

# Michelson-Morley experiment explanation by HK

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## **Abstract:**

*Michelson and Morley conducted experiments to investigate the possibility of luminiferous ether being present in the universe for light beam propagation. Is the experiment appropriate for detecting aether in the universe or not? Morley and Michelson conducted such exquisite experiments. However, there seems to be a discrepancy between the experimental and theoretical data. This may be because the derivation of the Michelson and Morley experiment did not include the speed of the light source. The objective of this theory is to explain the null result obtained by the Michelson-Morley experiment, to use the new derivation of the Michelson-Morley experiment to include the light source speed, and to observe the result. The main aim of this theory is to demonstrate that the velocity of light is relative rather than independent. The velocity of light is different in different frames of reference. Interestingly, there has been little discussion about the source speed of light until now. In this paper, we utilize the classical mechanics of relative motion to derive the Michelson and Morley experiment. By introducing the light source speed in the derivation, our theoretical and experimental values will match. However, further experiments are required to fully prove whether the speed of light is constant or relative and whether it is dependent or independent.*

**Keywords:** *Luminiferous aether, Fizeau experiment, aberration of starlight, Albert A. Michelson, Michelson-Morley experiment, Special Relativity, Maxwell's equations, interferometer, Fresnel's drag coefficient, Dayton Miller, Kennedy - Thorndike experiment.*

## **Introduction**

The Michelson-Morley experiment is a stunning demonstration of ether's existence in the cosmos. It is possible to test for the presence of aether with this experiment. Is it accurate? The null result of the Michelson Morley experiment that in means light speed is constant. Is it right? The idea that light speed in a vacuum is constant regardless of light sources and observers forms the basis of Einstein's Special Relativity. Stated otherwise, the speed of light as measured at any point in space is the same as the speed of light as measured at their motion. Does it sound true? Ever since Einstein initially postulated this in 1905, scientists have been debating it for the past thousand years. Is this assumption supported by any experimental evidence? Then, we have to find out if a light carrier such as Aether exists and what are those existing evidences to prove that light speed is not constant. It is the purpose of this paper to answer those questions and verified the null result of the Michelson Morley experiment.

Physics theories of the 19th century assumed that just as surface water waves must have a supporting substance, i.e, a "medium", to move across (in this case water ), and audible sound required a medium to transmit its wave motion (such as air or water ), so light must also require a medium, the "luminiferous aether" to transmit its wave motions. Because light can travel through a vacuum, it was assumed that even a vacuum must be filled with aether. Because the speed of light is so great, and because material bodies pass through the aether without obvious friction or drag, it was assumed to have a highly unusual combination of properties. Designing experiments to investigate these properties was a high priority of physics[1]. Earth orbits around the sun at a speed of around 30km/s. the Earth is in motion, so two main possibilities were considered: 1) the aether is stationary and only partially dragged by Earth (proposed by Augustin-Jean Fresnel in 1818), or 2) the aether is completely dragged by Earth and thus shares its motion at earth's surface (proposed by George Stokes, 1st Baronet in 1844).in addition, James Clark Maxwell (1865) recognized the electromagnetic nature of light and developed what is now called Maxwell's equations, but these equations were still interpreted as describing the motion of waves through an aether, whose state of motion was unknown. Eventually, Fresnell's idea of an (almost) stationary aether was preferred because it appeared to be confined by the Fizeau experiment (1851)[2] and the aberration of starlight[3]. The Fizeau experiment was carried out by Hippolyte Fizeau in 1851 to measure the relative speeds of light in moving water. Fizeau used a special interferometer arranged to measure the effect of the movement of a medium

upon the speed of light [2]. In 1881, American physicist Albert Abraham Michelson designed a prototype experiment device known as the Michelson interferometer. Michelson expected that the earth's motion would produce a fringe shift equal to 0.04 fringe - that is, of the separation between areas same intensity, but he did not observe the expected shift by that device [4]. In 1885, Michelson began a collaboration with Edward Morley, spending considerable time and money to confirm with higher accuracy Fizeau's 1881 experiment on Fresnel's drag coefficient, to improve on Michelson's 1881 experiment, and to establish the wavelength of light as a standard of length [2]. Michelson-Morley Experiment (1887), The seminal Michelson-Morley experiment aimed to detect the motion of Earth through the ether. Surprisingly, the results showed no variation in the speed of light, challenging the existence of the ether medium [5][6]. Morley was not convinced of his own result and went on to conduct additional experiments with Dayton Miller from 1902 to 1904. Again, the result was negative within the margins of error[7][8]. Einstein's Theory of Special Relativity (1905), Albert Einstein revolutionized physics with his theory of special relativity, which discarded the need for an ether medium. Instead, he postulated that the speed of light is constant in all inertial frames, rendering the ether concept obsolete [9][10]. In 1932, Roy Kennedy and Edward Thorndike modified the Michelson - Morley experiment by making the path lengths of the split beam unequal, with one arm being very short. The Kennedy - Thorndike experiment took place for many months as the Earth moved around the sun. Their negative result showed that the speed of light is independent of the velocity of the apparatus in different inertial frames[11].

### **Methodology**

The research can be conducted through various methods, such as the theoretical method, the experimental method, and the computational method. In this particular instance, the theoretical method was chosen to be correction of null result of the Michelson Morley experiment. According to the undulatory theory[11] of the light assumed the existence of a medium called aether, whose vibration produce the phenomena of the heat and light and which is the supposed to fill all space. according to the Fresnel, the aether, which is enclosed in the optical media partakes of the motion of these media, to an extent depending on the their indices of the refraction. for air, this motion would be the but a small fraction of that of the air itself and will be neglected. Assuming then that the aether is at rest, the earth moving through it. Michelson Morley experiment conducted to the existence of ether present the universe or not. But they are found to be null result from the experiment. The goal of this research study is to resolve the Michelson-Morley experiment's null result. The principle of relativity is used in broad physics to solve this null result.

Assuming then that the ether is at rest and the earth is moving through it, then the earth is moving at  $v$  speed with respect to the aether. Michelson and Morley's experiment was conducted on the earth's surface, and the earth's surface moves at  $v$  speed. The whole apparatus moves in the earth motion direction, with the velocity of the earth in its orbit. As a result, all apparatus is set on the earth's surface such that the whole apparatus moves at  $v$  speed, including the speed of the light source, in either the aether frame or the earth frame if we suppose the earth is moving at  $v$  speed. If the light propagates at  $c$  speed and the light source at  $v$  speed are in the same direction, then we experience the light speed as  $c+v$ . We observe both the aether frame and the earth frame when we consider that the earth is in motion and the whole apparatus moves at  $v$  speed, and the light source also moves at  $v$  speed (according to general physics, let a car move at  $u$  speed and a person inside the car throw a ball at  $v$  speed if the car and the ball are in the same direction, then the observer outside of the car observes the ball speed as  $u+v$ ). and if the light beam and light source speed are in the opposite direction, then we experience the light speed as  $c-v$  (let a car move at  $u$  speed and a person inside the car throw a ball at  $v$  speed; if the car and the ball are in the opposite direction, then the observer outside of the car observes the ball speed as  $u-v$ ).

The speed of the light is different, and the frame is different in measurement. such as the speed of the light measure on the earth surface is the same in different directions. For this speed of light in the earth direction, the earth moves in a uniform motion. It is considered in this way that the motion of the earth is a move at  $v$  speed, and then every apparatus moves at the same speed on the earth surface, including the light source. If the light measures in the earth direction, in this case, if the light speed is  $c$  and the light source speed is  $v$ , then the light speed appears to be  $c+v$ , and if the light source moves at  $v$  speed, then the relative

speed of light is  $c+v-v$ , which is equal to  $c$ . For this speed of light in the opposite direction of the earth, the earth moves in a uniform motion. It is considered in this way that the motion of the earth is a move at  $v$  speed, then there are light beams and light sources that move in opposite directions at the same speed on the earth surface, including light sources. If the light measures in the earth direction, in this case, if the light speed is  $c$  and the light source speed is  $v$ , then the light speed is  $c-v$ , and if the light source moves at  $v$  speed, then the relative speed of light is  $c+v-v$ , which is equal to  $c$ . In this way, the speed of light in different directions is the same as on earth. Michelson Morley experiment in there are also assume light speed is same.

Speed of light measured from the aether frame of reference for this light source emits a light beam on the earth surface, assuming then that the aether is at rest and the earth is moving through it. If the earth is moving at  $v$  speed with respect to the aether frame of reference, then a light source on the earth's surface emits light in a different direction. If the light source emits a light beam in the same direction, Then, when we observe the speed of light from the aether frame, we see that light speed becomes light source speed plus light speed. Thus, the speed of light is  $c+v$  observed from aether frame of reference (according to general physics, let a car move at  $u$  speed and a person inside the car throw a ball at  $v$  speed; if the car and the ball are in the same direction, then the observer outside of the car observes the ball speed as  $u+v$ ). If the light source emits a light beam in the opposite direction, Then, as we observe the speed of light from the aether frame, we see that light speed becomes light source speed, or light speed. Thus, the speed of light is  $c-v$  observed from aether frame of reference (according to general physics, let a car move at  $u$  speed and a person inside the car throw a ball at  $v$  speed; if the car and the ball are in the opposite direction, then the observer outside of the car observes the ball speed as  $u+v$ ).

### Result and analysis

The Michelson Morley experiment setup for testing the existence of aether. The setup involves a light source emitting a beam of light that is partially transmitted and partially reflected by a partly transparent glass at an angle of  $45^\circ$  degrees. The light ray  $sa$  is partly transmitted in  $ac$  and partly reflected in  $ab$  at  $90^\circ$  with  $sa$ . The transmitted light ray  $ac$  hits mirror  $M_1$ , then, reflected from mirror  $M_1$ , the reflected ray  $ca$  hits the glass  $G$  and is reflected in  $ad$  at  $90^\circ$ . Again, the reflected light ray  $ab$  hits mirror  $M_2$ , and the reflected ray returns in  $ba$  incident to the glass  $G$ , and then the transmitted light beam goes to  $ad$  and interferes with the reflected light ray  $ca$  to  $ad$ , and interference patterns are formed, which are observed from the telescope. The distance between the glass and mirror  $M_1$  is  $L_1$ , and mirror  $M_2$  is  $L_2$ , as shown in Figure 1.

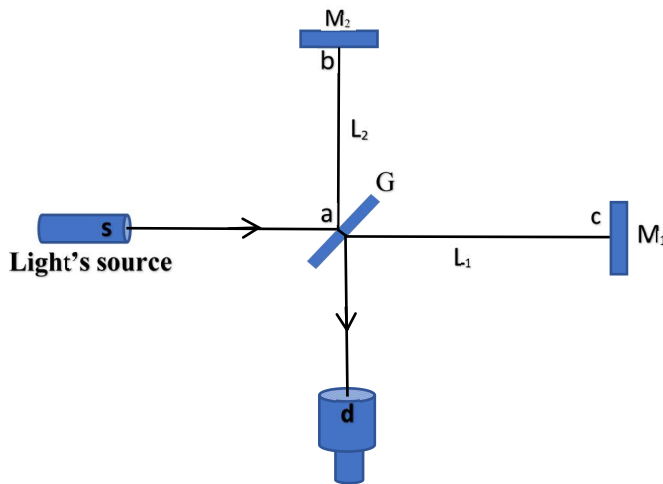


Figure 1. Michelson Morley experiment for the rest frame of reference

Suppose now, the aether being at rest, that the whole apparatus moves in the direction  $sc$ , with the velocity of the earth in its orbit, the directions and distances traversed by the rays will be altered. Thus, the ray  $sa$  is

reflected along  $ab$ , the angle  $b_1ab$ , being equal to the aberration  $=\alpha$ , is returned along  $ba_1$ , ( $aba_1=2\alpha$ ), and goes to the focus of the telescope, whose direction is unaltered. The transmitted ray goes along  $ac$ , is returned along  $ca$ , and is reflected at  $a_1$  making  $ca_1d$  equal  $90 - \alpha$ , and therefore still coinciding with the first ray. It may be remarked that the rays  $ba_1$  and  $ca_1$  do not now meet exactly in the same point  $a$ , though the difference is of the second order; this does not affect the validity of the reasoning. Let it now be required to find the difference in the two paths  $aba_1$  and  $aca_1$ , as shown in figure 2.

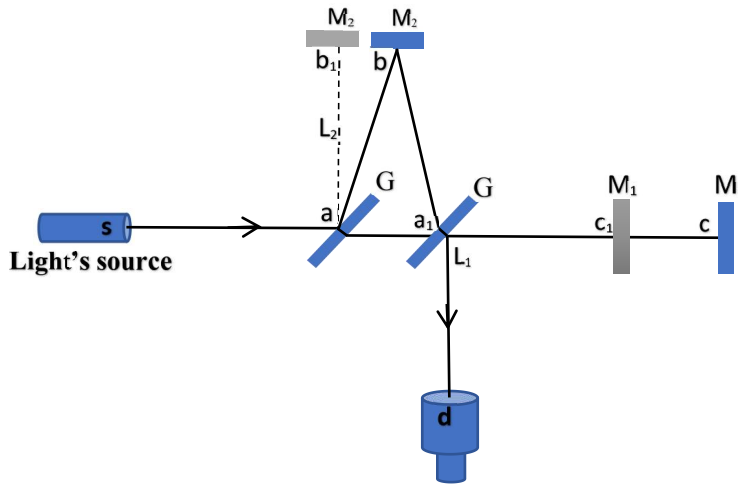


Figure 2. Michelson Morley experiment for the motion frame of reference

Suppose now that the aether is at rest, the earth moving through it. Then the earth is moving at  $v$  speed with respect to the aether. Here  $v$  is the orbital velocity of the earth, that the whole apparatus moves in the direction  $sc$  at  $v$  speed, and also the light source also moves at  $v$  speed in the earth direction. Because the light source is set up on the earth's surface and the earth is moving at speed  $v$ , the light source is also moving at speed  $v$  due to the orbital velocity of the earth. If the velocity of light is  $c$  and the light source is moving at  $v$  speed due to earth motion, then the light speed appears equal to the speed of the light source plus the speed of light itself such as the light speed equation  $c + v$ . If the light source and light speed are in the same direction, then the speed of light will appear as  $c + v$  according to principle of classical mechanics (According to the principle of relativity, if a person inside a car throws a ball at a speed  $v$  in the same direction to the car's motion at speed  $u$ , then the speed of the ball observed from outside the car would be  $v + u$ . This is because the ball inherits the car's motion and its speed is relative to the car's speed.). In this way speed of light observe from the aether frame of reference is  $c + v$ . It passes through the half silvered mirror at the origin at  $T=0$ . The reflecting mirror is at that moment at distance  $L_1$  and is moving with velocity  $v$ . The transmitted light ray hits the mirror at time  $T_1$  and thus travels the distance  $(c+v)T_1$ . At this time, the mirror has traveled the distance  $vT_1$ . Thus  $(c + v)T_1 = L_1 + vT_1$  or  $cT_1 + vT_1 = L_1 + vT_1$ . Thus,  $T_1 = L_1/c$ .

and consequently the travel time  $T_1=L_1/c$ . The same consideration applied to the backward journey, then the light source and reflected light beam are opposite to each other so that light light speed is  $c-v$  observe from aether frame of reference according to principle of classical mechanics (According to the principle of relativity, if a person inside a car throws a ball at a speed  $v$  in the opposite direction to the car's motion at speed  $u$ , then the speed of the ball observed from outside the car would be  $v - u$ . This is because the ball inherits the car's motion and its speed is relative to the car's speed.). The reflected ray  $sa_1$  hits the partly transparent glass at time  $T_1$  and thus travels the distance  $(c - v)T_1$ . At this time, the glass has traveled the distance  $vT_1$ . Thus  $(c-v)T_2=L_1-vT_2$  and  $T_2=L_1/c$ . Therefore total travel time  $T_L=T_1+T_2$  is  $T_L= L_1/c + L_1/c = T_L = 2L_1/c$ .

**For the reflected light:** Let us consider the light source moving at  $v$  speed, and the light source emitting a light beam is perpendicular to the light source direction. If the light propagate  $c$  speed in aether frame and the light source moves at  $v$  speed, as shown in Figure 3.

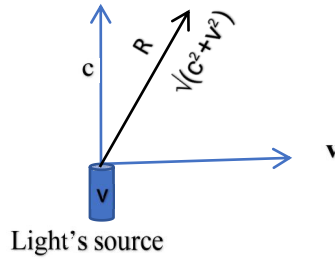


Figure 3. The light source that emits a light beam is perpendicular to its light source direction.

If a light source is emitting light perpendicular to its direction of motion, then we can use vector addition to determine the resultant magnitude and direction of the light. According to general physics, if we consider a car moving at speed  $u$  and a man inside throwing a ball perpendicular to the car's direction at speed  $v$ , then the resultant speed of the ball can be calculated using the triangle law of vector addition which is  $\sqrt{u^2+v^2}$ . Similarly, applying the triangle law of vector addition to the light emitted by the moving light source, we appear its resultant speed of light which is  $\sqrt{c^2+v^2}$ . This indicates that the light travels in a direction perpendicular to the direction of the light source its remains constant for the aether frame of reference.

In this way, If a light source is positioned on the Earth's surface and moves at the same speed as the planet, the speed of light would remain constant in the ether frame of reference. When the light source moves perpendicular to the direction of the light beam and the light is reflected off partially transparent glass, it inherits the speed of the light source for the perpendicular direction of the speed of light at  $c$ . This would result in the light traveling at  $\sqrt{c^2+v^2}$ , which can be observed from the aether frame.

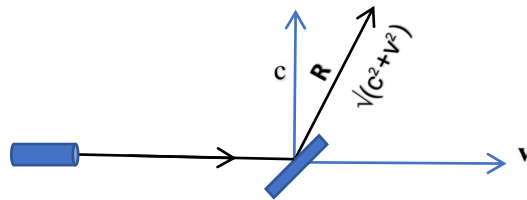


Figure 4. The light source that emits a light beam is reflected from the partially transparent glass perpendicular to its light source direction.

Therefore, if two vectors  $c$  and  $v$  are perpendicular to each other, the resultant vector of  $c$  and  $v$  is  $\sqrt{c^2+v^2}$ .

**For the reflected light ray ab:**

From the above explanation, the velocity of light in a perpendicular direction is  $c$ , and there are two vectors  $c$  and  $v$  that are perpendicular to each other. The resultant velocity of  $c$  and  $v$  is  $\sqrt{c^2+v^2}$  as shown in Figure 4.

The speed of light in vertical direction or  $y$  direction is  $c$ . So when the light hit the mirror, the travel path of the beam is  $L_2$  in the  $y$  direction at time  $T_3$ . Thus  $T_3=L_2/c$ . which is the same for the backward journey. The total time  $T_t=2T_3 = 2L_2/c$ . Or,

The speed of light in vertical direction or  $y$  direction is  $c$ . The beam is propagating at the speed of light  $\sqrt{c^2+v^2}$  and hits the mirror  $M_2$  at time  $T_3$ , traveling the distance  $\sqrt{c^2+v^2}T_3$ . At the same time the mirror has traveled the distance  $vT_3$  in the  $x$  direction. So in order to hit the mirror, the travel path of the beam is  $L_2$  in the  $y$  direction and  $vT_3$  in  $x$  direction. This inclined travel path follows from the transformation from the interferometer rest frame to the aether rest frame. Therefore, the Pythagorean theorem gives the actual beam travel distance of  $\sqrt{L_2^2+(vT_3)^2}$ . Thus  $\sqrt{c^2+v^2}T_3 = \sqrt{L_2^2+(vT_3)^2}$  and consequently the travel time  $T_3=L_2/c$ , which is the same for the backward journey. The total time  $T_t=2T_3$  is  $T_t = 2L_2/c$ .

Time difference between  $T_L$  and  $T_t$  is  $\Delta t_1 = T_L - T_t = 2L_1/c - 2L_2/c$ .

If the experiment setup rotates at  $90^\circ$ . then, After the initial setup, rotating the apparatus by  $90$  degrees allowed for a change in the orientation of the interferometer's arms relative to the direction of Earth's motion around the Sun. This adjustment was crucial to detect any variation in the speed of light due to the Earth's motion through the supposed ether medium. Therefore, the time difference  $\Delta t_2 = 2L_2/c - 2L_1/c$ .

Now time difference between before rotation to after rotation is  $\Delta t = \Delta t_1 - \Delta t_2 = 2L_2/c - 2L_1/c - 2L_2/c + 2L_1/c = 0$ .

Based on the theory, there is no time difference between the earth direction and its rotation at  $90^\circ$  for the whole apparatus. There is no time difference conduct between the experiment in the earth direction and its rotation at  $90^\circ$  for the whole apparatus by the Michelson Morley experiment. which indicates that there is no possibility of any interference pattern fringe shift in this hypothesis. Consequently, the experiment produced the same result, and the null conclusion of the Michelson-Morley experiment was fully confirmed when the theoretical and experimental values matched.

### Discussion

It appears that we are discussing a theory related to the speed of light and its measurement in different directions while considering the movement of the Earth with respect to the ether. According to this theory, there should be no time difference and no interference pattern shift. The theoretical value and the experimental value match each other. It's interesting to consider the implications of this theory and how it relates to our understanding of light and its behavior. The main purpose of the theory is to solve the null result of the Michelson-Morley experiment. According to this theory, this model experiment is not applicable for measuring the existence of ether if it exists, and it is also not applicable to measuring the velocity of light, whether it is dependent or independent. According to this theory, the speed of light is different in different frames of reference. The speed of light in the earth frame in all directions is the same if its relative speed is the same in all directions, but in the aether frame, the speed of light is different in different directions. Thus, the velocity of light is dependent on the frame of reference. Thus Light speed is not constant for all observers. Hence, we are required to use other types of experiments or theories to determine whether the velocity of light is independent or dependent.

Michelson Morley was doing an experiment on the earth's surface to find the null result. The Michelson-Morley experiment demonstrated that light moves at the same speed in all directions, challenging the prevailing notion of an "ether" medium through which light was thought to propagate. This null result prompted a reevaluation of the fundamental principles governing light's behavior. The null result of the Michelson-Morley experiment was solved by Einstein's special relativity. In my research paper, I want to use another perspective to solve the null result of the Michelson-Morley experiment by using the general physics of the principle of relativity. For the existence of aether detection applying the derivation formula, no one included the light speed in the derivation part. In my research article, when there is inclusion of the light source speed in the derivation parts, If the light speed and the light source speed are in the same direction, then the light speed adds the source speed, and if the light speed and the light source speed are in the opposite direction, then the light speed subtracts the source speed, and then derives a theory and resolves this problem. So, the Michelson-Morley experiment appeared to have a problem and the experimental and theoretical paths do not match. When we take in the light source speed, then our theoretical and experimental data match. According to my research, the Michelson-Morley experiment is not applicable for measuring the existence of ether, and it is also not applicable to measuring the velocity of light, whether it is dependent or independent. It shows that the velocity of light is dependent and not the same for all observers.

According to my research article, the velocity of light is different in different frames. Thus, the velocity of light is not constant for all observers. Hence, Einstein's Special Relativity is proof wrong. Now that we think about the experiment, the velocity of light is independent, which is not true. Because of the theory,

the relative motion concept is used, and the light fringe is not shifted, which satisfied the Michelson-Morley experiment. So the light speed is dependent there. Then the theory and experiment will match each other. For this measurement, we required an in-order theory or experiment to check whether this type of velocity of light is actually dependent or independent.

1. I don't know why the aether exists, but something is maybe exiting the universe like the aether. But I am sure that for the propagate of light is required medium its may be not necessary maybe. In the future, if we find the like aether medium in any space and remove the like aether from the space, then we will see the like black body. In this region, we see the light go when it reaches the region; the light doesn't cross the region, and the light stops. It is more interesting and magical.
2. The postulate of the special theory of relativity in the first inertial frame of reference for the physics phenomenon is the same. That is true, but the second postulate is that the is that the speed of light is constant for all observers. That does not prove the Michelson-Morley experiment that the light speed is constant, according to my research article, but it is also true that the light speed is constant, so we are required to do another set of experiments to solidly prove that the light speed is dependent or independent.
3. When a light source is in motion relative to an observer, the observed frequency of the light changes. If the source is moving away from the observer, the observed frequency decreases, leading to a shift towards the red end of the spectrum known as Redshift. Conversely, if the source is moving towards the observer, the observed frequency increases, resulting in a shift towards the blue end of the spectrum, known as blueshift. According to this the speed of light is not dependent. Hence its match with this research article.

### **Conclusion**

It is interesting to note that the Michelson-Morley experiment is often cited as a classic example of a null experiment, where the expected outcome is not observed. In this case, the experiment found a null result. The main goal of the theory is to explain the null result obtained by the Michelson-Morley experiment, which does not include the speed of the light source in its derivation sections. When the speed of the light source is accounted for in these sections, the theoretical value matches the experimental value. Therefore, we were able to confirm the null result of the Michelson-Morley experiment. Moreover, the experiment was unable to detect the presence of aether in the universe for the light beam that required a medium like aether to propagate. The experiment's conclusion does not suggest that the velocity of light is independent; it concludes that the velocity of light is relative and depends on different observers in different frames. It is worth noting that in the future, we may require other theories and experiments to determine whether the speed of light is dependent or independent. It is also important to mention that light is not required to have a medium for propagation. By applying a detailed analysis to the Michelson-Morley experiment with the Light Speed, we find not only that ether does not exist but also that the speed of light cannot be constant.

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