Regarding the Proof for the Existence of a Luminiferous Ether Using a Rotating Inteferometer Experiment

Georges Sagnac

Abstract: This is English translation of Georges Sagnac's second paper, which presents his "rotating interferometer experiment" where the phenomenon known as the *Sagnac effect* manifests itself. This paper was originally published, in French, as: Sur la preuve de la réalité de l'éther lumineux par l'expérience de l'interférographe tournant. Note de G. Sagnac, présentée par E. Bouty. *Comptes rendus*, 1913, tome 157, pages 1410–1413. Translated from the French in 2008 by William Lonc, Canada. The Editor of *The Abraham Zelmanov Journal* thanks William Lonc for this effort, and also Ioannis Haranas, Canada, for assistance. Special thank go to the *National Library of France* and Nadège Danet in person for the permission to reproduce the originally Sagnac paper in English.

In *Comptes rendus* of October 27 last (page 708 of this Volume 157), I showed that an interferometer using a closed optical path enclosing a given *area* and rotating in the plane of the path, detects the movement of the system relative to the ether in space.

§1. The interferometer, described elsewhere in detail, is sketched in the diagram below: a plate revolving horizontally (50 cm diameter) carries with it, solidly attached (mounting screws fitted with counter-screws) all the optical components and the luminous source O: a small electric lamp with a horizontal metallic filament. The microscope objective C_{o} projects the image of the filament, through the Nicol prism N, onto the horizontal slit F in the focal plane of the collimator objective C; m is a mirror. The parallel polarized beam, with vertical Fresnel vibrations, is split at the thin layer b of air $\mathfrak{J}$, as in most of the interferometers in my research (*Comptes rendus*, tome 150, 1910, page 1676) that I used for an optical study of the Earth's motion (*Congrès de Bruxelles*, Sept., 1910, tome 1, page 207; *Comptes rendus*, tome 152, 1911, page 310; *Le Radium*, tome VIII, 1911, page 1). Beam T, propagated through the air layer $\mathfrak{J}$, reflects successively from 4 mirrors and travels around the path $\mathfrak{J}-a_1-a_2-a_3-a_4-\mathfrak{J}$ with an area S. Beam R, reflected at the same air-layer J, goes around the same path but in the opposite sense. When the two beams return to $\mathfrak{J}$, T is propagated again, and R is reflected again. They now travel in the same direction as T^2 and

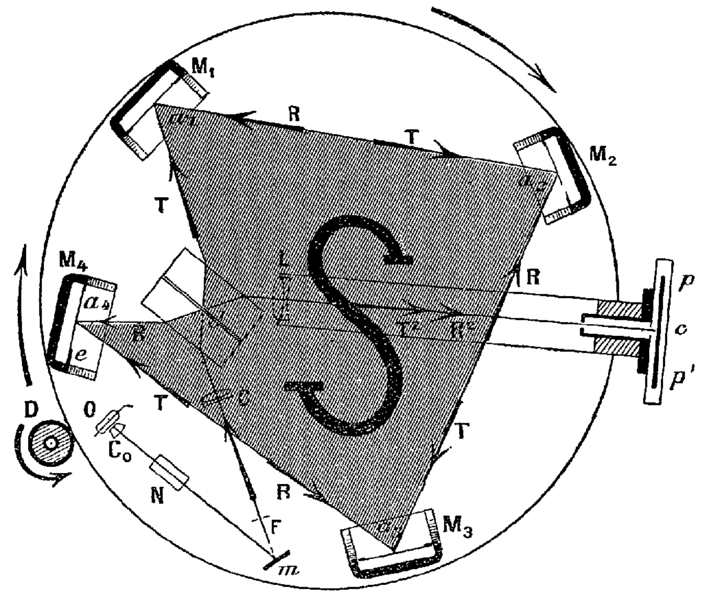
R^2, and interfere at the principal focus of lens L on the fine-grained photographic plate pp'.

§2. Procedure. — I remind the reader that the perfect superposition of the two opposing beams T and R results in an extinction in the lens's field of view for the lamp's indigo radiation, close in wavelength to the radiation from a mercury-arc lamp. In addition, a small rotation ε of the beam-splitter $\mathfrak{J}$ about a vertical axis in a right-handed sense (D) or left-handed (S) changes the dark field into a vertical central fringe accompanied by parallel fringes on both sides.

Once the fringes are suitably adjusted, and the photographic plate pp' installed in the holder in red light, I slowly activate an electric motor, the vertical axis of which has a horizontal disk D attached to it. The disk has a leather rim that is in contact with the rim of the circular plate. Once the desired rotational frequency N is reached, I take a photograph by sending a current to the small lamp O via slip rings on the axle of the circular plate.

§3. Direction and magnitude of the optical rotation effect. — In Fresnel's hypothesis of the ether, the luminous waves T and R propagate in the ether with a speed V_0 independent of the motion of the interferometer. The phase of the waves T in the right-handed sense (*see* the diagram) is changed along the closed path, as if the luminiferous ether had a left-handed rotation when the system rotates in the sense d [right-handed] and magnitude $4\pi NS$ of *this rotation*, or *relative circular motion* C of the ether within the closed optical path gives, according to the expression $\frac{C}{\lambda V_0}$, a lag x in the phase of the waves in beam T, and advances by the same amount the phase of the waves in beam R propagating in the reverse direction. The fringes should then move by $2x$ divisions. The absolute direction of this displacement y of the fringes should be pp', that is, d, like the rotation of the interferometer (the effect is in the *positive* direction) if the drive wheel rotates in the D direction [right-handed]. The displacement z equal to $2y$ or $4x$, measured by comparing image s with image d, should therefore be in the sense d. If the drive-wheel is rotating in the S direction [left-handed], then displacements y and z should change sense.

After many runs, I have always observed the sense to change as expected. The fact that the effect z reverses when I rotate the beam-splitter $\mathfrak{J}$ by even a fraction of a degree when reversing the rotation direction of D, identifies the effect as a phase-difference associated with the circular motion of the interferometer, and allows for isolation from



the effect of deformation in the optical component *s*.

I now offer examples of the measurement of z compared with values calculated from the expression $\frac{16\pi NS}{\lambda V_0}$; I determined the wavelength λ corresponding to the fringe-spacing obtained with the small lamp O and compared it with the fringe-spacing for the 436 nμ radiation from a mercury arc-lamp; there was little difference. The measurements were made by one of the two methods described in my Note of October 27th last. The central fringe *c*, well-defined in the negative image that I studied, and the weak lateral fringes *f*, are outlined only by a narrow half-light, conducive to a precise measurement of the points obtained by a slight enlargement while positioning the sharp fringe between the two parallel wires of an ocular micrometer.

	Sense	N	z from c	z from f	z calc.
Method 1	S [left]	0.86	−0.026	≫	−0.029
($S = 863$ cm^2)	D [right]	1.88	+0.070	≫	+0.065
Method 2	S [left]	2.21	−0.072	−0.078	−0.075
($S = 866$ cm^2)	S [left]	2.35	−0.077	−0.080	−0.079

The interferometer produces and records, from the expression $\frac{1}{2}z$, the rotation effect in first order, of the assembly's movement as a whole without importing any external reference marks.

The outcome of these measurements shows that in ambient space, light propagates with speed V_0 independent of the motion of the apparatus, the light source O and the optical system. This property of space describes the luminiferous ether experimentally. The interferometer measures, according to the expression $\frac{1}{4}z\lambda V_0$, the relative circular motion of the luminiferous ether within the closed optical path $\mathfrak{J}-a_1-a_2-a_3-a_4-\mathfrak{J}$.

Vol. 1, 2008 **ISSN 1654-9163**

THE ABRAHAM ZELMANOV JOURNAL

The journal for General Relativity,
gravitation and cosmology

TIDSKRIFTEN ABRAHAM ZELMANOV

Den tidskrift för allmänna relativitetsteorin,
gravitation och kosmologi

The Abraham Zelmanov Journal is a non-commercial, academic journal registered with the *Royal National Library of Sweden.* This journal was typeset using LaTeX typesetting system. Powered by Ubuntu Linux.

The Abraham Zelmanov Journal är en ickekommersiell, akademisk tidskrift registrerat hos *Kungliga biblioteket.* Denna tidskrift är typsatt med typsättningssystemet LaTeX. Utförd genom Ubuntu Linux.