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The interrupted 'rotating disc' experiment

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Abstract. Realising a modification of the historical Harress–Sagnac experiment, we establish that the velocity of light along the chord of a rotating disc is direction dependent.

According to our absolute space–time theory (Marinov 1977, 1981a), the velocity of light with respect to a frame moving at velocity v in absolute space, if measured with the help of a clock which rests in this frame, is called the proper relative light velocity and is

$$c'_0 = c/(1 + v\cos\theta'/c), \tag{1}$$

where θ' is the angle between the velocity v and the direction of light propagation measured with respect to the moving frame; c is the velocity of light with respect to absolute space measured on a clock which rests in absolute space, or the 'to-and-fro' velocity in any inertial frame measured on a clock attached to this frame.

In the historical Harress–Sagnac experiment (called also the 'rotating disc' experiment) two photons (two light pulses) which fly together are separated by a semi-transparent mirror. One of these photons (called 'direct') proceeds along the direction of rotation and the other (called 'opposite') in the opposite direction. Hence, according to our formula (1), the 'direct' photon will return to the point of separation (the semi-transparent mirror) after the 'opposite' one with the time delay

$$\Delta t_0 = \int_0^d \frac{\mathrm{d}r}{(c'_0)_{\mathrm{dir}}} - \int_0^d \frac{\mathrm{d}r}{(c'_0)_{\mathrm{opp}}} = \frac{2}{c^2}\int_0^d v\cos\theta'\,\mathrm{d}r = 4\frac{\Omega S}{c^2}, \tag{2}$$

where Ω is the angular velocity of rotation, d is the path covered ($\mathrm{d}r$ is its differential element) and S is the area encircled by both photons respective to the moving disc.

The same time delay, measured with the help of a clock which rests in absolute space, will be $\Delta t = \Delta t_0(1 - v^2/c^2)^{-1/2}$. This is the fundamental relation expressing the *absolute* time dilation which is firmly defended by our theory (Marinov 1975a). If $v \ll c$, we can assume $\Delta t = \Delta t_0$, and this assumption is always to be made when effects which are first-order in v/c are analysed, as is the case in the present paper. In (Marinov 1978a) we analyse the first-order effects in the different variations of the 'rotating disc' experiment which can be set up if a refractive medium is being used, and in (Marinov 1976) the second-order effects.

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Formula (2) can be written in the following form, where not the area encircled but the path covered by the photons should figure:

$$\Delta t = \frac{2}{c^2}\int_0^d \boldsymbol{v} \cdot \mathrm{d}\boldsymbol{r} = \frac{2vd}{c^2}, \tag{3}$$

the result on the RHS being obtained by the assumption that the 'direct' and 'opposite' photons fly along the circumference of the rotating disc (this can be done with the help of a polyhedral mirror); then $d = 2\pi R$ is the circumference of the disc, where R is its radius.

In the Harress–Sagnac 'rotating disc' experiment the point of separation of the 'direct' and 'opposite' photons is the same as the point of their meeting, so that the light paths of the interfering photons are closed curves. If we interrupt these closed paths and make the points of separation and meeting different, the light paths of the 'direct' and 'opposite' photons which become different for rest and motion of the disc may be made straight lines. This is the interrupted 'rotating disc' experiment reported in the present paper. This experiment shows patently that the velocity of light is direction dependent along a straight line on a rotating disc. Its scheme was the following (see figure 1).

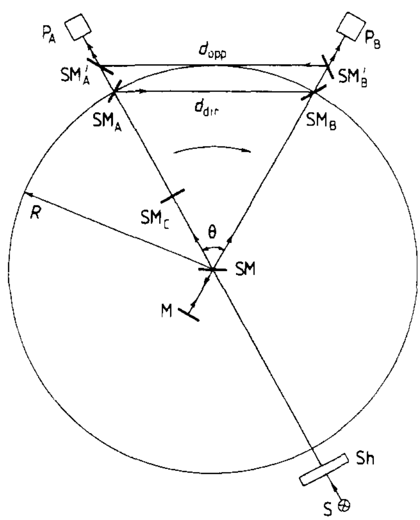

Figure 1. The interrupted 'rotating disc' experiment.

The light source S was a He–Ne laser. Sh was a shutter which was governed by the rotating disc and let light pass only at a strictly defined position of the disc when both photoresistors P_A, P_B were illuminated. Later we realised that since the areas of the photoresistors are small, the shutter is unnecessary. If S, P_A and P_B were also to be mounted on the rotating disc, the shutter Sh would be entirely unnecessary. SM was a semi-transparent mirror, M a mirror, and SM_C a corrective semi-transparent mirror which reduced the number of photons along the path to SM_A to the number of photons along the path to SM_B.

Let four photons be emitted by S at the same moment and suppose that they cover the following paths:

first photon: $S-SM-SM_C-SM_A-SM'_A-P_A$;

second photon: $S-SM-SM_C-SM_A-SM_B-SM'_B-P'_B$;

third photon: $S-SM-M-SM-SM_B-SM'_B-SM'_A-P_A$;

fourth photon: $S-SM-M-SM-SM_B-SM'_B-P_B$.

Using formula (2) and figure 1, we find that in the case of rotation (with respect to the case at rest) the time it takes for the third (fourth) photon to reach P_A (P_B) is shorter than the time it takes for the first (second) photon to reach P_A (P_B) by the amount

$$\Delta t_A = (2\Omega R^2/c^2)\tan\tfrac{1}{2}\theta \qquad (\Delta t_B = (\Omega R^2/c^2)\sin\theta). \tag{4}$$

The photoresistors P_A, P_B were put in the arms of a Wheatstone bridge. They were illuminated *uniformly* by interfered light. When the disc was at rest, the bridge was put into equilibrium, so that both photoresistors were illuminated by equal light intensities. This was achieved by adjusting micrometrically SM'_A and SM'_B and changing in such a way the path difference between the first and third photons until the bridge comes into equilibrium. Then we set the disc in rotation. With increasing rotational velocity, the bridge came into greater and greater disequilibrium, passing through a state of maximum disequilibrium. At a certain angular velocity Ω, when the sum of the differences in the optical paths $\Delta = (\Delta t_A + \Delta t_B)c$ became equal to the wavelength λ of the light used, the bridge was again in equilibrium. In this case

$$\lambda = \Delta = (\Omega R^2/c)(2\tan\tfrac{1}{2}\theta + \sin\theta). \tag{5}$$

We experimentally checked this formula. The sensitivity of the method is considered in (Marinov 1977, 1978a). Our interferometric 'bridge' method leads to a precision $\delta\Delta/\lambda = \pm 2.5\times 10^{-4}$ when we search for a maximum sensitivity, i.e. when the illumination over the photoresistors at equilibrium of the bridge should be the average. We have not searched for a maximum sensitivity, taking $\delta\Delta/\lambda = \pm 10^{-2}$.

We experimentally checked formula (5), putting $\lambda = 632.8$ nm, $\theta = 60.0° \pm 0.5°$, $R = 40.0 \pm 0.2$ cm. The number of revolutions per second $N = \Omega/2\pi$ was measured by a light stroboscopic cyclometer and maintained automatically with a precision $\delta N/N = \pm 2\times 10^{-4}$. We registered $N = 92.90 \pm 0.02$ rev s^{-1}. Putting the figures into formula (5), we obtained, supposing the velocity of light is unknown, $c = (2.98 \pm 0.07)\times 10^8$ m s^{-1}, where $\delta c = \pm 7\times 10^6$ m s^{-1} was the maximum error.

Apart from the experiment reported in this paper, on the same disc we carried out two other groups of very important experiments: two variations of the Harress–Sagnac 'rotating disc' experiment and the original non-inertial 'moving platform' experiment (Marinov 1978a, 1981b). The same method was always used, namely, we generated *two pairs* of interfering light beams which illuminated two photoresistors put in the arms of a Wheatstone bridge. Always, when changing the velocity of rotation, the illumination over one of the photoresistors increased and over the other decreased, thus bringing the bridge into disequilibrium. In all these experiments the light source and the photoreceivers are solid with respect to the laboratory and only at a certain position of the rotating disc (over a small angle of rotation) did the photoreceivers become illuminated. We succeeded in having stable interference pictures which were not disturbed by the rotation of the disc and the trembling of the different mirrors. We consider our method as original and very sensitive and we suppose it can be applied in other domains of measuring technique when one can make the effect to be measured influence in the 'opposite' sense the interference pictures in two pairs of light beams and become competitive to the well known 'lever of Jones'.

One of the referees suggested I must clearly state whether the result of the reported experiment is in contradiction to the predictions of special relativity. I discussed this topic in numerous publications (let me cite Marinov 1975b, 1978b). According to me, special relativity cannot explain even the result of the historical Harress–Sagnac experiment, as for its explanation one must assume that in a moving frame the velocity of light is direction dependent. The relativists have overcome this difficulty by stating that a Sagnac effect appears only on a closed path and is a result of a non-inertial motion (the disc is rotating!). Thus, according to special relativity, on a straight path on a rotating disc a 'Sagnac effect' does not exist, as a straight path may be chosen short enough and considered as inertially moving. I called (Marinov 1982) the effect (2) (area multiplied by angular velocity) the *Sagnac effect*, and the effect (3) (distance multiplied by linear velocity) the *Marinov effect*, as I was the first to observe it (Marinov 1974, 1980). Thus, according to relativity, a Sagnac effect does exist but a Marinov effect does not exist. Indeed, if a Marinov effect exists along a chord on a disc rotating in a laboratory, it must exist along a chord on a rotating disc representing our spinning Earth, and along a chord on a rotating disc representing our Earth revolving around the Sun, or around the centre of the Galaxy. Thus if the effect I have measured in the experiment reported in this paper is accepted, one must by the law of formal logic accept my measurements of the Earth's absolute velocity.

References

Marinov S 1974 *Czech. J. Phys.* B **24** 965
—— 1975a *Int. J. Theor. Phys.* **13** 189
—— 1975b *Phys. Lett.* **54A** 19
—— 1976 *Int. J. Theor. Phys.* **15** 829
—— 1977 *Eppur si muove* (Bruxelles, CBDS, 2nd edn: Graz, East-West, 1981)
—— 1978a *Found. Phys.* **8** 137
—— 1978b *Found. Phys.* **8** 801
—— 1980 *Gen. Rel. Grav.* **12** 57
—— 1981a *Classical Physics* (Graz, East-West)
—— 1981b *Ind. J. Phys.* **55B** 403
—— 1982 *Proc. Int. Conf. on Space–Time Absoluteness 1982* (Genoa, July 1982, ed East-West, Graz)