can be calculated using ratio:

$d/v=L/c$ from where $d=vL/c$

If the ether wind v equals 30,000 m/s (the earth's velocity around the sun), length L is 11 m, and c is the velocity of light, 300,000,000 m/s, displacement d would amount to:

$d=0.0011\ m$ or $d=1.1\ mm$

Three main properties of the ether wind

From the above vector presentation of the effects of the ether wind on the light beams we can conclude that the ether wind has 3 main characteristics or properties:

1. The ether wind can increase or decrease the velocity of the light beams.

2. The ether wind can change the direction of the light beam in the direction of the wind.

3. The ether wind can affect the velocities of the light beams, but not the apparatus or any material object.

Using these properties and the above equations, the ether wind could have been detected and its speed measured in a much simpler way than by using Michelson-Morley interferometer and done a century or so earlier.

Proof #1. A simple experiment designed to detect and measure the ether wind could have been performed in Newton's time

Laboratory and Earth at rest

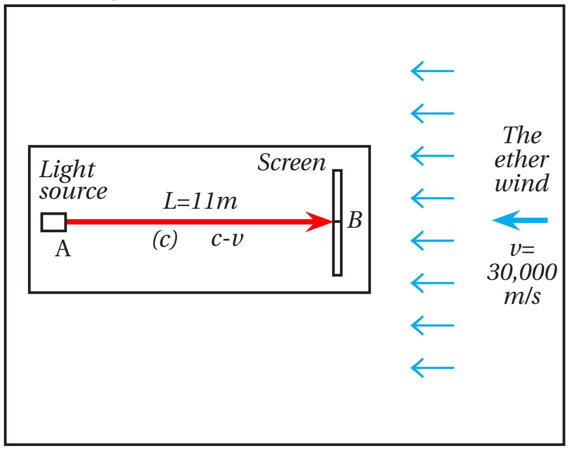


Figure 4

On an optical table in a laboratory, a pencil beam moving parallel to the supposed ether wind is directed toward a screen 11 m away *(Fig. 4)*. The length of 11 m in the next three figures could be achieved by using several mirrors, as was done in the original Michelson-Morley experiment of 1887. It is shown here as one beam for making the drawings of the beam's displacement simpler and more comprehensive. Using mirrors, the experiment could have been performed on an optical table in a laboratory.

The light source and the screen are firmly fastened to the platform. The ether wind, acting parallel but in the opposite direction, would reduce the speed of the beam to *c-v*, but it would have no effect on its direction of travel. *Beam's initial direction is set in this orientation.*

When the optical table is rotated counter-clockwise and 90^0 relative to the motion of the ether wind *(Fig. 5)*, the ether wind moving at speed v would be acting broadside against the beam.

Laboratory and Earth at rest

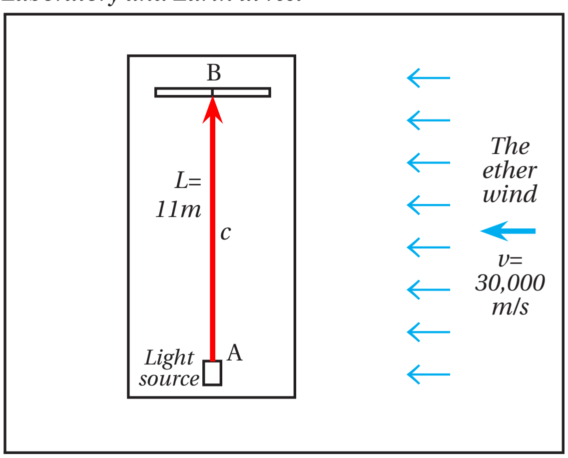


Figure 5

The initial beam directions are shown in red—while the resulting ones are shown in black.

As stipulated by the mechanical properties of the ether wind, the wind would change the direction of the beam to the left, as shown in *Fig. 6*.

The light beam would travel along the <u>*hypotenuse*</u> of a right triangle ABB', at speed $\sqrt{c^2+v^2}$, with a <u>*plus*</u> sign in the square root.

The beam will now arrive on the screen at B', a distance d from the original place of arrival at B before the rotation took place. As shown earlier, displacement d can be calculated using ratio:

$$d/v=L/c \qquad \text{from where} \qquad d=vL/c$$

If the speed of the ether wind v was the same as the motion of the earth around the sun, but in the opposite direction, 30,000 m/s, and the distance L was 11 m, the displacement would amount to:

$$d = 1.1 \text{ mm}$$

Laboratory and Earth at rest

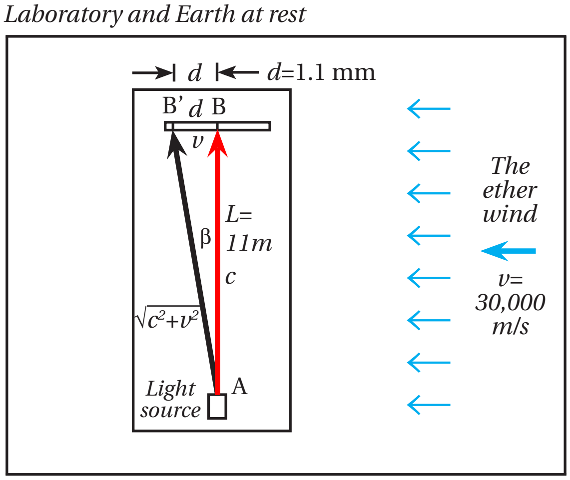


Figure 6

Three surprising realizations

1. The beam displacement $d=1.1$ mm in *Fig. 6* is huge in optical terms—it could be observed with the naked eye. Thus, the ether wind could have been detected and measured in an utterly simple way, about a century before the MM experiment was performed.

2. If the ether wind did exist and we were able to determine the displacement d, the ether wind would have enabled us to determine the speed of the ether wind v and thus the speed of the earth though space from the above equation $d=vL/c$, from where $v=cd/L$.

3. The three figures represent the travel of the parallel beam in the MM experiment when rotated 90^0 from a parallel to a vertical orientation relative to the ether wind. They show that the vertical light beam must travel along the <u>*hypotenuse*</u> of a right triangle at speed $\sqrt{c^2+v^2}$ that has a <u>*plus*</u> sign in the square root. According to Michelson, however, the vertical beam would travel along the <u>*side*</u> of a right triangle at a speed that has the <u>*minus*</u> sign in its square root ($\sqrt{c^2-v^2}$).

Proof #2. When the ether wind changes its magnitude, the vertical light beam cannot change its initial direction

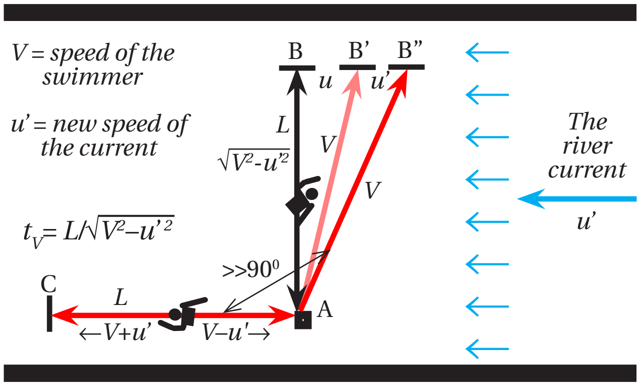


Figure 7

Change in the speed of the river current in the swimmers' model of the MM experiment

Suppose the current in the swimmers' model becomes faster so that speed *u* changes to speed *u'*.

The swimmer traveling across the current *(Fig. 7)* must now swim more upstream from A in the direction of B", in order to travel straight across and reach point B.

He makes a conscious choice of the swimming angle, while the initial direction of the 2nd swimmer remains parallel to the current.

The time to swim across current is now $L/\sqrt{V^2-u'^2}$

Change in the speed of the ether wind in the MM experiment according to the swimmers' model

It has been assumed for over a century that the same change in direction of the swimmer swimming across the current in *Fig. 7* would also happen to the vertical light beam in the actual MM experiment *(Fig. 8)*.

Laboratory and Earth at rest

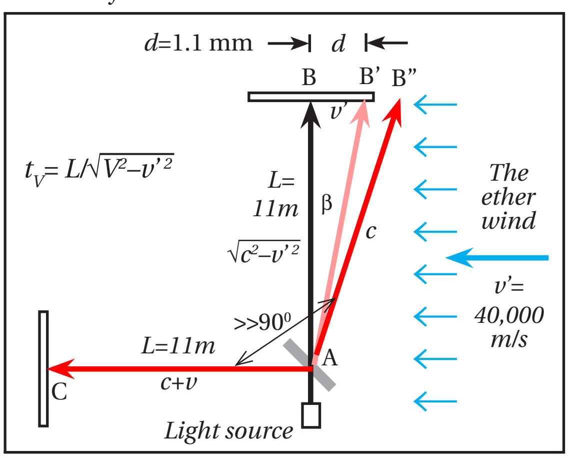


Figure 8

However, there is nothing in the MM experimental setup that is capable of changing the initial direction of the vertical light beam when the magnitude of the ether wind is increased. The only thing that was done in the actual experiment is the 90⁰ rotation of the whole setup. No other "tweaking " of any kind was done, nor can be done.

The ether wind is the only thing that can change the initial travel direction of the vertical light beam.

Therefore, the travel paths of the vertical light beam shown in *Fig. 18,* that mimics the swimmer model in *Fig. 7,* is untenable.

Hence, the mechanical system of two swimmers racing in a river is not equivalent to the actual MM experiment.

Because of this difference, the time of travel of the swimmer swimming across the river current is different than the travel time of the vertical beam in the MM experiment.

Laboratory and Earth at rest

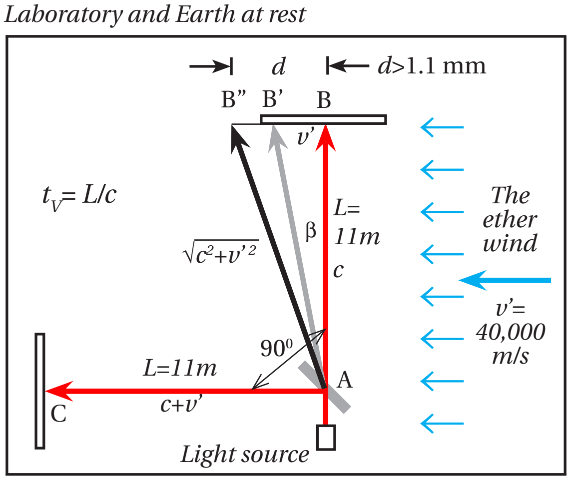


Figure 9

Correct diagram of the MM experiment when the ether wind changes its speed

The only viable outcome when the ether wind is increased is shown in *Fig. 9*, where the beam is further displaced in the direction of the wind and travels along the hypotenuse AB".

According to our new experiment to detect the ether wind shown in *Fig. 4-6*, the only thing that can change the direction of the vertical light beam is the magnitude of the ether wind. There is no other way of affecting the speed and direction of the light beams in the MM experiment when the ether wind is blowing through the laboratory.

When the speed of the ether wind is increased to *v'*, the direction of the vertical beam would change and the angle of deflection would increase. The speed of the beam would also increase; however, the distance traveled would proportionally increase so that the travel time would remain unchanged, *L/c*.

Proof #3. Error in Ohanian vector analysis

Every vector presentation of the motion of the light beams in the MM experiment mimics the swimmers' model, where one swimmer swims slightly upstream in order to travel perpendicularly to the current. With his swimmers' model, Michelson had set the pattern for all future interpretations of his experiment. So is the case with Ohanian vector analysis when the laboratory and the interferometer are at rest and the ether wind is blowing through the laboratory.

Figures 10a and *10b* show the addition of vectors representing the parallel light beam shown in red and the ether wind shown in blue, when the beam travels first in the same direction as the ether wind, then in the opposite direction. The result of the additions, the resulting vectors, are shown in black.

Figure 10c shows the initial direction of the vertical light beam shown in red traveling at an angle (upwind, as it is in the swimmers' model), forming greater than a 90⁰ angle with the parallel beam.

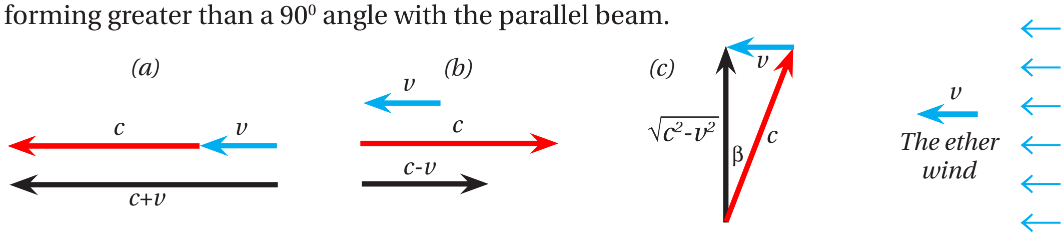


Figure 10

Because of the ether wind, the direction of the vertical beam changes in the above figure, so the beam travels perpendicularly to the ether wind and along the <u>*side*</u> of a right triangle, shown by a vector in black.

This is a vector presentation of the interactions in the swimmers' model.

In the actual MM experiment, however, *the vertical beam cannot change its initial direction of travel.*

MM interferometer is constructed with two arms forming a 90⁰ angle. This angle cannot be modified. *If we angle the the MM interferometer relative to the ether wind, so that its initial direction of the vertical beam is slightly upstream* (as in Michelson's two-swimmers model of the experiment or in the Ohanian drawing in *Fig. 10c) we would also have to change the angle of the parallel beam, as shown in Figures 11a and 11b. We would then have to recalculate the parallel beams' travel time, which no one has ever done.* The vector additions would take a different form, as shown below.

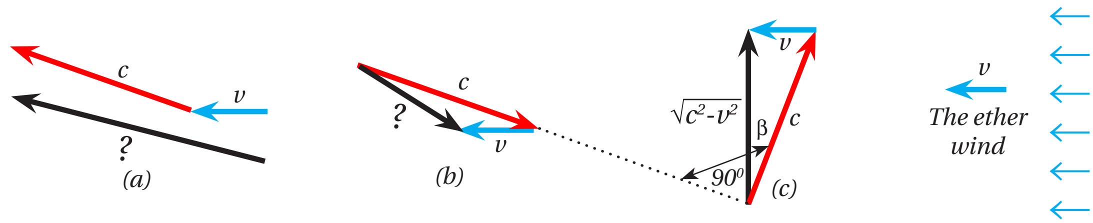


Figure 11

Therefore, if the initial direction of the vertical beam is at an angle relative to the ether wind, as shown in red in *Fig. 11c* (and in *Figure 10c* in the Ohanian drawing), then the initial direction of the other beam, also shown in red, must form a 90⁰ angle with the initial direction of the vertical beam. However, it will not be parallel to the direction of the ether wind. That is, it will be at an angle relative to the ether vector shown in blue in *Figures 11a* and *11b*. These vector additions would yield different resulting velocities than those shown in black in the Ohanian drawing in *Fig. 10*, and would result in different travel times.

The change in the angle of the vertical beam can only be accomplished by the ether wind or by changing the angle of the beamsplitter or the entire apparatus relative to the ether wind, which would affect both beams.

Ohanian vector presentation in *Fig. 10* shows vector interactions in the swimmers' or the comparable model of the MM experiment, not in the actual one.

The only viable vector presentation of the MM experiment in the ether setting

The only viable vector presentation of the MM experiment when the laboratory and the interferometer are at rest and the ether wind is blowing through the laboratory is shown below.

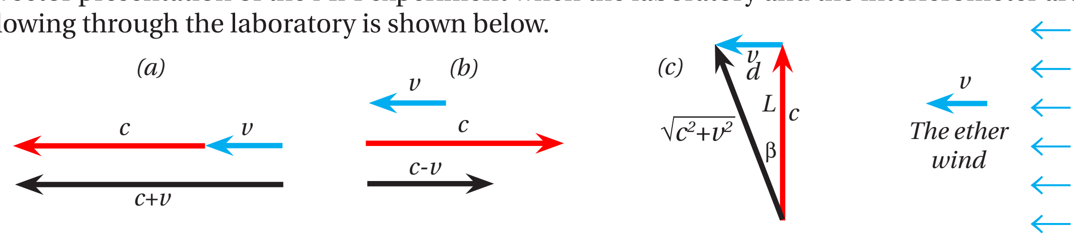


Figure 12

When the beam is projected perpendicularly to the direction of the ether wind *(Fig. 12c)*, the wind will displace the light beam in the direction of the ether wind so that it travels along the <u>*hypotenuse*</u> of a right triangle of velocities at velocity $\sqrt{c^2+v^2}$ and in time *L/c*.

Therefore, Michelson's velocity of the vertical beam ($\sqrt{c^2-v^2}$) and the time of travel *(*$L/\sqrt{c^2-v^2}$*)* cannot be correct.

Proof #4. Feynman's method of graphically explaining the Michelson-Morley experiment *hides an error*

Richard Feynman presented in his *Lectures on Physics* [4] his interpretation of the MM experiment in the ether setting, along with a diagram of the experiment *(Fig. 13b)*. Feynman wrote: *"If the apparatus is at rest in the ether, the times would be precisely equal, ..."*, as shown in *Fig. 13a*.

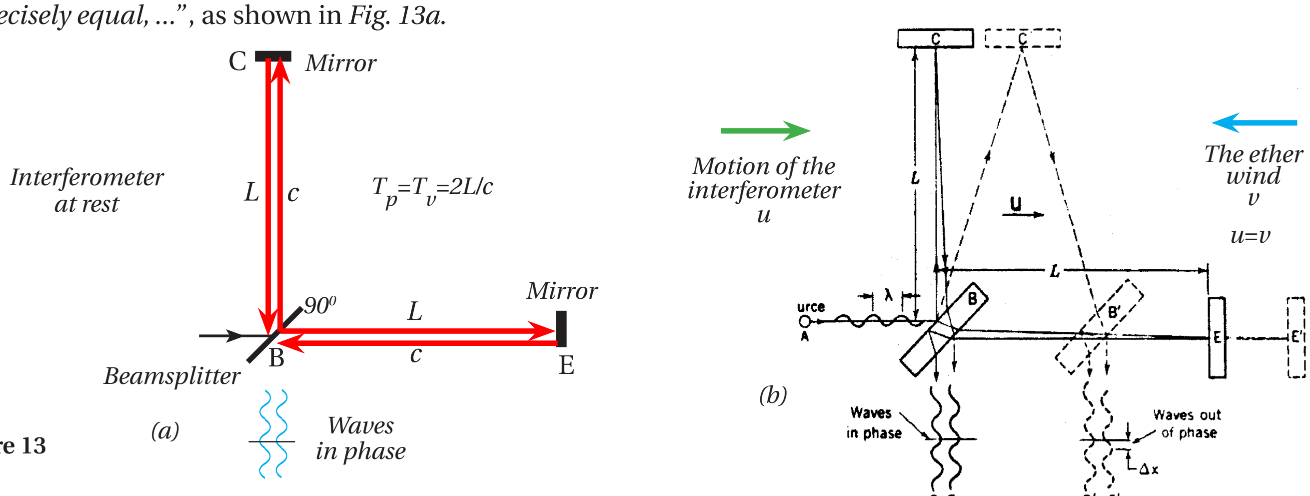


Figure 13

Feynman continued: *"... but if it (the interferometer) is moving to the right with a velocity u, there should be the difference in the times" (Fig. 13b)*. (Motion of the interferometer *u* and the ether wind *v* with arrows were added.)

If we are sitting at a desk with this page in front of us, we would see the apparatus moving from left to right, representing a new moving frame of reference where the earth and the inteferomitter are now moving through the ether. A detailed version of the drawing is shown below.

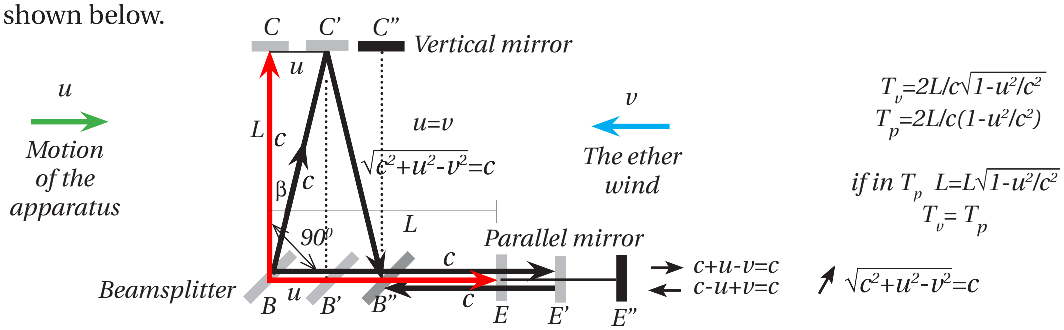


Figure 14

Feynman took into consideration the velocity of the ether wind *v* canceling the velocity of the earth *u* to arrive at velocity of the light beam *c* in all directions, but the effect of the ether wind on the direction of the motion of the vertical beam is ***missing***.

Vector presentation of the Feynman's model of the MM experiment shows the error in his model

Feynman's model has three moving components. They are:

1. Motion of the earth and the apparatus at velocity *u*.
2. The ether resistance or the wind *v* acting in the opposite direction.
3. Motion of the light beams in all directions at velocity *c*.

> *Feynman did not notice that his interpretation of the MM experiment, according to both the ether theory and Einstein's mechanics, contradicts the principle of relativity, as their travel times at rest are different then when the apparatus is in motion.*

The three moving components in the *vertical beam* interaction can be represented as three vectors shown in *Fig. 15*.

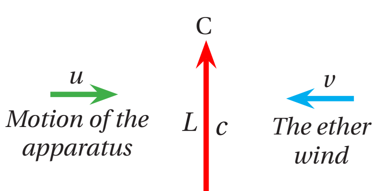


Figure 15

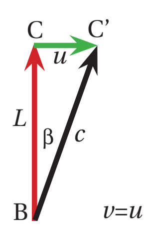


Figure 16

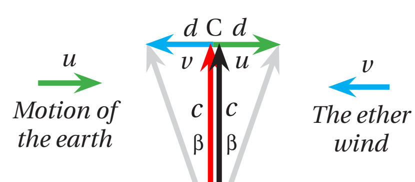


Figure 17

However, when the 3 moving components in Feynman's model are presented as 3 vectors, only 2 moving components are taken into consideration *(Fig.16)*. *The ether wind vector is missing*. The correct vector addition is shown above in *Figure 17*. The change of direction caused by the motion of the earth is supposed to be cancelled by the ether wind. Hence, the beams' speed *c*.

Without realizing, Feynman presented a diagram of the relativistic model of the MM experiment, where there is no ether, where light beams travel at speed *c* in all directions, unaffected by the motion of the source.

The fact that the light beams travel at the same speed *c* in all directions in both models, explains the erroneous belief that the ether and the relativistic model of the MM experiment are identical; a belief that has survived to this day.

Proof #5. Three distinct mechanical systems require three distinct vector additions in the motion of the vertical light beam of the MM experiment

1. Model according to Newton's classical mechanics

According to Newton, the ether has no effect on the motion of the light beams as they travel like any other particles of matter. In this model, there are *2 moving components*:

1. **Motion of the earth and the apparatus at velocity *u***
2. **Initial direction of motion of the vertical beam at the initial velocity *c***

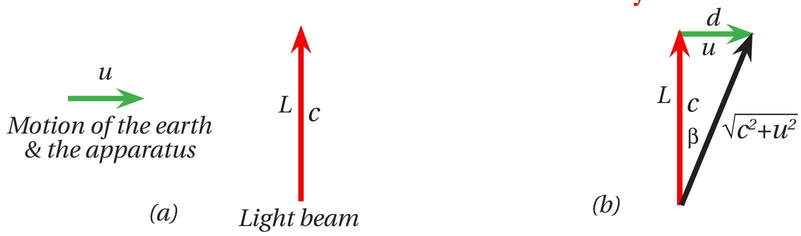


Figure 18

Figure 18a shows the two vectors representing the velocity of the interferometer *u* and the velocity *c* of the vertical light beam. The addition of these two vectors is shown in *Fig. 18b*, which yields the resulting vector and resulting velocity shown in black with the *plus* sign in the square root.

2. The ether model of the MM experiment

The ether model has *3 moving components*.

1. **Motion of the earth and the apparatus at velocity *u***
2. **The ether resistance or the wind acting or moving in the opposite direction at velocity *v***
3. **Initial direction of motion of the vertical beam at the initial velocity *c***

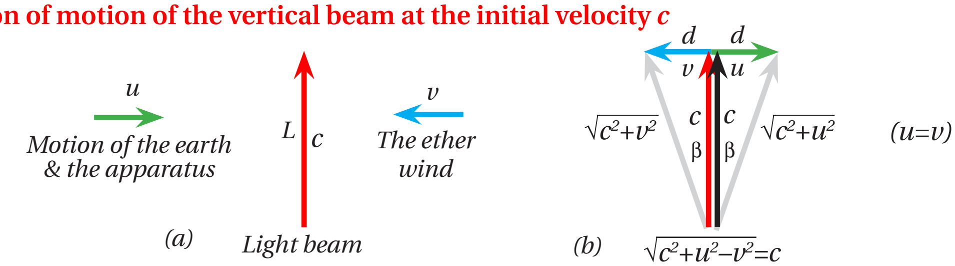


Figure 19

Having an equal but opposite effect, the ether wind cancels the effects of the motion of the earth on the ***velocity*** and ***direction*** of the vertical light beam, so that the beam travels at velocity *c* along the initial direction. The addition of the three vectors in *Fig. 19a* yields the resulting vector shown in black *(Fig. 19b)* that has the same direction and magnitude as the vector that represents the initial velocity *c* shown in red. Once again, according to the theory of the existence of the ether and the ether wind, the ether wind affects the motion of the light beam but has no effect of the motion of the interferometer.

3. Einstein's model of the MM experiment

In Einstein's model, the ether and the ether wind do not exist and the light beams travel at a constant velocity *c* in all directions, unaffected by earth's motion. This model has *2 moving components*:

1. **Motion of the earth and the apparatus at velocity *u***
2. **Initial direction of motion of the vertical beam at the initial velocity *c***

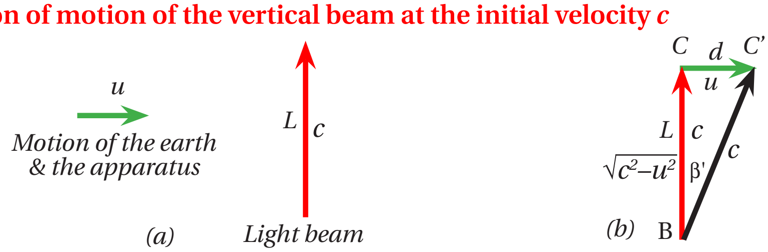


Figure 20

The addition of the two vectors in *Fig. 20a* yields the resulting vector shown in black in *Fig. 20b*. This is a highly unusual addition because the magnitude of the resulting vector in black is represented by the same velocity *c* as the initial vector shown in red. This addition represents the essence of Einstein's concept that light cannot travel faster than the velocity *c*, yet it will travel along the longer distance AC' in the same amount of time. Also, to calculate the time along BC', Einstein acknowledges that the velocity of light is not constant, as the velocity vector in red is slower than speed *c*. (This paradox is the subject of another paper.)

The above 3 distinct vector additions, with 3 distinct mechanical systems and with 3 distinct mechanical characteristics mandate 3 distinct diagrams of the MM experiment.

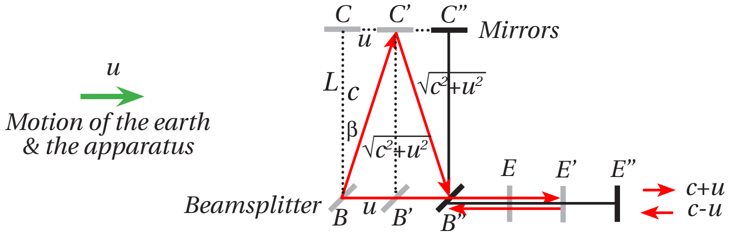
Proof #6. Three distinct vector interactions require three distinct diagrams of the Michelson-Morley experiment

1. Diagram according to Newton's classical mechanics

According to Newton, there is no ether and light travels like particles of matter. There are *2 moving components* in this diagram:

1. **Motion of the earth and the interferometer at speed *u***
2. **Motion of the light beams at different speeds than speed *c***

Figure 21



$t_{BC'}=L/c$
$t_{C'B''}=L/c$
$t_{BE'}=L/c$
$t_{E'B''}=L/c$
$T_p=T_v=2L/c$

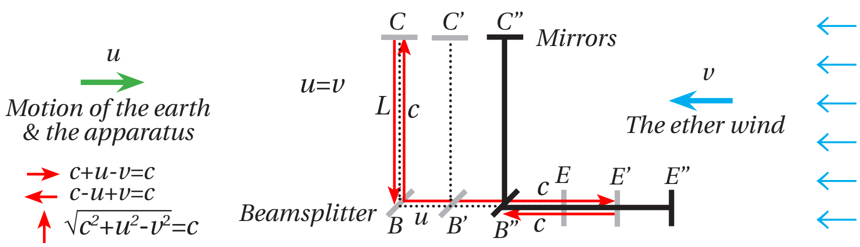
Due to the motion of the earth, the vertical beam travels along the hypotenuse of the two right triangles at the speed that has a plus sign in the square root and in time *2L/c*. Along the parallel path, the motion of the earth will add its speed component to the parallel beam *(c+u)*, than reduce the speed on the way back to the beamsplitter *(c–u)*. The total time of travel will be the same as for the vertical beam *(2L/c)*. In other words, the two beams reunite at the beamsplitter at the same time and in the same phase, thus preventing any phase shift in the experiment and is in agreement with its results.

2. Diagram according to the theory of the ether existence

The ether model has *3 moving components*:

1. **Motion of the earth and the interferometer at speed *u***
2. **The ether resistance or the wind acting or moving in the opposite direction at speed *v***
3. **Motion of the beams in all directions at speed *c***

Figure 22



$t_{BC}=L/c$
$t_{CB}=L/c$
$t_{BE'}=L/(c–u)$
$t_{E'B''}=L/(c+u)$
$T_v=2L/c$
$T_p=2L/c[1-(u^2/c^2)]$

According to mechanical characteristics of the ether, having an equal but opposite effect of the motion of the earth, the ether wind cancels the effects of the motion of the earth on the <u>*speed*</u> and <u>*direction*</u> of the beams so that they travel at a constant speed *c* in all directions. *Due to the ether wind, the vertical beam would be left behind as the interferometer is displaced to the right, similarly to throwing something out the window of a moving car*. The beams would arrive at the beamsplitter at different times, in different places and in a different phase.

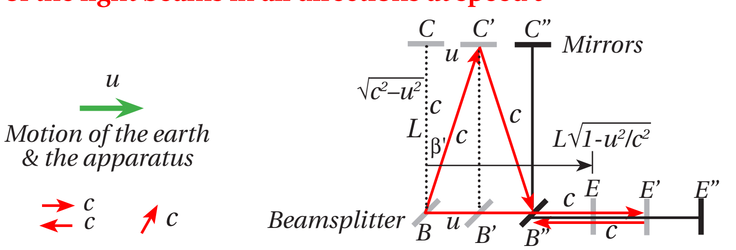
3. Diagram of the MM experiment according to Einstein's theory

The light beams travel at a constant speed *c* in all directions, unaffected by earth's motion. Einstein's model has *2 moving components:*

1. **Motion of the earth and the interferometer at speed *u***
2. **Motion of the light beams in all directions at speed *c***

$t_{BC'}=L/\sqrt{c^2–u^2}$ $\quad ct_{BE'}=L+ut_{BE'}$ $\quad t_{BE'}=L/(c–u)$
$t_{C'B''}=L/\sqrt{c^2–u^2}$ $\quad ct_{E'B''}=L–ut_{BE''}$ $\quad t_{E'B''}=L/(c+u)$
$T_V=2L/\sqrt{c^2–u^2}$ $\quad T_p=2Lc/(c^2–u^2)$
$T_V=2L/c\sqrt{1–u^2/c^2}$ $\quad T_p=2L/c(1–u^2/c^2)$

Figure 23



If L contracts to $L\sqrt{1-u^2/c^2}$
$T_p=2L\sqrt{1-u^2/c^2}/c(1–u^2/c^2)$
$T_p=2L\sqrt{1-u^2/c^2}/c\sqrt{1-u^2/c^2}\sqrt{1-u^2/c^2}$
$T_p=T_V=2L/c\sqrt{1-u^2/c^2}$

Motion of the earth would cause the vertical beam to travel along AC' and C'B" at speed *c* and meet the parallel beam at B", traveling also at speed *c* in both directions. Because of this speed, the two beams arrive at the beamsplitter at different times. The concept of contractions of the parallel length was introduced so that the two beams arrive at the same time and, thus, explain the absence of the fringe shift in the actual experiment.

For the first time in the history of the MM experiment, the three drawings of this experiment according to three different theories and three different mechanical systems are presented here next to each other. The new and correct ether diagram of this experiment in *Fig. 22* is also presented here for the first time in the history of the experiment.

Proof #7. Discrepancies in the Michelson's and Morley's paper of 1887

The paper appeared in *The American Journal of Science* under the title *"On the Relative Motion of the Earth and the Luminiferous Ether."* [6]

Figs. 1 and 2 in the paper show the diagrams of the experiment drawn by M&M. The motion of the vertical ray and the calculations of the times and distances traveled are identical to Feynman's interpretation of this experiment elaborated upon in *Proof #4*.

Everything that is written about the discrepancies in the Feynman's calculations of the vertical time in *Proof #4* applies to Michelson's and Morley's interpretation.

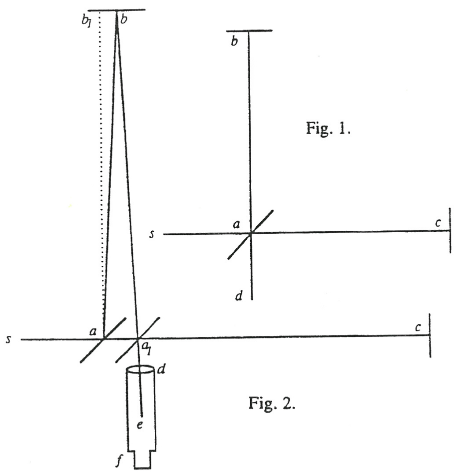


Fig. 1.

Fig. 2.

The authors of the above two diagrams wrote:

> "Let *sa*. fig. 1. be a ray of light which is partly transmitter in *ab*, and partly transmitted in *ac*. being returned by the mirrors *b* and *c*. along *ba* and *ca*. *ba* is partly transmitted along *ad*. and *ca* is partly reflected along *ad*. If then the paths *ab* and *ac* are equal, the two rays interfere along *ad*.
>
> "Suppose now, *the ether being at rest, that the whole apparatus moves in the direction sc. (fig. 2) with the velocity of the earth in its orbit.* the direction and distances traversed by the rays will be altered thus:—the ray *sa* is reflected along *ab*, ... is returned along ba_1. ... and goes to the focus of the telescope, whose direction is unaltered." (Emphases added)

The above diagram shows the vertical ray arriving at the mirror at point *b* in *Fig. 2*, but does not show how it arrived at this point.

According to the authors, when *"the whole apparatus moves"* trough the stationary ether and to the right, the *"distances traversed by the rays will be altered thus:—the ray sa is reflected along ab, ..."* That is, the vertical ray arrives at *b* due to the motion of the earth and the apparatus.

But where is the effect of the ether?

How did the ether affect the direction of travel of the vertical light ray?

Or, how did the vertical light ray interact with the motion of the earth and the ether as it traveled across it; and how are its speed and the travel time calculated?

It has been generally assumed that the ether, the ether wind, or the resistance of the ether, had an equal effect on the motion of the light rays as the motion of the earth, but in the opposite direction, as shown in Ohanian's vector presentation in *Fig. 10*.

However, the effect of the ether on the direction and the time of travel of the vertical ray is missing in this diagram and in Feyman's diagram of the MM experiment *(Fig. 13b)*, rendering all calculations of times and distances traveled by the vertical light ray faulty and meaningless.

As mentioned in *Proof #4*, without realizing, Feynman and Michelson and Morley (M&M) presented a diagram of the experiment according to Einstein's theory where there is no ether and the light rays travel at the constant speed *c* along all optical paths, and where the vertical ray is affected only by the motion of the apparatus, as shown in *Fig. 13*.

M&M's diagram in their *Fig. 2* is not only poorly executed and inaccurate, it is also confusing. It shows the beamsplitter and the vertical mirror moving to the right, while the parallel mirror stays in the same place, at *c*, unaffected by the motion of the earth. Feynman's diagram in *Figure 13b* is more accurate on this point.

Furthermore, point *b* in M&M's *Fig. 1* shows the vertical ray's arrival at the mirror when the apparatus is at rest. But in *Fig. 2*, point *b* shows ray's arrival at the mirror when displaced by the motion of the earth.

Even a more confusing detail is in the parallel times. Time T is "time light occupies to pass from *a* to *c*." This is the distance D when the apparatus is at rest and light traveled from *a* to *c* in Fig. 1. However, the time on the return is along the distance from *c* to a_1, where the beamsplitter and apparatus moved to the right in *Fig. 2*. But the mirror at *c* didn't move.

M&M presented the following specs of the experiment:

"Let V = velocity of light.
v = velocity of the earth in its orbit.
D = distance *ab* or *ac*, fig. 1.
T = times occupies to pass from *a* to *c*.
T_1 = time light occupies to return from *c* to a_1

"Then $T = D/(V-v)$, $T_1 = D/(V+v)$. The whole time of going and coming is

$T+T_1 = 2DV/(V^2-v^2)$", (which is the same as $2D/V\sqrt{1-v^2/V^2}$)

M&M stated that the parallel time on the return is: "T_1 = time light occupies to return from *c* to a_1." But to calculate this time, they used equation $T_1=D/(V+v)$, where the length length D is longer than *c* to a_1.

In other words, the total parallel time according to their specs is:

$$T_P = T+T_1= D/(V+v) + ca_1/(V-v)$$

However, when they calculated the total parallel time, they used a different equation:

$$T_P = D/(V+v) + D/(V-v)$$

This equation for calculating the total parallel time do not correspond to their drawing in *Fig. 2*. It is taken from the swimmers' model, when the apparatus is at rest and the light rays travel along the same distance D, first with the ether current *(V+v)* and, on the way back, against the current *(V–v)*.

The parallel ray in their drawings is supposed to travel from a to the displaced mirror at c_1, which is not shown in the diagram, and, on the return, from c_1 to a_1.

Compare the scanty and confusing M&M's diagrams of their experiment with the detailed diagrams presented in this paper, that result in clarity and accuracy.

In the nut shell, Michelson started his calculations with the incorrect swimmers' model in 1881, believing that it was equivalent to the MM experiment when the interferometer is at rest and the ether wind was blowing through the laboratory and the interferometer.

Then, when joined with Edward Morley in 1887, they created a confusing and inaccurate diagram of the same experiment, partly showing the interferometer being at rest and the ether wind blowing through the laboratory and the interferometer; and partly showing the interferometer moving through the ether, where the effect of the ether on the direction of the vertical light ray was not taken into account.

Furthermore, neither Michelson nor Einstein, Feynman and all other physicists to the present time had noticed that their diagrams of the MM experiment contradict the principle of relativity. The beams' travel times when the interferometer is at rest are different then when the apparatus is in motion. This inequality is impermissible by this principle, as it would enable us to distinguish the state of rest from the state of uniform motion. According to the principle of relativity, the state of rest is indistinguishable from the state of uniform motion.

Unfortunately, all the diagrams of the MM experiment found in physics textbooks and manuals of the theory of relativity are based on the inaccurate and confusing Michelson and Morley's diagrams, or the Michelson swimmers' model, perpetuating the misconceptions and causing further errors in other branches of physics.

Conclusion

The proofs presented in this paper show that, according to the mechanical characteristics of the ether (as understood by Michelson, Lorentz, Eddington and explained in practically every physics textbook), the total vertical time in the MM experiment cannot be $2L/c\sqrt{1-u^2/c^2}$ but it must remain $2L/c$ regardless of the speed of the earth and regardless of whether or not the ether wind is acting in the experiment. They also prove that the calculations of the vertical time in the MM experiment done by Michelson, Lorentz, Eddington, Feynman and many other physicists is incorrect and that a major error of enormous consequences was made in the interpretation of this experiment.

The new drawing of the MM experiment, drawn according to the mechanical characteristics of the ether *(Fig. 22)*, shows that not only would the beams reunite at the beamsplitter at different times than originally calculated by Michelson in 1887, the vertical beam would be displaced 2.2 mm from the predicted rendezvous point with the parallel beam at the beamsplitter.

The essence of the error in the interpretation of this experiment is that because in the swimmers' model of the MM experiment the swimmer changes its direction of swimming slightly upstream in order to swim straight across the current, this gave the impression that the change of direction due to the ether wind was taken into account and treated that way in all subsequent interpretation of the MM experiment. Hence, the error remained undiscovered to the present time.

Referring to the MM experiment, Einstein wrote: *"This was the first path which led me to the special theory of relativity."* [5] However, he did not notice the error in the interpretation of the MM experiment or the error in the magnitude of Lorentz's contraction needed to explain the null results of this experiment. Einstein incorporated Lorentz's theory of contractions and his transformation equations, now known as Lorentz-Einstein transformation equations, into his theory of relativity, all rendered meaningless due to the error.

References

[1] Hans Ohanian, *Principles of Physics,* W.W. Norton & Co., New York, p. 759, 1994.

[2] Peter J. Nolan, *Fundamentals of College Physics*, Wm. C. Brown Publishers, Dubuque, IA, 2nd Edition, p. 853, 1995. Scribner's

[3] Dorothy Michelson Livingston, *The Master of Light*, Charles Sons, NY, 1997, p. 77.

[4] Richard Feynman, *Lectures on Physics*, Allan Wydle, Reading, MA, 1963, Vol. 1, p. 15.3.

[5] Albert Einstein, *How I Created the Theory of Relativity*, Physics Today, Vol., 8. p. 45-47

[6] Albert A. Michelson and Edward W. Morley, *On the Relative Motion of the Earth and the Luminiferous Ether*. Amer. J. of Sci. Volume XXXIV, Nov. 1887, pp. 333-341