Explanation of Michelson-Morley, Sagnac and Moving Source Experiments

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Abstract

The Michelson-Morley experiment was flawed in that it was meant to detect something that never existed: the ether. The ether hypothesis should have been subjected to a thorough conceptual test even before doing a physical experiment. The Michelson-Morley experiment was capable to detect the ether, but was/is incapable to detect absolute motion. The terms 'absolute motion' and 'motion relative to ether' were always wrongly presumed to be the same. Despite the failure of Michelson-Morley experiment, absolute motion was detected with several other kinds of experiments, such as the Sagnac, the Michelson-Gale, the Marinov, the Silvertooth, the Roland De Witte experiments. A new interpretation of absolute motion and the speed of light is proposed in this paper: the speed of light is constant relative to the apparent source. The effect of absolute motion is to create an apparent change in the position (distance and direction) of a light source relative to the observer, for absolutely co-moving source and observer. For absolutely co-moving source and observer, the effect of absolute motion is to create a change in the path length, and not the speed, of light. Apparent Source Theory (AST) consistently explains the Michelson-Morley experiment, Sagnac effect and moving source experiments. Any true theory of the speed of light should convincingly explain *both* the Michelson-Morley and Sagnac experiments before making any other claims. AST hints on the fundamental nature of light itself. Light is a dual phenomenon : local and non-local.

Introduction

In 1887 Michelson and Morley devised and carried out a brilliant experiment to detect and determine the velocity of the earth relative to the then prevailing hypothetical ether. However, they didn't detect any fringe shift and this was not what they expected. This experiment has been repeated in its various forms during the last one hundred years and no motion relative to the ether has been detected.

Despite the failure of Michelson Morley experiments, the ether/absolute motion has been detected by different kinds of experiments, including the Sagnac effect (1913), the Michelson-Gale experiment (1925), the Roland De Witte, the Marinov, the Silvertooth (1986) experiments. Even the historical Michelson-Morley experiment result was not null, but a small fringe shift was reported. The Miller experiments are known to have detected small, systematic fringe shifts.

Consider Michelson-Morley experiment (MMX) and Sagnac effect. Why no fringe shift is observed in MMX but is observed in Sagnac experiment? A true model of the speed of light should convincingly reconcile these two experiments before making any other claims. All existing theories of the speed of light: Special Relativity, ether theory and emission theory, fail at least on one of the two experiments.

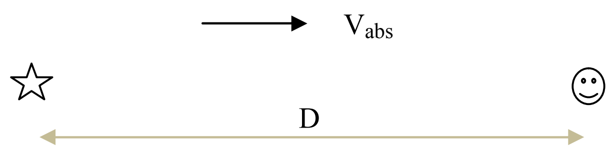
Distinction between absolute motion and the ether

This discrepancy makes one to suspect a flaw in the conception of Michelson-Morley (MM) experiment. The MM experiment was meant to detect something that never existed: the ether. The ether hypothesis should have been subjected to some conceptual test even before doing a physical experiment. For example, the ether was thought to exist and flow through material objects freely, i.e. it doesn't interact with matter. Since light itself was assumed to be a wave of the ether, then light would also pass through any object, which is absurd.

The null result of Michelson-Morley experiment was interpreted to mean non-existence of absolute motion. Absolute motion was presumed to be motion relative to the ether. No one suspected if there was distinction between the two. A new interpretation of absolute motion and the speed of light is proposed in this paper. In this paper we will prove the existence of absolute motion by putting aside the 'relative to what question' for the time being.

Apparent Source Theory (AST)

Consider a light source and an observer absolutely co-moving as shown below.

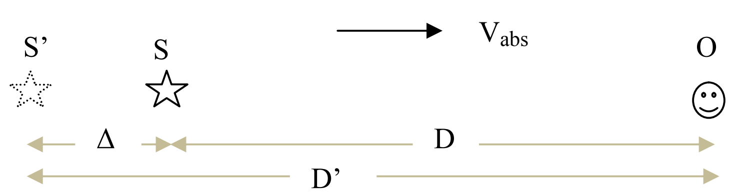


If the source and observer are at absolute rest ($V_{abs} = 0$), the time delay between emission of a light pulse and its detection at the observer will be:

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

However, if $V_{abs} \neq 0$, the time delay will be different, i.e. $T \neq \frac{D}{c}$. We may *postulate* that the effect of absolute motion is to create a change in the time delay T. At this point we make a careful interpretation. Why does time delay T vary with absolute velocity? Is it because the speed of light is variable relative to the observer, as for a sound wave? No, because this would imply a medium for light transmission which was disproved by the Michelson-Morley experiment. For co-moving source and observer, the speed of light is always equal to *c*. How then does T vary with absolute velocity if c is constant, as physical distance D is also constant ?

This puzzle is solved as follows: time delay T varies with absolute velocity because the source observer distance *apparently* changes with absolute velocity. For absolutely co-moving source and observer, light behaves *as if* the distance between source and observer is different from the actual, physical distance D. In other words, the position of the source apparently changes relative to the observer, for absolutely co-moving source and observer. Relative to the observer, the source appears to be farther than its physical distance D, in the case of an observer in front of the source with reference to the direction of motion.



The source appears to have shifted away from the observer by distance Δ. The observer O measuring the time delay T between emission and detection of the light pulse will be able to make correct explanation and prediction only by assuming that the light pulse started from S' and not from S, and by assuming that the speed of light is equal to c relative to the apparent source S'.

The amount by which the source apparently shifts position is determined as follows. The time elapsed for the light pulse to go from apparent source position S' to the observer is equal to the time elapsed for the source to move from position S' to S. i.e.

$$\frac{D'}{c} = \frac{\Delta}{V_{abs}}$$

But

$$D' = D + \Delta$$

From the above two equations

$$D' = D\frac{c}{c - V_{abs}} \quad \text{and} \quad \Delta = D\frac{V_{abs}}{c - V_{abs}}$$

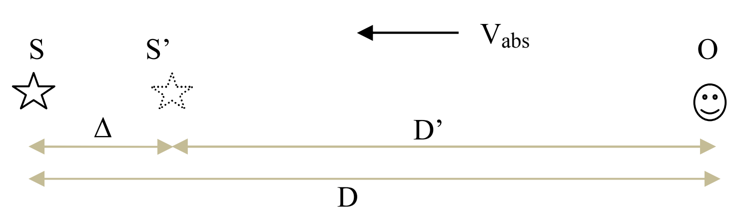
The time delay T will be:

$$T = \frac{D'}{c} = \frac{D}{c - V_{abs}}$$

In the above *interpretation*, each apparent source position S' applies only to a single point relative to the source. This means that the apparent source position is different for observers at different positions relative to the source. Each observer sees their own apparent source. This is because the apparent source distance D' depends on the physical source distance D and on absolute velocity V_{abs}.

Thus the effect of absolute motion is just to create an apparent change in position (distance and direction) of the source relative to the observer. To analyze an experiment involving absolutely co-moving source and observer, therefore, we just replace the real source with an apparent source. Then we analyze the experiment by assuming the speed of light to be constant *relative to the apparent source*. ***The speed of light is always constant relative to the apparent source.***

Similar analysis applies for an observer behind the light source, i.e. an observer 'chasing' a light source. In this case, the source *appears* to have shifted towards the observer by an amount Δ.



$$\frac{D'}{c} = \frac{\Delta}{V_{abs}}$$

But

$$D' = D - \Delta$$

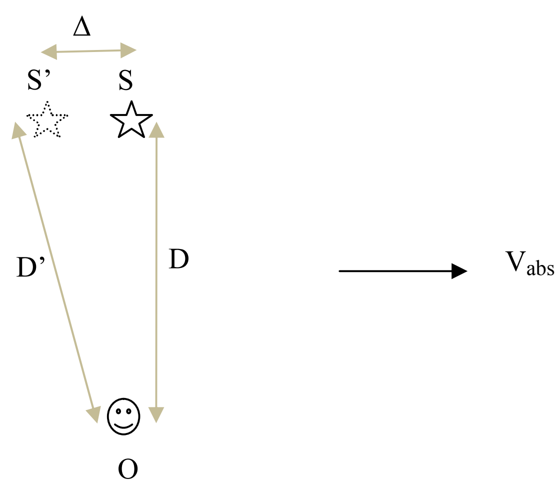
From the above two equations

$$D' = D\frac{c}{c + V_{abs}} \quad \text{and} \quad \Delta = D\frac{V_{abs}}{c + V_{abs}}$$

The time delay T will be:

$$T = \frac{D'}{c} = \frac{D}{c + V_{abs}}$$

Next imagine a light source S and an observer O absolutely co-moving as shown below, with the relative position of S and O orthogonal to the direction of their common absolute velocity.



During the time interval that the light pulse goes from S' to O, the source goes from S' to S.

$$\frac{D'}{c} = \frac{\Delta}{V_{abs}}$$

But,

$$D^2 + \Delta^2 \simeq D'^2$$

From the above two equations

$$D' = D\frac{c}{\sqrt{c^2 - V_{abs}{}^2}}$$

Therefore, the time delay *T* between emission and detection of the light pulse in this case will be:

$$T = \frac{D'}{c} = \frac{D}{\sqrt{c^2 - {V_{abs}}^2}}$$

From the above interpretation, we can work out the procedure to analyze any light speed experiment as follows:

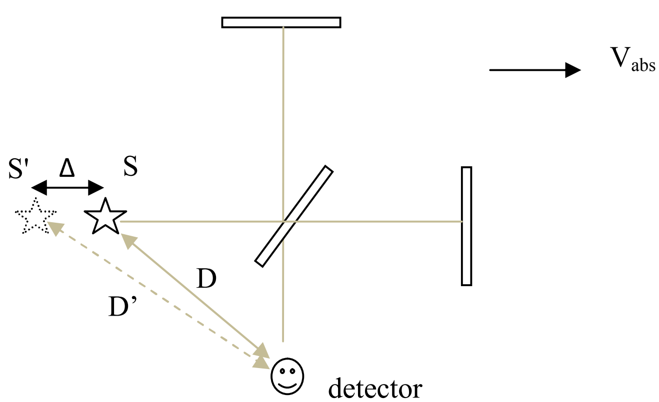
1. Replace the real source with an apparent source
2. Analyze the experiment by assuming that the speed of light is constant relative to the apparent source.

This means that we replace the real source with an apparent source to account for absolute motion. Once we put the apparent source at the apparent source position, we assume space to be Galilean, and analyze the experiment by assuming the speed of light to be constant c relative to the apparent source. This is analogous with conventional emission theory in which the speed of light is constant relative to the source.

The distance D we use to determine apparent source position D' in the above analyses is always the *direct* source observer distance, even if no light comes directly from the source to the observer, but through mirrors as in the Michelson-Morley experiment.

Michelson-Morley experiment

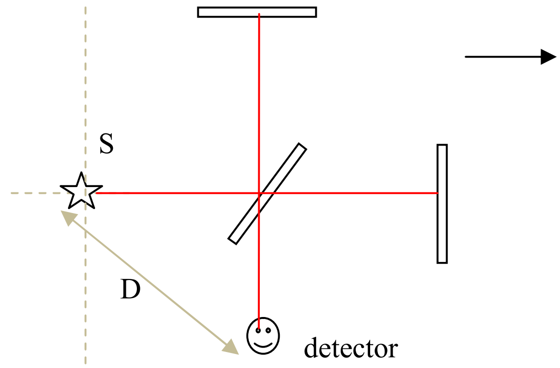
Now let us apply Apparent Source Theory (AST) to the Michelson-Morley experiment.



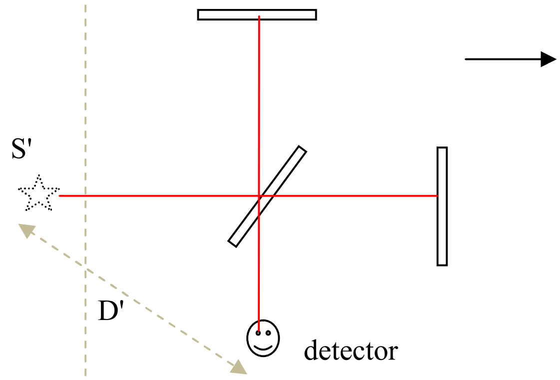
In the above diagram of Michelson-Morley experiment, the real source S has been replaced by an apparent source S'. Once we replace S with S', we assume the speed of light to be constant relative to S'. We may think of this as applying conventional emission theory to S'.

To understand the above analysis, one only needs to ask: assuming Galilean space, will actually/ physically moving the source from position S to position S' create any fringe shift? The obvious answer is NO because both the lateral and longitudinal beams would be affected equally.

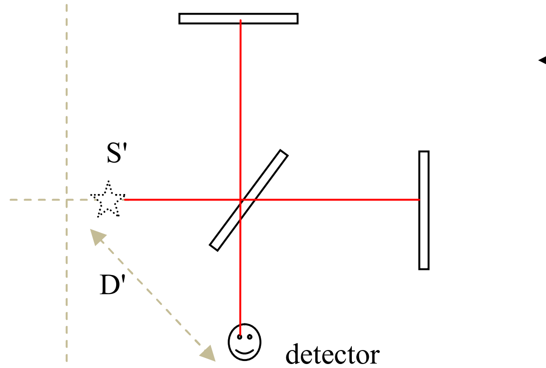
The above diagram is redrawn below to show cases of zero absolute velocity and non zero absolute velocities. No (significant) fringe shift will be expected simply because the source position has changed. Note that *physically* light always starts from the real source S, but light acts *as if* it started from apparent source S'.



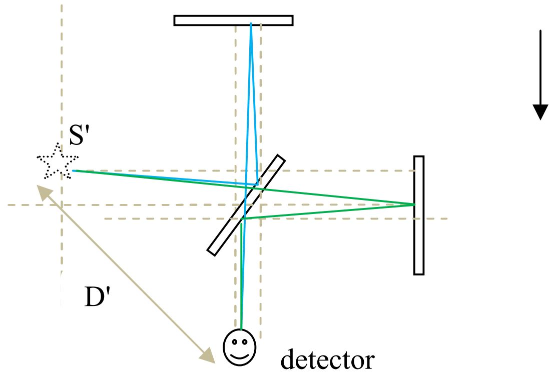
Zero absolute velocity. Light starts from physical source S.



Non- zero absolute velocity to the right. Light acts *as if* it started from apparent (non-physical) source S'.



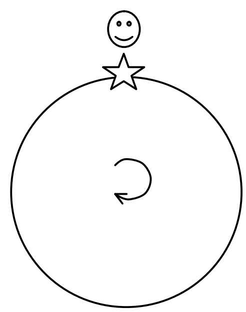
Non- zero absolute velocity to the left. Light acts *as if* it started from apparent (non-physical) source S'.



Non- zero absolute velocity downwards. Light acts *as if* it started from apparent (non-physical) source S'.

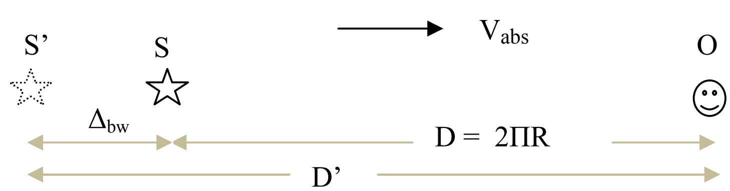
Sagnac effect

Let us consider a hypothetical Sagnac interferometer.



Assume that the light source emits light in the opposite directions tangentially. The two light beams travel in circular paths in opposite directions before being detected at the detector. A circular mirror is used to make light travel in circular path.

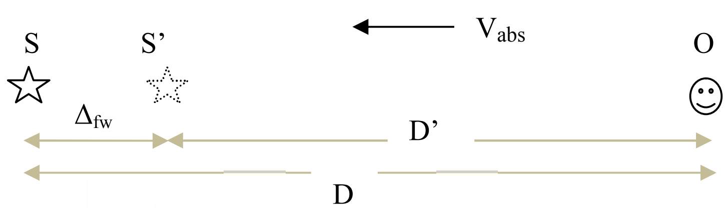
Consider the light emitted in the forward direction. This case can be considered to be an absolute translation problem already discussed, with the observer in front of the source.



From our previous analysis:

$$D' = D\frac{c}{c - V_{abs}} = 2\Pi R\,\frac{c}{c - V_{abs}} \quad \text{and} \quad \Delta_{bw} = D\,\frac{V_{abs}}{c - V_{abs}}$$

The case for light emitted backwards can be represented as follows.



$$D' = D\frac{c}{c + V_{abs}} = 2\Pi R\,\frac{c}{c + V_{abs}} \quad \text{and} \quad \Delta_{fw} = D\,\frac{V_{abs}}{c + V_{abs}}$$

The observer sees two different apparent sources: when looking in the backward direction and when looking in the forward direction. The distance of the apparent source when looking in the backward direction is greater than the physical source observer distance D = 2ΠR. The distance of the apparent source when looking in the forward direction is less than the physical source observer distance D = 2ΠR.With the apparatus rotating, therefore, a fringe shift will be observed at the detector.

The path difference of the forward and back ward beams will be:

$$\Delta = \Delta_{fw} + \Delta_{bw} = D\,\frac{V_{abs}}{c+V_{abs}} + D\,\frac{V_{abs}}{c-V_{abs}} = D\,\frac{2V_{abs}c}{c^2-{V_{abs}}^2}$$

But , D = 2ΠR and $V_{abs} = \omega R$

From which

$$\Delta = 2\pi R\,\frac{2V_{abs}c}{c^2-{V_{abs}}^2} = 4\pi R\,\frac{\omega R c}{c^2-\omega^2R^2} = 4\pi R^2\frac{\omega c}{c^2-\omega^2R^2} = 4A\,\frac{\omega c}{c^2-\omega^2R^2}$$

where A= ΠR^2 is the area of the circle.

Dividing both the numerator and denominator by c^2

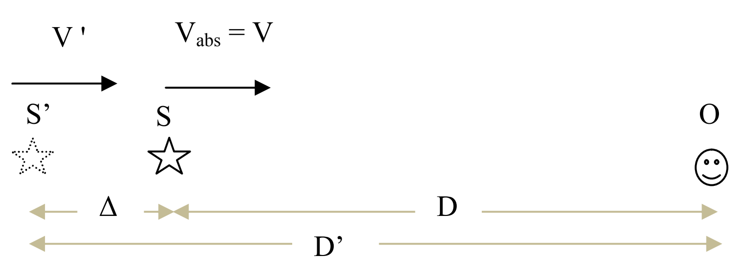
$$\Delta = \frac{4\omega A c}{c^2-\omega^2R^2} = \frac{\frac{4\omega A}{c}}{1-(\frac{\omega R}{c})^2}$$

In the above analysis of a hypothetical Sagnac experiment, we just interpreted it as two absolute translational motions, with the observer chasing the light source and the observer escaping from the light source. There is no reason why we can't consider the Sagnac effect as an absolute translation, at least for this hypothetical, simplest case. This is because the observer is moving along the light paths, just like an observer behind or in front of a light beam, for absolutely co-moving (translating) source and observer.

Moving source experiments

So far we have been considering the special case of absolutely co-moving source and observer. A general principle governing the speed of light is proposed as follows. The procedure of analysis of any light speed experiment is as follows:

1. Determine the distance between the observer and the apparent source *at the instant of emission.* This is determined from source observer physical distance at the instant of emission and *source absolute velocity.*
2. From the absolute velocities of the source and the observer, determine the velocity of the source *relative* to the observer, from which the velocity of the apparent source *relative* to the observer will be determined
3. Solve the problem by assuming that the speed of light is constant *relative to the apparent source*



Now we apply the above general analysis to the specific case of moving source and stationary observer shown above. Consider a light source moving towards an observer that is at absolute rest. We want to show that the speed of light is independent of the speed of the source.

Assume that the distance between source and observer *at the instant of light emission* is D. Assume also that the observer is at absolute rest.

The procedure of analysis is to determine the distance between the *apparent source* and the observer at the instant of emission and the velocity of the apparent source relative to the observer.

The apparent source distance D' at the instant of emission is :

$$D' = D \frac{c}{c - V_{abs}}$$

The velocity V' of the apparent source is determined by differentiating both sides of the above equation with respect to time:

$$D' = D \frac{c}{c - V_{abs}} \Rightarrow \frac{dD'}{dt} = \frac{dD}{dt} \frac{c}{c - V_{abs}} \Rightarrow V' = V \frac{c}{c - V_{abs}}$$

where V is the velocity of the real source and V' is the velocity of the apparent source relative to the observer.

According to AST, the speed of light is constant relative to the apparent source. So the speed of light relative to the observer will be c + V ' . Therefore, the time elapsed between emission and detection of light will be:

$$T = \frac{D'}{c + V'} = \frac{D \frac{c}{c - V_{abs}}}{c + V \frac{c}{c - V_{abs}}} = \frac{Dc}{c\,(c - V_{abs} + V\,)} = \frac{D}{c} \qquad (\text{ because } V_{abs} = V)$$

Physically the light always starts from the real source S but light behaves as if it started from S' . Even though light appears to have been emitted from an apparent distance D' > D, the increase in distance is exactly compensated by the increase in the velocity of light. The velocity of light relative to the observer is c + V', where V' is the velocity of the apparent source relative to the observer. Therefore, the physically measured speed of light is independent of source velocity.

This shows that the physically measured speed of light is independent of source velocity, as confirmed by several experiments.

Discussion

The main aim of this paper is to present a new *model* of the speed of light that can consistently predict and explain the results of light speed experiments. But a question would surely arise: what is the physical meaning of Apparent Source Theory (AST) ? I would like to note that the physical meaning of AST has no importance in the analysis of light speed experiments, but is only useful for some intuitive understanding of the theory. AST can be understood intuitively as follows: the speed of light is $c + V_{abs}$ in the backward direction and $c - V_{abs}$ in the forward direction *relative to a source* moving with absolutely velocity V_{abs}. This is why the speed of light does not depend on the speed of the source. If a source moving towards a stationary observer emits light, the light will not arrive earlier because the speed of light relative to the observer will be the sum of the speed of light relative to the source in the forward direction (which is $c - V_{abs}$) and the speed of the source relative to the observer : $(c-V_{abs}) + V_{abs} = c$. AST implies bending of light rays relative to the source in lateral directions. Hence AST implies aberration of light even for absolutely co-moving source and observer.

As a successful theory, AST also gives profound implications regarding the fundamental nature of light itself. The puzzle of light being a local or a non-local phenomenon is a centuries old puzzle and is still unsolved. The solution to the puzzle as implied by AST is proposed as follows:

Light is a dual phenomenon: local and non-local (action at a distance).

The other important problem is the implication of AST on Maxwell's equations. The electric and magnetic fields at every point in space seem to be controlled independently by the source. Consider absolutely co-moving source and observer. The light detected at the point of observation is more accurately understood as coming directly at the speed of light from the (*apparent*) source, and not from an adjacent point as in local phenomenon (e.g. sound wave). What is meant here is that light at point of observation comes from adjacent points of space, but we can't observe this physically, we just imagine it. If one tries to observe what is happening at an adjacent point, they will detect a wave coming to that point only. To every point of observation comes *its own* wave. Light is a dual phenomenon: local and non local. The current understanding of Maxwell's equations is based on a tacit assumption of the ether. Electromagnetic wave is still thought to be a local phenomenon, just as material waves, which is wrong. An EM wave propagates from the (apparent) source to the point of observation according to Maxwell's equations. We should not think this as material waves. We can't observe the propagation of the wave in the path between the apparent source and the observer: we just imagine it. *Each point in space surrounding the source observes its own, independent EM wave coming from the (apparent) source.* This is the distinction between electromagnetic waves and material waves. In material waves, all points along the path of a wave see the same wave, only differing in phase. *In the case of a light source (an EM wave source), an independent wave propagates to each point in space !*

Conclusion

We have seen that Apparent Source Theory (AST) can consistently explain the Michelson-Morley experiment, Sagnac effect, moving source experiments, and moving observer experiments. Existing theories of light including Special Relativity, ether theory and emission theory fail on least on one of these experiments.

References

1. Absolute/Relative Motion and the Speed of Light, Electromagnetism, Inertia and Universal Speed Limit *c* - an Alternative Interpretation and Theoretical Framework, by Henok Tadesse, Vixra

Thanks to God and His Mother, Our Lady Saint Virgin Mary