

Decisive Test for the Ritz Hypothesis

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The Sagnac experiment is analysed in terms of the Ritz hypothesis, after first setting out the principles and ideas that underpin the analysis. One is the concept of an extinction distance, the distance over which all memory of the source velocity is lost as a result of absorption and re-emission by the atoms and molecules in the medium. It is shown that no fringe shift should occur on rotation of a Sagnac type interferometer in high vacuum, but the expected shift should occur in laboratory air where the extinction distance is much shorter than the dimensions of the apparatus. An outline is given of a proposed experiment that will provide a comparative test in vacuum and in air, thereby acting as a decisive test of the Ritz hypothesis.

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1. Introduction

It is over one hundred years since Albert Einstein [1] proposed his Special Theory of Relativity to explain the null result of the Michelson-Morley experiment [2]. In that time his theory has become widely adopted as representing physical reality at relativistic velocities. The alternative explanation embodied in the Ritz Hypothesis [3] has been generally discarded, but as yet no decisive test has been performed to disprove this hypothesis.

I count myself among the sceptics, who over the years have expressed concerns about the implications of the Special Theory of Relativity, such as the contraction of space and the time dilation that must accompany a moving body. Dingle [4] wrestled with the Twin Paradox and not long ago Schultz Poquet [5] has expressed more general concerns.

I have recently published the results obtained from applying the Ritz Hypothesis to systems having linear relative motion between source and observer [6], and have shown that it satisfactorily explains the various experimental observations. The individual findings will be outlined later in the paper.

One significant omission from my previous work concerned rotating optical systems, most notably the Sagnac experiment [7]. Having since carried out an analysis of this experiment, I found a predicted difference in behaviour depending on whether the light propagation takes place in vacuum or in laboratory air. This result may form the basis of what may prove to be a decisive test that will either disprove or validate the Ritz hypothesis.

To avoid any confusion resulting from in-built assumptions that might negate the arguments to be presented, I now detail the principles and ideas underpinning them. After a brief description of Sagnac's four-arm interferometer test, the analyses are then set out,

firstly for the case of high vacuum, then for the case of laboratory air at Standard Temperature and Pressure (STP). The paper concludes with a brief description of the proposed decisive test.

2. Principles

Absolute Time and Absolute Space

Of prime importance to the Ritz Hypothesis are the principles that time and space are absolute, as defined by Newton in his *Principia* [8], where he stated that time is *Absolute, true, and mathematical time, of itself, and from its own nature flows equally without regard to anything external* and space is *Absolute space, in its own nature, without regard to anything external, remains always similar and immovable*.

This means using three dimensional Euclidean geometry free of any transformation such as the Lorentz transformation as adopted by Einstein in his Special Theory of Relativity. The analyses to be presented therefore contain no time dilation and no space contraction. Consequently there can be no Twin Paradox. This is not to deny any apparent change in time interval, for intervals short compared with the transit time, which manifests itself as a Doppler frequency shift for light received by an observer from a relatively moving source.

As regards absolute space, true empty space is only achieved in a perfect vacuum, because space otherwise contains a very large number of air molecules, for instance $2.687 \times 10^{23} \text{ m}^{-3}$ at STP.

The Ritz Hypothesis

Expressed in its simplest form, this states that light emitted from a moving source spreads out with a velocity c as a spherical wave about a centre which acquires the velocity of the source at the instant of emission. As shown in my recent publication, the first

consequence of linear relative motion between source and observer is that the observed direction of the moving source is displaced from its true direction by an amount dependent on the relative velocity of the source, consistent with the well-known (astronomical) aberration of light found by Bradley [9]. The second consequence is that the frequency of the radiation received by the observer is shifted from that emitted by the source by an amount dependent on the relative motion between them. An unexpected finding was that, when radiation is received by the observer from all directions, more of it is registered as red shifted than blue shifted, the more so the greater the velocity. This could have implications in respect of the astronomical red shift and the expansion of the universe [10].

Moving Mirrors

When reflection takes place at a mirror, electrons in the metal surface oscillate in response to the incoming radiation, thereby creating the reflected wave, the whole process taking place within a few cycles. Any time delay in the reflection process is the same irrespective of the direction of travel of a moving mirror. Therefore a moving mirror may be considered to act as both a moving receiver to the incoming radiation and a moving source for the reflected wave.

Extinction Distance

One further consequence of the Ritz hypothesis is that it predicts a regular and marked variation in intensity for a rotating source at astronomical distances. One major reason why the Ritz hypothesis was abandoned previously is that no such variation was observed for rotating double star systems where it might have been expected [11]. The situation has been further complicated by the discovery of pulsars [12] at radio frequencies, which have been attributed to rapidly rotating sources. In order to explain this dichotomy, the previous work invoked, not only the Ritz Hypothesis, but also the concept of

an *Extinction Distance*. According to this concept, as a result of light being absorbed and re-emitted by the atoms and molecules in the medium through which it is propagating (though not necessarily with any net absorption), all memory of the velocity of the original source is lost after this distance has been exceeded. The acquired additional velocity is then relevant to the motion of the medium rather than that of the original source.

This distance was estimated to amount to
$$z \sim \frac{0.5}{n - 1} \quad (1)$$

For visible light, this amounts to about 1 mm in laboratory air at STP, but extends to about 1 km in a high vacuum of 10^{-3} torr. In the depths of inter-stellar space it rises to about 2 light years. Although a vast distance, this is still short enough that optical pulsars are not observed. The fact that pulsars are observed at radio frequencies over distances between 200 and 7000 light years was attributed to the Extinction Distance being very much longer at radio frequencies.

When the Extinction Distance was taken into account, the previous work also gave a plausible explanation for the results of Fizeau's aether drag experiment [13].

3. The Sagnac Experiment

In 1913 Sagnac [5] was the first to report a fringe shift attributable to rotation of an interferometer apparatus. Sagnac's equipment has been described in detail by Post [14]. His interferometer had four arms arranged in a closed loop as sketched in Figure 1, unlike the Michelson interferometer which had only two perpendicular arms. In the Sagnac interferometer two light beams created at the half-silvered mirror H traversed in opposite directions around the four arms to produce an interference fringe pattern at the detector. The

interferometer was mounted together with light source and detector, on a turntable. When the turntable was rotated at two revolutions per second, Sagnac detected a fringe shift of 0.07 fringes as a result of reversing the direction of rotation. The interferometer had 0.0860 m^2 loop area. The light source was Hg indigo (wavelength 435.8 nm).

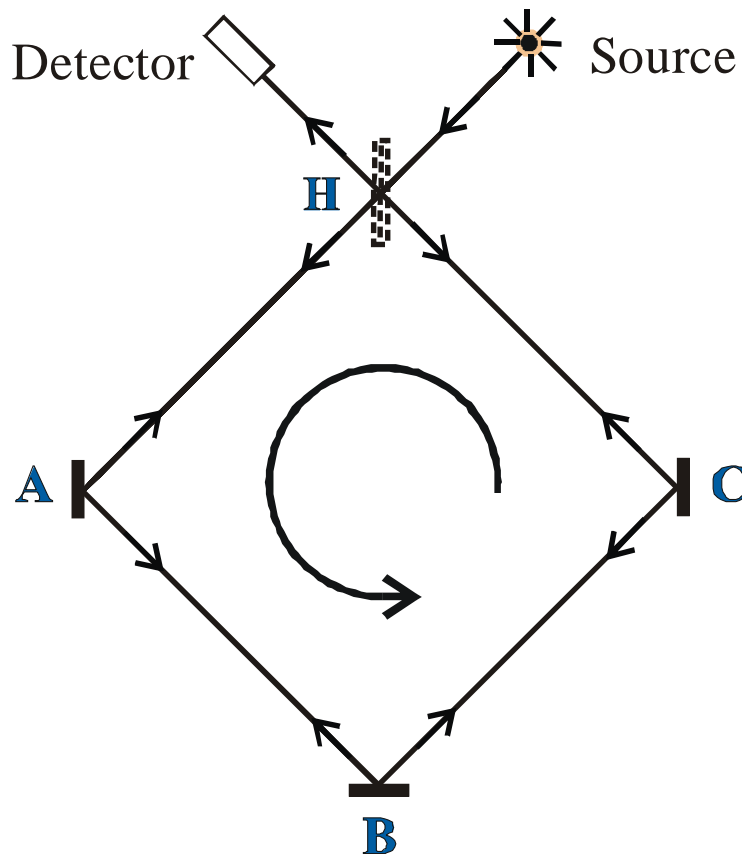


Figure 1. The Sagnac Interferometer

One crucial feature of the Sagnac interferometer is that the rotational movement of the mirror system takes place through a relatively stationary medium, whereas in the Michelson-Morley experiment the mirrors and medium move together through space.

4. Analysis in Terms of the Ritz Hypothesis

The propagation of light around the Sagnac interferometer may be analysed in terms of the Ritz hypothesis with the aid of the sketch

given in Figure 2. The rotational velocity of each mirror is $v = \omega d$ where ω is the rate of angular rotation. For v small compared with the velocity of light, each mirror may be considered to undergo a small linear movement during the time taken for light to propagate from source to receiver (observer). In that time, the source has moved from S to $S'_{1,2}$ and the observer has moved from O'_1 to O_1 or from O'_2 to O_2 , the subscripts referring respectively to propagation with and against the direction of motion. We consider two cases: in high vacuum and in air. For the former, light propagates with velocity c with respect to the velocity of the source, as has been described previously [3]. For the latter, the extinction distance is very short compared with the dimensions of the apparatus so that light propagates directly from the original source position to the observer positions.

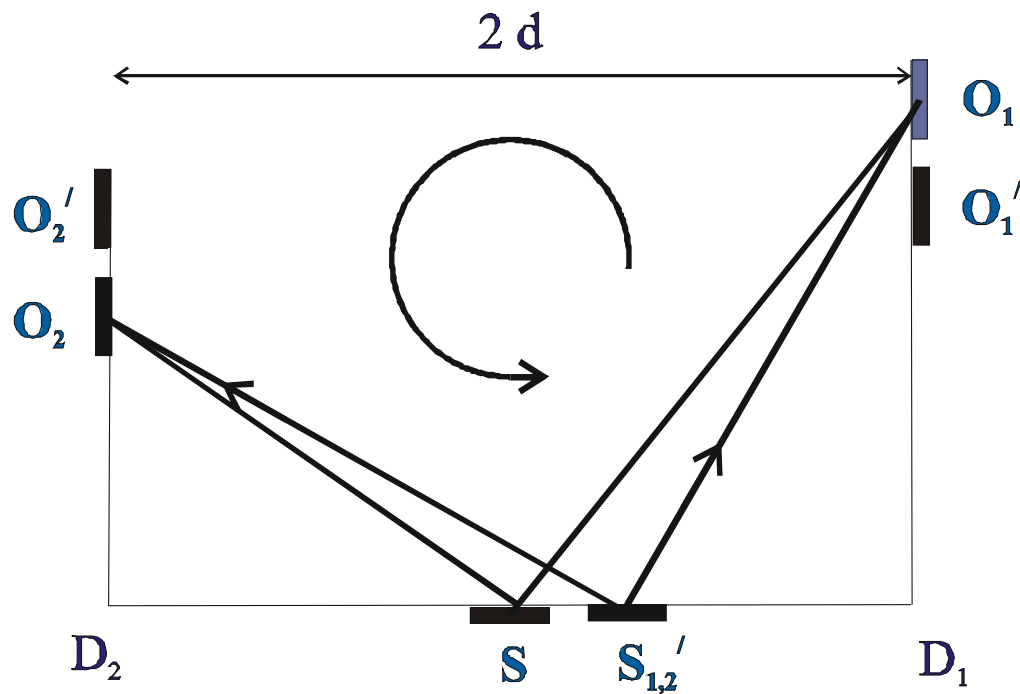


Figure 2. Sketch showing light propagation in one quadrant of the interferometer; subscript 1 \vec{v} in the direction of interferometer rotation and subscript 2 \vec{v} against it

In high vacuum case

The centre of the wavefront is at $S'_{1,2}$ when the wavefront reaches O_1 or O_2 (we shall see that the propagation times are identical for propagation with and against rotation).

$$\begin{aligned} \text{Now } O_1' O_1 = S S'_{1,2} = v t_1 \text{ and } S'_{1,2} O_1 = c t_1 ; \\ \text{also } O_1 D_1 = d + v t_1 \text{ and } S'_{1,2} D_1 = d \sqrt{1 - v^2/c^2} \\ \text{Hence } (c t_1)^2 = (d + v t_1)^2 + (d \sqrt{1 - v^2/c^2})^2 \end{aligned} \quad (2)$$

$$\begin{aligned} \text{Similarly } O_2' O_2 = S S'_{1,2} = v t_2 \text{ and } S'_{1,2} O_2 = c t_2 ; \\ \text{also } O_2 D_2 = d \sqrt{1 - v^2/c^2} \text{ and } S'_{1,2} D_2 = d + v t_2 \\ \text{so that } (c t_2)^2 = (d \sqrt{1 - v^2/c^2})^2 + (d + v t_2)^2 \end{aligned} \quad (3)$$

Clearly, the transit times are identical, irrespective of the direction of travel. This means that no fringe shift will occur when the apparatus is rotated in vacuum.

In laboratory air case

In this situation, the mirrors are in motion but the air medium is stationary. Because the Extinction Distance in the laboratory air is very short compared with the dimensions of the apparatus, light propagates directly from the original source position to the observer positions. This says that

$$SO_1 = c t_1, \quad SO_2 = c t_2 \text{ and the transit times are now given by:} \\ (c t_1)^2 = d^2 + (d + v t_1)^2, \text{ which gives}$$

$$c t_1 = d \left(\sqrt{2 + v/c + \sqrt{1 - v^2/c^2}} \right) \quad (4)$$

$$(c t_2)^2 = d^2 + (d \sqrt{1 - v^2/c^2} + v t_2)^2, \text{ which gives} \\ c t_2 = d \left(\sqrt{2 \sqrt{1 - v^2/c^2} + v/c + \sqrt{1 - v^2/c^2}} \right) \quad (5)$$

For one arm of the interferometer the transit time difference between opposite directions is

$$t_2 - t_1 = 2 v d / c^2 .$$

The fringe shift for transits involving all four arms is

$$\left| \frac{8 v d}{c^2} \times f \right| = \left| \frac{8 v d}{c} \right| \left| \frac{4 A}{e} \right| \quad (6)$$

where we have used the fact that the area enclosed by the interferometer is $A = 2 d^2$. The fringe shift occurring due to reversal of the direction of rotation is double this amount. The expression is identical to that given by Sagnac. Substituting his experimental values gives a shift on reversal of 0.066 fringes, in good agreement with the 0.07 found.

5. The Decisive Test for the Ritz Hypothesis

Since the analyses have shown that no fringe shift is expected if the Sagnac experiment is performed in high vacuum, only if in laboratory air, this gives us a means of testing the Ritz hypothesis, by performing the experiment under both sets of conditions. To do this, the interferometer must be enclosed in a vessel capable of being evacuated, which in turn means using magnetic bearings to support the interferometer; also rotating it by means of an induction motor drive.

An interferometer of ~0.4 m diameter is proposed. To improve the magnitude of any fringe shift, the rotation rate would be increased to as high as (say) 20 revolutions per second. From equation (6), using light with $\zeta \sim 500$ nm (say), the predicted fringe shift on moving from rest to full speed in laboratory air is

$$\tau = 8 v d / c \zeta = 0.27 \text{ fringes.}$$

Since the half-silvered mirror is transverse to its motion, it would be necessary to streamline it with transparent (plastic?) lead-in and lead-out fairings, so as to minimise any disturbance of the air flowing past when rotation takes place at high speed at atmospheric pressure. A minimal support structure for the mirrors is proposed for the same reason.

The light source and detector would probably not be attached to, and so not rotate with the interferometer, but could be outside the vacuum vessel and be pulsed in synchronism with the alignment of the half-silvered mirror.

A possible experimental sequence might be as follows. Set up the fringe pattern with the interferometer rotating at low or zero speed, and with the vessel containing the interferometer fully evacuated to high vacuum. Increase the speed of rotation up to its maximum and observe (if the Ritz hypothesis is true) that no fringe shift occurs. Then let the vessel's pressure rise to atmospheric and observe that the expected fringe shift occurs. Finally, reduce the speed of rotation to zero and observe that the fringe pattern returns to its original position.

It need hardly be said that, were the Ritz hypothesis to be substantiated, it would have profound implications for modern day Physics. In my opinion, it is highly desirable that this Decisive Test be carried out. I therefore encourage interested organisations with sufficient funds to undertake its implementation, which is well beyond my limited means.

References

- [1] Einstein A, Zur Elektrodynamik bewegter Körper, *Ann. Phys.*, **17**, p891-921, (1905), translation in: *Relativity: The Special and General Theory*, Methuen & Co, London, (1920, reprinted 1964)
- [2] Michelson A A, Morley E W, On the Relative Motion of the Earth and the Luminiferous Ether, *Am. J. Science*, **34**, 333-344, (1887) Cited in secondary

source: *Physics Today* **40** (5), (1987), (Special edition commemorating the centennial of the Michelson-Morley experiment)

- [3] Ritz W, *Recherches Critiques sur l'Electrodynamique Generale*, *Ann. de Chim. et Phys.*, **XIII**, 145-275; (1908), translation by: Hovgaard W, Ritz's *Electrodynamic Theory*, *J. Math. Phys.*, **11**, 218-254, (1932)
- [4] Dingle H, The Case Against Special Relativity, *Nature*, **216**, 119-122, (1967)
- [5] Schultz Poquet JJ, An Astronomical Test for the Second Postulate of the Special Theory of Relativity, *Apeiron*, **12**, 228-255, (2005)
- [6] Ballad J P, *Revisiting Electromagnetic Phenomena: Introducing the Radiated Electrical Property*, Ch 1-5, Hillcroft Publications, Stafford, UK, (2007)
- [7] Sagnac G, *l'Ether Lumineux Demontre par l'Effet du Vent Relatif de l'Ether dans un Interferometre en Rotation Uniforme*, *Comptes Rendus Acad. Sci.*, Paris, **157**, 708-710, (1913)
- [8] Newton I, *Philosophiae Naturalis Principia Mathematica*, London, Book 1: Definitions, Scholium , (1687), - translated by: Motte A in: *On the Shoulders of Giants*, Ed: S Hawking, Running Press, Philadelphia, USA, 737-742, (2002)
- [9] Bradley J, A New Discovered Motion of the Fixed Stars, *Phil. Trans. Roy. Soc.*, London, **35**, 637-661, (1728)
- [10] Hubble E P, A Relation Between Distance and the Radial Velocity Among Extra-Galactic Nebulae, *Proc. Nat. Acad. Sci.*, **15**, 168-173, (1929)
- [11] Joy A H and Sandford R F, The Dwarf Companion to Castor as a Spectroscopic Binary and Eclipsing Variable, *Astrophys. J.*, **64**, 250-257, (1926)
- [12] Hewish A, Bell S J, Pilkington D J H, Scott P F, & Collins R A, Observation of a rapidly pulsating radio source, *Nature*, **217**, 709-713, (1968)
- [13] Fizeau H, *Sur les Hypotheses Relatives a l'Ether Lumineux, et sur une Experience qui Parait Demontrer que le Mouvement des Corps Change la Vitesse avec laquelle la Lumiere se Propage dans Leur Interieur*, *Comptes Rendues Acad. Sci.*, **33**, 349-355, (1851)
- [14] Post E J, Sagnac effect, *Revues of Modern Physics*, **39** (2), 475-494, (1967)