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The Relative Motion of the Earth and the Ether Detected

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"I have reviewed the experiment of Sagnac, having in mind the claim that the ether can not be detected experimentally. I have asserted that, in the light of the experimentally found variation of clock rate with motion, this experiment does detect the ether."

Herbert E. Ives, Science 91, 79, 1940

"If future experiments were to reveal a non-zero aether drift, then Einstein's relativity would crumble."

Diana Buchwald and Kip S. Thorne
Preface, The Born-Einstein Letters, 2005

Abstract—This paper explores first-order methods of detecting the ether or preferred reference frame of a semi-classical absolute space theory, which has been shown by many researchers to produce results that are in close agreement with special relativity. It is demonstrated that the first-order experiments of Roemer and Doppler detect the relative motion of the Earth and the ether in the Earth's approximately uniform motion around the Sun, precisely the motion that the famous Michelson-Morley experiment failed to detect. Our results therefore confirm the existence of a detectable ether that is inconsistent with special relativity.

Keywords: special relativity—ether—preferred reference frame—Roemer—Doppler—cosmic microwave background radiation

1. Introduction

One of the most famous experiments in the history of science is the Michelson-Morley experiment[1]. In this experiment conducted in 1887, two scientists, Albert Michelson and Edward Morley, searched for evidence of movement through the luminiferous ether, a continuous medium believed by 19th century scientists to fill all of space and to be the bearer of light waves. This belief arose on the basis of overwhelming theoretical and experimental evidence that accumulated over many years[2]. Based on an interferometric method, the experiment was designed to determine the speed of the Earth's movement through the ether as it revolved around the Sun, using the expected change in light speed resulting from movement with or against the associated ether wind.

The experiment was of second-order in that the effect being searched for was proportional to the second power of the ratio between the velocity of the movement v and the velocity of light c. As is well known, the Michelson-Morley experiment was unsuccessful and this represented a serious blow to the ether hypothesis. In 1925 Miller did appear to achieve some level of detection[3] but his results were later claimed by others to have arisen from diurnal and seasonal variations in equipment temperature[4]. Several repetitions of the same basic experiment, one as recently as 2003, have all yielded negative results[5–8] and as a result today, the scientific community generally believes that no experiment has detected or can detect movement through the ether[9–15]. However, it is well established, based on the theoretical and experimental work of Ives[16–19] and earlier theoretical work by Lorentz[20], Fitzgerald and Larmour[2], that because of the compensating effect of length contraction and frequency reduction, the Michelson-Morley and other second-order experiments will always yield approximately null results. This class of experiments is therefore generally unsuitable for detecting ether drift and hence the question of the detection of the ether remains open.

It is important to note that Lorentz, acknowledged as the pre-eminent theoretical physicist at the beginning of the 20th century, defended the concept of the ether right up to his death in 1928. In 1904 he wrote, "The problem of determining the influence exerted on electric and optical phenomena by a translation, such as all systems have in virtue of the Earth's annual motion, admits of a comparatively simple solution, so long as only those terms need be taken into account, which are proportional to the first power of the ratio between the velocity of the translation v and the velocity of light c"[20(p11)]. Lorentz was here indicating that first-order rather than second-order methods can easily detect the Earth's approximately uniform motion around the Sun. At the speeds involved, such experiments are essentially immune to the second-order effects of length contraction and frequency reduction. Many years before in 1879, Maxwell also suggested a first-order method to detect ether drift arising from the Earth's galactic movement[15,21] but the unavailability of sufficiently sensitive equipment prevented the execution of this experiment. In 1913 Sagnac[22] claimed ether drift using a first-order method for rotational but not uniform motion. First-order experiments have been re-visited recently using maser and Mossbauer technology[23,24] but null results were obtained. In the case of the Mossbauer experiment[24], Ruderfer, who had proposed the experiment[25], concluded in a published erratum[26] that a null result was actually the expected result.

Despite these difficulties, interest in a preferred or absolute frame continues. For example, in a paper published in *Physical Review A* in 1988, Gagnon et al.[27] studied a semi-classical ether-type absolute space theory in which light propagates isotropically at a fixed speed in a preferred reference frame. These authors referred to this absolute space model as the generalized Galilean Transformation (GGT) since it involved the classical Galilean transformations adjusted to take into account the real effects of the Fitzgerald-Larmour-Lorentz

(FLL) contractions first experimentally confirmed by Ives[16–19] according to which a rod of length l_o in a preferred frame, when moving with speed v relative to that preferred frame, is shortened to a length l given by

$$l = l_o(1 - v^2/c^2)^{1/2} \tag{1.1}$$

and a system of frequency f_o when stationary in the preferred frame, has a reduced frequency f given by

$$f = f_o(1 - v^2/c^2)^{1/2} \tag{1.2}$$

resulting in

$$x = \gamma(x_o - vt_o), \quad y = y_o, \ z = z_o, \ t = \gamma^{-1} t_o \tag{1.3}$$

Here the zero-subscript coordinates are the coordinates of space and time in the preferred reference frame, the unsubscripted coordinates are coordinates in a reference frame moving at speed v relative to the preferred frame, c is the speed of light in the preferred reference frame and v is the FLL contraction factor given by

$$\gamma = (1 - v^2/c^2)^{-1/2} \tag{1.4}$$

Thus for measurements made by an observer at rest in the preferred frame, the (real) speed u'_r relative to the moving frame is given by

$$u'_r = u - v \tag{1.5}$$

where u is the speed relative to the preferred frame. This is the Galilean law of velocity composition. If the measurements are carried out by an observer moving relative to the preferred frame, Levy[28(pp42–43)] has shown that because of FLL contractions i.e. contracted meter sticks and retarded clocks, the (apparent) speed u'_a relative to the moving frame is given by

$$u'_a = (u - v)/(1 - v^2/c^2) \tag{1.6}$$

Equation (1.6) can be written as

$$u'_a \ (1 - v^2/c^2) = u - v \tag{1.7}$$

which is the Galilean law of velocity composition obtained when contracted meter sticks and retarded clocks are used to measure speed relative to the moving frame. From (1.5) and (1.7), the real speed u'_r and the apparent speed u'_a are related by

$$u'_a \ (1 - v^2/c^2) = u'_r \tag{1.8}$$

The Galilean law of velocity composition (1.6) is different from the special relativity law of velocity composition, which is[21]

$$u' = (u - v)/(1 - uv/c^2) \tag{1.9}$$