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LETTER TO THE EDITOR

A proposed experiment to measure the one-way velocity of light

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Abstract. A simple experiment is proposed, with the aid of which it is suggested that the earth's absolute velocity may be measured.

The experimental arrangement is shown in figure 1.

EM is a motor rotating a shaft of length d. As we showed theoretically and experimentally (Marinov 1977), with a rotating axle one can realise a Newtonian time synchronisation (Marinov 1975), i.e. one can establish a *momentary* contact between two spatially separated events. The shaft has two mirrors on its ends, RM_1 and RM_2, called the rotating mirrors. Intense light emitted by the laser L is split by the semi-transparent mirror SM into two beams. In the following description the alternative route is shown in parentheses. The 'transmitted' ('reflected') beam passes through the semi-transparent mirror SM_1 (is reflected by mirror M and passes through the semi-transparent mirror SM_2) and is reflected by the rotating mirror RM_1 (RM_2); then it is reflected by the semi-transparent mirror SM_1 (SM_2) and, reflecting on the right-angled mirror M_0, strikes the photomultiplier PM_1 (PM_2) where the light pulse is transformed into an electric pulse. The outputs of the photomultipliers (*opposed* to one another) are applied to the horizontal plates of the oscilloscope Osc. One is interested only in the leading edge of the light (and electric) pulses, so that the duration of the pulses is of no importance. Only the *steepness* of the edges is important. Instead of pulses *reflected* by the rotating mirrors, with the help of the holes H_1, H_2 and the mirrors M_1, M_2, one can obtain pulses *cut* by the rotating shaft.

The display mechanism of the oscilloscope is triggered by one of the electric pulses. We shall assume that the pulses are trapezoidal, which can be achieved by limiting the electric outputs to a certain level. If the display time is longer than the duration of the pulses, then, in the general case when M_0 is not exactly at the mid point, or RM_1 and RM_2 are not exactly parallel, we shall see two oppositely oriented pulses on the screen. If the display time is shorter than the duration of the pulses, only one pulse will be seen on the screen. Moving the system M_0–PM_1–PM_2 to the left or right, we can make the leading edges of both pulses on the screen coincide in time. This signifies that the light pulses reflected from RM_1 and RM_2 reach M_0 at exactly the same moment.

The direction from SM_1 to SM_2 is called 'direct' and from SM_2 to SM_1 'opposite'. Let us suppose that the absolute velocity v of the laboratory is pointing in the 'direct' direction. In this case the velocity of the 'direct' light pulse will be $c+v$ and of the

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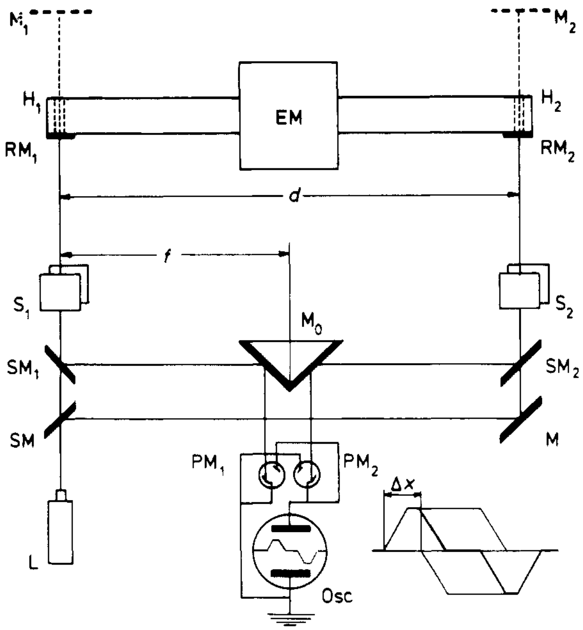

Figure 1. The oscilloscopic 'coupled mirrors' experiment.

'opposite' light pulse, $c + v$ (with respect to the laboratory). Thus, if we begin to rotate the whole apparatus (which is mounted on a horizontal rotating platform) two opposite pulses will appear on the screen; after a rotation through 180° (when the velocity of the 'direct' pulse will be $c \div v$ and of the 'opposite' pulse $c - v$) the pulses will be a maximum and after a rotation through 360° they will again disappear. If the constant of scanning is k s cm^{-1}, then the maximum distance Δx (see the figure) will correspond to a time difference $\Delta t = k\Delta x$, which can be expressed through the parameters of the apparatus as follows:

$$\Delta t = \frac{b}{c-v} - \frac{d-b}{c+v} - \left(\frac{b}{c+v} - \frac{d-b}{c-v}\right).$$

Thus, to first order, $\Delta t = 2dv/c^2$.

The shaft should then be rotated in the opposite direction and Δt re-established.

Assuming $v = 300$ km s^{-1} (Physics Today 1978) and taking $d = 1{\cdot}5$ m, we obtain $\Delta t = 10$ ps. Thus, if one could use an oscilloscope with horizontal time base 10 ps cm^{-1}, then, assuming that the inaccuracy of reading is 1/10th part of the scale, one will be able to measure the absolute velocity with an accuracy of 10%. Since the experiment does not depend upon coherence, d is only limited by mechanical constraints. If d is considerably larger, the necessity for such a high speed oscilloscope is relaxed. Higher accuracy will be achieved if one uses a dual beam oscilloscope.

In Marinov (1977) we give the method for establishing the absolute velocity of the laboratory and the equatorial coordinates of its apex from the measurements made during a day.

For more information concerning the technique of measurement see Biretta and Lang (1978) and the five references from the American Journal of Physics therein, where a similar technique is used for measuring the 'there-and-back' light velocity which is always c.

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