Apparent change of position of light source relative to detector/observer due to rotation and acceleration - a new interpretation and analysis of Michelson-Morley and Sagnac experiments

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Abstract

To a detector on a rotating Sagnac device, the source appears to be farther away when 'looking' in the backward direction than when 'looking' in the forward direction. The effect of rotation is just to create an apparent change in the position of the source relative to the detector, in proportion to the angular velocity of the device. This paper does not present any new mathematical analysis for the difference between path lengths of the forward and backward light beams in the Sagnac interferometer. The well known equation for the difference in path lengths, $4\omega A / C$, is given a new interpretation. The new interpretation in this paper is that *the apparent source is always at the center of the wave fronts*. Regarding the Michelson-Morley (MM) experiment, this paper presents a surprising result: no fringe shift will occur even on an accelerated MM device, in contrast to the title of this paper! This is because the apparent shift of the position of the source relative to the detector has the *same*, *common* effect on the time delays of both light beams. The path length of both the forward and lateral beams are affected equally. This paper, together with the Relativity of Electromagnetic Waves theory [1] which was proposed earlier by this author, provides a new theoretical framework which can explain all or most of the phenomena and experiments related to the speed of light. The new theoretical framework is a fusion between Ritz's emission theory and Einstein's light postulate, together with a truly empty notion of space.

Introduction

There is no theory or postulate of light so far that can explain *all* the observed phenomena and experiments on the speed of light AND with out invoking unintuitive hypotheses and bizarre consequences. The ether theory has been ruled out by the famous Michelson-Morley experiment. Ritz's emission theory has been ruled out by the many experiments that established the source speed independence of the speed of light and by the Sagnac effect. Special Relativity better agrees with experiments and observations but it introduces the unintuitive hypotheses of length contraction and time dilation (or relativity of space and time). Moreover, it doesn't predict stellar aberration in the earth bound reference frame [2]. A closer examination of SR reveals that it is based on an implicit assumption of the ether and does not completely get rid of the ether hypothesis as claimed. Moon and Spencer's Universal Time Postulate is not in agreement with the fact that the speed of light is independent of the speed of its source. Moreover, it has a consequence that acceleration of the source is felt instantaneously at all points (distances) from the source.

Perhaps the contradiction between Sagnac effect and the Michelson-Morley experiments has been the most challenging problem related to the speed of light.

The Relativity of Electromagnetic Waves theory [1] proposed earlier by this author explains most experiments and phenomena related to the speed of light except the Sagnac effect. The Relativity of Electromagnetic Waves theory and the new theory proposed in this paper form a new theoretical frame work that can explain all or most experiments and phenomena related to the speed of light.

Discussion

Sagnac's experiment

Imagine a stick of length *L* with a light source S fixed to one of its ends and a detector D fixed to its other end (Fig.1) .

If the stick is moving inertially (neither accelerating nor rotating), a light pulse emitted by the source will travel a path of length *L* and will be detected after a time delay of *L/C* , where *C* is the speed of light.

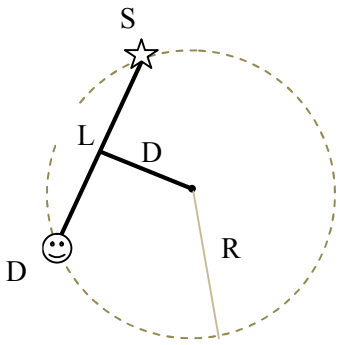

Fig.1

Suppose that the stick is rotating about some center in the clockwise direction as shown in the figure. (Fig. 2)

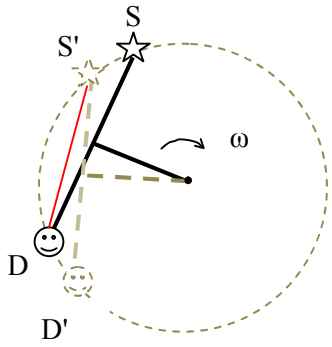

Fig.2

The source and the detector are at points S and D respectively, at an instant of time *T*. At time instant *T*, the detector is detecting light (red line) which was emitted at an earlier instant of time *T ′* (red line). At time *T ′* the source and the detector were at points S' and D' respectively.

There is nothing new in the above analysis, but a new interpretation is introduced in this paper.

The new interpretation is stated as:

To the detector, the light source appears to be at a position S' relative to the detector, at distance L' from the detector. This is again interpreted as: the center of the wave fronts is always at the apparent source S' and moves with the apparent source S' .

The procedure to analyze this problem is first to determine the apparent position S' of the source relative to the detector, which includes the apparent distance *L'*, and then analyze the problem as if the device is stationary (i.e. not rotating).

This same basic approach will apply in the analysis of Sagnac's experiment. The difference between the path lengths of the forward and backward light beams in a Sagnac's interferometer is determined from the well known equation:

$$\Delta = (4\omega A) / C$$

In this paper we will not attempt to re-derive this equation. A new interpretation of this result is proposed in this paper as follows:

The source appears to be shifted towards the detector by half this amount 'as seen by the detector' in the forward direction and it appears to be shifted away from the detector by half this amount 'as seen by the detector' in the backward direction. The key interpretation in this paper is that the apparent source is always at the center of the wave fronts.

The effect of rotation is just to create an apparent change in the position of the source relative to the observer.

The consequences of this interpretation are:

1. Although the center of the wave fronts always moves with the apparent source, it is still possible to explain the fringe shift.

2. The speed of light relative to the detector (and *relative to all detectors/observers*), in vacuum is always a constant *C*.

Michelson-Morley experiment

In this paper, a new way of analyzing Michelson Morley experiment is proposed. Imagine a stick of length *L* , with a light source S fixed at its rear end and a detector D fixed at its front end (Fig.3).

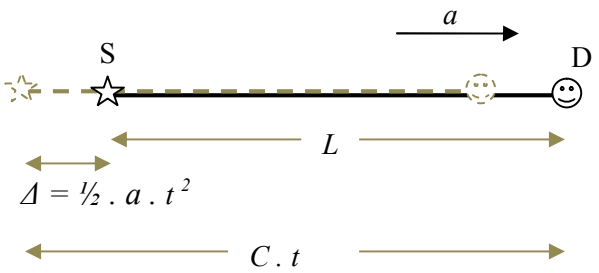

Fig.3

If the stick moves inertially, a light pulse emitted by the source has to travel a path of length L before it is received by the detector. Hence, the light pulse will be detected after a time delay of L/C, where C is the speed of light.

If the stick is accelerating forward along its axis, however, the light pulse has to travel an extra distance which is $\frac{1}{2}.a.t^2$, where a is the acceleration and t is the time interval between emission and reception, which is to be determined from the equation:

$$C \,.\, t - 1/2 \,.\, a \,.\, t^2 = L \,.$$

The valid solution to this quadratic equation is

$$t = (1/a) \,.\, (C - (C^2 - 2aL)^{1/2})$$

The extra distance is determined by the acceleration and the length of the rod.

The new interpretation is : *to the detector, the position of the source appears to be shifted away relative to the detector by an amount equal to the extra distance, $\frac{1}{2} \,.\, a \,.\, t^2$. The apparent source is always at the center of the wave fronts.*

Let us try to analyze the Michelson - Morley experiment (MMX) by applying the above theory.

At first sight, it might seem that a fringe shift should be observed on an accelerating Michelson-Morley device. However, a little careful thought reveals that no fringe shift will occur even during acceleration. *This is because the apparent shift of the source is always common to both the forward and the lateral beams* (Fig.4). *Both the forward and lateral beams are affected equally*. Therefore, according to this theory, no fringe shift will be observed however large the acceleration is.

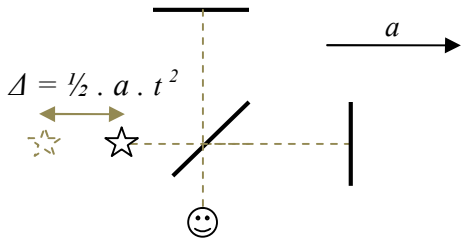

Fig.4

The effect of acceleration on an MMX is to create a change in path length and hence a change in time delay between emission and reception , in the *same* way to both beams.

A kind of MMX thought experiment in which acceleration can result in fringe shift is explained as follows (Fig.5). S1 and S2 are two coherent light sources each at a distance D from the reflector.

The difference between the path lengths (the difference b/n length of the two red lines) of the two beams will be:

$$\Delta = (D^2 + (1/2 \,.a \,.\, t^2)^2)^{1/2} - (D - \tfrac{1}{2} \,.\, a \,.\, t^2)$$

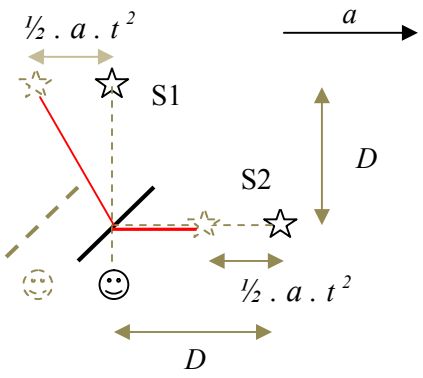

Fig.5

The procedure of analysis of Sagnac's and Michelson-Morley's experiments and thought experiments of the above kind is first to determine the apparent position of the source relative to the detector, then replace the real source with an apparent source at the apparent position and then analyze the experiment as if the device is stationary (i.e. not rotating or not accelerating).

This paper, together with a previous paper in which the Relativity of Electromagnetic Waves theory [1] was proposed by this author, provides a new theoretical framework which can explain all or most of the phenomena and experiments on the speed of light. The new theoretical framework is a fusion between Ritz's emission theory and Einstein's light postulate, together with a truly empty notion of space. Special Relativity (SR) is a theory which is based on an implicit assumption of the ether. The new theory has the feature of Ritz's emission theory in that the center of the wave fronts always moves with the apparent source, without creating Willem de Sitter's bizarre effects with binary stars. The new theory has the feature of Einstein's light postulate in that the speed of light relative to any observer is always constant, despite the fact that the center of the wave fronts always moves with the apparent source. The speed of light is independent of the velocity of the source and the velocity of the observer. The new theory gives a new interpretation to Einstein's light postulate with out the need of length contraction time dilation hypotheses.

Conclusion

This paper introduces a new way of explaining the two well known experiments. The mathematical analysis of Sagnac's effect is well known. What was wrong was the interpretation. The absence of fringe shift on the Michelson-Morley experiment has never been explained so as to bring an end to the controversies. In this paper, a new way of analyzing the MMX has been introduced. The key interpretation introduced in this paper is that rotation and acceleration result in an apparent change in the position of the light source relative to the detector.

Always thanks to God and His Mother, Our Lady Saint Virgin Mary.

References and notes

1. *' A novel solution to the century old light speed paradox. Divorce of the light postulate from Special Relativity; Relativity of Electromagnetic Fields/ Waves'*. http://vixra.org/pdf/1302.0065v5.pdf

2. *Stellar Aberration and the Postulates on the Velocity of Light*, by Domina Eberle Spencer and Uma Y. Shama