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Research Paper

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Looking for Effect of Motion of Source on Velocity of Light on Revisiting the Michelson-Morley Experiment

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Abstract— This commentary reflects on the second postulate of special theory of relativity on advent of Michelson-Morley experiment. Of course the experiment could not complete the task doesn't mean that the velocity of light is not relative though it is finite. The property of the aether or even of vacuum which permits body to have uniform motion without any resistance may play significant role in maintaining the speed of light constant with respect to which is a subject of our investigation and could produce null results in Michelson-Morley experiment. Our attempt is to discover the influence of motion of source on the velocity of light first when both velocities are perpendicular to each other and second when both are parallel. The investigation shows that the light velocity is constant with respect to its source, however, when the source comes in motion; its velocity gets vectorially added to the velocity of light as it happens for all bodies. Moreover the starlight aberration surprisingly supports to the first case which is circumvented yet. In Michelson-Morley experiment, the light source was always rest with respect to the apparatus consequently the speed of light was constant with respect to the apparatus giving no shift in the fringes.

Keywords— Speed of light, Aether, Light aberration, Michelson-Morley experiment.

I. INTRODUCTION

As light travels in the form of electromagnetic waves, in the late 19th century physicists postulated that luminiferous aether [1,2] permeated all through space providing a medium through which light could travel. Michelson and Morley designed an apparatus, in order to find out the velocity of earth in the aether. They carried series of observations in the year 1887 [3] finally concluding no change in the speed of light could be observed while rotating the apparatus in any directions confirming no evidences of aether unexpectedly. Overall conclusions drawn from the experimental results were that the space is not filled by the medium aether and light can travel trough vacuum with constant speed independent of the state of its source or the observer and surprisingly, it became one of the base of special theory of relativity in the form of second postulate. Actually, velocity of any body is, in general, a consequence of relative motion between the body and the observer and as velocity of light is finite, therefore, it should be relative. However, this general perception was precluded from the speed of light on the advent of Michelson-Morley experiment and further by Kennedy- Thorndike experiment performed in 1932 [4]. While constructing the postulates of special theory of relativity the wave nature of light was familiar and as wave requires medium for propagation and light is propagating without medium means its velocity cannot be relative and must be absolute. However, in 1905 Einstein, while explaining the photoelectric effect, proposed that the energy of a light ray spreading out from a point source is not continuously distributed over an increasing space but consists of a finite number of energy quanta which eventually became known as photons revealing particle nature of light. In fact particle nature of light does not require medium for its travel. On the advent of particle nature of light, the starlight aberration and laser light aberration is reinvestigated in order to see the effect of motion of laser source on the light and surprisingly found that the velocity of laser source is vectorially added to the velocity of light photons when both velocities are perpendicular to each other. Thus the laser source is simply acting as a gun of photons as like usual gun of particles. Next aim of this presentation is to see whether the same can happen when the velocity of the laser source and the emitted photons are along the same direction. Hypothetical discussion carried here supports to it too. First case is already supported by the starlight aberration observations. Experiments are suggested for verification of the second case consequently the success of which will conclude that the velocity of photons and hence of light depends on states of the source which may affect the second postulate of the special theory of relativity. It may happen only because of particle nature of light. In Michelson-Morley experiment and the other similar experiments too, the light source was always rest with respect to the apparatus hence the speed of light was always constant with respect to the source and hence apparatus, so no fringe shift could be observed.

II. EFFECT OF MOTION OF LASER SOURCE ON VELOCITY OF LIGHT

People knew about starlight aberration since from late the late 1600s [5] whose principle is here illustrated by a laser light aberration by Figure 1(a) where the laser source is at rest and the observer, as a telescope, is in motion with velocity *v* in perpendicular to the direction of the light velocity *c*. The actual position of the laser source is at A but as the telescope is in motion with velocity *v*, it is be tilted by appropriate angle θ to receive the photon at its end consequently the laser source appears to be placed at A′ which is its apparent position. The aberration angle θ is then by $\tan\theta = v/c$. However, velocity of any body is a relative thing between the body and the observer and which one is at rest is immaterial. Therefore in the laser light aberration, the effect is only due to the relative motion between the laser source and the observer. It means if telescope is at rest and the laser source is kept in motion as illustrated in Figure 1(b), the same effect must be observed. Its explanation can be given with considering the laser source as a photon gun. The photon gun is now ejecting the photons with velocity c towards a telescope T′, which is also moving with same velocity *v* of the laser source in parallel. As the relative velocity between them is zero means they are rest with respect to each other, therefore, the wave vector of the light wave, receiving by the telescope T′ is always directed towards the telescope and the light waves or photons move towards the telescope with constant velocity *c*. Now the photon emitted by the gun at position B′ will be received by the telescope T′ when it will reach at position C at that time the laser source also would have reached at position B. However, this phenomenon is also observed by a telescope T placed at position C at rest such that the photon gun velocity is implanted on the photon, like a simple gun implants its velocity on the fired bullet when it is placed on a moving object like a plane where the direction of the gun firing and direction of plane velocity are perpendicular to each other. In this way, while moving the photons along direction of wave vector, they are pushed to the side with velocity *v* as a result they move diagonally as shown in figure 1(b). To receive such photons, the telescope T is to be rotated along this direction along which the laser source appears to be present. Actually it is the apparent position, since at the time of receiving the photons; the laser source is reached at B. It happens may be because of the aether does not exist or if it exists then it cannot maintain the light speed constant with respect to him moreover the light bear particle nature in addition to the wave nature. Clearly, this picture shows that the velocity of the source is vectorially added to the velocity of photons or of light when both velocities are perpendicular to each other. A possible experiment is discussed in the next section for verification of the light aberration illustrated in figure 1(b).

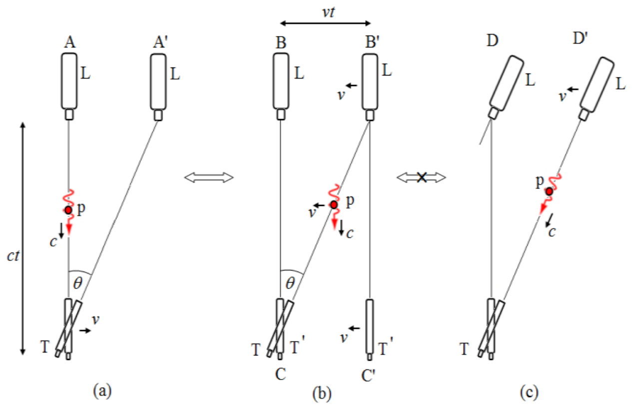

Figure 1. Laser light aberration when (a) source is rest and observer is in motion and, (b) source is in motion and observer is rest. (c) Displacement in the apparent position of the laser source from its true position because of Light-time correction.

The Light-time correction phenomenon is different and is illustrated in figure 1(c) in which the displacement in the apparent position of the laser source from its true position causes by the source motion during the time it takes its light to reach an observer. In this case the light travel towards the observer in such a way that the wave vector of the wave is along the direction of the travel.

III. EXPERIMENT FOR LASER LIGHT ABERRATION

In starlight aberration, observer on earth surface consequently in motion with earth's orbital velocity 30 km/s around the sun observes the aberration of starlight. Such types of result should also be observed when source is in motion despite the observer. For that the source emitting light is to be moved with high velocity to get substantial result on the occasion of very large velocity of light. Fortunately, laser sources are available for production of sharp beam of light photons however to move them in high velocity may become a grueling task. However, to perform experiment in usual laboratory and to attain such high velocity of the laser source, one option comes forward is to put the laser source on a rotating arm. The arm may be rotated with required speed to get high tangential velocity where the laser beam emerges in perpendicular to it. The expected aberration in laser beam may be observed at suitable distance from the source. Such type of designing is illustrated in figure 2 consists of a portable laser source producing sharp beam of photons fixed on one end of the arm producing laser beam parallel to the rod going away. The screen is fixed at distance *d* and an obstacle in front of the laser source so that the laser photons falling on the screen will be blocked when the laser go in front of the obstacle while rotation. At first, keeping the laser source *S* at rest, spot *a* is marked on the screen where the laser light falls on screen when laser beam is just touching to the obstacle. Further, rotate the rod with suitable rpm *w* by driving an electric motor and mark point *b* on the screen where laser light ends while falling on the screen. Due to the rotational velocity of the shaft, tangential velocity attained by the laser source would be 2□*Rw*. For instance, *R* = 3m, *w* = 3000rpm, the tangential velocity comes to, *v* = 942m/s. As, *c* = 2.99792×10^8m/s, it gives *c/v* = 318250.5 indicating to get 1cm displacement of the laser spot on the screen, for the particular rotational speed, the screen should be placed at distance 3.182505 km from the source. Endurably, this distance appears to be large, the results, obtained in this way, will have exalted importance. Instead of setting the screen up to such large distance, one may take multiple reflections of the due beam in two parallel plane mirrors separated by a fixed distance and obtain suitable travelled path before examination. In addition, a slit may be used instead of the obstacle. Such types of alternatives may be used, on demand of situations, at the time of performance of the experiments.

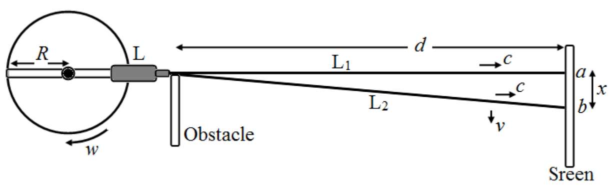

Figure 2. Laser source S is fitted on rotating bar to get tangential velocity *v* which causes to shift the laser spot on the screen.

With the discovery of the Starlight aberration, there should be no problem or hindrance in monitoring and getting the expected results from the above experiment. Eventually, it will endorse the implication of the source motion on the light velocity when the laser light velocity and laser source velocity are perpendicular to each other. Therefore, the next attempt is to get effect of the source velocity on the velocity of the light at the time when the source is going in the direction of the light propagation and vice versa too. This will have far-reaching implications for scientific convictions. Further section discusses it.

IV. EFFECT OF SOURCE MOTION ON SPEED OF LIGHT WHEN BOTH ARE MOVING ALONG A STRAIGHT LINE

The first is to see hypothetically that, like in preceding section, the source velocity can have any effect on light velocity when both are moving along same direction. For that we consider figure 3 in which a laser source L and a telescope T are moving along a straight line with uniform velocity *v*. As they are relatively rest and the telescope receives a photon emitted by the laser in time *t* then the distance between them is *ct* and is always constant. Now another observer at rest observers this phenomenon in such a way that the laser gun emits a photon at position A in the direction of telescope which receives the photon in time t at position B’ since meanwhile the telescope ahs moved from B to B’ in time *t*. Therefore, the distance traveled by the photon in time *t* is *ct*+*vt* with velocity *c*+*v* consequently the velocity of the laser source is implanted on the photon velocity. This happens only because of velocity of the light or photon is finite and absence of the aether.

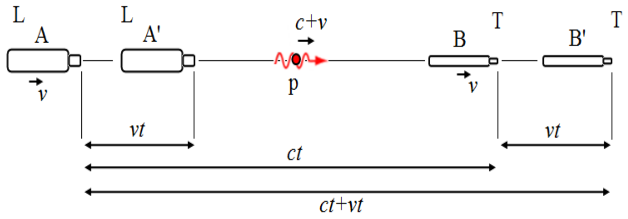

Figure 3. (a) Observer is rest with respect to source and receiver and (b) source and receiver are moving with velocity v along a straight line with respect to the observer.

Similarly, if the photon is emitted in opposite direction of the velocity of laser source then the velocity of the photon or light wave counted by the rest observer would be *c* - *v*. Figure 4 illustrates the source, moving with velocity *v* with respect to the observer, emits light waves in different directions with different velocities. Thus the light photons or waves should move with different velocities in different directions depending on the relative motion between source and observer. The theoretical visualization seems to be consistent; nevertheless, experiments proof are obligatory.

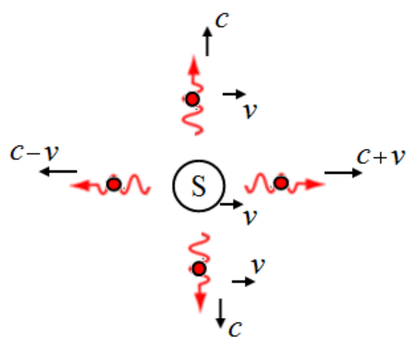

Figure 4. Light source S moving with velocity *v* implements its velocity on light emitted photons.

V. DESIGN OF EXPERIMENT TO VERIFY THE EFFECT OF SOURCE MOTION ON SPEED OF LIGHT WHEN BOTH ARE MOVING ALONG A STRAIGHT LINE

At this point the major difficulty is how to measure direct speed of light. However, the speed of light can be expressed as $c = f\lambda$ and when light source moves, certainly changes the frequency *f*. It means *c* to remain constant, the wavelength λ to be changed correspondingly whereas if we found λ remains unchanged it restricts *c* to have corresponding change which will solve the enigma. So we go to design experiment to measure wavelength of light emitted by a source which is in motion. A laser source, once again, may be used in this experiment. Results of diffraction by grating are wavelength dependent and commonly performed in physics laboratories; therefore it may be used for the expected verifications. A grating having, grating constant 15000 lines/inch, produces first order, in diffraction pattern, at angle 21.94398767^0 for the He-Ne laser beam of wavelength 632.8nm. If we expect change in the first order angle by 1′, the wavelength of the incident light on the grating must be 630nm. To get this wavelength of the laser light emitted by He-Ne laser source, according to the Doppler Effect, the laser source is to be moved with 216662.4km/s towards the grating and is very high. Further the gratings are generally made from some materials like a glass, and in above observations it is rest consequently it may change the speed of laser light while passing through it. Therefore, it is reliable to fit the grating on the laser source stand in order to move it with the laser source. The setup is illustrated in figure 5. Now the grating acts as secondary source of light and is moving with tangential velocity 216662.4m/s towards the observer or screen, the diffracted light will have wavelength 630nm producing the first order at angle less by 1′, means now at 21.927321^0. Actually, the light rays forming the first order are moving at angle 21.927321^0 relative to the grating velocity and are not exactly parallel to the grating velocity. To have such velocity component along the direction of first order, the actual grating and the assembly have to move with velocity 233558.4151m/s. However, to get such a high tangential speed of the assembly, the arm of length 3m from axis of rotation, should be revolved with revolution 743816.6 per minute and is very high. Suppose we become successful in running the experiment then the first order of diffraction patter to be observed at angle 21.927321^0 then it will confirm that the wavelength of the beam is 630nm which is decreased because of the speed of laser source. If we found the first order at angle 21.94398767^0 means the wavelength of the laser beam is 632.8nm and is not changed consequently the speed of light is changed. The successful run of this experiment will reveal the fact.

For better understanding, we may introduce some other techniques in observations such as the screen is made up of photosensitive material and records the screen shot at any desired time. Divide the screen into two parts, *A* and *B*, such that half portion of the each spot of diffracted light falls on screen *A* which moves with grating and other half portion falls on screen *B* which is at rest. Now we allow the assembly containing source, grating, and screen *A*, to move with required velocity and take screen shots when both screens are in the same plane. What do we expect? Undoubtedly, both screen shots would show the same diffraction angle. Similarly, by keeping the assembly at rest and moving the screen *B* with desired velocity towards the assembly and recording the screen shots when both screens are in the same plane will also show same diffraction angles. Hence the wavelength recorded by both screens will be the same. The wavelength is a property of the wave and indeed it can't be different for different observers. Therefore, the frequency and consequently the velocity of light should depend on the relative velocity between the source and the observers.

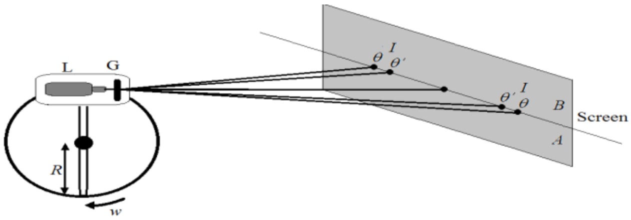

Figure 5. Laser source S and grating are fitted on rotating bar to get tangential velocity v. The resultant diffracted light beam is analyzed.

Let us look for another option. Light travels in the form of electromagnetic (EM) waves. Further, EM waves of desired wavelength can be generated. With use of EM waves of desired wavelength an experiment may be designed which will give direct access to measure the wavelength of the waves. One such experiment is discussed below.

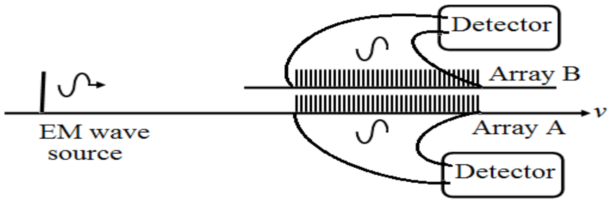

Figure 6. Two arrays of antennas, one is in motion and other is at rest measuring the wavelength of the emitted EM wave.

Construct an array of antennas, say array *A*, for direct measurement of wavelength λ emitted by the EM wave source. When the wave links to the antennas, they will give response according to the instantaneous amplitude of the wave linked to them which may be recorded simultaneously by the detector to calculate the wavelength λ. Now make the source and the array of antennas both to move with constant velocity v along a straight line, as illustrated in figure 6, and record the corresponding wavelength. Obviously it will be again λ as the source and the array of antennas is relatively rest with each other. Now we construct another array of antennas, say *B*, similar to array *A*. By keeping the array *B* at rest and moving the assembly, containing EM source and array *A*, towards the array *B* with constant velocity v where both arrays parallel to each other and record the wavelength by both arrays when they are close to each other. As same wave is linked to both arrays, therefore, should produce same response calculating same wavelength as the response depends on instantaneous amplitude of the wave linked to the individual antennas and not on the velocity of the wave. Furthermore, where the amplitude of the wave is to be high or low, at any instant, is own property of the wave and it does not depend on the way how the detectors are going to count; consequently the wavelength determined by both arrays would be the same. However the frequencies recorded by array B will be more than the array A. Measurement of corresponding frequencies will show that the speed of the wave relative to array A and array B is c and $c+v$ respectively.

VI. DISCUSSION

While analyzing the effect of motion of source on velocity of light hypothetically, first we came across the case where source velocity and light velocity were perpendicular to each other. The analysis eventually endorses effect of source motion on velocity of light is indeed. An experiment of laser light aberration is suggested for verification of it. It is also supported by the Starlight aberration. This happens because of the relative motion between the star and the observer on earth which is in orbital motion around the sun. Clearly light aberration appears because of the relative motion between source and observer; therefore, it indeed happens when source is in motion and observer at rest. Therefore, the laser light aberration experiment will work according to the expectations, proving the velocity of source is implemented on the velocity of light.

Further we have examined hypothetically the case when both, source and light, are moving along a straight line and found that the source velocity, in this case too, is implemented on the velocity of light. We discussed few possible experiments for verifications, where we have chosen to analyze the possible changes in wavelength of the light wave when source is in motion. As wavelength is own property of the wave producing impact of particular length in space cannot depend on who is detecting. Therefore, we expect these experiments, of course there will be a great task to construct and perform them precisely, to produce expected results eventually the picture of light waves or photons emitted by a source moving with velocity v would be as illustrated in figure 4. It will directly affect the second postulate of special theory of relativity.

Finally we come across the case of aether. The discussion does not oppose or supports emphatically to its existence. If it exists and allows any body to have uniform motion without any resistance then it will also support to implications of source velocity on velocity of light. If it does not exist then of course the vacuum is doing the same. At the end we come across the Michelson-Morley experiment. The aether, if exists, is merely maintaining fix speed of light with respect to its source as per the above discussion. Therefore, the Michelson-Morley experiment is not competent to determine the velocity of the earth with respect to the said aether, and hence which body is at rest and which one is in motion with respect to the said aether is still indistinguishable.

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