

Michelson- Morley experiment: A misconceived & misinterpreted experiment

Mohammad Shafiq Khan

H. No. 49, Al-Farooq Colony, Rawalpura, Srinagar, Kashmir- 190005, India
shafiqifs@gmail.com

Abstract

A thorough review of the Michelson-Morley experiment reveals that the experiment had been not only misinterpreted but also misconceived. Under the theory & methodology adopted by Michelson & Morley the reasons of misconception and misinterpretation have been found to be: 1. Doppler Effect of light was not taken into account and 2. The motion of the solar system was not also taken into account. Since this experiment formed the basis of misinterpretation of absence of luminiferous ether in the space and as the consequence of absence of luminiferous ether the concept of length contraction in the direction of motion, theories of relativity, space-time concept and big bang theory were adopted. The basis of all these theories and concepts is challenged. The present article is the detailed and corrected version of the article 'Ultimate Proof of Energy Theory of Matter & Cosmology' Mohammad Shafiq Khan (2010a) necessitated by the article 'Foundation of Theory of Everything; Non-living & Living Things' Mohammad Shafiq Khan (2010b). This article finally explains the Michelson-Morley experiment.

Keywords: Michelson - Morley Experiment, time-frame, luminiferous ether, recessional velocity, blue-shifting, red-shifting, anisotropy, Lorentz symmetry

Introduction

In the article Mohammad Shafiq Khan (2010b) it is stated that the article Mohammad Shafiq Khan (2010a) should be considered for its contents wherein it was suggested that the Michelson-Morley experiment was misinterpreted for concluding the absence of luminiferous ether as the Doppler Effect was not taken into account. This article describes that the said experiment had been not only misinterpreted but also misconceived to conclude the absence of luminiferous ether. To understand this article readers are supposed to have thoroughly studied the articles 'The Relative Motion of the Earth and the Luminiferous Ether' (1881) by Albert Abraham Michelson, 'On the Relative Motion of the Earth and the Luminiferous Ether' (1887) by Albert Abraham Michelson & Edward Morley, Mohammad Shafiq Khan (2010b), and 'Energy Theory of Matter & Cosmology' Mohammad Shafiq Khan (2010c).

The history, background and consequences of Michelson-Morley experiment are very well-known and as such need not be discussed herein. In this article the conclusions drawn from 'null' result of the said experiment are challenged on the same premises on which the conclusion about the absence of the luminiferous ether was drawn. Article Mohammad Shafiq Khan (2010b) describes the foundation of a theory which challenges the physics which evolved during the twentieth century and since the basis of twentieth century physics is the 'null' result of Michelson-Morley experiment and the evidence that the said experiment was misconceived and misinterpreted would indirectly substantiate the theory put forward under the article Mohammad Shafiq Khan (2010b).

How Michelson - Morley experiment was Misconceived & Misinterpreted

The perusal of the articles Albert Abraham Michelson (1881) and Albert Abraham Michelson and Edward Morley (1887) would reveal that only the orbital motion of earth was considered as rotational motion of the earth and the orbital & recessional motion of the solar system were not considered for drawing the conclusion. To clarify this fact a para from the article Albert Abraham Michelson and Edward Morley (1887) is reproduced as follows

'In what precedes, only the orbital motion of the earth is considered. If this is combined with the motion of the solar system, concerning which but little is known with certainty, the result would have to be modified; and it is just possible that the resultant velocity at the time of the observations was small though the chances are much against it. The experiment will therefore be repeated at intervals of three months, and thus all uncertainty will be avoided'.

A serious lapse had been committed by Michelson in the experiment concluded and reported under article Albert Abraham Michelson (1881); which had been aptly pointed out by H. A. Lorentz. This serious lapse could be easily understood by below reproduced para of the article Michelson and Edward Morley (1887);

'In deducing the formula for the quantity to be measured, the effect of the motion of the earth through the ether on the path of the ray at right angles to this motion was over looked. The discussion of this oversight and of the entire experiment forms the subject of a very searching analysis by H. A. Lorentz, who finds that this effect can by no means be disregarded. In consequence, the quantity to be measured had in fact but one half the value supposed, and as it was already barely beyond the limits of errors of experiment, the conclusion drawn from the result of the experiment might well be questioned; since, however, the main portion of the theory remains unquestioned, it was decided to repeat the experiment with such modifications as would insure a theoretical result much too large to be masked by experimental error'.

Now then the final picture of the experiment; as described by Michelson-Morley; could be represented by the Fig.1. Since readers are supposed to have studied the article Albert Abraham Michelson (1881) and Michelson and Edward Morley (1887) thoroughly as such Fig.1 & experimental set-up would require no description. However it be borne in mind that in the calculations which follow it is presumed that ether exists in space and the light propagates in ether with a constant velocity 'c' with respect to the ether at rest. Also the instrument which includes mirrors M_1 & M_2 and semi-silvered mirror/point of interference are in motion with respect to ether with a velocity v .

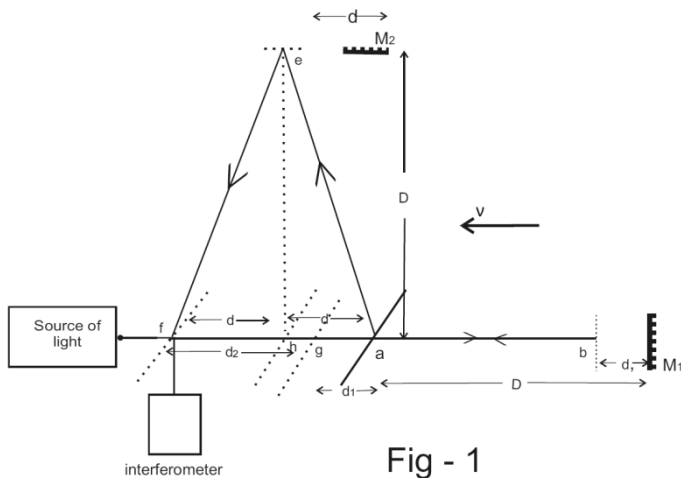


Fig - 1

Let t_1 be time required for propagation of light from 'a' to 'b' and let d_1 be the distance the mirror M_1 travels during the time t_1 (Since mirror M_1 is moving toward the position 'a' and d_1 is the distance mirror M_1 moves with respect to ether at rest during the period light pulse reaches the position 'b')

$$ct_1 = D - d_1 \dots \dots \dots (1)$$

Since the instrument moves in ether with a velocity v

$$d_1 = vt_1 \dots \dots \dots (2)$$

$$ct_1 = D - vt_1$$

$$t_1 = \frac{D}{c + v} \dots \dots \dots (3)$$

$$d_1 = \frac{Dv}{c + v} \dots \dots \dots (4)$$

Similarly t_2 be time required for propagation of light from 'b' to 'f' and let d_2 be the distance semi-silvered mirror travels during the time t_2 ; d_2 is distance traveled by semi-silvered mirror with respect to ether at rest during the period light pulse moves from position 'b' to 'f'

Then

$$ct_2 = D + d_2 \dots \dots \dots (5), \quad d_2 = vt_2 \dots \dots \dots (6)$$

$$t_2 = \frac{D}{c - v} \dots \dots \dots (7) \quad \text{Hence} \quad d_2 = \frac{Dv}{c - v} \dots \dots \dots (8)$$

Let 'd' be the distance mirror M_2 moves during the period the light propagates from 'a' to the mirror M_2 and the time be denoted by t

$$ct = \sqrt{D^2 + d^2} \dots \dots \dots (9), \quad d = vt \dots \dots \dots (10)$$

$$t = \frac{D}{\sqrt{c^2 - v^2}} \dots \dots \dots (11) \quad d = \frac{Dv}{\sqrt{c^2 - v^2}} \dots \dots \dots (12)$$

The distance traversed by the light in the direction of the earth's motion to arrive at the point of interference is $D - d_1 + D + d_2$

$$D - d_1 + D + d_2 = 2D + d_2 - d_1$$

$$\begin{aligned} &= 2D + \frac{Dv}{c - v} - \frac{Dv}{c + v} \\ &= 2D + \frac{2Dv^2}{c^2 - v^2} \\ &= \frac{2Dc^2}{c^2 - v^2} \\ &= \frac{2D}{1 - \frac{v^2}{c^2}} \\ &= 2D\left(1 - \frac{v^2}{c^2}\right)^{-1} \\ &= 2D\left(1 + \frac{v^2}{c^2}\right) \dots \dots \dots (13) \end{aligned}$$

neglecting the terms of fourth & higher order as Michelson & Morley had done.

The distance traversed by the light in the perpendicular direction to the earth's motion to arrive at the point of interference is $2\sqrt{D^2 + d^2}$

$$\begin{aligned} 2\sqrt{D^2 + d^2} &= 2\sqrt{D^2 + \frac{D^2 v^2}{c^2 - v^2}} \\ &= 2\sqrt{\frac{D^2 c^2}{c^2 - v^2}} \\ &= 2\frac{D}{\sqrt{1 - \frac{v^2}{c^2}}} \dots \dots \dots (14) \\ &= 2D\left(1 - \frac{v^2}{c^2}\right)^{-\frac{1}{2}} \\ &= 2D\left(1 + \frac{1}{2}\frac{v^2}{c^2}\right) \dots \dots \dots (15) \end{aligned}$$

neglecting the terms of fourth and higher order.

From equation (13) and (15) we deduce that the difference of the distances traversed by light in the two arms of the experiment is $D\frac{v^2}{c^2}$. Evidently the distance traversed by light in the arm of the experiment along the direction of motion of instrument is higher by $D\frac{v^2}{c^2}$.

The time taken by the light pulse in traversing the vertical arm is $2t$; so

$$2t = 2\frac{D}{c\sqrt{1 - \frac{v^2}{c^2}}} \dots \dots \dots (16)$$

The time taken by the light pulse in traversing the horizontal arm is $t_1 + t_2$

$$t_1 + t_2 = \frac{D}{c+v} + \frac{D}{c-v}$$

$$t_1 + t_2 = 2 \frac{Dc}{c^2 - v^2}$$

$$t_1 + t_2 = \frac{2D}{c(1 - \frac{v^2}{c^2})} \dots\dots\dots(17)$$

neglecting the terms of fourth and higher order; we could write (16) and (17) as

$$2t = \frac{2D}{c} (1 + \frac{1}{2} \frac{v^2}{c^2}) \dots\dots(18) \quad t_1 + t_2 = \frac{2D}{c} (1 + \frac{v^2}{c^2}) \dots\dots(19)$$

Evidently the time taken by light pulse in traversing the horizontal arm is more by $\frac{Dv^2}{c^3}$. So far the calculations of

the Michelson-Morley experiment match with the calculations in this article.

The reason of misconception and misinterpretation of Michelson-Morley experiment had been that without measuring the actual distances traversed by the light pulses in the two arms of the experiment; before the two light pulse were allowed to interfere; and without measuring the actual time taken by the light pulse in traversing the two arms of the experiment the inference was drawn that the time taken by the light pulse in traversing the two arms of the experiment is same and also the distances traversed by the light pulse in traversing the two arms of the experiment is same as the consequence of the 'null' result of the shift of the interference fringes; when the instrument is revolved through 90° without considering the Doppler Effect. It needs no over-emphasis that Doppler Effect had to be taken into consideration before drawing any conclusion. Now then if it is shown that notwithstanding the differences in the distances and time taken by the light pulses in traversing the two arms of the experiment; before these were allowed to interference; there had to be no shift of the interference fringe when the instrument is revolved through 90° after taking the Doppler Effect into consideration; that should leave no doubt that the Michelson-Morley experiment was misconceived and misinterpreted. In what follows is to show that the experiment was misconceived and misinterpreted which even an under-graduate student of physics can understand. Let us consider the propagation of the light pulse in the two arms of the instrument separately (Fig.2). As the light pulse moves from 'a' (semi - silvered mirror) towards the mirror M_1 and by the time it reaches the mirror M_1 the mirror moves to the position 'b' at a distance ' d_1 ' from the original position of the Mirror M_1 . Assuming that there is luminiferous ether and light propagates at a fixed velocity ' c ' with respect to the luminiferous ether. Since light moves with a defined velocity ' c ' with respect to the ether at rest and since the mirror M_1 is moving towards the point 'a' so the mirror M_1 will observe the

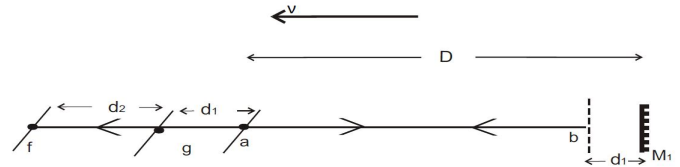


Fig - 2

light as blue-shifted according to the Doppler Effect. By the time light pulse reaches mirror M_1 the point 'a' will shift to the position 'g' which is at a distance ' D ' from the position 'b' of the mirror M_1 . As the light pulse is reflected from the mirror M_1 from the position 'b' and by the time the light pulse reaches the point of interference the point 'a' reaches the position 'f' at a distance ' d_2 ' from the position 'g'. Since the ether is supposed to be at rest and light moves with respect to ether with a velocity ' c ' the point of interference is receding from the point 'b' with a velocity ' v ' thus according to the Doppler effect the light will be observed to the red-shifted as it reaches the point 'f'. Let the total number of waves which the light will have to traverse to reach the point 'f' be N_H .

$$N_H = \frac{D - d_1}{\lambda_{BS}} + \frac{D + d_2}{\lambda_{RS}} \dots\dots\dots(20)$$

Where λ_{BS} is the wavelength of the blue-shifted light due to the approaching motion of the receiver mirror M_1 with the velocity v . and λ_{RS} is the wavelength of the red-shifted light due to the receding motion of the receiving point (point of interference) with the velocity ' v '. Let λ_0 be the wavelength of the same light as observed by the observer who is at rest with respect to the ether. The Doppler Effect; as was & is known presently in non-relativistic physics; had to be taken into account and the change in wave-length is given as follows:

$$\lambda_{BS} = \frac{\lambda_0}{1 + \frac{v}{c}} \dots\dots\dots(21)$$

$$\lambda_{RS} = \frac{\lambda_0}{1 - \frac{v}{c}} \dots\dots\dots(22)$$

$$N_H = \frac{D - d_1}{\frac{\lambda_0}{1 + \frac{v}{c}}} + \frac{D + d_2}{\frac{\lambda_0}{1 - \frac{v}{c}}}$$

$$N_H = \frac{D - \frac{Dv}{c+v}}{\frac{\lambda_0}{1 + \frac{v}{c}}} + \frac{D + \frac{Dv}{c-v}}{\frac{\lambda_0}{1 - \frac{v}{c}}}$$

$$N_H = \frac{Dc}{c+v} \times \frac{c+v}{\lambda_0} + \frac{Dc}{c-v} \times \frac{c-v}{\lambda_0}$$

$$N_H = \frac{D}{\lambda_0} + \frac{D}{\lambda_0} = 2 \frac{D}{\lambda_0} \dots\dots\dots(23)$$

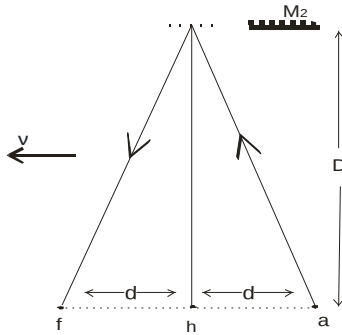


Fig. - 3

point 'a' towards the mirror M_2 and also the receding motion is involved when the light pulse is reflected from mirror M_2 as it proceeds towards the point 'f'; the point of interference (Fig.3). As the light pulse proceeds from point 'a' to the mirror M_2 which is at a distance 'D'; the light pulse traverses not the distance 'D' but actually traverses the

distance $\frac{D}{\sqrt{1-\frac{v^2}{c^2}}}$; which is more than 'D'. Hence a receding

motion is involved while the light pulse traverses from 'a' to the mirror M_2 and also during the time the same light pulse is reflected from the mirror M_2 till the light pulse reaches point 'f'; the point of interference.

Additional distance traversed by the light pulse while moving from 'a' to M_2 or M_2 to 'f'

$$= \frac{D}{\sqrt{1-\frac{v^2}{c^2}}} - D$$

Time period over which the additional distance is traversed

$$= \frac{D}{c\sqrt{1-\frac{v^2}{c^2}}}$$

$$\text{Velocity of receding} = \frac{\text{Additional Distance}}{\text{Time Period over which the additional distance is traversed}} = \frac{\frac{D}{\sqrt{1-\frac{v^2}{c^2}}} - D}{\frac{D}{c\sqrt{1-\frac{v^2}{c^2}}}}$$

$$= c - c\sqrt{1-\frac{v^2}{c^2}} \\ = c - c\left(1 - \frac{1}{2}\frac{v^2}{c^2}\right)$$

neglecting the terms of fourth & higher order.

$$\text{Velocity of receding} = \frac{1}{2}\frac{v^2}{c} \dots\dots\dots(24)$$

Velocity of receding while the light pulse propagates from the mirror M_2 towards the point 'f' is the same.

Accordingly the light pulse, while it traverses in the arm perpendicular to the direction of the movement of the instrument, is also red-shifted because of the receding

velocity of $\frac{1}{2}\frac{v^2}{c}$. Thus the wavelength of the light in this

arm of the instrument is red-shifted and let λ_{VRS} be the wavelength of the red-shifted light.

$$\text{Now } \lambda_{VRS} = \frac{\lambda_0}{1 - \frac{1}{2}\frac{v^2}{c^2}} \dots\dots\dots(25)$$

Thus the number of waves which the light will have to traverse in the vertical arm say N_V

$$N_V = \frac{\text{Distance traversed}}{\text{wavelength}}$$

Distance traversed is given by equation (14)

$$N_V = \frac{2D}{\lambda_0 \left(1 - \frac{1}{2}\frac{v^2}{c^2}\right)} \quad N_V = \left(\frac{2D}{\sqrt{1-\frac{v^2}{c^2}}}\right) \times \left(\frac{1 - \frac{1}{2}\frac{v^2}{c^2}}{\lambda_0}\right)$$

Equating $\left(1 - \frac{1}{2}\frac{v^2}{c^2}\right)$ to $\sqrt{1-\frac{v^2}{c^2}}$ after neglecting the terms of fourth & higher order.

$$N_V = \frac{2D}{\lambda_0} \dots\dots\dots(26)$$

We deduce from equation (23) and (26) that whatever be the distances traversed by the light pulses and whatever be the time taken by the light pulses in traversing the two arms of the instrument before the light pulses interfere; the light pulses have to traverse the same number of waves in the two arms of the instrument. When the instrument is revolved through 90° the number of waves would remain the same and as such there could not be any shift in the interference fringes. Thus when we take Doppler Effect into consideration there had to be 'null' result of the experiment despite the fact that there is difference in the time taken by the light pulses in traversing the two arms of the instrument and also despite the fact there is the difference in the distance traversed by the light pulses while traversing the two arms of the instrument according to theory and methodology of Michelson & Morley. This should be sufficient to show that Michelson-Morley experiment was misconceived and misinterpreted to conclude the absence of the luminiferous

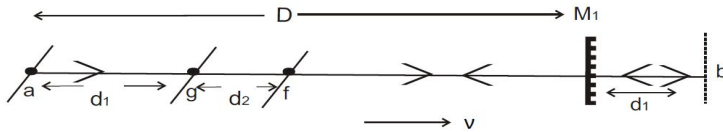


Fig - 4

ether. However, Fig.4 & Fig. 5 and calculations would reveal that the result of the experiment would remain the same when the movement of the instrument with respect to the luminiferous ether is reversed.

$$d_1 = vt_1 = \frac{Dv}{c-v} \dots\dots(27) \quad d_2 = vt_2 = \frac{Dv}{c+v} \dots\dots(28)$$

The distance traversed by light pulse from point 'a' to 'b' is $D+d_1$ while the light pulse is red-shifted as the mirror M_1 is moving away and similarly the distance traversed by the light pulse after it is reflected is $D-d_2$ and during this travel light pulse is blue-shifted. Thus number of waves which the light pulse has to traverse in this arm of the instrument .

$$N_H = \frac{D+d_1}{\lambda_{RS}} + \frac{D-d_2}{\lambda_{BS}}$$

$$N_H = \left(\frac{D + \frac{Dv}{c-v}}{\frac{\lambda_0}{1 - \frac{v}{c}}} \right) + \left(\frac{D - \frac{Dv}{c+v}}{\frac{\lambda_0}{1 + \frac{v}{c}}} \right)$$

$$N_V = \frac{2D}{\lambda_0} \dots\dots\dots(29)$$

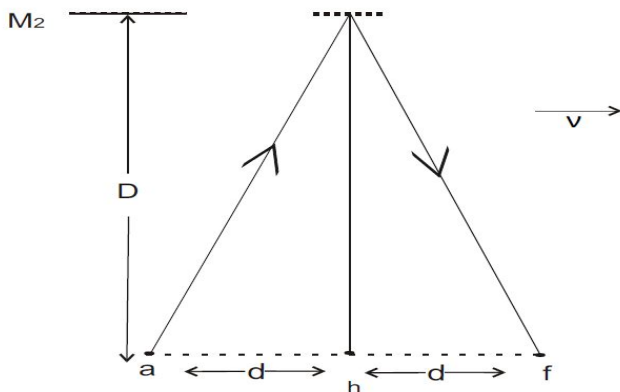


Fig. - 5

Here also the formulae (24) (25) and (26) would apply

$$N_V = \frac{2D}{\lambda_0}$$

Hence even then there has to be the 'null' result of the experiment. This condition will arise when the experiment is repeated after six months when the direction of motion of the instrument is reversed due to the position of the earth.

There is one more aspect which is being considered probably again for the first time in the history of Michelson-Morley experiment which needs to be taken into account to finally decide upon the Michelson-Morley experiment. This aspect concerns the distances traversed by light pulses in the horizontal and vertical arms from the semi-silvered mirror to the point of the interference. The horizontal light pulse travels the distance of d_1+d_2 from the original position of the semi-silvered mirror when it interferes with the vertical light pulse; whereas the vertical pulse travels the (horizontal) distance of $2d$ from the original position of the semi-silvered mirror when it interferes with the vertical light pulse.

$$d_1 + d_2 = vt_1 + vt_2$$

$$d_1 + d_2 = \frac{Dv}{c+v} + \frac{Dv}{c-v} = \frac{2Dvc}{c^2 - v^2} \dots\dots\dots(30)$$

$$2d = \frac{2Dv}{\sqrt{c^2 - v^2}} \dots\dots\dots(31)$$

Equation (30) & (31) could be written also as

$$d_1 + d_2 = \frac{2Dv}{c} \times \frac{1}{1 - \frac{v^2}{c^2}} \dots\dots\dots(32)$$

$$2d = 2 \frac{Dv}{c} \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} \dots\dots\dots(33)$$

Evidently $d_1 + d_2 > 2d$

$$d_1 + d_2 - 2d = \frac{2Dv}{c} \left[\frac{1}{1 - \frac{v^2}{c^2}} - \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} \right]$$

$$= 2 \frac{Dv}{c} \left(1 + \frac{v^2}{c^2} - 1 - \frac{1}{2} \frac{v^2}{c^2} \right)$$

neglecting the terms of fourth & higher order.

$$d_1 + d_2 - 2d = D \frac{v^3}{c^3}$$

This is the ultimate dependence of the shift of interference fringes on the velocity of the earth. Now according to the calculations of the Michelson & Morley the

difference of distances is $D \frac{v^2}{c^2}$ which corresponds to the

$\frac{4}{100} = .04$ of the distance between interference fringes of

the yellow light but actually the difference is $D \frac{v^3}{c^3}$ which

would correspond to $\frac{4}{100000} = .000004$ of the distance

between interference fringes which in no case could have been detected at the time. Detection of shift in the interference fringes to this extent is being detected presently with highly accurate and sophisticated Michelson-Morley experimental instruments. Factually this fringe shift is negligible and we may safely conclude that the 'null' result of the Michelson-Morley experiment is actually the evidence of the existence of the luminiferous ether.

Recall equation (23) and (26) the number of wavelengths which the two light pulses travel before they interfere is independent of the velocity of the earth and these only depend on the wavelength of the light and the lengths of the arms. So the future experiments like Kennedy-Thordike experiment (1932) and later experiments using lasers and masers which have been misinterpreted as the proof of the theory of relativity; actually confirm the existence of the luminiferous ether.

Recall equations (14) and (16)

The distance traversed and time taken by the light pulse in the vertical arm is

$$\text{Distance} = \frac{2D}{\sqrt{1 - \frac{v^2}{c^2}}} \dots (34)$$

$$\text{Time} = 2t = \frac{2D}{c\sqrt{1 - \frac{v^2}{c^2}}} \dots (35)$$

Similarly recall the equations (13) and (19) which gives the distance traversed by the light pulse and time taken by the light pulse in the horizontal arm

$$\text{Distance} = \frac{2D}{1 - \frac{v^2}{c^2}} \quad \text{Time} = t_1 + t_2 = \frac{2D}{c\left(1 - \frac{v^2}{c^2}\right)}$$

Since the 'null' result of the Michelson-Morley experiment was misinterpreted to conclude that there is no difference of time or distances while the light pulse traverses in the two arms of the experiment, it was proposed by the Lorentz & FitzGerald that the experiment could be explained only if we assume that there is length contraction in the direction of motion

by a factor of $\sqrt{1 - \frac{v^2}{c^2}}$. Thus in the above equations (horizontal arm distance traversed and time taken) we have

to replace D by $D\sqrt{1 - \frac{v^2}{c^2}}$ then these equations would be;

$$\text{Distance} = \frac{2D}{\sqrt{1 - \frac{v^2}{c^2}}} \quad \text{Time} = t_1 + t_2 = \frac{2D}{c\sqrt{1 - \frac{v^2}{c^2}}}$$

These equations now equate with equations (34) and (35)

Now if we assume that there is no luminiferous ether and the velocity of light is 'c' irrespective of the motion of the source and the observer. Then if 2D is the distance light pulse has to traverse with the contraction already included, then actual distance between the point 'a' and the mirror

$$M_1 \text{ is } \frac{D}{\sqrt{1 - \frac{v^2}{c^2}}}. \text{ Thus the actual distance traversed by the}$$

$$\text{light pulse in the horizontal arm is } \frac{2D}{\sqrt{1 - \frac{v^2}{c^2}}} \text{ and accordingly}$$

$$\text{the time taken is } \frac{2D}{c\sqrt{1 - \frac{v^2}{c^2}}} \text{ which exactly matches with}$$

equation (34) and (35). This being one of the strange coincides and the second coincidence was that Woldemar Voigt in the same year i.e. 1887 proved mathematically that the D'Alembert's wave-equation of space and time dependent scalar wave function is not invariant under Galilean transformation and he arrived at a transformation in

which there is a factor of $\sqrt{1 - \frac{v^2}{c^2}}$ of space contraction and

time dilation. The solution arrived by Voigt later on became the Lorentz transformation on the basis of the 'null' result of the Michelson-Morley experiment wherein it was concluded that there is no luminiferous ether and accordingly the velocity of light had to be treated as constant 'c' irrespective of the relative motion of the source and the observer. In absence of the luminiferous ether; for which the misinterpretation of Michelson-Morley experiment served as the basis; there was no alternative but to adopt the space contraction and invariability of velocity of light irrespective of the relative motion of the source and the observer as the intrinsic characteristic of light. When these two concepts are applied to the transformation between two coordinate systems in uniform relative motion; the outcome is the time dilation. To demonstrate this let us consider the Galilean transformation between two coordinate systems in uniform relative motion; we will consider only the transformation of the space coordinates

$$x' = x - vt$$

Let the time of the two coordinate systems be t and t'

Adopting the space-contraction

$$x' = \gamma(x - vt) \dots (36)$$

Adopting the invariability of velocity of light

$$x' = ct' \text{ and } x = ct$$

Equation (36) could now be written as

$$ct' = \gamma(ct - vt)$$

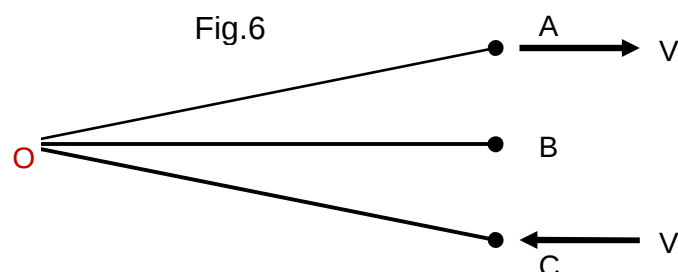
$$t' = \gamma\left(1 - \frac{v}{c}\right)t \quad \text{or} \quad t' = \gamma\left(t - \frac{v}{c^2}x\right) \dots (37)$$

Thus time dilation is the outcome of the adoption of the space contraction and the invariability of velocity of light as Woldemar Voigt's mathematical solution had predicted.

But in absence of the luminiferous ether the concepts of space contraction in the direction of motion and invariability of velocity of light as the intrinsic characteristic of light were adopted despite these concepts were illogical, irrational and against all known science even at the time.

Logically, the experimental measurement of refractive indices of different transparent materials loudly and clearly reveals that the velocity of light does depend upon the medium and cannot be intrinsic characteristic of light.

Let there be source of light O and there be three observers A, B and C with the instruments for measurement of wavelength of the light they receive. Without any reference to the existence of the luminiferous ether, the three observers be such that the observer A is in receding motion with respect to the source of light O with a velocity 'v', the observer B be at rest with respect to the source of light O and the observer C be in approaching motion with respect to the source of light O with a velocity v. Now according to the Lorentz transformation the space between O & A and O & C is contracted whereas there is no effect on the space between O & B. This suggested that almost the same space is contracted and the same space, between O & B, is not contracted. This evidently is illogical and seems to be absurd on the face of it.



Keeping in view the Fig.6 consider the very well known experimentally and theoretically studied Doppler Effect. It should be borne in mind that Hubble observations are simply the experimental measurements of the Doppler Effect. Now according to the Lorentz transformation the space is contracted when the observer is approaching or receding. In classical physics as well as in the modern physics including relativistic physics light is known to be a wave phenomenon. Since space is contracted due to the approaching or receding motion of the observer with respect to the source of light so the waves should get contracted and thus the wavelength should be reduced. Hence according to the Lorentz transformation light should be blue-shifted whether the observer is approaching or receding the source. This is against all the experimental observations of the Doppler Effect especially Hubble observations wherein only red-shifting have been observed; if we presume that red-shifting is not due to expansion of space which shall be shown in this article. Thus the concept of space contraction in the direction of motion cannot be correct.

Consider the same Fig.6. There is the same source of light, same space and same types of instruments with observers A, B & C and the only difference is the relative

motion of the observers with respect to the source. It will be illogical and irrational to even imagine that the difference in the relative motion of the instruments with respect to the source could change the wavelength of the light being emitted by the source or the relative motion of the source and the observers could affect the space. There has to be something intrinsic to the instruments which changes due to the relative motion of the instruments and the source of light as the result of which the wavelength of the same light is observed to be different. That is exactly what the theory put forward in the article Michelson and Edward Morley (1887) has established. Due to the relative motion of the source and the observer; which would cause difference in motion of the observer with respect to the ether; which being the cause of the difference in the time frame of the observer.

Michelson and Morley in no case, should have ignored the motion of the solar system about which little was known at that time, as honestly conceded by them. Thus even the misconceived and misinterpreted conclusions of the Michelson-Morley experiment had to be provisional till everything about the motion of the solar system was known. Michelson and Morley had decided that the effects of the motion of the solar system could be neglected if the experiment is repeated at the intervals of three months and if there is no effect on the result of the experiment. But this decision of Michelson & Morley; as will be explained; is one of the fundamental errors in the theory & methodology adopted. A thorough review of the Michelson-Morley experiment would not be complete if we do not consider the motion of the solar system. As established in the article Michelson and Edward Morley (1887) and also proved in this article that the circular motion of the earth could not result in any considerable shift of the interference fringes when the instrument is revolved by 90° .

Now let us consider the situation when the instrument is aligned in the direction of the motion of the solar system. The formulae and the principles will remain the same and the mathematical deductions would also remain the same when we considered the orbital motion of the earth. As we have seen that according to the Michelson & Morley the difference of the distances traversed by the light pulses

before they interfere is $D \frac{v^2}{c^2}$ whereas the actual difference

of the distances as worked out in this article is $D \frac{v^3}{c^3}$.

According to the calculations of the Michelson & Morley there should have been the shift of 0.04 interference fringes of the yellow light when the instrument is revolved by 90° whereas actually according to this article there could be the shift of .000004 interference fringes. But since the solar system is by now known to be revolving around the centre of the galaxy with an orbital velocity of about 7.3 times than the orbital velocity of the earth around the sun. Thus the shift of the interference fringes when the instrument is aligned in the direction of the motion of the solar system would be $(7.3)^3 = 390$ times that what we have worked out while we have considered the orbital motion of the earth. Thus the highest shift of the interference fringes could be 0.0015 (for yellow

light) when the instrument is aligned in the direction of the motion of the solar system. Hence the shift of the interference fringes would vary from 0.000004 to 0.0015 (for yellow light) depending upon the alignment of the instrument with respect to the motion of solar system at the time of the experiment. Thus the result of the experiment would depend upon the position of the place on earth where the experiment is undertaken.

The Michelson-Morley experiment has been repeated since 1887 and every time there had been improvement in the quality of light (anisotropy) and instrumentation but the results fall within the range as predicted in this article by a strange coincidence. In the absence of luminiferous ether, these studies are made under the context of violation of the Lorentz symmetry and anisotropy of space.

In the article Mohammad Shafiq Khan (2010a) the same mistake was committed which Michelson had committed in his explanation of the 1881 experiment. Besides I had arrived at the same conclusion as in this article; but with the help of very crude calculations wherein d , d_1 and d_2 were not taken into account but only the Doppler Effect was taken into account.

Finally I could not think of any other simpler way of showing that Michelson-Morley experiment was misconceived and misinterpreted which even an undergraduate student of physics can understand without any difficulty.

Experimental & Theoretical Evidences

Even under the methodology & theory adopted by Michelson & Morley; which will be shown to be incorrect there are sufficient experimental & theoretical evidences which favour the thesis put forward in this article and which also confirm that Michelson-Morley experiment was misconceived and misinterpreted. Since the difference of distances traversed by light pulse in two arms of Michelson-Morley instrument, if we presume luminiferous ether in the space according to the

Michelson & Morley is $D \frac{v^2}{c^2}$

and when the instrument is revolved by 90° there should be shift in the interference

fringes by $2D \frac{v^2}{c^2}$ fringes.

Now according to the thesis of this article there could be shift

in the interference fringes to the extent of $2D \frac{v^3}{c^3}$. Now

when we presume that the instrument is aligned in the plane which is perpendicular to the movement of solar system; then we have to consider only the orbital motion of the earth. Thus the ratio of expected shift of interference fringes under

Michelson & Morley and thesis of this article is $\frac{2D \frac{v^2}{c^2}}{2D \frac{v^3}{c^3}} = \frac{c}{v}$

where v is the velocity of the earth. Thus this ratio is 10,000. This has to be the highest possible ratio. Now consider the position when the instrument is aligned along the motion of the solar system. In this case the difference of distances traversed by the light pulse in the two arms of the

experiment is $2D \frac{v_s^3}{c^3}$ (v_s is the velocity of solar system)

whereas according to the Michelson & Morley the difference is

again the same $2D \frac{v^2}{c^2}$ (v is the velocity of earth). Thus this

ratio would be $\frac{v^2 c}{v_s^3}$. Since the solar system is known to be

revolving around the centre of the galaxy with an orbital velocity which is about 7.3 times the orbital velocity of the

earth, hence the ratio would be $\frac{c}{(7.3)^3 c} = \frac{10000}{390} \approx 25$.

Thus the ratio would vary from 25 to 10,000 depending upon the position of the place of the experiment on the earth. Following table gives this ratio in respects of Michelson-Morley experiments conducted up to 1930.

Table I (the erratic experiments of Miller has been excluded and only the easily available experimental results on internet have been quoted)

Name	Location	Year	Fringe shift expected	Fringe shift measured	Ratio
Michelson and Morley	<u>Cleveland</u>	1887	0.4	< 0.02 or ≤ 0.01	40
Morley and Miller	<u>Cleveland</u>	1902-1904	1.13	≤ 0.015	80
Miller	<u>Cleveland</u>	1923-1924	1.12	≤ 0.03	40
Miller (sun light)	<u>Cleveland</u>	1924	1.12	≤ 0.014	80
Kennedy	<u>Pasadena/Mt. Wilson</u>	1926	0.07	≤ 0.002	35
Piccard & Stahel	with a <u>Balloon</u>	1926	0.13	≤ 0.006	20
Piccard & Stahel	<u>Brussels</u>	1927	0.13	≤ 0.0002	185
Piccard & Stahel	<u>Rigi</u>	1927	0.13	≤ 0.0003	185
Michelson et al.	<u>Mt. Wilson</u>	1929	0.9	≤ 0.01	90
Joos	<u>Jena</u>	1930	0.75	≤ 0.002	375

The perusal of the Table 1 would reveal that the thesis of this article is confirmed by the experimentation spread over about half a century.

Since last a few decades; in absence of the luminiferous ether; these studies are made under the context of misconceived anisotropy of space. The experimental results under the anisotropy of space are also consistent with the thesis of this article. Working out the exact correlation between the experimental results of experiments conducted under anisotropy of space is irrelevant and beyond the scope of this article. However the misconceived anisotropy

of space has to be proportional to $\frac{v^3}{c^3}$ which is of the order

of 10^{-12} which; coincidentally; being the experimental observations. This should be sufficient experimental evidence for misconception & misinterpretation of Michelson-Morley experiment and existence of luminiferous ether under the methodology & theory adopted by Michelson & Morley.

Final explanation of Michelson experiment

Under the theory & methodology adopted by Michelson & Morley the Doppler Effect had to be taken into account the way non-relativistic Doppler Effect was and is presently known. Secondly the motion of the solar system also had to be taken into account.

In the article Mohammad Shafiq Khan (2010b) a transformation was derived between the ether at rest frame of reference and the reference frame which is in any uniform motion with respect to former frame of reference. Under that transformation there is absolutely no effect on any aspect of light/radiation when the moving reference frame is in uniform circular motion without any component of receding or approaching motion. Firstly Michelson and Morley should not have converted the orbital motion of earth into linear motion and worked out the calculations on that basis. This is basis of all the confusion created by Michelson-Morley experiment and this is the fundamental error in the theory & methodology of Michelson & Morley.

If we assume that sun is in the galaxy whose centre coincides with the centre of the universe and has no recessional component for the purpose of simplicity of explanation. The transformation derived in the article Mohammad Shafiq Khan (2010b) is

$$\vec{r}' = \vec{r} - \vec{v}t' \quad t' = \gamma t \quad \text{Where} \quad \gamma = \frac{1}{1 + \frac{\hat{c} \cdot \vec{v}}{c}}$$

Now for the circular motion the condition that $t'=t=0$ and the origins of two coordinate systems coincide cannot be applicable; hence for such the coordinate systems the transformation would be

$$\vec{r}' = \vec{r} - \vec{R} - \vec{v}t' \quad \& \quad t' = \gamma t$$

$\vec{R}$ being the radius of the coordinate system in circular motion.

Since for circular motion $\hat{c} \cdot \vec{v} = 0$; as $\hat{c}$ is the unit directional vector of light; source of which is at the origin of ether at rest frame of reference.

Hence the transformation would be

$$\vec{r}' = \vec{r} - \vec{R} - \vec{v}t' \quad \& \quad t' = t$$

Since the time-frame of the two coordinate systems is the same and as explained in article Mohammad Shafiq Khan (2010b) [4] no Doppler Effect would be called into play. For such circular motions we could for all practical purposes and for all calculations treat the ether at rest. Since the vertical as well the horizontal arms of the Michelson-Morley instrument have the same angular motion; Michelson & Morley should not have assigned uniform linear motion to

the instrument. This is true about the rotational motion of the earth also if the sun & the galaxy had no recessional motion. But since the solar system & the galaxy (of which sun is one the stars) are having the circular motion as well as recessional motion. For the component of the circular motion of the solar system we could safely assume ether to be at rest. The calculations done in this article are applicable to the recessional velocity of the solar system rather than the motion of the earth. It should be borne in mind that since the time-frame of all the components of the instrument and the earth is the same; hence though Doppler Effect will be called into play but it will not be detectable. But the velocity which is to be considered is the resultant recessional velocity of the solar system) & the galaxy (of which the sun is of the stars. Thus the results of the Michelson-Morley experiment which presently are being found with highly sophisticated instrumentation are concerning the resultant recessional velocity of the solar system & the galaxy (of which the sun is of the stars; which vary depending upon the position of the experiment on the earth and the alignment of the instrument with respect to the direction of the resultant recessional velocity.

The most important theoretical evidence in favour of the thesis of this article would be the invariance of the wave-equation in the ether at rest frame of reference and any other frame of reference which is in uniform motion with respect to the ether at rest frame of reference. The wave-equation in the ether at rest frame of reference is

$$c^2 \nabla^2 \psi = \frac{\partial^2 \psi}{\partial t^2}$$

In the article Mohammad Shafiq Khan (2010b) we have derived the transformation between two coordinate systems; (in spherical polar coordinates) one of which is at rest with respect to the ether at rest frame of reference and the other is moving with velocity $\vec{v}$ when the origins of the two coordinates are coinciding at $t = t' = 0$. The transformation is

$$\vec{r}' = \vec{r} - \vec{v}t' \dots \dots \dots (38)$$

$$t' = \gamma t \dots \dots \dots (39)$$

Where

$$\gamma = \frac{1}{1 + \frac{\hat{c} \cdot \vec{v}}{c}} \dots \dots \dots (40)$$

$\hat{c}$ being the unit directional vector of light, source of which is at the origin of the ether at rest frame of reference.

Evidently $\hat{c} \cdot \vec{v}$ is the recessional or approaching velocity of the reference frame. The spherical polar coordination have been adopted for derivation of transformation between the two coordinate systems in relative uniform motion (one of which is the absolute reference frame of ether at rest) because this is the most suitable coordinate system which describes the motion of the celestial objects. The transformation could be simply applied in two dimensions which in no case would be over-simplification. Assuming the conditions of $r \geq 0, 0 \leq \theta \leq 180^\circ$ and $0 \leq \phi \leq 360^\circ$ for

the radial coordinate, polar angle and azimuth angle respectively. The moving reference frame could be described in the spherical polar coordinates by assuming polar angle $\theta = 0^\circ$ wherein only radial coordinate r and azimuth angle ϕ are variables. Now *Laplacian* in spherical polar coordinates is

$$\nabla^2 = \frac{1}{r^2} \frac{\partial}{\partial r} \left(r^2 \frac{\partial}{\partial r} \right) + \frac{1}{r^2 \sin \theta} \frac{\partial}{\partial \theta} \left(\sin \theta \frac{\partial}{\partial \theta} \right) + \frac{1}{r^2 \sin^2 \theta} \frac{\partial}{\partial \phi^2}$$

Since $\theta = 0^\circ$

Hence

$$\nabla^2 = \frac{1}{r^2} \frac{\partial}{\partial r} \left(r^2 \frac{\partial}{\partial r} \right)$$

$$\text{Thus } \nabla^2 = \frac{\partial^2}{\partial r^2} + \frac{2}{r} \frac{\partial}{\partial r}$$

Thus wave equation in two dimensions with $\theta = 0$ could be written as

$$c^2 \nabla^2 \psi = c^2 \frac{\partial^2 \psi}{\partial r^2} + \frac{2c^2}{r} \frac{\partial \psi}{\partial r} = \frac{\partial^2 \psi}{\partial t^2} \dots\dots\dots(41)$$

Equation (38) could be written as after multiplying both sides by $\hat{c}$

$$\hat{c} \cdot \vec{r} = \hat{c} \cdot \vec{r} - \hat{c} \cdot \vec{v} \cdot t'$$

$$r' = r - \hat{c} \cdot \vec{v} \cdot t'$$

$$\partial r' = \partial r - \hat{c} \cdot \vec{v} \cdot \gamma \partial t$$

For any point in space which is observed with the help of light/radiation

$$r = ct \text{ so } \partial r = c \partial t$$

$$\partial r' = \partial r - \hat{c} \cdot \vec{v} \frac{\gamma}{c} \partial r$$

$$\partial r' = \left(1 - \frac{\hat{c} \cdot \vec{v}}{c} \cdot \frac{1}{1 + \frac{\hat{c} \cdot \vec{v}}{c}} \right) \partial r$$

$$\partial r' = \gamma \partial r \text{ and also } r' = \gamma r$$

Dividing both sides of equation (41) by γ^2

$$\frac{c^2}{\gamma^2} \frac{\partial^2 \psi}{\partial r^2} + \frac{2c^2}{\gamma^2 r} \frac{\partial \psi}{\partial r} = \frac{\partial^2 \psi}{\gamma^2 \partial t^2}$$

$$c^2 \frac{\partial^2 \psi}{(\gamma \partial r)^2} + \frac{2c^2}{\gamma r} \frac{\partial \psi}{\gamma \partial r} = \frac{\partial^2 \psi}{(\gamma \partial t)^2}$$

$$c^2 \frac{\partial^2 \psi}{\partial r'^2} + \frac{2c^2}{r'} \frac{\partial \psi}{\partial r'} = \frac{\partial^2 \psi}{\partial t'^2}$$

$$c^2 \nabla'^2 \psi = \frac{\partial^2 \psi}{\partial t'^2}$$

This should show that the wave-equation is invariant under the transformation derived in the article Mohammad Shafiq Khan (2010b) wherein the luminiferous ether is supposed to be present in the space. In the article Mohammad Shafiq Khan (2010b) the value of γ was derived when the same transformation was adopted and applied such that the wave-equation is invariant. For those under-graduate students of physics who do not understand the invariance of the wave-equation of the wave-motion of light/radiation under a transformation to a moving coordinate system, this means that velocity of light is constant with respect to the moving coordinate system or reference frame irrespective of its motion with respect to the absolute reference frame of ether at rest.

Since for the transformation between ether at rest frame of reference and the reference frame having circular motion would give $\partial r' = \partial r$ and $\partial t' = \partial t$; evidently the wave-equation is invariant under such a transformation. Readers have to bear in mind that in all moving reference frames the observed velocity of light is constant in the time frame of the moving reference frames and the time frame of the moving reference frames would depend on the net recessional velocity of the moving reference frames.

Discussion

Voigt, Lorentz and Einstein did not realize that there could be any other transformation which does not involve any space contraction and under which wave-equation could be invariant. It has been shown that Michelson-Morley experiment was misconceived and misinterpreted. With ether in space, the main task being the derivation of the transformation between two reference frames; one of which has to be the absolute reference of ether at rest and other reference frame being in uniform motion with respect to the ether at rest frame of reference; and secondly to show that the velocity of light/radiation is constant irrespective of the relative motion of the source and the observer. These tasks have been accomplished in the article Mohammad Shafiq Khan (2010b).

Michelson-Morley experiment was considered as the experimental proof of length contraction of space in the direction of motion and this coupled with the invariability of velocity of light/radiation irrespective of relative motion of source and the observer as the reason of time dilation which subsequently lead to the space-time concept, theories of relativity and big bang theory. Having shown that Michelson-Morley experiment is in fact experimental evidence of the existence of ether the simple conclusions are that concept of space-contraction in the direction of motion, space-time concept, theories of relativity and big bang theory cannot be correct.

This article and Mohammad Shafiq Khan (2010b) are unique in the sense that these articles justify the Doppler Effect & Hubble observation and show that space is absolute as there is not a single direct experimental evidence of space contraction. Secondly the main evidence of space expansion is the Hubble observations of red-shifting of the visible spectrum of the light from the galaxies. Since the time frame of the receding observer (receding with respect to the ether at rest frame of reference) is slower than the absolute frame of reference of ether at rest accordingly the observer

will observe the wave phenomenon of the light/radiation on its time frame and the observed frequency of the wave phenomenon will be reduced and since light/radiation is observed to have a constant velocity 'c' with respect to the observer; hence the wave length of the light/radiation will be observed to be increased (red-shifted) depending upon the receding velocity of the observer. Conversely wave-length of the light/radiation will be observed to be reduced (blue-shifted) due to the approaching motion of the observer. In the article Mohammad Shafiq Khan (2010b) it has been shown that in nature galaxies and stars have only the receding motion with respect to each other; hence this explains the red-shifting of the visible spectrum of the light as observed by Hubble.

With the help of thesis put forward under this article and the theory put forward under article Mohammad Shafiq Khan (2010b) it will be a very simple proposition to show that the conclusions drawn from Sagnac experiment are also misconceived and misinterpreted.

As described in the article Mohammad Shafiq Khan (2010b) once the existence of luminiferous ether is adopted everything could be logically, scientifically and mathematically explained. The secrets of state of existence of space, time, matter, radiation and that of interactions in nature are contained in the luminiferous ether and when we adopt the existence of luminiferous ether all secrets unfold which stand described in the article Mohammad Shafiq Khan (2010b).

The invariability of velocity of light irrespective of the relative motion of the source and the observer as the intrinsic characteristic of light is simply a preposterous axiom in absence of the luminiferous ether.

Cosmologically in nature the motion of the stars and galaxies are spiral motions with the outward recessional component of the motion for reasons already explained in article Mohammad Shafiq Khan (2010b).

Conclusion

The article shows that Michelson-Morley experiment was misconceived and misinterpreted to conclude the absence of the luminiferous ether. In absence of the luminiferous ether, Michelson-Morley experiment cannot be explained without introducing the contraction of space in the direction of motion. Contraction of space in the direction of motion coupled with the invariability of velocity of light irrespective of the relative motion of the source and the observer leads to the time dilation and interdependence of space and time - in short space-time concept. Thus this article shows that space contraction in the direction of motion & space-time concept and so theories of relativity, big bang theory and every science and theory based on these concepts cannot be correct. This article confirms the existence of the luminiferous ether; the physical characteristics of which are described in the article Mohammad Shafiq Khan (2010b). The alternative state of existence of space, time, matter, radiation and luminiferous ether is described in the article Mohammad Shafiq Khan (2010b). The humanity was deceived by denying the existence of ether in the space which is visible to even a layman. If during the night anybody stands near an electric

lamp with the filament and stresses the muscles of the eye; he would see the shining ether around the lamp.

The concepts and theories based on the space-time concept and contraction of space in the direction of motion have resulted in the evolution of the physics in the twentieth century which fundamentally cannot be correct. The physics so evolved has been taken too far; as far as to deny the existence of God. The alternative theistic state of existence of space, time, matter, radiation, luminiferous ether and the nature of the interactions in nature is described in the article Mohammad Shafiq Khan (2010b). This article together with articles Mohammad Shafiq Khan (2010b), Mohammad Shafiq Khan (2010c) and 'Theory of Origin & Phenomenon of Life' by Mohammad Shafiq Khan (2010d) are the scientific evidences against the philosophy of materialism; which philosophy has been adopted by the mankind for science; both physical and biological sciences; social, political and individual life since last about one and a half centuries.

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References

1. Albert Abraham Michelson (1881) The relative motion of the Earth and the luminiferous ether. *Am. J. Sci.* 22, 120-129. Available on www.archive.org/details/americanjournal62unkngoog
2. Albert Abraham Michelson and Edward Morley (1887) On the relative motion of the Earth and the luminiferous ether. *Am. J. Sci.* 34 (203): 333-345. Available on www.aip.org/history/exhibits/gap/PDF/michelson.pdf
3. Mohammad Shafiq Khan (2010a) Ultimate proof of energy theory of matter & cosmology. *Indian J. Sci. Technol.* 3 (8), 948-954. Available on www.indjst.org
4. Mohammad Shafiq Khan (2010b) Foundation of theory of everything: Non-living things and living things. *Indian J. Sci. Technol.* 3 (9), 955-981. Available on www.indjst.org
5. Mohammad Shafiq Khan (2010c) Energy theory of matter & cosmology. *Indian J. Sci. Technol.* 3 (8) 943-947. Available on www.indjst.org
6. Mohammad Shafiq Khan (2010d) Theory of origin & phenomenon of life. *Indian J. Sci. Technol.* 3 (8), 937-942. Available on www.indjst.org