Absolute Motion, the Speed of Light, Electromagnetism, Inertia and Universal Speed Limit *c* – Apparent Change of Point of Light Emission Relative to an Absolutely Moving Observer

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Absolute/Relative Motion and the Speed of Light, Electromagnetism, Inertia and Universal Speed Limit *c* - an Alternative Interpretation and Theoretical Framework

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Abstract

A new model and theoretical framework of absolute motion and the speed of light is proposed in this paper. 1. For absolutely co-moving light source S and observer O, with uniform rectilinear motion, the effect of absolute motion is to create an apparent change in the position of the source relative to the observer. The apparent source, just as the real source, is at rest relative to the observer and the speed of light is constant relative to the apparent source. Therefore, the procedure of analysis of a light speed experiment in this case is to replace the real source by an apparent source and analyze the experiment by assuming that the speed of light is constant relative to the apparent source. Once the real source is replaced with an apparent source to account for absolute velocity, we assume emission theory in which the group velocity of light is constant relative to the (apparent) source and depends on mirror velocity. The position of the apparent source is determined by assuming the ether to calculate the time delay of light emitted by the source and detected *directly* by the observer and *interpreting* the change in time delay as being due to an apparent change in the source position relative to the observer, rather than as being a result of varying speed of light which would be the case if the ether existed. In this paper it is revealed that the ether doesn't exist but absolute motion does exist. 2. For all other cases/experiments in which the light source S, an observer A and mirrors have independent, arbitrary absolute and relative velocities, for uniform rectilinear motion and for accelerated motion, including rotation, the experiment is analyzed according to the following principle: *an observer A who is at a given point relative to the light source, at a given instant of time, observes what a co-moving observer at that point is observing at that instant of time*. A co-moving observer O is defined in this paper as an observer who is at a given point in the reference frame of the source at the instant of light emission and continues to move with the same velocity (magnitude and direction) as the velocity of the source *at the instant of light emission*. For example, to determine the time instant when light emitted by a source is observed by an arbitrary observer (A) with known initial position and motion (velocity and acceleration) at the instant of light emission, we find a point relative to the source where a co-moving observer O at that point observes light at the time instant that observer A is passing through that point. 3. The phase velocity of light is constant, independent of source, observer and mirror velocity. The group velocity of light is independent of source absolute velocity, but depends on observer absolute velocity and on mirror velocity. 4. A new law of Exponential Doppler effect of light is proposed as: $\lambda' = \lambda\, e^{V/c}$ and $f' = f\, e^{-V/c}$, where V is the source observer relative velocity. 5. Light has dual natures: local and non-local, constant (phase) velocity and variable (group) velocity, behaving according to both ether (wave) theory and emission (particle) theory. Static electric and magnetic fields also have dual nature: finite and infinite speed of transmission 6. Inertia is electromagnetic radiation reaction. The speed of light is the universal limit on *absolute* velocities of all physical objects in the universe. The mass (inertia) increase of electrons with velocity is due to non-linear law of electromagnetic radiation power and radiation reaction. As the *absolute* velocity of a body approaches the speed of light, any further acceleration will result in or require increasingly infinite amounts of radiation power and radiation reaction. 7. Gravity is a difference between electrostatic attraction and repulsion forces. 8. Absolute velocity of an object is the resultant of its mass weighed velocities *relative* to all massive objects in the universe. The universal principle that applies to all light speed experiments is : an observer at a given point relative to the source, at a given instant of time , observes the same light phenomenon being observed by a co-moving observer at that point, at that instant of time. A co-moving observer is an observer that continues to move at the same velocity the source had at the instant of light emission. However, a more convenient procedure for experiments involving rectilinear motions is : 1. Replace the real source by an apparent source 2. Determine the velocity of the apparent source relative to the observer 3. Analyze the experiment by assuming that the speed of light is constant relative to the apparent source;

i.e. once the real source is replaced by an apparent source , we apply (modified) emission theory in which the group velocity is constant relative to the apparent source and depends on mirror velocity, but the phase velocity is always constant. Physically (intuitively) the group velocity (magnitude and direction) of light varies *relative to the real source*, due to absolute motion of the source. AST is a modified emission theory, a fusion between emission theory and ether theory. In the Sagnac experiment, the source appears farther away than its physical distance when looking in the backward direction and closer than its actual/ physical distance in the forward direction, relative to the detector. Physically this means that the velocity of light is $c + V_{abs}$ in the backward direction and $c - V_{abs}$ in the forward direction, *relative to the source* , hence a fringe shift at the detector. In the case of the Michelson-Morley experiment, an apparent change in the position of the light source relative the detector does not create a fringe shift, for the same reason that an actual (physical) change of the source position doesn't create any significant fringe shift. The group velocity of light *relativeto the source* moving with absolute velocity $V_{abs}$is $c - V_{abs}$ in the forward direction and $c + V_{abs}$ in the backward direction. Therefore, the velocity of light relative to a stationary observer will be: $(c - V_{abs}) + V_{abs} = c$ and $(c + V_{abs}) - V_{abs} = c$. The (group) velocity of light changes *relative* to the source in such a way that it will not be affected by source velocity.

1. Introduction

The notions, theories, experiments and phenomena on the absolute or relative nature of motion and space, the nature and speed of light, the phenomenon of electromagnetic radiation and the nature of static fields are numerous, puzzling, divergent and have been the source of centuries of confusions. The resolution of the many associated contradictions and puzzles has remained a daunting task to this date. Despite all claimed successes and advance of modern physics, physics remains to be still vague even at its fundamental, elementary levels. Many 'elementary' problems remain unsolved. For example, what is the 'speed' of static fields? What is gravity? How is electromagnetic radiation created? The problem of the speed of light is still a puzzle. Electromagnetism remains to be (one of) the most puzzling area of physics.

The principle of relativity, introduced by Galileo, is known to be one of the most cherished ideas in physics. The principle of relativity states that the laws of physics are the same in all inertial reference frames. It presumes that no experiment exists that can detect absolute motion.

The notion of absolute space/ absolute motion was also intuitive and existed since Newton, but its real meaning remained obscure. The absolute reference frame remained incomprehensible: relative to what is absolute motion determined?

The fundamental nature of light was another centuries old puzzle. Newton proposed the corpuscular theory of light. Huygens proposed the wave theory of light. Several experiments were carried out to test the two views: wave theory and emission theory. These include the Bradley stellar aberration experiment, the Arago star light refraction and aberration experiments, the Fizeau experiment and Young's double slit experiment. The results of these experiments were puzzling because in some cases light behaved as a wave and in other cases as corpuscles. For example, while Bradley's stellar aberration can be explained by corpuscular (emission) theory, and difficult to understand in terms of wave theory, it was found out that the angle of aberration didn't vary for different stars and also did not show any variation with time, that would be expected due to Earth's orbital motion, implying wave theory. In the Arago and Airy star light experiments, a telescope filled with optical media (glass, water) was used to observe star light aberration. A change in angle of aberration was expected as compared to the angle of aberration observed by air filled telescope, due to index of refraction of glass and water, but no such change was observed. This was explained by Fresnel’s ether drag formula, adding another version of ether theory, but further complicating the problem. The interference pattern in Young's double slit experiment implied the wave nature of light. The particle nature of light was also discovered later near the beginning of the twentieth century, with the photoelectric effect and other quantum phenomena.

In 1868 Maxwell developed equations which predicted that the speed of light is a constant *c*. Perhaps the most important confirmation of Maxwell's equations is its prediction of the speed of light, which was confirmed by experiments, such as the A. Michelson rotating mirror experiment. Maxwell's equations were one of the greatest discoveries in physics. However, Maxwell’s equation’s or their interpretation may still be incomplete. They were originally formulated with the assumption of the ether. Another problem is the lack of radiation reaction in the solution to Maxwell's equations, for uniformly accelerating charge. Also Maxwell's equations do not predict the photon (light quanta). The light speed problem is seen as the interpretation of the constant *c* in Maxwell's equations.

In 1887, Michelson and Morley (MM) set out to experimentally detect the absolute velocity of the Earth relative to the ether. The experiment failed to detect the expected fringe shift. This was the final blow to the long prevailing ether hypothesis and was the remarkable beginning of a century of puzzlement to come. Actually, the fringe shift in MM experiment was not null, but a much smaller fringe shift was observed. Since the observed fringe shift was much smaller than expected, that was interpreted as null. The light speed puzzle was thus born: relative to what is the speed of light constant *c* ? The non-existence of the ether conflicted with the belief that light was a wave, that was proved by the Young’s double slit experiment.

The notion of absolute motion was thus abandoned in favor of relativity, both due to conceptual problems and the failed MM experiment. The ether hypothesis was not conceptually compelling in the first place. Failure to comprehend and detect absolute motion thus became the argument against its validity. The words ether and absolute space/absolute motion were always (wrongly) used synonymously. This paper proposes a new interpretation of absolute motion and the non-existence of the ether.

To account for the null result of the MM experiment, Lorentzproposed the Lorentz contraction hypothesis in which motion relative to the ether would result in length contraction in the direction of motion. Lorentz's hypothesis was later disproved by the Kennedy-Thorndike experiment.The speed of light is variable relative to the observer in the Lorentz hypothesis. Einstein discarded the ether altogether and formulated the Special Relativity Theory (SRT) in which lengths contract due to relative motion, not due to motion relative to the ether. Not only lengths contract but time is also dilated, so that the speed of light is constant in all inertial reference frames, for all observers.SRT is based on Lorentz transformations. Einstein explicitly announced the emptiness of space. SRT is derived from its two postulates: the principle of relativity and the constancy of the speed of light. Both of its two postulates are perceived as firm foundations of the theory. Einstein's thought experiment (chasing a beam of light) is particularly beautiful and compelling. SRT is the mainstream theory today, claimed to be one of the most experimentally tested theories in physics.

SRT predicts the outcome of *some* experiments with apparent accuracy, such as the Ives- Stilwell experiment and the 'time dilation' for cosmic ray muons. These are 'impossible' for conventional theories. But SRT unambiguously fails on a number of other experiments, such as the Silvertooth experiment. SRT is also counter intuitive, illogical and a source of many paradoxes, such as the Twin Paradox and the less known Trouton-Noble paradox. Even though SRT is accepted by the wider scientific community, many prominent scientists discarded it. A significant 'anti relativity' community exists today, arguing against the validity of SRT and proposing alternative theories.

The ether theory and emission theory existed along with SRT with their own minority proponents. Both have decisively failed on a number of experiments. For example, emission theory is the most natural explanation for the MMX null result. Prior to SRT, Einstein himself considered it seriously before abandoning it due to its 'complications'. The scientist who pursued the emission hypothesis most aggressively was Waltz Ritz who had his own version of emission theory. However, emission theories were disproved by moving source experiments and the de Sitter binary star argument. Emission theory also was not compatible with Maxwell's equations [18], which proved to be correct by predicting the speed of light. The ether hypothesis agreed with moving source experiments and the Sagnac effect, but it failed to explain the MM null result. These theories are currently outside the mainstream physics. The emission theory, particularly, has already been almost completely abandoned.

Numerous experiments related to the speed of light have been performed for decades and centuries. Several experiments were done before the advent of SRT, many more were performed to confirm or disprove SRT. The one truth about all these experiments is that they have all defied any natural and logical explanation within a single, existing theoretical framework. Despite all claims, there is no single theory of the speed of light to this date that can explain all or most of these experiments. No single model of the speed of light exists to this datethat does not fail on a number of basic experiments.

Listed below are many of the experiments and observations related to the speed of light:

- conventional Michelson-Morley experiments, including the Miller experiments
- modern Michelson-Morley experiments
- the Kennedy-Thorndike experiment
- the Sagnac experiment and the Michelson-Gale experiment, and the Dufour and Prunier test
- the Silvertooth experiment
- the Marinov experiment
- the Roland De Witte’s experiment
- A. Michelson and Q. Majorana moving mirror and moving source experiments
- the Roamer experiment
- the de Sitter’s binary star experiment
- the Venus planet radar range data anomaly (Bryan G.Wallace)
- lunar laser ranging experiment
- terrestrial light speed measuring experiments, such as the A. Michelson rotating mirror exp't

- the Rosa and Dorsey experiment
- Bradley stellar aberration experiment
- the Trouton-Noble experiment
- the Fizeau, the Arago, the Airy, the Hoek experiments and Fresnel's drag coefficient
- the ‘positron annihilation in flight’ experiment
- 'time dilation' experiments: the Hafele-Keating, GPS, cosmic ray muonexperiments
- the Ives-Stilwell experiment (transverse Doppler effect), and the fast ion beam experiment
- the Mossbauer rotor experiment
- relativistic ‘mass increase’ of the electron
- limiting light speed experiments
- bending of starlight near the sun
- Mercury perihelion advance
- Binary star (in relation to stellar aberration)
- Pioneer anomaly
- CMBR frequency anisotropy
- cosmological red shift and cosmological acceleration, ‘dark energy’, ‘dark matter’

There are also relatively recent crucial experiments that may shed light on the ever confusing subject of 'speed' of electrostatic fields, according to this paper:

- Measuring Propagation Speed of Coulomb’s Field, A. Calcaterra, et al [4]
- Astronomical experiment to determine the direction of Sun's gravitational pull on Earth[5].

The mainstream physics community considers many of these experiments as evidences of relativity (SRT and GRT), some experiments are ignored or considered 'invalid' simply b/c they are in disagreement with relativity, such as the Silvertooth experiment, and a few as anomalous.

Despite all claimed evidences, the fate of the principle of relativity still depends on whether or not someone will be able discover an experiment that can detect absolute motion. If a single experiment detects absolute motion, then Einstein’s relativity would be invalidated in its current form.

Several experiments have been performed throughout the last century that detected absolute motion. The null result of the Michelson-Morley experiment is the main evidence claimed to support SRT. Actually it is known that it was not a null result but a small fringe shift was observed. The Miller experiments are well known to have detected small, systematic fringe shifts.

Modern Michelson-Morley experiments, which use microwave and optical cavity resonators, showed NULL results, unlike conventional MM experiments; no absolute motion has been detected. This paper discloses a fundamental flaw in both the conventional and modern MM experiments.

The Sagnac and the Michelson-Gale experiments detected absolute motion as early as 1913 and 1925, respectively. These experiments have always been controversial because proponents of relativity argue that rotational motion is involved. But a'linear' Sagnac effect has also been demonstrated by RuyongWangetal.

The Marinov (1976), the Silvertooth (1986) andthe Roland De Witte(1992) experiments detected absolute translational velocity. Since no rotation is involved in these experiments, there can be no excuse for their rejection by the scientific community.

The Silvertooth experiment (1986) was particularly mind blowing, as the direction (towards Leo) and velocity (378 Km/s) reported was subsequently confirmed by the NASA COBE satellite from CMBR frequency anisotropy measurement. The detected change in 'wavelength' was correlated with sidereal time. The Silvertooth experiment conclusively disproved SRT. The Silvertooth experiment was a deadly blow to relativity but the mainstream physics community managed to forget about it.

Emission (ballistic) theory also is supported by the Michelson-Morley experiment, the Venus planet radar range anomaly (Bryan G.Wallace's), the Lunar Laser Ranging (LLR) experiment. LLR supports emission theory because, considering Earth's velocity (390 Km/s) in space, the detector on Earth would miss light reflected from the retro reflector on moon.

SRT has also been shown to be logically flawed by so many authors, and was rejected by many scientists, including Ernest Rutherford, Nicolas Tesla, Lorentz and many others.

As its second postulate, SRT assumes that the speed of light is the same for all observers. However, there is no direct, non-controversial evidence for this postulate. We had to rely only on Einstein's (beautiful) thought experiment: 'chasing a beam of light'. For example, one possible experiment could have been for an observer moving towards or away from a stationary light source and looking for a change in *wavelength* (implied by Einstein's light postulate?). However, according to this paper the fast ion beam experimentmay be as a confirmation of change in wavelength with observer velocity.Also, the Arago and Airy star light refraction experiments confirm the constancy of phase velocity, according to this paper.

On the other hand, the speed of light has been measured for centuries with increasing accuracy, from astronomical observations and terrestrial experiments, such as the Albert Michelson rotating mirror experiment. Apparently no variation has been observed in different experiments implying that the measured speed of light does not depend on the orientation of the measuring apparatus relative to the Earth's orbital or absolute velocity. A related problem is the issue of one way and two way speed of light and clock synchronization.

Thus the principle of relativity and the absolute notion both seem to have supporting evidences and the absolute notion has never been truly ruled out as often claimed in SRT. All the three well known theories of light namely, Einstein’s light postulate, emission theory and the absolute space (ether) theory, seem to have their own supporting evidences.
One may wonder then why relativity theory persists as a mainstream theory, despite increasing pool of experimental and logical evidences against it. One reason is the apparent success of SRT in predicting the results of some experiments, such as the Ives-Stillwell experiment, the Hafele-Keating experiment and the GPS corrections (both controversial) , mass increase of relativistic electrons, cosmic ray muon 'time dilation' and limiting light speed experiments. It is absolutely impossible to explain these experiments conventionally.

One perplexing aspect of SRT is its prediction of mass increase with velocity and the universal speed limit, which is the speed of light. These have been confirmed by accelerating electrons and beta particles with very high voltages and the velocity of the particles has always been just less than the speed of light and also violated the predictions of classical physics. The limiting light speedhas also been confirmed by time of flight method [14,15]. For a dissident of Einstein's relativity, this is a conundrum. This is because, if we assert that the speed of the particles has no relation to the speed of light, or if we assume that some of the particles could exceed the speed of light, why then do the velocities of *most* of these particles always build up near the speed of light? Velocity dependent Coulomb's law is one appealing explanation but it fails because the speed of cosmic ray muons has also been proven to confirm to the light speed limit by time of flight method[15]. Moreover, the energy of electrons accelerated to near light speed has been shown to continue to increase as the accelerating voltage is increased[14]. Also in the experiment[4] the reported agreement between experiment and prediction suggests that charge observer relative velocity will not affect the observed electric field of the charge.

SRT's successes have been effectively used as cover for its failures. On the other hand, it was the null result of the Michelson-Morley experiment that invoked the 'length contraction', 'time dilation' speculations. Even though Einstein was said to be unaware of the MM experiment when he formulated SRT, the 'length contraction' or length and time transformations were already proposed before him by Lorentz -Fitzgerald, which was meant to explain the Michelson Morley null result. What Einstein did was to give a new interpretation, by eliminating the ether. So it can be said that the whole relativity theory was based on the MM experiment null result. Therefore, if a more intuitive and logical alternative explanation for MM experiment is found, then Einstein's theory of relativity should be invalidated, irrespective of any other experiments claimed to support it.

The Ives-Stilwell experiment may be more credible because Herbert Ives himself was a dissident of Einstein's relativity. Other evidences of relativity, such as GPS correction, muon 'time dilation', Hafele-Keating experiment, however, are still controversial. For example, Van Flandern argued that relativity corrections are not actually used in GPS. Some authors also argue that circular logic is involved in the muon 'time dilation' experiment because the velocity of the particle is determined from its energy using the relativistic equation. Many of the experiments claimed as evidence of SRT are reported to have confirmed SRT to within such and such accuracy, ' to within 1% ' , ‘such parts in a billion’ etc. , even in cases where the experiments are controversial. This is intended to suppress challenges against Einstein's relativity and to discourage alternative ideas. How can a wrong theory be confirmed with such precision ?!

The main reason for the persistence of SRT, however, is that no alternative theory exists that can explain all conventional and 'relativistic' experiments. For example, Silvertooth himself could not provide a clear theoretical explanation of his experiment and this became an excuse for the mainstream physics community to ignore an experimental fact. Many scientists and authors have proved the logical invalidity of SRT, but no competing, successful alternative theory has ever come out to this date. The biggest challenge is not in pointing out the numerous logical flaws in SRT, but in finding an alternative competing explanation.

Therefore, we are in no shortage of experimental and logical evidences against relativity today. What is lacking is a theoretical framework that can explain the manyexperimental and observational facts that have accumulated for decades and centuries. For example, no theory exists today that can satisfactorily explain *all* of the following experiments: the Michelson-Morley experiment, the Sagnac effect, moving source experiments and moving mirror experiments and the Silvertooth experiment.

Naturally, I started by searching for an idea that can reconcile the MM experiment and the Sagnac effect. No theory of the speed of light is valid at least if it cannot explain both these experiments with the same treatment.All known existing theories (SRT, ether theory, emission theory) fail at least on one of these experiments. SRT proponents simply choose to ignore the Sagnac effect or they apply a different treatment to it.

After a considerable effort and puzzlement over years, I came across the seed of idea that can reconcile the MM experiment and Sagnac effect and developed this insight it into the Apparent Source Theory (AST). AST can also explain moving source and moving mirror experiments, moving observer experiments, the Miller experiments, the Silvertooth experiment, the Marinov experiment, the Roland De Witte experiment, the Bryan G.Wallace experiment, the Michelson rotating mirror light speed experiment, within a single theoretical framework. AST discloses the mystery behind the 'null' result of the MM experiments and why the Miller experiment detected a small fringe shift. It reveals the fallacy in modern and conventional Michelson-Morley experiments. It shows why the velocity of light is independent of source velocity and why it should depend on observer and mirror velocity. Apparent Source Theory (AST) is a model of the speed of light that can successfully explain many apparently contradicting experiments.

This paper builds on my previous paper [13]and attempts to develop a coherent theoretical framework of existing theories and notions, experimental evidences and observations related to the speed of light. A new theoretical framework is proposed in which the notion of absolute space/ absolute motion, emission theory and Einstein's light postulate, are seamlessly, naturallyfused into a single theoretical framework, with features of each theory left out that do not fit into the new model. Ether theory and emission theory are wrong in their current form and no length contraction time dilation of SRT exists. All existing known notions and theories of motion and the speed of light (absolute / relative, emission theory, absolute (ether) notion, Einstein's light postulate) play a crucial role in the new theoretical framework. Some existing aspects of Special Relativity, relativistic mass increase and universal light speed limit, are also adopted with a new interpretation and profound implications.

For a shorter presentation of the new theory (Apparent Source Theory), the author recommends papers [26][27][28][29][30][31][32][33].

2. Speed of light relative to an inertial observer

2. 1. Co-moving light source, observer and mirrors in absolute motion with constant velocity

In this section we discuss experiments with co-moving source and observer.

2.1.1. Apparent Source Theory (AST)

The idea that reconciles the Sagnac effect and the Michelson-Morley experiment is as follows:

for co-moving light source and observer, the effect of absolute velocity is to create a change in path length, and not the speed, of light.

Another way of stating this is:

for co-moving light source and observer, the effect of absolute velocity is to create an apparent change in the position (distance and direction) of the light source relative to the observer/detector.

This can be seen as a fusion of ether (or classical absolute space) theory and emission theory. It is very helpful to see it as modified emission theory.

The key idea is that there is no ether. With the ether hypothesis, light was assumed to be *only* a local phenomenon. This is the blunder that led to a confusion of more than a century. Michelson and Morley conceived their experiment based on this mistake. They treated light as ordinary, material waves, such as the sound wave. The Michelson-Morley experiment was designed to detect something that never existed: the ether. It disproved the ether, but was not capable of detecting absolute motion. This paper discloses the distinction between the two.

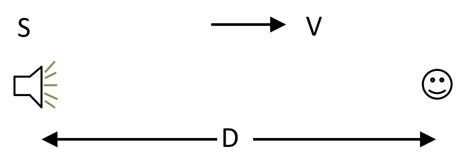
The null result of MM experiment should not have been a big surprise because the ether hypothesis itself was not anything more than a hypothesis. It never developed into the status of a theory. It could be invalidated conceptually, without any experiment. Any speculation should be subjected to a thorough conceptual test even before doing a physical experiment.

One simple argument against the ether would be as follows. The ether is assumed to have no interaction with matter. It exists and flows freely in material objects. Light was thought to be a wave of the ether, analogous to water waves being waves of water. In this case, therefore, light also should be able to pass through any physical object as light itself is just vibration of the ether. So we would be able to see objects behind opaque walls. And this is absurd. Since the ether does not interact with matter, then how would light even interact with our eyes?The ether was redundant. No one knew what the ether was made of.

Light is not only a local phenomenon. It is a dual phenomenon, both local and a non-local (action at a distance), simultaneously.

The ether and absolute motion were always (wrongly) perceived to be the same. This paper shows that the ether does not exist but absolute motion does. This is possible with a new interpretation of absolute motion.

Let us first consider a sound source and a receiver, co-moving with velocity V relative to the air.



If the source and receiver are both at rest relative to air, i.e. V = 0, a sound pulse emitted by S will be received after a time delay of:

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

If the source and the receiver are co-moving relative to the air, we can analyze the experiment by assuming the source and the receiver to be at rest, with the air flowing to the left. Since the speed of sound relative to the air is c_s, the speed of sound relative to the receiver will be:

$$c_s - V$$

Now a sound pulse emitted by the source will be received by the receiver after a time delay of:

$$t_d = \frac{D}{c_s - V}$$

In this case, it takes longer for sound waves to catch up with the receiver. By noticing a change in t_d , the observer can know that he/she is moving relative to the air and can calculate his velocity relative to air from knowledge of D and t_d.

Now we consider light. Since the ether hypothesis was disproved by the null result of Michelson-Morley (MM) experiment, there is no medium for light transmission. Yet the existence of absolute motion has been confirmed by several other experiments, such as Sagnac, Silvertooth, Marinov, Roland De Witteexperiments. Even the historical MM experiment result was not null and small, systematic fringe shifts were detected in the Miller experiments.But modern MM experiments are even more flawed than the conventional MM experiments and, fundamentally, cannot detect any absolute motion. All ether drift experiments disproved the ether but not absolute motion.

So the ether does not exist, but absolute motion does. How can we perceive absolute motion if no medium exists? We can understand absolute motion as follows.
Let us formulate a postulate:

For absolutely co-moving source and observer, it takes light emitted from the source a time delay $t_d$different from *D/c* to reach the observer. This means that the observer knows that he is inabsolute motion by noticing a change (increase or decrease) in time delay t_d. If absolute motion is valid, which has been proved experimentally, then light emitted by source will take more or less time than *D/c* to reach the observer, for absolutely co-moving source and observer.

For sound wave, the speed of sound relative to the receiver will be different from c_s, for source and receiver co-moving relative to air, where c_s is the speed of sound relative to air. Consider the problem in the reference frame of the sound source and the receiver, with the air flowing past them. So the time delay is known to be due to a change in the speed of sound relative to the receiver. Since there is no medium for light, there is no medium flowing past the observer and the light source, so the speed of light relative to the observer cannot be different from *c* , for absolutely co-moving source and observer. To assume that the speed of light will vary relative to the observer, for absolutely co-moving source and observer, would be inconsistent with the fact that there is no medium for light transmission. Therefore, for co-moving source and observer, the speed of light is always equal to *c* relative to the observer. Note, however, that the speed of light will *apparently* differ from *c* for co-moving source and observer, as will be seen later on. This apparent change in velocity of light occurs when we assume that light started from the physical source position, which is wrong. Physically the light always starts from its source and not from empty space, but light behaves *as if* it started from an apparent position of the source and this is the correct model that successfully explains many experiments.

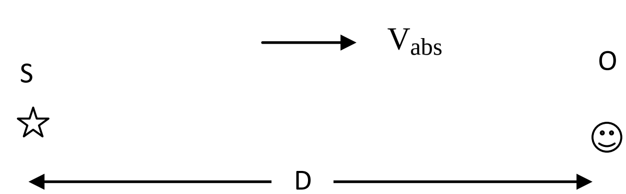
The key question is:

But how can t_d be different from D/c if the speed of light is still equal to c relative to the observer, for absolutely co-moving source and observer ?

The solution to this puzzle is that, for time delay t_d to be different from *D/c* , the distance between the light source and the observer should *apparently*differ from *D*.

Thus, the effect of absolute motion for co-moving source and observer is to create an apparent change in the <u>position</u> (distance and direction) of the light source relative to the observer.

Imagine a light source S and an observer O, both at (absolute) rest, i.e. $V_{abs} = 0$.

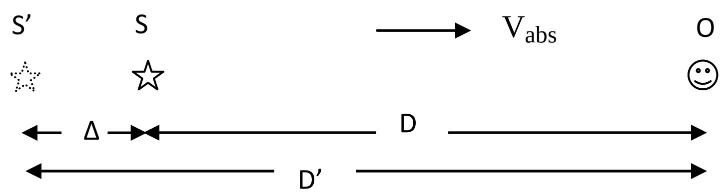


A light pulse emitted by S will be detected after a time delay of

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

This time delay is both the group and phase delay.

Now suppose that the light source and the observer are absolutely co-moving to the right.



The new interpretation proposed here is that the position of the source S changes apparently to S', *as seen by the observer, in the reference frame of the observer*. Once we make this interpretation, we can follow the classical (ether) way *just to make the calculations*, to determine the amount (Δ) by which the source position apparently changes. For example, when we say ' during the time that the source moves from S' to S, light moves from S' to O ' , we are not saying this in the conventional sense.

During the time (t_d) that the source 'moves' from point S' to point S, the light pulse moves from point S' to point O, i.e. the time taken for the source to move from point S' to point S is equal to the time taken for the light pulse to move from point S' to point O.

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

But

$$D + \Delta = D'$$

From the above two equations:

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

and

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

The effect of absolute motion is thus to create an apparent change of position of source relative to the observer, in this case, by amount Δ .

Once we have determined the apparent position of the source as seen by the co-moving observer, we can analyze the experiment either in the reference frame of the observer or in the absolute reference frame. Next we determine the time delay between emission and observation of light.

<u>In the reference frame of the co-moving observer</u>

1.The apparent source is at distance D' relative to the co-moving observer
2. The apparent source is at rest relative to the co-moving observer
3. The speed of light is constant relative to the apparent source

Therefore, a light pulse emitted by the source is detected at the observer after a time delay of:

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

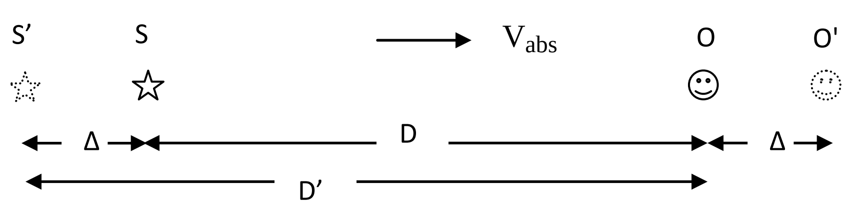
To the observer, the source S appears farther away than it physically is. For the observer, the center of the spherical wave fronts is always at S' and moves with it. We can see this as a modified emission theory, as a fusion of emission theory and ether (absolute) theory.

<u>In the absolute reference frame</u>

All light speed experiments should be analyzed in the co-moving observer's reference frame. The principle of analysis for any light speed experiment is this: *the time delay of light for an arbitrary observer at a given point relative to the source is equal to the time delay of light for a co-moving observer at that point.*

Therefore, analysis in the absolute reference frame is redundant. However, we present the analysis here in the hope to further illustrate AST.

Therefore, once we have replaced the real source S by an apparent source S', *as seen by a co-moving observer*, we can also analyze the experiment in the absolute reference frame and should get the same time delay as above.

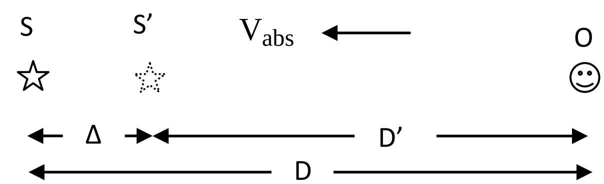


At $t = 0$, the apparent source emits light, and the observer is at O . After a time delay t_d the light catches up with the observer, at O' . Since the source and observer have the same velocity, the observer will move the same distance Δ as the apparent shift of the light source. Light emitted at

S' is detected at O'. Since the speed of light is constant relative to the apparent source, it is equal to $c + V_{abs}$ in the absolute reference frame. Note that this is only apparent (an artifact) and does not mean that the measured speed of light is $c + V_{abs}$ in the absolute reference frame. The measured (physical) speed of light is always equal to c in the absolute reference frame. The time t_d it takes light to travel from S' to O' is equal to the time it takes the observer to move from O to O'. Therefore,

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

In the same way, for absolute velocity directed to the left:



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

From which

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

and

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

In this case, it appears to the observer that the source is nearer than it actually is by amount Δ.

Once we have determined the apparent position of the source (S') as seen by the co-moving observer, we can determine the time delay t_d in the co-moving observer's reference frame or in the absolute reference frame.

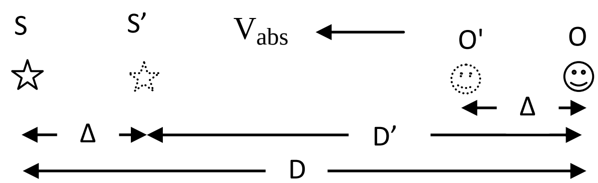
<u>In the co-moving observer's reference frame</u>

1. The apparent source is at distance D' relative to the co-moving observer
2. The apparent source is at rest relative to the co-moving observer
3. The speed of light is constant relative to the apparent source

Therefore, a light pulse emitted by the source is detected at the observer after a time delay of:

$$t_d = \frac{D'}{c} = \frac{D\,\frac{c}{c+V_{abs}}}{c} = \frac{D}{c+V_{abs}}$$

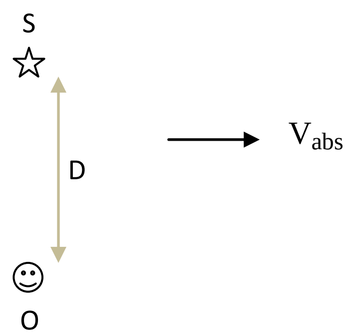
<u>In the absolute reference frame</u>



The time t_d it takes light to travel from S' to O' is equal to the time it takes the observer to move from O to O'.

$$t_d = \frac{D' - \Delta}{c - V_{abs}} = \frac{D\,\frac{c}{c+V_{abs}} - D\,\frac{V_{abs}}{c+V_{abs}}}{c - V_{abs}} = \frac{D}{c+V_{abs}}$$

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

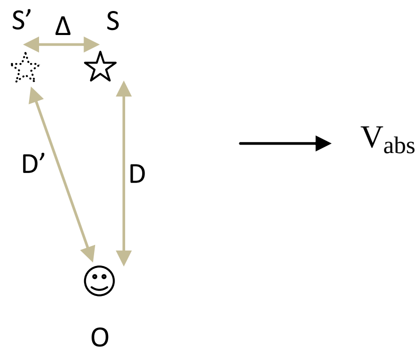


S and O are moving to the right with common absolute velocity V_{abs}.

If V_{abs} is zero, a light pulse emitted from S will be received by O after a time delay t_d

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

If V_{abs} is not zero, then the light source appears to have shifted to the left as seen by observer O.



In this case also, the effect of absolute velocity is to create an apparent change in the *position* of the source relative to the observer.

In the same way as explained previously,

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

i.e. during the time interval that the light pulse goes from S' to O, the source goes from S' to S.

But,

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

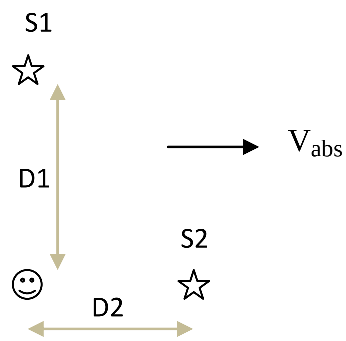
From the above two equations

$$D' = D\frac{c}{\sqrt{c^2 - V_{abs}{}^2}} \text{and} \quad \Delta = D\frac{V_{abs}}{\sqrt{c^2 - V_{abs}{}^2}}$$

Therefore, the time delay t_d between emission and reception of the light pulse in this case will be

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

Now suppose that there are two ideally *coherent* light sources S1 and S2 , as shown below. Recent experiments show that interference between independent laser lights is possible.

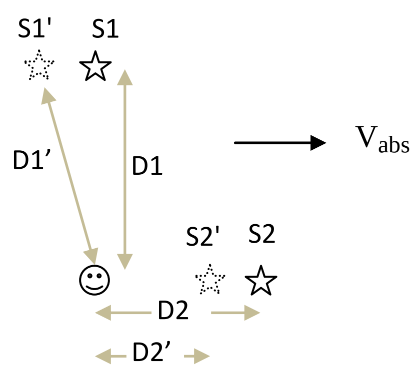


S1, S2 and observer O are co-moving absolutely to the right with absolute velocity V_{abs}.

If V_{abs} is zero the two time delays will be :

$$t_{d1} = \frac{D1}{c} \quad , \quad t_{d2} = \frac{D2}{c}$$

If $V_{abs}$is not zero, the positions of the sources will change apparently relative to the observer as shown below and hence the two time delays will be affected differently and hence a fringe shift occurs as the whole system is rotated (orientation of the apparatus changed relative to absolute velocityvector)



In this case, the two time delays will be different.

$$D1' = D1 \frac{c}{\sqrt{c^2 - {V_{abs}}^2}}$$

$$D2' = D2 \frac{c}{c + V_{abs}}$$

Therefore

$$t_{d1} = \frac{D1'}{c} = \frac{D1}{\sqrt{c^2 - V_{abs}{}^2}}$$

and

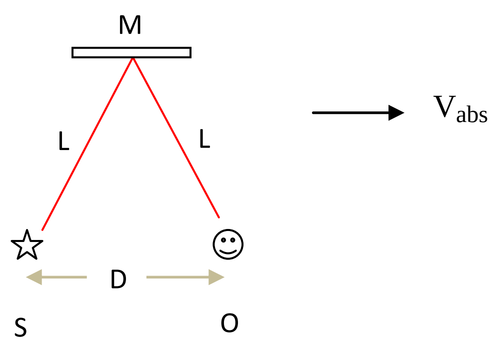
$$t_{d2} = \frac{D2'}{c} = \frac{D2}{c + V_{abs}}$$

Hence, it can be seen that a fringe shift would occur as the magnitude of the absolute velocity is changed or as the whole apparatus is rotated.

So far we have considered only the simplest ideal systems in which only a light source and an observer are involved. However, real experiments involve mirrors, causing confusions, so in the next section we will analyze a system additionally consisting of mirrors.

Consider a light source S, an observer O and a mirror M , co-moving to the right with absolute velocity V_{abs}.

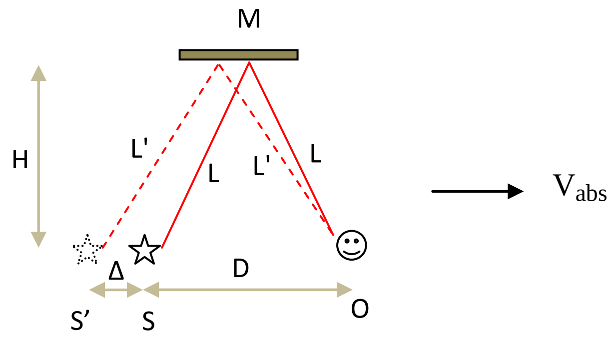
<u>In the co-moving observer's reference frame</u>



If $V_{abs}$is zero, then the time delay between emission and reception of a light pulse will be

$$t_d = \frac{2L}{c}$$

If V_{abs} is not zero, then, as discussed previously, the source S appears to have shifted away from the observer O by an amount Δ. The effect will be the same as physically shifting the source in a Galilean space and applying emission theory. In other words, we replace the real source with an apparent source and then analyze the experiment by assuming that the speed of light is constant relative to the apparent source.



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

Hence the length of the light path from S’ to O will be:

$$2L' = 2\sqrt{(\frac{D+\Delta}{2})^2 + H^2}$$

Therefore, the time delay will be

$$t_d = \frac{2L'}{c} = \frac{2}{c}\sqrt{(\frac{D+\Delta}{2})^2 + H^2}$$

where D is the ***direct*** distance from observer to source. Note that, throughout this paper, we always take source-observer *direct* distance to determine apparent position of the source, for experiments involving absolute translation. So the effect of absolute motion is just to create an apparent change in the position of the light source relative to the observer. This avoids all the confusions that arise in systems consisting of mirrors. We would not say, for example, that the mirror will move to a different position while the light beam is in transit, etc., as in standard, classical theories, such as in ether theory and SRT. Only the position of the light *source* is thought to change apparently relative to the observer. As already said, we can think of this as actually/ physically shifting the source from position S to S' in Galilean space, with the same effect, *for that observer*. In other words, we replace the real source with the apparent source to account for the absolute velocity. Once we have done this, we assume Galilean space and simply use (modified) emission theory. Modified emission theory is one in which the *group* velocity is constant relative to the *apparent source* (it is constant relative to the *source* in conventional emission theory), whereas the phase velocity is constant *c* independent of source or observer velocity. Constancy of phase velocity is explained in a later section.

According to AST, the procedure of analysis of light speed experiments is:

1. Replace the real source with an apparent source
2. Analyze the experiment in the reference frame of the observer by assuming the *group* velocity of light to be constant relative to the apparent source.

Equivalently, the above procedure means that we replace the real source with an apparent source and then analyze the experiment by assuming Galilean space in which (modified) emission theory holds. In modified emission theory, the *group* velocity is constant relative to the apparent source. Apparent Source Theory applies only to group velocity, not to phase velocity because the phase velocity is always constant, independent of source or observer velocity[6], as will be discussed later on.

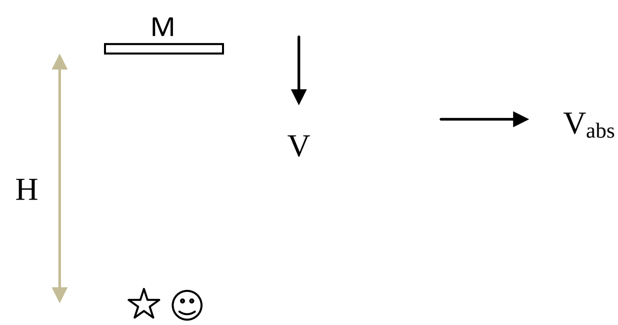
What if the mirror is moving relative to the observer in the above experiment? Assume that the mirror is moving towards or away from the source and the observer with velocity V, with the source and observer at rest relative to each other, but with a common absolute velocity as shown in the next figure. How are such experiments analyzed?

The procedure of analysis is restated below:

1. Replace the real source with an apparent source (i.e. a source at the apparent position)
2. Analyze the experiment in the reference frame of the co-moving observer by assuming that the *group* velocity of light to be constant relative to the apparent source.

Let us consider a simple case in which the distance D between source and observer is much less than the distance H to the mirror, so that we can assume that the source and observer are essentially at the same point in space. From our analysis so far, the lesser the distance between co-moving source and observer, the lesser will be the apparent change of source position due to absolute motion, hence the lesser observable absolute motion will be. *For all experiments in which co-moving source and observer are so close enough to each other that they can be assumed to be at the same point in space, absolute motion will have no effect on the experiment.*

In this case, there will not be any significant apparent change of position of the source relative to the observer. The source and the observer can be considered to be at rest (according to the procedure mentioned above), with the mirror moving towards them with velocity V. An outstanding experiment confirming this assertion is the anomalous radar range data of planet Venus as discovered by Bryan G.Wallace. The detail analysis of this experiment will be made later on.



If the mirror is not moving, the round trip time of a light pulse emitted by the source will be:

$$t_d = \frac{2H}{c}$$

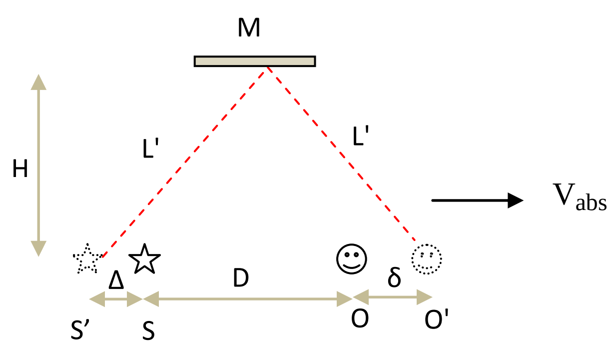
If the mirror is moving with velocity V, we apply emission (ballistic) theory after replacing the real source by the apparent source (which in this case is almost at the same position as the real source), the *group*velocity of the reflected light will be c + 2V, relative to the observer.

The analysis of the round trip for the case of a moving mirror will be made in the section ahead which explains the Bryan G.Wallace experiment. In this experiment, the planet Venus acts as the moving mirror M.

In the absolute reference frame

Once the real source is replaced with an apparent source (as seen by the co-moving observer), we can analyze the experiment in the absolute reference frame and we should get the same result as in the co-moving observer's reference frame analysis above.

Therefore, the procedure of analysis of any light speed experiment is:
1. Replace the real source with an apparent source, as seen by a co-moving observer
2. Analyze the experiment in the absolute reference frame, by assuming that the speed of light is constant relative to the apparent source.



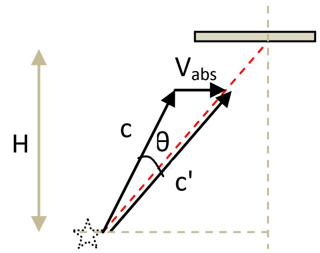
The time *T* elapsed for the light to travel from S', reflection at mirror, then arrive at O' is equal to the time taken for the observer to move from O to O'. The speed of light is *c* relative to the apparent source. We have to determine the speed of light *c'* in the dashed light ray, as seen in the absolute reference frame.

$$\frac{2L'}{c'} = \frac{\delta}{V_{abs}}$$

But

$$(\frac{\Delta + D + \delta}{2})^2 + H^2 = L'^2$$

The relationship between c, V_{abs} and c' is as follows.



$$\frac{\sin\theta}{V_{abs}} = \frac{\frac{H}{L'}}{c} = \frac{\sin(\theta + sin^{-1}\left(\frac{H}{L'}\right))}{c'}$$

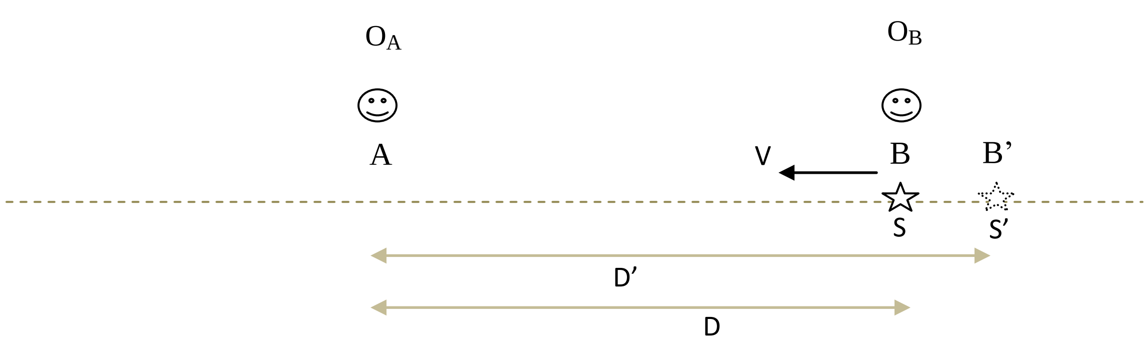
From the last three equations it is possible to determine δ and hence L' , from which T can be calculated.

Apparent contradictions in Apparent Source Theory

<u>Where does a light beam start?</u>

Even though we have seen so far that the new interpretation(AST) has succeeded in resolving the most challenging contradictions and paradoxes of the speed of light, an apparent contradiction has been identified in AST.

Assume two observers O_A and O_B, both at absolute rest, at points A and B, respectively, with distance between them equal to D.



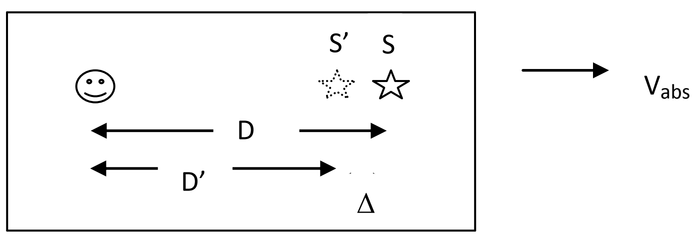
A light source S is moving towards observer O_A. Assume that the source emits a very short light pulse just at the moment it is passing through point B, as seen by observer O_B. The light pulse will be seen by observer O_A after a delay of time. A key idea in this paper is as follows:

For observer O_B, the light beam was emitted from its own position, from point B. For observer O_A, however, it is as if the light beam was emitted from the apparent source position, point B', and not from point B. Obviously, this is counterintuitive at first sight. According to all conventional theories, the light beam starts from the same point in space, for all observers.

Observer O_B witnessed that the source emitted light from point B, from his own position. Who is right ? Logically no other observer can be moresure than observer O_B regarding where the source was at the instant of emission, i.e. from which point the light pulse was emitted. This is because observer O_B was in the proximity of the source at the instant of emission.

The solution of this apparent paradox is as follows.

1. For a light source that is at absolute rest, light always starts from the source's physical position, for all moving or stationary observers.
2. For a source that is in absolute motion, however, the apparent point where a light beam started (the past position of the source) is determined by two factors
   - The absolute velocity of the source
   - The distance between the source and the observer *at the instant of emission*.



Imagine a light source and an observer in a closed room (Galileo's ship thought experiment). The light source emits a light pulse. The observer wants to know the point in spacewhere the light pulse started.

If the laboratory is at absolute rest, the light started from the point where the source physically is, i.e. from point S which is at a distance D from the observer. If the laboratory is in absolute motion, as shown, the light pulse started not from the current/instantaneous point where the source is now but from a point in space S' that is at a distance D' from the observer.

From our previous discussions,

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

and

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

From the above formula, we see that the point where the light apparently started depends on two factors:

- Physical distance D between source and observer and
- Absolute velocity of the laboratory

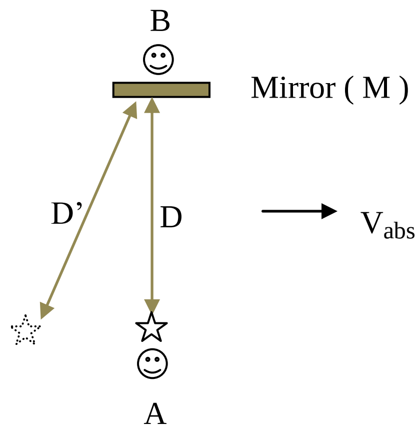
This means that for D= 0 , i.e. source and observer exactly at the same point in space (which is actually not possible, just imagined), the distance Δbetween the real source position and the apparent source position will be zero, i.e. the light starts exactly from where the source is physically. For D= 0 ,light always starts from the source position.

For a non-zero distance D, however, absolute velocity will have an effect on the apparent position where the light pulse started. As distance D becomes larger and larger, this will 'amplify' (multiply) more and more the effect of absolute velocity. This means that absolute velocity affects the amount of apparent change of position of the light source *through*distance D, because Δis a *product* of D and [$V_{abs} / (c \pm V_{abs})$].

Returning back to the case of observers O_A and O_B , for observer O_B the light source started (was emitted by the source) almost from point B, the point through which the source was passing at the instant of emission. For observer O_A , however, the light started not from point B, but from point B'. However, for the case of a light source in absolute motion and observer at rest, this apparent change in position of the source is exactly compensated for by the fact that the speed of light also changes apparently because the speed of light is constant c relative to the apparent source, according to AST. Therefore, the apparent change in source position is only an artifact and has no real effect. The time delay between emission of light and detection by observer O_A is just equal to D/c , and not D'/c . However, for absolutely co-moving source and observer, the apparent change in source position has real effect in that the time delay will be D'/c and not D/c.

This is the distinctive idea which enabled the resolution of many paradoxes and contradictions between experiments. The *physical meaning* of this apparent change in position of the source will be presented later.

Another contradiction arose on the way to the new theory. Assume an absolutely co-moving system below.



Suppose that a light pulse is emitted from the source towards the mirror M and reflected back to the source (to observer A). We assume that observer A is at the same point in space as the light source, hence, for observer A, the apparent position of the source will be almost the same as the real position of the source, because the effect of absolute velocity will be nullified because observer A is almost at the same point as the source, as discussed above. Hence, observer A will predict that the time delay between emission of the light pulse and its reception (after reflection from mirror) will be:

$$\tau = \frac{2D}{c}$$

From this, observer A predicts that the time interval between emission and reflection at the mirror to be:

$$\frac{\tau}{2} = \frac{D}{c}$$

Assume that A and B each have synchronized clocks. Observer B recorded the time instant when he/she detected the light pulse. But observer B detects light after a delay of

$$\tau = \frac{D'}{c}$$

and not D/c.

Assume that A and B also have a means to communicate instantaneously. Just after a time delay of D/c after emission of the light pulse, observer A calls observer B (through instantaneous communication) and asks him/her if he/she has just detected the light pulse. Observer B says that the light pulse hasn't arrived yet, because D' / c > D / c. This is a paradox !

For observer B, the light started not from the real (physical) position of the source, but from the apparent position of the source and hence the light pulse has to travel a larger path length (D') before arriving at observer B's location.

But a question still arises: How can the light be reflected from the mirror 'before arriving at the mirror', as the time interval (D/c) calculated by observer A for the light pulse to *arrive* at the mirror is less than the time interval (D'/c) of *detection* calculated by observer B ?
This apparent paradox is resolved as follows in the current version of this paper, after a long time of puzzlement since the first version of this paper.

The light pulse *actually*, physically arrives at the mirror (at observer B position) after a delay of D'/c , not after D/c. But for observer A the light pulse always behaves *asif* the forward and backward times are both D/c. This means that for all measurements made at or sufficiently close to the source, absolute motion is 'invisible', i.e. has no observable effect. The effect of absolute motion can be observed only for measurements made at points far enough away from the source. This means that for *all* observations/ measurements made at point of observer A, the light behaves *asif* it took a time delay of D/c to the mirror and D/c back to observer A, so that the round trip time actually measured by observer A will be 2D/c. This means that if the actual time from source to mirror is D'/c (which is greater than D/c), and if the actual round trip time is 2D/c, then the actual time delay from mirror back to source should be 2D/c - D'/c.In fact, this is the only way to determine the time from mirror back to the source, i.e. the back flight time can only be found as 'the round trip time minus the forward flight time'. It follows that the actual forward flight time is greater than the actual backward flight time. This is even more evident in the explanation of the Bryan G.Wallace Venus radar range experiment, to be discussed in a section ahead.

I was content with the above explanation until I found out a serious problem. Conventionally, observer A should always detect the reflected pulse later than observer B detects the light pulse.

This means that

$$\frac{D'}{c} < \frac{2D}{c}$$

But

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

Therefore

$$\frac{D'}{c} < \frac{2D}{c} \Rightarrow \frac{D}{\sqrt{c^2 - {V_{ab}}^2}} < \frac{2D}{c} \Rightarrow V_{ab} < \frac{\sqrt{3}}{2}c$$

Therefore, the condition for observer B detecting the light pulse earlier than observer A detecting the reflected pulse is

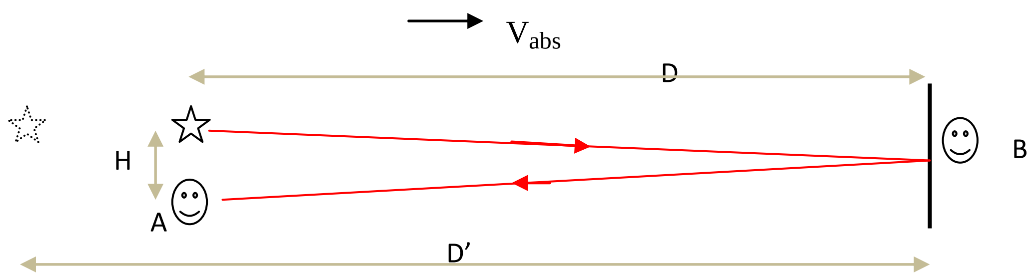
$$V_{ab} < \frac{\sqrt{3}}{2}c$$

If

$$V_{ab} > \frac{\sqrt{3}}{2}c$$

then observer A detects the reflected pulse earlier than observer B detects any light pulse ! How can the light pulse reflect from the mirror before/without being detected by observer B ? ! This shows that light should not be considered as ordinary waves. Light is not only a local phenomenon; light is a dual phenomenon: local and non-local.

Additionally consider the following example, with D >>H .



The condition for observer B to detect the light pulse earlier than observer A detects the reflected light is:

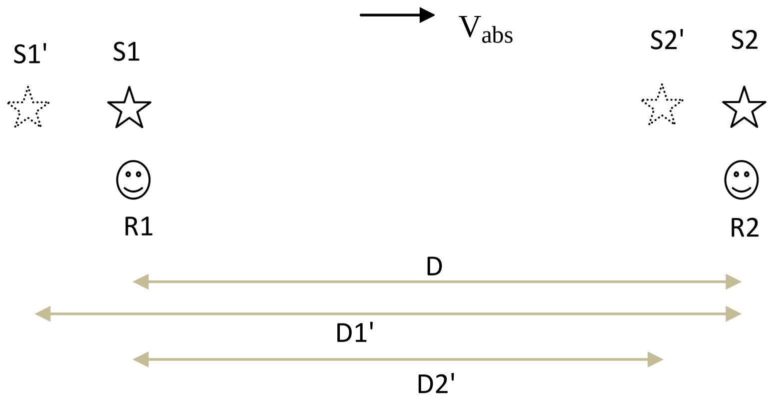
$$\frac{2D}{c} > \frac{D}{c - V_{abs}} \quad \Longrightarrow \quad V_{abs} < \frac{c}{2}$$

The solution might be in quantum mechanics. Observer B will never detect the same photon that is detected by observer A . The assertion that light has different velocities in different directions fails to explain this. After all, this assertion is rooted in ether theory.

This is rooted in light being not only a local phenomenon, but also a non-local phenomenon.

Proposed experiment to test Apparent Source Theory

Consider the following optical experiments. In the first experiment, a short light pulse is emitted by source S1 and detected by detector R2 which triggers source S2 to emit a short light pulse . Detector R1 detects the light pulse and triggers source S1 to emit another light pulse which will be detected by detector R2 and so on. This is a system of two transponders.
A counter counts the number of round trips.



The apparent distance D1' will be:

$$D1' = D\frac{c}{c - V_{abs}}$$

The apparent distance D2' will be:

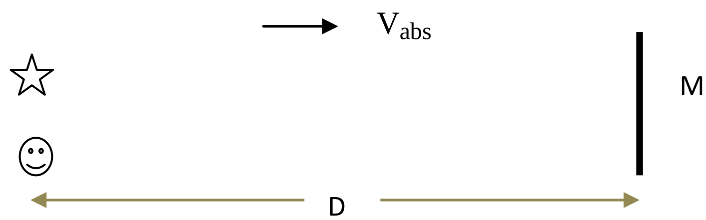
$$D2' = D\frac{c}{c + V_{abs}}$$

The round trip time will be:

$$\frac{D1' + D2'}{c} = \frac{D}{c - V_{abs}} + \frac{D}{c + V_{abs}} = \frac{2D}{c}\frac{1}{1 - \frac{V_{abs}{}^2}{c^2}}$$

For D = 10 m , Vabs = 390 Km/s , the round trip time will be 66.6667793334 ns .

Now consider a slightly different experiment, shown below, with the light source, the detector and the mirror co-moving absolutely. In this case light comes back to the point of emission by reflection from a mirror.



The light source emits a short light pulse towards the mirror. The reflected light is detected by the detector, which triggers the light source to emit another light pulse and so on. A counter counts the number of round trips.

The round trip time will be:

$$2T = \frac{2D}{c}$$

For D = 10 m , the round trip time will be 66.6666666667 ns . Unlike the previous experiment, Earth's absolute velocity will not affect this experiment.

The difference in the round trip times of the above two experiments will be

$$\frac{2D}{c}\frac{1}{1-\frac{{V_{abs}}^2}{c^2}} - \frac{2D}{c} \approx \frac{2D}{c}\frac{{V_{abs}}^2}{c^2}$$

Let us see the difference between the number of round trips counted in the two cases, in one day (24 hours). One day is 86400 seconds.

The number of round trips counted in 24 hours in the first experiment will be:

$$\frac{86400 * 10^9}{66.6667793334} = 1295997809762$$

The number of round trips counted in 24 hours in the second experiment will be:

$$\frac{86400 * 10^9}{66.6666666667} = 1295999999999$$

The difference in the number of round trips of light pulses counted in the two cases, in 24 hours will be:

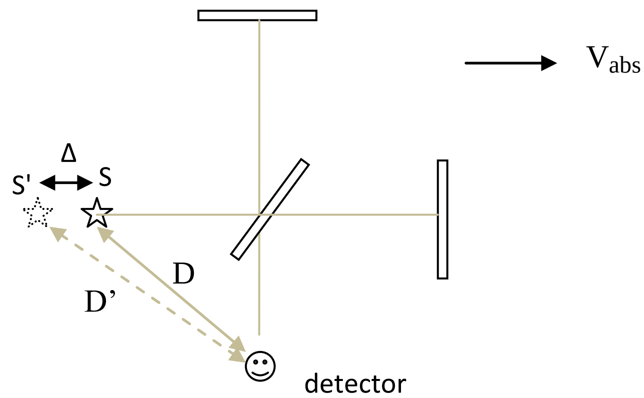
$$1295999999999 - 1295997809762 = 2190237\ counts$$

Instead of one day, if we calculate for 10 minutes the difference will be 15,210 counts !
Note that the propagation delay time in the circuits between detection and emission of the light pulses have to be considered, in a practical experiment. If the experiment takes long time, for example 24 hours, the axis of the apparatus should be made to follow and continuously be pointing towards constellation Leo.

2.1.2. Michelson-Morley experiments

Conventional Michelson-Morley experiments

With the interpretation (theory) presented so far, the Michelson- Morley and the Kennedy-Thorndike experiments can be explained. One of the secrets behind the null results of these experiments is that only a single light source was used, with a single light beam split into two.



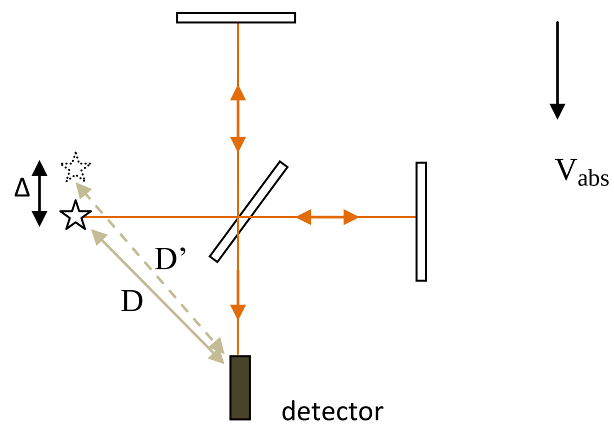
From the above diagram of the Michelson-Morley experiment, arranged for circular or straight parallel fringes, we see that the effect of absolute velocity is just to create an apparent change of the position of the light source relative to the detector, for absolute velocity V_{abs} directed to the right.

The best way to understand the effect of this apparent change of source position is to ask:
what is the effect of actually, physically shifting the source from position S to position S' ,
(assuming Galilean space and emission theory)?

Obviously there will be no (significant) fringe shift because, intuitively, both the longitudinal and lateral beams will be affected identically. It is possible to prove this experimentally in optics.

Therefore, in the present case, the apparent shift of the source position is common both to the forward and transverselight beams and doesn't significantly change the relative path lengths of the two beams and hence no significant fringe shift will occur. I propose this to be analyzed in optics. The effect is the same as physically changing the source position, which would not create any fringe shift obviously.The group and phase will be delayed by the same amount, due to the apparent change in source position.

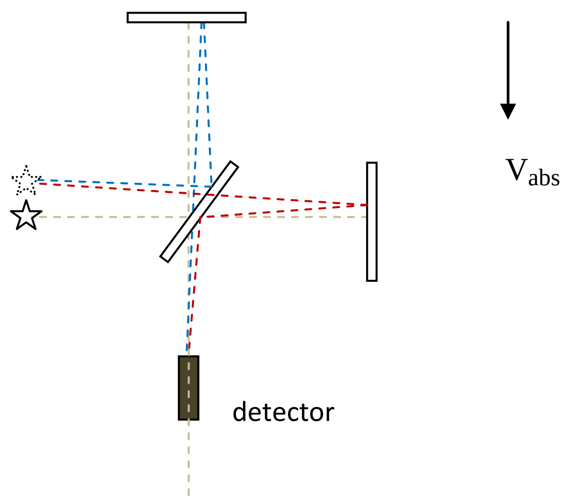
Now let us consider the case of absolute velocity directed as shown below. For an absolute velocity V_{abs} directed downwards, the apparent position of the light source will be as shown below, as seen by the detector.



What is the effect of absolute velocity in this case? In the same way as above, we ask: what is the effect of actually, physically shifting the source position from S to S' ? In this case also there may be a very small fringe shift because the two beams will be misaligned and will haveslightly different path lengths.This may be why a very small fringe shift was always observed in conventional MM experiments.

Note that there is no beam with slant path as in the conventional MMX analysis of SRT or ether theory. This is one distinction in Apparent Source Theory.

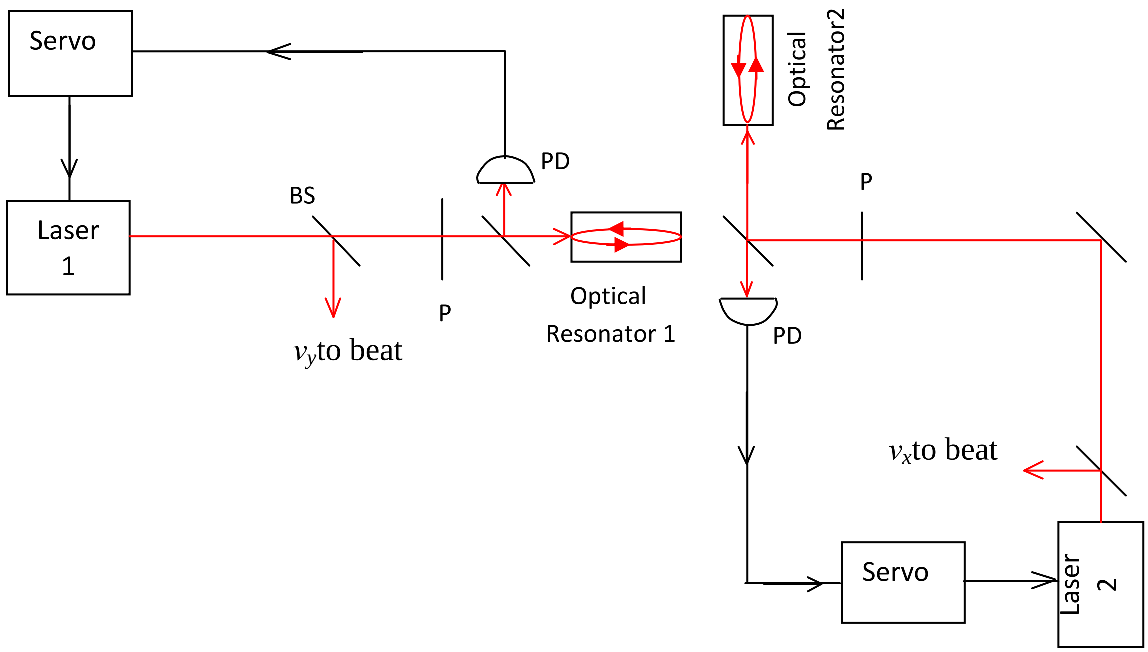
Now we can see why there were NON-NULL results in many conventional MM experiments, such as the Miller experiments. There will be the same small (insignificant) fringe shift as if the light source was actually (physically) shifted to the apparent position shown in the figure below. If the light source is physically shifted to the position shown, the path lengths of the two beams arriving at the observer (detector) should change slightly differently. The two beams will also be misaligned. From optics, it is possible to calculate the changes in the two path lengths.



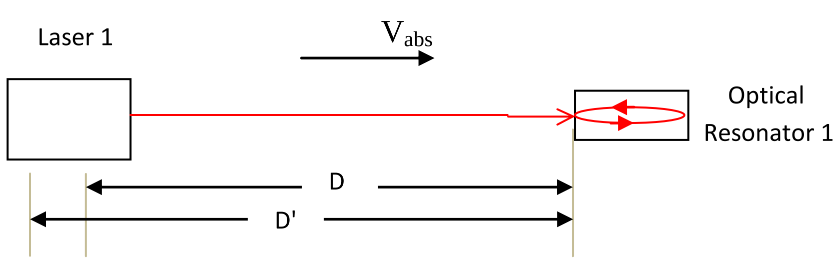
The blue and red dotted lines show the two light beams. The drawing is not meant to be accurate but only to illustrate the idea.

Modern Michelson-Morley experiments

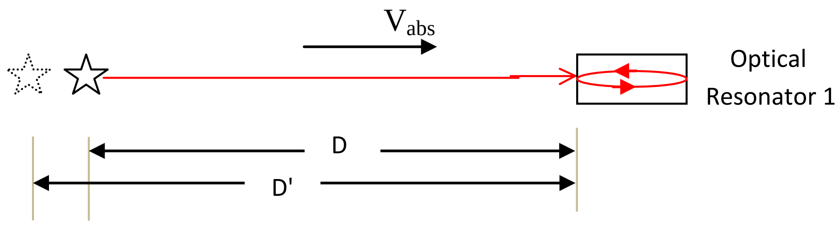
We will look at the experiment performed by Muller et al [19].



Let us consider one of the two optical resonator systems.



The laser has been represented as a single coherent point source, as shown below.



Let us just assume that the point source is at distance D from the optical cavity.
According to Apparent Source Theory, the effect of absolute motion for co-moving source and observer is to create an apparent change in the position of the source as seen by the observer. Therefore, to an observer at the inlet of the optical resonator, for example,the source appears to be fartherthan its actual position for the absolute velocity shown in the above diagram. For all observers at all points along the path of light and at all points inside the optical resonator, the effect of absolute motion is simply to create an apparent change in the position of the source; the source appears farther than it actually (physically) is.

The procedure of analysis, as discussed already, is:
1. Replace the real source with an apparent source 2. Solve the problem by assuming that the speed of light is constant relative to the apparent source.

In other words, the above procedure means that we replace the real source with an apparent source and analyze the experiment by assuming Galilean space. We know that in Galilean space the (group) velocity of light is constant relative to the source. It is proposed that the phase velocity is always constant[6], independent of source or observer velocity.

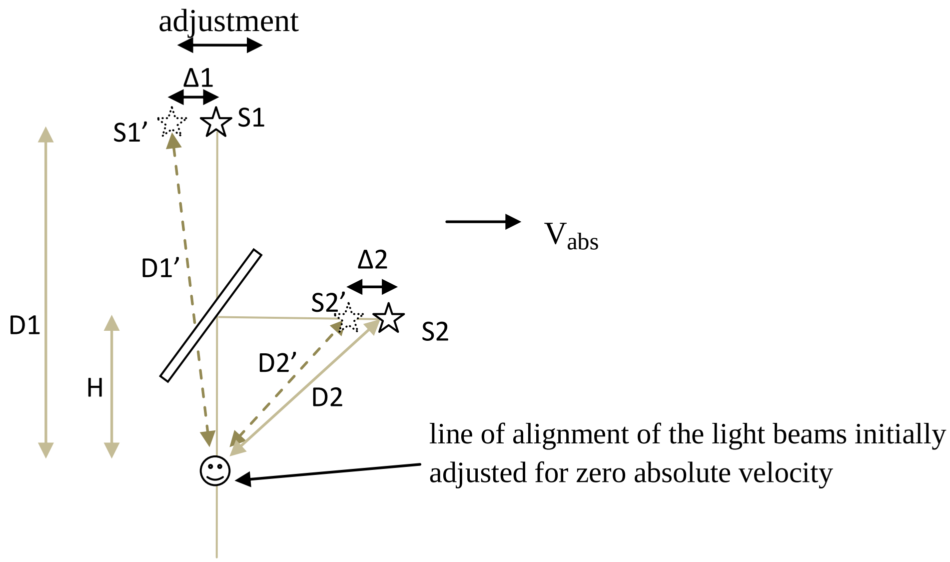
All we need is to answer is: what is the effect of apparent change of source position, which is equivalent to physical/real change of source position ?

Obviously, the apparent or physical position of the source inside the laser does not have any significant effect on the resonance frequency of the resonator.

The Muller etal experiment was conceived by assuming that absolute motion would change the resonance frequency of the resonator. This means that, if the laser frequency is constant, the resonatorwouldbe slightly detuned due to changes in absolute velocity (by rotating the apparatus), which would result in decreasing of the amplitude of the wave at all points inside the cavity resonator. But changing the distance between the laser and the optical cavity does not affect the resonance frequency/wavelength of the cavity.

Proposed modified Michelson-Morley experiments

According to AST, one method to detect absolute motion with an MMX type experiment is to use two ideally coherent light sources, as shown below. The single light source in the conventional MM apparatus is omitted and the two reflecting mirrors are replaced by two ideally coherent light sources.Recent experiments show interference between two photons is possible.



With zero absolute velocity, the two light beams arriving at the detector are adjusted to be aligned. Then, due tonon-zero absolute velocity, the two beams will be misaligned and a fringe shift will occur. The position of the source S1 may be adjusted (towards the right) until the two light beams are aligned again. The amount of adjustment of position of S1 required to align the two beams again can be used to determine the absolute velocity.

Let the two light sources be at distances D1 and D2 from the detector. Note that D1 and D2 are the *direct* distances between the detector and the sources and does *not* involve any distances to the mirrors.

As discussed previously, therefore:

$$t_{d1} = \frac{D1'}{c}$$

$$= \frac{D1}{\sqrt{c^2 - {V_{abs}}^2}}$$

and, t_{d2}can be determined after D2' is determined from the following equations.

$$\frac{D2'}{c} = \frac{\Delta 2}{V_{abs}} \qquad \ldots\ldots\ldots..(1)$$

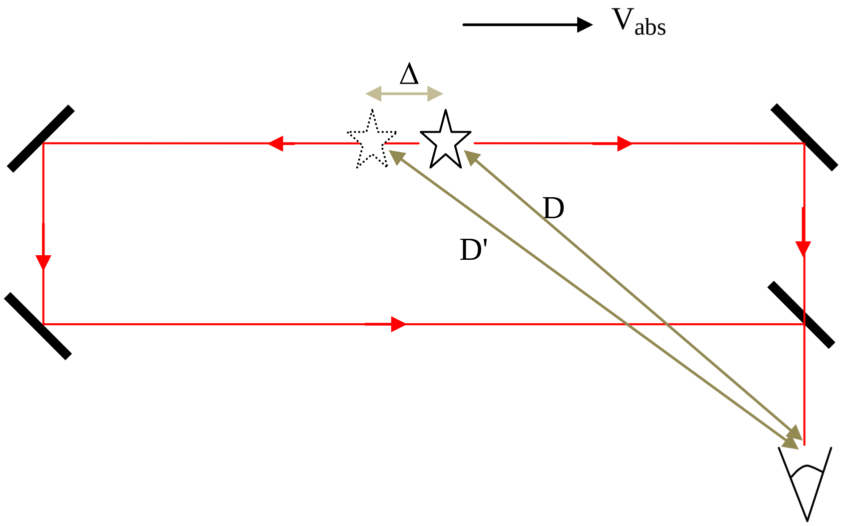
$$\sqrt{D2^2 - H^2} \;-\; \sqrt{D2'^2 - H^2} \;=\; \Delta 2 \qquad \ldots\ldots\ldots\ldots\ldots\ldots..(2)$$

A large fringe shift corresponding to the absolute velocity of the Earth (about 390 Km/s) would be observed when changing the orientation of the apparatus.

One may ask: The modern MMX experiments which are based on optical resonators use two independent orthogonal laser light beams from two independent laser light sources; why then did the experiments fail to detect absolute motion? These experiments look for differences in the frequencies of the two orthogonal beams, which are tuned to two cavity resonators. The experiment is based on the assumption that, if the ether existed, the resonant frequency of the two cavities would be affected and this would be detected by locking the frequency of the two lasers to the resonance frequencies of the cavities. As explained so far, the effect of absolute motion is to create a change in path length and hence a change in phase. The phases of the two beams change differently. A change in phase difference (and not a change in frequencies) occurs. The resonance frequency of the optical cavities do not change due to absolute motion; for a point inside the optical cavity, only the phase of the wave changes. The Modern Michelson-Morley experiment will be discussed in more detail later on.

But there is a problem with the practicality of the above proposed experiment. The coherence time of even the best lasers available is in the order of milliseconds. It is not possible/practical torotate the apparatus within one millisecond to detect the absolute motion of the Earth. The above proposed experiment is only theoretical and is meant only to clarify the theory. But the good news is that a more practical and basically the same kind of experiment has already been carried out. This is the Roland De Witte 's experiment. He used two *independent*, Cesium stabilized 5 MHz sources with co-axial cables. He detected absolute motion by comparing the phases of the two independent signals and observed sidereal dependence.

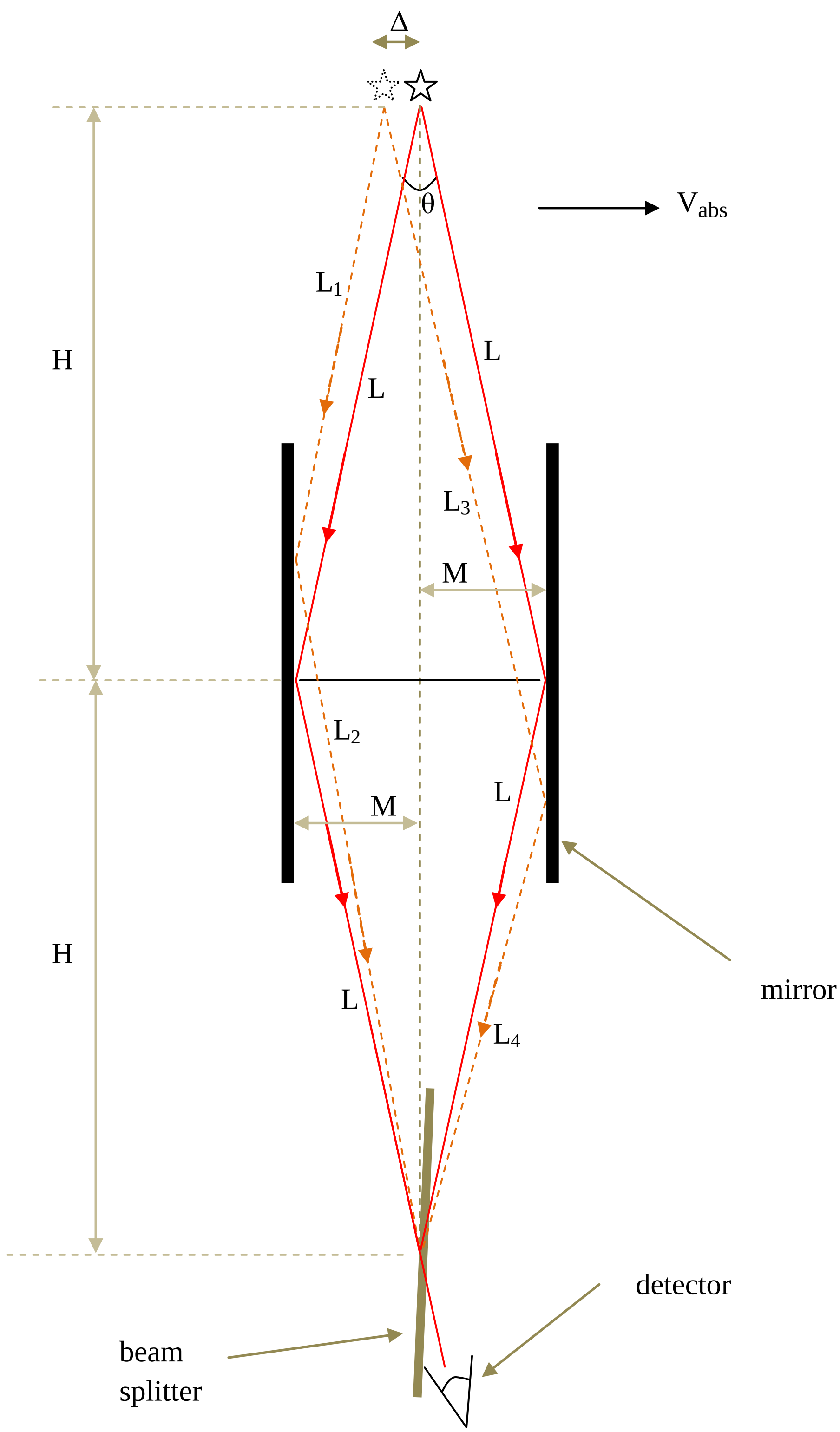
Another hypothetical experiment which, unlike the Michelson-Morley experiment, is capable of detecting absolute velocity is shown below. A single light source is used in this case.



The source in this experiment should emit a photon in either direction with nearly equal (or comparable) probabilities, so that the photon interferes with itself at the detector. This is why the experiment has been called hypothetical. Real macroscopiclight sources cannot emit a single photon in opposite directions. Theoretically an isolated atom can be used as the source, since it can emit (nearly) equally in both directions. Real sources cannot be used since atoms in real sources maynot emit a photon in opposite directions. No beam splitter should be used to send a photon in opposite directions so that it interferes with itself at the detector, as in the Michelson-Morley experiment; the experiment will fail to detect absolute motion if a beam splitter is used.

As the apparatus is absolutely moved to the right, the path length of the right beam is lengthened and the path length of the left beam is shortened. A very large fringe shift will be observed ! For example, if distance D is about one meter, Δ is of the order of one millimeter, for absolute velocity 390 Km/s. One millimeter is about 2063 wavelengths, for λ = 630 nm !.

Perhaps a possibly practical version of the above experiment is as follows. It contains a light source, two parallel plane mirrors, a beam splitter and a detector.


Δ
θ
Vabs
L1
L
L
H
L3
M
L2
M
L
H
L
L4
mirror
detector
beam
splitter

In the above experiment it is assumed that each photon has (nearly) equal probability of going to the right or to the left mirror. This is true for small angles θ , but the experiment becomes less sensitive to absolute motion as angle θ becomes small.

Let us try to analyze this experiment to see if it is sensitive enough to detect Earth's absolute velocity.With zero absolute velocity, the difference in path length of the two light beams is zero. For non-zero absolute velocity ($V_{abs} \neq 0$), we proceed as follows.

For the left light beam (L_1L_2), since angle of incidence is equal to angle of reflection:

$$\frac{M-\Delta}{L_1} = \frac{M}{L_2}$$

and

$$\sqrt{{L_1}^2 - (M-\Delta)^2} + \sqrt{{L_2}^2 - M^2} = 2H$$

For the right light beam (L_3L_4), since angle of incidence is equal to angle of reflection:

$$\frac{M+\Delta}{L_3} = \frac{M}{L_4}$$

and

$$\sqrt{{L_3}^2 - (M+\Delta)^2} + \sqrt{{L_4}^2 - M^2} = 2H$$

For example, we are required to compute L_1, L_2, L_3, L_4 given the following.

H = 10m , M = 0.1m

Since

$$\Delta \approx \frac{V_{abs}}{c} D \qquad \text{and} \qquad D = 2H$$

$$\Delta = \frac{390Km/s}{300000Km/s} * 20m = 0.026m = 2.6\,cm$$

L_1, L_2, L_3, L_4were determined analytically and the result is shown below.

$${L_1}^2 = \frac{(M-\Delta)^2\,((M-\Delta)^2 + M^2 + 2M(M-\Delta) + 4H^2)}{(M-\Delta)^2 + M^2 + 2M(M-\Delta)}$$

and

$${L_3}^2 = \frac{(M+\Delta)^2\,((M+\Delta)^2 + M^2 + 2M(M+\Delta) + 4H^2)}{(M+\Delta)^2 + M^2 + 2M(M+\Delta)}$$

Using Excel, I computed the values for H = 10m , M = 0.1m and Δ = 0.026m

$$(L_3 + L_4) - (L_1 + L_2) = 519973\ nm$$

For a wavelength of λ= 630nm , we observe a fringe shift of

$$\frac{519973nm}{630nm} = 825.354\ wavelengths\ !$$

This is an extremely sensitive experiment!!!

The angle θ is:

$$\frac{\theta}{2} = tan^{-1}\left(\frac{M}{H}\right) \Longrightarrow \quad \theta = 2tan^{-1}\left(\frac{M}{H}\right) \Rightarrow \theta = 2tan^{-1}\left(\frac{0.1}{10}\right) = 0.02\ radians$$

$$\Longrightarrow \quad \theta = 1.146\ degrees$$

For H = 1.5m , M = 0.02m , Δ = 0.0039m = 3.9 mm

$$(L_3 + L_4) - (L_1 + L_2) = 103990.6\ nm$$

For a wavelength of λ= 630nm , we observe a fringe shift of

$$\frac{103990.6nm}{630nm} = 165\ wavelengths\ !$$

The angle θ is:

$$\frac{\theta}{2} = tan^{-1}\left(\frac{M}{H}\right) \Longrightarrow \quad \theta = 2tan^{-1}\left(\frac{M}{H}\right) \Rightarrow \theta = 2tan^{-1}\left(\frac{0.02}{1.5}\right) = 0.0267\ radians$$

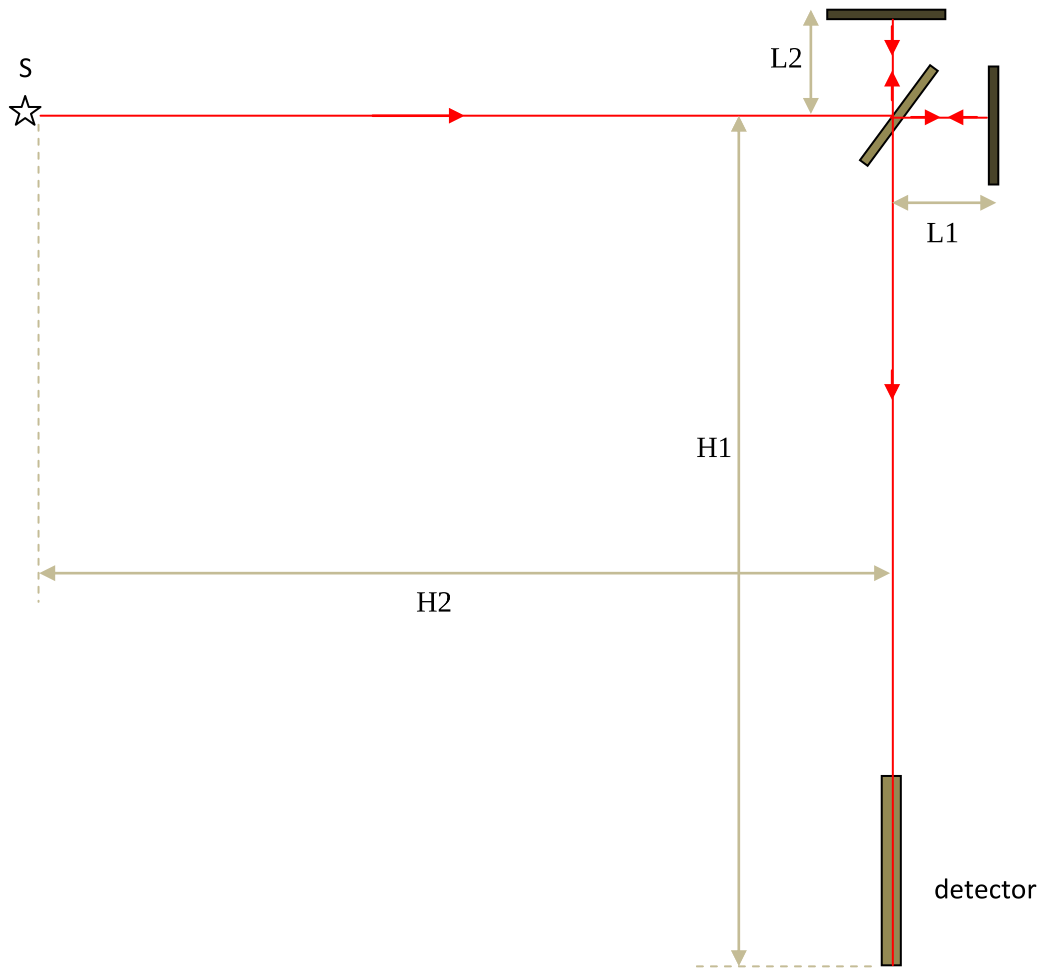
$$\Longrightarrow \quad \theta = 1.53\ degrees$$

Why the 1887 Michelson-Morley experiment and subsequent experiments with much longer arm lengths were less sensitive than the 1881 Michelson experiment [38]

Although no one has ever viewed it this way, the 1881 Michelson experiment was more sensitive than the 1887 Michelson-Morley experiment, even though the 1887 apparatus an arm length almost ten times the 1881 apparatus.

This mystery has been identified and revealed by Apparent Source Theory. In my recent paper[38], it has been revealed that *arm length and the fringe shift have inverse relation !* According to Apparent Source Theory, *the longer the arm length, the less sensitivetheMichelson-Morley apparatus* is to absolute motion! I have also proposed a much more sensitive modified Michelson-Morley experiment in my paper[38].

Proposed experiment to test absolute motion and Apparent Source Theory



As we have seen above, Apparent Source Theory has revealed the century old mystery of the Michelson-Morley experiment: *increasing the arm length made the apparatus less sensitive to absolute motion.* Moreover, the dimensions H1 and H2 turned out to determine the fringe shift. Note that H1 and H2 are irrelevant in ether theory and Special Theory of Relativity.

Therefore, to make the apparatus more sensitive to absolute motion, the arm lengths L1 and L2 should be decreased. It turns out that H1 and H2 must be long, whereas L1 and L2 must be short if the instrument is to be sensitive at all.

Suppose that:

$$H1 = 1m \ , \qquad H2 = 1m \ , \ L1 = 10\ cm \ , \qquad L2 = 10\ cm$$

As shown in my paper [38], for Earth's absolute velocity of about 390 Km/s, the resulting path difference is 210.78 nm , and the corresponding fringe shift for λ = 575 nm is 0.366572 fringes !

If instead,

$$H1 = 20m \ , \qquad H2 = 20m \ , \ L1 = 10 \ cm \ , \qquad L2 = 10 \ cm$$

The path difference will be 23,894 nm, and the corresponding fringe shift for λ = 575 nm is 41.55 fringes !

Note that using folded light paths before the beam splitter will completely suppress the sensitivity of the apparatus to absolute motion. If the Michelson interferometer is to be sensitive to absolute motion at all, the arm lengths (distances between the beam splitter and mirrors, L1 and L2) should be as small as possible and the distances of the source and the detector from the beam splitter (H2 and H1) should be as large as possible. However, these distances (H2 and H1) should be direct distances as shown in the above figure and folded light paths (by using multiple reflections from mirrors, as in the 1887 Michelson-Morley experiment) should not be used to realize the large distances required.

For example in the 1881 Michelson experiment:

$$H1 \approx 20cm \ , \qquad H2 \approx 20cm \ , \ L1 = 1.2 \ m \ , \qquad L2 = 1.2m$$

The fringe shift for V_{abs} = 390 Km/s, the path difference will be 12.125 nm and the corresponding fringe shift for λ = 575 nm will be about 0.0211 fringes. Michelson measured a fringe shift of about 0.018 fringes.

In the 1887 Michelson-Morley experiment:

$$H1 \approx 0.65m \ , \qquad H2 \approx 0.65m \ , \ L1 = 11 \ m \ , \qquad L2 = 11m$$

The fringe shift for V_{abs} = 390 Km/s, the path difference will be 15.33 nm and the corresponding fringe shift for λ = 500 nm will be about 0.031 fringes. The measured value was 0.02 fringes.

In one of the Miller experiments:

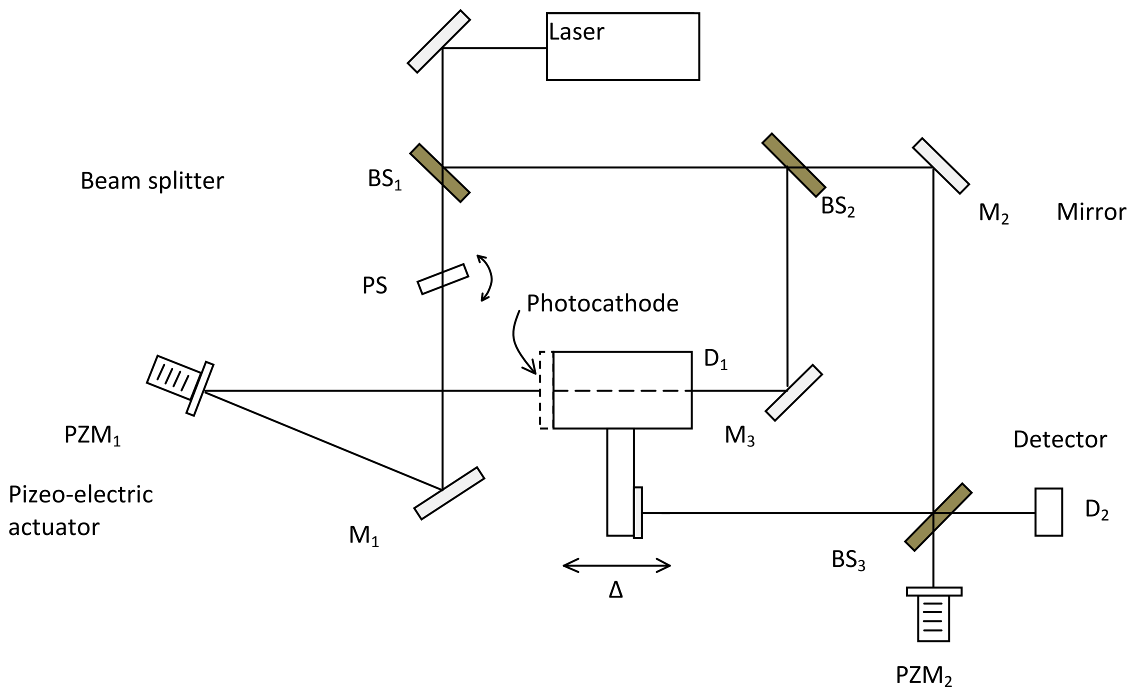
$$H1 \approx 2m \ , \qquad H2 \approx 2m \ , \ L1 = 32 \ m \ , \qquad L2 = 32m$$

The fringe shift for V_{abs} = 390 Km/s, the path difference will be 150 nm and the corresponding fringe shift for λ = 500 nm will be about 0.0995 fringes. Miller measured a fringe shift of about 0.08 fringes.

These fringe shifts are of the same order of magnitude as measured in those experiments. There may be some discrepancies due to uncertainty about H1 and H2.In some cases, there was a tendency of the apparatus to be more sensitive with altitude, such as in the Mount Wilson Miller experiments. Moreover, there is also uncertainty about the component of Earth's absolute velocity in the plane of rotation of the interferometer, at the time of the experiment.

2.1.3. The Silvertooth experiment

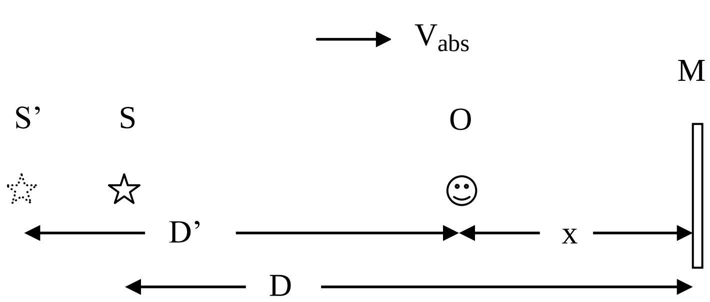
In this section Apparent Source Theory (AST) will be applied to the Silvertooth experiment. The diagram below is taken from Silvertooth's paper of 1989 from the journal Electronics and Wireless World.



The Silvertooth experiment is the other crucial evidence of absolute motion.

In this section, the 'wavelength' change effect in Silvertooth experiment will be explained.

Imagine a light source S, an observer O and a mirror M , co-moving with absolute velocity V_{abs} to the right as shown below.



'Wavelength'and velocity of incident light

Light emitted by S at time t = 0 will be received by observer O after time delay t_d.From the previous discussions:

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

(note that D in this equation is not the one shown in the above figure)

SubstitutingD – x in place of D

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

Time delay will be

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

Assume that the source emits a light wave according to

$$\sin \omega t$$

The light wave will be received at the detectoras

$$sin\omega(t - t_d) = sin\omega(t - \frac{D}{c - V_{abs}} + \frac{x}{c - V_{abs}})$$

$$= \sin(\omega t - \frac{\omega D}{c - V_{abs}} + \frac{\omega x}{c - V_{abs}})$$

The above is a wave equation. If we take a 'snapshot' of the wave at an instant of time t = τ ,the above equation will be:

$$\sin(\omega\tau - \frac{\omega D}{c - V_{abs}} + \frac{\omega x}{c - V_{abs}})$$

The two terms ω τ and ωD / (c- V_{abs}) represent phase shifts. The 'wavelength' is determined from the third term:

$$\frac{\omega x}{c - V_{abs}}$$

If we have a function

$$\sin\ kx$$

then the wavelength can be shown to be

$$\frac{2\pi}{k}$$

In the same way, for the function

$$\sin\left(\frac{\omega x}{c - V_{abs}}\right)$$
$$k = \frac{\omega}{c - V_{abs}}$$

Hence the 'wave length' of the incident light will be

$$\lambda_{INC} = \frac{2\pi}{k} = \frac{2\pi}{\frac{\omega}{c - V_{abs}}} = (c - V_{abs})\frac{2\pi}{\omega} = \frac{c - V_{abs}}{f}$$

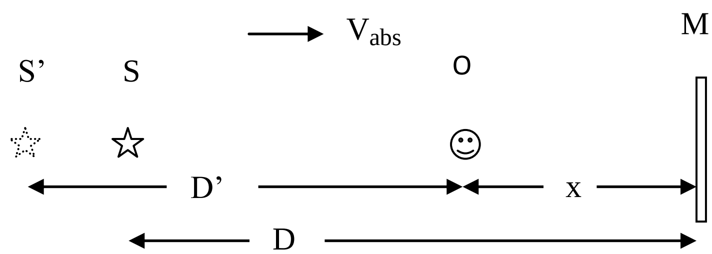
Note that the 'wavelength' predicted here is different in form from the 'wavelength' predicted by Silvertooth, in his paper, but the results obtained are nearly the same as will be shown shortly.

This shows an *apparent* change in wavelength and hence an apparent change of speed of light relative to the observer, for absolutely co-moving source and observer. However, to interpret this as an actual/real change in wavelength is wrong or inaccurate. Neither the wavelength nor the phase velocity has changed. To understand this rather confusing statement, the best way is to ask: assuming Galilean space, will an *actual*/physical change of the position of the source result in change of speed or wavelength observed by the observer, for co-moving source and observer? Obviously no. For the same reason, an *apparent* change in the position of the source should not result in change of wavelength and speed of light. This can be confirmed by measuring the wavelength with a spectroscope. The independence of wavelength and speed of light from Earth's absolute velocity has been confirmed because no variation of spectroscopic measurements of characteristic wavelengths emitted by atoms has ever been observed or reported. The Ives-Stilwell experiment confirms that absolute velocity of the Earth doesn't affect phase velocity and wavelength of light, because, if it did, large variations in ' transverse Doppler shift ' would be observed in different experiments due to possible variations in orientation of the experimental apparatus, as the ion velocity in the Ives-Stilwell experiment (≈ 1000Km/s) is comparable to Earth's absolute velocity (390 Km/s). The fast ion beam experiment is another evidence. Wavelength change occurs only due to Doppler effect, which depends only on source observer *relative* velocity.

The apparent wavelength pattern observed in the Silvertooth experiment arises due to Apparent Source Theory. This means that for every point, the apparent position of the light source is different. For material waves, such as the sound wave, the wave starts from the same point for all observers in the same reference frame. In AST, the apparent past position of the light source (the point where it was at the instant of emission) is different for different observers at different positions (distance and direction) even if they are in the same reference frame.

Wavelength and velocity of reflected light

Next we determine the 'wavelength' of the reflected light.



Time delay between emission and reception before reflection of light from mirror M, at point *x*, has been determined as follows (preceding section).

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

Relative to an observer at point x, who is observing the reflected light, time delay between emission and reception of reflected light will be:

$$t_d = \frac{D'}{c} + \frac{2x}{c} = \frac{D - x}{c - V_{abs}} + \frac{2x}{c}$$

$$= \frac{D}{c - V_{abs}} - x\left(\frac{1}{c - V_{abs}} - \frac{2}{c}\right)$$

$$= \frac{D}{c - V_{abs}} + x\frac{c - 2V_{abs}}{c(c - V_{abs})}$$

If the source emits light according to

$$\sin \omega t$$

The reflected light wave will be received at point x as

$$\sin \omega(t - t_d) = \sin \omega\left(t - \frac{D}{c - V_{abs}} - x\frac{c - 2V_{abs}}{c(c - V_{abs})} \right)$$

The coefficient of x is:

$$k = \omega\frac{c - 2V_{abs}}{c(c - V_{abs})}$$

As before, the 'wavelength' of reflected light will be:

$$\lambda_{REF} = \frac{2\pi}{k} = \frac{2\pi}{\omega \frac{c-2V_{abs}}{c(c-V_{abs})}}$$

$$= \frac{c(c - V_{abs})}{f(c - 2V_{abs})} = \frac{1}{f} \cdot \frac{c(c - V_{abs})}{c - 2V_{abs}}$$

Conventionally, one would expect the 'wave length' of the reflected light to be equal to $(c + V_{abs}) / f$, because the 'wavelength' of incident light is $(c - V_{abs}) / f$, such as in ether theory. However, it turned out in the above analysis that this is not the case. However, it can be shown that the actual difference between the two expressions is very small, as will be shown below.

The absolute velocity of the Earth is known to be V_{abs} = 390 Km/s

$$\lambda_{REF} = \frac{1}{f} \cdot \frac{c(c - V_{abs})}{c - 2V_{abs}}$$

$$= \frac{1}{f} \cdot \frac{300000(300000 - 390)}{300000 - 2 * 390}$$

$$= \frac{1}{f} * 300{,}391\ Km$$

According to classical (ether) theory

$$\lambda_{REF} = \frac{1}{f} \cdot (c + V_{abs})$$

$$= \frac{1}{f} * (300{,}000 + 390) = \frac{1}{f} * 300{,}390\ Km$$

The ratio between the wavelengths is:

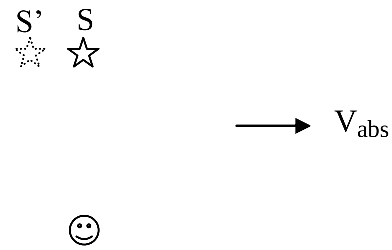
$$\frac{\frac{1}{f} * 300{,}390\ Km}{\frac{1}{f} * 300{,}391\ Km} = 0.99999667$$

Note again that this is not the real wavelength which is equal to $\lambda = c/f$. It is only an apparent wavelength. The apparent incident and reflected wavelengths differ as observed by Silvertooth and as shown above. The real incident and reflected wavelengths, which can be measured by a spectroscope, are both : $\lambda = c/f$.

In the above analyses, we considered the simplest cases in which the source, the observer and the mirror are in line, with the light beam incident perpendicularly on a mirror and reflected back on itself. It is possible to extend the analysis to more general cases for a better clarification of the theory(AST). In the next section we will look at the application of AST to some of these cases.

As the resulting solutions are more complicated (but straight forward) , we will only look at how to proceed.

Let us see at a case in which the source - observer relative position is perpendicular to the absolute velocity.



From previous discussions

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

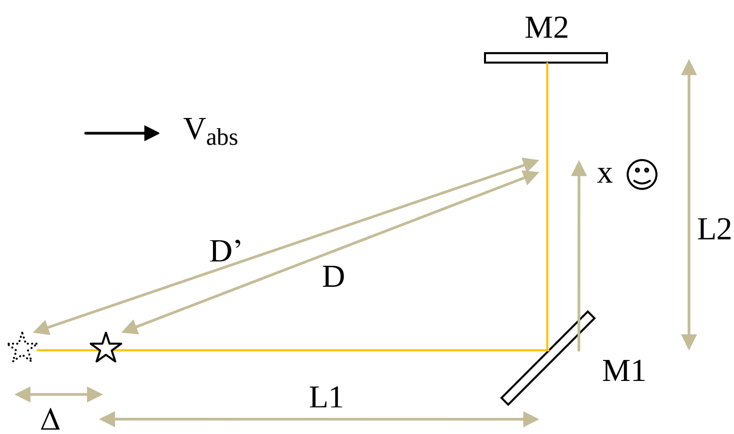
If the source emits according to

$$\sin \omega t$$

then the light received will be

$$\sin \omega (t - t_d)$$

Next consider the following case, as in Doug Marett’s replication of Silvertooth experiment [2]. An observer at point *x* will observe the incident light (light reflected from mirror M1, but before reflection from mirror M2) and the reflected light (light reflected from mirror M2).



To analyze this problem, we first have to determine the apparent change in position (Δ) of the source as seen from point x , due to absolute motion.
The time delay of the incident light will be:

$$t_d = \frac{\Delta + L1 + x}{c}$$

But

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

The above equation means that the time it takes a *direct* light beam to reach the observer at point x from the apparent source position S' is equal to the time it takes for the source to move from position S' to position S. Note that we have assumed a direct light beam from point S' to point x to determine the apparent change in the position of the source (Δ) for an observer at point x, even if there is no direct light beam from the source to the observer in this case (i.e. the observer sees only light reflected from mirror M1 in this case), due to an obstacle between the source and the observer.

Also

$$(\Delta + L1)^2 + x^2 = D'^2$$

and

$$L1^2 + x^2 = D^2$$

From the last three equations, the solution for Δcan be obtained as follows.

$$(\Delta + L1)^2 + x^2 = D'^2$$

$$(\Delta + L1)^2 = \frac{c^2\Delta^2}{{V_{abs}}^2} - x^2$$

resulting in the quadratic equation,

$$\Delta^2\left(\frac{c^2}{{V_{abs}}^2} - 1\right) - \Delta(2L1) - (L1^2 + x^2) = 0$$

The solution for Δwill be:

$$\Delta = \frac{2L1 + \sqrt{4L1^2 + 4\left(\frac{c^2}{{V_{abs}}^2} - 1\right)(L1^2 + x^2)}}{2(\frac{c^2}{{V_{abs}}^2} - 1)}$$

Now the time delay t_d can be obtained in terms of x from the previous equation:

$$t_d = \frac{(\Delta + L1 + x)}{c}$$

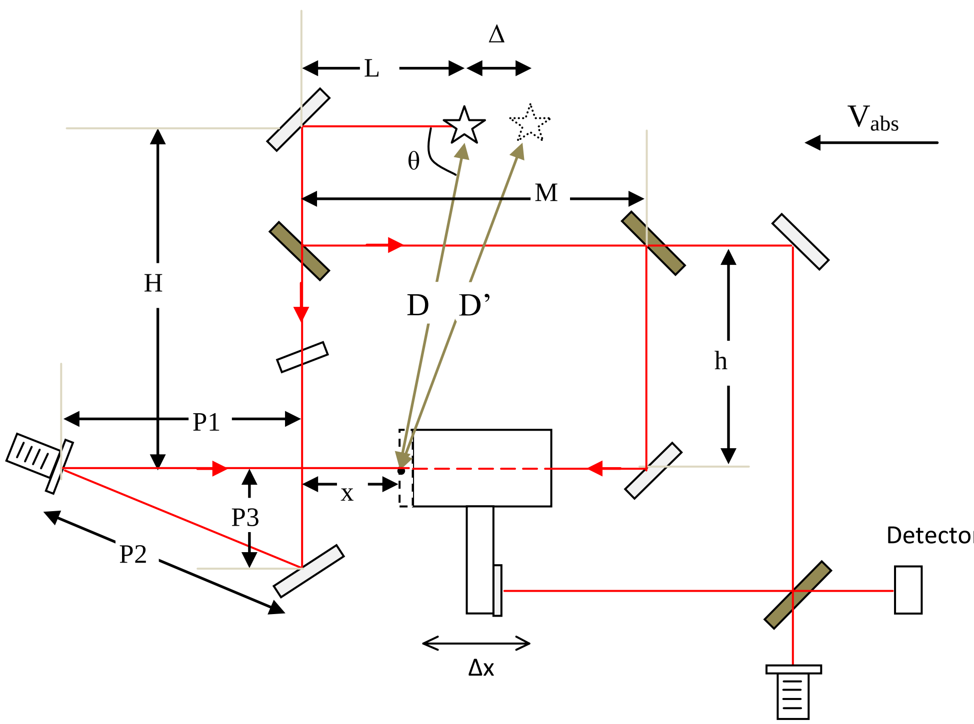
The solution for Δ shows that time delay varies with x in a more complex (non-linear) way. It can be seen that the time delay depends not only on x but also on higher powers of x . This results in dependence of the apparent wavelength on x, along x, which is unconventional. This shows that what was measured by Silvertooth is not real wavelength, because real wavelength does not change along the path of light.

For the reflected light, the equation for time delay $t_d$will be :

$$t_d = \frac{\Delta + L1 + x + 2(L2 - x)}{c}$$

The equation for Δ obtained above should be substituted in the above equation to determine the time delay and hence the 'wave length ' of the reflected light.

Now that we have understood at a basic level the ‘wavelength change’ observed in the Silvertooth experiment, by applying the Apparent Source Theory, next we attempt to analyze the actual Silvertooth experiment.



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

$$\sqrt{D'^2 - H^2} \quad - \quad \sqrt{D^2 - H^2} \; = \; \Delta \quad \dots\dots\dots\dots\dots\dots.. (2)$$

$$L - \; \sqrt{D^2 - H^2} \; = x \quad \dots\dots\dots\dots\dots\dots (3)$$

From equation (3)

$$(L - x)^2 = D^2 - H^2 \implies D = \sqrt{(L - x)^2 + H^2}$$

From equation (1)

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

Substituting for D' in equation (2)

$$\sqrt{\Delta^2 \frac{c^2}{{V_{abs}}^2} - H^2} \quad - \quad \sqrt{D^2 - H^2} \; = \; \Delta$$

After some manipulations we get a quadratic equation in Δ :

$$\Delta^2 \frac{c^2}{{V_{abs}}^2} - 2\Delta(L - x) - (H^2 + (L - x)^2) = 0 \;\; , \text{for} V_{abs} \ll c$$

From which

$$\Delta = \frac{{V_{abs}}^2}{c^2}(L - x) + \frac{{V_{abs}}^2}{c^2}\sqrt{(L - x)^2 + \frac{c^2}{{V_{abs}}^2}(H^2 + (L - x)^2)}$$

$$= \frac{{V_{abs}}^2}{c^2}(L - x) + \frac{{V_{abs}}^2}{c^2}\sqrt{(L - x)^2(1 + \frac{c^2}{{V_{abs}}^2}) + \frac{c^2}{{V_{abs}}^2}H^2}$$

$$\approx \frac{{V_{abs}}^2}{c^2}(L - x) + \frac{V_{abs}}{c}\sqrt{(L - x)^2 + H^2} \;, \qquad \text{for} V_{abs} \ll c$$

$$\approx \frac{V_{abs}}{c}\sqrt{(L - x)^2 + H^2} \;, \qquad \text{for} V_{abs} \ll c$$

Δis a non-linear function ofx.

For a given value of x_0, Δ can be approximated as a linear function for values of x close to x_0.

$$\frac{d\Delta}{dx} = \frac{V_{abs}}{c}\ (\frac{-(L-x)}{\sqrt{(L-x)^2+H^2}})$$

$$\frac{d\Delta}{dx}(at\ x = x_0) = \frac{V_{abs}}{c}\left(\frac{-(L-x_0)}{\sqrt{(L-x_0)^2+H^2}}\right) = -\frac{V_{abs}}{c}K_0 = -\frac{V_{abs}}{c}\cos\theta$$

But

$$\Delta\ (at\ x = x_0) = \Delta_0 = \frac{V_{abs}}{c}\sqrt{(L-x_0)^2+H^2}$$

Therefore

$$\Delta = \Delta_0 + \frac{d\Delta}{dx}x = \Delta_0 - K_0\frac{V_{abs}}{c}\ x \quad (\text{at}\ x = x_0\ )$$

Now that Δ has been determined, the two light waves can be determined. There are two waves propagating across the detector D1, one from right to left , the other from left to right.

Assume that the laser emits according to:

$$\mathrm{A}\sin(\omega \mathrm{t})$$

The path length for the left to right wave will be:

$$pl_{LR} = \Delta + L + H + P3 + P2 + P1 + x$$

The time delay will be

$$\tau_{LR} = \frac{pl_{LR}}{c} = \frac{\Delta + L + H + P3 + P2 + P1 + x}{c}$$

Therefore, the left to right wave will be

$$A_{x1}sin\omega(t-\tau_{LR}) = A_{x1}sin\omega\left(t - \frac{\Delta + L + H + P3 + P2 + P1 + x}{c}\right)$$

$$= A_{x1}sin\omega\left(t - \frac{\Delta_0 - K_0\frac{V_{abs}}{c}\ x + L + H + P3 + P2 + P1 + x}{c}\right)$$

At a given time t = τ , the 'snap shot' picture of the wave will be

$$= A_{x1} sin\omega \left(\tau - \frac{\Delta_0 - K_0 \frac{V_{abs}}{c} x + L + H + P3 + P2 + P1 + x}{c} \right)$$

$$= A_{x1} sin\omega \left(\tau - \frac{\Delta_0 + L + H + P3 + P2 + P1}{c} - x\left(\frac{1}{c} - K_0 \frac{V_{abs}}{c^2}\right) \right)$$

The coefficient of x is

$$\omega \left(\frac{1}{c} - K_0 \frac{V_{abs}}{c^2}\right)$$

Therefore, the 'wave length' of the left to right wave will be

$$\lambda_{LR} = \frac{2\pi}{\omega \left(\frac{1}{c} - K_0 \frac{V_{abs}}{c^2}\right)} = \frac{\lambda}{1 - K_0 \frac{V_{abs}}{c}}$$

Likewise the path length of the right to left wave will be

$$pl_{RL} = \Delta + L + (H - h) + M + h + (M - x)$$

Therefore, the right to left wave will be

$$A_{x2}\, sin\omega(t - \tau_{RL}) = A_{x2}\, sin\omega \left(t - \frac{\Delta + L + (H - h) + M + h + (M - x)}{c} \right)$$

$$= A_{x2}\, sin\omega \left(t - \frac{\Delta_0 - K_0 \frac{V_{abs}}{c} x + L + (H - h) + M + h + (M - x)}{c} \right)$$

At a given time t = τ , the 'snap shot' picture of the wave will be

$$= A_{x2}\, sin\omega \left(\tau - \frac{\Delta_0 - K_0 \frac{V_{abs}}{c} x + L + (H - h) + M + h + (M - x)}{c} \right)$$

$$= A_{x2}\, sin\omega \left(\tau - \frac{\Delta_0 + L + (H - h) + M + h + M}{c} + x\left(K_0 \frac{V_{abs}}{c^2} + \frac{1}{c}\right) \right)$$

The coefficient of x is

$$\omega \left(K_0 \frac{V_{abs}}{c^2} + \frac{1}{c}\right)$$

Therefore, the 'wave length' of the right to left wave will be,

$$\lambda_{RL} = \frac{2\pi}{\omega\left(K_0\frac{V_{abs}}{c^2} + \frac{1}{c}\right)} = \frac{\lambda}{1 + K_0\frac{V_{abs}}{c}}$$

According to Silvertooth, and classical formula,

$$\lambda' = \frac{\lambda}{(1 \pm \frac{V_{abs}}{c})}$$

There is a discrepancy between the formula based on the Apparent Source Theory (AST), which contains the factor K_0 , and the classical formula. Even though Silvertooth's theory is not clear andmaynotbecorrect, his experimental results closely agree with theclassicalformula and with the CMBR frequency anisotropy measurement.So it may seem that AST is not in agreement with Silvertooth's experiment. Butthere is also a possibility that K_0= cosθ is close to unity in the Silvertooth experiment. For example, if L-x = 4H, then K_0 =0.97.($K_0 \approx 1$, for L - x >> H). Unfortunately Silvertooth did not provide these dimensions in his papers.

The above discrepancy may seem to be a serious challenge to AST. However, considering the many successes of AST, it appears that this will not disprove AST, but requires further development of the theory. The problem may be that our analysis assumed an ordinary light source, whereas a laser source was used in Silvertooth experiment.

We interpret the above discrepancy as follows. Assuming that AST is correct, the result of Silvertooth experiment shows that the laser behaves as if it is at a distance much larger than L.

But why does the experiment behave as if distance L of the laser is much larger than its actual, physical distance ? This was one of the most challenging enigmas I faced in the development of AST and has been solved in the current version of this paper.

The mystery lied in AST and the process of light emission itself. How do we apply AST to analyze stimulated emission of light in lasers ?

Suppose that a photon originates from atom A in the forward direction which was excited by the laser pumping system. Relative to co-moving observer O , the apparent position of the emitting atom A is at A' . The photon emitted by atom A is reflected back and forth say, one hundred times, from the mirrors of the laser (assuming ideal mirrors with 100% reflection) and finally exit through the window. If there were no excited atoms for stimulated emission, the photon would be observed by observer O after a time delay of:

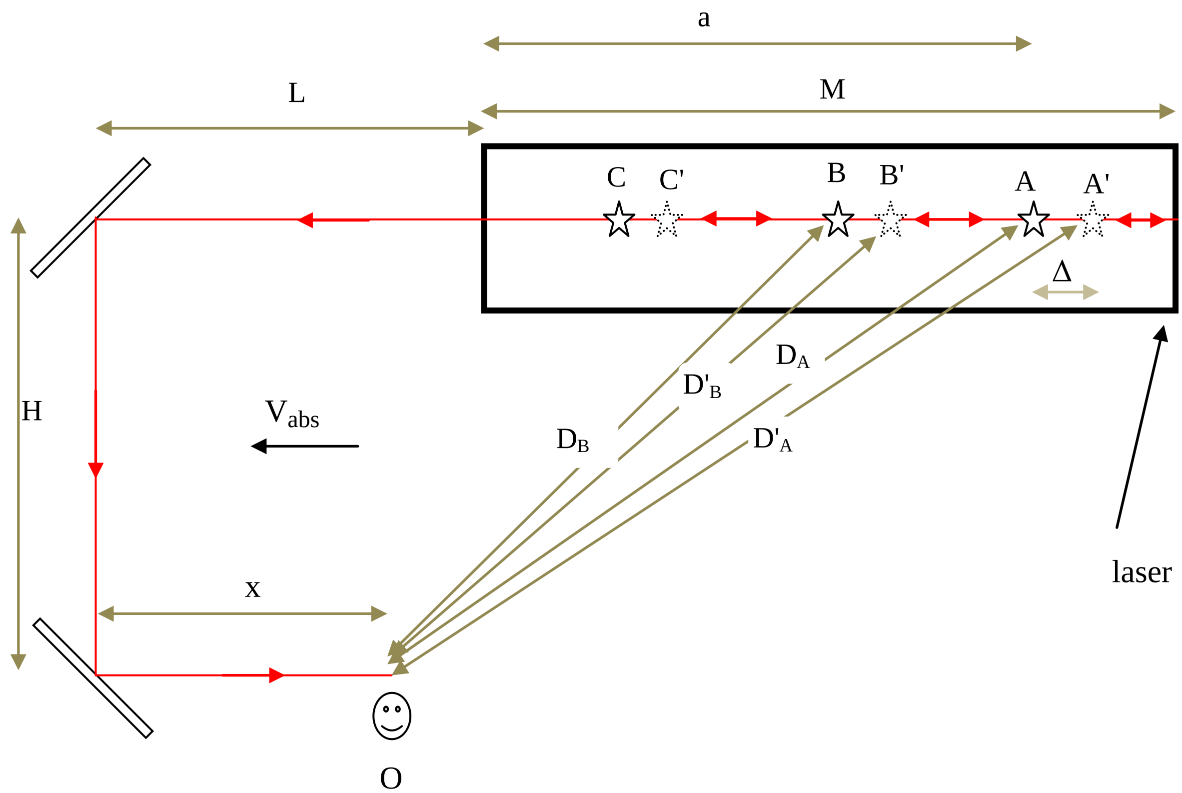
$$t_d = \frac{(a + \Delta) + 100M + L + H + x}{c}$$

For example, for D_A = 1m ,Δ is of the order of 1mm.

Now suppose that excited atoms B and C exist and the photon emitted by atom A stimulates emission from atom B, then from atom C , after passing through the atom 'gas' one hundred times. Then two coherent photons exit through the laser window.

The photon emitted by atom A stimulates emission of a coherent photon from excited atom B. Relative to the observer, atom B emitted light from its apparent position B' and therefore, this will introduce additional delay. The two coherent photons from A and B stimulate emission from atom C . Atom C will also introduce additional time delay due to apparent change of position relative to the observer. So far we have seen that an atom stimulated by the (coherent) photons travelling in the forward direction (in the direction of the absolute velocity) will delay the photon. But an atom stimulated by the (coherent) photons travelling backwards, after reflection from the front mirror, will introduce a time advance to the photon, relative to the observer. For example, if the coherent photons reflect from the front mirror and stimulate emission from atom C, the (coherent) photon will advance the photon because, relative to the observer, it emits from its apparent position C ' , and hence the photon will have less distance to travel to the back mirror.

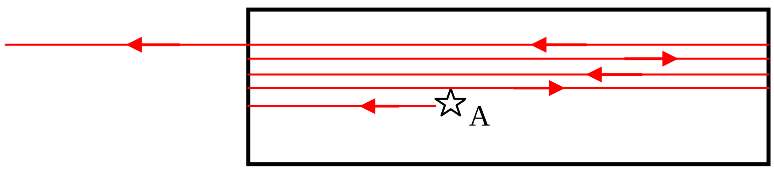
Therefore, stimulated emissions will delay the coherent photon (photons) when the coherent photon is travelling forward and will advance the coherent photon when the coherent photon is travelling backwards.



In an actual laser there are trillions of photons in a coherent photon. We have seen that atoms emitting in the forward direction (stimulated by photon travelling in the forward direction) will delay the photon, relative to the observer, and atoms emitting in the backward direction (stimulated by photon travelling in the backward direction) will advance the photon, relative to the observer.

In the analysis of Silvertooth experiment we have seen that the laser behaves as if distance L is much greater than its physical/actual value. This means that the laser photon is delayed, i.e. the apparent position of the laser is much greater than its calculated apparent position by using the direct physical distance between the laser and the detector. Since we have seen that the coherent photon is delayed by stimulated emissions while travelling forward and advanced by stimulated emissions while travelling backward, how can there be a *net* delay of the photon, as we have seen in the analysis of the Silvertooth experiment?

The answer to this question is that the number of forward stimulated emissions is always greater than the number of backward stimulated emissions because the laser exits through the front window. The following diagram illustrates this. Note that only the atom emitting the original photon is shown.



For any position of the original atom A (the atom that emits the initial single photon, excited by the laser pumping system), except the position very close to the front mirror, we can see that the number of stimulated emissions in the forward directions is always greater than the number of stimulated emissions in the backward direction. Typically, the order of magnitude of this net difference is 10 million, if the original photon is emitted from near the center of the laser, for example. The apparent change in the position (Δ) of each emitting atom is of the order of 1mm. Therefore, the total change in the positions of the emitting atoms will be : Δ = 1mm x 10000000 = 10Km. From this, we determine the effective distance L of the laser as:

$$\Delta \approx L\,\frac{V_{abs}}{c - V_{abs}} \;, \qquad for\;\; L \gg H$$

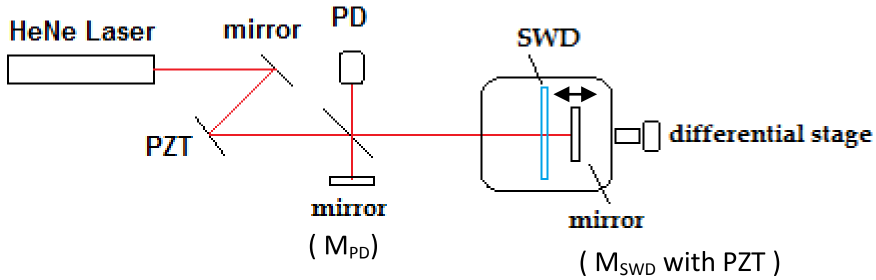
$$\Longrightarrow L = \Delta\frac{c - V_{abs}}{V_{abs}} \approx \Delta\,\frac{c}{V_{abs}} = 10\;Km * \frac{300000Km/s}{390Km/s} = 7692\;Km$$

Therefore, the laser behaves as if it is at a distance L = 7692 Km. This explains the result of the Silvertooth experiment.However, even if L = 10m, and H=1m , then K_0= cosθ = 0.995 and the formula will be almost the same as the Silvertooth (classical) formula.

An important point to be noted is that, if two atoms are stimulated and emitted coherent lasers at the same instant of time, each atom will introduce a time delay (or advance) to the coherent photon. This is because the photon is coherent. The billions of photons of a coherent laser beam all act as a single photon. A proof of this is that, according to AST, if the photons were considered as independent photons, they would lose their coherence due to absolute motion, at a short distance from the laser and we know that a coherent laser light will remain coherent within its coherence length.

A Replication of the Silvertooth Experiment

Doug Marett performed a modified version of the Silvertooth experiment[2].

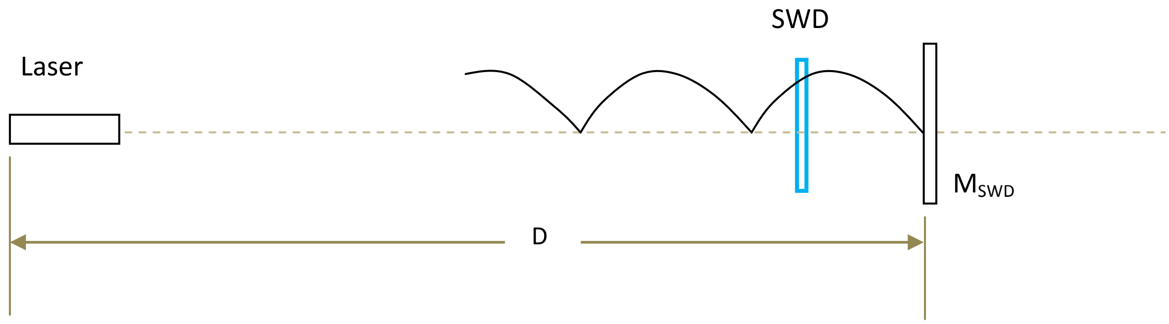


Doug Marett reported that he detected phase shift of the SWD voltage as the stage is moved, with the mirror M_{SWD} and the SWD detector co-moving with the stage.The M_{SWD} is also actuated with a triangle wave.How can movement of the stage create phase variation of the SWD voltage, with the mirror and the SWD sensor co-moving with the stage [20] ?

In all of the original Silvertooth experiments, two light beams pass through the SWD detector in opposite directions. As the stage is moved, the path of one beam is shortened, and the path of the opposite beam lengthened. In this case it is not difficult to figure out how the phase of the SWD voltage changes, as the stage is moved. In the Doug Marett's experiment, the standing wave is locked to the mirror and moves with it. So the position of the detector does not change relative to the standing wave. Sincethe paths of the two opposite beams always change equallyas the stage is moved, there would be no change in phase relationship between the incident and reflected light beams. Then how does the phase change at the SWD occur?

Even if we assumed the ether (as Silvertooth did), or any material wave such as a sound wave, Doug Marett's version of the experiment should not result in change in relative phases of the incident and reflected waves. Since the amplitude of the SWD at the surface of the mirror is always zero, the amplitude of the standing wave at the SWD detector should not vary as the stage is moved; the amplitude of the standing wave should change at the SWD only if its distance from M_{SWD} is changed. Only the distance of the SWDfrom the M_{SWD} matters. The distance from the laser or from the PZT is irrelevant when determining the phase relationship between the incident and the reflected light at the SWD. The SWD detector is always stationary relative to the SWD pattern, as the stage is moved. The standing wave is locked to the mirror.

The above argument, however, does not take into consideration the effect of the laser beam reflecting into the laser, hence forming a kind of resonant cavity.



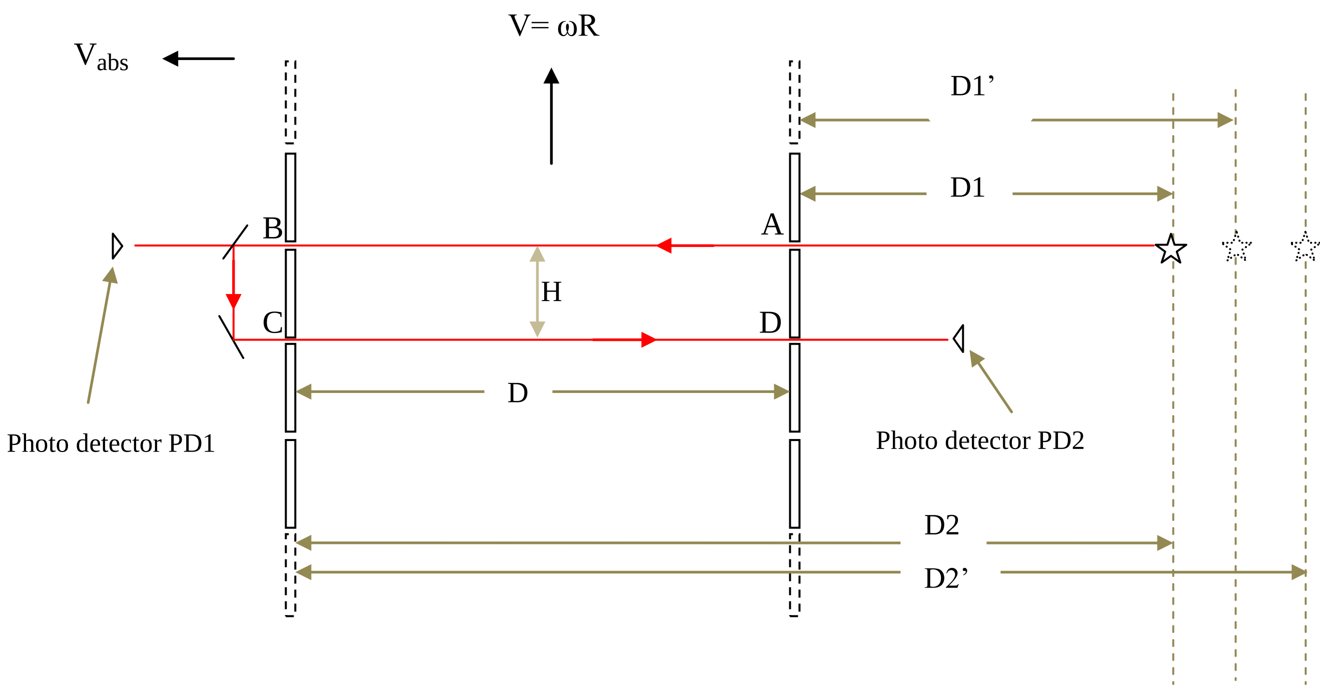
If we consider the whole optical system as a resonant cavity, then the distance D between the laser and the mirror becomes important. The standing wave will be maximum when D is an integral multiple ofhalfwave lengths. If D is not equal to an integral multiple of half wave lengths, the resonant system will be detuned and the amplitude of the standing wave will decrease at all points between the laser and the mirror. However, the standing wave is always locked to the mirror. So, as the distance between the laser and the mirror is changed, the standing wave pattern does not shift relative to the detector, but its amplitude will change.

Now, how does dithering the mirror affect the voltage at the detector? If we consider the optical system as a resonator system , then a movement of the mirror will make the system to be closer to or farther fromresonance condition. If the movement of the mirror makes the distance D closer to beingan integral multiple of halfwavelengths, the optical system will be closer to resonance and the amplitude of the standing wave will increase at all points. If the movement of the mirror makes the difference between distance D and an integral multiple of halfwavelengths larger and larger, the optical system will be detuned and the standing wave will be suppressed at all points. This is why the same movement of the mirror results an increase in the SWD voltage for some values of D and a decrease in the SWD voltage for other values of D.

The effect of absolute motion creates an apparent difference in wave lengths of the incident and reflected lights.

2.1.4. The Marinov Coupled-Shutters Experiment

In this section the Marinov experiment is explained by the Apparent Source Theory.



We assume a linearly translating long apparatus for simplicity.

Two photo detectors, PD1 and PD2 are placed as shown. Assume that four other photo detectors (not shown in the figure above) are placed at the four holes, at points A, B, C and D, just at the outlets/inlets of the holes. Assume that the light source emits a very short light pulse at time t=0. First we determine the time interval between detection of the light pulse at points B and A.

$$D1' = D1\frac{c}{c - V_{abs}}$$

and

$$D2' = D2\frac{c}{c - V_{abs}}$$

The time delay for light detection at point A will be

$$T_A = \frac{D1'}{c} = \frac{D1\frac{c}{c - V_{abs}}}{c} = \frac{D1}{c - V_{abs}}$$

The time delay for light detection at point B will be:

$$T_B = \frac{D2'}{c} = \frac{D2 \frac{c}{c - V_{abs}}}{c} = \frac{D2}{c - V_{abs}}$$

The time taken by light to move from A to B:

$$T_{AB} = T_B - T_A = \frac{D2}{c - V_{abs}} - \frac{D1}{c - V_{abs}}$$

$$= \frac{D2 - D1}{c - V_{abs}} = \frac{D}{c - V_{abs}}$$

The velocity of light propagation between the holes is :

$$\frac{D}{T_{AB}} = c - V_{abs}$$

As the absolute velocity changes in direction and magnitude, the time of flight between A and B varies.

Now let us determine the round trip time. We make some assumptions to simplify the problem. The separation distance (H) between the holes is nearly zero. Therefore,

$$T_B \approx T_C$$

From the assumption that H ≈ 0 , also follows that the photo detectors at points A and D are also almost at the same point and hence the same apparent distance (D1') of the source for both photo detectors.

The round trip time will be:

$$T_{AB} + T_{CD} = (T_B - T_A) + (T_D - T_C)$$

Let us first determine, T_D, the time of detection of the pulse at point D.

$$T_D = \frac{D1' + 2D}{c}$$

But

$$D1' = D1 \frac{c}{c - V_{abs}}$$

Therefore,

$$T_D = \frac{D1' + 2D}{c} = \frac{D1'}{c} + \frac{2D}{c} = \frac{D1}{c - V_{abs}} + \frac{2D}{c}$$

Now we can determine the time interval between detection of the pulse at point C and at point D.

$$T_{CD} = T_D - T_C = T_D - T_B = (\frac{D1}{c - V_{abs}} + \frac{2D}{c}) - \frac{D2}{c - V_{abs}}$$

$$= \frac{D1 - D2}{c - V_{abs}} + \frac{2D}{c}$$

$$= \frac{2D}{c} - \frac{(D2 - D1)}{c - V_{abs}}$$

But,

$$D = D2 - D1$$

Therefore,

$$T_{CD} = \frac{2D}{c} - \frac{D}{c - V_{abs}} = \frac{D}{c}\frac{c - 2V_{abs}}{c - V_{abs}}$$

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

From the above equation, the velocity of light propagation between points C and D is:

$$c\frac{c - V_{abs}}{c - 2V_{abs}}$$

This is distinct from the conventional formula

$$c + V_{abs}$$

which is the velocity of light propagation between points C and D according to the ether theory.

But the difference between the above two expressions is very small. If we substitute V_{abs} = 390 Km/s (absolute velocity of solar system) and c = 300, 000 Km /s into the former equation:

$$300{,}000\frac{(300{,}000 - 390)}{(300{,}000 - 780)} = 300{,}391.0166 \approx 300{,}391\ Km/s$$

From the latter equation:

$$c + V_{abs} = 300{,}000 + 390 = 300{,}390\ Km/s$$

The difference between the two results is only 1 Km/s which is less than 0.25 % of the Earth's (solar system's) absolute velocity.

Note that photo detectors PD1 and PD2 are assumed to be just at the holes B and D, respectively.

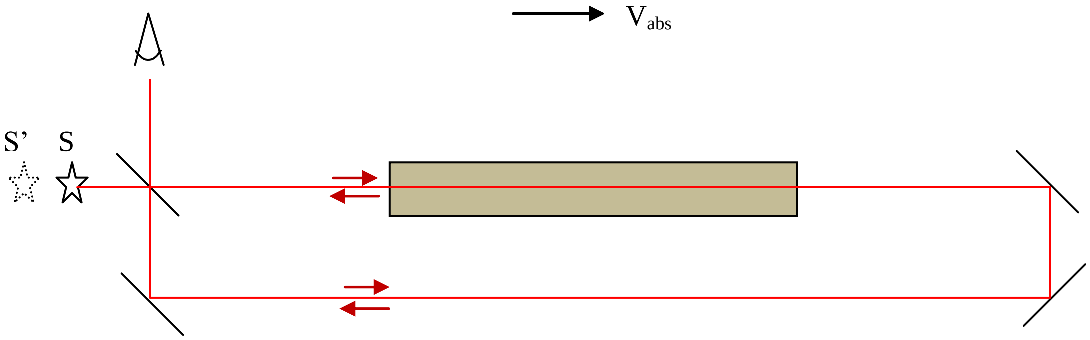
From the dependence of these time delays on absolute velocity, the variation of intensity of the light detected by the photo detectors with orientation of the apparatus, i.e. with absolute velocity, can be determined. The round trip time between the holes is independent of absolute velocity.

$$\text{Round trip time} = T_{AB} + T_{CD} = \frac{D}{c - V_{abs}} + \frac{D}{c\,\frac{c - V_{abs}}{c - 2V_{abs}}} = \frac{2D}{c}$$

Therefore PD2 current will not vary with absolute velocity, where as PD1 current will vary with absolute velocity.

2.1.5. The Hoek experiment

The null result of the Hoek experiment is expected because the water is not moving (relative to the light source). Only the source position apparently changes as seen by the detector due to rotation of the experimental apparatus with respect to Earth's absolute velocity, and this will not result in any fringe shift just as in the Michelson- Morley experiment.

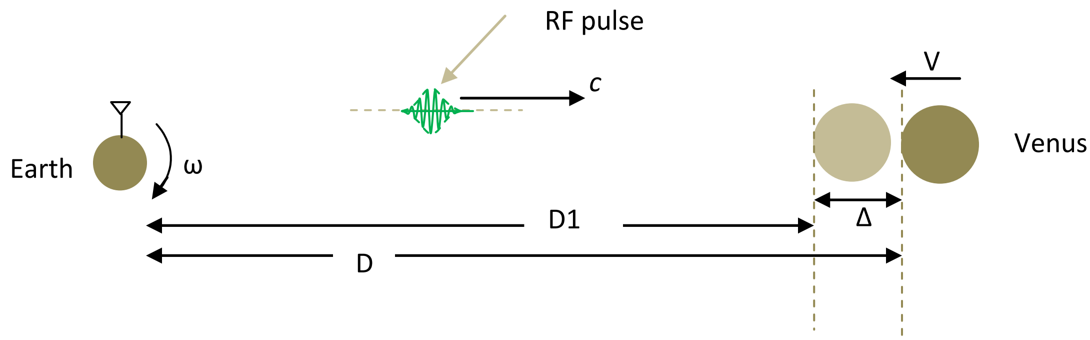


According to Apparent Source Theory, like the Michelson-Morley experiment, the effect of absolute motion is to create only a small fringe shift due to apparent change in position of the source, as seen by the detector.

2.1.6. 'Anomalous' radar range data from Venus planet as discovered by Bryan G. Wallace

One of the observations that seem to be in contradiction with Einstein's light postulate is the discovery by Bryan G.Wallace that analysis of radar range data of planet Venus did not conform totheprinciple of constancy of the speed of light.

The analysis of Bryan G. Wallace's experiment belongs to this section of co-moving source and observer because the source (RF transmitter) and the observer (RF receiver) are co-moving as both are bound to the Earth. The planet Venus acts as a mirror moving relative to the Earth. The effect of Earth's absolute velocity is negligible in creating an apparent change of position of the RF transmitter as 'seen' by the RF receiver because they are located at nearly the same location and because the distance to Venus is much greater than the distance between the transmitter and the receiver, which may be not more than a few tens of meters.



According to Special Relativity and ether theories, the center of the spherical wave fronts of the transmitted RF pulse remains at the point in space where the source was at the instant of emission. According to Apparent Source Theory, the center of the spherical wave fronts moves with the apparent source. As stated above, there is no significant difference between the real and the apparent positions of the source (the transmitter / antenna).
Remember the procedure of analysis:

1. Replace the real source with the apparent source (in this case almost the same as the real source)
2. Then analyze the problem by assuming that the speed of light is constant relative to the apparent source.

In the this case, the velocity of the RF pulse reflected from Venus relative to an observer on Earth is c+2V, according to emission theory, where V is the Earth Venus relative velocity. Suppose that at the instant of the reflecting of the RF pulse from Venus surface, the distance between the Earth and Venus is *D* and the Earth – Venus relative velocity is V.

The round trip time can be determined if we know the velocity of the RF pulse in the Earth's reference frame (which can be considered to be at rest, according to emission theory and Galilean relativity). The velocity of the transmitted RF pulse is obviously equal to *c* relative to the transmitter. The velocity of the reflected pulse will be $c + 2V$, relative to the Earth(reflection from a moving mirror).

Therefore, the total round trip time is determined as:

$$t_1 = \frac{D}{c} \quad , \quad t_2 = \frac{D}{c + 2V} \quad \text{and} \quad t_1 + t_2 = t$$

$$t = t_1 + t_2 = \frac{D}{c} + \frac{D}{c + 2V} = \frac{2D(c + V)}{c(c + 2V)}$$

$$\Rightarrow \quad D = \frac{tc}{2}\frac{c + 2V}{c + V}$$

where t_1 is the forward flight time, t_2 is the backward flight time and t is the round trip time of the RF pulse.

The distance D1 at the instant of reception of the pulse on Earth will be:

$$D1 = D - \Delta = D - t_2 V$$

$$= D - \frac{D}{c + 2V}\, V$$

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

$$= \frac{tc}{2}$$

In the case of Einstein's light postulate :

$$D1 = \frac{tc}{2} - \frac{tV}{2}$$

An important distinction here is that the absolute velocity of the solar system doesn't have any effect on this result and hasn't appeared in the above analysis, as explained in a previous section 'Apparent Contradiction' . To be clear, suppose that a detector and a clock were placed on Venus and another synchronized clock on Earth. If the time of detection of the radar pulse was recorded on Venus, it would be D'/c and not D/c, unlike our assumption in the above analysis, where D' is the apparent distance of the transmitter onEarth as seen by a detector on Venus (not shown in the above figure); as already discussed D' depends on D and absolute velocity V_{abs} of the solar system and the orientation of the Earth -Venus line relative to the solar system absolute velocity.

However, the peculiarnature of the speed of light is that it behaves as if this time is D/c, from the perspective of an observer on Earth.

According to the procedure already given, the observer on Earth
1. replaces the real transmitter position with an apparent transmitter position (which in this case is almost the same as the real transmitter position, because the observer is nearly at the same position as the transmitter (considering the large distance between Earth and Venus)
2. Analyze the experiment by assuming that the speed of light is constant relative to the apparent source (in the co-moving observer's reference frame or in the absolute reference frame) .

Since in Galilean space (or emission theory) the forward and back flight times will be D/c and D/ (c+2V) respectively, according to emission theory, where V is Earth - Venus relative velocity, the absolute velocity of the solar does not enter in the analysis of the experiment.

Repetition of the Bryan G.Wallace experiment using a lunar laser ranging experiment

Suppose that a laser pulse is emitted towards a mirror placed on the Moon and reflected back to the Earth and detected. The time elapsed between emission and detection is determined from Earth-Moon distance.

$$T = \frac{2D}{c}$$

In this case T = 2* 300,000 / 300,000 = 2 seconds

Now assume that the mirror on the moon is moving. This can be done by putting the mirror at the tip of a rotating rod, as in A.Michelson moving mirror experiment. Suppose that the velocity of the mirror is 100 m/s towards the Earth. Assume Earth-Moon distance to be 300,000Km, and speed of light 300,000 Km/s.

The laser light pulse will move at the speed of light *c*relative to the Earth before reflection from the mirror. After reflection, however, the pulse will move with velocity c+2V, where V is the mirror velocity, relative to the Earth.
Now

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

$$T = 1.999999333334 \text{ seconds}$$

The time difference between the above two time delays will be:

$$2.0 \text{ s} - 1.999999333334 \text{ s} = 666 \text{ nano second}$$

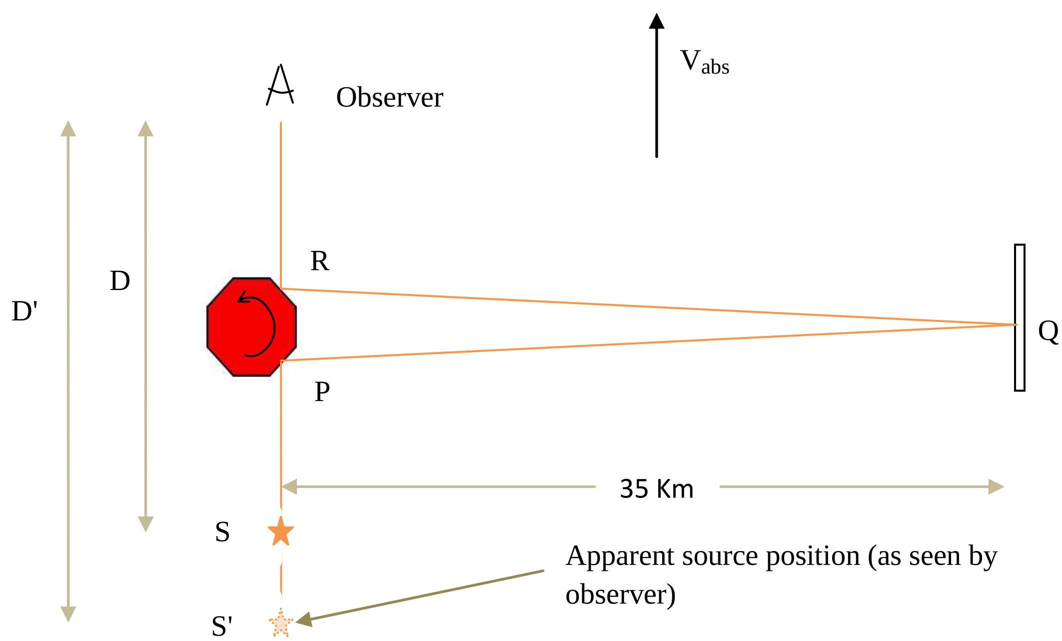
Detection of this difference will validate AST and disprove Special Relativity.

2.1.7. The A. Michelson rotating mirror light speed measuring experiment

The speed of light has been measured with increasing accuracy byOle Roamer, Bradley, Fizeau, Foucault and Albert Michelson, from observation of astronomical phenomena and by terrestrial experiments. Modern experiments use optical cavity resonators, microwave interferometer and laser methods. The currently accepted value is 2.99792458 x 10^8 m/s. Apparently, no variation in the speed of light has ever been detected with different orientations of the measuring apparatus relative to the orbital velocity of the Earth.

Let us consider the Albert Michelson rotating mirror experiment.As discussed so far, the source apparently shifts relative to the observer due to absolute velocity of the Earth (about 390 Km/s). We will see that this apparent shift of the position of the source relative to the observer does not affect the result of the experiment. The time taken by the light beam to move from the rotating mirror to the distant mirror and back to the rotating mirror, as 'seen' by the observer, is not affected by the absolute velocity of the Earth. What is affected by absolute velocity of the Earth is the total time taken for the light beam to go from the source to the observer. One may think of this as actually, physically changing the distance between the source and the observer (change distance of source from rotating mirror), which will not change the result of the experiment, obviously: the measured speed of light.

The same applies to optical cavity resonators and microwave and laser interferometer methods. The change in path length of the wave from source to detector due to absolute motion does not affect the result of such experiments. The *apparent* change of the position of the microwave source does not affect the frequency of a resonant cavity, just as *actually* changing the position of the source does not, in principle, affect the experiment .The frequency and the wavelength of light emitted by a source is not affected by an apparent or actual change of the position of the source.



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

To clarify this interpretation, assume that sensors are put at points P, Q and R. Points P and R are points in space where the light is reflected from the rotating mirror, point Q is point on the distant mirror where the light is reflected. If a short light pulse is emitted by the source at time t = 0 , then the light will be detected at points P, Q, and R, at times t_P , t_Q and t_R, respectively.

The distinction in the AST theory is as follows. The time it takes light pulse to go from the rotating mirror to the distant mirror (from point P to point Q), $t_Q - t_P$, and the time for the pulse to go from the distant mirror back to the rotating mirror (from point Q to point R), $t_R - t_Q$, will *actually* vary with the absolute velocity, as actually recorded by the sensors. The distinction in the AST theory is that this variation is not relevant to the observer, to predict the result of his experiment. The observer simply accounts for the absolute velocity by replacing the real source with the apparent source and analyze the experiment by assuming Galilean space and (modified) emission (ballistic) theory. Shifting the source from position S to position S' would not obviously affect the time from the rotating mirror to the distant mirror and the time from the distant mirror back to the rotating mirror, and the round trip time, from the perspective of the observer. Note that the observer is not actually measuring these times. He makes observations and measurements only at his own position.

But this difference is not important for the observer. The observer simply replaces the real source with the apparent source and analyze the experiment as if the whole system is at absolute rest or as if space is Galilean. Obviously, even real (physical) change of the light source does not affect the forward and backward flight times of the light pulse (assume absolute rest or Galilean space, for simplicity). Thus, for the observer, the forward and backward flight times are unaffected by absolute motion, as compared with a system (the source, the mirrors, the observer) at absolute rest.

Even though the two times are different, they are affected by absolute motion in such a way that their sum (the round trip time) is unaffected and will be the same as compared with a similar system that is at absolute rest or in Galilean space.

A different method was used by Rosa and Dorsey to measure the speed of light in 1907 .They measured vacuum permittivity ε_0 and vacuum permeability μ_0 from which the speed of light can be computed from the equation $c^2 = 1 / \varepsilon_0 \mu_0$. The result obtained was within 0.00005 % of the currently accepted value. This is an important experiment that shows that vacuum permittivity and vacuum permeability, and hence the vacuum *phase* velocity of light relative to any observer, are not affected by absolute motion. This can be another experimental evidence confirming Einstein's light postulate (for phase velocity).

Note that the group velocity of light will attain a component of the velocity of the rotating mirror , in accordance with the ballistic hypothesis, and this will slightly affect the measured velocity of light.

2.2. Light source, observer and mirrors in absolute and relative motions, with *inertial observer*

2.2.1. Apparent Source Theory for inertial observer

In the last section (section 2), we analyzed light speed experiments in which the source, the observer/detector, the mirrors, beam-splitters and other optical components were co-moving. There is no relative motion between them, but they are all in a common absolute motion, with constant velocity.All parts have common uniform motion, and no accelerations and relative motions are involved.

In this section we will consider light speed experiments in which the source, the observer/detector, mirrors, beam-splitters and other optical components can have independent absolute motions, but with constant velocities. This means that both absolute and relative motions can be involved in this case, but with *no acceleration of the observer*involved, which is the subject of the next section, section 4. However, basically, even experiments involving accelerated motions also will be analyzed based on the principle formulated in this section.

A general principle will be formulated which applies to all light speed experiments in which:

- source, observer and optical components are co-moving, with constant absolute velocity
- source, observer and optical components have independent absolute/relative motions, with constant velocities
- source, observer and optical components having independent accelerated absolute/relative motions

The principle formulated in this section applies for all light speed experiments, including interference and time of flight experiments.

In section 2 a simple, successful model was developed for the special case of co-moving light source, observer/detector, mirrors, beam-splitters and other optical components, in which only common constant absolute velocity is involved and no relative motions and accelerations are involved. There are no relative motions between the source, observer/detector and optical components and no accelerations in this case.

One of the most challenging problems I faced has been the problem of developing a general principle for all light speed experiments. It was the problem of developing the simple, successful model for uniformly co-moving source and observer (section 2) into a general principle/model that applies to all light speed experiments in which accelerated motions and relative motions between parts of the experimental apparatus are involved, such as the Sagnac experiment. In the previous versions of this paper, several attempts were made to formulate such a general principle but none was satisfactory. For example, the explanation for the Sagnac effect was not satisfactory. It was only recently that a breakthrough was made, after discovery of a crucial insight that resolves many of the puzzles, in my recent paper[37].

The general principle governing all light speed experiments is formulated as follows.

There is an apparent change in the point of light emission *relative to an absolutely moving inertial observer*. This means that there is an apparent change in the past position of a light source, relative to an absolutely moving *inertial* observer/detector. Relative to an inertial observer, there is an apparent contraction of space in front of the observer and an apparent expansion of space behind the observer. The contraction or expansion of space is only for point of emission electromagnetic fields and waves, including light, electrostatic fields and gravity.

Therefore, the procedure of analysis of light speed experiments is :

1. Construct an inertial reference frame in which the inertial observer is at its origin, with the +x axis parallel to the observer's absolute velocity vector. Determine the apparent point of light emission, relative to the inertial observer/detector. For an inertial observer that is in absolute motion, light acts as if it was emitted from an apparent point of emission, not from the actual/physical point of emission. For an observer that is at absolute rest the apparent point of light emission is the same as the actual point of emission.

2. Analyze the experiment by assuming that light is emitted from the apparent point of emission, not from the actual/physical point of emission, relative to the observer.

3. Therefore, according to the new theory proposed here, a *source* is a fixed point in the reference frame of the *inertial* observer. Therefore, there can be no motion of the *source* relative to the observerbecause a source is the apparent *point* of emission in the reference frame of the observer. Even if the physical light source was in motion relative to the observer at the instant of light emission, whether in uniform or accelerated motion at the instant of light emission, a source is just the (apparent) fixed point of light emission in the reference frame of the inertial observer.

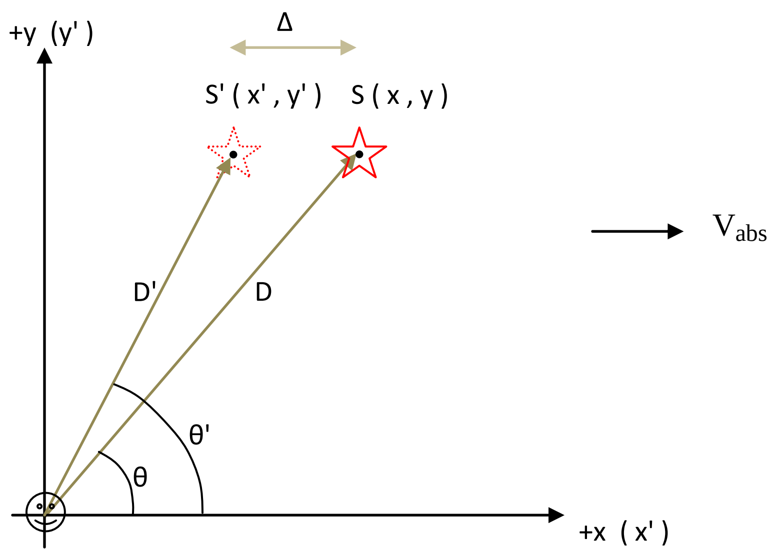
4. Therefore, in the analysis of any light speed experiment, the *source* (which is the apparent point of light emission) and the inertial observer/detector are *always* at rest relative to each other.

5. The problem is analyzed by taking into account the initial positions and motions of the mirrors, beam-splitters and other optical components. For example, if the mirror is moving away from the *source*, the light (the group) takes more time to catch up with the mirror. The path, path length and time of flight is determined by using simple classical optics, such as the law of light reflection from mirror.

6. All light speed experiments are divided in two categories:
   - those experiments in which the observer/detector is inertial
(this is the subject of this section and the previous section)
   - those experiments in which the observer/detector is in accelerated motion
(this is the subject of the next section, section 4)

All experiments in which the observer/detector is moving with constant velocity are analyzed basically in the same way, regardless of whether the light source, the mirrors, beam splitters are in uniform or accelerated motions.

The law governing the apparent point of emission of light relative to an absolutely moving inertial observer is formulated as follows[37].



For $V_{abs} << c$, the apparent point of light emission (the apparent past position of the source) is determined as follows. V_{abs} is the absolute velocity of the *observer*. Only the absolute velocity of the *observer* is relevant in all light speed experiments.

Note that point S(x,y) is the actual point of light emission whereas point S'(x',y') is the apparent point of light emission. In other words S(x,y) is the actual past position of the source and S'(x',y') is the apparent past position of the source. S(x,y) is the actual/physical position of the source at the instant of light emission whereas S'(x',y') is the apparent position of the source at the instant of light emission.

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

and

$$\sqrt{D^2 - y^2} - \sqrt{D'^2 - y'^2} = \Delta$$

and

$$y' = y$$

If D and y are given, then D' and Δ can be determined from the above equations. Therefore, from the above equations, substituting the value for Δ ,

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

Substituting y' = y,

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

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

$$\Rightarrow \quad (D^2 - y^2) + \left(\frac{D'}{c} V_{abs}\right)^2 - 2\left(\frac{D'}{c} V_{abs}\right)\sqrt{D^2 - y^2} = D'^2 - y^2$$

$$\Rightarrow D'^2\left(1 - \frac{{V_{abs}}^2}{c^2}\right) + 2D'\frac{V_{abs}}{c}\sqrt{D^2 - y^2} - D^2 = 0$$

This is a quadratic equation of D' , from which D' can be determined in terms of D, y, and V_{abs} .

For $V_{abs} << c$,

$$\frac{{V_{abs}}^2}{c^2} \cong 0$$

$$\Rightarrow D'^2 + 2D'\frac{V_{abs}}{c}\sqrt{D^2 - y^2} - D^2 \cong 0$$

But

$$\sqrt{D^2 - y^2} = x$$

Therefore,

$$\Rightarrow D'^2 + 2D'\frac{V_{abs}}{c}\, x - D^2 \cong 0$$

$$D' \cong \frac{-\left(2\,\frac{V_{abs}}{c}\,x\right) + \sqrt{(2\,\frac{V_{abs}}{c}\,x)^2 + 4D^2}}{2}$$

$$\Rightarrow \quad D' \cong -\left(\frac{V_{abs}}{c}\,x\right) + \sqrt{(\frac{V_{abs}}{c}\,x)^2 + D^2}$$

Again for $V_{abs} << c$,

$$\frac{{V_{abs}}^2}{c^2} \cong 0$$

$$\Rightarrow \quad D' \cong D - \left(\frac{V_{abs}}{c}\,x\right)$$

From

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

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

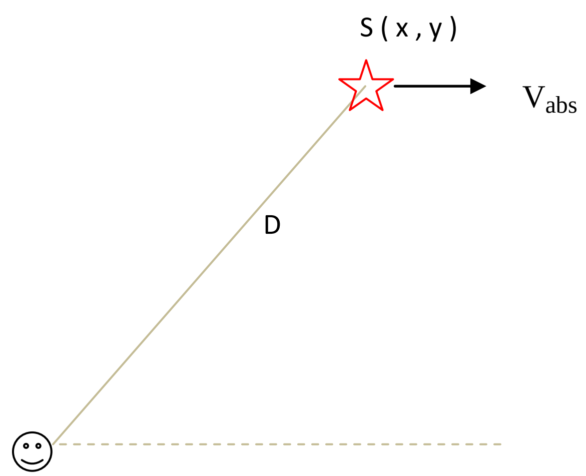
$$\Longrightarrow \quad \Delta \cong \frac{V_{abs}}{c} \left(D - \frac{V_{abs}}{c} x \right) \quad , \quad for \ V_{abs} \ll c$$

$$\Longrightarrow \Delta \cong \frac{V_{abs}}{c} D \quad , \quad for \quad {V_{abs}}^2 \ll c^2$$

To illustrate the above principle, we will consider different cases of source, observer and mirror motions.

Observer at absolute rest and light source in absolute motion

Suppose that the source was at point S at the instant of light emission. Since the observer is at absolute rest, the apparent point of emission is the same as the actual/physical point of emission.



Since the apparent point of light emission is the same as the actual point of emission, the time of flight will be:

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

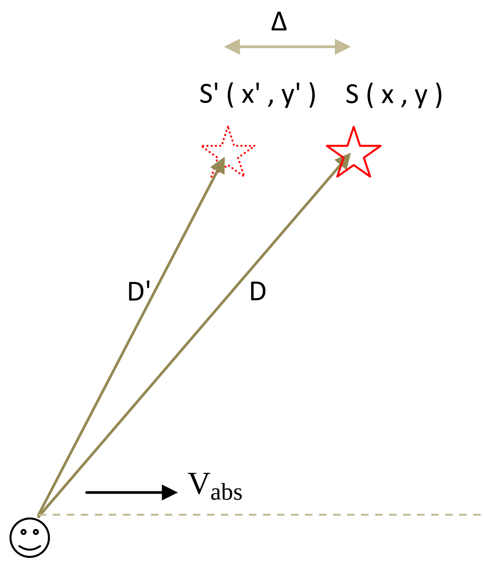
Light source at absolute rest and observer in absolute motion

Suppose that S is the actual point of light emission. Then, according to the new theory, light acts as if it was emitted from an apparent point of emission (S'), not from the actual point of emission (S).

Therefore,

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

The apparent point of emission is determined as already shown.



Since

$$\Longrightarrow \quad D' \cong D - \frac{V_{abs}}{c}\, x$$

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

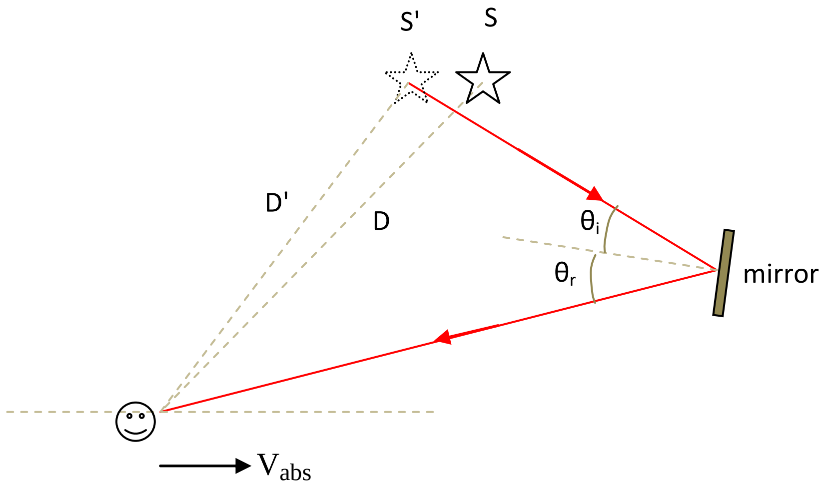
$$\Longrightarrow \quad t = \frac{D - \frac{V_{abs}}{c}\, x}{c}$$

Light source and observer in absolute and relative motions

The analysis of such experiments is the same as that of the previous case of an observer in absolute motion and light source at absolute rest. Only the absolute velocity of the inertial observer/detector is relevant in all light speed experiments. As for the light source, only the position of the light source relative to the observer at the instant of light emission is relevant and absolute or relative motion of the source is irrelevant.

Absolutely co-moving light source, observer and mirrors

So far we have considered only possible experiments in which no mirrors are involved and we have been dealing with the light coming to the observer directly from the source. For experiments in which mirrors are involved and there are no relative motions between the source, the observer and the mirrors, the procedure is as follows.

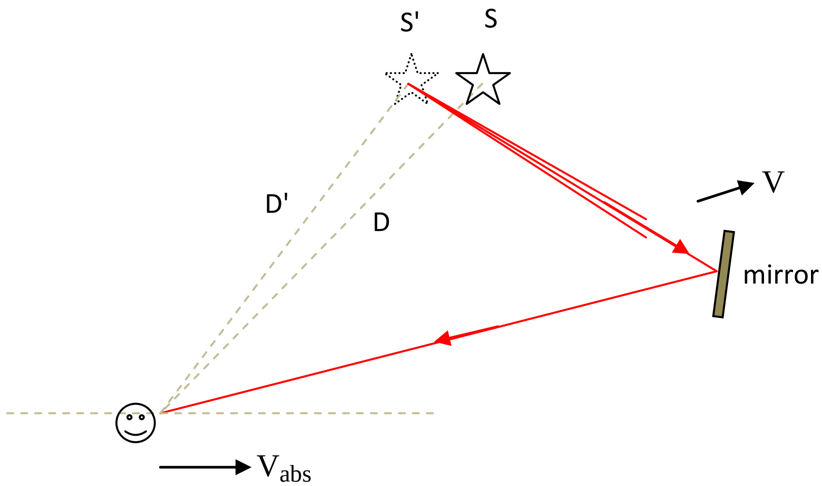


1. Determine the apparent point of emission relative to the observer
2. Analyze the experiment by assuming that light is emitted from the apparent point of emission, by applying classical optics, such as the law of reflection ($\theta_i = \theta_r$).

Co- moving light source and observer, with mirror moving relative to the source and observer

In this case the light source and the observer have common absolute motion. There is no relative motion between the source and observer. The mirror is moving relative to the observer (and the source).

The procedure of analysis is:
1. Determine the apparent point of emission (S') relative to the observer
2. Analyze the experiment by taking into account the initial position and motion of the mirror and by assuming that light was emitted from the apparent point of emission (S'), and by assuming ballistic hypothesis for the group velocity of light reflected from mirror. The problem is solved in the reference frame of the observer.
The path, path length and time of flight is determined according to the above procedure.



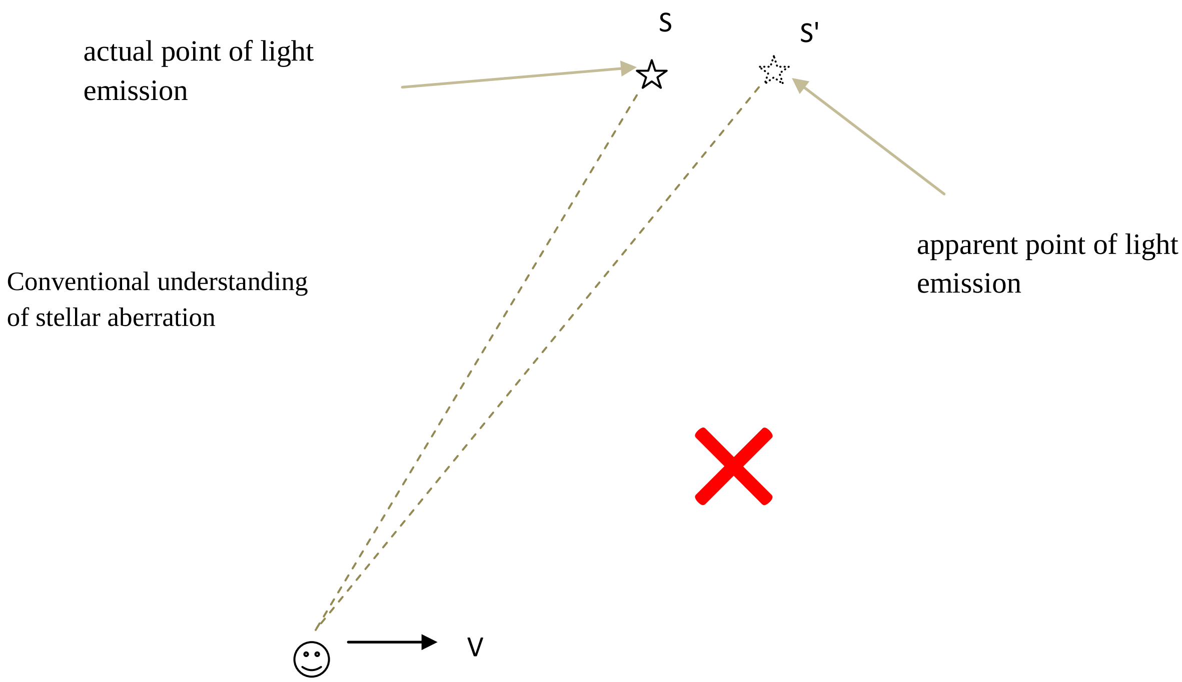
Qualitatively, solving the problem means determining which of the many photons emitted in different directions will pass through the point where the observer/detector is located. If the mirror was at rest relative to the source and observer, this is a simple problem that can be solved by applying the classical law of reflection (angle of incidence equals angle of reflection) . In this case, since the mirror is in relative motion, the problem is more complicated, but straightforward. Note again that the group velocity of light reflected from a mirror behaves according to the ballistic (emission) hypothesis: the group velocity of light reflected from a mirror varies with mirror velocity.

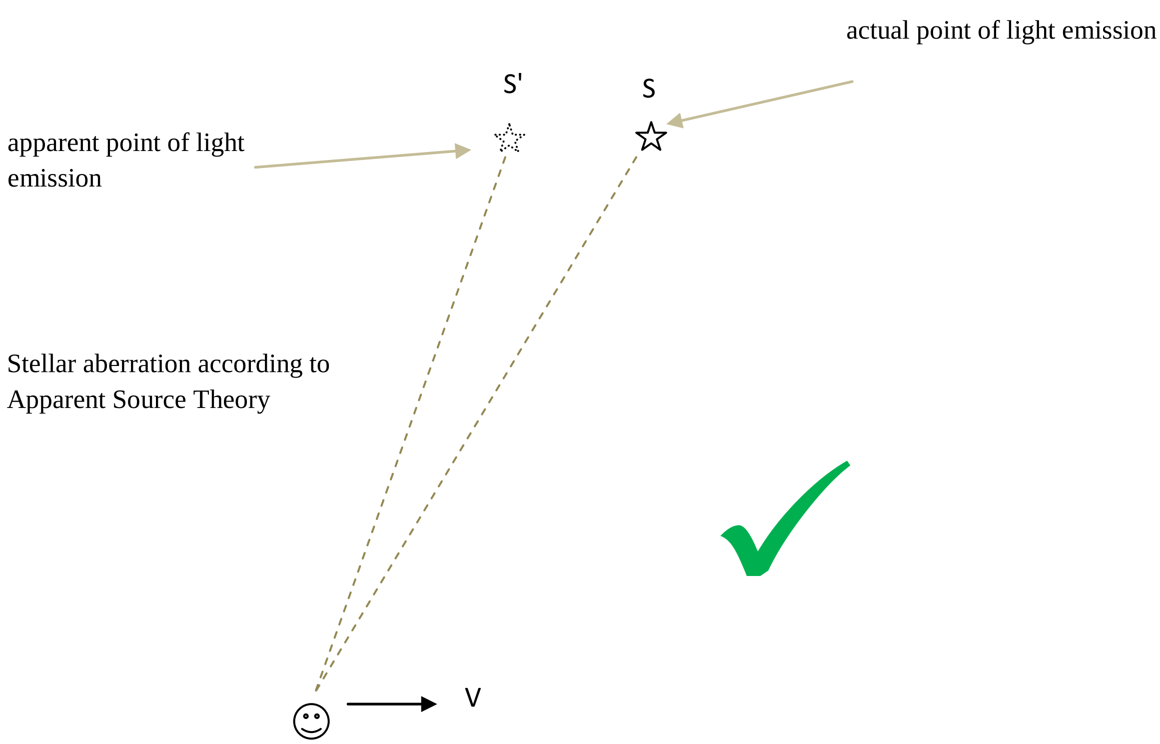
2.2.2. The phenomenon of stellar aberration

Stellar aberration is the phenomenon of apparent periodic annual change in position of stars observer from Earth, and was discovered by Bradleyin 1725. Bradley correctly explained this phenomenon as resulting from the motion of the Earth in its orbit around the sun (30Km/s). However, his explanation was based on the corpuscular hypothesis of light. It is based onan analogyof apparent change in direction of rain for an observer running in the rain. An observer moving in the rain needs to tilt his/her umbrella slightly forward even if the rain droplets are falling vertically, relative to a stationary observer. According to universally accepted current understanding, the apparent change in position of the stars is in the direction of the observer's velocity.

One of the profound consequences of Apparent Source Theory is that it changes current accepted explanation of stellar aberration in a completely unexpected way: the apparent change in direction of the stars is not in the same direction as the absolute velocity of the observer, in the direction opposite to the direction of observer's absolute velocity !

Since stellar aberration arises due to observer's absolute motion only (absolute motion of the source is irrelevant), we will consider a star at absolute rest and an observer in absolute motion.

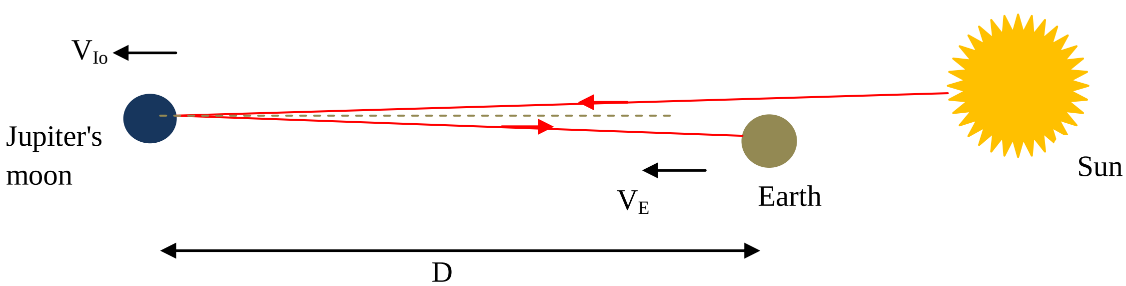

S
S'
actual point of light emission
apparent point of light emission
Conventional understanding of stellar aberration
V


actual point of light emission
S'
S
apparent point of light emission
Stellar aberration according to Apparent Source Theory
V

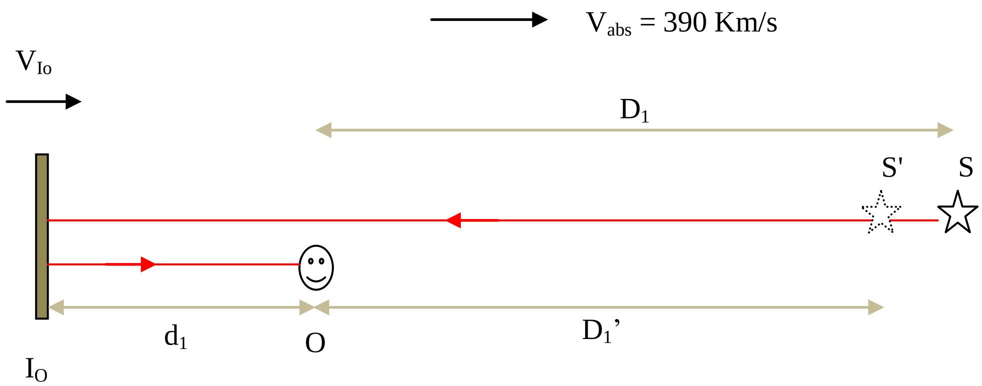
2.2.3. The Roamer experiment

Roamer observed that the eclipse time of Jupiter's moon Io is 22 minutes longer when the Earth was moving away from Jupiter than when it was moving towards Jupiter. From this observation, the speed of light was determined, for the first time. Before that time the order of the speed of light was unknown, and was even thought to be infinite.

The Roamer experiment is one of the decisive experiments that led me to the conclusion that the (group) velocity of light is variable, for a moving observer, and to abandon Einstein's light postulate as it is. We have already established that the group velocity of light is independent of source absolute velocity, but varies with observer absolute velocity. Group velocity also varies with the velocity of mirror. One objection to this theory is that the Albert Michelson moving mirror experiment, which apparently confirmed that the velocity of light does not depend on the velocity of mirror. But what was measured in the Michelson moving mirror experiment was a fringe shift. The Michelson experiment only confirmed that the *phase* velocity of light is independent of mirror velocity. The *group* velocity of light varies with mirror velocity and with observer velocity. Both group velocity and phase velocity are independent of source velocity. We have already discussed the explanation of the A. Michelson moving mirror experiment.



This problem is one in which a light source, observer and mirror are all in relative and absolute motions. The complete analysis of this problem involves determination of the apparent point of light emission, i.e. the apparent past position of the Sun. This depends on the direction of the absolute velocity of the observer (which is the observer on Earth in this case). The sun is the light source and Jupiter's moon acts as the mirror. Once the apparent point of emission, i.e., the apparent past position of the Sun, is determined, the problem is solved by taking into account the initial position (position at instant of light emission) and motion of Io in the reference frame of the Earth.



However, the absolute motion of the solar system has no significant effect on the eclipse time of Jupiter's moon. The variation in the eclipse time is due to the variation of the group velocity of light with mirror velocity, according to the ballistic hypothesis. The group velocity of light varies with the velocity of Jupiter's moon (the mirror) relative to the Earth.

Let the velocity of Io be V_{IO} relative to the Earth. Therefore, the group velocity of light reflected from Io relative to the Earth will be:

$$c \pm V_{IO}$$

Let d_1 be the distance between the Earth and Io at the instant of light reflection from Io . The time taken by reflected light to arrive at the Earth will be:

$$t = \frac{d_1}{c \pm V_{IO}}$$

3. Speed of light relative to non-inertial observer

3.1. Generalized Apparent Source Theory

So far we have analyzed light speed experiments in which the *observer/detector* are inertial. We have already stated that all light speed experiments can be categorized as follows:

1. Light speed experiments in which the observer/detector is moving with constant velocity (inertial observer)
2. Light speed experiments in which the observer/detector is in accelerated motion (non-inertial observer)

All light speed experiments involving *inertial observer/detector* are analyzed with basically the same procedure, regardless of whether the light source, the mirrors, beam splitters and other optical components are in inertial or accelerated absolute or relative motions.

And, all light speed experiments involving *non-inertial observer/detector* are analyzed with basically the same procedure, regardless of whether the light source, the mirrors, beam splitters and other optical components are in inertial or accelerated absolute or relative motions.
As stated in the previous section, the procedure of light speed experiments involving *inertial* observer/ detector is:

1. We assume that light is emitted at t = 0 and that
   - the point of light emission by the source (i.e., the point where the source was at the instant of light emission
   - the initial positions and motions (velocity and accelerations) of all other parts of the experimental apparatus (observer/detector, mirrors, beam-splitters, and other optical components) are given, in some inertial reference frame whose absolute velocity is known.

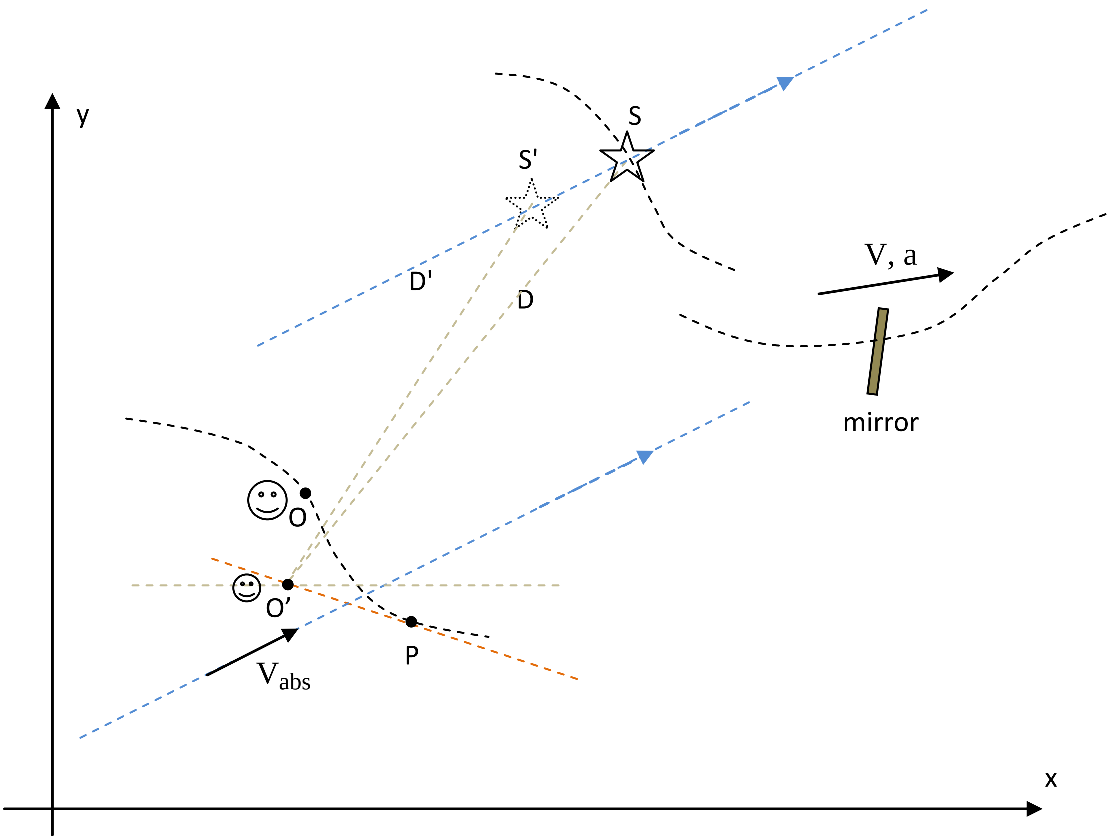
2. We then describe the positions and motions of all component parts of the light speed experiment in the reference frame of the observer/detector.
   - the actual point of light emission relative to the observer
   - the initial positions and motions of the mirrors, beam-splitters and other optical components relative to the observer

3. Once the *actual/physical point of light emission* and the initial positions and motions of the optical parts are defined (described) in the reference frame of the observer/detector, the next step is to determine the *apparent point of light emission*, as seen by the observer.

4. Then analyze the experiment by assuming that light was emitted from the apparent point of emission and by taking into consideration the initial positions and motions of the mirrors(inertial or accelerated), beam-splitters e.t.c.

In this case, source is a fixed *point* where light was apparently (not actually) emitted in the reference frame of the inertial observer. The experiment is analyzed by assuming ballistic hypothesis for the *group* velocity of light reflected from a moving mirror. The path, pathlength are determined, from which time of flight is also determined, for time of flight experiments. For interference experiments, the phase of the detected light relative to the emitted light is determined by using the path length and *constant phase velocity (c)* of light [37].

In this section, we will try to analyze light speed experiments involving *observers/detectors in accelerated motion*.



The procedure of analysis of experiments involving non-inertial observers/detectors is formulated as follows [37]:

1. We are given the initial positions (position at t = 0, the instant of light emission) and subsequent motions of the light source, accelerating observer, the mirrors, the beam splitters e.t.c., in some inertial reference frame whose absolute velocity is known.

Note that only the *position* of the light source at the instant of light emission(t = 0) is relevant and the motion (velocity or acceleration) of the light source during and after light emission is not relevant in determining the experimental results. The experimental outcome is determined by the positions and motions of the accelerating observer/detector, mirrors, beam-splitters, e.t.c.

2. We start by assuming that the accelerating observer O was at point O at the instant of light emission and that observer O will detect the light at some point P.
3. We then imagine some imaginary *inertial* observer O' , who was at point O' at the instant of light emission and who will arrive at point P simultaneously with accelerating observer O, with velocity (magnitude and direction) equal to the instantaneous velocity of observer O at point P, i.e., at the instant of light detection by observer O. This means that accelerating observer O and imaginary inertial observer O' will arrive at point P simultaneously, will detect the light at point P, while moving with equal instantaneous velocities.
4. From the above assumptions, the following requirement is derived:
- the time taken by non-inertial observer O to move from point O to point P is equal to the time taken by light to move from the apparent point of emission to point P, after reflection from the mirror

5. Then the positions and motions of the light source, the mirrors, beam splitters, … is described in the reference frame of the imaginary inertial observer O'. The expression for apparent point of light emission (as seen by imaginary inertial observer O') is determined. The *apparent* point of light emission is determined by the absolute velocity of the observer and the distance between the observer and the *actual*/*physical* point of emission.
Note that the two blue lines passing through the source S and observer O' are both parallel to the absolute velocity vector of observer O' and the apparent change in point of emission is parallel to this line, as shown.

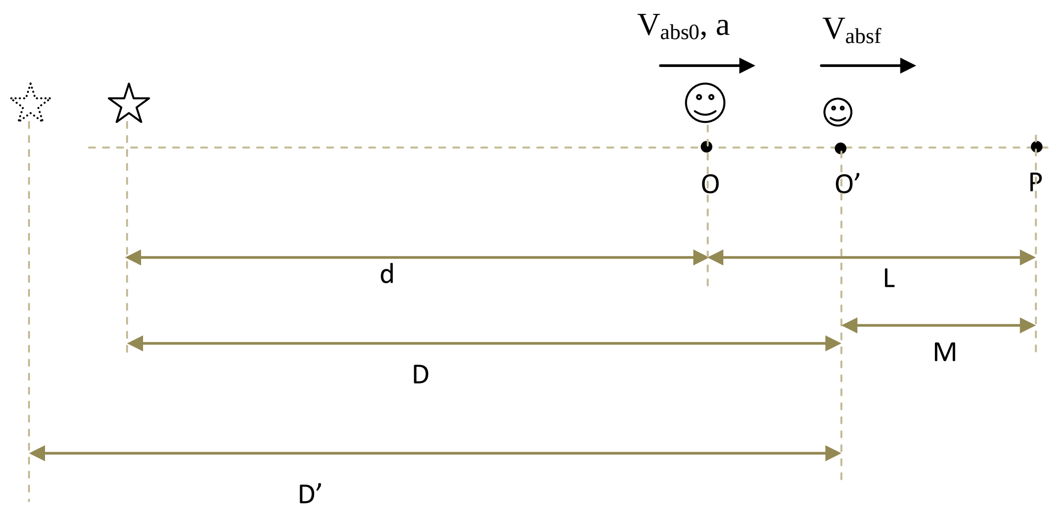
6. By assuming that light was emitted from the apparent point of emission and by taking into consideration the positions of the beam-splitters, mirrors and other optical parts, determine the expression for the time of flight of light from the apparent point of emission to the imaginary inertial observer O'.

7. Therefore, two additional requirements will be:
- the time take by observer O to move from point O to point P is equal to the time taken by imaginary inertial observer O' to move from point O' to point P.
- the time taken by inertial observer O' to move from point O' to point P is equal to the product of the velocity of inertial observer O' and the time of flight of light

8. So far we have three unknowns: path length OP, path length O'P and time of flight *t*. Since we have also three equations, all the unknowns can be determined.

Let us consider a simple example to illustrate the above principles and procedures. For simplicity, we will consider an observer accelerating along a straight line.

Imagine a light source that is at absolute rest. The light source emits a short light pulse at time $t = 0$, and the observer is at distance *d* and moving away from the light source, with initial absolute velocity V_{abs0} and acceleration a. The problem is to determine the time taken by light to catch up with the observer and the path length.



Let the accelerating observer be at point O at the instant of light emission (at t = 0).
Let us also assume that accelerating observer O will detect the light pulse at point P, which is a distance L from point O.

In accordance with the principle stated above, we assume an imaginary *inertial* observer O' who is at point O' at the instant of light emission, such that accelerating real observer O and inertial imaginary observer O' will arrive at point P simultaneously, and the velocity of inertial observer O' (V_{absf}) is equal to the instantaneous velocity of observer O at point P. This means that both observers O and O' arrive at point P simultaneously, will detect the light at point P, while both are moving with equal instantaneous velocities of V_{absf}.

Now, from the above assumptions, the time taken by observer O to move from point O to point P is equal to the time taken by observer O' to move from point O' to point P.

The time *t* taken by accelerating observer O to move from point O to point P is determined from:

$$L = V_{abs0}t + \frac{1}{2}a\,t^2$$

$$\Longrightarrow \quad a\,t^2 + 2V_{abs0}t - 2L = 0$$

$$\Longrightarrow \quad t = \frac{-2V_{abs0} + \sqrt{(2V_{abs0})^2 + 8aL}}{2a} = \frac{-V_{abs0} + \sqrt{V_{abs0}{}^2 + 2aL}}{a}$$

The time taken by inertial observer O’ to move from point O’ to point P is:

$$t = \frac{M}{V_{absf}}$$

But

$$V_{absf} = V_{abs0} + a\,t$$

and

$$M = d + L - D$$

Therefore:

$$t = \frac{d + L - D}{V_{abs0} + a\,t}$$

So far we have two equations , but three unknowns: *t* , *L* , *D*. Therefore, we need one more equation to completely determine these variables.

The next step is to determine the time of flight of light from the source to the observer.

For this we have to determine the apparent point of emission relative to the imaginary inertial observer O’.

At the instant of light emission (*t = 0*) , the actual/physical distance D between inertial observer O’ and the light source is :

$$D = d + (L - M)$$

In other words, D is the actual/physical point of light emission relative to inertial observer O’.

The apparent point of light emission, relative to inertial observer O’ is:

$$D' = D\,\frac{c}{c - V_{absf}}$$

Therefore, the time taken by light to travel from apparent point of emission to inertial observer O’ will be:

$$t = \frac{D'}{c} = \frac{D\,\frac{c}{c - V_{absf}}}{c} = \frac{D}{c - V_{absf}}$$

But

$$V_{absf} = V_{abs0} + a\,t$$

Therefore,

$$t = \frac{D}{c - V_{absf}}$$

$$\Longrightarrow \; t = \frac{D}{c - V_{abs0} - a\,t}$$

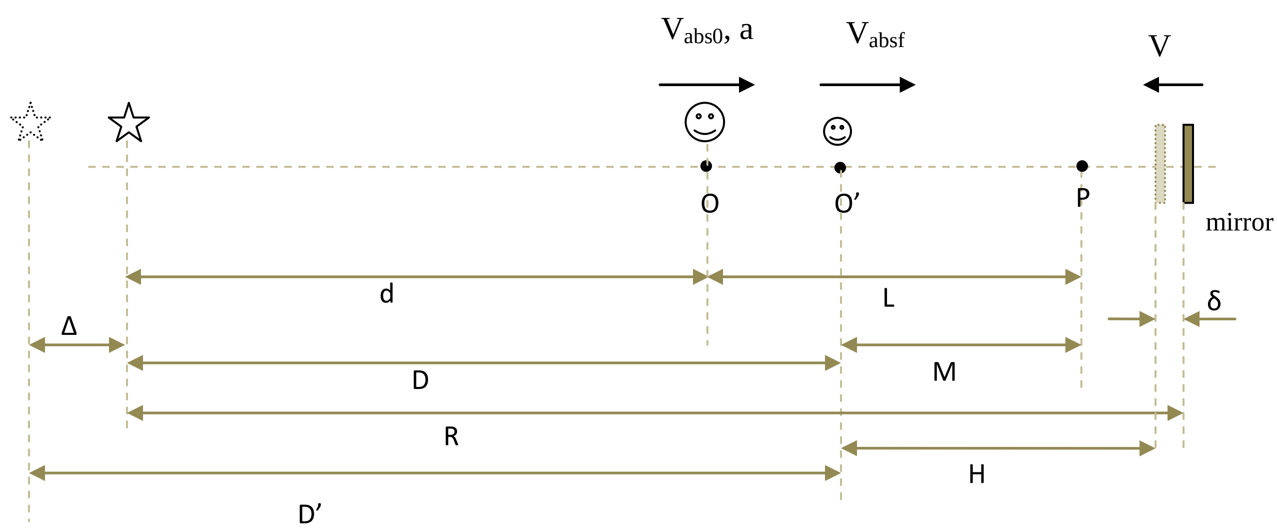
$$\Longrightarrow \; at^2 - (c - V_{abs0})t + D = 0$$

$$t = \frac{(c - V_{abs0}) \pm \sqrt{(c - V_{abs0})^2 - 4aD}}{2a}$$

From the three expressions above, we can determine the values of *t*, *L*, and *D*.

For more illustration, let us consider another problem in which moving mirror is involved.

Imagine a light source that is at absolute rest. The light source emits a short light pulse at time t = 0 . At t = 0 , the observer O is at point O, at distance *d* from the source, and moving with absolute velocity V_{abs0} to the right , with acceleration *a* to the right. At t= 0 , a mirror is at distance R from the light source, and moving with constant velocity V to the left in the absolute reference frame.



The problem is to determine the time *t* elapsed between emission of light and detection by accelerating observer O of the light reflected from the moving mirror.

As in the last example, we start by assuming that accelerating observer O will detect light reflected from the moving mirror at point P. We also imagine an imaginary inertial observer O' who is at point O' at $t = 0$ (i.e. at the instant of light emission) and moving to the right with absolute velocity V_{absf}, where V_{absf} is also the instantaneous velocity of accelerating observer O' at point P , such that observer O' and observer O will arrive at point P and detect the light simultaneously. The absolute velocity of inertial observer O' is the same as the instantaneous absolute velocity of observer O at point P, which means both observers will be moving with velocity V_{absf} at point P.

As in the last example, therefore, the time taken by observer O to move from point O to point P is equal to the time taken by imaginary inertial observer O' to move from point O' to point P.

But the time taken by observer O to move from point O to point P is determined from:

$$L = V_{abs0}t + \frac{1}{2} a t^2$$

$$\Rightarrow \quad a t^2 + 2V_{abs0}t - 2L = 0$$

$$\Rightarrow \quad t = \frac{-2V_{abs0} + \sqrt{(2V_{abs0})^2 + 8aL}}{2a} = \frac{-V_{abs0} + \sqrt{V_{abs0}{}^2 + 2aL}}{a}$$

The time taken by inertial observer O' to move from point O' to point P is:

$$t = \frac{M}{V_{absf}}$$

But

$$V_{absf} = V_{abs0} + a\,t$$

and

$$M = d + L - D$$

Therefore:

$$t = \frac{d + L - D}{V_{abs0} + a\,t}$$

So far we have two equations , but three unknowns: *t* , *L* , *D*. Therefore, we need one more equation to completely determine these variables.

The next step is to determine the time of flight of light from the source to the observer, after reflection from the mirror.

For this we have to determine the apparent point of emission relative to the imaginary inertial observer O'.

At the instant of light emission ($t = 0$) , the actual/physical distance D between inertial observer O' and the light source is :

$$D = d + (L - M)$$

In other words, D is the actual/physical point of light emission relative to inertial observer O'.

The apparent point of light emission, relative to inertial observer O' is:

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

The time taken by light to travel from apparent point of emission to the mirror and then, after reflection, to inertial observer O' is determined as follows.

For this, first we need to determine the point of reflection of light from the mirror. Note that the position of the mirror shown in the last figure is for t = 0.

Let us determine the time taken by light to move from the *apparent point of emission* to the mirror. The *group* velocity of light relative to the mirror is:

$$c + V$$

The distance between the mirror and the apparent point of emission at t = 0 is:

$$R + \Delta$$

But

$$\Delta = D' - D$$

Therefore, the time taken by light to move from the apparent point of emission to the mirror is :

$$t_1 = \frac{R + \Delta}{c + V} = \frac{R + D' - D}{c + V}$$

The velocity of the mirror relative to the imaginary inertial observer O' is:

$$V_{absf} - V$$

During this time (t_1) , the mirror will move a distance of:

$$\delta = t_1 V = \frac{R + D' - D}{c + V} V = \frac{R + D\frac{c}{c - V_{absf}} - D}{c + V} V$$

relative to (towards) inertial observer O'.

Therefore, light is reflected from the mirror at distance H relative to the inertial observer O'.

But

$$H = R + \Delta - D' - \delta$$

Now we can determine the total time *t* it takes light to travel from the apparent point of emission to the imaginary inertial observer O', after reflection from the mirror. This total time *t* is composed of two components: the time $t_1$it takes light to travel from the apparent point of emission to the mirror, which has already be determined, and the time $t_2$it takes reflected light to travel from the point of reflection to the inertial observer O'.

$$t = t_1 + t_2$$

As we have already stated, the group velocity of light reflected from a moving mirror behaves according to the ballistic hypothesis. Therefore, the group velocity of light reflected from the mirror will be:

$$c + 2\,(V_{absf} - V)$$

whereV_{absf} – V is the velocity of the mirror relative to the inertial observer O' .

Therefore,

$$t_2 = \frac{H}{c + 2\,(V_{absf} - V)} = \frac{R + \Delta - D' - \delta}{c + 2\,(V_{absf} - V)}$$

From which

$$t = t_1 + t_2 = \frac{R + D' - D}{c + V} + \frac{R + \Delta - D' - \delta}{c + 2\,(V_{absf} - V)}$$

But

$$\Delta = D' - D$$

$$\Rightarrow t = t_1 + t_2 = \frac{R + D' - D}{c + V} + \frac{R + D' - D - D' - \delta}{c + 2\,(V_{absf} - V)}$$

$$\Rightarrow t = t_1 + t_2 = \frac{R + D' - D}{c + V} + \frac{R - D - \delta}{c + 2\,(V_{absf} - V\,)}$$

Substituting the previous values for D’ and δ :

$$\Rightarrow t = t_1 + t_2 = \frac{R + D\,\frac{c}{c - V_{absf}} - D}{c + V} + \frac{R - D - \frac{R + D\frac{c}{c - V_{absf}} - D}{c + V}\,V}{c + 2\,(V_{absf} - V\,)}$$

But

$$V_{absf} = V_{abs0} + a\,t$$

Therefore

$$\Rightarrow t = t_1 + t_2 = \frac{R + D\,\frac{c}{c - (V_{abs0} + a\,t)} - D}{c + V} + \frac{R - D - \frac{R + D\frac{c}{c - (V_{abs0} + a\,t)} - D}{c + V}\,V}{c + 2\,((V_{abs0} + a\,t) - V\,)}$$

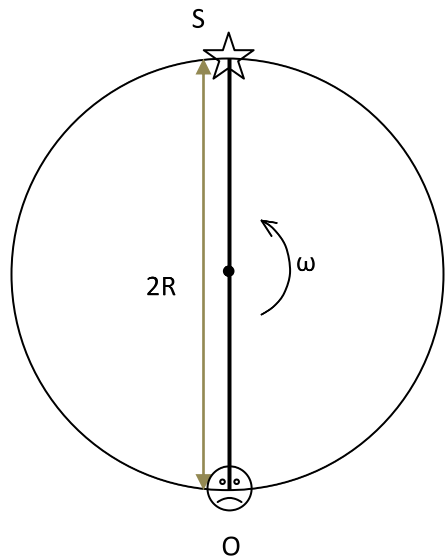
The unknowns in the above equation are *t* and *D*. Note that R is a given.

So far we have three equations and three unknowns: t , L, D , and hence we can completely determine these unknowns.

The above examples are relatively simple possible cases in which the observer is in accelerated motion, in which we have considered only rectilinear acceleration.

The analysis of experiments in which the observer’s velocity is continuously changing in magnitude and acceleration is basically based on the same principle, but more complicated. The problem is even more involved if the mirrors and beam-splitters are not only moving relative to the observer, but also are in non-rectilinear accelerated motion.

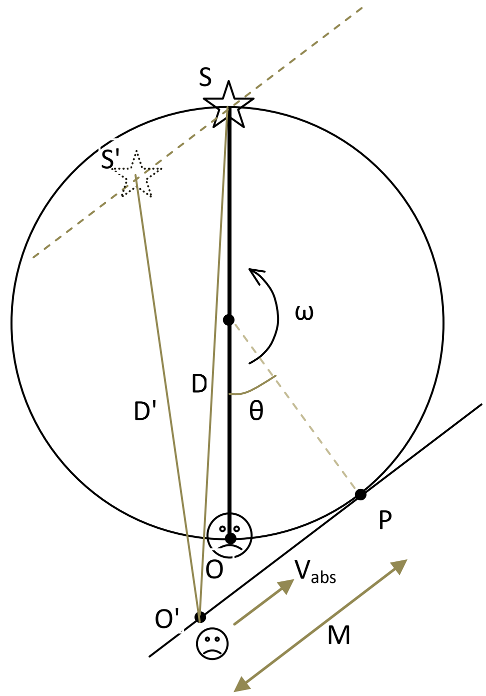
Let us consider a simple example of light source S and observer O attached to the two ends of a rigid rotating counterclockwise about the middle point of the rod. The radius of the circle is R .



The problem is to find the time elapsed between emission of light from the source and detection of the light by the observer and also to determine the path and path length of light and the phase of observed light relative to emitted light.

Assume that light is emitted just at the instant the source and observer are at the positions shown in the above figure. Therefore, at the instant of light emission (at $t = 0$) , the observer O is at point O. We know that this is a problem of an accelerating observer and therefore we will use basically the same procedures and principles as in the last example. Unlike the observer in the last example, which was in a rectilinear accelerated motion, the observer in the present problem is in a non-rectilinear accelerated motion.

We start by assuming that accelerating observer O will detect the light at point P. Since observer O is not inertial, we cannot solve the problem in the reference frame of observer O. Instead we imagine an inertial observer O' with initial position and velocity V_{absf}such that both observers O and O' will arrive at point P simultaneously and detect the light, with the velocity of observer O' equal to the instantaneous velocity of accelerating observer at point P. This means that both observers O and O' will detect the light at point P simultaneously, while moving with the same instantaneous velocity V_{absf}. We will solve the problem for imaginary inertial observer O'. By solving the problem for imaginary inertial observer O', we will automatically solve the problem for the real accelerating observer O.



The time taken by observer O to move from point O to point P is:

$$t = \frac{length\ of\ arc\ OP}{tangential\ velocity\ of\ observer\ O} = \frac{2\pi R\ \frac{\theta}{360^0}}{\omega R} = \frac{2\pi\ \frac{\theta}{360^0}}{\omega}$$

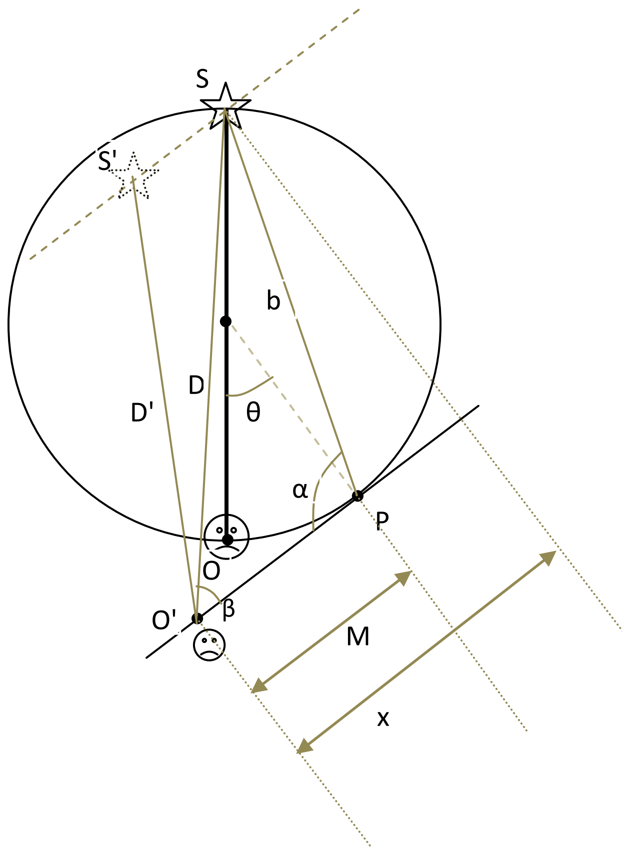
The time taken by inertial observer O' to move from point O' to point P will be:

$$t = \frac{path\ length\ O'P}{V_{absf}} = \frac{M}{V_{absf}} = \frac{M}{\omega R}$$

The time *t* is also the time of flight of light from apparent point of emission to inertial observer O'. The apparent point of emission is determined relative to inertial observer O'.

For this we draw a line parallel to line O'P (which is parallel to observer O' absolute velocity vector) through the actual/physical point of emission, which is S. The apparent point of emission is along this line, as show in the figure above.
Distance D is determined in terms of θ and M . Once D is determined, D' can also be determined.

Consider triangle SO'P in the following figure. Side SP can be expressed in terms of θ and R, where R is the radius of the circle.



It can be shown that

$$\alpha = 90^0 + \left(\frac{180^0 - (180^0 - \theta)}{2}\right) = 90^0 + \frac{\theta}{2}$$

and

$$length\ of\ SP = b = \sqrt{R^2 + R^2 - 2R^2\cos(180^0 - \theta)} = \sqrt{2}\,R\,\sqrt{1 + \cos\theta}$$

Now D can be determined.

$$D = \sqrt{M^2 + b^2 - 2Mb\ cos\alpha}$$

Since

$$t = \frac{M}{V_{absf}} = \frac{M}{\omega R}$$

$$\Longrightarrow M = t\,\omega R$$

Substituting the values for M, b and α:

$$D = \sqrt{M^2 + b^2 - 2Mb\ cos\alpha}$$

$$\Longrightarrow\ D = \sqrt{(t\,\omega R)^2 + (\sqrt{2}\,R\sqrt{1+\cos\theta})^2 - 2(t\,\omega R)(\sqrt{2}\,R\sqrt{1+\cos\theta})\cos(90^0 + \frac{\theta}{2})}$$

In section 3, we have determined that:

$$\Longrightarrow\quad D' \cong \left(1 - \frac{V_{abs}}{c}\right) x \quad , \quad for\ V_{abs} \ll c$$

where *x* is shown in the figure above.

x is determined by D and angle SO'P, which is shown as β .

$$x = D\cos\beta$$

Therefore,

$$\Longrightarrow\quad D' \cong \left(1 - \frac{V_{abs}}{c}\right) x = \left(1 - \frac{V_{abs}}{c}\right) D\cos\beta$$

But β can be determined from the following relation for triangle SO'P:

$$\frac{sin\beta}{b} = \frac{sin\alpha}{D}$$

$$\Longrightarrow\ sin\beta = \frac{b}{D} sin\alpha = \frac{\sqrt{2}\,R\sqrt{1+\cos\theta}}{D}\sin(90^0 + \frac{\theta}{2}) = \frac{\sqrt{2}\,R\sqrt{1+\cos\theta}}{D}\cos(\frac{\theta}{2})$$

Now cosβ can be determined from sin β .

$$cos\beta = \sqrt{1 - sin^2\beta} = \sqrt{1 - (\frac{\sqrt{2}\,R\sqrt{1+\cos\theta}}{D}\cos\left(\frac{\theta}{2}\right))^2}$$

We can now substitute the above value of cosβ in the previous equation for D'.

$$D' \cong \left(1 - \frac{V_{abs}}{c}\right) x = \left(1 - \frac{V_{abs}}{c}\right) D\cos\beta$$

$$\Longrightarrow\ D' \cong \left(1 - \frac{V_{abs}}{c}\right) D \sqrt{1 - (\frac{\sqrt{2}\,R\sqrt{1+\cos\theta}}{D}\cos\left(\frac{\theta}{2}\right))^2}$$

At last, we can determine the time of flight of light:

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

$$\Longrightarrow\ t = \frac{\left(1 - \frac{V_{abs}}{c}\right) D\ \sqrt{1 - \left(\frac{\sqrt{2}\, R\, \sqrt{1+\cos\theta}}{D} \cos\left(\frac{\theta}{2}\right)\right)^2}}{c}$$

The three unknowns in the above equation are D, t and θ.

So far we also have three independent equations:

$$t = \frac{2\pi\ \frac{\theta}{360^0}}{\omega}$$

$$t = \frac{M}{\omega R}$$

$$\Longrightarrow\ t = \frac{\left(1 - \frac{V_{abs}}{c}\right) D\ \sqrt{1 - \left(\frac{\sqrt{2}\, R\, \sqrt{1+\cos\theta}}{D} \cos\left(\frac{\theta}{2}\right)\right)^2}}{c}$$

We need to express M in terms of D and θ.

From triangle SO'P :

$$b = \sqrt{D^2 + M^2 - 2DM\cos\beta}$$

$$\Longrightarrow\ b^2 - D^2 + 2DM\cos\beta = M^2$$

$$\Longrightarrow\ M^2 - 2DM\cos\beta - (b^2 - D^2) = 0$$

$$\Longrightarrow M = \frac{2D\cos\beta \pm \sqrt{(2D\cos\beta)^2 + 4(b^2 - D^2)}}{2}$$

Substituting the values of *cosβ* and *b* in the above equation:

$$M = \frac{2D\sqrt{1 - \left(\frac{\sqrt{2}\, R\, \sqrt{1+\cos\theta}}{D}\cos\left(\frac{\theta}{2}\right)\right)^2} \pm \sqrt{\left(2D\sqrt{1 - \left(\frac{\sqrt{2}\, R\, \sqrt{1+\cos\theta}}{D}\cos\left(\frac{\theta}{2}\right)\right)^2}\right)^2 + 4\left(\left(\sqrt{2}\, R\, \sqrt{1+\cos\theta}\right)^2 - D^2\right)}}{2}$$

We can now substitute the value of M in the previous equation:

$$t = \frac{M}{\omega R}$$

$$\Longrightarrow\ t = \frac{\dfrac{2D\sqrt{1-\left(\frac{\sqrt{2}\,R\,\sqrt{1+\cos\theta}}{D}\cos\left(\frac{\theta}{2}\right)\right)^2} \pm \sqrt{\left(2D\sqrt{1-\left(\frac{\sqrt{2}\,R\,\sqrt{1+\cos\theta}}{D}\cos\left(\frac{\theta}{2}\right)\right)^2}\right)^2 + 4\left(\left(\sqrt{2}\,R\,\sqrt{1+\cos\theta}\right)^2 - D^2\right)}}{2}}{\omega R}$$

The unknowns in this equation are t, D and θ .

To summarize again, we have three equations:

$$t = \frac{2\pi\,\frac{\theta}{360^0}}{\omega}$$

$$t = \frac{\dfrac{2D\sqrt{1-\left(\frac{\sqrt{2}\,R\,\sqrt{1+\cos\theta}}{D}\cos\left(\frac{\theta}{2}\right)\right)^2} \pm \sqrt{\left(2D\sqrt{1-\left(\frac{\sqrt{2}\,R\,\sqrt{1+\cos\theta}}{D}\cos\left(\frac{\theta}{2}\right)\right)^2}\right)^2 + 4\left(\left(\sqrt{2}\,R\,\sqrt{1+\cos\theta}\right)^2 - D^2\right)}}{2}}{\omega R}$$

$$\Longrightarrow\ t = \frac{\left(1 - \frac{V_{abs}}{c}\right) D \ \sqrt{1 - \left(\frac{\sqrt{2}\,R\,\sqrt{1+\cos\theta}}{D}\cos\left(\frac{\theta}{2}\right)\right)^2}}{c}$$

From the above three equations, t, D and θ can be determined. However, the analytical solution can be prohibitively involved. Microsoft Excel can be used to solve the above equations by numerical method.

The above analysis shows how involved it is even to analyze an apparently simple problem in which observer acceleration is involved, by using Apparent Source Theory. One can imagine how complicated the analysis of Sagnac effect will be, in which multiple mirrors and a beam-splitter are involved.

Let us consider another problem in which a co-rotating mirror is involved. The light source, the observer and the mirror are connected rigidly and rotate as a unit.

The problem is to determine the time elapsed between emission and detection of light after reflection from the mirror.

The accelerating observer O was at pint O at the instant of light emission. We start by assuming that observer O will detect the light emitted by the source and reflected from the mirror at some point P.

The time taken by observer O to move from point O to point P is:

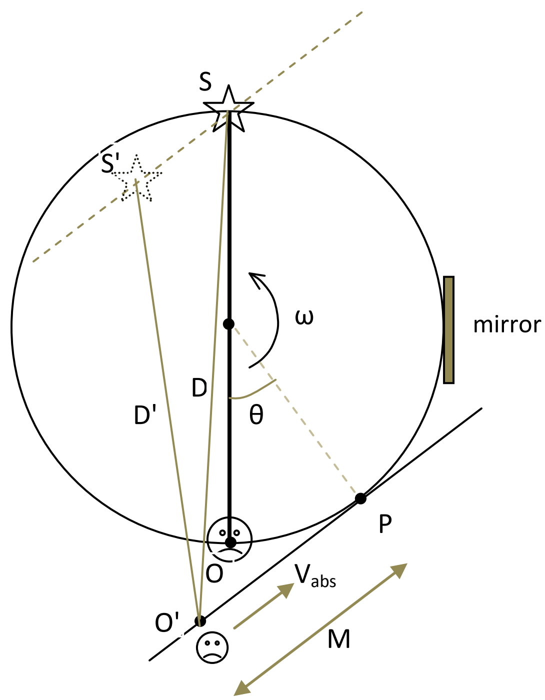
$$t = \frac{length\ of\ arc\ OP}{tangential\ velocity\ of\ observer\ O} = \frac{2\pi R\ \frac{\theta}{360^0}}{\omega R} = \frac{2\pi\ \frac{\theta}{360^0}}{\omega}$$

We imagine an imaginary inertial observer O' who is at point O' at the instant of light emission (i.e., at t = 0) and who will arrive at point P simultaneously with real accelerating observer O and whose velocity is equal to the instantaneous velocity V_{absf} of observer O at point P. Therefore, both observers O and O' will detect the light simultaneously at point P, while moving with equal (both magnitude and direction) instantaneous absolute velocities, V_{absf}.

The time taken by inertial observer O' to move from point O' to point P will be:

$$t = \frac{path\ length\ O'P}{V_{absf}} = \frac{M}{V_{absf}} = \frac{M}{\omega R}$$

So far we have two independent equations. We need a third equation to completely determine all the unknowns involved.



The time of flight of light emitted from the apparent point of emission (S') and reflected from the mirror and then detected by the imaginary inertial observer is determined as follows.
We first need to describe the position and motion of the mirror in the reference frame of the

inertial observer O'. Then, by assuming that light was emitted from the apparent point of emission in the reference frame of the inertial observer, and by assuming ballistic hypothesis for the group velocity of light reflected from a moving mirror, and also by applying the classical law of reflection from a mirror (angle of incidence equals angle of reflection), we get an expression for the time t of flight of light. This will provide us with the third equation and in combination with the two previous equations, the problem can be analyzed completely. Note that according to the ballistic hypothesis, light will acquire a component of the velocity of a moving mirror. However, this applies only for *group* velocity. The *phase* velocity of light in vacuum is always constant c regardless of motion of the light source, the observer or the mirror.

The actual analysis of this problem is even more involved and we will not undertake that in this paper. Nevertheless, it can be analyzed based on the principles stated above.

3.2. The Sagnac effect

Unlike the uniformly moving Michelson-Morley, Silvertooth, Marinov and other experiments that can be analyzed relatively easily by the procedure of Apparent Source Theory, the analysis of Sagnac effect was challenging. The attempts made in previous versions of this paper to apply Apparent Source Theory to Sagnac effect were not satisfactory. Apparent Source Theory has been truly successful only in the special case of inertially co-moving light source and observer. A generalized form of Apparent Source Theory is needed to analyze light speed experiments in which the light source, the observer, the mirrors, beam-splitters and other optical components have independent absolute and relative velocities, and accelerations are also involved. A good example is the Sagnac experiment.

In this paper, I have taken the whole text on the analysis of Sagnac from my other paper[37]. Note that there can be some repetitions of ideas already discussed above.

In the case of experiments of absolute translational motion, such as the Michelson-Morley experiment, the procedure of analysis is restated as follows:

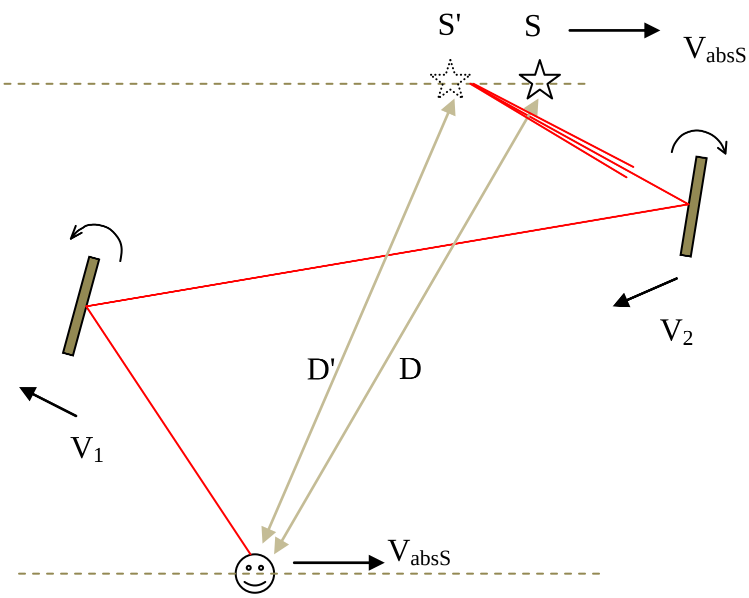
1. Replace the real light source with an apparent source. The apparent change in position of the source is determined by the direct source observer distance, the magnitude and direction of the absolute velocity and the orientation of source-observer line with respect to the direction of absolute velocity.

2. Analyze the experiment by assuming that light was emitted from apparent source position and that the speed of light is constant relative to the apparent source.

Only the light source is assumed to undergo apparent change of position due to absolute motion and all other parts of the apparatus (the beam splitter, the mirrors, e.t.c.,) are assumed to be at their actual/physical position, to analyze the Michelson-Morley experiment.

However, the analysis of the Sagnac effect is not as easy because the light source, the detector, the beam splitter and the mirrors are all in accelerated motions. Therefore, the Sagnac effect requires a general principle of analysis for arbitrary motions.

Consider absolutely co-moving light source and observer, and mirrors rotating and moving relative to the source and the observer.



Assume the source emits a very short light pulse just at time t = 0. The problem is to determine the time delay of light before it is detected by the observer. This is a complicated problem compared to the Michelson-Morley (MM) experiment in which the light source, the detector, the beam splitter and the mirrors are all at rest relative to each other.

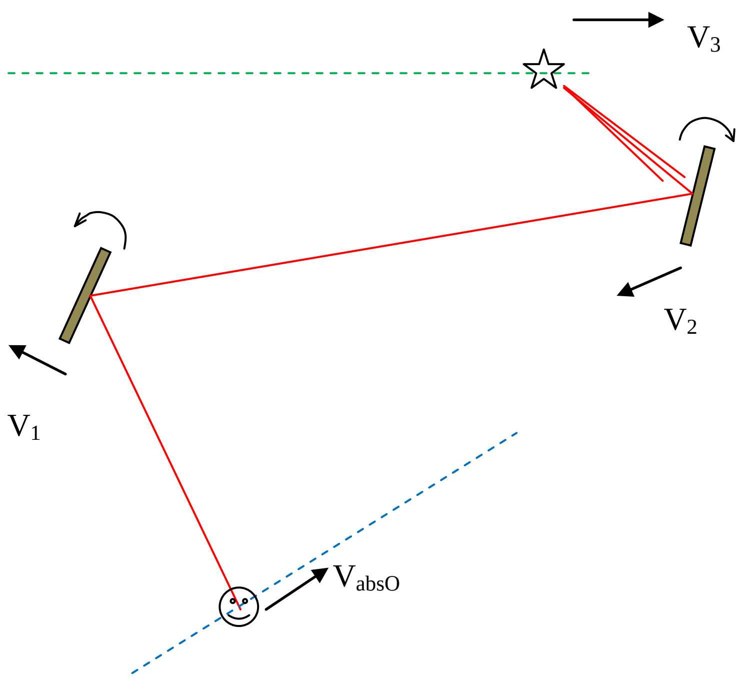
But the last statement assumes that the observer will detect that light pulse. However, if we assume that the beam width is infinitely small, the observer will detect the light pulse only if the positions (both linear and angular) and motions (both linear and angular) of the mirrors is such that the light beam will pass through the location of the observer. However, in practice, light sources emit light with finite beam width, as shown in the figure above. For any given linear and angular position and state of motion (translation and rotation) of the mirrors, in principle it is possible to determine the time delay between emission and detection and the total path length of the light pulse, although this will be a complicated problem.

For this, since the co-moving source and the observer are in absolute motion, the apparent position of the source relative to the observer should be determined first. This can also be interpreted as contraction of space relative to the observer in this case. Once the apparent position of the source is known, the path of the light pulse can be predetermined for known positions and motions of the mirrors, which is a classical optics problem but complicated one.

The analysis of the above experiment was based on Apparent Source Theory. But the apparent change in position of the source relative to the observer can be/should be seen as contraction of space relative to the absolutely moving observer.

But what if the source and the observer are not co-moving, i.e. if they have different absolute velocities, in which case they will also be moving relative to each other? Still a more general problem is if the absolute velocities of the source, the mirrors and the observer are not uniform (continuously changes magnitude and direction), with all parts (the light source, the mirrors, the observer) having independent motions.

At first let us consider the case of observer and source in relative motion. We assume that the light source and the mirrors are moving in the observer's reference frame.



We will apply Apparent Source Theory(AST).

According to AST:

1. All light speed experiments should be analyzed from the perspective of an *inertial* observer. The observer is the human or device directly detecting the light. The problems of the speed of light should be analyzed only from the perspective of the light detector (whether this is a human being or a device).
2. The speed of light coming directly from a light source is constant *c* relative to the inertial observer, irrespective of observer's absolute velocity. However, the group velocity of

light varies with mirror velocity.

3. Space contracts (expands) in front of (behind) an absolutely moving observer. However, this contraction and expansion of space applies only to the position of light sources (and to all sources of electromagnetic and gravitational fields and waves)

The procedure of analysis of this problem is as follows:

1. Define the physical positions and motions of the light source and mirrors (and beam splitters) in the reference frame of the inertial observer.

2. Then determine the *apparentpast position* of the source (i.e. the apparent position of the source at the instant of light emission) in the observer's reference frame, *relative to the inertial observer*. We cannot use the actual point of emission (i.e. the actual point where the source was at the instant of emission). We should use the apparent point of emission. Apply Apparent Source Theory to determine the apparent past position of the source, by using the actual position of the source, the absolute velocity of the observer in the Apparent Source Theory equation. We can also put a source at the actual point of emission and apply Apparent Source Theory.

3. Create an (x',y') coordinate with the inertial observer at the origin and with the x'-axis parallel with the observer's absolute velocity vector.To determine the apparent past position of the source in the absolutely moving observer's reference frame (x',y'), draw a straight line parallel to the observer's absolute velocity vector ($\mathbf{V}_{\mathbf{absO}}$) through the point where the source is located.

4. Apply Apparent Source Theory to determine the apparent past position of the source (the apparent point of light emission, not actual point of emission).

$$\Rightarrow \sqrt{x'^2 + y^2} = \frac{-\left(2x\frac{V_{abs}}{c}\right) + \sqrt{\left(2x\frac{V_{abs}}{c}\right)^2 + 4\left(1 - \frac{V_{abs}{}^2}{c^2}\right)(H^2 - x^2)}}{2\left(1 - \frac{V_{abs}{}^2}{c^2}\right)}$$

$$y' = y$$

$$z' = z$$

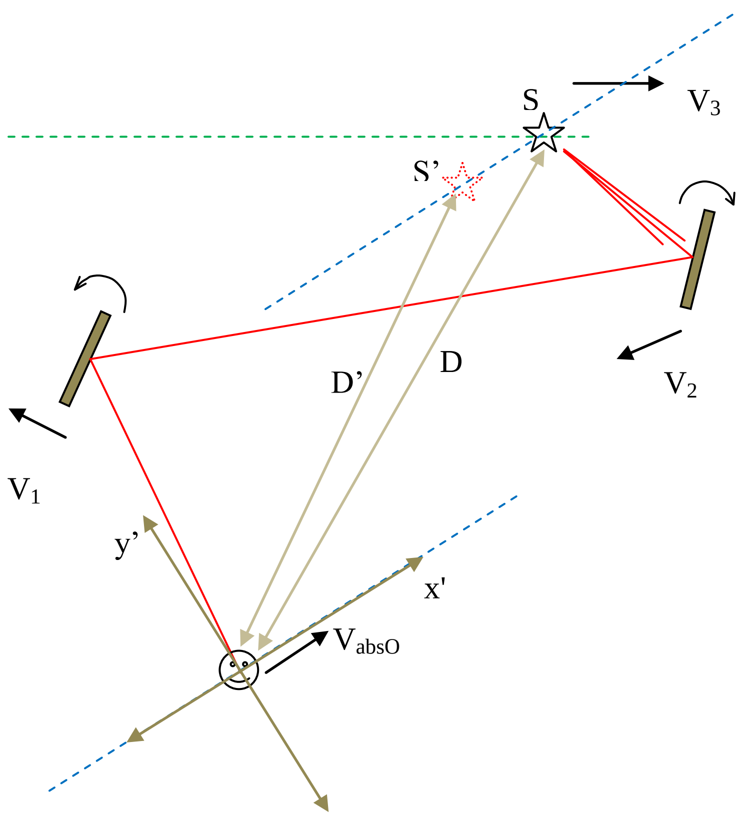
$$t' = t$$

5. Once the apparent past position (apparent point of emission) of the source is determined in the observer's frame, we imagine a light source fixed at the apparent point of emission and simply use emission (ballistic) theory according to which the velocity of light is constant relative to the source and varies with mirror velocity. Emission theory is wrong for a moving source, but correct for a stationary source. Emission theory is also correct regarding the velocity of light reflected from a moving mirror. However, emission theory is wrong regarding phase velocity of light. Since we are assuming an imaginary source fixed at the apparent point of light

emission, we can use emission theory to analyze the problem. Also since only group velocity (and not phase velocity) of light is relevant to determine the path length and time of flight, we can apply emission theory. Phase velocity will be used to get phase of detected light based on path length of light which is determined by group velocity.

To summarize this:
1. use emission (ballistic) theory to determine the path, path length and time of flight
2. use path length calculated in (1) above and constant phase velocity*c* to determine the phase of detected light.

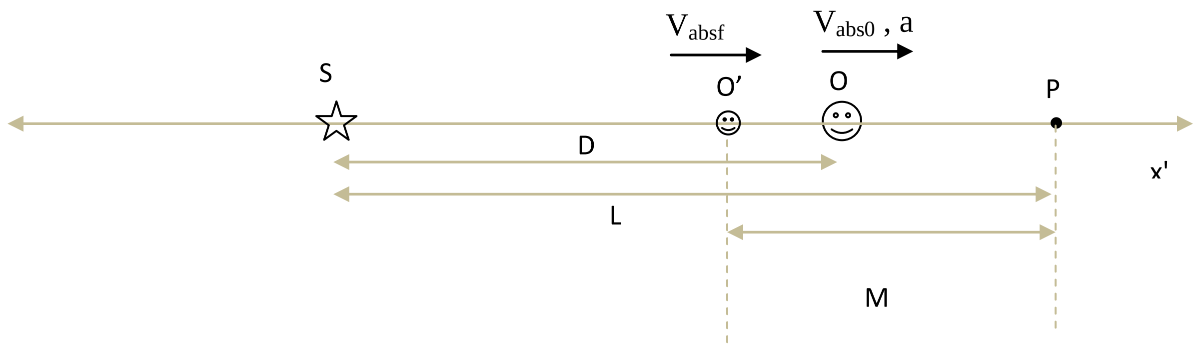
Note that Apparent Source Theory is applied only to determine the apparent past position of the source. For the mirrors, beam-splitters and all other parts, only their physical/actual positions relative to the observer is used.



So far we have assumed uniform motion of the light source, the observer, and the mirrors. Next we consider even a more general case in which the light source, the mirrors and the observer move in an accelerated motions (both magnitude and direction), in arbitrary curved paths.

As we have stated earlier, the reference frame of the inertial observer is the 'preferred' reference frame. However, we don't use the actual point of light emission (actual past position); we use apparent past position of the source relative to the inertial observer. However, all the problems we have analyzed so far involve uniform motion of the observer. What principle is applied for an observer in accelerated motion?

Consider a simple case in which an observer is accelerating directly away from a light source that is at absolute rest.



Suppose that, initially, at the instant of light emission, the observer was moving with initial absolute velocity V_{abs0}, at distance D from the source. Imagine that, just after emission of light, the observer starts accelerating to the right. The problem is to determine the time it takes light to catch up with the observer.

We will start by assuming that the observer O will detect the light at point P, which is at distance L from the light source.

The problem is to find the inertial observer that will be just passing through point P , moving with the instantaneous velocity of observer O at point P. For this, we first have to determine the absolute velocity of observer O at the instant that he/she is just passing through point P.

We use the formula for uniformly accelerated motion:

$$S = V_0 t + \frac{1}{2} a t^2$$

In this case

$$\frac{1}{2} a t^2 + V_0 t - S = 0$$

$$\Longrightarrow \quad a t^2 + 2V_0 t - 2S = 0$$

$$\Longrightarrow \quad t = \frac{-2V_0 \pm \sqrt{(2V_0)^2 - 4a(-2S)}}{2a}$$

$$\Rightarrow \; t \; = \frac{-2V_0 + \sqrt{4{V_0}^2 + 8aS}}{2a}$$

But

$$S = L - D$$

Therefore,

$$\Rightarrow \; t \; = \frac{-2V_0 + \sqrt{4{V_0}^2 + 8a(L - D)}}{2a}$$

$$\Rightarrow \; t \; = \frac{-2V_{abs0} + \sqrt{4{V_{abs0}}^2 + 8a(L - D)}}{2a}$$

During this time the observer will attain a final velocity of:

$$V_f = V_0 + at$$

$$\Rightarrow \; V_{absf} = V_{abs0} + a \left(\frac{-2V_{abs0} + \sqrt{4{V_{abs0}}^2 + 8a(L - D)}}{2a}\right)$$

$$\Rightarrow \; V_{absf} = V_{abs0} + \frac{-2V_{abs0} + \sqrt{4{V_{abs0}}^2 + 8a(L - D)}}{2}$$

This means that the observer O is moving at this velocity at the instant that he/she is just passing through point P. We have to determine the imaginary inertial observer O' moving with the same constant velocity as the instantaneous velocity (V_{absf}) of observer O at point P.

So, at the instant of light emission, the inertial observer was at a distance of:

$$M = V_{absf} * t$$

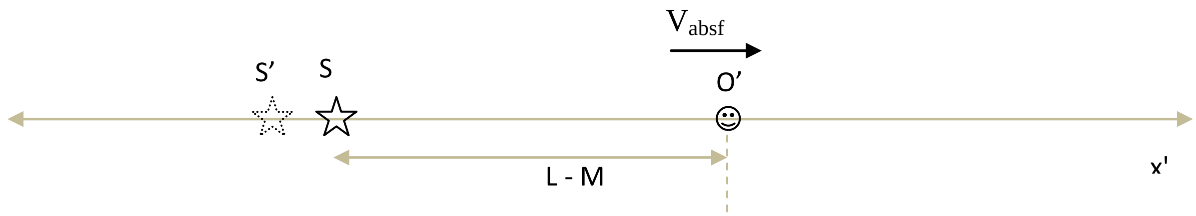
to the left of point P, as shown in the above diagram.

$$M = \left(V_{abs0} + \frac{-2V_{abs0} + \sqrt{4{V_{abs0}}^2 + 8a(L - D)}}{2} \right) * \; \frac{-2V_{abs0} + \sqrt{4{V_{abs0}}^2 + 8a(L - D)}}{2a}$$

The distance between S and O' , i.e. the distance between the source and imaginary *inertial*observer at the instant of light emission is:

$$L - M$$

Now we can determine the time of detection of light by the imaginary observer.



The apparent position of the source in the reference frame of the imaginary inertial observer is:

$$(L - M)\frac{c}{c - V_{absf}}$$

Note that the above formula is only approximate and we use it for simplicity, and it is accurate enough for $V_{abs} << c$; the correct formula would be :

$$(L - M)e^{\frac{V_{absf}}{c}}$$

So we use the approximate formula.

The time delay of light, therefore, will be:

$$t = \frac{D'}{c} = \frac{(L - M)\frac{c}{c - V_{absf}}}{c} = \frac{L - M}{c - V_{absf}} = \frac{L - V_{absf}t}{c - V_{absf}}$$

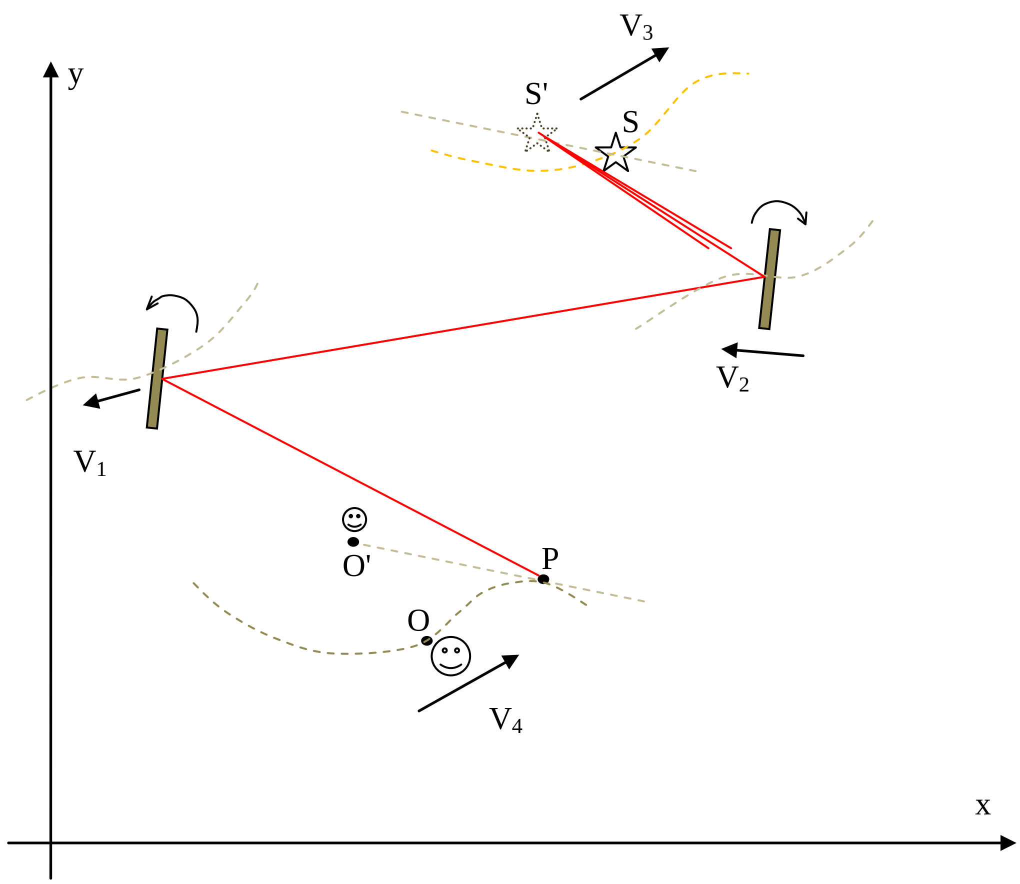
$$t = \frac{L - \left(V_{abs0} + \frac{-2V_{abs0} + \sqrt{4V_{abs0}^2 + 8a(L-D)}}{2}\right) * \frac{-2V_{abs0} + \sqrt{4V_{abs0}^2 + 8a(L-D)}}{2a}}{c - (V_{abs0} + \frac{-2V_{abs0} + \sqrt{4V_{abs0}^2 + 8a(L-D)}}{2})}$$

Equating this value of *t* with the previous value of *t* :

$$\frac{L-\left(V_{abs0}+\frac{-2V_{abs0}+\sqrt{4V_{abs0}{}^{2}+8a(L-D)}}{2}\right)*\ \frac{-2V_{abs0}+\sqrt{4V_{abs0}{}^{2}+8a(L-D)}}{2a}}{c-(\ V_{abs0}+\frac{-2V_{abs0}+\sqrt{4V_{abs0}{}^{2}+8a(L-D)}}{2}\ )}=\frac{-2V_{abs0}+\sqrt{4V_{abs0}{}^{2}+8a(L-D)}}{2a}$$

L is determined from the above equation and then used to determine time of flight t.

In the above example, we assumed rectilinear acceleration of the source. In reality, the motion of the observer can be non-rectilinear accelerated motion, as shown below.



The procedure of analysis is first to define the positions and motions of the mirrors, the beam splitter and other components, the observer, the light source in the absolute reference frame or any convenient inertial reference frame whose absolute velocity is known.

What is the preferred reference frame to analyze such experiment?

The preferred reference frame for an experiment involving an observer in non-rectilinear accelerated motion is the reference frame of an imaginary inertial observer who will be just passing through the same point and moving with the same velocity as the real observer at the instant of light detection.

The procedure is as follows:

1. We assume that the observer O will detect the light when he is just passing through point P. At the instant of light emission(at t = 0), observer O is at point O.
2. Based on the velocity function of the observer O, we get the expression for the time *t* taken by the observer to move from point O to point P. The initial absolute velocity (at the instant of light emission) of the observer is V_{abs0} and the final absolute velocity (at the instant of light detection) is V_{absf} , which is the instantaneous velocity of observer O at point P.

3. We get the expression for the instantaneous velocity (magnitude and direction) $V_{absf}$of the observer at the instant of light detection (at the instant of passing through P)

4. We assume an imaginary inertial observer O' whose velocity is V_{absf} and determine his initial location at the instant of light emission (t = 0) so that he/she will arrive at point P at the instant of light detection, i.e., real observer O and imaginary observer O' will arrive at point P simultaneously, so that both will detect the light at point P. Imaginary observer O' is at point O' at the instant of light emission.
This means we get an expression for the distance of imaginary inertial observer from point P(i.e. the distance between point P and point O') at the instant of light emission:

$$distance\ between\ P\ and\ O' \ = \ V_{absf} \ * t$$

where *t* is the time taken by observer O to move from point O to point P. Note that distances OP and O'P have been exaggerated in the diagram.

6. We then attach a reference frame to the imaginary inertial observer O' , with the x'-axis parallel to the path of observer O' , with observer O' at the origin.

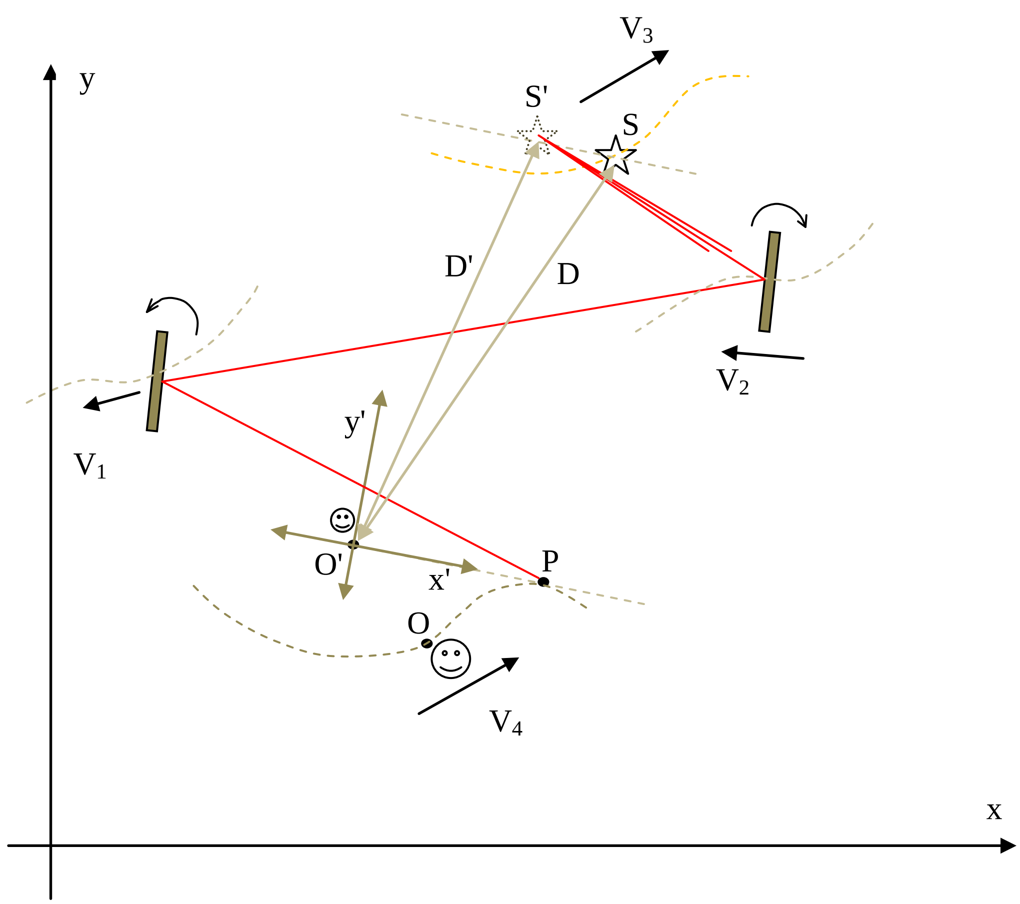
7. In the reference frame of imaginary observer O', we determine the apparent past position of the source (as opposed to actual past position of the source), shown as S' in the diagram. Note that S is the actual position of the source at the instant of light emission. S' is the apparent position of the source at the instant of emission. Up to this point we used only relative velocities. We use the absolute velocity of the observer to determine the apparent past position of the source. *Therefore, although all parts of an optical experiment will have their own absolute velocities, the only relevant absolute velocity in analysis of light speed experiments is the absolute velocity of the inertial observer and we only use it to determine the apparent past position of the source. Once we have determined the apparent past position of the source, we use only relative velocities.*

8. In the reference frame of the imaginary observer O', we define the positions and motions of

the mirrors, beam splitters

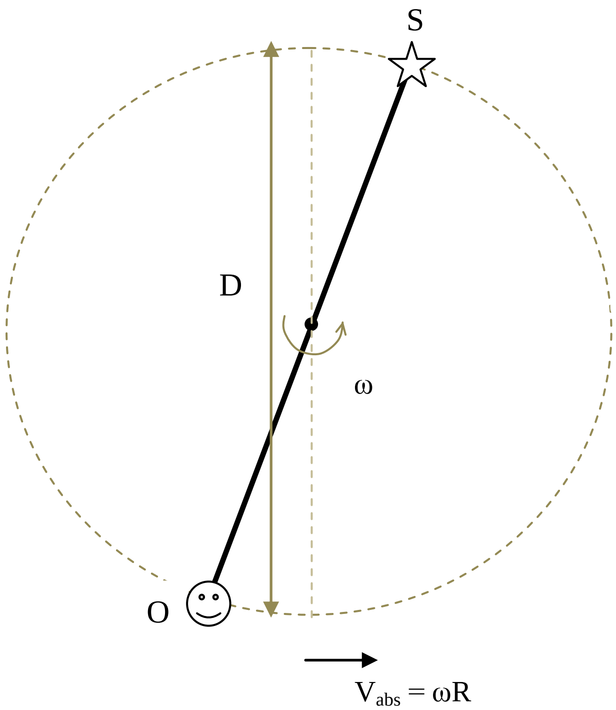
9. By assuming that light was emitted from S', and taking into consideration the positions and motions of mirrors, beam splitters e.t.c., we get the expression for the time delay of light between emission from S' and detection by the imaginary inertial observer O'.

10. By equating the expression for the time delay obtained in (2) with that obtained in (9), we solve the equation for the length of path OP, from which we get the time of flight t and pat and path length of light. The phase of detected light is then determined by using the path length of light.



Next we apply the above principle to the Sagnac effect. Since the light source, the beam splitter, the mirrors and the detectors are in accelerated motions, with rotations of the mirrors and beam splitter also involved, the above procedure applies to the Sagnac effect.

Let us first consider a simple problem involving rotation. An observer O and a light source S are attached to the two ends of a rigid rod and rotate about the center of the rod, as shown below.

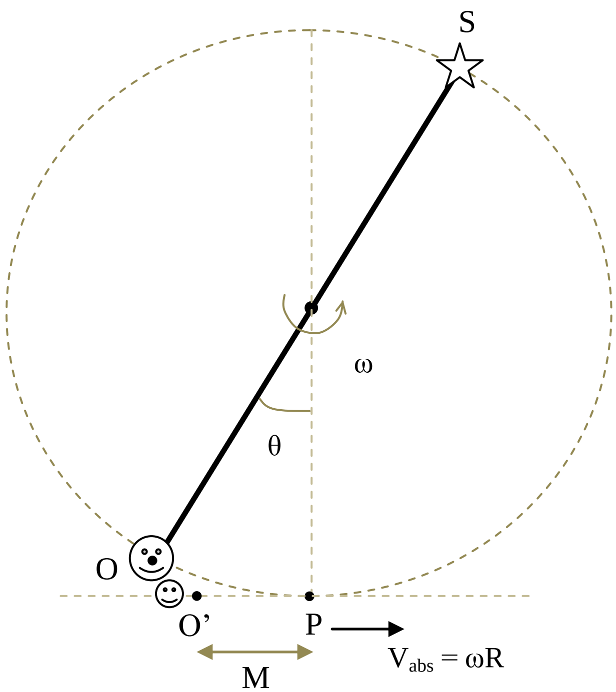


Our problem is to determine the path, the path length, the time delay and phase of a short pulse of light emitted by the source and detected by the observer.

We first use a convenient inertial reference frame to define the positions and motions of the different parts of the apparatus, in this case the source and the observer. We assume the apparatus to have zero absolute translational velocity. The most convenient inertial reference frame is the reference frame in which the device is rotating. For simplicity, we assume that the device (the whole system) is not in absolute translational motion, i.e. it is at rest regarding translational motion. Therefore, the tangential velocity of the observer will also be his/her absolute velocity.

So the absolute velocity of the observer will be:

$$V_{abs} = \omega R\,, \quad where \quad R = \frac{D}{2}$$



Suppose that the source emits a short light pulse at t = 0 at the position shown. We start by assuming that the observer will detect the light at point P. Therefore, observer O will be moving with absolute velocity ωR to the right as he is just passing through point P. According to the general procedure we introduced already, we find an imaginary inertial observer O' who will arrive at point P simultaneously with observer O and who is moving with the same velocity (magnitude and direction) as the instantaneous velocity of observer O at point P , which is ωR to the right . Therefore, observer O' will have a constant velocity ωR to the right.

The time taken for observer O to move from his/her current position(point O) (his position at t = 0 , which is instant of light emission) to point P is the same as the time taken by the imaginary inertial observer O' to move from point O' to point P. O' is the position of observer O' at t = 0.

We first get the expression of the time taken by observer O to move from point O to point P.

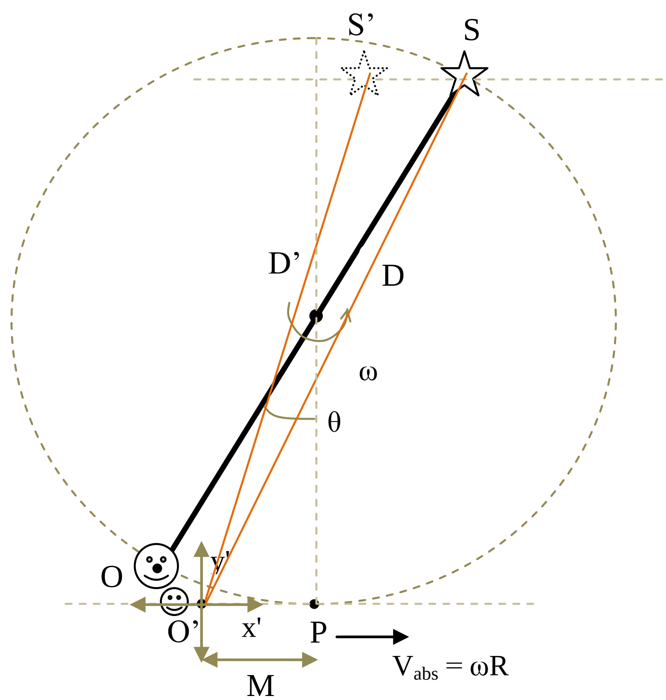
$$t = \frac{\left(\frac{2\pi R\theta}{360}\right)}{\omega R}$$

Next we get the expression for distance from O' to P, i.e. the position of imaginary inertial observer O' at the instant of light emission, denoted as length M in the figure above.

$$M = (\omega R)t$$

Once we get the expression for the location of the imaginary observer at the instant of light emission, we attach a reference frame (x', y') to O', with +x' axis parallel to the direction of the velocity of observer O'. We then define the *physical* positions and motions of all components of the experimental setup in the optical path. In this case, there are no mirrors and beam splitters and the only component of the experimental apparatus other than the observer O is the source S. For the source, we need only to find its location in the reference frame of imaginary observer O, at the instant of light emission. Therefore, for the source, all we need is its initial position at t = 0 in the inertial frame. We don't need to define its motion because, once the source emits light, its motion is irrelevant. We don't need the velocity of the source at the instant of emission or afterwards. However, for all other parts of the optical experiment, except observer O, which are mirrors, beam splitters and other components, we need to define their positions and motions in the inertial frame.

Then we determine the *apparent* position of the source relative to the inertial frame of imaginary observer O', which is always assumed to be at the origin his reference frame. The apparent position of the source is obtained by using the *physical* position of the source in the frame of imaginary observer O' and then applying Apparent Source Theory. Note that what apparently changes position in the imaginary observer's frame is the *point of emission*, not the physical source itself. This means we use Apparent Source Theory only to determine the apparent point of emission.



Then the problem is analyzed in the reference frame of O', to get the expression for the time delay of light from emission by the source to detection by the observer O', i.e. the time of flight.

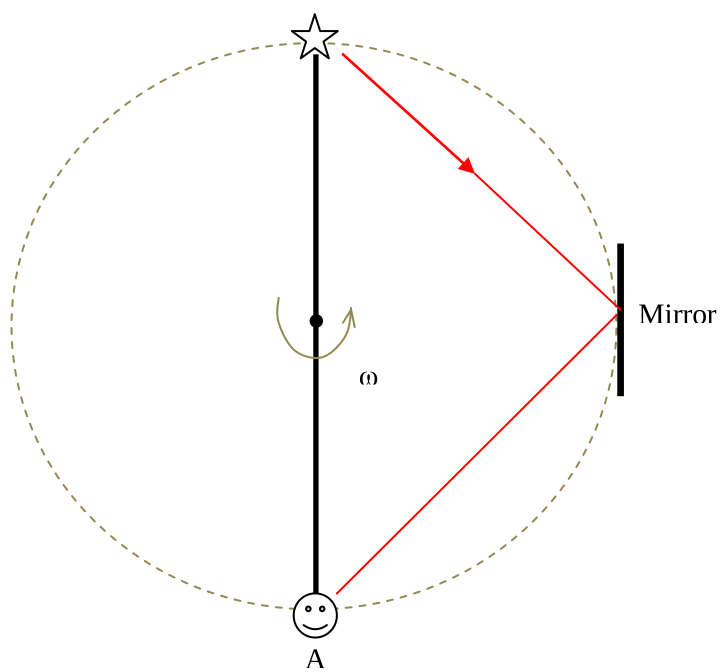
This expression is equated with the expression for time taken by observer O to move from point O to point P, which is:

$$t = \frac{\left(\frac{2\pi R\theta}{360}\right)}{\omega R}$$

The solution of this equation will give the value of θ, from which time of flight *t* can be obtained, which in turn will enable the determination of path and path length of light detected by observer O. Note that the time *t* determines the time of flight of the light pulse, which is the group delay, whereas the *path length* determines the *phase* of light observed by O.

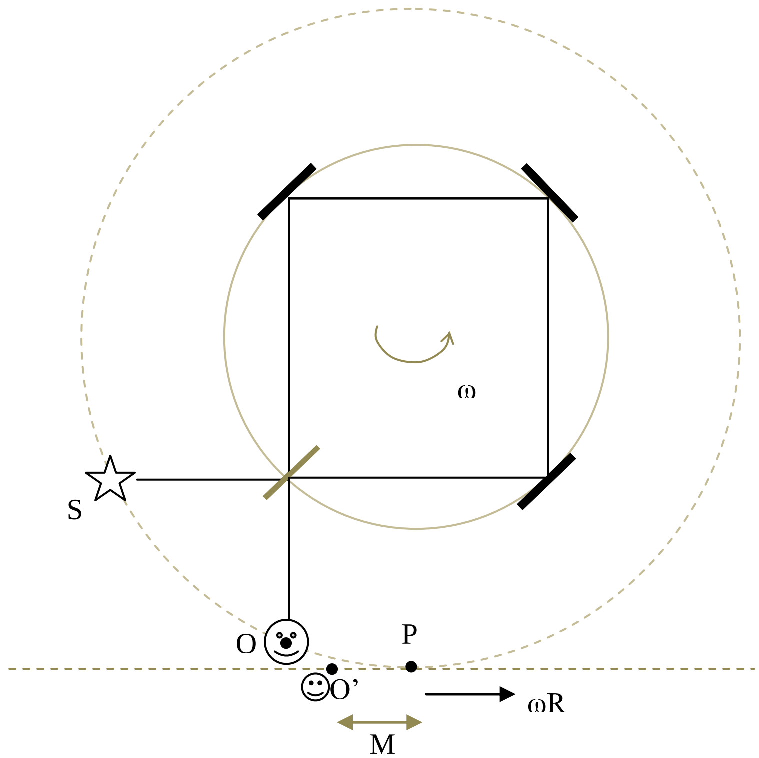
$$\text{phase of detected light relative to emitted light} = \Delta\phi = 2\pi f * \frac{\text{path length of light}}{\text{the phase velocity of light (c)}}$$

The same procedure can be followed if, for example, a mirror co-moving with the source and observer is added to the experiment, as shown below. Note also that the group velocity of light reflected from a moving mirror will acquire a component of the velocity of the mirror (ballistic hypothesis). Ballistic hypothesis is correct only for the *group* velocity of light reflected from a moving mirror. The group velocity of light is independent of the source velocity, but depends on mirror velocity.



The Sagnac effect is analyzed with the same procedure.

Suppose that light is emitted by the source at the position of the apparatus shown below. As before, we start by assuming that the accelerating observer O will detect the light at the instant that he is just passing through some point P, at which his absolute velocity is ωR to the right.



First we get the expression of the time *t* required for the observer O to move from its current position, point O,(position at instant of light emission, t = 0) to point P. This will be the length of arc OP divided by the tangential velocity of the observer.

Then we find the position of an imaginary inertial observer O' who will be just passing through point P at the same instant of time as observer O, and who has the same velocity as the instantaneous velocity of observer O at point P, which is equal to ωR to the right.

Therefore, for imaginary observer O' to arrive at point P simultaneously with observer O, observer O' should be at a distance of:

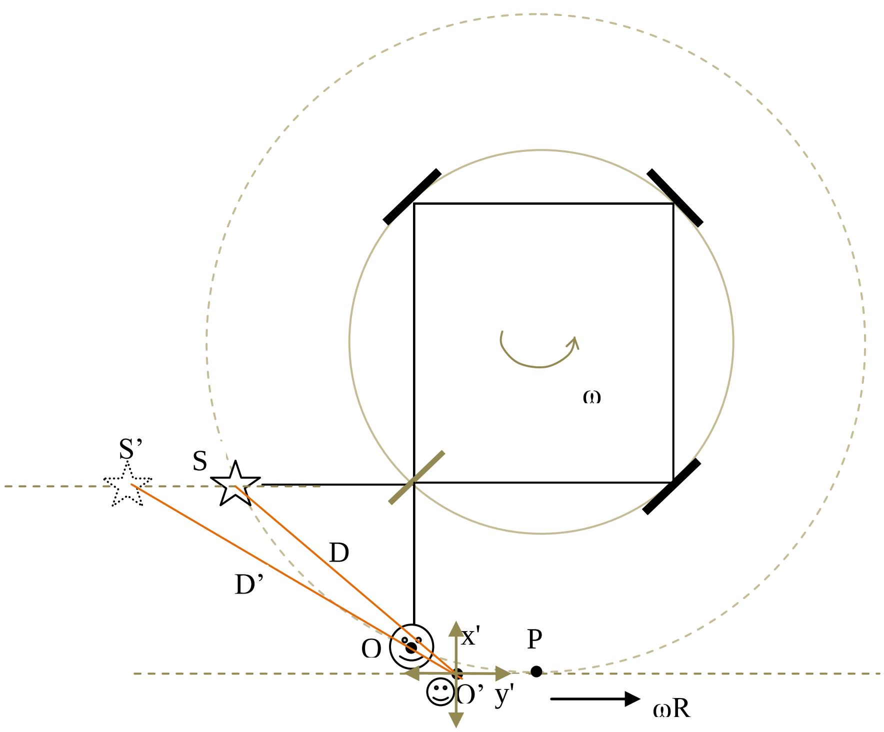
$$M = \omega R * t$$

from point P at the instant of light emission, where *t* is the time taken by observer O to move from point O to point P.

We then attach a reference frame (x', y') to inertia observer O', with observer O' at the origin and with +x axis parallel with the velocity vector of observer O'. Then the positions and motions of the mirrors and the beam splitters are defined in the (x', y') reference frame. We then determine the apparent position (S') of the source relative to observer O' (i.e. relative to the origin of (x', y')). By assuming that light is emitted from S', and by taking into account the positions and motions of the beam splitter and the mirrors, we determine the expression for the

time t taken for light to travel from source to observer O'. Note that we assume that the phase velocity of light is always constant, whereas the group velocity varies with mirror velocity. Once the expression for the time t is obtained, we equate it with the expression for t we obtained earlier, which was the time taken by observer O to move from point O to point P.
Solving the resulting equation enables the determination of time t and the path and path length of light. The phase of the detected light is determined by the path length, whereas the time of flight will be the time t itself.

In this procedure, note that we analyze the problem from the perspective of imaginary inertial observer O'. We determine the time of flight of light observed by observer O'. We solve the problem for observer O',and not for observer O. Since O and O' will detect the light simultaneously at the same instant, solving the problem for observer O' will automatically solve the problem for observer O. When we say that we define the positions and motions of parts of the experimental apparatus in the reference frame of the imaginary observer, we mean all parts except the accelerating observer O. We don't need to define the position and motion of the accelerating observer in the inertial frame because the accelerating observer will not affect the path of light and his/her position and motion in the inertial frame is not relevant. There is also a distinction regarding the source. We only need to locate the apparent point of emission, by using actual/physical position of the source at the instant of emission. Afterwards, the position and motion of the source is not relevant. Even at the instant of light emission, we need to know only the physical *position* of the source; the velocity of the source is not relevant at the instant of emission. For mirrors, beam splitters and other parts, we need to define their positions and motions in the reference frame of imaginary observer O'.



Therefore, we are analyzing the problem in the reference frame of an imaginary inertial observer O' who is moving with velocity of ωR to the right. It is as if the Sagnac device is translating to the left (relative to reference frame (x', y')) and rotating at the same time.

We will not undertake the quantitative analysis in this paper. However, we will see if this theory predicts the behavior of light in Signac's experiment, qualitatively.

We have stated that the Sagnac effect should be analyzed in the reference frame of an inertial observer moving with velocity ωR to the right, in the present case. Thus, the Sagnac apparatus is not only rotating in this reference frame, but also translating with velocity ωR to the left.

Therefore, there will be a combination of translational and rotational motions. The question is, can we ignore the translational motion of the device and only deal with the rotational motion, which would simplify theproblem?

As we have stated above, once we have defined the positions and motions of the parts of the experimental apparatus and determined the apparent point of emission (apparent past position of the source) in the reference frame of the imaginary inertial observer, we simply use conventional emission theory to analyze the path, path length and time of flight of light, in which only the group velocity (not the phase velocity) of light is relevant. Phase of the observed light is determined from the path length and frequency of observed light. But the path length is determined by using group velocity. According to conventional emission theory, the speed of light varies with source and mirror velocity. However, conventional emission theory is wrong regarding the dependence of light speed on source velocity. It is also wrong regarding the phase velocity of light, which I have proposed to be an absolute constant in vacuum, irrespective of source, mirror, and observer velocity. However, emission theory is correct with regard to group velocity of light and mirror velocity: the *group* velocity of light varies with mirror velocity.

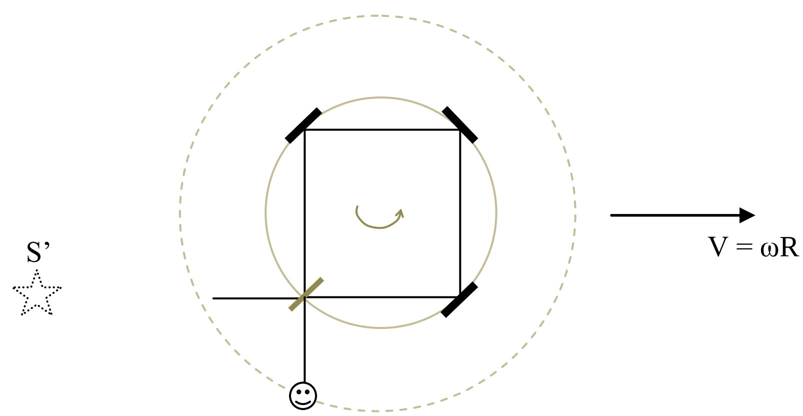
Therefore, even though conventional emission theory is wrong in general, we will use it in analysis of light speed experiments, as introduced in this paper, because we use only its correct features.

In the case of Sagnac effect, we can use emission theory for the analysis which involves only group velocity. Once we have determined the apparent point of emission in the inertial imaginary observer's reference frame, the motion of the source is irrelevant. The motion of the source is relevant only to determine the Doppler effect on observed light, for source and observer in relative motion. Since in the Sagnac experiment the path length of light is not changing, Doppler effect does not exist. Once we have determined the apparent past position of the source(apparent point of emission) we can put an imaginary source that is at rest in that inertial frame, at that point. Therefore, since the *apparent* source is at rest, we can say that the speed of light is constant relative to the *apparent* source. I mean that emission theory is correct for a stationary source. It fails only for a moving source. Therefore, for our purpose, since we are not considering the motion of the source, we can use emission theory of light for group velocity of light. In other words, emission theory fails only when the source starts moving and our imaginary source is stationary in the inertial observer's reference frame, fixed at the apparent past position of the source.

Going back to our earlier question regarding the effect of translational motion on Sagnac effect, we have reduced the problem of Sagnac effect to a simpler problem as follows. We can consider the inertial observer's frame as an absolute reference frame in which a light source is at rest but the mirrors and the beam splitter are in translational and rotational motions, i.e. the Sagnac apparatus is being translated as a whole while rotating at the same time.

As we have discussed above, therefore, we can apply emission theory to analyze the Sagnac experiment because the apparent source is at rest (in this case the apparent source is the apparent point where light was emitted). In any inertial reference frame in absolute motion, the *source* is the apparent point in that reference frame where light was emitted. For an observer at absolute rest, the apparent point of emission is the same as the actual point of emission. So, in this case the source is the (actual) point where light was emitted, which is fixed (not moving) in that reference frame. For an observer in inertial absolute motion, the (apparent) source is the *apparent fixed point of emission* in that observer's reference frame. In all cases, the source is the fixed point in thatframe where light was actually or apparently emitted. The point here is that the source (or apparent source) is a point in an inertial frame, which is fixed.

Therefore, since a *source* (as a point of light emission) cannot be moving, we can apply emission theory to analyze the Sagnac effect that is in both translational and rotational motions at the same time.



S' , which is the apparent point of emission, is at rest, so the speed (group velocity) of light emitted by the source is equal to c in the inertial reference frame in which the device is translating, until it hits the beam splitter. Once the light hits the beam splitter and the mirrors, it will attain a component of the translational velocity of the whole device. Therefore, once the light beam hits the mirrors, it almost behaves as if it came from a co-rotating imaginary source located on the apparatus so that it directs light with the same angle and towards the same point on the beam splitter and the mirrors, but relative to which the speed of light is c + w, which is the velocity of light coming from the source relative to an observer sitting on the beam splitter. So we have reduced the problem to conventional emission theory, according to which the *time of flight* of the two counter-propagating light beams is (almost ?) equal. So for the purpose of analysis, we can apply conventional emission theory in which the speed of light varies with both source and mirror velocity.

Therefore, even according to emission theory, even though the clockwise propagating and counterclockwise propagating *groups* will arrive simultaneously at the observer (both will have equal times of flight), the path lengths of the two beams differ significantly. In the above diagram of counterclockwise rotating Sagnac device, the counter clockwise propagating light will have to travel larger distance than the clockwise propagating light. This means that the path lengths of the two light beams is different.

Since we have stated that the phase of observed light is determined only by the frequency and path length of light, and not by time of flight, the Sagnac experiment will give a fringe shift.

In effect what we have seen is that absolute motion has little effect in the Sagnac effect. The only effect of absolute motion of the observer in the above analysis is to create an apparent change in past position of the light source (i.e. apparent point of emission). We can see that this has little effect on the fringe shift because it will affect both light beams almost equally.

Therefore, Sagnac effect is almost not a result of absolute motion, but a consequence of the distinction between phase velocity and group velocity of light. It is a consequence of the dependence of group velocity on mirror velocity and the absolute constancy of the phase velocity. Even though the two light beams arrive (almost) at the same time at the observer, their path lengths are different and this is what gives rise to a fringe shift.

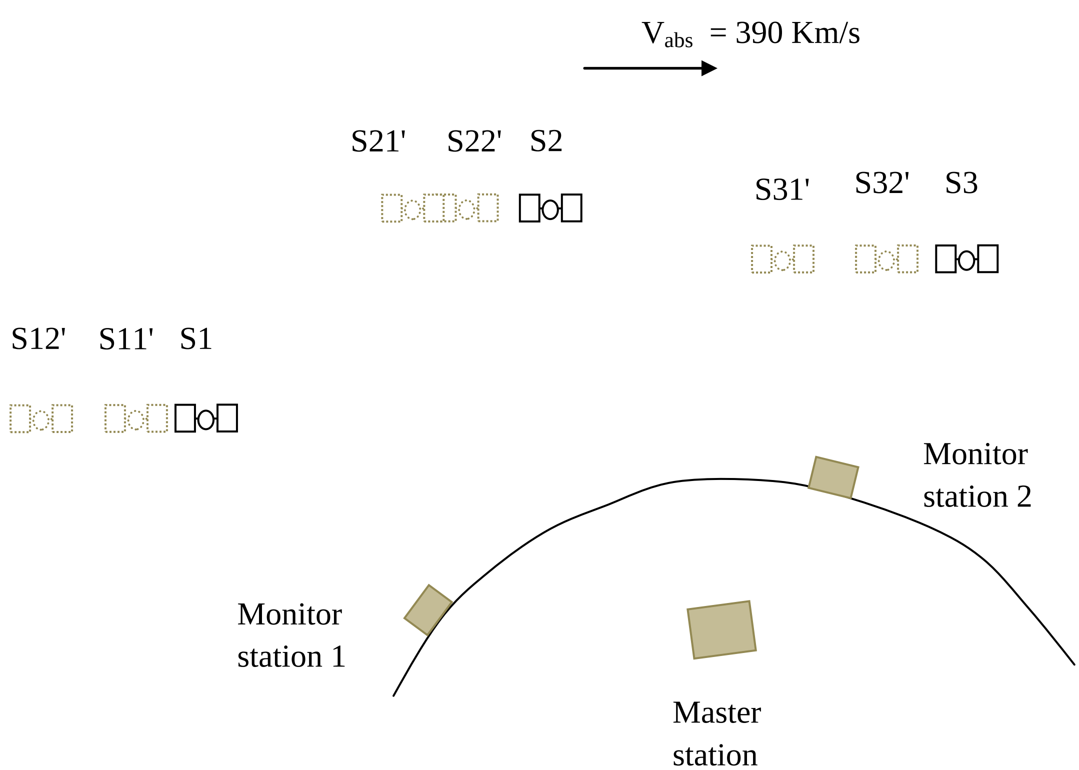
3.3. The Global Positioning System

The Global Positioning System (GPS) is a physical system which could provide an opportunity to observe the real behavior of the speed of light. However, the reality is that the GPS only added another problem to the already confusing light speed puzzle. The Silvertooth, Marinov and CMBR experiments already confirmed our absolute motion through space. But the GPS appears to hold correct (only?) in the ECI (Earth-Centered Inertial) frame, as if there was an ether entrained by the Earth and moving with it, but not rotating with it. However, the GPS was meant to be a practically useful system and was not meant to be an experiment to test the speed of light. In the GPS, Einstein's light postulate is applied.

Why is Earth's absolute velocity of about 390 Km/s (apparently) not detected by the GPS? Or has any one investigated into this ? Since the notion of absolute motion has been abandoned due to null results of Michelson-Morley experiments, perhaps there has been no motivation for this. I made some search for any paper that analyzes the GPS system with the assumption of absolute (non-entrained) ether, to see the magnitude and pattern of error introduced in position measurement, but I couldn't find any. Since Apparent Source Theory and ether theory can give similar results in some experiments, such an analyses or experiments would have been helpful. I guess that the error in position measurement by a GPS receiver due to Earth's absolute motion may have been somehow masked by the way the GPS works.

Although GPS is a non-inertial system, we will assume it to be inertial to answer the above questions.

Let us see how Apparent Source Theory applies to GPS.



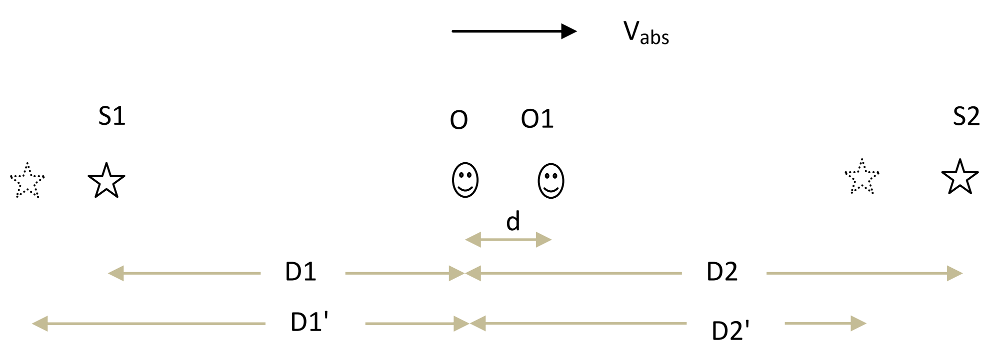
The control stations monitor the satellites from the signals they transmit and send the information to the master station, where the orbit and clock performance of each satellite is computed. These data are then uploaded to each satellite.

According to Apparent Source Theory, the monitoring stations measure the apparent position and not the real /physical position of each satellite. Note that the apparent position of each satellite is different as seen from each monitoring station.

The effect is that the actual/physical and apparent orbit of each satellite will be different. This may not have been a problem. The problem is even more complicated because the same apparent orbit does not apply for GPS receivers at different locations on Earth. Further complication comes from the fact that the ground stations transmitting data to satellites appear to be at their apparent positions (not shown in the figure) from the perspective of each Satellite. The transmission of data from the monitoring stations to the master station is also affected by Earth's absolute motion.

I am not going to make a quantitative analysis in this paper. But an important question is : how does all this show up in position measurement by a GPS receiver ? Suppose that a GPS receiver is fixed at some location on Earth. Will there be any periodic variation in the measured position of the GPS receiver, due to combined effect of Earth's absolute motion (390 Km/s) and Earth's diurnal rotation ? I think that this has not been observed because the Satellite orbit data is updated every few hours or because the effect may be very small.

Let us consider a simple example below, the observers and sources co-moving absolutely.



S1 and S2 are satellites, O represents control and monitoring station, O1 represents a GPS receiver. We assume that all clocks are perfectly synchronized, there is no relative motion between the satellites, the control and monitoring station and the GPS receiver, for simplicity. Our aim is to find the order of magnitude of error in position measurements caused by Earth's absolute motion (390 Km/s).

The control and monitoring station measures the distances of the satellites to be D1' and D2' , not D1 and D2, which are the physical positions of the satellites, according to AST. Note that we assumed that the control and monitoring station measures the distance of the satellites from the signals they transmit.

$$D1' = D1 \frac{c}{c - V_{abs}}$$

$$D2' = D2 \frac{c}{c + V_{abs}}$$

The travel times of signals from the satellites to the control and monitoring station are:

$$t_{d1} = \frac{D1'}{c} = \frac{D1}{c - V_{abs}}$$

$$t_{d2} = \frac{D2'}{c} = \frac{D2}{c + V_{abs}}$$

A GPS receiver just at the control and monitoring station measures the difference in time of arrival of the signals from the two satellites to be:

$$\Delta \mathrm{t}_0 = t_{d1} - t_{d2} = \frac{D1}{c - V_{abs}} - \frac{D2}{c + V_{abs}}$$

Let D1 = D2 = D , for simplicity

$$\Delta \mathrm{t}_0 = t_{d1} - t_{d2} = \frac{D}{c - V_{abs}} - \frac{D}{c + V_{abs}} = 2D \frac{V_{abs}}{c^2 - {V_{abs}}^2}$$

But for a GPS receiver at distance *d* from the control and monitoring station, the time delays of the signals of the two satellites will be:

$$t_{d1} = \frac{D + d}{c - V_{abs}}$$

$$t_{d2} = \frac{D - d}{c + V_{abs}}$$

The difference in arrival times of the satellite signals at position O1, according to Apparent Source theory, will be

$$\Delta \mathrm{t}_1 = t_{d1} - t_{d2} = \frac{D + d}{c - V_{abs}} - \frac{D - d}{c + V_{abs}} = 2D \frac{V_{abs}}{c^2 - {V_{abs}}^2} + 2d \frac{c}{c^2 - {V_{abs}}^2}$$

But the GPS receiver determines its position as follows, by assuming that the satellites are at distance (D1' + d) and (D2' - d), where Δt' is the difference in time of arrival of the two signals.

$$\Delta \mathrm{t}_1{}' = \frac{D1' + d}{c} - \frac{D2' - d}{c} = 2D \frac{V_{abs}}{c^2 - {V_{abs}}^2} + \frac{2d}{c}$$

If the GPS receiver used the equation based on AST,

$$\Delta \mathrm{t}_1 = 2D \frac{V_{abs}}{c^2 - {V_{abs}}^2} + 2d \frac{c}{c^2 - {V_{abs}}^2}$$

$$\Rightarrow \quad d = \left(\Delta t_1 - 2D\,\frac{V_{abs}}{c^2 - {V_{abs}}^2}\right)\frac{c^2 - {V_{abs}}^2}{2c}$$

The GPS receiver actually uses the equation,

$$\Delta t_1{}' = 2D\,\frac{V_{abs}}{c^2 - {V_{abs}}^2} + \frac{2d}{c}$$

$$\Rightarrow \quad d = \left(\Delta t_1{}' - 2D\,\frac{V_{abs}}{c^2 - {V_{abs}}^2}\right)\frac{c}{2}$$

The discrepancy (ε_d) between the distance *d* of the GPS receiver from the control and monitoring station, by using the above two equations can be estimated.

$$\varepsilon_d = \left(\Delta t_1 - 2D\,\frac{V_{abs}}{c^2 - {V_{abs}}^2}\right)\left(\frac{c}{2} - \frac{c^2 - {V_{abs}}^2}{2c}\right) = \left(\Delta t_1 - 2D\,\frac{V_{abs}}{c^2 - {V_{abs}}^2}\right)\frac{{V_{abs}}^2}{2c}$$

Assume the measured difference in arrival times (Δt_1 or Δt_1') of the two satellite signals to be 10ms, V_{abs} = 390 Km/s , D ≈ 20000 Km , c= 300000 Km/s .

$$\varepsilon_d \approx 10\text{ms} * \frac{390^2}{600000} = 0.002535\,Km \approx 2.5\,m$$

We see that absolute motion of the Solar System essentially affects GPS position measurement but the effect is very small: it is almost 'invisible' in GPS measurements. That maybe why the ECI frame appears to apply accurately to GPS and why the speed of light appears to be constant in the ECI frame. Note that the value of ε_d does not mean error in position measurement of actual GPS; it is meant to show that current GPS performance might be achieved even with the Earth in absolute motion (390 Km/s). Note also that we have only shown that the *difference* between arrival times, not the absolute times, of satellite signals at the GPS receiver is almost not sensitive to Earth's absolute motion in space.

Application of Apparent Source Theory to GPS can improve its accuracy.

4. Phase velocity, group velocity and Doppler effect of Light

4.1. Constant phase velocity and variable group velocity of light

Constant *phase* velocity of light

Einstein's beautiful thought experiment, 'chasing a beam of light', is very compelling and is in fact the main argument for Special Relativity. If the ether doesn't exist, as confirmed by the Michelson-Morley experiment, then Einstein is right in asserting that the velocity of light is independent of observer velocity. By 'velocity of light', we mean *phase* velocity and not *group*velocity. However, Einstein never made this distinction and this led him to the wrong theory of Special Relativity, length contraction, time-dilation speculations. Emission theory was also shown to be wrong conceptually and by experiments. One of the conceptual arguments against conventional emission theory is that it implies 'frozen' light[18], which is untenable. The above considerations are compelling to postulate the constancy of *phase* velocity of light, independent of source or observer relative or absolute velocities, even though no direct experimental evidence seems to exist. However, the fast ion beam experiment may be a direct evidence.

In an attempt to understand Einstein's light postulate, I developed a theory [6] in which the wave gets compressed or expanded as a result of source observer relative motion, the wavelength depending on source observer relative velocity. This is unlike all conventional knowledge. To my knowledge, no one ever considered such a possibility, i.e. changing of wavelength with observer velocity. According to ether theory, emission theory and Special Relativity ? , the wavelength of light does not depend on observer velocity.

The wavelength of light varies with observer velocity, according to Exponential Law of Doppler effect of light [8].*The phase velocity of light is always constant c relative to an observer, irrespective of source and observer relative or absolute motion, for constant velocity and during acceleration.*

The Exponential Law of Light theory [8] is considered to be the correct expression for the compression and expansion of the light wave resulting from source observer relative motion.

According to the theory of Exponential Law of Light, the expression for the Doppler wavelength and frequency shift is:

$$\lambda' = \lambda e^{V/c}$$

, for source and observer receding away from each other

$$f' = f e^{-V/c}$$

, for source and observer receding away from each other

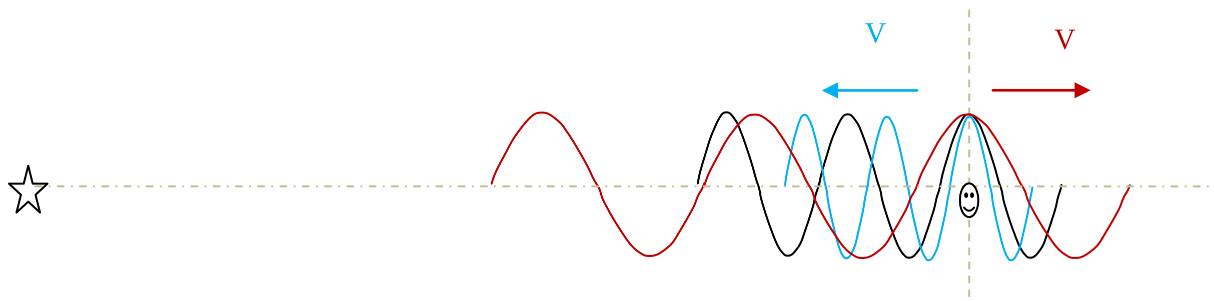
Thus,

$$\lambda' f' = \lambda\, e^{V/c}\; f\, e^{-V/c} = \lambda\, f = c$$

We see that the (phase) velocity of light is independent of source observer relative velocity. Obviously, this is different from classical, conventional thinking. For sound waves , only source velocity creates change in wavelength. Observer velocity doesn't change the wavelength of sound, but only the frequency. In the case of light, both the frequency and wavelength of light change [6] due to source observer-source relative velocity, and the Doppler effect is governed by the Exponential Law of Light [8].

Recently I came across a paper that made a somewhat similar proposal[23], that the constant *c* in Maxwell's equation should be interpreted as phase velocity, while searching information about GPS. However, the paper does not make clear *how* the phase velocity will be constant.

Intuitively, this can be understood from the next figure.



The black wave represents the wave for source and observer at rest relative to each other. The red and blue waves are for the cases of the observer moving away from the source and towards the source, respectively. Suppose that the observer is initially at rest relative to the source. He will observe the black wave. Now imagine that the observer accelerates instantaneously to velocity V towards the source. The wave observed by the observer will change instantaneously to the blue wave. The observer continues to observe the peak point (crest) of the wave but with shorter wavelength. The phase seen by the observer will be continuous (i.e. it will not jump to a different phase) but the wavelength will change discontinuously, if the acceleration to V occurs instantaneously. If the observer accelerates instantaneously from rest to velocity V away from the source, the observer will instantaneously start to see the red wave, but starts from the same instantaneous phase as the black wave, i.e. peak point. This means that if the observer was just seeing the peak of the black wave when he instantaneously accelerated from rest to velocity V away from the source, he will start and continue from the peak of the red wave. This may be seen as compression/expansion of the wave *towards/ away from the observer*. In my previous paper [6] the compression/expansion was towards/away from the source and this created undesirable effects.

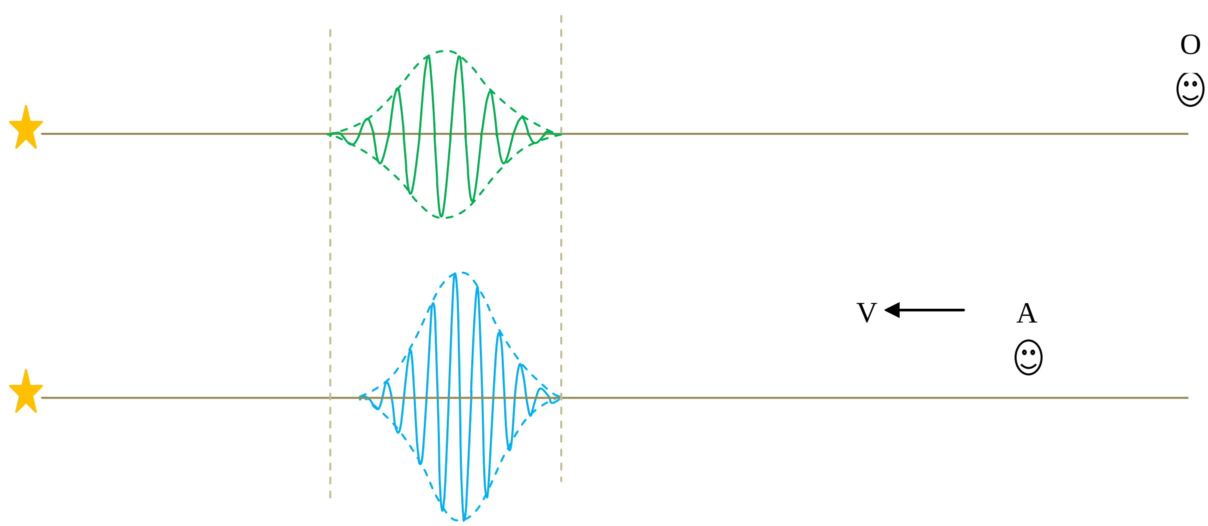
Obviously, this is different from classical, conventional thinking. For sound waves , only source velocity creates change in wavelength. Observer velocity doesn't change the wavelength of

sound, but only the frequency. In the case of light, both the frequency and wavelength of light change [6] due to source- observer relative velocity, and the Doppler effect is governed by the Exponential Law of Light [8].

Constant phase velocity and variable group velocity of light

Now that we have interpreted Einstein's thought experiment to mean that *phase* velocity is always constant c , we are freed from the confusion that group velocity also should be constant. By postulating that phase velocity is always constant c , we conform to Maxwell's equations. So there is no reason to assume that group velocity should also be constant always. Group velocity is independent of source velocity, but depends on observer and mirror velocity. With this theory we can think intuitively, clearly and explain many experiments and observations.
By making the distinction that the *phase* velocity, and not the group velocity, is constant, a century old puzzle has been solved. Special Relativity resulted from failure to make this distinction. The group velocity behaves in the conventional, intuitive way: $c \pm V$.

It is wrong and unnecessary to speculate that velocity of light is constant relative to all observers, without making this distinction. Therefore, there is no reason to think that the *group* velocity of light also is constant relative to any observer.



Consider two observers. Observer O is at rest relative to the light source and observer A is moving towards the light source.Observer A who is moving towards the light source should logically detect the light pulse earlier than the stationary observer O. However, observer A should observe a spatially compressed (smaller wavelength) form of the wave observed by stationary observer O, so that the phase velocity is always constant c relative to observe A.

Both the phases and the group (envelop) will be compressed for source-observer relative motion.

The amplitude of the envelope will also increase according to a new interpretation of Planck's relation[9][10].Doppler shift of light is accompanied with change in amplitude of the envelope due to Planck's relation, E = h f .

Consider a stationary light source and an observer moving away from the source with velocity V. The new finding here is that *the group velocity will be c – V relative to the observer. However, once the group catches up with the observer, the phase velocity is always constant c relative to the observer. The phase time delay will always be equal to the group time delay.*

Suppose that the source emits a light wave

$$\mathrm{A(t)} \sin \omega t \,, \quad \text{where A(t)is the envelope function}$$

An observer was at distance D from the source and just starts moving away from the source at relative velocity V at the instant of emission. Then the observer will detect

$$\mathrm{A}(\mathrm{t}-t_D) \sin \omega' (\, t - t_D) = \quad \mathrm{A}(\mathrm{t}-t_D) \sin 2\pi f' (\, t - t_D)$$

where

$$t_D = \frac{D}{c - V}$$

and

$$f' = f\, e^{\frac{-V}{c}} \quad (\, Exponential\ Doppler\ Effect\ \ theory\,)$$

The amplitude of the envelop function has been assumed to be only delayed in time; however, the new interpretation of Planck’s relation by this author implies that the amplitude of the envelope will also decrease with decrease in frequency. Therefore, the more correct expression of the wave detected by the moving observer will be:

$$\mathrm{A}'(\mathrm{t}-t_D) \sin 2\pi f' (\, t - t_D)$$

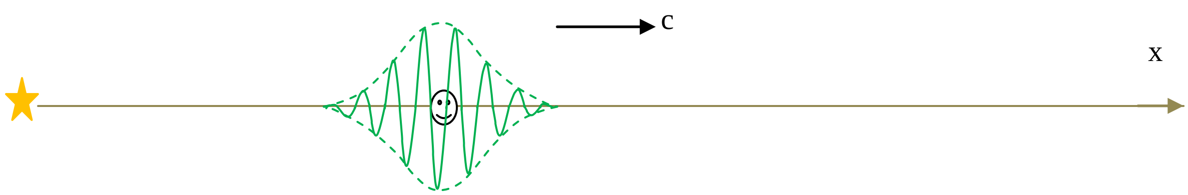
Note the slight compression of the blue sinusoidal *phases* as compared to the black sinusoidal waves, and also the compression of the *group*(envelop) for the moving observer (the blue wave).Note also the increase in the peak of the amplitude of the blue wave compared to the green wave.

For the stationary observer O, the phases are at rest relative to the envelope. However, for moving observer A, the phases are moving relative to the envelope.

One experimental evidence for the variable group velocity of light (varying with observer’s absolute velocity) is Ole Roamer’s observation that the eclipse time of Jupiter's moon I_o is longer when the Earth is moving away from Jupiter than when it is moving towards Jupiter, by about 22 minutes. This can be seen as the effect of absolute motion of the observer.

A new interpretation of Einstein's light speed thought experiment

Imagine a light source that is at rest and an observer moving away from the source at or near the speed of light, as Einstein imagined in his thought experiment. Assume that the observer was at the source position but just moving away at the speed of light at an instant of time t=0. Assume that the source emits a light pulse at this same instant of time, t=0.



According to the ' constant phase velocity variable group velocity ' theory, the phases always go past the observer at the speed of light, but the envelop will be at rest ('frozen') relative to the observer. Einstein (and no one else, as far as I know) never imagined such a possibility.

Experimental evidences exist for *constant phase velocity and variable group velocity of light*. These include the Albert Michelson moving mirror experiment and the Q.Majorana moving mirror experiment discussed already. In these experiments, although the group velocity of light depends on the mirror velocity, the phase velocity is independent of mirror velocity. Since phase velocity, and not group velocity, is relevant in experiments using interference method, this explains the results of A. Michelson and Q.Majorana experiments. Other experimental evidences also exist, such as the Arago star light refraction and aberration experiments.

The Arago, the Airy, the Fizeau, the Hoek experiments and Fresnel's drag coefficient

In this section we will see the fundamental significance of the Arago and Airy experiments.

The Arago refraction experiments

In1810 Dominique-Francois Arago performed experiments to test the emission theory of light that predicted variations in refraction angle of light from different stars. He observed no difference in the refraction angles of light from different stars, demonstrating that the speed of light from all stars is the same, independent of star velocity, supporting the wave theory. However, he performed another experiment in which he observed the angle of refraction of the light from the same star, instead of different stars, at different times of the year. Again he observed no change in the angle of refraction of the star light. This posed a problem not only to the emission theory, which he disproved in his first refraction experiment, but also to the wave theory. Fresnel successfully explained this phenomenon through his partial ether drag formula, which was also confirmed later by the Fizeau experiment. According to Fresnel's partial ether drag hypothesis, the velocity of light in moving optical media is given by

$$\frac{c}{n} + v.(1 - \frac{1}{n^2})$$

in the laboratory reference frame, where *n* is the index of refraction of the medium and *v* is the velocity of the moving medium.

Although Fresnel's formula was empirically successful, the underlying theory was found to be wrong. Then the Special Theory of Relativity arrived, claiming the correct explanation and the mainstream physics community assumes that this problem has been solved. However, SRT has been disproved both experimentally and theoretically, by the Apparent Source Theory proposed by this author. Therefore, Arago's experiment still requires an explanation, after one hundred years of Special Relativity.

As we already proposed, *the phase velocity of light is constant cindependent of observer or source velocity*. The group velocity of light is independent of source absolute velocity, but depends on observer absolute velocity. Since it is the phase velocity that is relevant in refraction, therefore, in the experiment of Arago, there will be no change in the refraction angle of the star light due to Earth's orbital motion because the phase velocity of light is always constant.

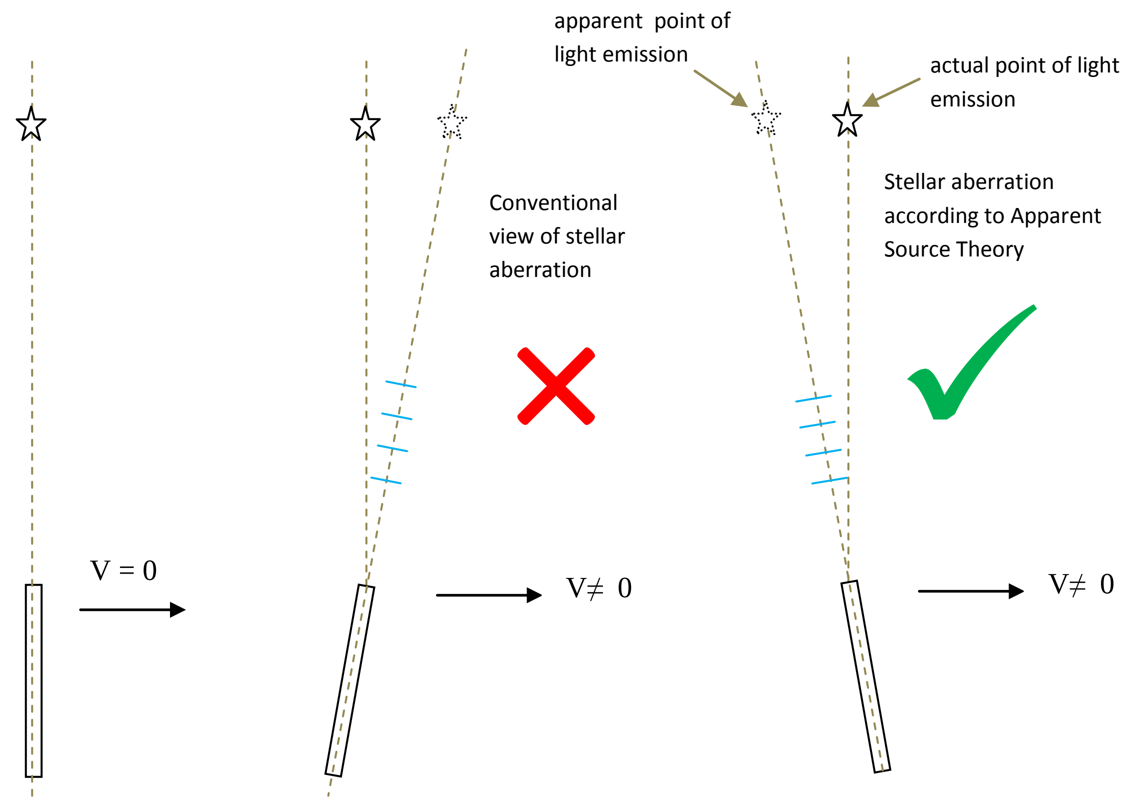
The Arago, the Airy stellar aberration experiments

In another experiment carried out by Arago and repeated later by Airy, a telescope filled with optical medium (glass or water) was used to observe stellar aberration to detect change in angle of aberration which was implied by Bradley's explanation of stellar aberration. Since the speed of light in glass is less than in air, a change in angle of aberration was expected. However, no change in aberration angle was observed compared to the aberration angle observed by a telescope filled with air.

First we restate again that the conventional understanding of stellar aberration that the apparent change in star position is in the direction of observer's velocity is wrong. According to Apparent Source Theory, the apparent change in position of the star is in the direction opposite to the velocity of the Earth ! This is a completely unexpected result !

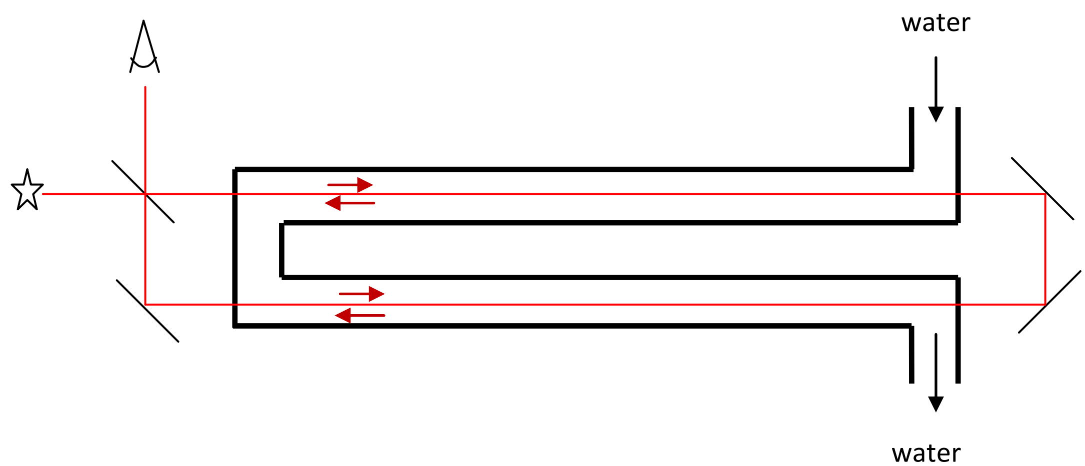
We now explain the aberration experiment. Consider a star that is directly overhead. When the observer (telescope) is at rest relative to the star, the light rays strike the surface of the medium (glass) perpendicularly, hence no refraction occurs. With the observer moving with velocity V, the position of the star changes apparently. *The wave fronts also rotate,* which is a strange nature of light, and thus the light strikes the glass at the same angle as before (perpendicularly), again no refraction. Therefore, the angle of aberration is independent of the medium in the telescope. The rotation of the wave fronts may be explained by non-existence of the ether.

For the observer in the reference frame of the telescope, light comes from the direction of the apparent star and hence no additional tilting of the telescope is required to compensate for the refraction index of the glass or the water. The strange thing here is that, for the observer moving with the telescope, the wave fronts are rotated, as shown in the figure above.



The Fizeau experiment

In 1851, Fizeau carried out an experiment that confirmed Fresnel's ether drag formula. An interesting point is that Fresnel's ether drag formula, which was later confirmed by the Fizeau experiment, was derived based on the star light refraction and aberration experiments of Arago. How could (can) Fresnel drag coefficient be derived based only on the Fizeau experiment alone, i.e. if the Arago star light refraction experiment were never carried out ? There is an alternative explanation of the Fizeau experiment [34].



4.2. Albert Michelson and Q. Majorana moving mirror experiments

Even though the Bryan G.Wallace experiment is also a case of moving mirror, only group velocity is relevant in its analysis, since it is a time-of-flight experiment. It was readily understood using the AST theory.

The Albert Michelson and Q. Majorana moving mirror experiments, however, used interference method, so their analysis will also involve phase velocity.

From analysis of Bryan G. Wallace experiment, we concluded that a moving mirror will alter the *group* velocity of light. But the *phase* velocity is always constant, irrespective of source, observer or mirror velocity, as will be discussed later on.

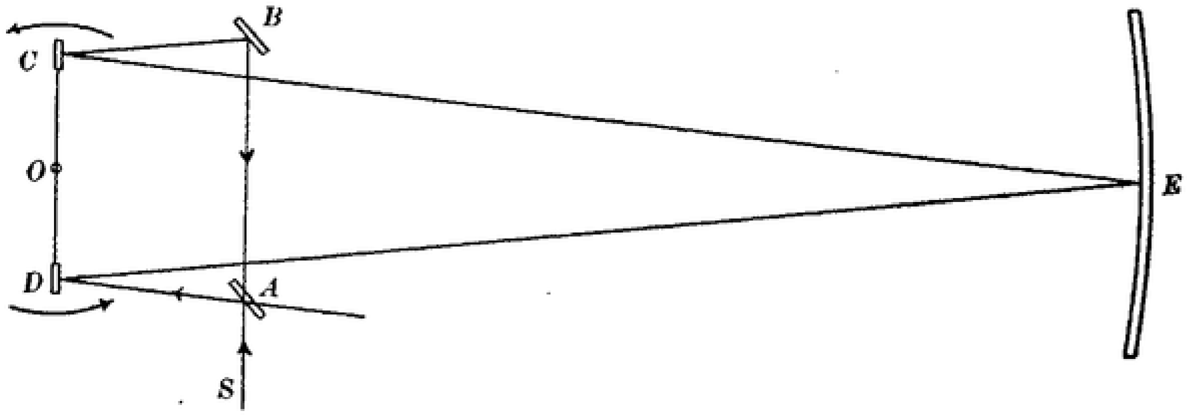
1. In absolute space, the group velocity of light is independent of source absolute velocity, but depends on observer absolute velocity. In Galilean space the group velocity varies with both source, observer (relative) velocity. For a light source that is at absolute rest, the group velocity of light varies with observer velocity, whereas the phase velocity is constant c independent of observer velocity. For a light source that is in absolute motion and an observer that is at absolute rest, both the group velocity and phase velocity are independent of source velocity.

2. The group velocity of light depends on mirror relative velocity

In principle, to account for the Earth's absolute velocity, we first replace the actual light source with an apparent source, as seen from the detector's position. We then analyze the experiment by assuming Galilean space and (modified) emission theory. Modified emission theory is one in which the phase velocity is constant *c* independent of source observer relative velocity, whereas the group velocity depends both on the source and observer velocity , in a conventional way, in Galilean space. To simplify the discussion, however, we ignore the absolute velocity of the Earth and just assume Galilean space and modified emission theory.

Albert Michelson moving mirror experiment

The A.Michelson moving mirror experiment was done to investigate the effect of mirror velocity on the velocity of light, by looking for a fringe shift due to a possible difference in the velocities, and arrival times, of the two light beams.



Assuming Galilean space, for simplicity of discussion, the group velocity of the two light beams will be different because group velocity depends on mirror velocity, according to AST. We have already concluded that the group velocity will depend on the mirror velocity. This means that, given sufficiently large mirror velocity, the faster beam will arrive earlier than the slower beam in such a way that they may not even overlap in time to create an interference pattern.

The phase of the detected light relative to the observed light is equal to the path length divided by the constant phase velocity *c*.

$$phase\ of\ detected\ light = \frac{path\ length}{c}$$

The fact that the two light beams have different group velocities will not significantly affect the fringe shift. The difference in group velocities will only affect the path lengths slightly.

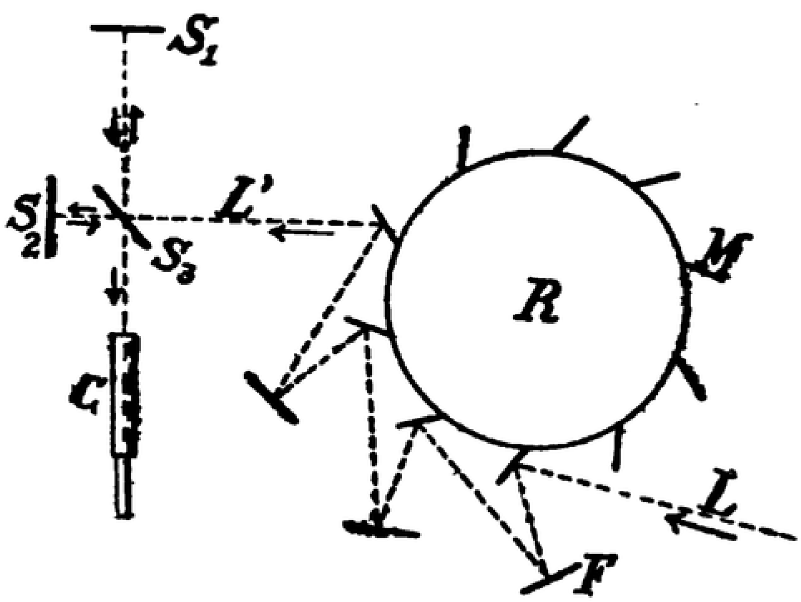
A photon that takes the path SADECBA (see above figure) will arrive early, whereas a photon that takes the path SABCEDA will arrive late. Obviously, the interference fringes are determined by the positions where the photons land, not by the group time delay of individual photons, which is irrelevant.Therefore, the difference in group velocities of the two light beams will have no effect on the interference pattern. If the photon takes the path of faster velocity (path ADECBA) it will only arrive slightly earlier than if it took the other path and this will have no effect on the interference pattern. My previous paper [9,10]providesa very intuitive way of understanding quantum phenomena.

Michelson wrongly interpreted the result of the experiment that the group velocity also is not affected by the mirror velocity, which is also the mainstream thought today. The quantum interpretation applies also to the Michelson-Morley experiment: *the photon takes only one of the two possible paths to the detector: the path of one or the other mirror, not both.*

Q.Majorana moving mirror experiment

According to conventional emission theory, the wavelength of light does not change with source, observer or mirror velocity; it is ' rigid '. The Q. Majorana experiment tested this hypothesis and disproved it. The emission theory was a straight forward explanation for the Michelson-Morley experiment.

As already stated, the group velocity of light depends on the mirror velocity according to the ballistic hypothesis. The phase velocity is always constant *c* independent of source, observer or mirror velocity. Hence, for the phase velocity to be constant, the wavelength should change and this was what was proved by this experiment.



Q.Majorana also did not make the distinction on phase velocity and group velocity, as proposed in this paper, i.e. constant phase velocity and variable group velocity.

4.3. Doppler effect of light

We have already discussed that the phase velocity of light is always constant *c* irrespective of source and observer relative or absolute velocity. Now we postulate the following:

Doppler effect of light depends only on source observer relative velocity and not on the absolute velocities of the sourceor the observer. More precisely, Doppler effect exists whenever there is relative motion between the real/physical source and an <u>inertial</u> observer, in the radial direction, at the instant of light emission.

The above postulate implies that only source observer relative velocity is relevant to Doppler effect. Source and observer absolute velocities are irrelevant in Doppler effect of light.

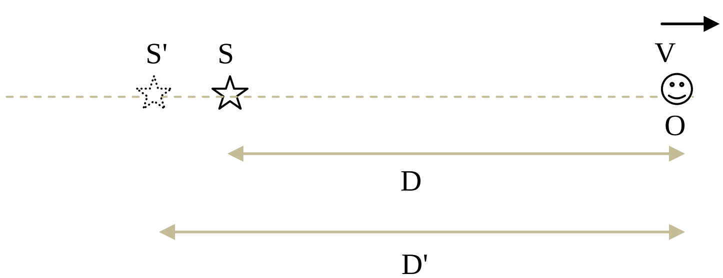
The disentanglement of absolute velocity from Doppler effect of light is one of the biggest challenges I faced during the development of this theoretical framework.

How Doppler effect is not affected by absolute velocity is described later on under ' Physical Meaning ' . For now we just apply the above postulate. Even though absolute velocity is not relevant to Doppler effect, I have chosen to make the discussion as different combinations of source and observer absolute velocities, even if only relative velocity is relevant, to show and clarify other effects such as aberration at the same time, for a more complete understanding.

Longitudinal Doppler effect

In this case we consider a light source and an observer directly approaching each other or receding away from each other, with radial velocity component only.

<u>Source at absolute rest, observer in absolute motion</u>



According to the theory I proposed in my recent papers[37][38], which is just a refined form of Apparent Source Theory, there will be an apparent change in point of light emission in relative to an absolutely moving observer.

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

This implies that the group velocity of light relative to the observer is:

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

However, the Doppler effect of light depends only on the velocity of the real/physical source *relative* to the inertial observer at the instant of light emission.

According to the Exponential Law of Light[8]:

$$\lambda_r = \lambda_0 e^{V/c} \text{ and} f_r = f_0 e^{-V/c}$$

where λ_0 and λ_r are emitted and received wavelengths, respectively.
and f_0 and f_r are emitted and received frequencies, respectively. V is positive for source and observer receding away from each other.

A light pulse emitted by the source is detected by the observer after a time delay of:

$$\tau = \frac{D}{c - V}$$

where D is the distance between source and observer at the instant of emission. This shows that the group velocity of light varies with observer velocity, as already discussed.

Observer at absolute rest and source in absolute motion

There is no aberration of light if the observer is at absolute rest. Aberration is a result of absolute motion of the observer.

$$\lambda_r = \lambda_0 e^{V/c} \text{ and } f_r = f_0 e^{-V/c}$$

The time delay between emission and detection of light, which is:

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

where D is the distance between source and observer at the instant of emission. This is based on the fact that the speed of light does not depend on the velocity of the source.

Transverse Doppler effect

Let us first consider Doppler effect of material waves, such as sound waves, with regard to transverse Doppler effect. For moving source and stationary receiver (relative to air) , there will not be any Doppler effect of sound emitted at the moment of closest approach, and there will be Doppler effect for sound received at the moment of closest approach.

For stationary source and moving receiver, there will be no Doppler effect of sound received at the moment of closest approach, whereas there will be Doppler effect of sound transmitted at the moment of closest approach.

In the case of light, we propose that [37][38]:

For observer at absolute rest and source in absolute motion:
- there is Doppler effect of light observed at the instant of closest approach, as for sound wave
- there is no Doppler effect of light emitted at the instant of closest approach, as for sound wave

For source at absolute rest and observer in absolute motion:
- there is Doppler effect of light observed at the instant of closest approach, unlike sound wave
- there is no Doppler effect of light emitted at the instant of closest approach, unlike sound wave

Therefore, we can say that true transverse Doppler effect existsonly in one case: for light observed at the moment of closest approach, in the case of source at absolute rest and observer in absolute motion. However, for stationary observer and moving source, light observed at the moment of closest approach is also blue shifted. Since sound wave also has this property, we would not call this transverse Doppler effect. Or we may call it 'classical transverse Doppler effect'.

The question is: Does this confirm transverse Doppler effect of Special Relativity ? And what about the Ives – Stilwell experiment? The red shift in the Ives – Stilwell experiment is not due to transverse Doppler effect, but due to a mysterious law governing the Doppler effect of light: Exponential Law of Doppler Effect of light [9], which predicts asymmetric longitudinal Doppler effect.

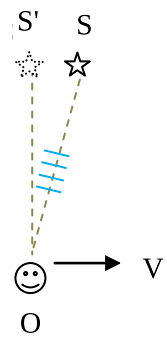
Next we analyze different cases for transverse Doppler effect of light.Before considering Doppler effect, let us consider related phenomenon.

Light received at the moment of closest approach

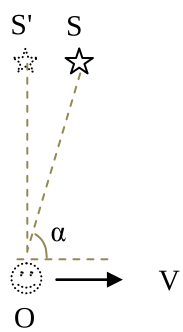
Source at absolute rest and observer in absolute motion

Again, Doppler effect depends only on source observer relative velocity and not on any source or observer absolute velocity.

There will be transverse Doppler effect in this case. There will also be aberration[37][38], and the orientation of the wave fronts will be different in the observer's reference frame, as shown below. Change in the angle of arrival of the wavefronts due to observer’s motion is a strange nature of light making it distinct from material waves. Arago’s and Airy's glass (water) telescope stellar aberration experiment can be explained by this theory. Remember the new theory of stellar aberration that the direction of apparent change in position of the source is opposite to the direction of observer's absolute velocity, which is the prediction of Apparent Source Theory.



There is apparent change in point of emission relative to the observer[37][38]. There is also transverse Doppler effect because there is a radial component of the velocity of the observer relative to the velocity of the *physical* source at the instant of light emission. At the instant of light emission, the observer was at point O' and moving with velocity V to the right.



Since there is a radial component of the relative velocity between the observer and the physical source at the instant of light emission, there will be (transverse) Doppler effect of light observed at the moment of closest approach.

The radial component of the relative velocity between the source and the observer is:

$$V \cos \alpha$$

Therefore, the frequency of light observed at the moment of closest approach is:

$$f' = f\, e^{\frac{V \cos \alpha}{c}}$$

This is obviously different from the formula of Special Relativity.

But

$$\cos\alpha = \frac{V}{\sqrt{c^2 + V^2}}$$

Therefore,

$$f' = f\, e^{\frac{V\cos\alpha}{c}} = f\, e^{\frac{V\frac{V}{\sqrt{c^2+V^2}}}{c}} = f\, e^{\left(\frac{V}{c}*\frac{V}{\sqrt{c^2+V^2}}\right)}$$

We know that

$$e^x = 1 + x + \frac{1}{2}x^2 + \frac{1}{6}x^3 + \ .\ .\ . \quad (\ for -\infty < x < \ \infty\ )$$

Therefore,

$$f' = f\, e^{\left(\frac{V}{c}*\frac{V}{\sqrt{c^2+V^2}}\right)} = f\ \left(1 + \frac{V}{c} * \frac{V}{\sqrt{c^2 + V^2}} + \frac{1}{2}\left(\frac{V}{c} * \frac{V}{\sqrt{c^2 + V^2}}\right)^2 + \ .\ .\ . \right)$$

$$\Longrightarrow \ f' \cong f\ \left(1 + \frac{V}{c} * \frac{V}{\sqrt{c^2 + V^2}} + \frac{1}{2}\left(\frac{V}{c} * \frac{V}{\sqrt{c^2 + V^2}}\right)^2 \right)$$

$$\Longrightarrow \ f' \cong f\ \left(1 + \frac{V}{c} * \frac{V}{\sqrt{c^2 + V^2}}\right) \ , \quad for\ \frac{V^4}{c^4} \ll \ 1$$

$$\Longrightarrow \Delta f = f' - f \cong f\ \left(\frac{V}{c} * \frac{V}{\sqrt{c^2 + V^2}}\right) = f\ \left(\frac{V}{c} * \frac{\frac{V}{c}}{\sqrt{1 + \frac{V^2}{c^2}}}\right)$$

$$\Delta f \cong f\ \left(\frac{\frac{V^2}{c^2}}{\sqrt{1 + \frac{V^2}{c^2}}}\right) \cong f\ \frac{V^2}{c^2} = \beta^2 f \ , \ for\ \frac{V^2}{c^2} \ll \ 1$$

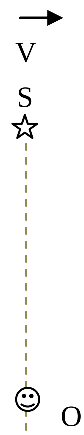
Thus, there is transverse Doppler effect in this case, but the predicted value is about twice that predicted by SRT. The transverse Doppler effect according to SRT is given by:

$$f' = \gamma f = \frac{1}{\sqrt{1 - \frac{V^2}{c^2}}}\ f$$

$$\Longrightarrow \ \Delta f \cong f - f' = f\left(1 - \frac{1}{\sqrt{1 - \frac{V^2}{c^2}}}\right) \cong \frac{1}{2}\frac{V^2}{c^2} f = \frac{1}{2}\beta^2 f$$

Therefore, according to Exponential Doppler Effect theory, there is asymmetrical longitudinal Doppler effect (as will be presented in the next section) and also transverse Doppler effect.

Source in absolute motion and observer at absolute rest

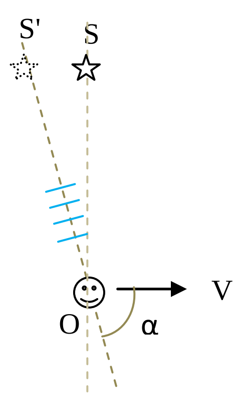


There is no (transverse) Doppler effect in this case because the radial component of the velocity of the *physical* source relative to the observer at the instant of emission is zero. Also, since the absolute velocity of the observer is zero, there is no aberration.

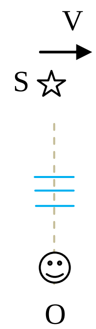
Light emitted at the moment of closest approach

Source at absolute rest and observer in absolute motion

Since the radial component of the velocity of the physical source relative to the observer at the instant of light emission is zero, there is no Doppler effect of observed light. According to my recent papers[37][38], there is an apparent change in point of light emission (aberration) due to observer's absolute motion.



Source in absolute motion and observer at absolute rest



Again, since the radial component of the velocity of the physical source relative to the observer at the instant of light emission is zero, there will be no transverse Doppler effect in this case.

Therefore, transverse Doppler effect (TDE) exists, but not as predicted by SRT. It is not only the presence of blue shift for light observed at the moment of closest approach, in the case of stationary source and moving observer, but also the absence of classical red shift for light emitted at the moment of closest approach, again in the case of stationary source and moving observer, that makes light strange when compared with classical material waves.

Summary

	sound		light	
	Stationary source Moving observer	Moving source Stationary observer	Stationary source Moving observer	Moving source Stationary observer
Light/sound observed at the moment of closest approach	no Doppler effect	'blue' shifted	blue shifted (unconventional)	blue shifted
Light/sound emitted at the moment of closest approach	'red' shifted at moment of observation	no Doppler effect	no Doppler effect (unconventional))	no Doppler effect

4.3. Exponential Law of Doppler Effect of Light - the mystery behind Ives-Stilwell experiment

In Special Relativity, transverse Doppler effect arises because of *multiplication* of the classical Doppler shift formula by the gamma (γ) factor.

However, the Ives-Stilwell experiment can be explained by a very compelling alternative theory-

Exponential Law of Light [8]. The observed red shift results from *asymmetrical* longitudinal Doppler shift, unlike the classical formula which predicts symmetrical longitudinal Doppler shift.

Although I previously proposed this theory[8] from a different line of reasoning, which I have abandoned now, the ease with which it explains the Ives-Stilwell experiment makes it very compelling and I have still adopted it in this paper.

The mysterious term governing Doppler effect of light is proposed as:

$$e^{V/c}$$

where V is the source - observer relative velocity.

Therefore, the formula for *longitudinal* Doppler effect would be:

$$\lambda' = \lambda e^{V/c} \text{ and} f' = f e^{-V/c}$$

V is positive for source and observer receding from each other.

Now, in the Ives-Stilwell experiment, the wavelength of the light emitted from the ion in the forward direction would be:

$$\lambda'_F = \lambda e^{V/c}$$

The wavelength of light emitted in the backward direction would be:

$$\lambda'_B = \lambda e^{-V/c}$$

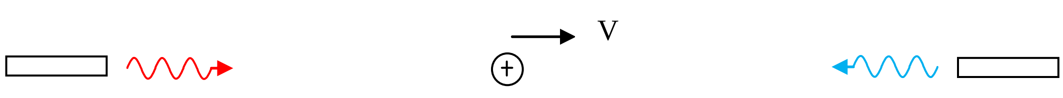
The average wavelength:

$$\Lambda = \frac{1}{2}(\lambda'_{\mathrm{F}} + \lambda'_{\mathrm{B}}) = \frac{1}{2}\lambda(e^{V/c} + e^{-V/c})$$

$$\Delta = \Lambda - \lambda = \lambda\left(\frac{1}{2}e^{V/c} + \frac{1}{2}e^{-V/c} - 1\right) \approx \frac{1}{2}\left(\frac{\mathrm{V}}{\mathrm{c}}\right)^2\lambda = \frac{1}{2}\beta^2\lambda \quad \text{(using Taylor's expansion)}$$

This is the same formula predicted by Special Relativity and confirmed by the Ives-Stilwell experiment.

Modern Ives-Stilwell experiment: fast ion beam experiment



The frequencies of the two laser beams as seen by the ion are related to the transition frequencies as follows:

$$f_{01} = f_R e^{-V/c}$$

$$f_{02} = f_B e^{V/c}$$

From which follows:

$$f_{01} f_{02} = f_R f_B \implies \frac{f_{01} f_{02}}{f_R f_B} = 1$$

where f_{01} and f_{02} are the two transition frequencies, in the rest frame of the ion and F_R and F_B are the frequencies of the parallel and anti-parallel laser beams, respectively.
The above result is consistent with experiments.

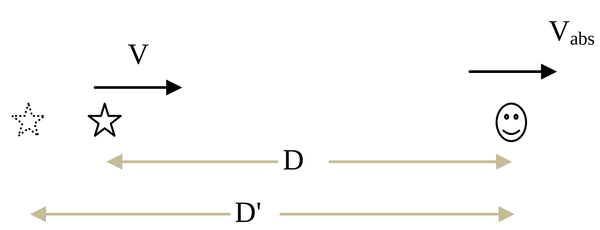
Earth's absolute motion and the Ives-Stilwell experiments

One of the most confusing problems in the development of AST and Exponential Law of Doppler effect of light has been regarding the effect of Earth's absolute motion on the observed Doppler effect in Ives-Stilwell and fast ion beam experiments. This problem is solved in this paper.

Consider an observer in absolute motion and a light source in motion relative to the observer. In papers[37][38] I proposed that there is an apparent change of point of light emission relative to (as seen by) the observer.

Suppose that the source emitted light from a point at distance D relative to the absolutely moving observer. Therefore, the apparent point of emission will be at a point:

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



The time of flight of light is:

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

The absolute motion of the observer will affect the time of flight of light. However, observer's absolute velocity has no effect on Doppler effect of light, which depends only on the velocity of the physical source *relative* to the observer at the instant of light emission.

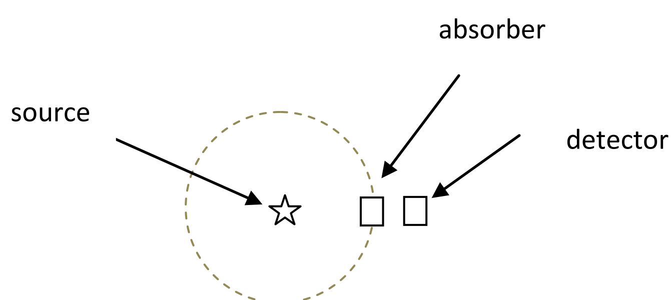
4.5. The Mossbauer rotor experiment

Another experiment considered as evidence for the theory of Special Relativity is the Mossbauer rotor experiment performed by Kundig.

The Mossbauer rotor experiment is a case of light source and observer in accelerated motions and the experiment is analyzed by using the generalized form of Apparent Source Theory already formulated and applied to Sagnac effect and by the Exponential Doppler Effect law. Once the position and absolute velocity of the imaginary inertial observer at the instant of light emission is determined, then Doppler effect is determined by the velocity of the real/physical source relative to the observer, at the instant of light emission.

Apparent Source Theory is concerned only in time of flight, path and path length of light and phase of detected light relative to emitted light. Apparent Source Theory does not directly apply for Doppler effect of light. In fact, absolute motion of the observer or the light source has no effect on Doppler effect. This claim is based on the Ives-Stilwell experiments in which no effect of Earth's absolute motion was observed. However, both Apparent Source Theory and Transverse Doppler Effect are applied in combination in order to solve such problems as the Mossbauer rotor experiment, in which accelerations are involved.

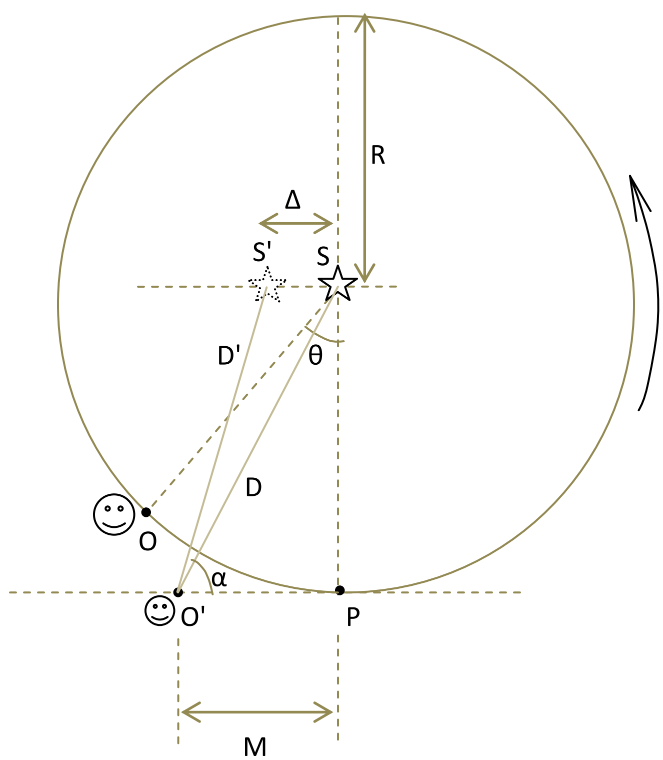
Doppler effect of light is governed by another law: Exponential Doppler Effect, in which only source and observer *relative* velocity is relevant. Absolute velocity of the observer or the light source does not affect Doppler effect.



We apply Apparent Source Theory and Exponential Doppler Effect theory to analyze the Mossbauer rotor experiment. In the case of Doppler effect experiments involving only inertial motions, such as the Ives-Stilwell experiments, the absolute velocity of the laboratory does not affect Doppler effect because we have stated that Doppler effect is determined by the velocity of the physical source relative to the inertial observer, at the instant of light emission. The absolute velocity of the laboratory only affects/determines the path, path length, time of flight and phase delay of light. Doppler effect is determined only by the source-observer relative velocity at the instant of light emission.

However, in the case of experiments in which accelerated observers/detectors are involved, such as the Mossbauer rotor experiment, the absolute velocity of the laboratory affects Doppler effect *indirectly*. This is because absolute velocity of the laboratory determines the position and velocity of the imaginary inertial observer at the instant of light emission, as already discussed, which in turn determines the Doppler effect[37][38]. This implies that the Mossbauer rotor experiment is indirectly affected by the Earth's absolute velocity (390 Km/s , towards Leo) .

Suppose that the source S emits light at time t = 0 , just at the instant that the observer O (which is the absorber in the Mossbauer rotor experiment) is at the position shown in the figure below.



As before, we start by assuming that the accelerating observer O will detect the light at point P. To analyze the experiment, we assume an imaginary inertial observer O' , who is at some point O' at the instant of light emission and who will arrive at point P simultaneously with observer O, and whose velocity is equal to the instantaneous velocity (magnitude and direction) of observer O at point P. In other words, real accelerating observer O and imaginary inertial observer O' will arrive at point P simultaneously and detect the light, while moving with equal instantaneous velocities.

There are three expressions for the time of flight of light.

The time *t* taken by observer O to move from point O to point P is:

$$t = \frac{length\ of\ arc\ OP}{tangential\ speed} = \frac{2\pi R \frac{\theta}{360^0}}{\omega R} = \frac{2\pi \frac{\theta}{360^0}}{\omega}$$

The time *t* taken by imaginary inertial observer O' to move from point O' to point O is:

$$t = \frac{length\ of\ path\ O'P}{velocity\ of\ observer\ O'} = \frac{M}{\omega R}$$

The time of flight *t* of light is the time taken for light to travel from the apparent point of emission S' to imaginary inertial observer O'.

$$t = \frac{distance\ S'O'}{c} = \frac{D'}{c}$$

We have already determined that:

$$\Delta \cong \frac{V_{abs}}{c} D \quad and \quad D' \cong D - \left(\frac{V_{abs}}{c}\ x\right), \quad for\ V_{abs} \ll c$$

where

$$x = D \cos \alpha$$

Therefore,

$$\Delta \cong \frac{V_{abs}}{c} D \quad and \quad D' \cong D - \frac{V_{abs}}{c} D \cos \alpha\ , \quad for\ V_{abs} \ll c$$

$$\Delta \cong \frac{V_{abs}}{c} D \quad and \quad D' \cong D\ (\ 1 - \frac{V_{abs}}{c} \cos \alpha\ )\ , \quad for\ V_{abs} \ll c$$

Substituting this value in the previous expression for *t* :

$$t = \frac{D'}{c} = \frac{D\ (\ 1 - \frac{V_{abs}}{c} \cos \alpha\ )}{c}$$

But,

$$\cos \alpha = \frac{M}{D}$$

Therefore,

$$t = \frac{D'}{c} = \frac{D\ (\ 1 - \frac{V_{abs}}{c} \frac{M}{D})}{c}$$

In summary, we have three unknowns (t, θ, and M) and three equations.

$$t = \frac{2\pi \frac{\theta}{360^0}}{\omega}$$

$$t = \frac{M}{\omega R}$$

$$t = \frac{D\ (1 - \frac{V_{abs}}{c}\frac{M}{D})}{c}$$

From the last two equations,

$$\Longrightarrow \frac{M}{\omega R} = \frac{D\ (1 - \frac{V_{abs}}{c}\frac{M}{D})}{c}$$

$$\frac{M}{\omega R}c = D\left(1 - \frac{V_{abs}}{c}\frac{M}{D}\right)$$

$$\frac{M}{\omega R}c = \left(D - \frac{V_{abs}}{c}M\right)$$

$$\frac{c}{\omega R}M + \frac{V_{abs}}{c}M = D$$

$$M = \frac{D}{(\frac{c}{\omega R} + \frac{V_{abs}}{c})} = \frac{D}{(\frac{c}{\omega R} + \frac{\omega R}{c})} \cong \frac{\omega R}{c} D$$

$$\frac{M}{D} \cong \frac{\omega R}{c}$$

Doppler effect is due to the radial component of the velocity of the real/*physical* source relative to the imaginary inertial observer at the instant of light emission.

Therefore,

$$f' = f\ e^{\frac{V\cos\alpha}{c}} = e^{\frac{\omega R\cos\alpha}{c}}$$

But

$$\cos\alpha = \frac{M}{D} = \frac{\omega R}{c}$$

$$\Longrightarrow f' = f\ e^{\frac{\omega R\cos\alpha}{c}} = f\ e^{\frac{\omega R * \frac{\omega R}{c}}{c}} = f\ e^{(\frac{\omega R}{c})^2}$$

From

$$e^x = 1 + x + \frac{1}{2}x^2 + \frac{1}{6}x^3 \ + . . .$$

$$\Longrightarrow \ e^{(\frac{\omega R}{c})^2} = \ 1 \ + \ (\frac{\omega R}{c})^2 \ + \frac{1}{2}(\frac{\omega R}{c})^4 + . . .$$

$$\Longrightarrow \ e^{(\frac{\omega R}{c})^2} \cong \ 1 \ + \ (\frac{\omega R}{c})^2 \ , \qquad for \ \omega R \ll \ c$$

$$\Longrightarrow \ f' \cong \ f \ (1 \ + \ \left(\frac{\omega R}{c}\right)^2 \ )$$

$$\Longrightarrow \ \Delta f \ = \ f' - f \ \cong \ f \ \left(\frac{\omega R}{c}\right)^2$$

The real accelerating observer O and the imaginary inertial observer O' will arrive at point P simultaneously and the frequency detected by the absorber in the Mossbauer rotor experiment is equal to:

$$\Longrightarrow \ f' \cong \ f \ (1 \ + \ \left(\frac{\omega R}{c}\right)^2 \ )$$

Although the Mossbauer rotor experiment is only concerned with the Doppler frequency shift, let us determine the time of flight for the sake of completeness.

From

$$t = \frac{M}{\omega R}$$

$$t = \frac{D \ (1 \ - \ \frac{V_{abs}}{c}\frac{M}{D})}{c} = \frac{(D \ - \ \frac{V_{abs}}{c} M)}{c}$$

and

$$D = \sqrt{R^2 + M^2}$$

$$\Longrightarrow \ t = \frac{\left(D \ - \ \frac{V_{abs}}{c} M \right)}{c} = \frac{\left(\sqrt{R^2 + \ M^2} \ - \ \frac{V_{abs}}{c} M \right)}{c}$$

$$\Longrightarrow \ \frac{M}{\omega R} = \frac{\left(\sqrt{R^2 + \ M^2} \ - \ \frac{V_{abs}}{c} M \right)}{c}$$

$$\Longrightarrow M \ (\frac{c}{\omega R} + \frac{V_{abs}}{c}) = \ \left(\sqrt{R^2 + \ M^2} \right)$$

$$\Longrightarrow M^2(\frac{c}{\omega R} + \frac{V_{abs}}{c})^2 = R^2 + M^2$$

$$\Longrightarrow M^2\left(\left(\frac{c}{\omega R} + \frac{V_{abs}}{c}\right)^2 - 1\right) = R^2$$

$$\Longrightarrow M = \frac{R}{\sqrt{\left(\left(\frac{c}{\omega R} + \frac{V_{abs}}{c}\right)^2 - 1\right)}} \cong \frac{\omega R^2}{c}$$

Since, as we have already obtained,

$$\frac{M}{D} \cong \frac{\omega R}{c}$$

Therefore,

$$\frac{\frac{\omega R^2}{c}}{D} \cong \frac{\omega R}{c} \quad \Longrightarrow \quad D \cong \frac{c}{\omega R}\frac{\omega R^2}{c} = R$$

But

$$D' \cong D - \frac{V_{abs}}{c} D\cos\alpha = D - \frac{V_{abs}}{c} M = R - \frac{V_{abs}}{c}\frac{\omega R^2}{c} = R(1 - \left(\frac{\omega R}{c}\right)^2)$$

The time of flight *t* will be:

$$t = \frac{D'}{c} = \frac{R(1 - \left(\frac{\omega R}{c}\right)^2)}{c} = \frac{R}{c}(1 - \left(\frac{\omega R}{c}\right)^2)$$

This is clearly different from the classical and conventional result:

$$t = \frac{R}{c}$$

R/c is the time of flight for a stationary observer along the circular path. This means that at the time instant the observer moving along the circular path is detecting the light at point P, a stationary observer at point P is not detecting light !!! Even though the two observers are at the same point at an instant of time, one observer may be detecting light at that instant while the other observer may not be detecting light at that instant !!! This is peculiar, unconventional nature of light predicted by Apparent Source Theory, and is unlike classical waves.

Proposed Mossbauer rotor experiment

I propose that the Mossbauer rotor experiment be repeated with the axis of rotation of the Mossbauer rotor set parallel to the direction of Earth's absolute velocity, towards Leo constellation, which has been discovered in the Silvertooth and NASA CMBR measurement experiments. The experiment should be repeated for different orientations of the axis of the experimental apparatus with respect to Earth's absolute velocity vector. If no Doppler effect is detected, i.e. no change (dropping) of the number of gamma ray photons detected, with increase in RPM of the rotor, then this will disprove the transverse Doppler effect.

Apparently the last proposed experiment has already been carried out by doing the Mossbauer rotor experiment at different times of the day. No diurnal variation of the effect has been detected. According to our theory, however, absolute velocity will indirectly affect the transverse Doppler effect. However, the order of magnitude of this effect can be known, which we will not address for now.

5. Physical meaning of Apparent Source Theory

So far we have developed a model of the speed of light that successfully predicts and explains the outcome of experiments of the speed of light and absolute/ relative motion. But the physical meaning of these models has been one of the greatest challenges in the development of this theoretical framework. We have already discussed an apparent paradox associated with Apparent Source Theory (AST). In AST, we have been replacing the real source with an apparent source and then assumed Galilean space and emission theory to *consistently* explain many experiments, such as the conventional and modern Michelson-Morley experiments, the Sagnac and Michelson-Gale experiments, moving source and moving mirror experiments, the Silvertooth and the Marinov experiments, the Roland De Witte experiment, the Bryan G. Wallace experiment, Bradley stellar aberration, Doppler effect , Einstein's thought experiment: chasing a beam of light, the Ives-Stillwell experiment. No existing theory of light can consistently explain even two of these experiments: the Michelson-Morley experiment and Sagnac effect. Different theories have been proposed within a single theoretical framework: Apparent Source Theory, constant phase velocity and variable group velocity of light, Exponential Law of Doppler effect of Light, and the dependence of Doppler effect only on relative velocity and not on absolute velocity.

Despite the success of this theoretical framework, understanding the physical meanings and the relationships of the theories posed a great challenge.

The puzzles were:

1. What is the physical meaning of replacing the real source with an apparent source ?
2. How can Doppler effect be disentangled from absolute velocity? Why does Earth's absolute velocity not affect characteristic wavelengths of atoms ? Why was Ives-Stilwell experiment not

affected by Earth's absolute velocity? No such effect of Earth's absolute motion has ever been observed.

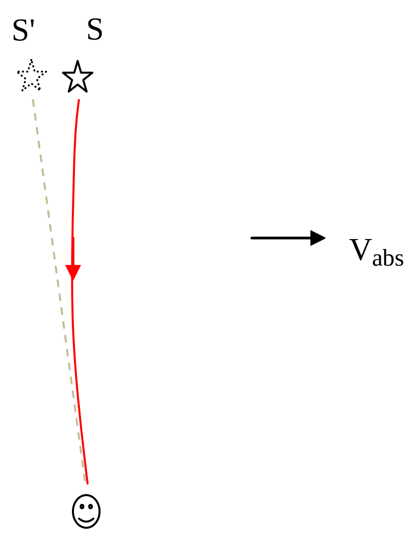
3. AST states that, for absolutely co-moving source and observer, only the path length, and not the velocity of light, changes. But we know that Silvertooth detected a change in 'wavelength'. Even if we may interpret that as an apparent change of wavelength, what does that mean?

However, we have to be cautious that we should clearly understand the physical meaning or we will be misled. We should use the physical meaning to get some intuitive understanding only and apply AST as described so far. It will be misleading to interpret the physical meaning conventionally. One example is the ' change' in wavelength detected in the Silvertooth experiment. The 'change' in wavelength is only apparent. The accurate description is that wavelength and speed of light will not be affected by absolute motion, for co-moving source and observer. Therefore, to solve problems, we just apply AST as described so far, by strictly adhering to the procedure:

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

We must understand the physical meaning of AST to help us understand the theory intuitively. For example, the experiment proposed in the next section is based on the bending of light rays, which is just a physical meaning. This intuitive understanding helps us to understand what is happening physically and hence to set up an appropriate experiment (putting a slit between source and observer).

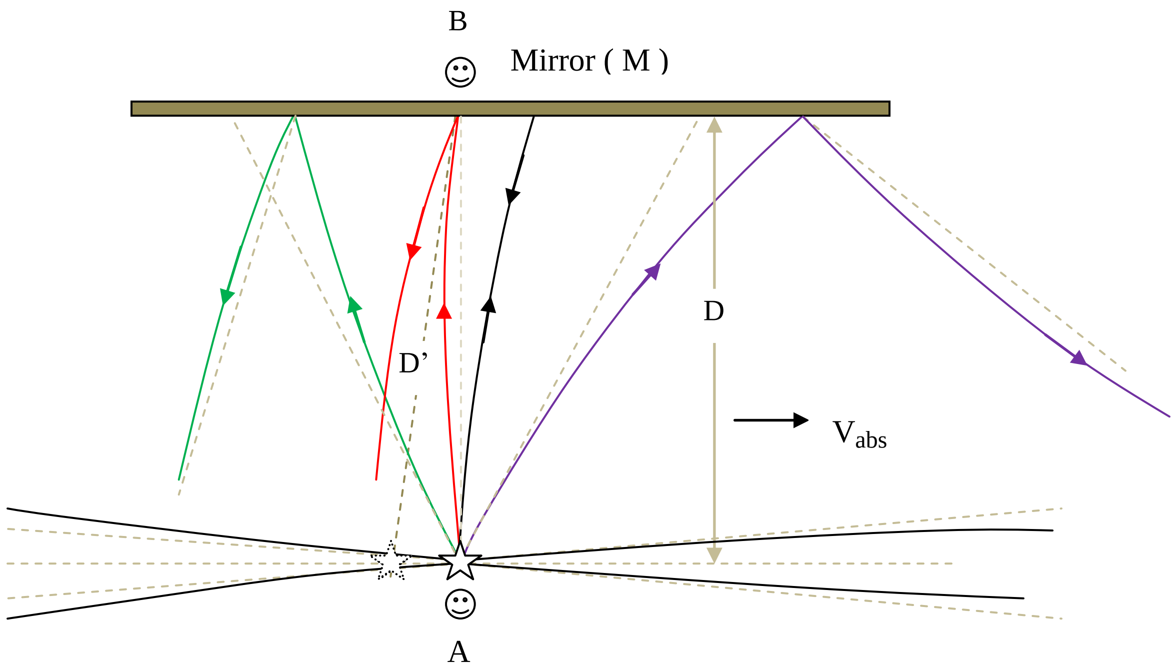
Imagine a light source and an observer absolutely co-moving, as shown below.



We see that the apparent change in position of the source is due to the curving of the light rays, as shown above.*The curve is determined by applying the Apparent Source Theory (AST) at every* *point*. Even though the source is physically, actually at position S relative to the observer, it appears to the observer that it is at position S' and this is due to the curving of the light ray which is a result of absolute velocity.

However, a crucial distinction, which I understood after years of confusion, is that the bending of light rays is only relative to an observer absolutely co-moving with the light source. For an observer that is at absolute rest, there will be no bending of light rays from a source that is in absolute motion, as already explained in the section on stellar aberration, and light behaves in the ordinary way in this case, with the center of the wave fronts remaining at the point of emission and straight light rays.

However, light still travelsin *straight line* from the *apparent source* to the observer.



The apparent contradiction described previously in the section:

' Where does a light beam start? Apparent contradiction in the new theory '

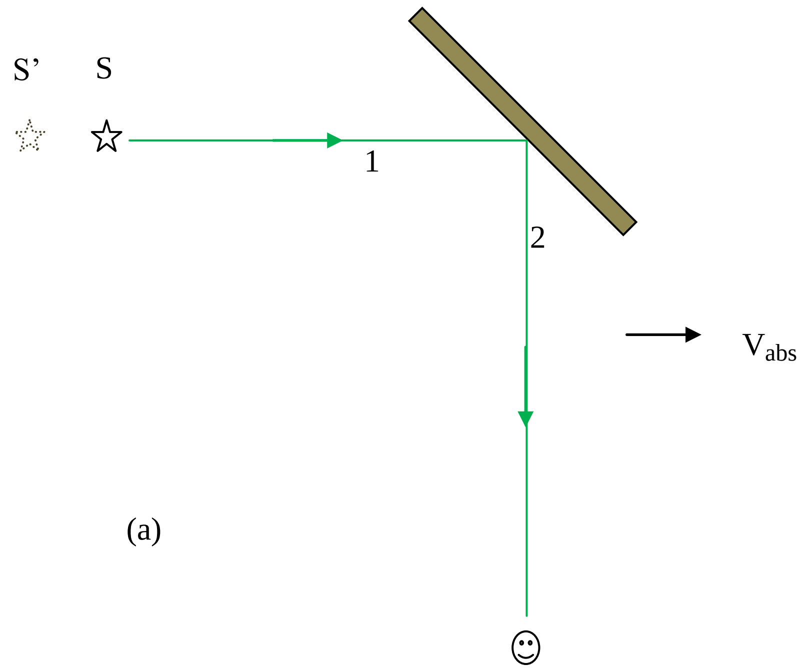
is resolved as shown in the above figure. To the observer B , the source apparently changes its position as shown and the time delay between emission and detection of light by observer B is calculated by dividing the distance between observer B and the apparent source by the speed of light, since observer B and the apparent source are co-moving and since the speed of light is equal to c relative to the apparent source : D'/c . For observer A, the apparent source position is the same as the real source position because observer A and the source are essentially at the same point in space. Once we replace the real source with an apparent source (which are the same in this case), we calculate the time delay between light emission from source and its detection by observer A by assuming emission theory or Galilean space (which means that the speed of light is constant relative to the apparent source: 2D/c .

The light rays from an absolutely moving light source will be curved as shown, for a co-moving observer. An interesting question is: how are the (curved) light rays constructed? For the incident rays, theoretically *at every point*, we apply the AST as described so far to calculate and locate the apparent source position as seen *from that point* and put a line of infinitesimal length at that point, with such a slope that it will pass through the apparent source position when projected, i.e. the infinitesimal line is part of the straight light ray coming from the apparent source. We do this to every point. Then a curved pattern of the flow of the incident light rays will emerge. For reflected rays, again *for every point*, we apply AST to calculate and locate the position of the apparent source as seen from that point. Then we easily draw the straight light ray that will come to that point from the apparent source after reflection from the mirror, with angle of incidence equal to the angle of reflection, as usual. Then we put an infinitesimal length of line at that point which is part of the straight light ray coming from the apparent source after reflection from the mirror. After doing this for every point a pattern emerges for reflected rays.

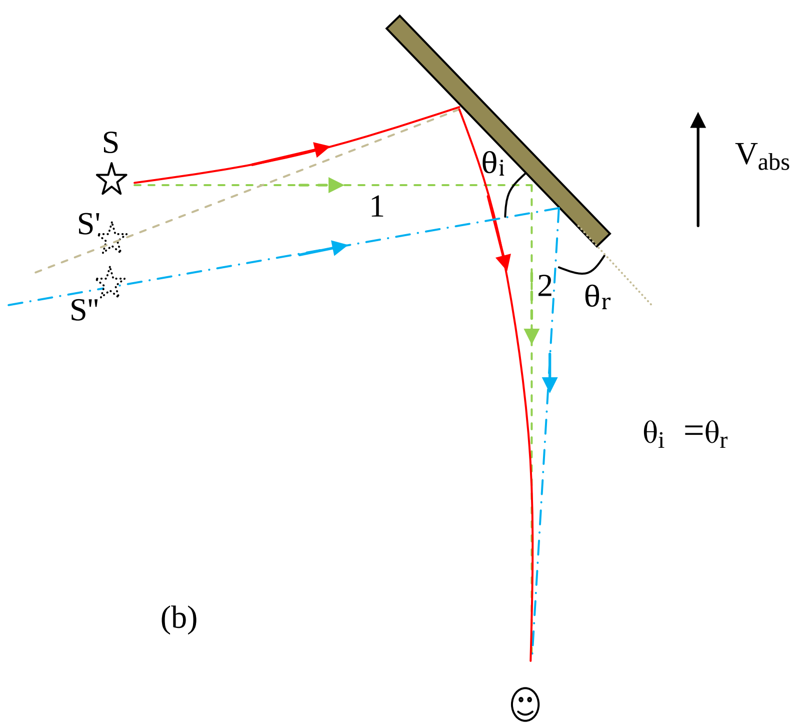
Note again that this is just to show what is happening physically so that we will have an intuitive understanding. We don't need to draw curved light rays to analyze and predict the results of experiments. Note that curving of light rays is real only for a co-moving observer and not real for an observer that is at absolute rest who sees straight light ray coming from the point where it was emitted from an absolutely moving source.

In the above discussion, it has been shown that the light rays from a light source in absolute motion will be bent in the lateral directions (i.e. in directions other than forward and backward directions). In the forward and backward directions, obviously, the light rays will not be bent, but the speed of light will be c - V and c + V *relative to the source*, respectively.

For better clarification and to make sure that there are no misunderstandings, let us consider two cases for the following system,. In the first case the system moves to the right with absolute velocity V_{abs} (a) , and with absolute velocity V_{abs} upwards in the second case (b). The question is: will there be bending of the light rays ? The mirror is inclined at 45^o .



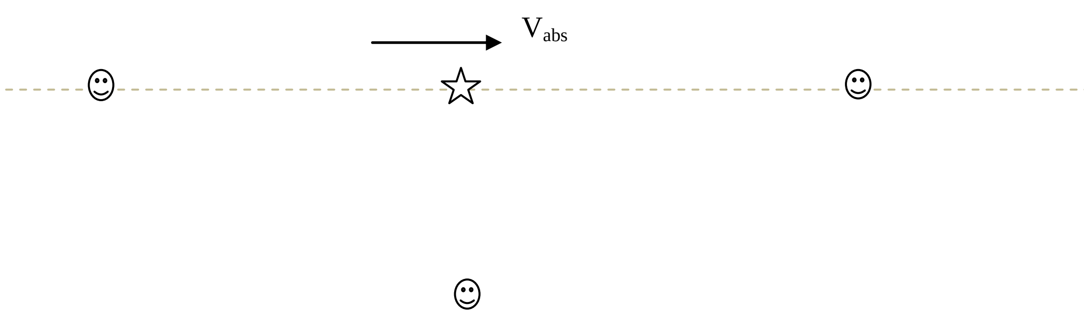
(a)



(b)

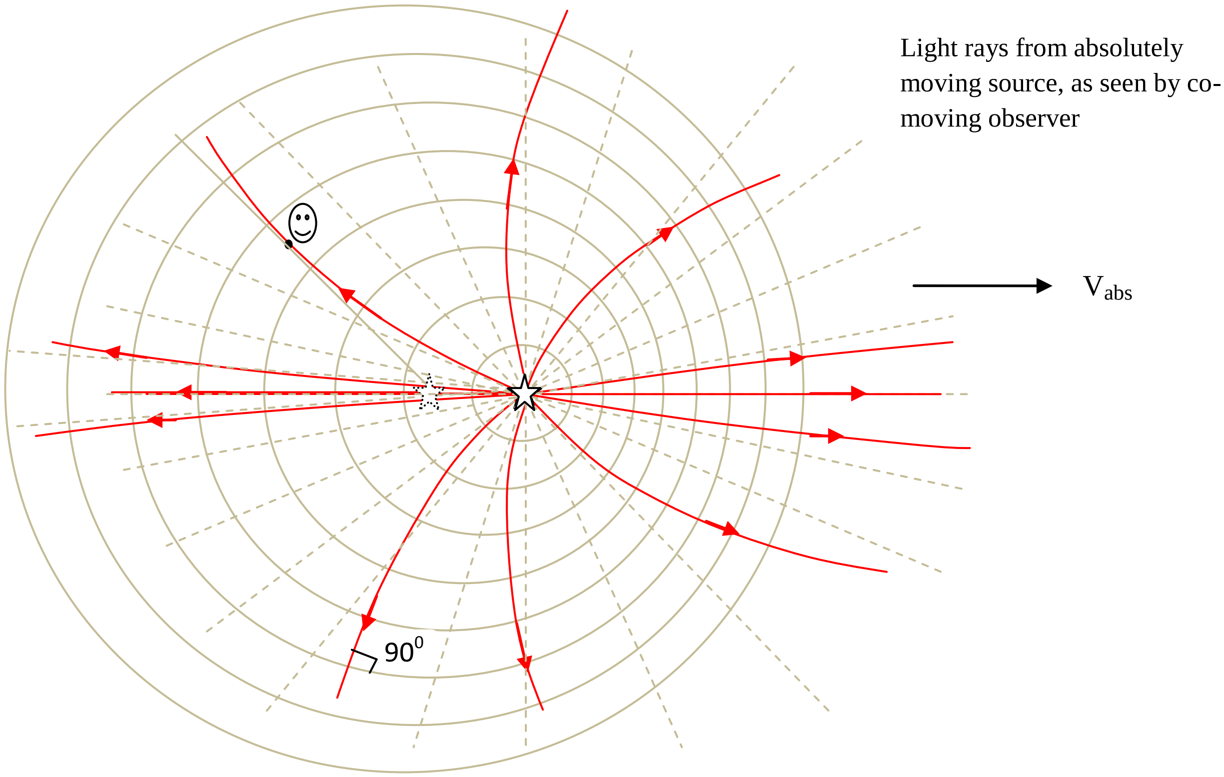
The answer is that there will not be any bending of both the incident ray 1 and the reflected ray 2 when the system is moving to the right in the first case (a) . For absolute velocity V_{abs}directed upwards (b) there will be bending of both rays, 1 and 2, as shown by the bent light rays in red. S' is the apparent source as seen from a point where the incident curved ray is reflecting from the mirror. S" is the apparent source as seen from the location of the observer. Note that theoretically the apparent source position has to be determined for every point in which case there will be infinite apparent sources. We have considered just two apparent sources. The drawing is not meant to be accurate but only for a qualitative explanation. Not that the reflected curved ray in (b) (blue) is tangent with the broken line at the observer, as shown in the diagram. The green broken rays 1 and 2 of the first case are shown just for comparison.

For an absolutely moving source, the group velocity of light is *constant* relative to the *apparent* source, not relative to the real source. The group velocity of light *varies* in magnitude and direction relative to the *real* source. Phase velocity is always constant, independent of any source or observer absolute or relative velocity.



Consider absolutely co-moving source and observers (see above figure).
The phase velocity is always constant c for all three observers, irrespective of the magnitude of absolute velocity. The phases will always move at c past the observers. For the front observer, the group velocity is $c - V_{abs}$. For the rear observer, the group velocity is $c + V_{abs}$. For the side observer, the group velocity is $(c^2 - V_{ab}^2)^{1/2}$. For the side observer, the light ray arrives from the direction of apparent source and not from the direction of the real source. Note that these velocities are obtained by dividing the source observer physical distance by the time delay between emission and detection of light. For the front and rear observers it can be shown that the group velocity of light determined in this way is also the local group velocity, i.e. small local distance near the observer divided by the time elapsed for light to travel that distance. For the side observer, the local group velocity is yet to be computed to check if it is the same as the average group velocity $(c^2 - V_{ab}^2)^{1/2}$ determined by dividing the source observer distance by the time elapsed between emission and detection.

The next diagram shows what happens physically to the light rays from a source that is in absolute motion. Note again the distinction that the bending of the light rays is observed by the observer who is absolutely co-moving with the light source. For an observer who is at absolute rest, there will be no bending of light rays emitted by an absolutely moving source. For the observer at absolute rest, light rays come in straight line from the point where it was emitted.



* note that the above diagram is not drawn accurately. The light rays should always make 90^0 with the wave fronts. The bending light rays are only for a co-moving observer. For an observer at rest, light rays come as usual in straight lines from the point where they were emitted.

In lateral directions the bending of light rays is large. As we approach the forward and backward directions, the bending of the light rays becomes less and less. In the forward and backward directions (with respect of direction of absolute velocity), the light rays are straight and there is no bending. Note that the drawing is not meant to be accurate, but only to serve as a qualitative illustration.

The group velocity of light is constant relative to the apparent source. Physically, this means that the effect of absolute motion of a light source is to create a change in the (group) velocity (magnitude and direction) of light <u>relative to the real source</u>.

Let us consider only the forward and backward light rays from a source in absolute motion, for simplicity.

Relative to the (real) sourcemoving with absolute velocity V_{abs}, the group velocity oflightis $c - V_{abs}$and$c + V_{abs}$, for the forward light beam and for the backward light beam, respectively.

This is just a modified emission theory because, for a given absolute velocity, the speed of light in a given direction is 'constant' ($c \pm V_{abs}$) *relative to the source*. The effect of absolute motion of the source is just to create a change in the group velocity (*magnitude and direction*) of light ***relative to the source***. In the forward and backward directions, only the magnitude of the light speed vary and the direction of the light rays are radial. In all other directions, both the magnitude and direction of the group velocity of light vary with absolute velocity of the source. The direction of the light rays are not purely radial and will have transverse components in the lateral directions because the light rays are curved.

According to conventional emission theory, the speed of light is the same *c*relative to the source and directed radially in every direction relative to the source. In Apparent Source Theory (AST) the group velocity of light from a source that is in absolute motion is not the same in every direction*relative to the source* and the light rays are curved in the lateral directions (in directions different from the forward and backward directions), for a co-moving observer. Just as conventional emission theory predicts a null fringe shift for the Michelson Morley experiment, so does AST because, for a given absolute velocity, and in a given direction relative to the source, the velocity of light is 'constant' *relativeto the source*. Note that by 'constant' we mean, for example, $c + V_{abs}$.

We can easily explain the circular Sagnac effect by the physical meaning of AST. Since the source has absolute velocity($V_{abs} = \omega R$) , the speed of the forward beam is $c - V_{abs}$ RELATIVE TO THE SOURCE and the speed of the backward beam is $c + V_{abs}$ RELATIVE TO THE SOURCE , hence a fringe shift. This is true for the hypothetical Sagnac interferometer discussed earlier.

The Michelson Morley experiment also can easily be explained by this intuitive, physical meaning of AST. A change of the speed of light *relative to the source*(due to source absolute velocity) will not cause any fringe shift because both the longitudinal and transverse light beams will be affected equally.

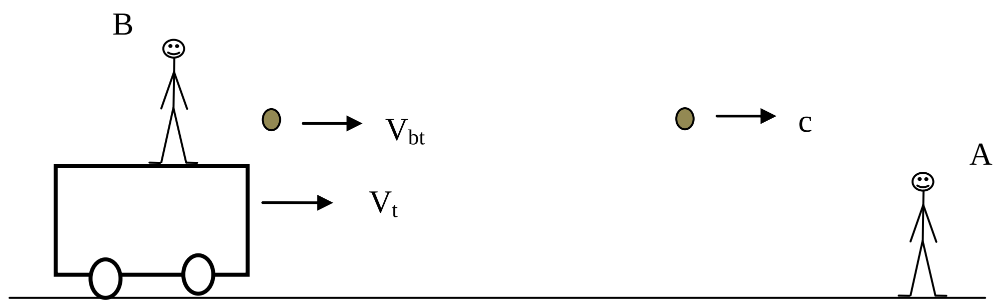
The explanation of moving source experiments is also straightforward. Consider a light source and an observer both at absolute rest. In this case the speed of light relative to the source will be isotropic, i.e. equal to *c* in all directions relative to the source. The observer will also measure the speed of light to be *c*. Now suppose that the source starts moving towards the observer with absolute velocity V_{abs}.*The effect of absolute motion of the source is to create a change in the speed of light relative to the source*. Therefore, the speed of light will be equal to $c - V_{abs}$ *relative to the source* in the forward direction and $c + V_{abs}$ *relative to the source* in the backward direction. The velocity of light relative to the observer in this case is the sum of the velocity of light relative to the source in the forward direction ($c - V_{abs}$) and the velocity of the source (V_{abs}).

velocity of light relative to the observer = $(c - V_{abs}) + V_{abs} = c$

If the source is moving away from the observer, the velocity of light relative to the observer is the difference between the velocity of light relative to the source in the backward direction ($c + V_{abs}$) and the velocity of the source (V_{abs}).

velocity of light relative to the observer = $(c + V_{abs}) - V_{abs} = c$
Therefore, we have shown that the velocity of light is independent of the velocity of the source.

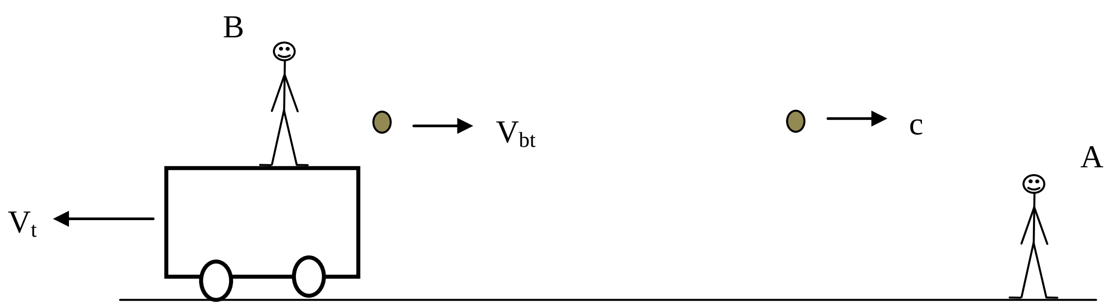
As an analogy consider a stationary observer A and a truck moving relative to A. Another observer B is on the truck, throwing balls in the forward or backward direction while the truck is moving. Suppose the truck (and observer B) moves towards observer A with velocity V_t . The requirement is that observer B adjusts the velocity of the balls *relative to the truck* (V_{bt}) so that the velocity of the ball relative to the stationary observer will always be constant *c* irrespective of the velocity of the truck.



$$V_t + V_{bt} = \text{constant} = c$$

If observer B throws balls towards observer A while the truck is moving away from observer A , as shown below, the velocity of the balls relative to A will be the difference between V_t and V_{bt}, which is constant as above.

$$V_t - V_{bt} = \text{constant} = c$$

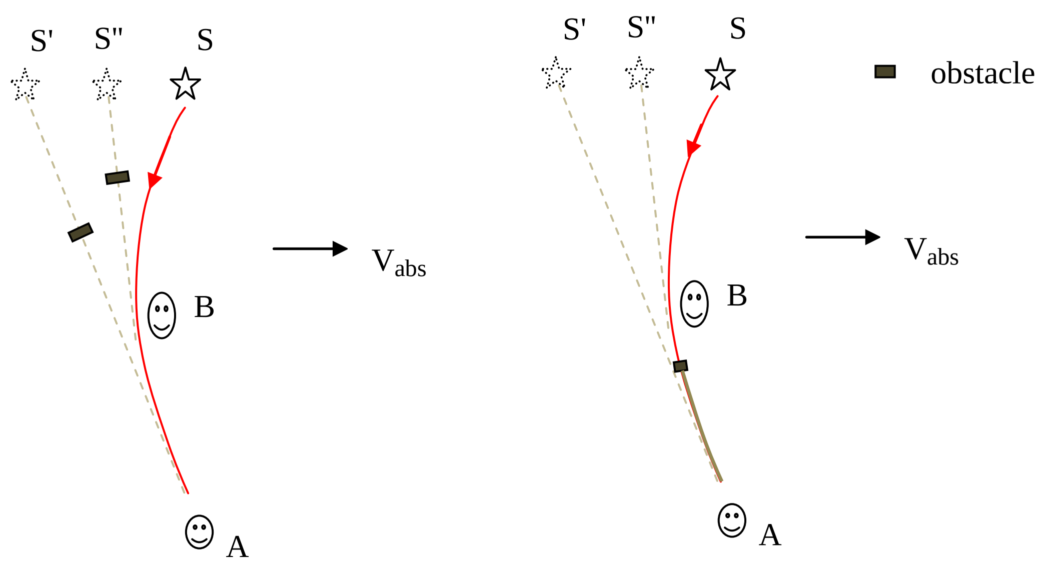


Therefore, the velocity of the balls relative to observer A is constant *c* independent of the velocity of the truck, analogous to the speed of light being constant *c* relative to an observer at absolute rest, independent of source velocity.

It is now easy to see the null result of the Michelson-Morley experiment (MMX) by the modified emission theory above. Modified emission theory is just conventional emission theory in which the velocity of light *relative to the source* depends on the absolute velocity of the source.

Apparent paradox

Let us see a strange phenomenon of light predicted by AST(according to the interpretation in my previous papers). Consider a light source and an observer co-moving with absolute velocity V_{abs} . The light rays from this source will be curved lines. The observer has to point his telescope towards the apparent source to see the light.



The puzzle is as follows. In the case of co-moving source and observer at absolute rest, placing an obstacle on the source -observer line will block the light going to the observer. What about the case of co-moving source and observer moving with some absolute velocity ? Will placing an obstacle along the (straight) line connecting the apparent source and the observer block the light going to the observer? What about placing an obstacle along the curved light rays ? What about placing an obstacle along the straight line directly connecting the observer and the real source ?

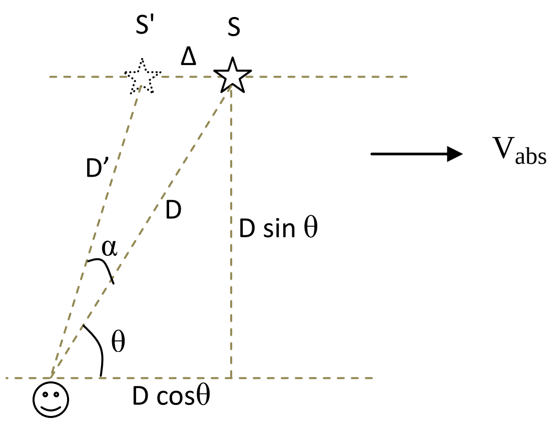
After much puzzlement over this and other paradoxes, the following solution was discovered. This paradox arose because I was reluctant to accept that the bending of light for absolutely co-moving source and observer is physical.

For absolutely co-moving source and observer, placing an obstacle on the straight line connecting the observer and the apparent source will not block light. And placing an obstacle on the straight line connecting the real source and the observer will also not block the light. Placing an obstacle along the curved light ray will block the light going to the observer.
The apparent source, as its name implies, is only apparent. The apparent source relative to an observer at a given point is only used to calculate the time delay of light and the direction of arrival of light relative to that observer. Light originates from its physical source and not from the apparent source. But light emitted from the physical source behaves as if it started from the apparent source. Therefore, although the observer has to look in the direction of the apparent source to see light, putting an obstacle between the line connecting the observer and the apparent source will not block light coming to the observer.

Proposed experiment to detect absolute motion and to test Apparent Source Theory

According to Apparent Source Theory (AST), the light rays from an absolutely moving source will be bent in the lateral directions, for a co-moving observer. Therefore, detection of bending light rays means detection of absolute motion and also confirmation of AST.

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



We want to get the relationship between θ and Δ .

$$\Delta = D cos\theta - \sqrt{D'^2 - D^2 sin^2\theta} \quad \ldots\ldots\ldots\ldots..(1)$$

$$\frac{D'}{c} = \frac{\Delta}{V_{abs}} \quad \ldots\ldots\ldots\ldots\ldots\ldots.(2)$$

From (1) and (2)

$$D'^2\left(1-\frac{V_{abs}{}^2}{c^2}\right)+\frac{2DV_{abs}}{c}\,cos\theta\;\;D'\;-\;D^2=0$$

which is a quadratic equation of D' .

$$\Rightarrow\;\; D'\approx D-\frac{DV_{abs}}{c}cos\theta\quad,\;\;\text{for}\,\frac{V_{abs}{}^2}{c^2}\approx 0$$

From (2) ,

$$\Delta=\frac{V_{abs}}{c}D'\quad\Longrightarrow\qquad \Delta=\frac{V_{abs}}{c}\left(\,D-\frac{DV_{abs}}{c}cos\theta\;\right)\ldots\ldots\ldots\ldots.(3)$$

But

$$\frac{sin\alpha}{\Delta}=\frac{sin\theta}{D'}\quad\ldots\ldots\ldots\ldots\ldots\ldots(4)$$

$$\Longrightarrow sin\alpha=\frac{V_{abs}}{c}sin\theta$$

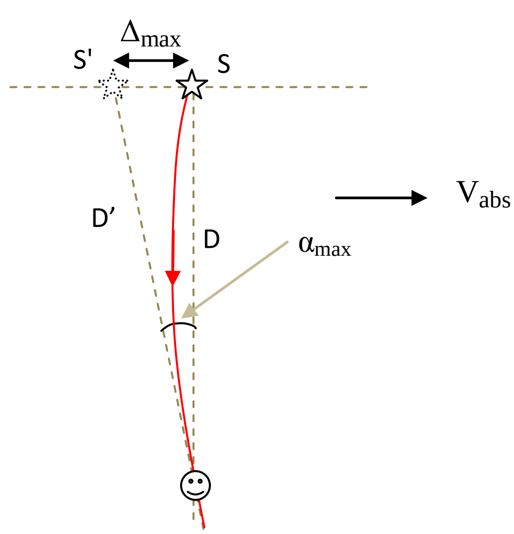
α will be maximum when $\theta = 90^0$

$$sin\;\alpha_{max}=\frac{V_{abs}}{c}\quad\Longrightarrow\qquad \alpha_{max}=sin^{-1}\frac{V_{abs}}{c}$$

From (3)

$$\Delta_{max}=\frac{V_{abs}}{c}D\qquad(\,\text{for}\;\theta=90^o)$$

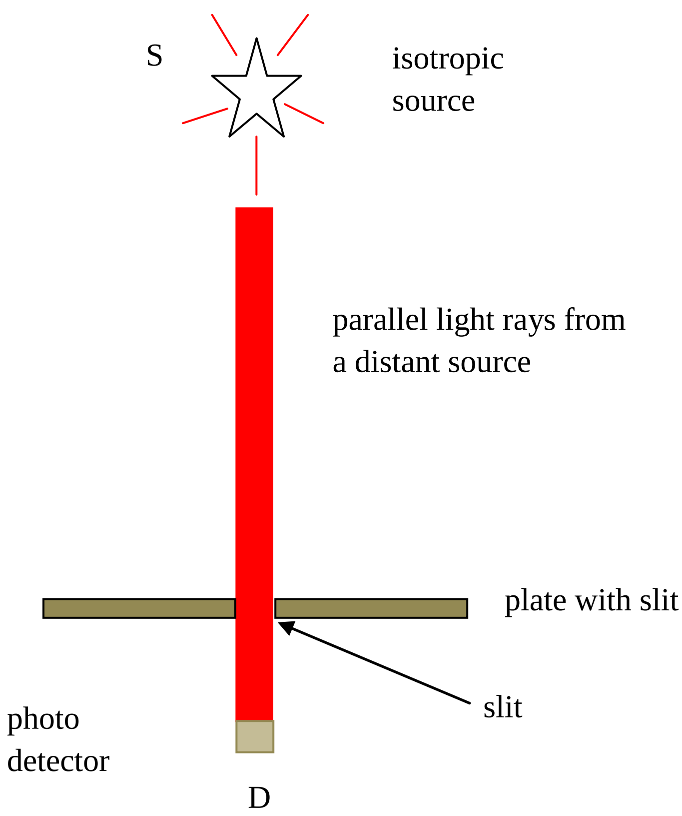
We have shown that the maximum apparent change in the position of the light source (Δ_{max} and α_{max}) , hence the maximum bending of the light rays, occurs when the absolute velocity of the co-moving source and observer is orthogonal to the line connecting the source and observer. Hence there will be maximum sensitivity with this orientation, as shown below.



Now that we have determined the orientation of the source and observer relative to the absolute velocity vector for maximum apparent change of position of the light source, and this can be used for maximum sensitivity to detect absolute velocity of the light source.

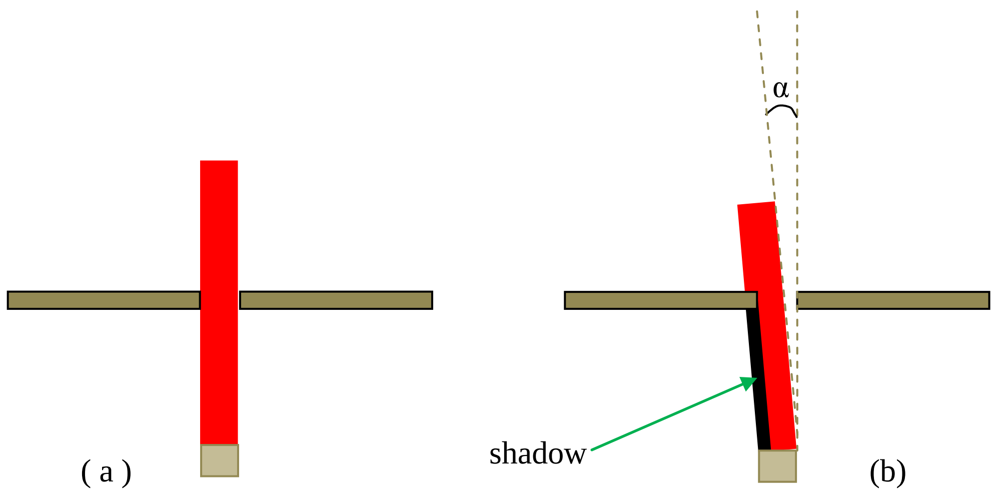
Assume that the source S is isotropic, i.e. it radiates equally in all directions. In this case, the intensity of light at the observer will not be affected significantly by absolute velocity, the only effect being light rays coming at an angle, which is very small for $V_{abs} << c$, and this will not practically affect the light intensity as compared to when absolute velocity is zero with straight light rays coming from the source. The effect of absolute velocity is to cause a change direction from which light arrives at the observer.

Let us see the experimental setup to detect absolute velocity with an isotropic light source.



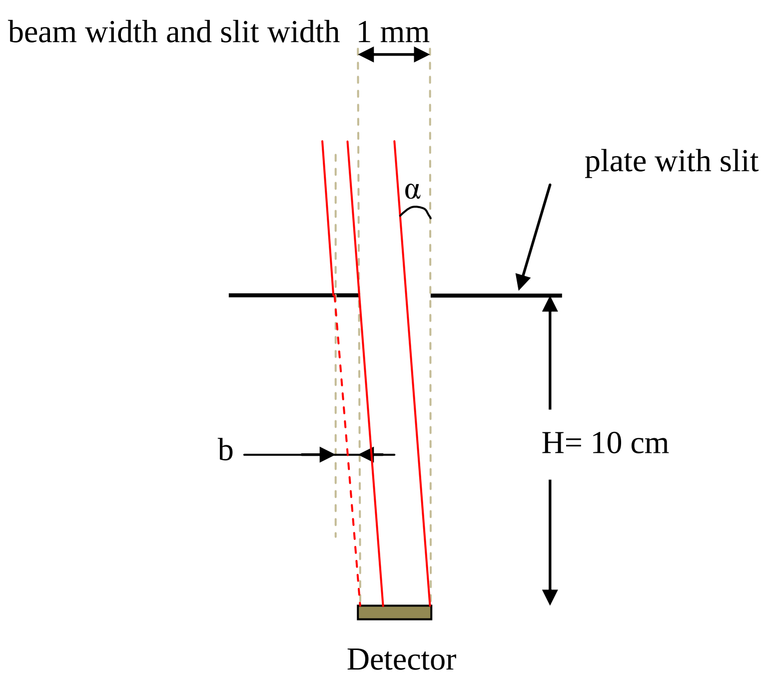
If the whole apparatus is at absolute rest, or if the line connecting the source and the photo detector (line SD) is oriented parallel to the absolute velocity vector, there will be no bending of the light ray.

But when the line SD is orthogonal to the absolute velocity vector, the light ray will be bent and the angle of arrival α of the light ray will be different from zero as shown in the next diagram.

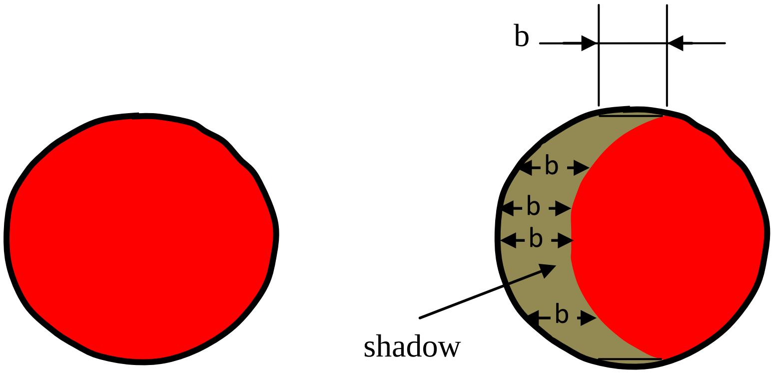


We can see that when the light is bent due to absolute motion, part of the light rays is blocked by the plate, creating a shadow and hence a decrease in intensity (quantity of light per unit area) of light falling on the photo detector. By measuring the voltage output of the photo detector, it is possible to observe variation of light intensity with variation in absolute velocity and with variation in orientation of line SD relative to the absolute velocity.

An approximate analysis is as follows.



Suppose that the slit is circular.



The left diagram shows a bright circular spot on the photo detector which will occur when there is no bending of the light ray. The right diagram shows what the spot of the light ray on the photo detector looks like, with a shadow due to bending of the light ray. Note that the size of the shadow has been exaggerated, which is actually only about 16.56% of the total area of the circle for an absolute velocity of 390 Km/s of the Earth.

$$\frac{b}{H} = sin\alpha = \frac{V_{abs}}{c}$$

$$\Rightarrow \quad b = H\,\frac{V_{abs}}{c}$$

If we take Earth's absolute velocity, V_{abs} = 390 Km/s , c = 300,000 Km/s

b = 100* 390/300,000 mm = 0.13 mm

Area of the shaded (shadowed) area is:

$$dA_{sh} = b\ dh \quad \Longrightarrow \quad A_{sh} \approx 2\int_0^r b\ dh = 2br$$

where r is the radius of the slit.

$$A_{sh} = 2 * 0.13 * 0.5 = 0.13\ mm^2$$

This is the area of the shadowed part.

The total area A of the circle is :

$$A = \frac{\pi D^2}{4} = \frac{\pi (1)^2}{4} = 0.785\ mm^2$$

Since we assumed an isotropic source, the intensity of the light falling is uniform, then we can calculate the percentage of change in intensity due to bending of the laser beam.

$$\frac{A_{sh}}{A} * \ 100\% \ = \frac{0.13}{0.785} * 100\ \% \ = 16.56\%$$

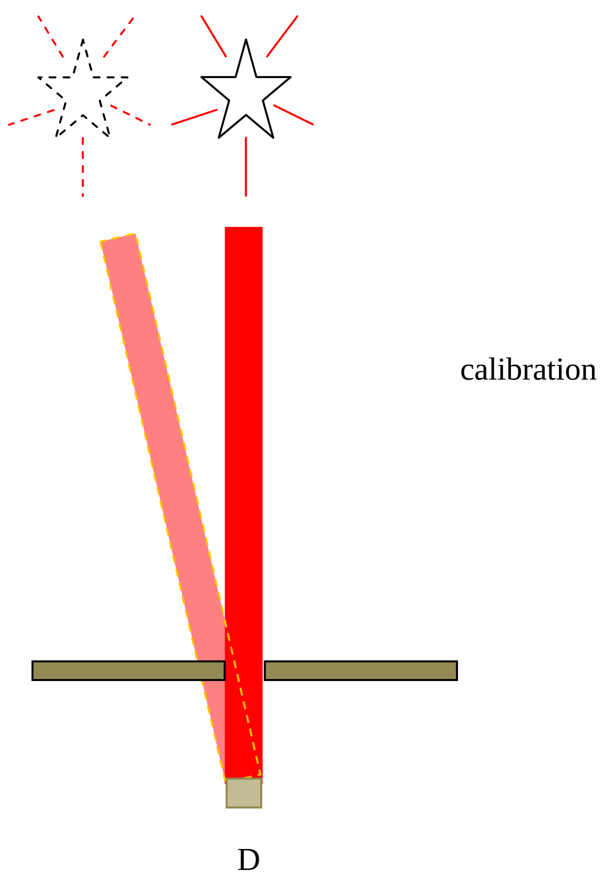
This is a big change !

To measure absolute velocities, the instrument has to be calibrated first. It would be easier and more accurate to use this method than to try to determine analytically the change in intensity for a given absolute velocity and for a given orientation of line SD relative to the absolute velocity.

The calibration is done by recording the voltage output of the photo detector for different angles of the arriving light ray, by changing the position of the source physically relative to the slit and the photo detector, as shown in the next diagram. Then, when measuring absolute velocity, the angle α of the light ray corresponding to the voltage output of the photo detector is read from the calibration table. Once the angle α is obtained, the absolute velocity is determined from the formula:

$$sin\alpha = \frac{V_{abs}}{c}$$

Remember that this formula applies for line SD orthogonal with the absolute velocity vector.



But there is problem with this method of calibration. For calibration, the apparatus needs to be at absolute rest so that the light rays from the source are radial and straight. Since the Earth is in absolute motion (390 Km/s), this method (calibration) is not practical.

There is another feasible method. The line SD (source-observer line) is oriented to be parallel (or anti parallel) with the Earth's absolute velocity. The assembly consisting the plate and the light detector is then rotated to different angles, with a resolution of a few arc seconds. At each angular position, the intensity of light detected by the detector is recorded in a calibration table, corresponding to each angular position. During calibration, the line SD is always parallel with Earth's absolute velocity. Once the calibration is completed, the plate and detector assembly is returned to its initial angular position and fixed in that position. The line SD is then oriented to be in the plane orthogonal to Earth's absolute velocity. The light intensity measured by the light sensor (detector D) is then noted and the corresponding angle α read from the calibration table, from which Earth's absolute velocity can be determined. The calibration method requires a rotation stage with resolution of about 2 arc seconds.

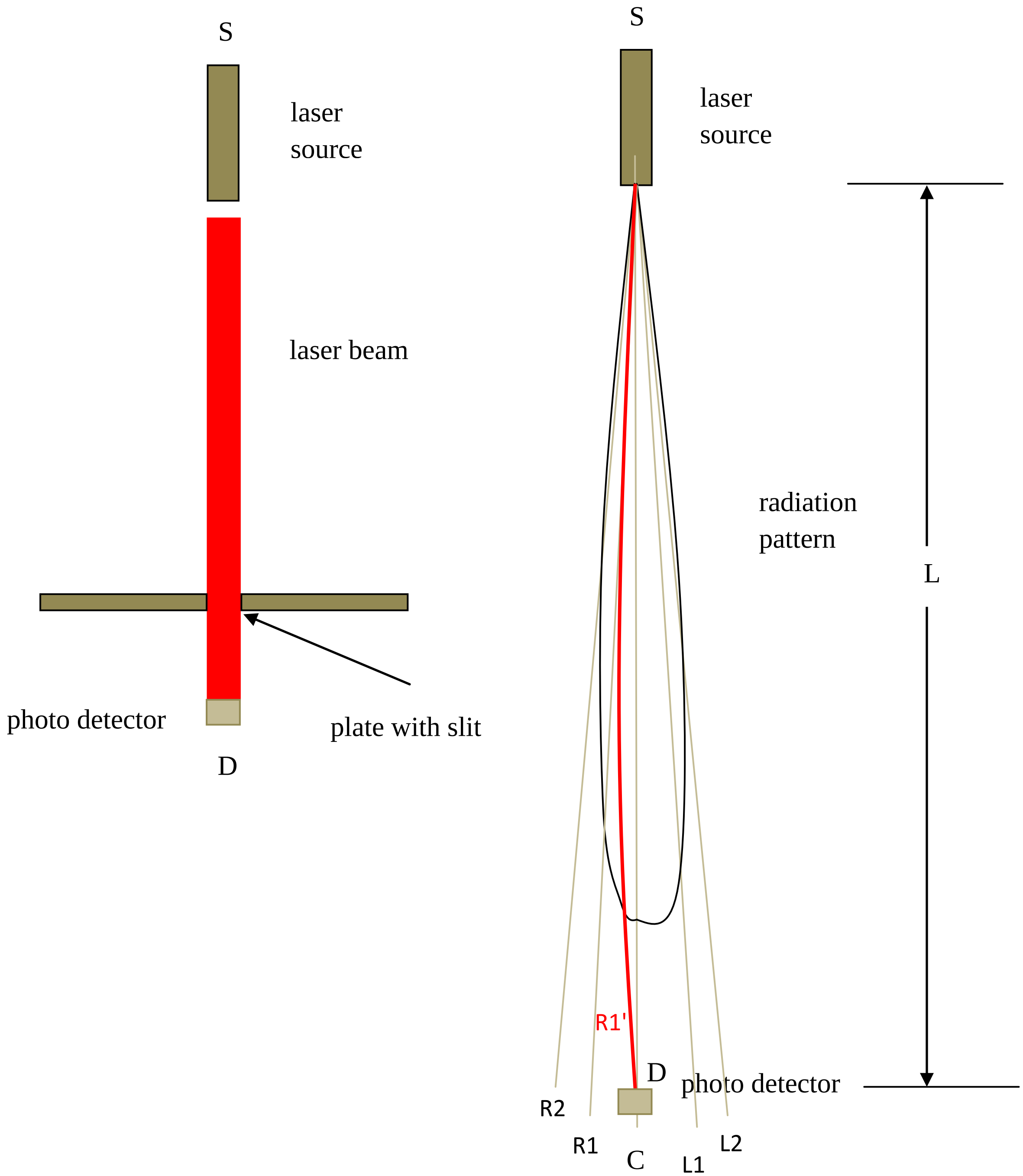
The other method is analytical method. This has practical limitations.

The procedure of measuring absolute velocity is as follows:

1. First align the source detector line (SD) to be orthogonal to the absolute velocity vector. This means that the line SD should be on a plane orthogonal to the absolute velocity vector.
How can we find this plane ? We use trial and error method. Rotation of the line SD in this plane will result in constant voltage output of the photo detector because the angle α will be constant in this plane; the bending of the light ray is constant. Rotation of the line SD in all other planes will result in variation of angle α , which will result in variation/ fluctuation of voltage of the photo sensor, as line SD is rotated in that plane. Another method is as follows. First the laser and the photo detector are nominally aligned for optimum light intensity falling on the photo detector. Then the orientation of the rod (line SD) in space is varied. As the orientation of the rod is changed in space, the amount of light falling on the photo detector varies, due to bending of the light rays by different extents depending on the orientation of the rod relative to the direction of the absolute velocity. The reading of the photo detector is recorded for all directions (orientations). The direction in which the photo detector detects maximum amount of light is parallel or anti-parallel to Earth’s absolute velocity vector.
2. Once the line SD is orthogonal to the absolute velocity vector, read the voltage output of the photo detector and try to determine the angle α analytically, from which absolute velocity is determined.

With this experiment, it is possible to determine the direction and magnitude of Earth's absolute velocity, hence confirm the validity of absolute motion.

In the experimental set up explained above, we assumed an isotropic source. Next we consider a practical case of non-isotropic source. By using a highly directional light beam, a laser beam, with the experimental set up described above, the sensitivity of the apparatus to absolute velocity can be significantly increased.



At first assume that there is no plate between the laser source and the photo detector. If the apparatus is at absolute rest and if the laser beam is aligned to the photo detector for maximum light intensity falling on the photo detector, the light ray going to the photo detector in this case will be ray C. Next assume that the apparatus is moving with absolute velocity to the right, without changing the alignment of the laser beam. In this case it will be light ray R1 that will go to the detector and not light ray C, even if we didn't change the alignment of the laser. The curved light ray (red curved line) is designated as R1' . R1 is tangent to R1' at the source.

In this case, since the intensity of ray R1 (R1') is less than intensity of ray C, then we detect a change in intensity at the detector due to absolute velocity.If we place a plate with slit between the laser source and the detector, as before, the sensitivity of the device will increase further.

Unlike the previous case of an isotropic source, the calibration in this case is feasible. To do the calibration, we first align the source detector line SD with the absolute velocity of the Earth, since we want to measure the Earth's absolute velocity. We do this because, if the line SD is aligned to be parallel with the Earth's absolute velocity, light ray from the source to the detector will not be bent and will always be straight. We have already explained how to find the direction of Earth's absolute velocity. The direction of Earth's absolute velocity is easily found by rotating the line SD (the apparatus) in different planes until we get a steady voltage at the output of the photo detector. The photo detector output voltage will be constant only when the device is rotated in a plane perpendicular to Earth's absolute velocity. Once we have found the direction of Earth's absolute velocity, we align the apparatus (line SD) to be parallel with the Earth's absolute velocity. We start by aligning ray C, which has maximum intensity, with the slit and the photo detector and record the voltage of the photo detector. Then we rotate the laser source to different degrees, with the line SD always parallel to Earth's absolute velocity, and record the voltage of the photo detector for each angle. For a resolution of 3 Km / s , we need an angular resolution of 2 arc seconds in rotating the laser source. Once we have completed the calibration table, we are ready to measure the Earth's absolute velocity. For this, we align the source detector line SD to be orthogonal to the absolute velocity. We then measure the voltage of the photo detector. From the calibration table, we read the angle α corresponding to that voltage and determine Earth's absolute velocity from:

$$sin\alpha = \frac{V_{abs}}{c}$$

Practically, however, we are interested in Earth’s absolute velocity, which is much less than the speed of light, and the required directionality of the laser beam is too high to be practical. Even a beam width of one degree will require very large distance L between source and detector. The use of the slit is therefore necessary.

A more feasible calibration method is to rotate the plate and photo detector assembly, as explained already.

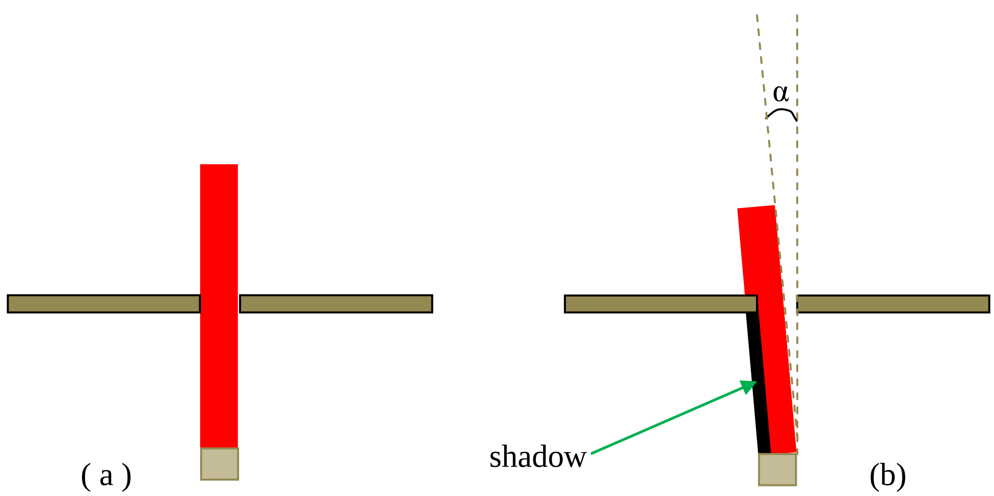
I conceived this experiment several months ago after I fully understood the physical meaning of Apparent Source Theory (AST), which is bending of light rays and variable velocity of light relative to the source. It took me quite a long time to figure out the physical meaning of AST. I long thought about the possibility of bending of light rays as a physical meaning to the theory but was unable to understand it clearly and completely, so I was in doubt about its reality (bending of light rays). I had a hard time to figure it out clearly because the physical meaning of AST is quite hard to understand. On top of that, bending of light rays seemed to be an extraordinary claim. Even with such a vague understanding, I decided to do the above experiment. However, I was unable to acquire the components needed for the experiment in time and just continued to develop the theory.

In the meantime, I came across a paper [17] on the internet in which the author claimed to have observed bending of a laser beam due to Earth's absolute motion. This created a big motivation for me because I was then sure that bending of light rays is real. The very fact that bending of light rays is proved to be real enabled me to think more clearly to advance the theory and its physical meaning. Before long, I was able to fully understand the physical meaning.
Once I understood the physical meaning, I decided to do the experiment. This is a very easy, cheap yet vital experiment. However, unfortunately, again I had difficulty to the components needed to do this experiment. It is not easy to make foreign purchases from my area. At last I decided just to publish the experiment as a proposal. At the same time I am trying to get the components and will hopefully do this experiment in the near future, with an accuracy just enough to confirm the Apparent Source Theory. A laser pointer and a photo detector would suffice.

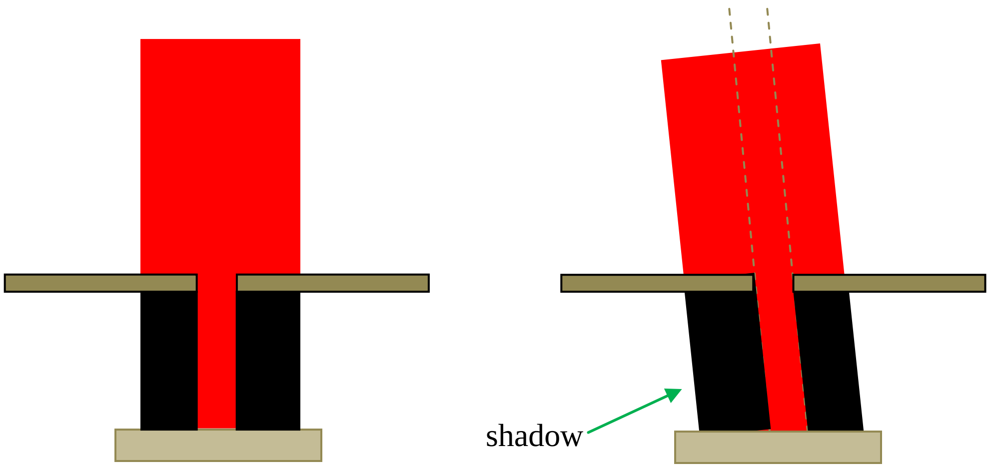
Actual experiment

I carried out a crude experiment, but could not detect the effect predicted. As I looked closely at the theory of the experiment described above, I found that the assumptions were not real.

We have assumed ideal conditions which are not real: the cross section of the light beam, the area of the slit and the area of the detector are equal.

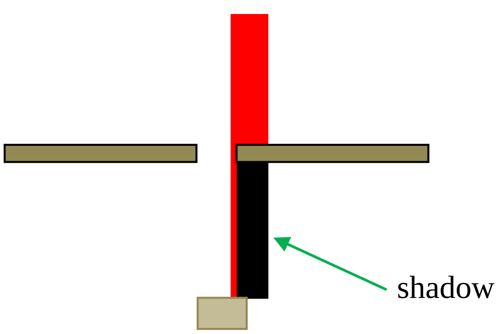


In reality, however, the area of the slit and the area of the sensor may not be equal. In fact, I used a slit width (area) very small compared to the area of the sensor. Moreover, the cross section area of the beam can be greater than the area of the slit.



From the above diagram, we can see that there will be no significant change in sensor output due to change in absolute velocity because, just as part of the sensor area comes under shadow caused by absolute motion, other part of the sensor which had been under shadow will be exposed to light due to absolute motion. Therefore, the decrease in sensor output due to part of the sensor that has been shadowed will be compensated for by increase in sensor output due to part of the sensor that will be exposed to light due to absolute motion. However, although the area of the sensor that is exposed to light will remain constant, the cross section of light falling on the sensor will decrease and this will create change in output of the sensor. However, this is an effect much smaller than we predicted in our previous analysis (16.56%), and may be orders of magnitude smaller, especially if the thickness of the slit is small enough. This is an effect that arises because real light sources are not point sources, but distributed sources.

A more practical experiment is proposed as follows.



With zero absolute velocity, that the light source should be shifted off the axis of the slit so that it is not completely visible to the sensor. With increase of absolute velocity to the right, more and more light emitting atoms will come into view of the sensor and this may be detected as change in sensor output.

Another improvement is to use much larger distance between the slit and the source, for example 100m. With a light source placed at a distance of 100m from the slit, the apparent change in position is about:

$$\Delta = \frac{V_{abs}}{c} D = \frac{390}{300000} * 100m = 0.13m = 13\ cm$$

For example, if a laser pointer is used, its apparent change in position when viewed from a distance of 100m is about 13cm, which is much larger than the diameter of the laser pointer and will act more like a point source.

However, with such large distance (100m) between the slit and the source, it is not practical to use active rotation of the apparatus to detect absolute motion. Only the diurnal rotation of the Earth can be used.

6. What is absolute velocity relative to ?

Absolute velocity as mass weighed resultant velocity of an object relative to all massive objects in the universe.

The problem of uniformly moving charges; the Trouton-Noble paradox

Now we consider the long standing problem of moving charges. We consider this problem at this point of this paper because of its profound implications to the understanding of absolute motion. In the discussions so far, we applied the new model or interpretation of absolute motion and the speed of light (AST), without being concerned by what absolute motion fundamentally is, i.e. the 'relative to what' problem.

One of the experiments being cited as evidence of Special Relativity is the Trouton-Noble experiment.

However, a little thought reveals that the theory of relativity faces an insurmountable problem to explain the Trouton-Noble experiment, whether torque (rotation) is observed or not. This is a well-known paradox : the Trouton-Noble paradox.

Contrary to the Trouton-Noble experiment, there is another experiment [11] in which the authors claimed to have detected a torque. Even in the Trouton-Noble experiment, the result was not null but much less than the expected amount. This is similar to the Michelson-Morley result that was interpreted as null when actually a small fringe was detected.

Assume that the Trouton-Noble experiment is sensitive enough to detect any possible absolute velocity. If no torque develops on the charge system, as apparently observed in the original experiment, then this is a real problem for relativity, not a supporting evidence. The problem is that, how can an observer moving relative to the Earth predict or explain a zero torque? This is a problem because, a torque should develop in a reference frame moving relative to the Earth, according to the classical laws of magnetism, because the charges are moving in that reference frame. Will there be torque (rotation) or not ? ! Since rotation is a phenomena on which all observers agree, there is no chance at all for the proponents of relativity in this case. I think this paradox is even harder than the Twin Paradox of Special Relativity.

It is strange how the mainstream scientific community has tolerated this paradox.

The consideration of the problem of moving charges led me to a deeper investigation of the meaning of absolute motion.

The solution to this century old problem may be related to quantum mechanics: *the observer effect*. Imagine a charge moving with a velocity V relative to an observer. From classical physics, the observer will experience the magnetic field of the moving charge. If the charge is moving relative to another observer with a different velocity U, then that observer also will measure a different magnitude of magnetic field. An observer in the reference frame of the moving charge will not detect any magnetic field. So far there seems to be no problem .

A problem stands out when we consider the Trouton- Noble (T-N) experiment. Consider the

Trouton-Noble experimental apparatus in different reference frames. In the reference frame in which the charges (the capacitor) is at rest, zero torque is predicted. The torque predicted is different for all different frames. So an observer moving relative to the Earth, for example an observer in the Sun's reference frame, will predict a non-zero torque. There are only two possibilities: either there will be a torque or not. The capacitor will turn or not. All observers agree on the rotation or non-rotation of the capacitor. Now, will the capacitor turn or not? Which observer will 'decide' on the observable quantity: rotation ? This paradox is a deadly blow to the theory of relativity. It is known as the Trouton-Noble paradox.

Pursuing the above reasoning, I came across a possible solution to the problem. The above paradox leads us to the inescapable conclusion that *the observer affects the result of an experiment*. This seems to be no new assertion, but is a new application of ideas in quantum mechanics in solving the problems of absolute/relative motion and the speed of light.

The observable quantity in the Trouton-Noble experiment, which is rotation (angular velocity or angular acceleration), is the resultant effect of all observers. All observers contribute to the torque developed in the device. It is intuitive to assume that not all observers have equal influence on the torque. I propose that the fundamental characteristic of an 'observer' that is important is the mass of the observer. In this sense any massive body is an 'observer'. The more massive an observer (an object) is the more influence it will have on the Trouton-Noble experiment. This means that if the Trouton-Noble device has different velocities relative to two objects, for example the Sun and a space craft, it is the velocity of the T-N device relative to the sun that almost completely determines the torque. The velocity of the T-N device relative to the space craft has negligible effect on the torque.

Trouton and Noble did not observe the expected rotation of the capacitor. This result is very difficult to explain because, even if the T-N device is at rest relative to the Earth, it is in motion relative to the Sun (30 Km/s) which is much more massive than the Earth, and relative to billions of stars in the universe (390 Km/s).

Therefore, it is not clear why absolute motion was detected with the Silvertooth, the Marinov , the Roland De Witteand the Miller experiments, but was not detected by the Trouton-Noble experiment. Perhaps the T-N experiment was not sensitive enough or was flawed. But another experiment [11] was reported in which the authors claimed detection of torque. In that experiment, the capacitor was not shielded, unlike the other T-N experiments. Even the result of the original Trouton-Nobel experiment was *not null,* but was only much less than expected.

Even if I have asserted that the fundamental quantity defining an observer is its mass, much remains to be clarified regarding such a hypothesis. *How* does the mass of an object physically affect an experiment, i.e. with what mechanism? Does shielding the capacitor prevent the charges from being 'observed' by celestial objects in the universe ?

Absolute motion as motion relative to by massive cosmic objects.

Absolute motion has been detected by many experiments, such as the Miller, Silvertooth, Marinov, Roland De Witteexperiments. The failure of conventional and modern Michelson-Morley experiments to detect the (expected) fringe shift is due to a serious flaw of the experiments. Those experiments were designed to detect the ether, and were successful in disproving the ether hypothesis. However, they were flawed to detect absolute motion. Absolute motion and motion relative to the ether were always (wrongly) perceived to be the same.

Now the question is: if the ether does not exist, as disproved by the Michelson-Morley experiment, relative to what is absolute motion defined?

If physical matter is only that exists in the universe, i.e. if the ether doesn't exist, and if absolute motion exists, then one is left with the only possible idea that absolute motion is basically just motion relative to matter in the universe. Therefore, absolute motion is basically relative motion.

The next problem to be solved arises is: how is absolute velocity formulated as motion relative to matter in the universe?

Imagine a hypothetical universe in which only the Solar System exists. A space ship of mass, say 1000 kg is launched in to space, so that the space ship and the Sun are in relative motion. If absolute motion is basically just relative motion, then the space craft and the Sun are not only in relative motion but also in absolute motion.

Intuition tells us that the Sun must be *almost* at absolute rest and it is the space ship that is in absolute motion because the mass of the Sun is about 2 x 10^{30}Kg !Compare this with the mass of the space ship which is only 1000 Kg .

From these arguments, one may formulate the theory of absolute motion as follows:

The absolute velocity of a spaceship is the resultant of weighed velocities of the body relative to all matter in the universe.

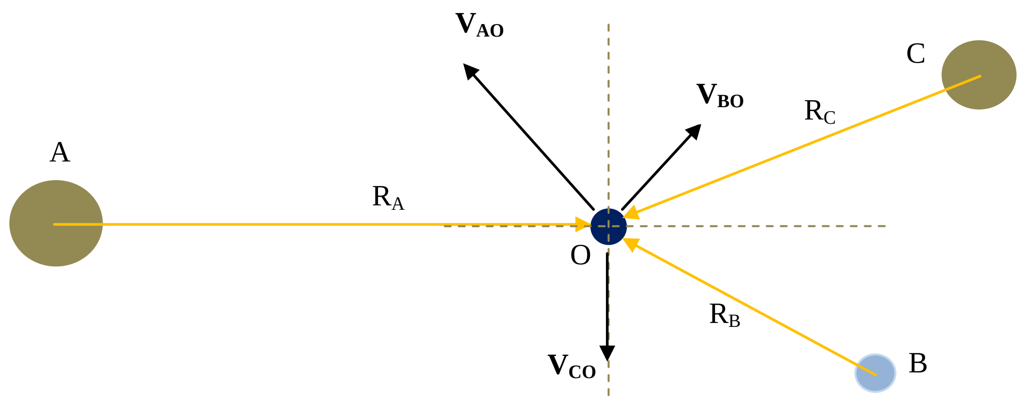
As argued above, the weight of each relative velocity should depend on the masses of the cosmic bodies relative to which the spaceship is moving.

We formulate the absolute velocity of the spaceship more specifically as follows:

The absolute velocity of the spaceship is the resultant of its mass weighed velocities of the spaceship relative to all matter in the universe.

Imagine a hypothetical universe in which only three bodies exist, A, B and C, for simplicity.

A, B, C, D and O are massive celestial objects (see next figure) in motion. We seek to determine the absolute velocity of object O, with a Michelson-Morley device attached to it. To determine the absolute velocity of O, we determine the resultant of the mass weighed velocities of objects A, B, C and D in a reference frame (S_O) attached to object O. It is proposed here that this resultant velocity is the velocity of the absolute reference frame S_{absO} relative to S_O.



$$\boldsymbol{V}_{\boldsymbol{absO}} = \frac{M_A}{M_T}\boldsymbol{V}_{\boldsymbol{AO}} + \frac{M_B}{M_T}\boldsymbol{V}_{\boldsymbol{BO}} + \frac{M_C}{M_T}\boldsymbol{V}_{\boldsymbol{CO}}(\text{vector sum})$$

where M_T is the total mass in the universe.

$$M_T = M_A + M_B + M_C + M_O$$

The more massive an object the more influence it has in determining the absolute velocity of another body .

Therefore, the absolute velocity of O is V_{absO} , which is the velocity of O relative to S_{absO}.

But this absolute reference frame S_{absO} applies only for object O . Each of the objects will have their own associated absolute reference frames: S_{absA} ,S_{absB} , S_{absC} , which are in motion relative to each other ! There is no single, universal absolute reference frame.

However, note that we assumed in the above analysis that there are only four massive objects in the universe. We know that there are more than one hundred billion galaxies in the universe. It can be shown according to the above analysis that the absolute reference frames of all objects are almost at rest relative to each other, due to the enormous number of massive objects in the universe. Therefore, we can say that there is essentially a single universal absolute reference frame.

Therefore, the absolute velocity (378 Km/s) of the Earth as detected in the Silvertooth experiment is theoretically the resultant sum of mass weighed velocities of the Earth relative to all celestial bodies (all matter) in the universe.

The implication of this hypothesis is that distance from the massive objects is irrelevant in the determination of absolute velocity. For example, Galilean space is usually approximated by a region of space far enough away from all matter in the universe. In the above formula, however, distance of object O from celestial bodies A and B, does not appear to have any effect on absolute velocity.

This theory may solve the centuries old perplexing paradox: Relative to what is the absolute velocity of a body determined? The answer is: Relative to all matter (cosmic massive objects) in the universe.

Galilean space

From our discussion so far, Galilean space doesn't exist physically. We have used Galilean space only as a mathematical abstraction in solving problems of absolute motion. The procedure to solve a problem of the speed of light, with a source and observer in absolute motion is:
1. Replace the (real) source with an apparent source to account for absolute motion
2. Solve the problem by assuming Galilean space and by applying modified emission theory for group velocity. The phase velocity is always *c* independent of source and observer velocities.
In Galilean space, the group velocity of light is constant relative to the source, i.e. varies with source, observer and mirror velocity; the phase velocity is always constant *c*.
Galilean space exists only as a mathematical abstraction.

7. Absolute motion and electromagnetism, inertia, and the speed of electrostatic and gravitational fields

The problem of whether the electrostatic force is instantaneous or is propagated at the speed of light is a long standing one and one of the most confusing and unresolved problems in physics. According to Coulomb's law, electrostatic fields are instantaneous; therefore, there will be no aberration of the field from a moving charge. According to Special Relativity (SRT) and Quantum Electrodynamics (QED) electrostatic force propagates at the speed of light.

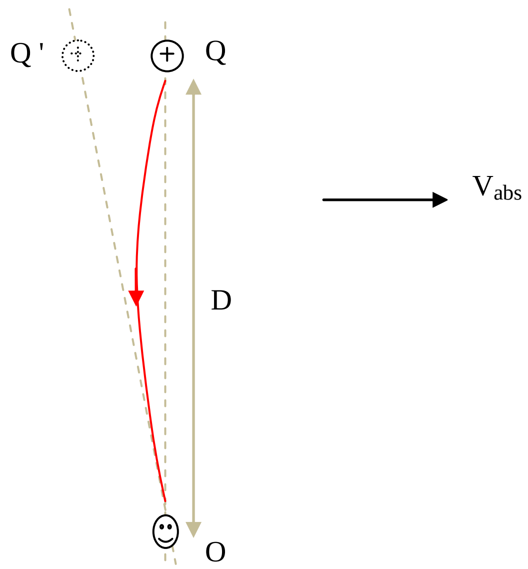
The standard solution of Maxwell's equations for a charge in uniform motion is by using Leinard's retarded potential. The interpretation of the result is confusing[4]. A new experiment[4] has been performed that seems to support infinite speed of propagation of electrostatic fields.

However, there is another astronomical observation that disagrees with the infinite speed of propagation of electrostatic fields. This is based on my proposal at the end of this paper that gravity is just an electrostatic effect. And, observations show that the Earth accelerates towards a point 20 arc seconds ahead of the visible sun. Considering the absolute velocity (390 Km/s) of the solar system, according to AST this can be shown to imply that the ‘speed’ of gravity (electrostatic field) is in fact the same as the speed of light.

The speed of electrostatic (and gravitational) fields is one of the most confusing subjects in physics. Tom Van Flandern has discussed this in an interesting way [5].

Absolutely co-moving charge and observer

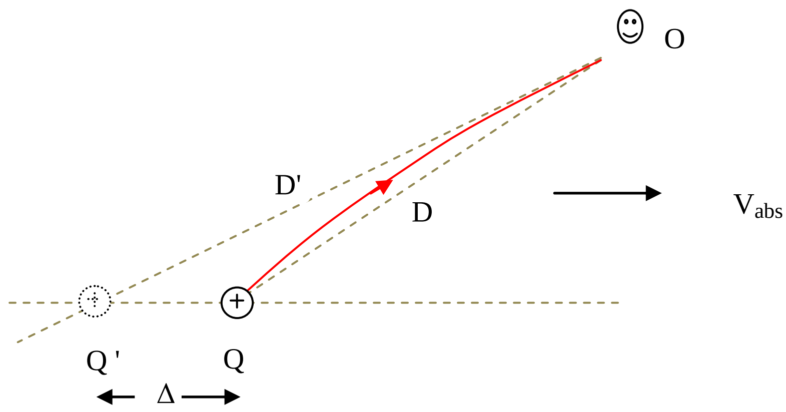
A new theory of electrostatic fields is proposed as follows. Consider absolutely co-moving charges Q and an observer O, both on a common platform, initially at rest.While both are at rest, radial, straight electric lines of force emanate from the charge. Imagine that the charge and observer instantaneously accelerate from rest to a common absolute velocity V_{abs}.



The new theory proposed here is that the observer detects the absolute velocity instantaneously, as there will be an instantaneous apparent change in the position of the charge relative to the observer. The observer detects the change in state of motion of the platform instantaneously, but the position of the charge changes apparently. To the observer, the electric lines of force come from apparent charge Q' and not from the physical charge Q. It is *as if* electrostatic field propagated at the speed of light, yet, at the same time, the observer detects change in state of (absolute) motion of the co-moving charge instantaneously.

For absolutely co-moving charge and observer, the line of force will be bent, creating an apparent change of position of the charge, as shown above.

We state the above theory more fundamentally as follows: *the electric lines of force emanating from an absolutely moving charge bend, as seen by co-moving observer. Only lines of force emanating from a charge at absolute rest are straight lines.*There will be aberration even for absolutely co-moving charge and observer.



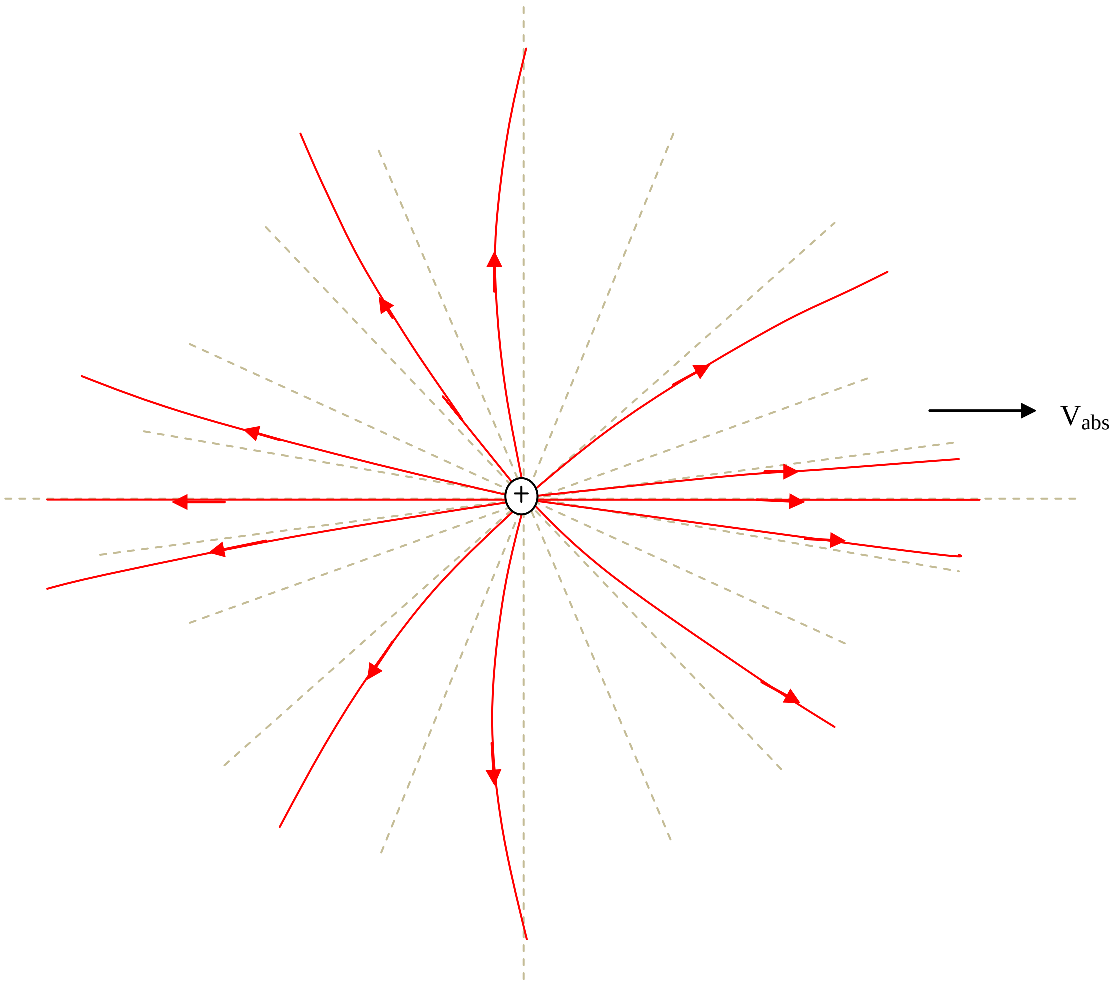
The apparent change in position of a light source depends on the speed of light. In this case, it is *as if* the electrostatic field was ' propagated ' at the speed of light. Actually there is no propagation.

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

Where **D** and **D'** are written in bold to denote vector quantities.

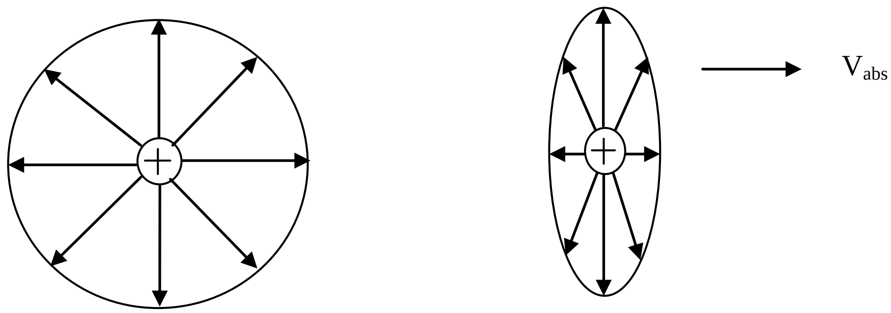
The above notation *seems* to mean that during the time that the field 'propagates' from position Q' to observer O , the charge moves from position Q' to position Q. This is only apparent, however. There is no propagation of static fields. It is as if thebentline of force is rigidly carried by the real charge Q and the straight lines of force are rigidly carried by the apparent charge Q'. The result of the Calcatera et al experiment[4] is interpreted by this theory.

To summarize the above: static field is (nearly) instantaneous, but the lines of force are bent due to absolute velocity. The lines of force are straight only if the charge is at absolute rest.
The next figure shows the electric lines of force of a charge in absolute motion. The bent lines of force are rigidly carried by and moving with the charge.



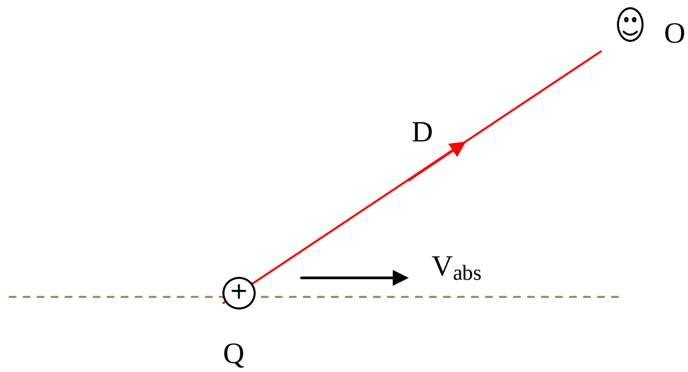
From the above figure, we see that bending of the lines of force is maximum in lateral/transverse directions, at or near the ninety degrees (orthogonal) directions. In the forward and backward directions (0^0 and 180^0), there is no bending of the light rays. In directions close to these directions, for example 2^0 or 178^0 , there is a very slight bending only. In these directions, the lines of force or the equi-potential lines will get compressed or expanded, respectively.
The bending electric lines of force move rigidly with the charge. Change in absolute velocity of the charges changes the bending of the light rays.

There is also additional effect due to absolute motion of the charge. The electric field around a charge that is at absolute rest is isotropic,whereas the electric field around an absolutely moving charge is distorted, as shown in the diagram below. This is predicted by the Lienard-Wiechert retarded potential method.



Charge in absolute motion, observer at absolute rest

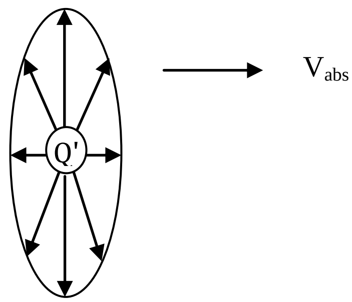
Consider a charge Q and an observer O both at absolute rest initially. In this case, the lines of force are straight lines going out of the charge, with magnitude according to Coulomb's law.



The most confusing problem has been what would happen if the charge accelerates suddenly from rest to a velocity V_{abs} , at time t = 0. The question is: will the observer detect the change in state of motion of the charge with a delay of the speed of light or instantaneously? It is proposed in this paper that the observer O detects the change in state of motion or a change in position of the charge *instantaneously*.The magnitude of the electric field will be according to the conventional formula for the electric field of a uniformly moving charge, discussed in next section. To the stationary observer, it is as if the field is rigidly attached to the field. However, for a co-moving observer, the line of force will be bent, as already discussed.

The electric field at O changes *instantaneously*, and the electric field around the charge will also be distorted, *for a co-moving observer*. The counter intuitive conclusion is this: *the electric field at O is computed by assuming that the charge Q has been moving with (absolute) velocity V_{abs} indefinitely, and applying Lienard-Wiechert retarded potential*.Even though the charge started moving a short time ago, it behaves as if it has been in uniform motion forever! However, such confusion arises from the simplistic conventional assumption that electrostatic fields propagate at the speed of light.There are two separate conventional views on the speed of propagation of electrostatic fields: light speed propagation and instantaneous propagation. Both of these views are simplistic and miss the novel dual nature of light. Apparent Source Theory successfully models this odd behavior. Electrostatic force has *dual* nature: *instantaneous* propagation and *light speed* propagation.

The effect of absolute motion of a charge is to distort its electric field, as already discussed.



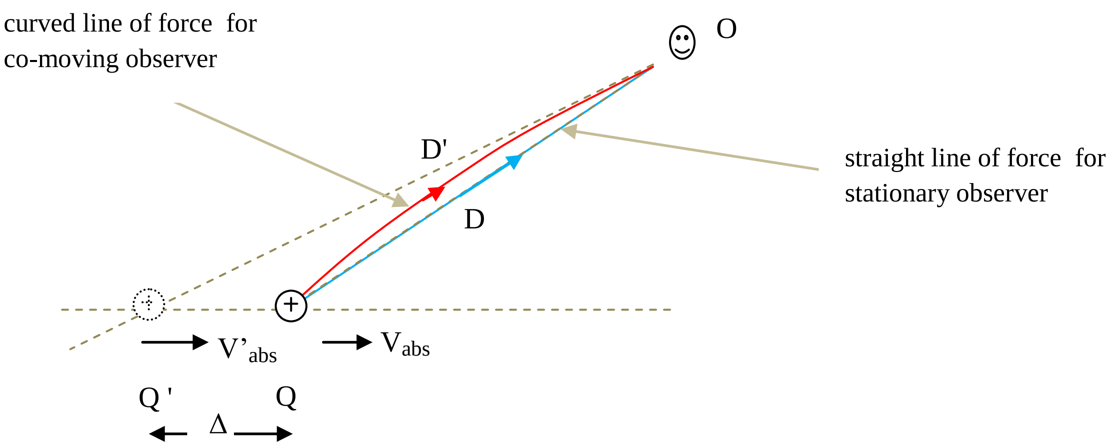
There are a lot of ambiguities related to the standard analysis and interpretation of the electric field of a moving charge. For example, what is the velocity V : is it absolute velocity or relative velocity ? Does motion of the observer also distort the observed field ?

According to the new interpretation of AST, the electric field at O due to charge Q is given by:

$$E(t) = \frac{e}{4\pi\varepsilon_0}\frac{\boldsymbol{R}(t)}{R(t)^3}\frac{1-\frac{{V_{abs}}^2}{c^2}}{\left(1-\frac{{V_{abs}}^2}{c^2}sin^2\theta(t)\right)^{\frac{3}{2}}}$$

Velocity of the charge in this formula is considered as absolute velocity. The electric field is distorted and approaches infinity as the absolute velocity approaches the speed of light. This is because the mass of the electron, which is radiation reaction (as will be proposed later), approaches infinity as the absolute velocity of the electron approaches the speed of light.

For absolutely co-moving charge and observer, there will be an apparent change in source position, as seen by the observer, as already discussed. The question here is: will there be an apparent change in the position of the charge for an observer at rest also ? The experiment[4] was crucial to answer this question.



For the stationary observer, it is as if the electric field is rigidly carried by the moving charge, straight radial lines emanating from the charge.

For absolutely co-moving light source and observer, there will be an apparent change in the position of the source relative to the observer and this will have a real effect in that there will be a change in the time delay between emission and detection of light. In fact, the effect is the same as actually, physically changing the position of the source. In the case of light source absolutely moving relative to an observer at rest, there is no such apparent change in source position.

Even though Apparent Source Theory has been highly successful in experiments involving inertially co-moving source and observer, it has not been as successful with regard to experiments involving light source and observer having independent absolute velocities and accelerated motions. After several years of confusion, the key idea has been revealed in my recent papers[37][38].

The mystery turned out to be the absolute velocity of an inertial observer[37][38]. The generalized form of Apparent Source Theory is stated as, as already discussed:

There is an apparent change in point of light emission relative to an absolutely moving inertial observer. In other words, there will be an apparent change in the past position of a light source relative to an absolutely moving inertial observer.

This means that there is no apparent change in point of light emission for an observer at absolute rest and light behaves as coming from the actual/physical, not apparent, point where it was emitted.

With the same analogy, for absolutely co-moving charge and observer, there will be an apparent change in the position of the charge as seen by the observer. This apparent change in charge position has real effect: change in magnitude and direction of the charge. There will also be distortion of the field due to absolute motion, as discussed already. In the case of a charge in absolute motion and observer at rest, there is no apparent change in charge position as seen bt the stationary observer and the lines of force come directly from the physical charge, with the electric field moving rigidly with the charge.

Electric field of a uniformly moving charge - Lienard-Wiechert retarded potential

According to Lienard-Wiechert retarded potential, the electric field at *r (x,y,z)*from a charge *e* traveling with constant velocity *v*, at a time *t* can be written as [4]:

$$\boldsymbol{E}(\boldsymbol{r},t) = \frac{e}{4\pi\varepsilon_0}\frac{1-\frac{v^2}{c^2}}{(R(t') - \frac{\boldsymbol{R}(t').\boldsymbol{v}}{c})^3}\ (\ \boldsymbol{R}(t') - \ \boldsymbol{v}\frac{R(t')}{c}\ \ )$$

where

$$\boldsymbol{R}(t') = \boldsymbol{r} - \boldsymbol{v}\, t'$$

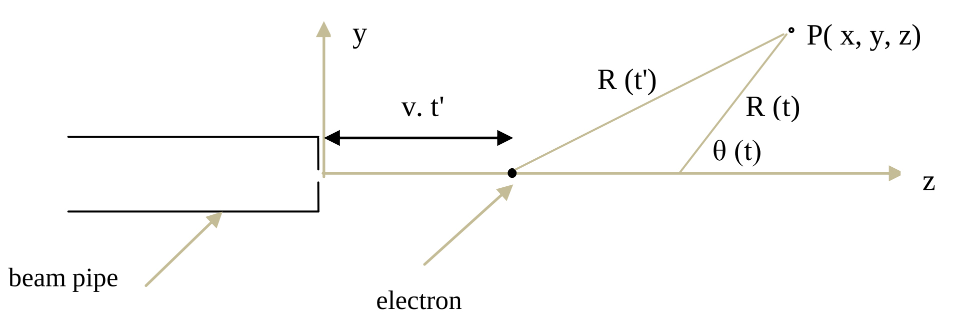
is the distance between the moving charge and the space point where one measures the field at time *t*, and

$$t' = \ t - \frac{R(t')}{c}$$

The field from a steadily moving charge can also be written as:

$$E(t) = \frac{e}{4\pi\varepsilon_0}\frac{\boldsymbol{R}(t)}{R(t)^3}\frac{1-\frac{v^2}{c^2}}{(1-\frac{v^2}{c^2}sin^2\theta(t))^{\frac{3}{2}}}$$

Where**R**(t) is the vector joining the charge position and the point at which we evaluate the e.m field at time *t* and θ(t) is the angle between **v** and **R**(t).



The maximum transverse electric field with respect to the direction of motion can be computed:

$$E_{max} = \frac{e}{4\pi\varepsilon_0}\frac{\gamma}{y^2}$$

a value obtained when the charge is at a distance γy at a time

$$t' = t - \frac{\gamma y}{c}$$

where

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

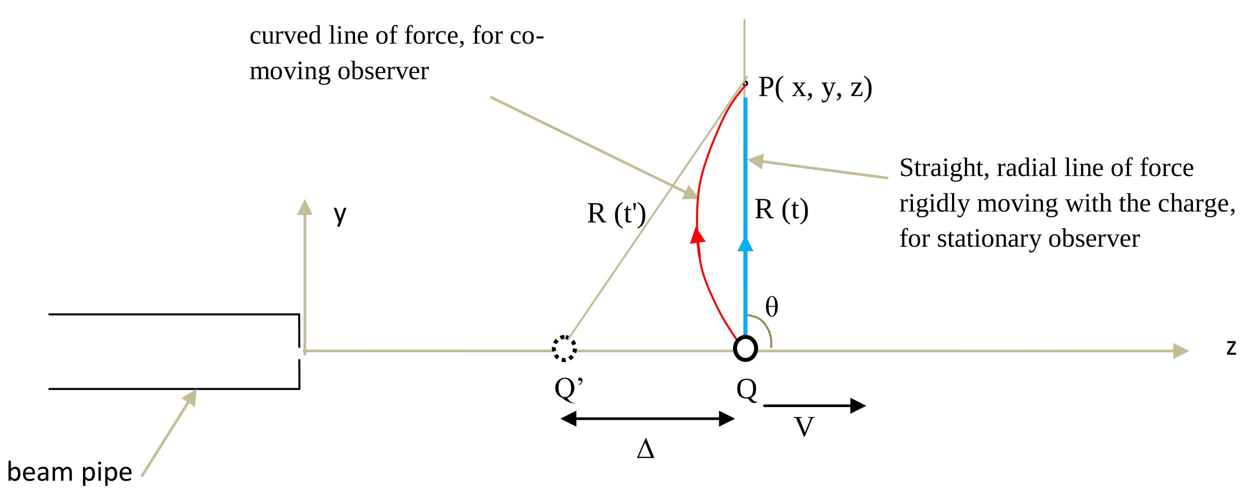
Lienard-Wiechert retarded potential states that the electric field at point P at time *t* is caused by the charge at an earlier time *t'* , due to finite speed of 'propagation' of the field.

In the experiment[4], γ = 1000 , y = 30 cm, hence z = - 300m. E_{max} is caused by the electron when it was at position z = -300 m. Since the electron can never be physically at z = -300m in this experiment, this is very intriguing for conventional thinking.

The experiment[4] is perhaps the most crucial experiment ever done in relation to static fields, to develop the model of electrostatic fields proposed in this paper. I concluded that the Lienard-Wiechert retarded potential is partly the correct model to *predict* the outcome of experiments but its interpretation has been wrong. However, it doesn't reveal the apparent change in position of the charge for absolutely co-moving charge and observer. Static fields do not have any propagation delay as thought in the conventional interpretation of Maxwell's equations and theLienard-Wiechert retarded potential.

Electrostatic fields have dual nature: finite speed of propagation and infinite speed of propagation.

Now we apply AST to experiment[4].



From the figure above, we can see that the maximum transverse electric field is detected at point P when the charge is physically at Q, as measured by the stationary sensor at point P.

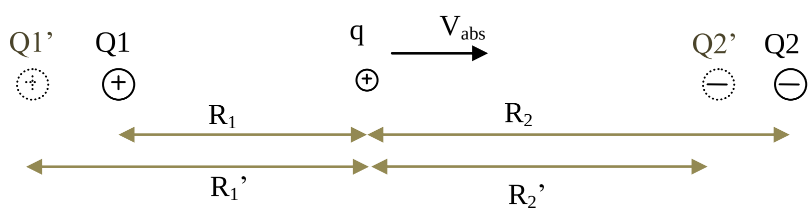
Charge at absolute rest, observer in absolute motion

As we have already stated, there will be an apparent change in charge position due to observer's absolute motion. However, this theory should be reconciled with the argument I made in previous versions of this paper:

" Motion of the observer relative to the charge (relative to the apparent charge) has no effect on the observed electric field. The experiment[4] has confirmed this because the γ of the electron beam, which was 1000, was determined by the conventional assumption that the electron beam does not affect the accelerating field. The reported good agreement between the measured and predicted voltage (V_{max}) indicates that the calculated γ was correct.

For a charge at absolute rest and an observer in motion, the motion of the observer has no effect on the observed electric field magnitude and direction. "

Consider a positive test charge q moving with absolute velocity V_{abs} , between a positive charge Q1 and a negative charge Q2, both at absolute rest.



If the test charge q is also at absolute rest, the Coulomb force acting on q will be:

$$F = \varepsilon_0 \frac{Q_1 q}{{R_1}^2} + \varepsilon_0 \frac{Q_2 q}{{R_2}^2}$$

If the test charge is moving to the right with absolute velocity V_{abs}, the positions of the charges Q1 and Q2 will change apparently, as seen by moving charge q.

$$R_1{}' = R_1 \frac{c}{c - V_{abs}}$$

and

$$R_2{}' = R_2 \frac{c}{c + V_{abs}}$$

The Coulomb force will be:

$$F = \varepsilon_0 \frac{Q_1 q}{{R_1}'^2} + \varepsilon_0 \frac{Q_2 q}{{R_2}'^2}$$

$$F = \varepsilon_0 \frac{Q_1 q}{(R_1 \frac{c}{c - V_{abs}})^2} + \varepsilon_0 \frac{Q_2 q}{(R_2 \frac{c}{c + V_{abs}})^2}$$

$$\Longrightarrow F = \frac{\varepsilon_0 \, q}{c^2} \left(\frac{Q_1}{\left(R_1 \frac{1}{c - V_{abs}}\right)^2} + \frac{Q_2}{\left(R_2 \frac{1}{c + V_{abs}}\right)^2} \right)$$

Let Q1 = Q2 = Q

$$\Longrightarrow F = \frac{\varepsilon_0 \, q}{c^2} \left(\frac{Q}{\left(R_1 \frac{1}{c - V_{abs}}\right)^2} + \frac{Q}{\left(R_2 \frac{1}{c + V_{abs}}\right)^2} \right)$$

$$\Longrightarrow F = \frac{\varepsilon_0 \, Qq}{c^2} \left(\frac{(c - V_{abs})^2}{(R_1)^2} + \frac{(c + V_{abs})^2}{(R_2)^2} \right)$$

$$\Longrightarrow F = \varepsilon_0 \, Qq \left(\frac{1 - \frac{{V_{abs}}^2}{c^2}}{(R_1)^2} + \frac{1 + \frac{{V_{abs}}^2}{c^2}}{(R_2)^2} \right)$$

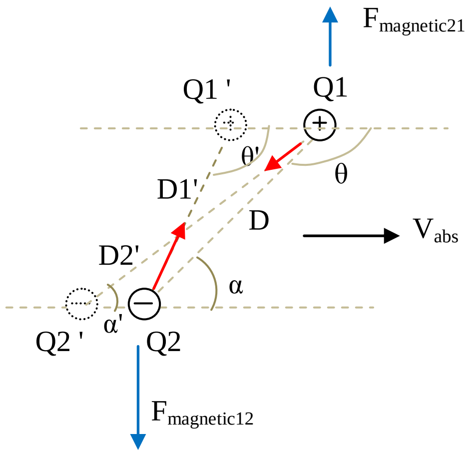
If the test charge q is at absolute rest:

$$F = \varepsilon_0 \frac{Q_1 q}{{R_1}^2} + \varepsilon_0 \frac{Q_2 q}{{R_2}^2} = \varepsilon_0 Qq \left(\frac{1}{{R_1}^2} + \frac{1}{{R_2}^2} \right)$$

The above two equations should be evaluated for different values of R1 and R2.

Magnetic field

I thought of the possibility that AST may express magnetic field as an electrostatic field modified due to absolute motion and as such not a fundamental quantity. However, on closer examination, I came to the conclusion that magnetic field is a fundamental quantity because I couldn't explain the magnetic force between two current carrying conductors by electric field alone.



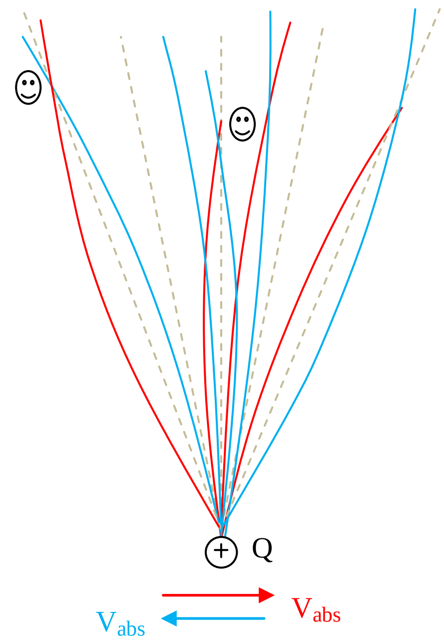
For absolutely co-moving charges Q1 and Q2 , the magnetic force of Q1 on Q2 is calculated by using distance D1' and angle θ' , and not by using D and θ, although the physical distance between the charges is D and the physical angle is θ .Also the magnetic force of Q2 on Q1 is determined by using D2' and α', and not D and α. It can be seen that the magnetic force of Q1 on Q2 is different (greater) from the magnetic force of Q2 on Q1. Note that, to an observer at absolute rest, unlike the co-moving observer, the magnetic field behaves in the classical way.

The magnetic force (blue) creates a counter-clockwise torque. The electrostatic force (red) creates clockwise torque (see figure on the right) because the force of electrostatic attraction by Q1 on Q2 is greater than that by Q2 on Q1 because of difference in the apparent distances of the other charge in each case. Therefore, it is the resultant of the two torques(electrostatic and magnetic) that is to be expected in the Trouton-Noble experiment.

Electromagnetic radiation

Another long standing problem is the problem of electromagnetic radiation. Conventionally, it is believed that electromagnetic radiation is produced by accelerating charges. But the physical process involved is not known clearly.

This paper reveals the mystery of electromagnetic radiation. Consider an accelerating or oscillating charge. Let us see what an observer *in the reference frame of the charge* observes.



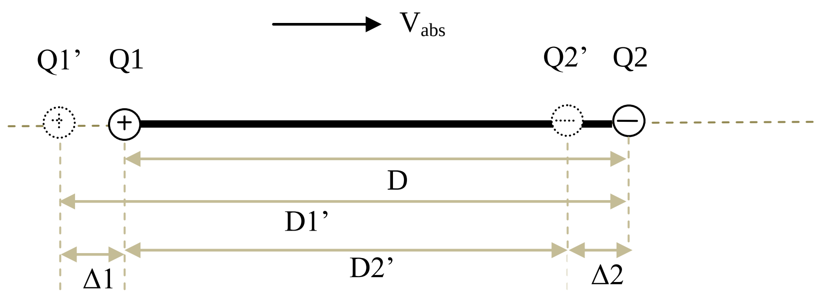
Since the lines of force are bending relative to the charge due to absolute motion, the lines of force will have *transverse* component. As the charge oscillates left and right, the observer in the reference frame of the charge observes that there is a time varying *transverse* component of the electric field, changing directions and magnitudes as the charge accelerates to the right and to the left. The time varying transverse component of the electric field causes electromagnetic radiation. We can see that maximum radiation occurs in the lateral directions, with no radiation in the longitudinal directions. This means that *rate of change of absolute motion* (acceleration) is the cause of electromagnetic radiation.

Note again that only co-moving observer sees the bending of lines of force. For a stationary observer, the field rigidly moves with the charge.

Reactionless thrust, free energy, anti-gravity, the Biefeld-Brown effect

I have already shown that Apparent Source Theory predicts reactionless thrust and free energy[24].

Consider two opposite charged balls fixed to the ends of a rigid rod. Assume them to be point charges.



D is the actual, physical distance between real charges Q1 and Q2. D1’ is the apparent distance of Q1 as seen by Q2. We can also say that D1’ is the distance of apparent charge Q1’ from real charge Q2. D2’ is the apparent distance of Q2 as seen by Q1.We can also say that D2’ is the distance of apparent charge Q2’ from real charge Q1.

Now the electrostatic force exerted by Q1 on Q2 will be:

$$F_{12} = \frac{1}{4\pi\varepsilon_0}\frac{Q1\,Q2}{(D1')^2}$$

The electrostatic force exerted by Q2 on Q1 will be:

$$F_{21} = \frac{1}{4\pi\varepsilon_0}\frac{Q1\,Q2}{(D2')^2}$$

But

$$D1' = D\,\frac{c}{c - V_{abs}} \text{ and } \qquad D2' = D\,\frac{c}{c + V_{abs}}$$

The above equations for D1' and D2' result from new interpretations of 'speed' of electrostatic fields proposed in my paper[1].

The net force on the rod will be:

$$\Delta F = F_{21} - F_{12} = \frac{1}{4\pi\varepsilon_0}\frac{Q1\,Q2}{(D2')^2} - \frac{1}{4\pi\varepsilon_0}\frac{Q1\,Q2}{(D1')^2} = \frac{1}{4\pi\varepsilon_0}Q1\,Q2\,\left(\frac{1}{(D2')^2} - \frac{1}{(D1')^2}\right)$$

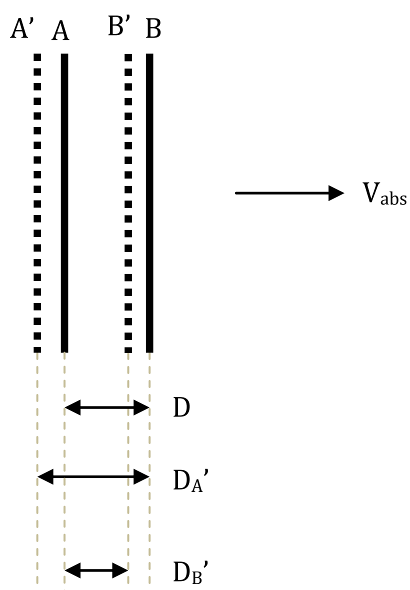
$$\Delta F = \frac{1}{4\pi\varepsilon_0}\frac{Q1\,Q2}{D^2}\left(\frac{4\,V_{abs}}{c}\right)$$

There is a net force on the system ! The force is directed in the direction of the absolute velocity.

Now consider a parallel plate charged capacitor, with plates named A and B, and with an air (vacuum) dielectric. Assume that the capacitor is absolutely moving to the right. For ease of discussion, assume that the capacitor dimensions are such that the electric field lines are parallel to each other and perpendicular to the capacitor surfaces, i.e. we neglect distortion due to absolute motion. In reality, according to AST, a charge at a given point on one plate doesn't see the other plate as a flat plane, but as a curved plane.
A' is the apparent position of plate A as seen by plate B. And B' is the apparent position of plate B as seen by plate A.The electrostatic force between the plates of a parallel plate capacitor is given by:

$$F = \frac{\varepsilon_0 A V^2}{2D^2} = \frac{\varepsilon_0 A}{2}\frac{V^2}{D^2}$$

where$V$ is the potential difference across the capacitor, D is the plate separation distance and A is the area of each plate. This is the formula for the force exerted by one plate on the other.



D_A' is the apparent distance of plate A as seen by plate B. D_B' is the apparent distance of plate B as seen by plate A. Strict application of AST shows that, to a point charge on one capacitor plate the opposite plate is not a plane but somewhat curved. However, we can use the above simplistic assumption to a good approximation.

Now we determine the force exerted by plate A on plate B.

$$F_{AB} = \frac{\varepsilon_0 A}{2} \frac{V^2}{(D_A{}')^2}$$

And the force exerted by plate B on plate A will be:

$$F_{BA} = \frac{\varepsilon_0 A}{2} \frac{V^2}{(D_B{}')^2}$$

The NET force on the capacitor will be:

$$\Delta F = F_{BA} - F_{AB} = \frac{\varepsilon_0 A}{2} \frac{V^2}{(D_B{}')^2} - \frac{\varepsilon_0 A}{2} \frac{V^2}{(D_A{}')^2}$$

But

$$D_A{}' = D \frac{c}{c - V_{abs}} \text{and} D_B{}' = D \frac{c}{c + V_{abs}}$$

From which,

$$\Delta F = \frac{\varepsilon_0 A}{2} V^2 \left(\frac{1}{(D_B{}')^2} - \frac{1}{(D_A{}')^2} \right)$$

$$\Delta F = \frac{\varepsilon_0 A \ V^2}{2D^2} \frac{4V_{abs}}{c} = \frac{\varepsilon_0 A}{2} \left(\frac{V}{D}\right)^2 \frac{4V_{abs}}{c} = \frac{\varepsilon_0 A}{2} E^2 \frac{4V_{abs}}{c}$$

where E = V/D is the electric field strength.

If there is a dielectric between the plates, the ‘speed’ of the electrostatic field (c) is modified by the dielectric constant ε .

$$c' = \frac{c}{\varepsilon}$$

Therefore

$$\Delta F = \frac{\varepsilon_0 A}{2} \frac{V^2}{D^2} \frac{4V_{abs}}{c'} = \frac{\varepsilon_0 A}{2} \frac{V^2}{D^2} \frac{4V_{abs}}{\left(\frac{c}{\varepsilon}\right)} = \frac{\varepsilon_0 \varepsilon \ A}{2} \frac{V^2}{D^2} \frac{4V_{abs}}{c}$$

From the above formula, we can see that the net force on the capacitor is :

- directly proportional to the square of the applied voltage
- inversely proportional to the square of plate separation distance
- directly proportional to the area of the plates
- directly proportional to the relative permittivity of the dielectric material.
- directly proportional to the absolute velocity, for $V_{abs} << c$

That the net force is directly proportional to the square of the electric field strength (E = V/ D) implies that dielectric materials with the highest dielectric strength are vital to the realization of free energy devices. Diamond has the highest known dielectric strength, about 2000 MV/m [9]. Mylar also has a high dielectric strength, typically 500 MV/m at DC, for small thicknesses.

The above formula will be further modified by a factor [1].

$$\Delta F = \left(\frac{\varepsilon_0 \varepsilon\ A}{2} \frac{V^2}{D^2} \frac{4V_{abs}}{c} \right) \left(1 - \frac{{V_{abs}}^2}{c^2} \right)$$

For $V_{abs} << c$, the factor ($1 - V_{abs}{}^2/c^2$) ≈ 1 .

To illustrate the possibilities, consider a parallel plate capacitor with diamond as the dielectric material.

$A = 1m^2$, $\varepsilon = 5.5$, dielectric strength = 2000 MV/m

The absolute velocity of the Earth, V_{abs} = 390 Km/s and c = 300000 Km/s , $V_{abs} << c$

$$\Delta F = \frac{\varepsilon_0 \varepsilon\ A}{2}\ E^2 \frac{4V_{abs}}{c} = \frac{8.85 * 10^{-12} * 5.5 * 1}{2} * (2000 * 10^6)^2 * \frac{4 * 390}{300000}$$

$$\Delta F = 506220\ N = 50622\ Kgf$$

This is an enormous net force from a single capacitor !

Now let us push the limits even further. We can increase the net force enormously by stacking up hundreds of thousands of such capacitors connected in parallel to a voltage source. Assume each capacitor has a thickness of 50 nm, with each plate 10nm thick and the dielectric 30nm thick. A voltage of about 60 V is applied to the capacitors for maximum electric field intensity of 2000 MV/m. If we construct a capacitor stack containing 20 million such capacitors (the total thickness of the stacked capacitor will be 1m) , the net force will be:

$$\Delta F = 50622\ * 20000000\ Kgf = 1\ trillion\ Kgf\ !$$

This is the weight of about 10,000 aircraft carriers.

Thus, according to AST, a free energy device that has a size of only $1m^3$ can produce a net force that can lift 10,000 aircraft carriers. Even if one part in a million of this were true, all our energy needs would be fulfilled. The purpose of this calculation is just to inspire researchers on what is possible if the AST prediction is correct. Although AST neatly predicts free energy and reactionless thrust, it may not be complete and needs development.

One of the experimental evidences for AST in predicting free energy is the report by Thomas Brown that the effect continuously varies with time, including variation with sidereal time, indicating connection between the effect and Earth's absolute motion.

Non- linear law of electromagnetic radiation power and radiation reaction - Universal speed limit *c*

In my previous paper [13] , with the theories
' Apparent Source Theory '
' Constant Phase Velocity and Variable Group Velocity of Light ' and
' Exponential Law of Light '

, I was able to explain many conventional light speed experiments and the Ives-Stilwell experiment.

Despite the success of the above theories, however, there was a category of experiments which remained very tough to explain. These were the muon 'time dilation' , the limiting light speed experiments and the 'mass increase' of relativistic electrons,. The speed of electrons and beta particles accelerated with very high voltageshave been measured even by time of flight method and were always found to be just less than the speed of light. If Special Relativity is wrong (as confirmed by the much compelling alternative theories listed above), then how is it that SRT is still successful to explain these experiments. This was very challenging.

After a considerable bewilderment, I came to realize that there is some profound mystery of nature yet to be discovered.

Before long, I came across a paper [1] on the internet in which I found a crucial hint on the missing link. In this paper, the author (Musa D. Abdullahi) proposes an alternative explanation to the Bertozzi’s experiment. In the Bertozzi'sexperiment[14], an electron is accelerated with a high voltage and its kinetic energy is measured using calorimetry. It is found out that, as the accelerating voltage is increased further in the range required for relativistic speeds of the electron, the measured heat energy continues to increase, despite the fact that the speed of the electrons is always just under the speed of light, which was confirmed by time of flight method. What sparked my thought were a few statements made by the author in his papers [1] and in an e-mail exchange we had regarding his paper on the Bertozzi's experiment.

' *. . . Special relativity . . . gives radiation power* $R = \gamma^4 Rp$*, where* γ *is . . . The factor* γ^4 *means* *that the radiation power increases explosively as the speed v approaches that of light c. . . . '*

' ... Radiation reaction force R_f *is missing in classical and relativistic electrodynamics and it makes all the difference.. . . '*

' So it is not the energy of the electrons which continues to increase but the emitted radiation. This emitted radiation has a heating effect as may be detected by calorimetry.'

' It is as if the electron, under acceleration by an electric field, encounters a kind of 'frictional force' opposing motion, which prevents it from going beyond the speed of light. '

The above statements brought to my attention ' radiation reaction ' and the gamma (γ) term of Special Relativity to consider them as a possible explanation of limiting light speed and relativistic mass increase experiments. So I interpreted these ideas for a new alternative interpretation: 'relativistic' mass increase and light speed as the limiting (maximum possible) *absolute velocity* in the universe. This means that no absolute or relative velocity equal to greater than the speed of light is possible in the universe.

The author of the paper[1] asserts that the continued increase in the heat energy with increasing voltage is due to the heating effect of explosively increasing radiation power and that the mass of the electron does not increase with velocity.

Now, what is the explanation for the impossibility to accelerate electrons or beta particles to or beyond the speed of light ?As the *absolute* velocity of the (charged) particles approaches the speed of light, any further increase in absolute velocity will increasingly cause or require radiation of infinite amounts of electromagnetic energy, and infinite amount of radiation reaction, so that it would be impossible for these particles to attain the speed of light. In other words, it gets extremely difficult to accelerate and, to a somewhat lesser extent, to decelerate, an electron which is moving with an absolute velocity close to the speed of light. It becomes harder and harder to change (to increase or to decrease) the absolute velocity of an electron which has already attained an absolute velocity close to the speed of light. Near the speed of light, it requires practically infinite amount of energy to *change* the *absolute velocity* of the electron.

So far we have been talking about charged particles, which can radiate electromagnetic energy when accelerated.

In this paper we just adopt the gamma (γ) factor of Special Relativity,

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

So the formula for radiated power should contain the gamma term, so that radiated power becomes infinity at the speed of light.

The formula for radiated power from a charged particle is, according to Special Relativity[1]:

$$R_P = \frac{q^2 a^2}{6\pi\varepsilon_0 c^3}\gamma^4 (\text{ Lienard formula})$$

The radiated power becomes infinity at the speed of light. We will use this relationship in an argument about universal absolute velocity limit as the speed of light. Note that light speed limit applies only to physical objects, objects with mass, according to this paper.

One long standing problem is that of radiation reaction. The radiation reaction is given by[1]:

$$F_{rad} = \frac{q^2}{6\pi\varepsilon_0 c^3}\frac{da}{dt} (\text{ Abraham} - \text{Lorentz formula})$$

We know that radiation is caused by acceleration. But the above formula implies that there will be no radiation reaction for constant acceleration because the rate of change of acceleration will be zero in this case. The above formula doesn't reflect our hypothesis that radiation reaction will be infinite near the speed of light, i.e. there is no gamma term in the above formula. If this hypothesis is correct, then this implies that Maxwell’s equations and their solution should be reconsidered.

Special Relativity also has problems with radiation reaction[1].

Mass increase of relativistic electrons

The experimentally established increase in mass of relativistic electrons, as compared to non-relativistic electrons, is just an increase of radiation reaction of the electron as its absolute velocity approaches the speed of light. Therefore, this is just an increase in inertia or mass of an electron.

Mass (inertia) may be nothing but radiation reaction !

Consider a charge being accelerated by an external force. We know that the charge will radiate electromagnetic energy. From Newton's law we know that a force is required to accelerate an object with mass. As a massive object is pushed, by the principle of action and reaction, there will be a reaction force.

Consider an electron accelerated by an electric field. Conventionally, the electric field has to supply two kinds of energies:

1. kinetic energy to the electron (because electron has mass)
2. energy radiated by the electron

The new theory proposed here is that inertia is nothing but radiation reaction. Thus, as an electron is pushed, it will radiate and a radiation reaction arises. Inertia arises from radiationreaction.

All energy imparted to the electron will be radiated.
The electron radiates not only during acceleration, but also during deceleration. A force is needed to stop a moving electron and this is again due to radiation reaction.

Mass (inertia)

Mass increase of relativistic electrons has already been explained above as non-linear law of radiation reaction. As the absolute velocity of the electron approaches the speed of light, it requires nearly infinite amount of radiated power to impart any further acceleration to it. This means that there will be practically infinite radiation reaction. This may be nothing but (practically) infinite mass (inertia) of the electron, as proposed above.

What about neutral objects ?Does the limiting speed of light apply only to charged particles or is it *universal*, i.e. does the limiting light speed apply to all physical objects ? The problem with neutral particles or objects here is that there is no experimental evidence in the laboratory.

If charged particles can never attain or exceed the speed of light, which is now an experimentally established fact, so should neutral particles, since neutral particles are composed of charged particles. Thus we conclude that neutral particles/ objects also can't attain or exceed the speed of light. So the speed of light is the universal *absolute* velocity limit to all physical objects in the universe.

The above argument encourages us to make a radical speculation. What if inertia (mass) itself is nothing but radiation reaction?! I mean that a massive object resists any change in its state of motion because of radiation reaction, i.e., the inertia of an object is due to radiation reaction. One appealing feature of this idea is that both inertia and radiation reaction are reaction forces opposing acceleration. The long standing difficulty in understanding radiation reaction might also be a hint that there is some profound mystery.

The immediate objection to this assertion is that neutral objects cannot radiate even if accelerated because they carry no net charge.

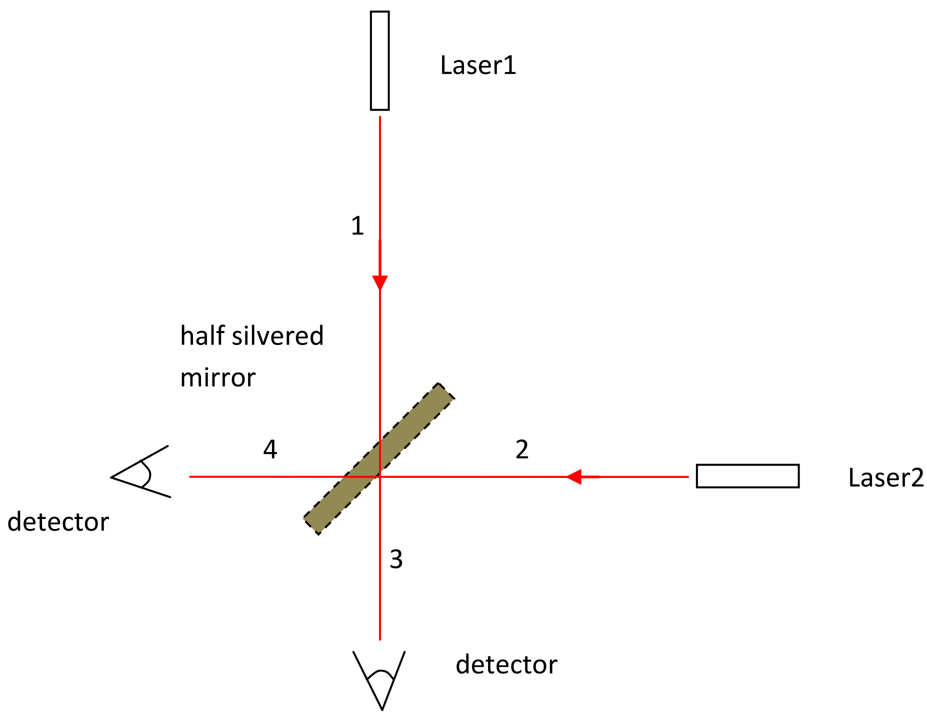
Despite this problem, I persisted to pursue this hypothesis that inertia may be just radiation reaction because this is a very compelling idea with profound implications, if proved to be correct.

I came across a solution to the above stated problem that neutral objects do not radiate. The solution is connected with the fact that there is no medium (ether) for light transmission.

The electrons, protons and all charged elementary particles in a macroscopic object all radiate if that object is accelerated. The individual charged particles behave in the same way as when they are free/isolated. An electron bound in a macroscopic object and a free electron are governed by the same law: an accelerated electron radiates. If the free electron and the neutral object containing the bound electron have equal accelerations, then the two electrons will develop equal radiated power and equal radiation reaction. An electron bound in a neutral object does not stop to radiate simply because there are positively charged particles in that object that will also radiate so as to cancel the radiation of the electrons.

However, the radiated power of the bound electrons will never be accessible because it is cancelled by the power radiated from the positive bound charges. However, 'canceled' doesn't mean that the energy disappears. The radiated energies of negatively and positively charged particles inside a neutral object simply become *inaccessible*. Whether the radiated power is accessible (as for a free accelerated electron) or inaccessible (as for an electron bound in a neutral accelerated object), there will always be radiation reaction and that may be the same thing as what has been known as 'inertia' for centuries.

The following argument shows that this may not be an extraordinary claim .



Consider the lasers to be ideal : their coherence time is infinite , and both have exactly the same frequencies and intensities, the arm lengths are exactly equal. The beam divergences are nearly zero.

First the phases of the two lasers are adjusted so that the two light beams interfere with complete destructive interference at the detectors. Detectors placed on paths 1 and 2 (not shown) will detect light, but detectors placed anywhere along paths 3 and 4 will not detect any light. Now, the puzzle is: where does the energy go? Detectors placed on paths 3 and 4 will detect light only if one of the two lasers is switched off.

The above argument shows that photons may be emitted yet not accessible. A photon does not 'mix' with other photons. Two photons may simultaneously act on the same particle, but the two photons will not be 'lost' due to 'mixing' with other photons. Similar argument applies to the radiation from bound charged particles of a neutral object. Since everyday accelerations of macroscopic objects is of very low frequency, the cancelling of two photons will be even more complete.

Therefore, a neutral object reacts to any acceleration because of the same phenomenon that a free electron reacts to any acceleration: radiation reaction.

Therefore, universal light speed limit will also apply to neutral particles and objects. The radiation reaction of an electron inside a neutral macroscopic object moving at absolute velocity close to the speed of light is the same as the radiation reaction of a free electron moving at the same absolute velocity. This means that if the free or the bound electrons are accelerated while moving with absolute velocities close to the speed of light, both the free electron and the object containing the bound electron having equal absolute velocity and accelerations, the radiated power and the radiation reaction on the two electrons is also equal.

In my paper [39] I have proposed an improved version of these ideas.

Gravity; Mercury perihelion advance; Stability of planetary orbits.

Evidence that the speed of gravity is not infinite and is equal to the speed of light

Tom Van Flandern argued that [5] planetary orbits would be unstable if the speed of gravity is finite, and he set a lower limit of $2 \times 10^{10} c$ on the speed of gravity. In this paper, however, finite speed of gravity is proposed because it may explain Mercury perihelion advance. It will also be shown that the speed of gravity need not be infinite (as argued by Van Flandern) and that it is possible to explain stable planetary orbits and observations during solar eclipse by using finite speed of gravity and it will be shown that the 'speed' of gravity is in fact equal to the speed of light.

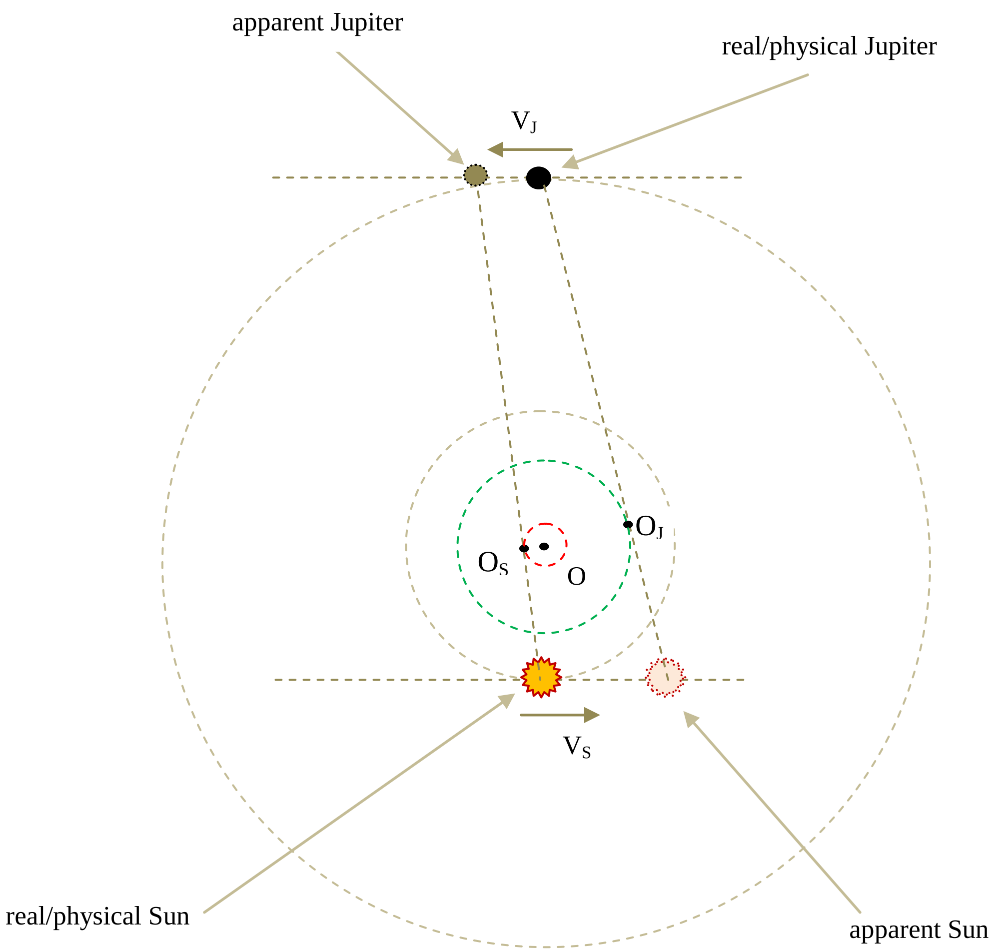
In this section, we apply the Apparent Source Theory to gravity to explain gravitational phenomena. It is found that observations show light speed 'propagation' of gravity, not instantaneous propagation. Even though we show that the 'speed' of gravity is equal to the speed of light, actually there is no propagation, but there is aberration of gravity. Just like electrostatic fields, gravity behaves *both as if it is instantaneous and as if it propagates with light speed*.

Let us assume that the sun-planet system (the bary-center) to be at absolute rest, with the planet revolving the Sun.

The usual fallacy is to think of the sun and the planet to be on opposite sides of a single bary-center, which would imply unstable orbit for finite speed of gravity because of a non central force component. This fallacy is rooted in a hidden assumption of the ether. This hidden assumption of the ether is the source of most confusions surrounding absolute/relative motion and the speed of light. Even Einstein did not actually escape from the ether trap as he implicitly assumed the ether in Special Relativity.

In the next figure, two bary-centers, O_S and O_P , are shown. O_S is the bary-center for the Sun and the *apparent* Jupiter, and O_P is the bary-center for Jupiter and the *apparent* Sun. We see that the real Sun and the real Jupiter are never on opposite sides of a single bary-center.

We can see that *the orbits* of the Sun and Jupiter revolve around a single common bary-center (right figure). Therefore, it is not the Sun and the Jupiter themselves, but the *centers* of their respective *orbits* that should be thought as revolving around the common bary-center. O_S and O_J (shown in the figure) are just the instantaneous bary-centers. The small red dashed circle is the locus of the Sun-apparent Jupiter bary-center, and the green dashed circle is the locus of Jupiter-apparent Sun bary-center. These two bary-centers themselves revolve around the bary-center of the system. Note that the orbits shown are the 'instantaneous orbits'. Since the two bary-centers are continuously changing, the planet and the Sun will stay in the orbit shown in the figure only for a moment, i.e. the planet and the Sun move in continuously changing orbits.



With this scheme, the orbits would be ‘complex’ but stable, even if we assume a finite speed of gravity. Such a 'complex' orbit may account for the perihelion advance of Mercury and orbits that are not perfect ellipses. We know that Newton's law doesn't predict perihelion advance for one sun - one planet system (Sun-Mercury system). So according to Apparent Source Theory(AST), then there can never be pure circular or pure elliptic orbits in absolute space. There can't be perihelion advance in Galilean space. Pure circular and pure elliptic orbits are possible only in Galilean space.The observed perihelion advance of Mercury may be evidence for absolute motion (andforApparent Source Theory).

This theory is a fusion of ether theory and emission theory, for gravity.

The explanation provided so far applies to absolute space. In Galilean space, emission theory can simply explain stability of orbits, again without requiring infinite speed of gravity. But Galilean space is only an abstraction that is useful in solving problems of absolute motion and does not exist in reality.

Mercury perihelion advance

Paul Gerber correctly predicted the advance of Mercury perihelion by assuming that the speed of gravity is equal to the speed of light and this proves the correctness of AST as applied to gravity.

However, the apparent change in direction of gravity predicted by Apparent Source Theory [37] is opposite to the change in direction predicted by Paul Gerber's theory.

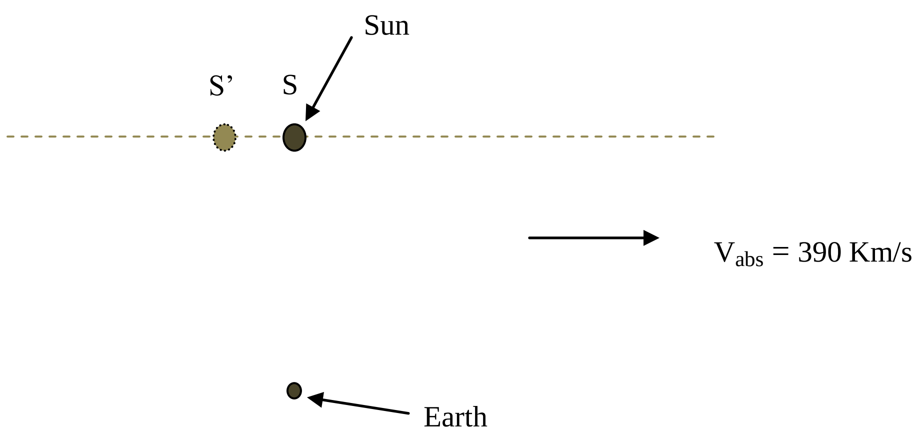
Astronomical evidence that the 'speed' of gravity is equal to the speed of light.

The following are quotes taken from Tom Van Flandern's paper [5]

" …. The Earth accelerates towards a point 20 arc seconds in front of the visible sun ... In other words, the acceleration now is towards the true, instantaneous direction of the Sun now, …"

" … Why do total eclipses of the Sun by the Moon reach maximum eclipse 40 seconds before the Sun and Moon's gravitational forces align ? … "

The new interpretation of absolute motion proposed in this paper turns these observations into evidences showing that gravity 'propagates' at the speed of light. Note that, as explained already, there is only apparent propagation. The effect is as if there was gravity propagation at the speed of light, but there is no actual propagation in static fields.



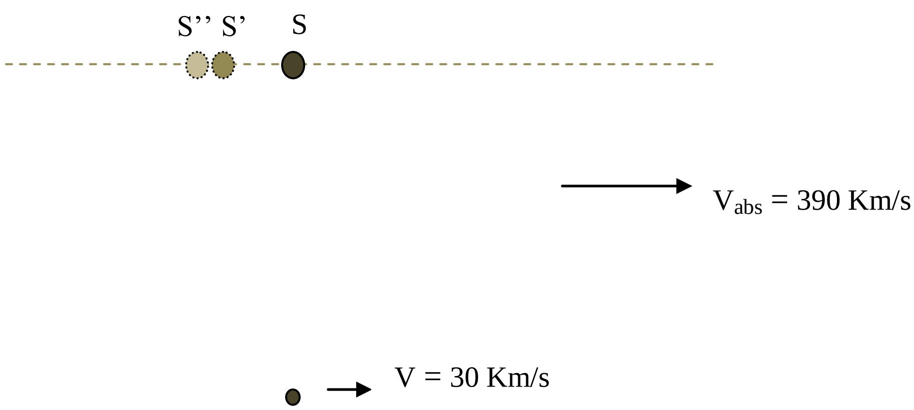
Assume that the Sun and the Earthare co-moving absolutely as shown above, with no relative motion between them. The amount of apparent change of the Sun's position is determined by the absolute velocity (390 km/s) , the Earth-Sun distance and the speed of light. The light rays are coming from the direction of the apparent Sun (S').

The angular position of the true, instantaneous position S of the Sun relative to its apparent position S' is determined as follows.

$$\frac{390Km}{2\pi * 300{,}000Km} * 360 * 3600 \text{ arc seconds} = 268 \text{ arc seconds}$$

Assume now that we measure the direction of Sun's gravity at the same time and it also pointed towards the apparent Sun (S'). What do we conclude ? We conclude that the speed of gravity is equal to the speed of light. If the 'speed' of gravity was infinite, the Sun's gravity would be towards S.

In the above argument, we assumed that the Earth is not moving relative to the Sun. Now we consider the Earth's motion relative to the Sun (30 km/s).



The sun will now appear to be at position S"(20arc seconds ahead of S'), due to Earth's *relative* motion. This is due to Bradley's aberration[37][38].

The mistake in Van Flandern's argument is that he considered point S' to be the true, instantaneous position of the Sun. Such mistake is committed in all arguments based on the principle of relativity, which denies the absolute motion of the solar system in space (390 Km/s). The true instantaneous position of the Sun is at S, 268 arc seconds ahead of S'. We consider this also to be the instantaneous, true position of the Sun because the Earth and the Sun have common absolute velocity. Such an interpretation is distinct from the ether or classical absolute space theory. This is an application of the fusion of the ether and emission theories to gravitation.

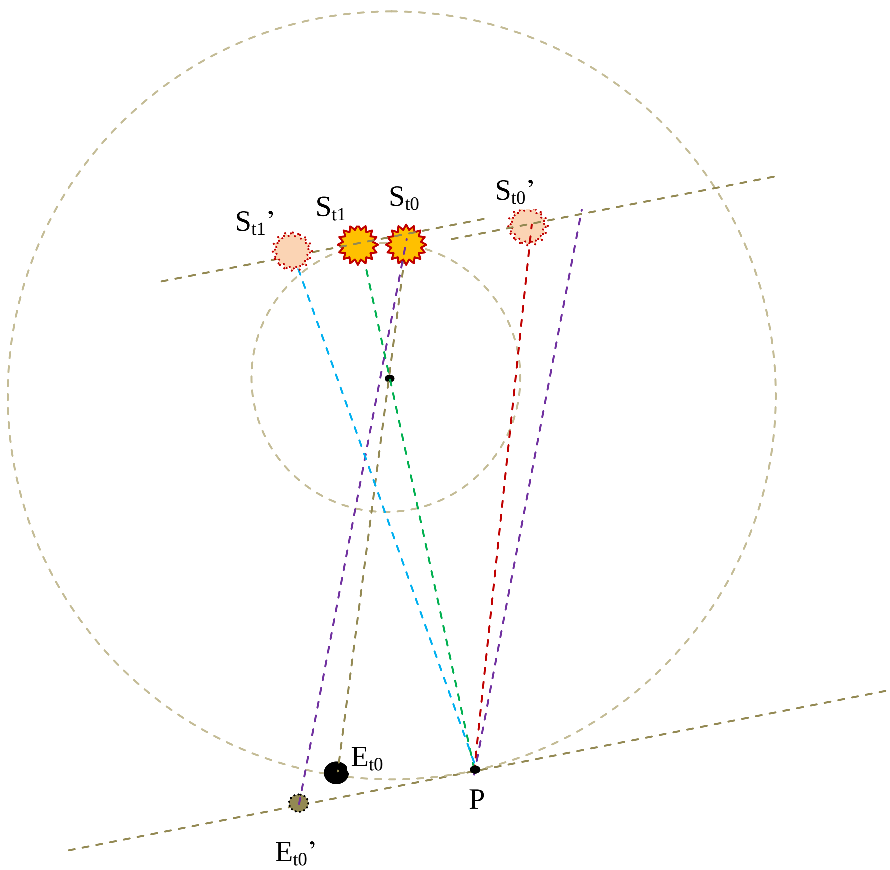
Thus, if the 'speed' of gravity was different from the speed of light, the Earth would accelerate towards a point <u>*different from*</u>*' a point 20 arc seconds in front of the visible sun'. This would be 288 arc seconds (i.e. 268 plus 20) in front of the visible sun, assuming the Earth's relative velocity and the Solar System's absolute velocity lie in the same plane, for simplicity.*

" …. The Earth accelerates towards a point 20 arc seconds in front of the visible sun ... In other words, the acceleration now is towards the true, instantaneous direction of the Sun now, …"

This observation shows that gravity is also directed towards S', showing that the speed of gravity is equal to the speed of light. One may ask : why does gravity also not act towards S'' instead of towards S'?i.e. why does Bradley aberration not apply to gravity?

For simplicity, we will assume that the Sun and the Earth revolve around a single bary-center and let us ignore the absolute velocity of the Solar system, which is 390 Km/s.

This problem requires us to consider the motion of the Earth as non-inertial. It can be shown that if the Earth and the Sun were co-moving inertially, there would be no difference between the direction of light and the direction of gravity.



Assume that the Sun emits light at t = 0, at the instant when the sun is at the point S_{t0} and the Earth is at the point E_{t0} , as shown in the above figure. Since the Earth is not strictly inertial, just as in the case of the Sagnac effect, we imagine an imaginary inertial Earth E' , which is at point E_{t0}' at the instant of light emission (t = 0) and which will arrive at point P simultaneously with the real Earth E, and moving with absolute velocity (magnitude and direction) equal to the instantaneous absolute velocity of the Earth at point P.

We start by assuming that the Earth (an observer on the Earth) E and the imaginary inertial Earth

E’ will detect the light at some point P, simultaneously.

We will do only a qualitative analysis here. In the reference frame of the imaginary inertial Earth E’, the apparent direction of light emission is along the red line. The purple line is the actual/physical direction of light emission. Thus, when the Earth E and the imaginary inertial Earth E’ arrive at point P, the light appears to come from the direction of the red line.

However, at the instant the Earth is at point P, the Sun will have moved to point S_{t1} . Since the Earth is moving to the right, the apparent direction of Sun’s gravity is in the direction along the blue line. Thus, at point P the observer on Earth is seeing light that was emitted about *eight minutes* ago coming from the direction along the red line and also detecting gravity *now* in the direction along the blue line (‘now’ because the speed of gravity is infinite).

Therefore, the light comes along the red line, whereas gravity comes along the blue line.

It is not difficult to figure out that the angle between the red line and the blue line is about 20 arc seconds. The red line is 20 arc seconds to the left of the purple line and the blue line is about 20 arc seconds to the left of the green line. Therefore, it follows that the angle between the red line and the blue line is equal to the angle between the purple line and the green line and this is approximately the angle travelled by the Sun during the time interval that the light travels from the Sun to the Earth, which is about 20 arc seconds.

In other words, the 20 arc seconds difference in direction of light and gravity arises because the speed of gravity is infinite and the speed of light is c .

Finite (c) and infinite speed of gravity

In the above discussions, we have given a new interpretation to astronomical observations that the speed of gravity is equal to the speed of light. However, since gravity is just a net electrostatic force (as will be discussed next), and since electrostatic forces have both finite (light speed) and infinite speed at the same time, the same is true for gravity.

The experimental and observational evidences for the dual nature of the speed of gravity are:

1. stability of planetary systems

2. astronomical observation that the Sun's gravitational pull on the Earth is directed towards 20 arc seconds in front of the visible Sun.

3. Mercury perihelion advance

Electrostatic theory of gravity

The new interpretation of observations and experiments on gravity presented in the last section led me to the striking conclusion that the 'speed' of gravity is equal to the speed of light.

Even after discovering that the speed of gravity is equal to the speed of light, the implication of this didn't happen to me immediately. At a certain moment such a striking 'coincidence' took my attention.

How can the speed of gravity be equal to the speed of light? Aren't gravity and light fundamentally different phenomena ? Isn't gravity a mysterious phenomenon? Can this be mere 'coincidence' ?

I had never considered the possibility that gravity may be an electrostatic or electromagnetic force. Once this 'coincidence' came to my attention, it didn't take me long before coming across a very compelling idea:

Gravity may be due to difference between electrostatic attractive and repulsive forces.

This means that the force of attraction between opposite charges is slightly greater than the force of repulsion between similar charges. In previous versions of this paper, I interpreted this as difference between free space permittivity for attractive and for repulsive forces. However, this created a conceptual problem[25]: which of the two permittivities would we use in Maxwell's equations, i.e. which of the two permittivities determines the speed of light ? Therefore I abandoned this idea of different permittivities and was able to solve this problem in [25], by introducing additional factors in Coulomb's law.

Coulomb's law is modified as follows[25]:

$$F_{att} = \frac{1}{4\pi\varepsilon_0}\frac{Q1\,.\,Q2}{r^2}K_{att}$$

$$F_{rep} = \frac{1}{4\pi\varepsilon_0}\frac{Q1\,.\,Q2}{r^2}K_{rep}$$

Where K_{att} is the constant for opposite charges and K_{rep} is for similar charges. K_{att} and K_{rep} are numbers very close to 1 and with extremely small difference between them to give rise to gravitational force. K_{att} is greater than K_{rep} because gravity is an attractive force.

I wondered if anyone else has already made such a proposal and searched the web, and found a paper [12] proposing the same idea, even claiming to have confirmed this hypothesis experimentally. I learned that this idea was first? proposed by Michael Faraday.

Gravitational magnetic field

Just as gravitational force is a difference between electrostatic attraction and repulsion forces, there should also be a net magnetic force between two neutral objects in absolute motion. Consider two neutral physical objects A and B moving in the same or opposite directions in parallel paths. In addition to the net electrostatic force (gravitation), there is an additional net static magnetic force between the two bodies. The force of magnetic attraction between the charges in A and B is different (less or greater ?) from the force of magnetic repulsion force.

Implications for Lorentz's ether theory and Einstein's relativity theories

The whole story of relativistic physics began with the null result of first order and second order ether drift experiments and the constant *c* in Maxwell's equations. The theoretical framework proposed in this paper has successfully explained many light speed experiments that have puzzled physicists for decades, without invoking any exotic ideas such as the ether, length contraction, time dilation.

Experimental evidences for absolute motion have accumulated over decades, including the Miller experiments, the Sagnac effect, the Marinov, the Silvertooth, the CMBR anisotropy, the Roland De Witte experiments.

Experimental evidences [35] also exist supporting the dependence of the (group) velocity of light on the observer velocity

Since it has been confirmed experimentally [4] that electrostatic fields have infinite speed, this will disprove the Special Theory of Relativity which has its foundation on the assumption that no information can be transmitted at speed greater than the speed of light. The universal speed limit applies only to physical objects.

The equivalence principle has also been shown to be wrong[25].

We know the paradoxes created by Special Theory of Relativity, the twin paradox and the Trouton-Noble paradox being just two of them.

Therefore, Lorentz's transformations and all theories based on it (Lorentz's ether theory, Special Relativity and General Relativity) are rendered irrelevant by theoretical and experimental evidences presented in this paper.

8. Other miscellaneous experimental associated with the theory of relativity

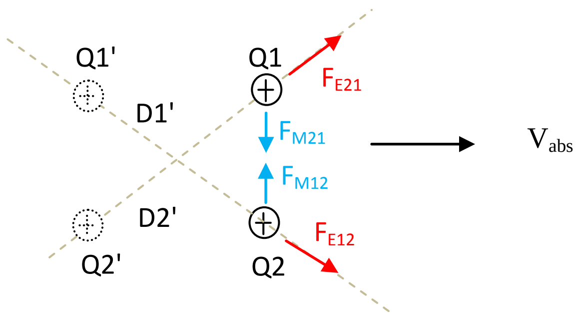
'Time-dilation'

The Hafele-Keating ,muon time-dilation, GPS correction experiments are claimed to confirm gravitational and kinematic time-dilation of GRT and SRT. Since SRT (hence GRT) has been disproved in this paper by presenting a compelling alternative theory (AST), basically its predictions are no more valid. The experimental results normally associated with SRT may be categorized as those that may be genuine and those that may be fraudulent. Even if the effects predicted by SRT were really observed, these should be questioned : were these effects observed *exactly* as predicted by SRT ? Were they really observed with the precisions (1% etc.) claimed? The Hafele-Keating experiment has been shown to be due to manipulation of raw data so as to obtain the result predicted by SRT.

A possible explanation of the kinematic ' time- dilation ' effects observed is a change in the line spectra of the (Cesium) atoms of the atomic clock due to absolute motion. As the absolute velocity of an atomic clock changes, the mass of the electrons in the atoms of the atomic clock change, which in turn affects the energy levels of the atoms.

Gravitational 'time-dilation' effects also may be due to a change in mass of the atoms and electrons with distance from cosmic massive objects (in this case the Earth). The mass of an electron in a Cesium clock decreases with distance from Earth. This hypothesis is based on a theory proposed by this author [25] that inertial mass and electrical self-inductance are fundamentally the same phenomenon. The mass of the atom and the electron (also the proton, the neutron) decreases with distance from Earth for the same reason that the self-inductance of a coil decreases with distance from ferromagnetic objects.

In the case of muon 'time-dilation' some qualitative explanation is possible. Consider two same sign charges absolutely co-moving .



As the absolute velocity V_{abs} approaches the speed of light, the repulsive electrostatic force (red) between the two charges also approaches zero since the apparent distance of each charge approaches infinity. Hence, even thought the charges have same sign, there will be no repulsive force between them. In addition to lack of repulsive force, there will be an attractive force: magnetic force (blue). As the absolute velocity decreases, the repulsive electrostatic force increases and the attractive magnetic force decreases. This might explain muon ' time- dilation '.

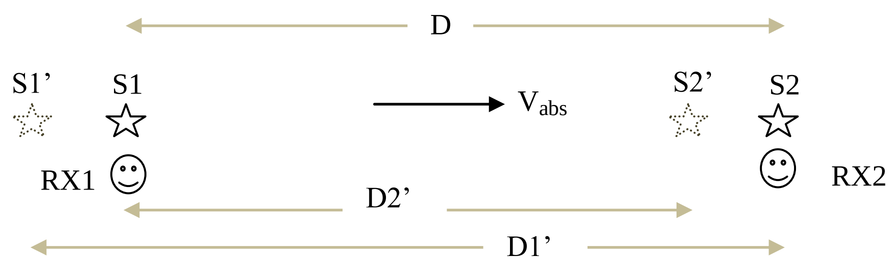
The conclusion is that if any such an effect exists in some form, it obviously need an explanation. However, SRT (and GRT) is not one.

Absolute velocity may affect the capacitance of a capacitor, because the position of each plate will change as seen by the other plate (distorting the electric field, creating electric field gradient) , and hence the oscillation frequency of electronic oscillators and resulting in change of clock rate.

A hypothetical clock

I will describe a hypothetical clock whose rate will depend on its absolute velocity, just to clarify the new theory.
Consider a clock working on the following principle, in absolute space. Two pulsed light sources S1 and S2, separated by distance D and two detectors located at the two sources so that the two

light sources and the two detectors form a transponder system, all co-moving absolutely.



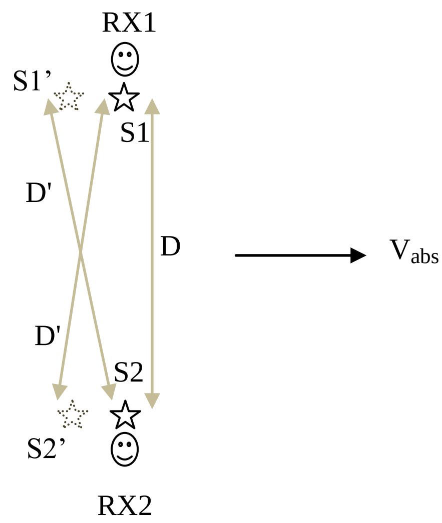
The operation of the clock is as follows: S1 emits a light pulse, then the detector RX2 detects the pulse, S2transponds with another light pulse without delay, the detector RX1 detects the light pulse and S1 transponds without delay and so on. An electronic pulse counter can count the number of transmissions and hence a clock.

The round trip time depends on absolute velocity as shown below:

$$\frac{D2'}{c} + \frac{D1'}{c} = D\frac{c}{c + V_{abs}}\frac{1}{c} \quad + \quad D\frac{c}{c - V_{abs}}\frac{1}{c}$$

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

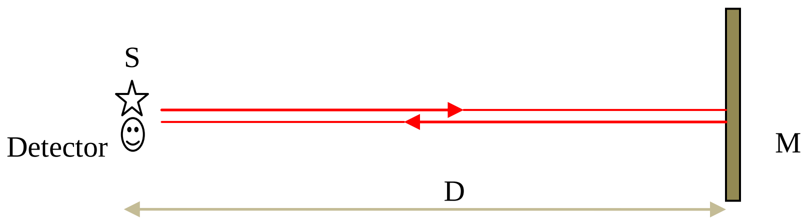
It can be shown in a similar way that for absolute velocity directed perpendicular to the line connecting the two transponders.



$$\text{Round trip time} = \frac{2D'}{c} = \frac{2D}{\sqrt{c^2 - V_{abs}{}^2}}$$

We see that the round trip time and hence the clock rate is affected by absolute velocity. The higher the absolute velocity, the slower the clock. Only the rate of the clock slows down ; there is no ‘time dilation’.

Note that the hypothetical clock is made from transponder system. To make the distinction clear, let us consider another kind of clock, which is made of a pulsed light source, a light detector (receiver) and a mirror.



The pulsed light source S and the light detector are very close to each other, so they can be assumed to be at the same point in space. The clock operates as follows. The source S emits a short light pulse, which is reflected from the mirror M back to the detector. Upon detecting the reflected light pulse, the detector actuates the source to emit a light pulse again, which is reflected back to the detector and so on. The rate of such clock is independent of absolute velocity because the round trip time is always equal to 2D/c.

These examples are only about kinematic 'time-dilation'.

What about real atomic clocks? Electronic clocks? The hypothetical clock is made of a transponder system. How can slowing down of atomic clocks be explained? . We have clearly seen that our hypothetical clock, that uses time of flight method, is affected by absolute motion.

In the above discussion I just tried to show that it is possible to build a clock whose rate is affected by absolute motion. But I can't clearly figure out how an atomic clock slows down due to absolute or relative motion (kinematic time dilation). The Hafele-Keating experiment and GPS correction are controversial and many authors, such as A.G Kelly, consider these as a fraud.

Conclusion: Within the new theoretical framework proposed in this paper, there is no prediction or explanation for gravitational and kinematic 'time dilation' of atomic clocks , as claimed in Special Relativity. But the effect of change in mass with absolute velocity and with distance from massive cosmic objects as proposed in this paper, might have an effect at the atomic level, changing emission and absorption lines of atoms.

Star light bending near the sun

The bending of star light near the sun is currently considered to be due to the mass of the sun, according to General Relativity. An alternative explanation [7, 22] has been proposed for the bending of light near massive objects. It is proposed that the effect is not due to the mass of the sun, but due to its size. This is based on a new insight into the Huygens-Fresnel principle.

It may be tempting to speculate that vacuum permittivity and permeability is affected by massive objects, in their vicinity, to explain the bending of star light near the Sun. I propose that vacuum permittivity and permeability, hence the speed of light, is not affected by massive objects and is constant throughout the universe. I propose that the Rosa and Dorsey experiment (1907) be repeated at different distances from the Earth to see if there is any effect on vacuum permittivity and permeability.

9. Conclusion

The real nature of the speed of light has remained a mystery ever since the historical Michelson-Morley experiment and Maxwell's discovery of the speed of light. There are numerous and divergent empirical evidences that have accumulated for centuries, defying any natural, intuitive, logical explanation, within a single theoretical framework. All known theories of the speed of light, including Special Relativity, emission theory and ether theory, failed on a number of experiments. Physicists have failed to create a model of the speed of light that can consistently predict or explain the outcome of experiments, let alone understand the fundamental nature of light. There is no known theory of light so far that can consistently explain even three of the experiments: the Michelson- Morley experiment, Sagnac effect and Silvertooth experiment. The model of the speed of light proposed in this paper (AST) successfully explains many experiments that have remained mutually contradicting and controversial for decades. A few theories and interpretations have been proposed as a single theoretical framework.

1. The *group* velocity of light is constant relative to the apparent source. The effect of absolute motion of a light source is to create an apparent change of its past position relative to an observer. Physically this means that the group velocity of light varies*relative* to the real source, due to absolute motion and also means bending of light rays in lateral directions.

The procedure of analysis of light speed experiments is as follows:I. Determine the distance between the observer and the apparent source *at the instant of emission*II. 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 determinedIII. Solve the problem by assuming that the speed of light is constant *relative to the apparent source,* in the co-moving observer's reference frame or in the absolute reference frame.

2. The *phase* velocity of light is always constant c, independent of source or observer velocity,whereas the group velocity is independent of source velocity but depends on observer and mirror velocity. This model disentangles absolute velocity from Doppler effect.
3.TheexponentialLawof Doppler effect of light.
4. Absolute velocity of an object is the resultantof its mass weighed velocities relative to all massive objects in the universe.
5. Mass (inertia) might be nothing but radiation reaction.
6. The speed of light is the universal speed limit of physical objects in the universe.
7. Light is a dual phenomenon: local and non-local
7. The speed of static electric fields have a dual nature: finite (light speed) and infinite
8. Gravity is a difference between attractive and repulsive electrostatic fields.

The Apparent Source Theory (AST) fully explains conventional and modern Michelson-Morley experiments, the Sagnac experiments, moving source and moving mirror experiments, moving observer experiments, the Silvertooth, the Marinov, the Roland De Witte, the Bryan G Wallace experiments. The procedure to apply AST is : 1. Replace the (real) source with an apparent source 2. Solve the problem by assuming that the group velocity of light is constant relative to the apparent source. AST also enabled us to give a new interpretation to observations of direction of Sun's gravity on Earth, during solar eclipses. The 'speed' of gravity has been shown to be equal to the speed of light. This fact, together with a very simple, compelling theory that gravity may be just a difference of electrostatic attraction and repulsion forces, led to the conclusion that gravity must be just a form of electromagnetic phenomenon. Constant phase velocity and variable group velocity of light provides a compelling interpretation of Einstein's thought experiment: chasing a beam of light. The Exponential Law of light correctly explains the Ives-Stilwell experiment. The mystery of electromagnetic radiation has been revealed. Relativistic mass increase of charged particles and hence universal light speed limit hasbeen explained based on the law of non-linear radiation reaction. The equivalence of inertia with radiation reaction has been proposed. A successful theoretical framework of the speed of light has been presented in this paper. This will enable understanding of the nature of light at a more fundamental level and other phenomenon. This entails reconsideration of Maxwell's equations, their solutions and interpretations. Maxwell’s equations do not predict radiation reaction correctly and do not predict universal speed limit. While this paper has solved many long standing problems of the speed of light, a number of anomalous observations still exist, such as cosmological red shift and the Pioneer anomaly.

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

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