Apparent Constancy of the Speed of Light and Apparent Change of Position and Time of Light Emission Relative to an Inertial Observer in Absolute Motion

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Abstract

Many experiments have been performed over decades and centuries to investigate the problem of absolute motion and the speed of light, with reported results ranging from complete null results and very small fringe shifts to large first order effects. All existing classical and modern theories, including the ether theory, emission theory, special relativity have failed to successfully address at least one or more of these experiments. I have developed a new model of the speed of light, called Apparent Source Theory (AST), that can successfully explain many of these experiments. Despite its successes, however, AST has some associated paradoxes. Moreover, some of its predictions have not been confirmed in the crude experiments I have performed recently. These paradoxes disappear with a subtle modification to AST, while maintaining all the successes of its original version. According to the original version of AST, the effect of absolute motion of an observer is to create an *apparent change in position* (distance and direction) of the light source relative to the inertial observer, with the center of the light wave fronts always moving with the same velocity as the velocity of the inertial observer. In this paper, AST is modified by stating that not only there is an apparent change in position, but also an apparent change in time of light emission due to absolute motion of the observer, compared to observers at absolute rest. In effect, the point of light emission relative to an observer is fixed in the observer's reference frame, which is the position of the source relative to the observer *at the instant of light emission*, regardless of the (inertial) motion of the observer. Therefore, the new model is based on three assumptions. Absolute motion of an observer causes 1.Apparent change in position of light emission 2. Apparent change in time of light emission 3. The center of the light wave fronts always moves with the same velocity as the velocity of the inertial observer. It is concluded that there is no conventional light interference experiment using a single light source that will show any significant fringe shift due to absolute translational motion. Therefore, only experiments based on time of flight or other unconventional, novel experiments such as the Silvertooth experiment can detect absolute motion.

Introduction

The failure of the 1887 Michelson-Morley experiment to detect the *expected* fringe shift has been the basis of the theory of relativity. Many experiments have been performed ever since to investigate the problem of absolute motion and the speed of light, with reported results ranging from complete null results[1] and very small fringe shifts[2] to large first order effects[3].

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1. Modern Michelson-Morley experiments using cryogenic optical cavity resonators
2. The Miller experiments
3. The Marinov, the Silvertooth and the Roland De Witte experiments
4. A. Michelson and Q. Majorana
5. As reported by Bryan G Wallace

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Numerous other light speed experiments have been performed over the decades and centuries to probe the nature of the speed of light, including the Roamer experiment, Bradley stellar aberration, the Arago and the Airy star light refraction and aberration experiments, the Fizeau experiment, the Sagnac effect, moving source, moving observer and moving/rotating mirror experiments[4], the Eschaglon experiment, and the Venus planet radar range data anomaly[5] .

All existing classical and modern theories, including the ether theory, emission theory, special relativity and their variations, have failed to successfully address at least one or more of these and other light speed experiments. In principle, if a theory can explain the Michelson-Morley experiment but fails to explain the Silvertooth experiment or stellar aberration or Sagnac effect, then that theory's explanation of the Michelson-Morley experiment is also *fundamentally* wrong. In mainstream physics, the culture has been to keep pushing the limits on those experiments that agree with special relativity but completely ignore those experiments that seem to contradict it. This is not in accordance with the scientific method. Therefore, contrary to all claimed advance of theoretical physics during the past century, there is no model of the speed of light so far that can *consistently* explain *all* the known light speed experiments. All known theories are known to have failed with regard to at least one or more experiments.

I have, over a period of many years, developed a new model of the speed of light, called Apparent Source Theory (AST) [1][5][6], that has successfully explained many light speed experiments. However, despite its success, AST has some associated paradoxes. Moreover, some of its predictions have not been confirmed in the experiments I have performed recently. These paradoxes disappear with a subtle modification to AST, while maintaining all the successes of its original version. According to the original version of AST, the effect of absolute motion of an observer is to create an apparent change in *position* of the light source relative to the observer, *with the center of the light wave fronts always moving with the same velocity as the velocity of the inertial observer*.

In this paper, a new theoretical disproof of special relativity theory is also presented (see Appendix).

Original version of Apparent Source Theory

I will briefly introduce the original version of Apparent Source Theory (AST). AST for inertially co-moving light source and observer is formulated as follows.

The effect of absolute motion for inertially co-moving light source and observer is to create an apparent change in the position of the source relative to the observer. According to Apparent Source Theory, unlike ether theory, the effect of absolute motion for co-moving light source and observer is to change the point of light emission as seen by the observer, and NOT to change the speed of light relative to the observer. The speed of light relative to the observer is always constant c , regardless of absolute motion of the observer. The center of the light wave fronts is always co-moving with the observer.

With this model, we can gain an intuitive understanding of why the Michelson-Morley (MM) experiment gives 'null' results. 'Null' has been quoted here because the MM experiment gives complete null results only for some orientations of the interferometer relative to the absolute velocity vector, and gives small fringe shifts for other orientations.

As we can see from the diagram (Fig.1), absolute motion of the Michelson-Morley interferometer to the right causes only an apparent change in the point of light emission relative to the observer, from S to S'. The velocity of light is always constant *c* relative to the observer, regardless of the absolute velocity of the interferometer.

The best way to clarify this is to ask: will changing the position of the source from S to S' (instead of setting the interferometer in absolute motion) cause any fringe shift ? Obviously, the answer is NO, because both the longitudinal and transverse waves will be delayed by the same amount and hence no fringe shift will occur.

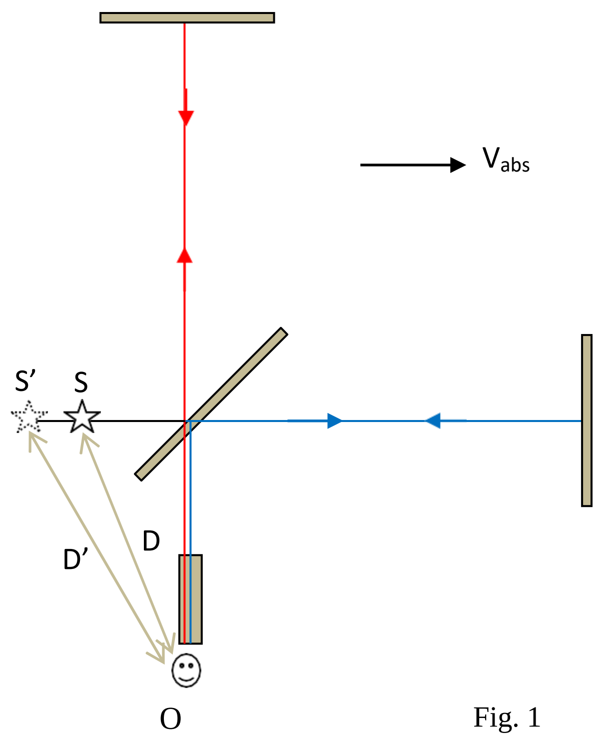

Fig. 1

Note that the velocity of light as 'seen' by an 'observer' at absolute rest is equal to $c + V_{abs}$. However, this velocity ($c + V_{abs}$) is only an illusion because the *real observer* is the one who is actually *detecting* the light, which is observer O. This is what makes the behavior of light extremely elusive. Therefore, according to AST, when we say the velocity of light is constant *c* relative to all *observers*, we mean observers who are actually detecting the light. The source of all the confusions in physics during the last century is the fallacy of trying to make the speed of light constant relative to some third 'observer' who is not actually detecting the light. In special relativity, this 'observer' is the inertial reference frame. Special relativity states that the speed of light is constant in all inertial reference frames.

What about the small fringe shifts observed in the Miller experiments? For absolute velocities parallel to the longitudinal axis of the interferometer, the fringe shift caused by absolute velocity is completely *null*. However, fringe shifts can occur for absolute velocities not parallel to the longitudinal axis. For example, for absolute velocity perpendicular to the longitudinal axis and directed downwards, the situation is shown below.

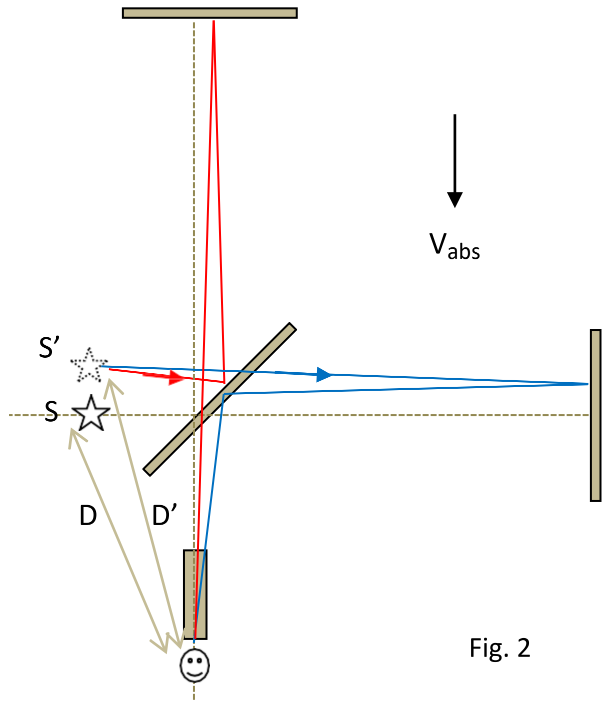

Fig. 2

The path lengths of the longitudinal (blue) and the transverse (red) light beams are changed slightly *differently* due to absolute motion, and hence causing a small fringe shift.

Therefore, the new theory has successfully explained why the Michelson-Morley experiment gives 'null' fringes shifts. A requirement to a new theory is to make unique predictions. Next we present the new experiment and results.

Problems and paradoxes with the original version of AST

In my paper [8], I have described some of the paradoxes that arise from AST. For example, one paradox can be identified in the diagram of Fig.2. What if the part(s) of the mirror where the blue or red ray hits is missing? Will the observer detect the light or not ?

Another problem (paradox?) with the original version of AST is shown in Fig.3. As shown, an observer, a light source and a plate with slit between them are co-moving. According to AST, the position of the source changes from S to S'. The problem/paradox is : will the observer see the light through the wall of the slit or not? But we have never observed hiding of a light source behind a nearby object due to (absolute) motion, considering the fact that we are moving with velocity 390 km/s in space. Neither have we ever seen light (a light source) 'passing through' an opaque wall.

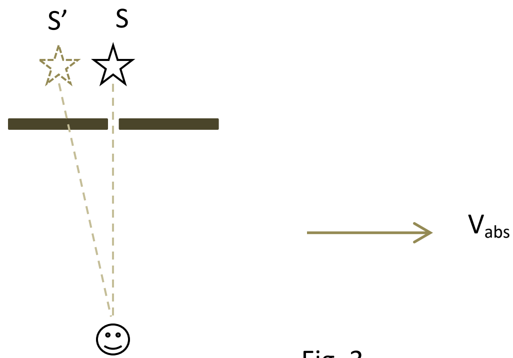

Fig. 3

Experimental test of some of the predictions of AST

One of the experiments I proposed [1] based on AST is shown in Fig.4. With the apparatus at absolute rest, interference fringes are formed at the position of the observer by the (blue) direct light and the (red) reflected light. With the whole apparatus and the observer in (absolute) motion, there will be an apparent change in the position of the source from S to S'. The interference fringes at the observer are now formed by the direct ray (blue broken line) and the reflected ray (red broken line). In my paper [1], I have calculated a large fringe shift. However, I carried out a crude experiment to test this prediction of AST, but did not observe any fringe shift.

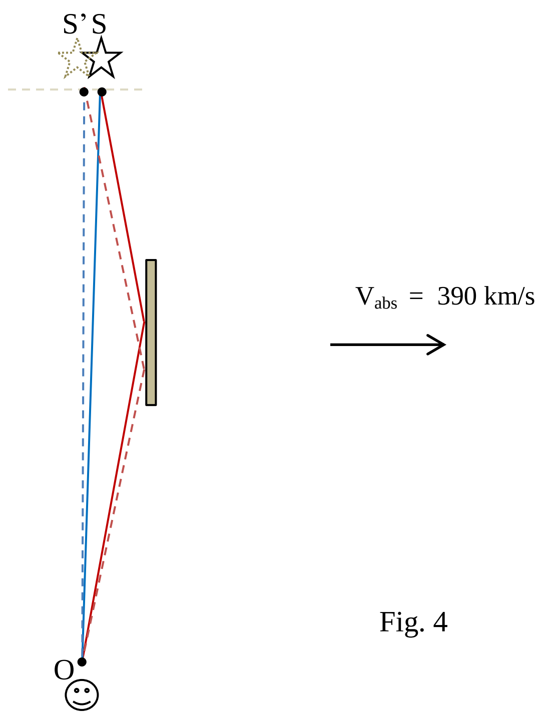

Fig. 4

I have also done other experiments but did not observe any fringe shift.

I have come to the alternative conclusion that there is no conventional interferometer experiment that can detect absolute translational motion from fringe shifts. There is no interferometer experiment that can detect any *significant* fringe shift due to absolute motion. Absolute motion can be detected only by time of flight experiments or other novel, unconventional experiments such as the Silvertooth experiment.

Modification of Apparent Source Theory

A subtle modification of Apparent Source Theory (AST) is as follows.

According to the original form of AST, the effect of absolute motion of an inertial observer is to create an apparent change in source *position* relative to the observer. Therefore, in the Michelson-Morley experiment shown below (Fig.1), with the whole apparatus moving to the right with absolute velocity V_{abs}, the light apparently comes from the apparent source position S', not from S.

This model is modified as follows.

The effect of absolute motion of the Michelson-Morley experiment is to create an apparent change in the *position and time of emission* of light relative to the co-moving observer/detector, with the center of the light wave fronts always moving with the velocity of the (inertial) observer/detector. The new model makes three assumptions/postulates. The effect of absolute motion is:

1. Absolute motion of an observer creates an apparent change in *position* of light emission relative to the inertial observer.
2. Absolute motion of an observer also creates an apparent change in *time* of light emission relative to the inertial observer.
3. The center of light wave fronts always moves with the same velocity as the velocity of the inertial observer.

This model can explain many light experiments such as the Michelson-Morley experiment, stellar aberration, moving source, moving observer and moving mirror experiments.

We reformulate the modified Apparent Source Theory as follows.

1. Light always starts from the point of emission in the reference frame of the inertial observer. This means that the point of light emission is fixed relative to the observer, regardless of the inertial motion of the observer. The point of light emission relative to the observer is always the same as the position (distance and direction) of the source relative to the observer at the instant of emission, regardless of the absolute velocity of the source.

2. However, the position and time of light emission is apparently changed (as compared to the position and time for observers at rest) relative to the (absolutely) moving observer. This change in time of light emission is obtained by assuming the ether (although the ether doesn't exist).

3. The center of light wave fronts always moves with the same velocity as the velocity of the inertial observer.

Thus, unlike the original interpretation of AST, according to modified AST light starts from the real source position S (relative to the observer/detector). *The apparent source position S' is used only to determine the apparent change in time of light emission as seen by the observer/detector.*

Therefore, according to the new interpretation of AST, the *change* in time delay of light *directly* reaching the observer is not because of an apparent change in position of the source, but due to an *apparent change of time* of light emission. In the Michelson-Morley experiment (Fig .1), the time delay of light to *directly* reach the observer will be increased because of absolute motion of the observer. However, this delay is not directly because of (apparent) change of source position, but because there is a delay of instant of light emission as seen by the observer, indirectly because of an apparent point of light emision.

Therefore, the procedure of analysis is as follows:
1. First to determine the apparent position (distance and direction) of the source.
2. Calculate the (apparent) change in time of emission for the moving observer:

$$\Delta t = \frac{D' - D}{c}$$

3. Determine the time taken by light to reach the observer, assuming that light comes directly from the actual point of emission in the reference frame of the observer.

Thus we can see the extremely subtle way nature tries to hide absolute motion.

Formulation of modified Apparent Source Theory

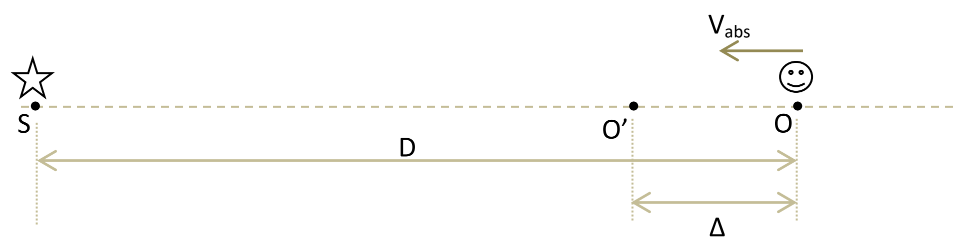

Fig. 5

Consider an observer moving towards a light source with absolute velocity V_{abs} (Fig.5). Suppose that the source emits a short light pulse at $t = 0$, while the observer is just passing through point O. Classically, we know that the observer meets the light pulse at point O'. To determine Δ, we note that the time interval taken by the light pulse from S to O' equals the time interval taken by the observer to move from O to O', i.e.

$$\frac{D-\Delta}{c} = \frac{\Delta}{V_{abs}} \quad \Longrightarrow \quad \Delta = D\,\frac{V_{abs}}{c+V_{abs}}$$

We will use this value for Δ in the following formulation of AST.

Again suppose that an observer is moving towards a light source with absolute velocity V_{abs} (Fig.6). At time $t = 0$, a short light pulse is emitted from the source from point S. At this point, we introduce the new theory that the time and position of emission of the light ($t = 0$ and point S, respectively) are for observers at rest. According to the new model, unconventionally, the time instant and position of light emission for a moving observer is different from that of an observer at rest.

For the moving observer, light is emitted *earlier* than $t = 0$, at $t = -t_1$, just as the observer is/was passing through point O''. Also, the point of light emission for the moving observer is not S, but S'. Therefore,

$$t_1 = \frac{D}{c} - \left(\frac{D-\Delta}{c}\right) = \frac{\Delta}{c} = \frac{1}{c}\,D\,\frac{V_{abs}}{c+V_{abs}}$$

From which,

$$x = V_{abs}\ t_1 = V_{abs}\ \frac{1}{c}\,D\,\frac{V_{abs}}{c+V_{abs}} = \frac{V_{abs}}{c}\,\Delta$$

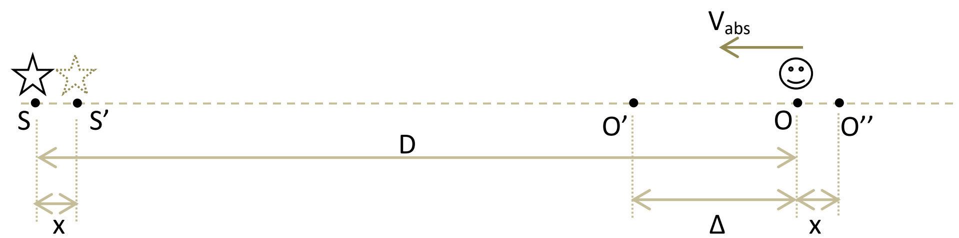

Fig. 6

Fig. 7

Now consider an observer moving away from a light source with absolute velocity V_{abs} (Fig.7). Suppose that the source emits a short light pulse at $t = 0$, while the observer is just passing through point O. Classically, we know that the observer meets the light pulse at point O'. To determine Δ, we note that the time interval taken by the light pulse from S to O' equals the time interval taken by the observer to move from O to O', i.e.

$$\frac{D+\Delta}{c} = \frac{\Delta}{V_{abs}} \quad \Longrightarrow \quad \Delta = D\,\frac{V_{abs}}{c - V_{abs}}$$

We will use this value for Δ in the following formulation of AST.

Again suppose that an observer is moving away from a light source with absolute velocity V_{abs} (Fig.7). At time $t = 0$, a short light pulse is emitted from the source from point S. In the same as above, we introduce the new theory that the time and position of emission of the light ($t = 0$ and point S, respectively) are for observers at rest. According to the new model, unconventionally, the time instant and position of light emission for a moving observer is different from that of an observer at rest.

For the moving observer, light is emitted *later* than $t = 0$, at $t = t_1$, just when it is passing through point O''. Also, the point of light emission for the moving observer is not S, but S'. Therefore,

$$t_1 = \frac{D+\Delta}{c} - \frac{D}{c} = \frac{\Delta}{c} = \frac{1}{c}\,D\,\frac{V_{abs}}{c - V_{abs}}$$

From which,

$$x = V_{abs}\ t_1 = V_{abs}\ \frac{1}{c}\ D\,\frac{V_{abs}}{c - V_{abs}} = \frac{V_{abs}}{c}\,\Delta$$

Fig. 8

General formulation of modified Apparent Source Theory

In the last section, we have considered the cases of an observer moving directly towards or away from a light source. In this section, we will consider an observer moving in arbitrary direction relative to the source.

Consider a light source and an observer, as shown (Fig.9). Let us start with the conventional view: at the instant of light emission (t = 0) , the distance between the source and the observer is D. However, this statement is based on conventional view because we are assuming that the light is emitted at t = 0 *for all observers*. Conventionally, the instant of emission of a light pulse is the same for all observers, and only the instant of detection of light differs between observers depending on their position and velocity.

According to the new theory proposed in this paper, however, (absolute) motion of an observer not only changes the time of light detection but also the (apparent) *time of light emission*! For observers at different positions and moving with different velocities, the times of emission of the same light pulse are different!

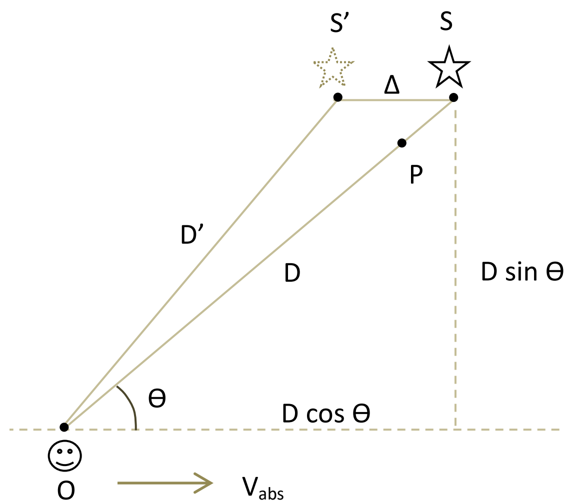

Fig. 9

Suppose that the distance between an observer and the point of light emission at the instant of emission is D, as shown (Fig.9). The procedure of analysis is first to determine the apparent position of the source, i.e. D' and Δ . Then we determine the time $t = D'/c$, which is the time taken by light to reach the observer from the apparent point of emission S’. Once we determine t we no more assume that light starts from the apparent point of emission (S’). The modified Apparent Source Theory states that the point of light emission relative to a moving inertial observer is fixed in the reference frame of that observer, regardless of the (absolute) motion of that observer, and we assume that the speed of light is always constant relative to that point.

Rather than an apparent change in point of light emission, we instead assume an *apparent change in time of light emission* for that observer.

Accordingly, let us first determine the apparent position of the source in Fig.9. Let us assume co-moving source S and observer O.

As I have repeatedly shown in my previous papers [1][5][6], during the time interval that the source moves from S' to S, the light moves from S' to O.

$$\frac{\Delta}{V_{abs}} = \frac{D'}{c} \quad . \ . \ . \ . \ . \quad (1)$$

But

$$(D \cos\theta - \Delta)^2 + (D \sin\theta)^2 = D'^2 \quad . \ . \ . \quad (2)$$

Given D , Θ and V_{abs} we can determine D' and Δ from equations (1) and (2).

Once we have determined D' we can get the apparent change in the time of light emission for observer O. In this case, the light for moving observer O is emitted earlier than for all observers that are at rest, before $t = 0$! This is an apparent violation of causality.

The apparent *change* in the time of light emission for the moving observer is:

$$\Delta t = \frac{D' - D}{c}$$

Therefore, in the case of inertially co-moving source and observer, the light always comes from the actual, physical position of the source relative to the observer. However, absolute motion manifests itself through an apparent change in *time of light emission*. Therefore, the light will arrive earlier than if the source and observer were at absolute rest because the light is emitted earlier. For the moving observer, the light always moves a distance D (not D').

Therefore, by the time light is emitted for observers that are at rest, the light for the moving observer will have already reached point P (Fig. 5), where :

$$distance\ OP = D'$$

Although the above analysis is general and applies for any relative positions of the source and the observer and for any direction of absolute velocity relative to the line connecting the source S and the observer O, let us repeat the above procedure for the observer moving in the opposite direction, to avoid any confusions. Moreover, whereas in the last case the light for the moving observer will be *apparently* emitted earlier than for stationary observer, in this case the light for the moving observer is emitted apparently later than for stationary observers.

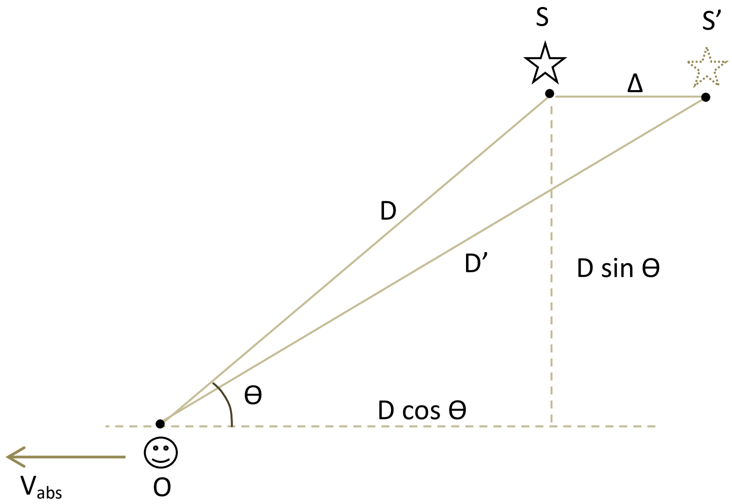

Fig. 10

Similar to the last analysis, during the time interval that the source moves from S' to S, the light moves from S' to O.

$$\frac{\Delta}{V_{abs}} = \frac{D'}{c} \qquad . \ . \ . \ . \ . \quad (3)$$

But

$$(D\cos\theta + \Delta)^2 + (D\sin\theta)^2 = D'^2 \quad . \ . \ . \quad (4)$$

Given D, Θ and V_{abs} we can determine D' and Δ from equations (3) and (4).

Once we have determined D' we can get the apparent change in the time of light emission for observer O. In this case, the light for moving observer O is emitted apparently *later* than for all observers that are at rest, before $t = 0$! This is unconventional!

The apparent *change* in the time of light emission for the moving observer will be:

$$\Delta t = \frac{D' - D}{c}$$

Null result of interferometer experiments

From the above analysis we can see that it is impossible to detect absolute motion by using interferometer experiments because no significant fringe shifts will occur. This is because absolute motion of the (Michelson-Morley) interferometer will *not cause any significant change in the path difference* of two light rays originating from a single source, taking different paths to reach the point of detection. The effect of absolute motion is only to cause *equal time change* (time delay or time advance) to *both* the light rays, which will not cause any fringe shift.

Absolute motion can cause fringe shift only if the fringes were formed by interference of two light beams from two *independent* light sources! However, such experiment is not possible with current technology because the coherence length of light sources is too small to observe any stationary, visible, stable fringes formed by light rays from two independent sources.

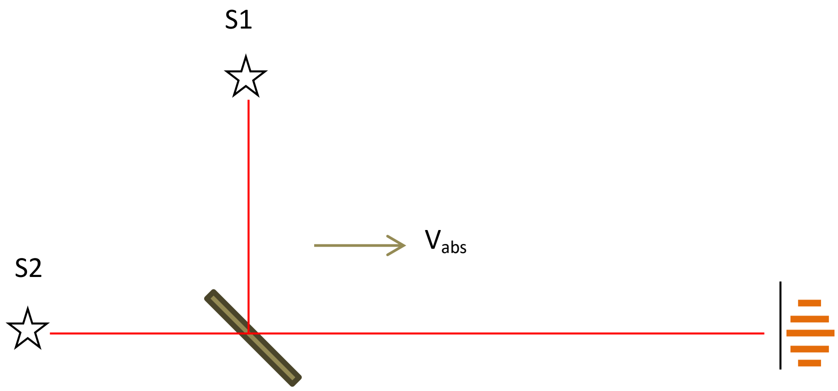

Fig. 11

The Miller experiments

The question arises: then what are the small, consistent fringe shifts observed in the Miller and other repetitions of the Michelson-Morley experiment? The only explanation I can think of is that the small possible fringe shifts are caused by the fact that the light sources used are extended, not theoretical point sources assumed in AST. Therefore, the parts of the extended light source can act as *independent* sources and hence causing small fringe shifts.

Similar argument holds for the Eschaglon experiment.

Modern Michelson-Morley experiments

The modern Michelson-Morley experiments based on cryogenic optical cavity resonators are known to give complete null results. The modified AST gives a straightforward explanation for this. The only effect of absolute motion is to create an apparent change in time of emission of light, which obviously does not affect the resonance frequency of the cavity.

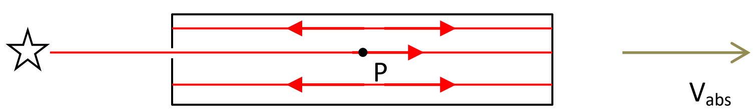

Fig. 12

For any point P inside the cavity, the effect of absolute motion is just to create a time delay or advance (phase delay or advance) for the waves passing through that point. For example, at point P both the incident and reflected waves will be delayed or advanced *by the same amount* due to absolute motion. Since absolute motion does not affect the phase *relationship*/*difference* between the incident and reflected waves at a point, the amplitude of the wave will not change, which means that absolute motion does not affect the resonance frequency of the cavity. However, absolute motion will change the phase relationships between *two points* in the cavity, which does not affect the cavity resonance frequency.

Stellar aberration

The phenomenon of stellar aberration has been one of the most challenging problems to the early version of AST. Stellar aberration is one of the key phenomena that guided the later development of AST. In fact, I was able to introduce the idea of apparent time delay of light emission in an effort to apply AST to stellar aberration.

Consider an observer that is moving to the right at point O' at the instant of light emission, $t = 0$. (Fig.9). The light is emitted from point S. From the new theory, however, $t = 0$ is the time instant of light emission for all observer that are at absolute rest and the time of light emission of the moving observer will be different due to absolute motion.

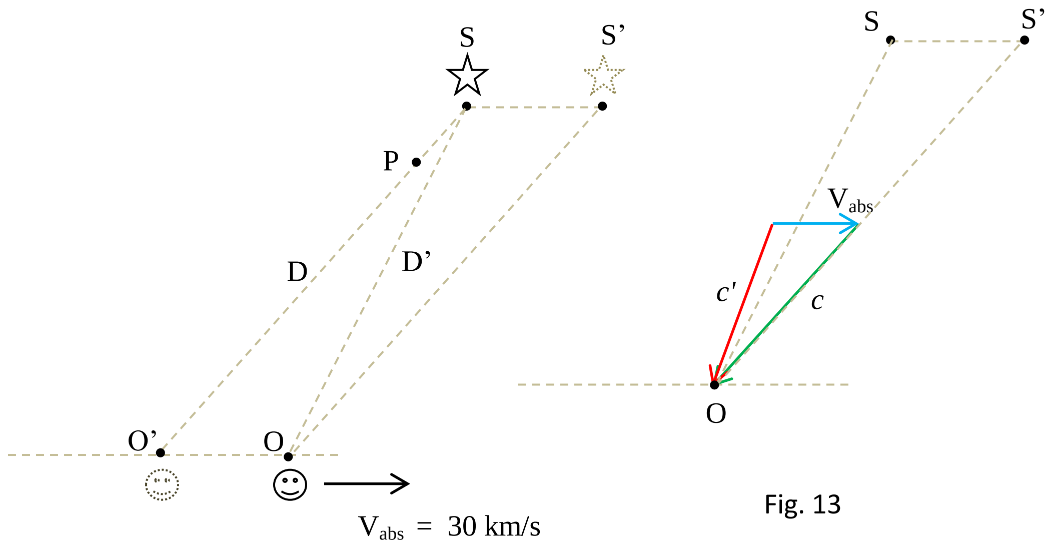

Fig. 13

The moving observer will detect the light at point O. For the moving observer, the light moves the distance *D*, whereas for an observer at rest at point O the light moves distance D'. The moving observer needs to point his/her telescope in the direction parallel to line O'S , whereas the stationary observer at point O needs to point his/her telescope in the direction parallel to line OS. But both the moving and the stationary observers will detect the light simultaneously at point P. The question is: how can the moving and the stationary observers detect the light at point O simultaneously if the light travels different distances (*D* and *D'* , respectively) for the two observers?

The solution is that for this case light will be emitted *apparently earlier* for the absolutely moving observer than for the stationary observer. Therefore, by the time light is emitted for all observers at absolute rest ($t = 0$) , the light for the moving observer will have reached point P, and hence has already moved distance SP, where:

$$distance\ of\ O'P = D'$$

For the moving observer light is emitted *apparently earlier* by Δt compared to all observers at rest, where:

$$\Delta t = \frac{D' - D}{c}$$

Let us see the problem relative to the absolute reference frame. The green vector is the velocity of light *c* relative to the moving observer, which is parallel to line OS' (or O'S). The blue vector is the absolute velocity of the observer. The red vector is the velocity of light (*c'*) for the moving observer (that is, the velocity of light *aimed* for the moving observer) as seen in the absolute frame.

Now we can see that the light for the stationary observer at point O is coming from the direction of OS, whereas the light for the moving observer at point O (red vector) is coming from the direction different from OS. This is unconventional! Classically, and conventionally, light comes from the same direction OS, for all observers (moving or stationary) detecting light at point O.

As shown in Fig.10 below, the path of the light for the moving observer is shown as the broken orange curve, as seen in the absolute reference frame. The path of light for the observer at rest is shown in the broken green curve.

Now let us see the implications of this. We have stated that the light for the observer at rest at point O comes from the direction OS, but the light for the moving observer at point O comes from a different direction.

Suppose that an observer is at rest at point O until just before the light reaches point O. Here is the puzzle. The observer has been at rest until just before light reaches point O, so we would think that the light for that observer is coming from the direction of OS, along the green broken path. But the observer accelerates almost instantaneously to absolute velocity V_{abs} to the right just before the light reaches point O, so now we would think that the light for the moving observer comes from a different direction, along the orange broken curve. Does the light go back in time to change its path and its direction of arrival at point O retroactively?

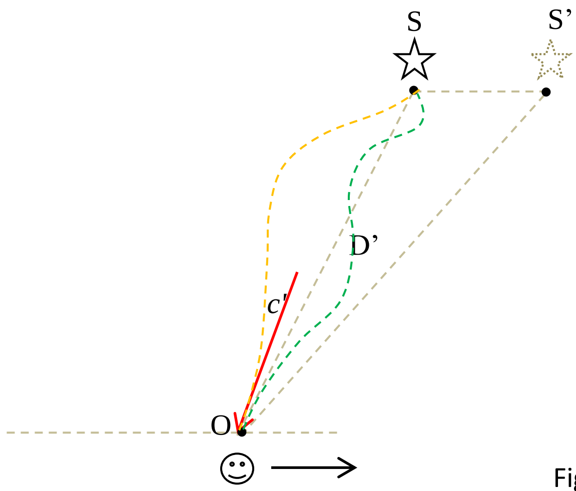

Fig. 14

The answer is no. Here is the profound implication of the AST explanation of stellar aberration. *Nature has foreknowledge at the time of light emission that the observer would accelerate to* V_{abs} *at point O just before the light reaches point O. Therefore, the light is emitted to reach point O along the orange broken path, and not along the green broken path in the first place* ! *This is a deeply profound evidence of God and His literal intervention in the universe !*

For an observer in the opposite direction, the situation is as follows (Fig. 15).

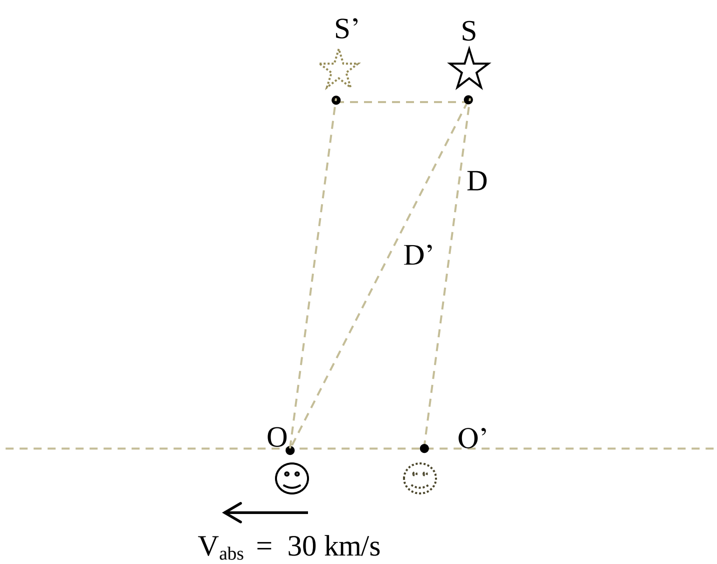

Fig. 15

At the instant of light emission ($t = 0$ for all observers at rest) from point S, the observer is moving to the left with absolute velocity V_{abs} , at point O'. The moving observer will detect the light at point O, simultaneously as a stationary observer at point O. However, the moving observer needs to point his/her telescope parallel to line O'S (or OS'), whereas the stationary observer needs to point his/her telescope parallel to line OS. For the moving observer light travels distance *D*, whereas for the stationary observer light travels distance *D'*. Again, the question is: how can the moving and stationary observers detect the light at point O simultaneously if light travels different distances in the two cases. The solution is that light is emitted *apparently later* by Δt for the moving than for the stationary observer where:

$$\Delta t = \frac{D' - D}{c}$$

The Arago and Airy experiments

With the modified Apparent Source Theory, the explanation of the Arago and the Airy star light refraction and aberration experiments is straightforward. This is because, according to AST (and modified AST) *the center of the light wave fronts always moves with the same velocity as the velocity of the inertial observer*. *The velocity of light is always constant c relative to the center of the wave fronts, hence relative to that inertial observer.*

Let us consider the detection of light at point O by a moving observer and by an observer at rest at point O (Fig.12). The velocity of the center of the light wave fronts for the observer at rest will be zero because the velocity of that observer is zero. Hence the observer at rest needs to point his/her telescope in the direction parallel to line SO.

The velocity of the center of the light wave fronts for the moving observer will be 30 km/s to the right because the absolute velocity of that observer is 30 km/s to the right. Therefore, the moving observer needs to point his/her telescope in the direction parallel to line S'O.

The velocity of light for the moving observer, relative to the moving observer, is shown in red. The velocity of light for the observer at rest is shown in blue.

Therefore, since the center of the light wave fronts always moves with the velocity of the observer, it is impossible to detect absolute motion as a change in refraction angle or aberration angle. Absolute motion of the observer does not affect the refraction and aberration angles.

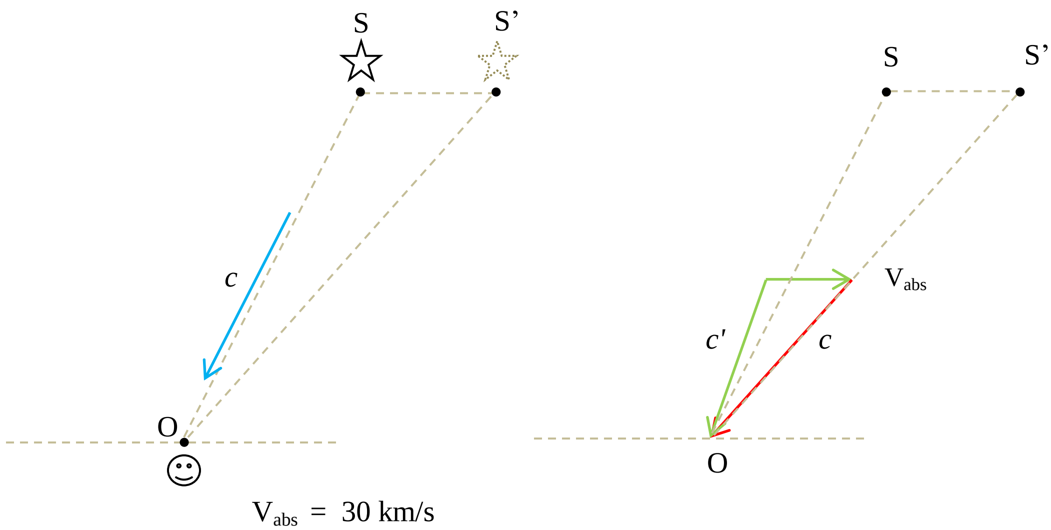

Fig. 16

The Arago star light refraction experiment is shown in Fig.17. Suppose that at first the observer and the telescope are at absolute rest and that there is no prism in front of the telescope. In this case the observer sees the star light as coming from a certain direction. Next the observer puts a prism in front of the telescope. The observer needs to rotate the telescope by an angle Θ to see the star again.

The above procedure is repeated but with the observer (and the telescope) moving with absolute velocity V_{abs} to the right. What Arago found is that the angle through which he needed to rotate the telescope is the same (Θ) irrespective of the (absolute) velocity of the observer.

The (modified) AST explanation for this is that the (observed, measured) *phase* velocity of light is always *constant c* regardless of the velocity/motion of the observer. Also, the center of the light wave fronts always moves with the same velocity (magnitude and direction) as the velocity of the *inertial* observer.

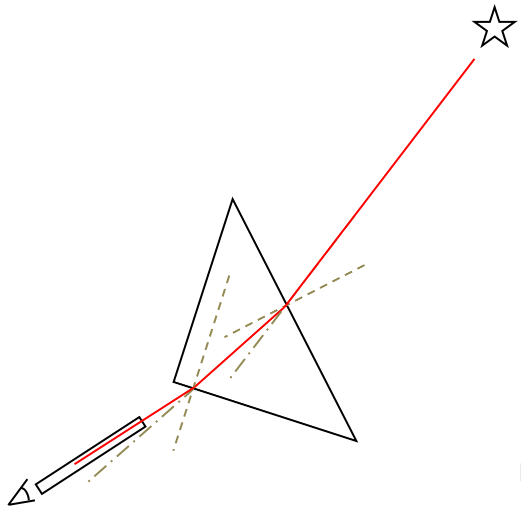

Fig. 17

Also the Airy water-filled telescope experiment was carried out to test if the value of stellar aberration angle depended on the velocity of the observer (and the telescope), and no such dependence was observed. The (modified) AST explanation is that the center of the light wave fronts always moves with the same velocity (magnitude and direction) as the velocity of the *inertial* observer.

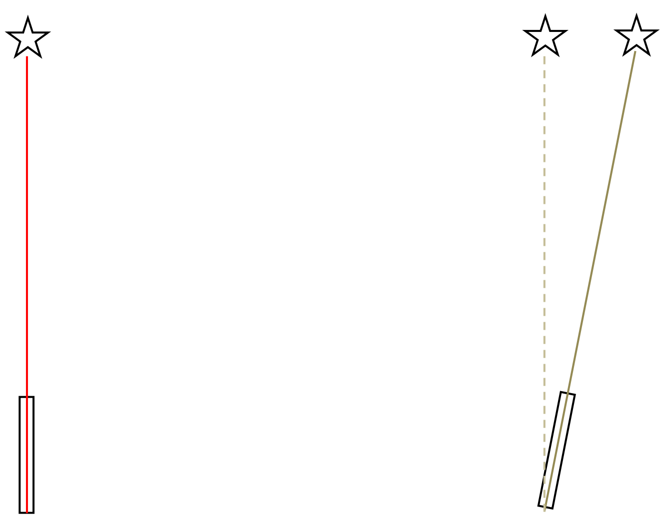

Fig. 18

Moving source, moving observer and moving mirror experiments

Obviously the motion of the source does not affect the speed of light, actual or apparent. In terms of (modified) AST, this is because for an observer at rest (only the source moving), there will be no change in the time of light emission.

The motion of the observer apparently affects the apparent speed of light relative to that observer, as seen in the absolute reference frame. However, fundamentally the absolute motion of the observer does not affect the speed of light but only the *apparent time of light emission* for that observer, hence the time of detection of light at the observer, as we have discussed already.

We will repeat the theory for better clarification. Consider a light source S and an observer O (Fig.15). The source emits a short light pulse at $t = 0$. The distance between the source and the observer at the instant of emission is *D*. At $t = 0$, the observer is moving with absolute velocity V_{abs} to the right (away from the source).

According to (modified) AST, the procedure of analysis is first to obtain the apparent point of light emission, i.e. distance *D'* in this case. Then we can get the *apparent change in time of light emission* for the moving observer:

$$\Delta t = \frac{D' - D}{c}$$

In this case, the *apparent* time of emission for the moving observer will be *later* than $t = 0$ by Δt. Once we get Δt, we assume that the point of light emission for (relative to) the moving observer is at distance *D*, not *D'* , in the moving observer's reference frame. The speed of light is constant *c* relative to that observer. In other words, the center of the light wave fronts for that observer (*for light detected by that observer*) always moves with the same velocity as the velocity of the observer. Thus, the moving observer detects the light later than if he/she was at rest not because the velocity of light changes relative to the observer, but because light is emitted later than $t = 0$ for that observer.

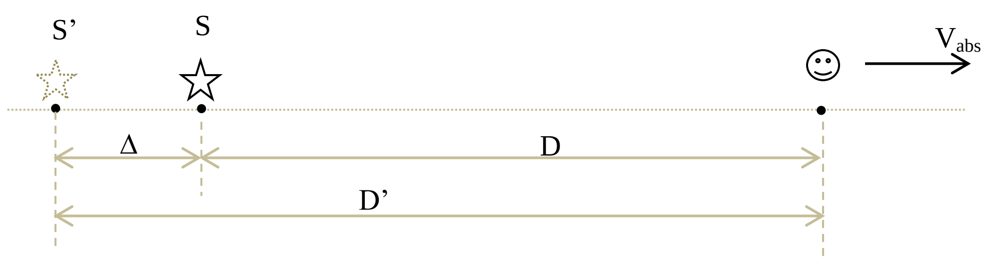

Fig. 19

Let us see the extreme subtlety of the behavior of light. What is the time taken by light to catch up with the moving observer? What is the speed of light relative to the moving observer?

There are two different answers to this question: one is fundamental and the other is apparent.

Fundamentally, the time *interval* taken by light to catch up with the observer is:

$$t_d = \frac{D}{c}$$

However, the time instant of detection is:

$$T = \Delta t + t_d = \frac{D' - D}{c} + \frac{D}{c} = \frac{D'}{c}$$

The speed of light relative to the moving observer is always constant *c*, irrespective of the observer's absolute velocity, because *the center of the light wave fronts moves with the same velocity as the absolute velocity of the observer*, both in magnitude and direction.

Apparently, from the perspective of some other 'observer' that is at rest, the speed of light relative to the moving observer is $c - V_{abs}$. However, this is not fundamentally correct, but only apparent.

For an observer moving to the left (towards the light source), similar analysis applies (Fig. 20).

The source emits a short light pulse at $t = 0$. The distance between the source and the observer at the instant of emission is *D*. At $t = 0$, the observer is moving with absolute velocity V_{abs} to the left (towards the source).

Again according to (modified) AST, the procedure of analysis is first to obtain the apparent point of light emission, i.e. distance *D'* in this case. Then we can get the apparent change in time of light emission for the moving observer:

$$\Delta t = \frac{D' - D}{c}$$

In this case, the *apparent* time of emission for the moving observer will be *earlier* than $t = 0$ by Δt (disregarding the sign). Once we get Δt, we assume that the point of light emission for (relative to) the moving observer is at distance *D*, not *D'* , in the moving observer's reference frame. The speed of light is constant c relative to that observer. In other words, the center of the light wave fronts for that observer (*for light detected by that observer*) always moves with the same velocity as the velocity of the observer. Thus, the moving observer detects the light *earlier* than if he/she was at rest not because the velocity of light changes relative to the observer, but because light is emitted *earlier* than $t = 0$ for that observer.

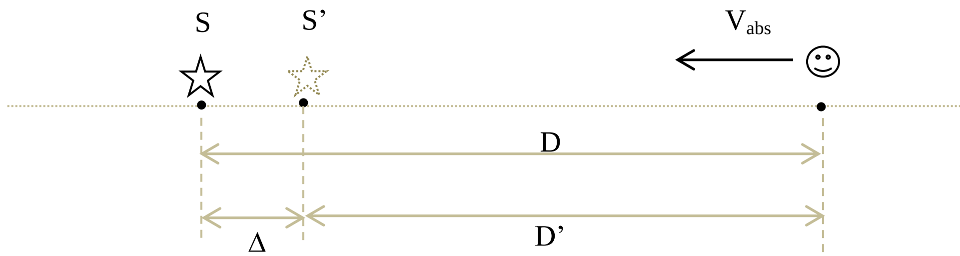

Fig. 20

Moving mirror experiments and the Venus planet radar range data anomaly

One of the most confusing behaviors of light is manifest in moving mirror experiments. One of the only known experiments in this regard is the Venus planet radar ranging experiment, which was, ironically, done to test Einstein's General Relativity theory. As reported by Bryan G Wallace, a large first order effect contradicting constancy of the speed of light was observed. The data contradicted not only Einstein's relativity theory, but also ether theory, and supported the long forgotten and abandoned emission/ballistic theory. It appears that the velocity of light is affected by the velocity component of the mirror (Venus) towards the Earth ! Mainstream physicists have nothing to say about this experiment, just like the Silvertooth and the Marinov experiments.

(Modified) AST can be seen as a fusion of ether and emission theories. In AST, the effect of absolute motion of an observer is just to create an apparent change in the time of light emission for that observer (i.e. *for light detected by that observer*). Once absolute motion is accounted for in this way, we just assume the emission/ballistic model to analyze experiments.

According to emission theory, the component of the *relative* velocity of the mirror towards the source and the observer will add to or subtract from the velocity of light. However, we need to make a new distinction here: phase velocity and group velocity. The *phase velocity* of light is always constant *c*, regardless of the velocity of the source/observer/mirror, and regardless of uniform or accelerated motion of the observer. The *group* velocity of light apparently varies with the observer/mirror velocity.

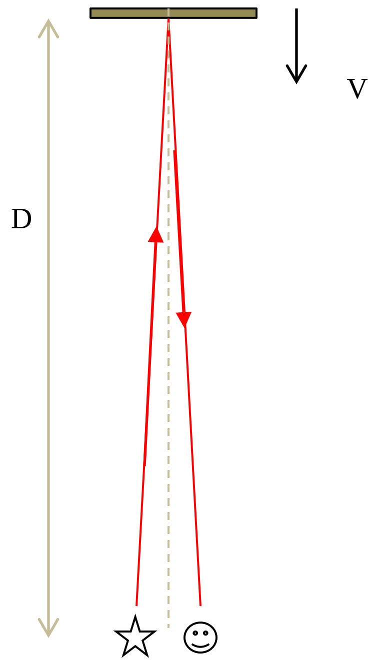

Fig. 21

Since the source and the observer/detector are almost at the same point in space (both on Earth), the effect of absolute motion of the observer is almost completely suppressed.

The center of the RF pulse wave fronts moves with the same velocity as the (absolute) velocity of the observer, the RF pulse starts from the actual/physical position of the source (antennas). The change in time delay due to absolute motion of the observer (which is 390 Km/s) is negligible because the distance between the source and the observer is very small. We assume ballistic theory to analyze the experiment.

Let the distance between the source/the observer and the mirror at the instant of light reflection be D. The forward flight time will be:

$$t_1 = \frac{D}{c}$$

The backward time will be:

$$t_2 = \frac{D}{c + 2V}$$

The round trip time will be:

$$T = t_1 + t_2$$

$$\Longrightarrow T = \frac{D}{c} + \frac{D}{c + 2\,V} \quad \Longrightarrow T = \frac{2D(\,c + V\,)}{c\,(c + 2\,V)}$$

Constant phase velocity and constant/variable group velocity of light

According to ballistic theory, the velocity of the reflected light is c + 2V, where V is the component of the mirror relative velocity towards the observer. The question is: why was this not observed in other moving mirror experiments, particularly in the A. Michelson moving mirror experiment?

The explanation I have already proposed in my earlier papers is that the phase velocity is always constant *c*, irrespective of source/observer/mirror velocity, for all observers, including non-inertial (accelerating) observers. It is the group velocity of light that depends on mirror velocity. However, the explanation of how the phase velocity can be constant but the group velocity variable was one of the most difficult problems I faced. This puzzle is finally solved as follows.

All the behaviors of light we know from experience are only *apparent* or *average* of the actual, fundamental property of light. The constancy of the velocity of light is only an apparent/average property. Fundamentally, the speed of light is not constant along its path. Also the fact that light travels in a straight line is again only an apparent property of light. Fundamentally, light travels in curved paths, with continuously changing magnitude and direction of its instantaneous velocity.

However, these properties of light are fundamentally inaccessible to experiments.

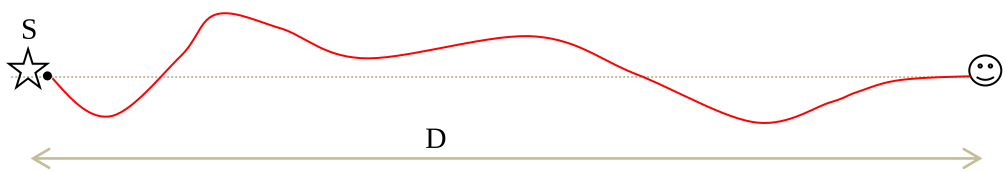

Fig. 22

From the diagram (Fig.22) above, with both the source and the observer are at rest, we can see that light travels in arbitrary curved paths such that the average/apparent speed of light is always constant *c*.

$$\text{Observed or measured speed of light} = \frac{D}{\Delta T} = constant = c$$

where ΔT is the time interval between emission and detection.

Along its path, however, light can travel at subluminal or superluminal speeds, accelerating and decelerating.

We can also see that, whatever curved path light takes from the source to the observer, the final part of its path, just before the point of observation is such that the tangent to the curve at the point of observation passes through the source, to simulate that light travels in a straight line from source to observer.

Returning to the question of how the group velocity of light reflected from a mirror can be variable ($c \pm 2V$), the mystery that may have eluded science so far is that the phase velocity, hence the (*local*) group velocity, of light becomes *c just before detection*. Therefore, the measured/apparent/average group velocity of reflected light, is equal to ($c+2V$), whereas the *phase* velocity is always constant c . Note that both the *instantaneous* phase velocity and instantaneous group velocity of light, which are always equal, are not constant along the path of the beam. However, fundamentally this is inaccessible to any physical experiments.

This is why some experiments, particularly the A Michelson moving mirror experiment, failed to detect any change in the speed of light due to mirror velocity. Therefore, it is impossible to detect the effect of mirror velocity on the speed of light by experiments based on fringe shifts.

Vacuum permittivity and permeability, Maxwell's equations

One of the mysteries in physics is why vacuum has property (permittivity and permeability) if there is no light carrying medium. Physicists know this puzzle, but just accept it.

The new explanation proposed in this paper is that the permittivity and permeability of vacuum we know are only apparent, average values. The answer to the question: " if space is empty, how can it have property? " is that the property of space is *simulated*, 'not real' in the sense of classical physics. If correct, this is a deep mystery that would never be revealed in any other way. To assume that vacuum permittivity and permeability are real is to assume the non-existent light carrying medium.

Maxwell's equations are far from complete because they are based on classical view, that is the non-existent ether. Their solution does not predict the particle nature of light (photons). Maxwell's equations should be modified to predict the non-constancy of the instantaneous velocity of light, which means continuously changing velocity and non-rectilinear path of light.

Lunar Laser Ranging experiment

The Lunar Laser Ranging (LLR) experiment, in combination with the Silvertooth and the Marinov experiments, is one of the evidences of Apparent Source Theory. The argument is as follows. The Silvertooth and the Marinov experiments have clearly detected our absolute velocity in space. But on the other hand, the LLR experiment is not affected by our absolute velocity (390 Km/s). AST is the only theory that can resolve this contradiction.

Acceleration

So far we have considered inertial observers. Now we will generalize AST for non-inertial (accelerating) observers. Consider a light source S (at point S) and an observer O (at point O) moving along the curved path with a continuously changing velocity (continuously changing magnitude and direction of velocity), (Fig. 23). Suppose that the observer is at point O at the instant of light emission, at $t = 0$. However, note that $t = 0$ is the time of emission for observers at absolute rest. As we have already stated, according to (modified) AST, for an observer in absolute motion the time of emission of light is not $t = 0$. The *time of emission* for an absolutely moving observer is delayed or advanced ($t \neq 0$), depending on the direction of the observer absolute velocity with respect to the line connecting the source and the observer.

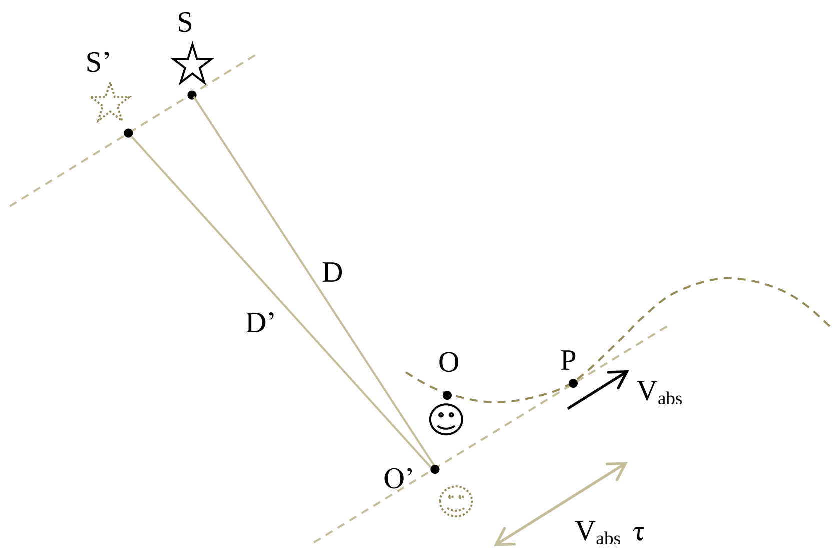

Fig. 23

The problem is to determine the point along the path where the moving observer will detect the light, and the time delay of light for the moving observer. The procedure of analysis is as follows.

We start by assuming some point P along the path where the observer will detect the light. Since the motion and path of the observer is completely defined, we know the time τ taken by the observer to move from point O to point P and the instantaneous absolute velocity (V_{abs}) of the observer at point P. We assume an imaginary inertial observer O' who is moving with the same velocity as the instantaneous absolute velocity of the real observer at point P. We assume that the real *accelerating* observer O and the imaginary *inertial* observer O' detect the light simultaneously at point P. From τ and V_{abs} we know the point O' where the imaginary inertial observer is at the instant of light emission ($t = 0$) . At $t = 0$, imaginary observer O' is at distance $V_{abs}\ \tau$ from point P. Then from the relative positions of O' and S, we can determine *D* and *D'*, as discussed already by applying equations (1) and (2).

Then the time delay of light is determined from: $T_d = D'/c$. If T_d is equal to the time (τ) taken for the observer to move from O to P , then we have solved the problem. If not, which is much more likely (because we chose point P arbitrarily), we repeat the above procedure.

Note that, with the modified AST the apparent source position S' is determined only to get the time delay of light; the light always starts from the real/physical source position S, not from S'.

Many actual experiments involve not only a light source and an observer, but also mirrors, beam-splitters, etc.

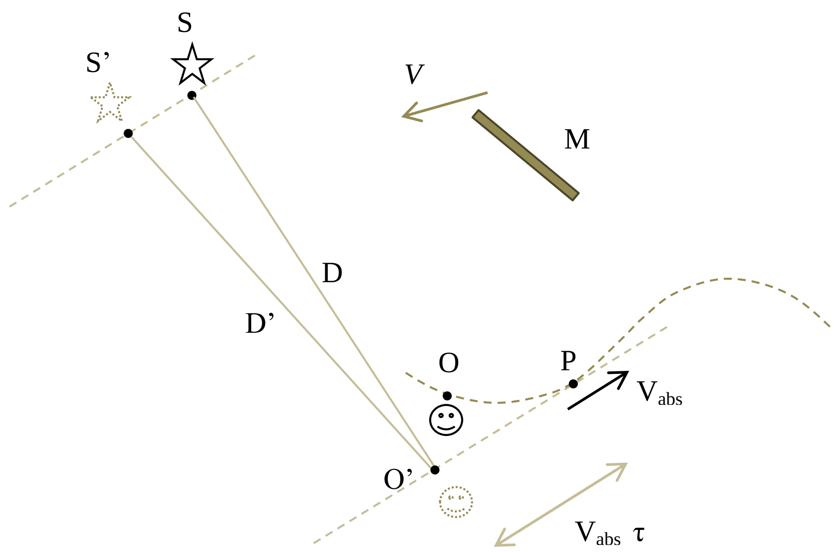

Fig. 24

Consider a light source S , an observer O and a mirror M (Fig. 24). The observer is moving along a defined curved path with continuously changing magnitude and direction of absolute velocity. The mirror M is moving with arbitrary velocity V. The motions and velocities of the observer and the mirror are relative to the absolute reference frame.

At time $t = 0$ the light source emits a very short light pulse. At the instant of emission ($t = 0$), the observer is at point O. The problem is to find the point P along the path where observer O will detect the light pulse.

We start by assuming that observer O will detect the light pulse reflected from the mirror at some point P. We know the instantaneous absolute velocity V_{abs} of observer O at point P. Then we draw a line tangent to the curved path at point P. Then we assume an imaginary inertial observer O' who is moving with the same velocity as the instantaneous velocity (V_{abs}) of the observer O at point P . Real accelerating observer O and imaginary inertial observer O' detect the reflected light pulse simultaneously at point P. Observer O takes time τ to move from point O to point P.

From V_{abs} and τ, we determine the location of imaginary inertial observer O' at $t = 0$. Then we determine distances D and D', from which the change in time of emission is determined for the imaginary inertial observer O'.

$$\Delta t = \frac{D' - D}{c}$$

We can analyze the experiment in the observer's reference frame or in the absolute reference frame. The *apparent* velocity of light in the absolute reference frame is the vector sum of the velocity of light in the observer's reference frame (which is always constant c) and the absolute velocity of the observer. From this we can determine the time of detection of the reflected light, assuming that the group velocity of light varies with mirror velocity according to the ballistic model. If the time of detection is different from the time of arrival of the accelerating observer at point P, we repeat the above procedure until they are equal.

This analysis applies to the Sagnac effect. Therefore, the previous analysis of the Sagnac effect in my previous papers needs to be corrected accordingly.

The Sagnac effect

The application of the Apparent Source Theory (AST) to the Sagnac effect has been one of the most (perhaps the most) challenging problems in the development of the theory. The enigma of the Sagnac effect has been resolved in my other paper [10].

Speed of electrostatic and gravitational fields

The speed of gravitational (and electrostatic) fields is one of the greatest puzzles in physics. Tom Van Flandern described the confusions regarding the speed of gravitational fields [9].

I have already proposed a very compelling solution to this mystery in my previous papers, based on Apparent Source Theory (AST). The subtly modified version of AST presented in this paper gives even clearer explanation, avoiding some problems with the original explanation.

I formulate the (modified) AST explanation of the speed of electrostatic and gravitational fields as follows, and based on this, propose equations for the anomalous Mercury perihelion advance.

The problem and confusion regarding the problem of speed of gravitational fields is usually presented as follows. Suppose that the Sun disappeared suddenly. Obviously, sunlight would disappear on Earth after a delay of about 8.3 minutes. The question is: will the gravitational pull of the Sun on Earth disappear suddenly or with the delay of the speed of light? What is the speed of gravity? Finite (light speed) or infinite?

The profound mystery behind the speed of gravity is revealed as follows. The speed of gravity is both finite (the speed of light c) and infinite.

Suppose that the Sun suddenly disappeared at $t = 0$. About 8.3 minutes before the actual disappearance of the Sun (that is at $t = -\ 8.3$ minutes), zero gravitational field will be emitted towards the Earth, moving at the speed of light c. The zero gravitational field reaches the Earth at

t = 0, at the instant of disappearance of the Sun. Therefore, by (apparent) violation of causality, the effect of disappearance of the Sun is felt instantaneously on Earth, implying instantaneous action, although the change in gravitational field travelled at the finite speed of light c to reach the Earth.

Next let us see the effect of absolute motion of the observer with regard to gravitational fields. Imagine a cosmic object (for example, the Sun) and an observer, both at rest. The distance between them is D. The gravitational field at the location of the observer is determined by Newton's law of gravitation. The force of gravity is directed towards the cosmic object (the Sun).

Now suppose that the observer is moving with absolute velocity, V_{abs}. The modified AST states that gravitational field at the location of the moving observer is determined by Newton's law of gravitation, but there is an apparent change in position (distance and direction) of the cosmic object (the Sun) as seen by the moving observer. Therefore, we use apparent distance D', instead of actual distance D. However, the distinction of the modified AST from the original AST is that the gravitational field is directed towards the actual position of the Sun, not towards its apparent position. We use D' only to calculate the *magnitude* of the field at the location of the moving observer.

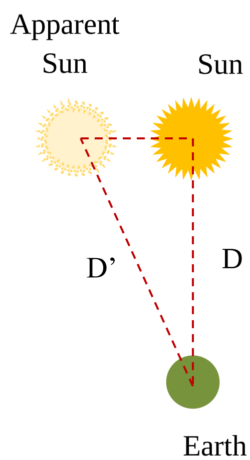

Fig. 25

Mercury perihelion advance

The above theory can be applied to the problem of the anomalous Mercury perihelion advance, as follows.

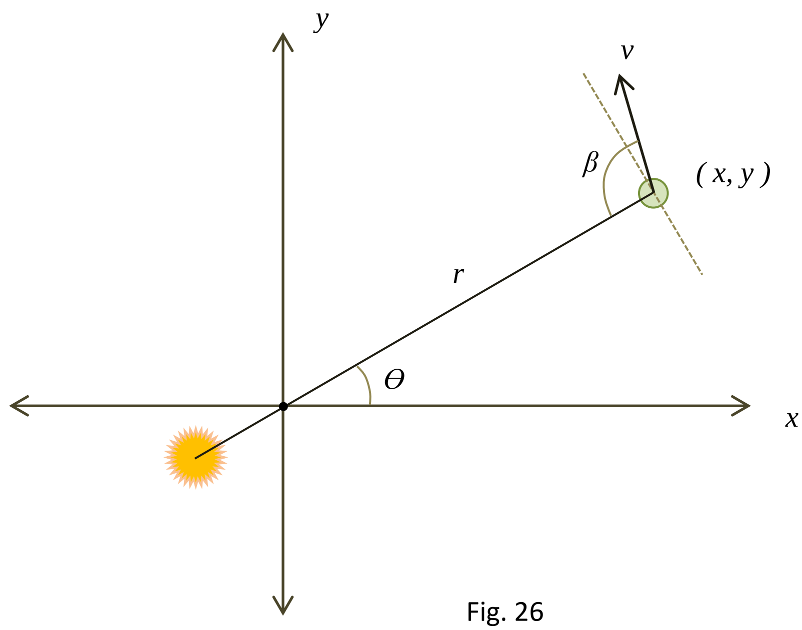

Fig. 26

$$\frac{-GMm}{r'^{\,2}}\cos\theta \;=\; m\,\frac{d^2x}{dt^2}$$

$$\Longrightarrow\; \frac{-GMm}{r'^{\,2}}\,\frac{x}{r} \;=\; m\,\frac{d^2x}{dt^2}$$

$$\frac{-GMm}{r'^{\,2}}\sin\theta \;=\; m\,\frac{d^2y}{dt^2}$$

$$\Longrightarrow\; \frac{-GMm}{r'^{\,2}}\,\frac{y}{r} \;=\; m\,\frac{d^2y}{dt^2}$$

But, according to (modified) AST,

$$r' \;\cong\; r\,\frac{c}{c - V\cos\beta}$$

These can be solved by computer numerical method (by using Ms Excel) to see if the anomalous 41 arc seconds per century is predicted correctly. Note that we have approximated *r* to be the distance of the planet (Mercury) from the barycenter. For an exact analysis, *r* is the distance between the Sun and the planet.

Conclusion

In this paper, we have seen a new model of the speed of light, Modified Apparent Source Theory (AST), according to which: 1. The center of the light wave fronts for an observer is at the point of light emission relative to the inertial observer and moves with the same velocity as the absolute velocity of the inertial observer. 2. There is an apparent change in the time of light emission for an absolutely moving observer compared to an observer at rest. This is because of an apparent change in position of light emission. However, light is always assumed to come from the actual/physical point of emission, not from the apparent point of emission, unlike the previous version of AST. The modified AST model can explain many light speed experiments without any paradoxes introduced by the original version of AST.

Glory be to Almighty God Jesus Christ and His Mother Our Lady Saint Virgin Mary.

References

1. *A Modified Michelson-Morley Experiment*, by Henok Tadesse

   http://vixra.org/pdf/2101.0180v2.pdf

2. *Scientific Proof of God Based on Quantum Phenomena- Wave-Particle Duality as an Overwhelming Evidence of Direct Divine Intervention!*, by Henok Tadesse

   http://vixra.org/pdf/2006.0083v3.pdf

3. *Causality Violation in Quantum, Electromagnetic and Gravitational Phenomena – Wave-Particle Duality as an Overwhelming Direct Evidence of Divine Intervention!* by Henok Tadesse

   http://vixra.org/pdf/2006.0084v1.pdf

4. *Light Speed, Absolute Motion and Quantum Phenomena- Does Nature Have a Foreknowledge of Observer's Motions and Actions? Scientific Proof of God*, by Henok Tadesse

   http://vixra.org/pdf/2007.0162v2.pdf

5. *Co-Existence of Absolute Motion and Constancy of the Speed of Light – Scientific Proof of God*, by Henok Tadesse

   http://vixra.org/pdf/2008.0084v4.pdf

6. *Constancy of the Speed of Light Relative to All Observers*, by Henok Tadesse

http://vixra.org/pdf/2110.0162v1.pdf

7. UNIT 5 INTERFERENCE BY DIVISTON OF WAVEFRONT, page 16

https://egyankosh.ac.in/bitstream/123456789/19062/1/Unit-5.pdf

8. *Apparent Paradoxes in Apparent Source Theory*, by Henok Tadesse

http://vixra.org/pdf/1704.0142v5.pdf

9. *The Speed of Gravity- What the Experiments Say*, by Tom Van Flandern

10. Cracking the enigma of the Sagnac effect, www.vixra.org, by Henok Tadesse

APPENDIX

A Contradiction in Special Relativity Theory

It is a basic requirement of special relativity theory (SRT) that all relatively moving inertial observers agree on an observable (interference fringe shift, for example). It is shown that SRT trivially leads to a disagreement on the observables (interference fringe shift) in two relatively moving inertial reference frames. No such contradiction exists in Galilean relativity.

<u>Fringe shift predicted in two relatively moving inertial reference frames</u>

Consider two inertial reference frames S and S' , with origins O and O' respectively (see Fig 27). S' is moving with velocity v relative to S, in the + x direction. S is the reference frame of the laboratory. At time $t = 0$, the origins O and O' coincide. An observer A with an interferometer is moving with velocity v_0 in the lab frame S , in the + x direction and is just passing through the origin O at $t = 0$. To avoid complications due to Doppler effect, we assume that the light source moves with velocity v_0 to the left, and is just passing through point E at $t = 0$.

The difference form of the Lorentz transformation equations is given below.

$$\Delta x' = \gamma \; (\Delta x - v \, \Delta t \;) \quad , \quad \Delta t' = \gamma \; (\Delta t - \frac{v \Delta x}{c^2} \;)$$

where

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

Δx is the difference in path lengths of the two light beams in frame S, and $\Delta x'$ is the difference in the path lengths of the two light beams in frame S'. Δt is the difference in the time of arrival of the two light beams in frame S, and $\Delta t'$ is the difference in time of arrival of the two light beams in frame S'.

Suppose that the interference fringe shift of the light speed experiment predicted in frame S is N, and the fringe shift predicted in frame S' for the same experiment is N'. It is a requirement of special relativity theory that there should be an agreement on the observable (the fringe shift) in both frames, i.e. $N = N'$. Let us see if this is actually the case.

We know that,

$$N = \frac{c \, \Delta t}{\lambda} \qquad and \quad N' = \frac{\mathrm{c} \, \Delta t'}{\lambda'}$$

or

$$N = \frac{\Delta x}{\lambda} \qquad and \quad N' = \frac{\Delta x'}{\lambda'}$$

But, because of time dilation :

$$\lambda' = \gamma \lambda$$

Therefore,

$$N' = \frac{c\,\Delta t'}{\lambda'} = \frac{c\,\gamma\,\left(\Delta t - \frac{v\Delta x}{c^2}\right)}{\gamma\lambda} = \frac{c\,\left(\Delta t - \frac{v\Delta x}{c^2}\right)}{\lambda} = \frac{c\;\Delta t}{\lambda} - \frac{\frac{v\Delta x}{c}}{\lambda} = N - \frac{v\Delta x}{c\lambda} \neq N$$

Galilean relativity, however, does not lead to such disagreement, as shown below.

$$\Delta x' = \Delta x - v\,\Delta t$$

$$\Delta t' = \Delta t$$

$$c' = c \pm V \Rightarrow \frac{c'}{c} = 1 \pm \frac{v}{c}$$

$$f' = f \quad \Rightarrow \frac{c'}{\lambda'} = \frac{c}{\lambda} \quad \Rightarrow \lambda' = \lambda\,(1 \pm \frac{v}{c})$$

Therefore,

$$N' = \frac{c'\,\Delta t'}{\lambda'} = \frac{(c \pm v)\,\Delta t}{\lambda(1 \pm \frac{v}{c})} = \frac{c\,\Delta t}{\lambda} = N$$

Consider the following hypothetical experiment for illustration.

In the lab frame S, the moving observer A detects the clockwise propagating light at (x_2, t_2) and the counter-clockwise propagating light at (x_3, t_3).

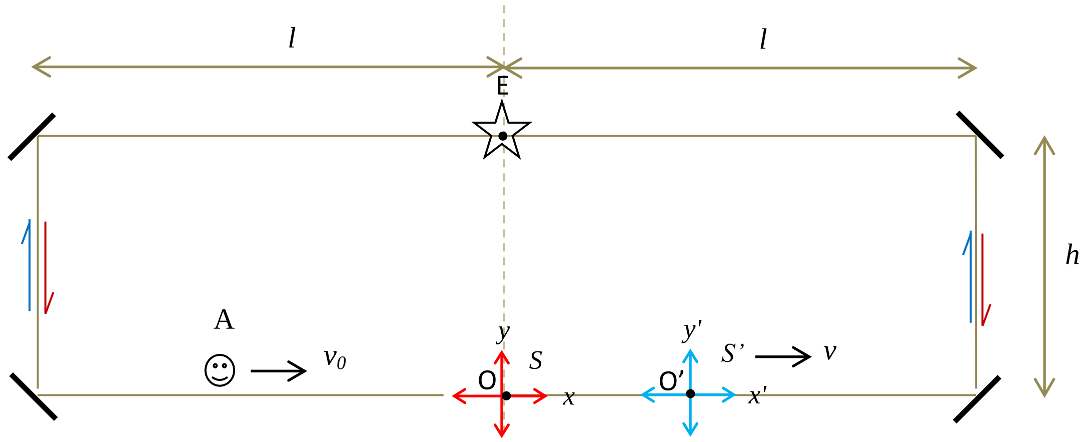

Fig. 27

In frame S, for the clockwise propagating light:

$$\frac{2l + h - x_2}{c} = \frac{x_2}{v_0}$$

$$\Rightarrow \; x_2 = \frac{v_0 \, (2l + h)}{c + v_0}$$

and

$$t_2 = \frac{x_2}{v_0} = \frac{(2l + h)}{c + v_0}$$

For the counter-clockwise propagating light:

$$\frac{2l + h + x_3}{c} = \frac{x_3}{v_0}$$

$$\Rightarrow \; x_3 = \frac{v_0 \, (2l + h)}{c - v_0}$$

and

$$t_3 = \frac{x_3}{v_0} = \frac{(2l+h)}{c - v_0}$$

$$\Delta x = x_3 - x_2 = v_0\,(2l+h)\,\frac{2v_0}{c^2 - v^2}$$

$$\Delta t = t_3 - t_2 = (2l+h)\,\frac{2v_0}{c^2 - v^2}$$

The fringe shift as predicted in frame S can be written as:

$$N = \frac{\Delta x}{\lambda} = \frac{v_0\,(2l+h)\,\frac{2v_0}{c^2 - v^2}}{\lambda}$$

But

$$\Delta x' = \gamma\,(\Delta x - v\,\Delta t)$$

$$\Rightarrow \Delta x' = \gamma\,\left(v_0\,(2l+h)\,\frac{2v_0}{c^2 - v^2} - v\,(2l+h)\,\frac{2v_0}{c^2 - v^2} \right)$$

$$\Rightarrow \Delta x' = \gamma\,(2l+h)\frac{2v_0}{c^2 - v^2}\,(v_0 - v)$$

The fringe shift predicted in frame S' will be:

$$N' = \frac{\Delta x'}{\lambda'} = \frac{\gamma\,(2l+h)\frac{2v_0}{c^2 - v^2}\,(v_0 - v)}{\gamma\,\lambda} = \frac{(2l+h)\frac{2v_0}{c^2 - v^2}\,(v_0 - v)}{\lambda}$$

We already obtained,

$$N = \frac{\Delta x}{\lambda} = \frac{v_0\,(2l+h)\,\frac{2v_0}{c^2 - v^2}}{\lambda}$$

Therefore,

$$N' = \left(1 - \frac{v}{v_0}\right) N$$

We can see that special relativity leads to a disagreement on the observed fringe shift in two inertial reference frames:

$$N' \neq N$$

For $v_0 = 0$, $N' = N = 0$. Therefore, the fringe shifts in S and S' agree only when $v_0 = 0$, that is when the observer looking at the fringe shifts is at rest relative to S. This is the case of the Michelson-Morley and similar experiments. In the case of $v_0 \neq 0$, which is the case of Sagnac effect and the hypothetical experiment discussed above, special relativity leads to a contradiction.

In summary, we have uncovered a flaw/ contradiction in special relativity theory that may have been overlooked for more than a century. No such contradiction exists in Galilean relativity. We have seen that special relativity theory leads to a disagreement between inertial frames on observables (fringe shift). This contradiction is not present in the case of the Michelson-Morley and similar experiments, which is the reason it remained hidden for so long. A rigorous, consistent application of special relativity and Lorentz transformations, which has been lacking in many of the analyses made by physicists so far, has led to this finding. The prevailing practice has been an intuitive application of ad hoc mixture of length contraction and time dilation concepts (which are only consequences of the Lorentz transformations) and classical views.