On the Michelson-Morley Experiment

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The null result of the Michelson-Morley experiment would be due to that the electric field is contracted in the line of motion.

Key words: moving electric charge, contracted electric field.

In this experiment there are four times to consider: T_1, T_2, T_3 and T_4. The first two are for the longitudinal displacement and the last two for the transversal one. From the experiment it is obtained that:

$cT_1 = L + vT_1$, where c is the speed of the light in the vacuum, L the length of the arm and v its speed; then

$$T_1 = \frac{L}{c-v} \tag{1}$$

$cT_2 = L - vT_2$, then

$$T_2 = \frac{L}{c+v} \tag{2}$$

And the total travel time in the longitudinal displacement would be

$$T_l = T_1 + T_2 = \frac{L}{c-v} + \frac{L}{c+v} = \frac{2L}{c}\frac{1}{1-\frac{v^2}{c^2}} \tag{3}$$

$cT_3 = \sqrt{L^2 + (vT_3)^2}$, then

$$T_3 = \frac{L}{\sqrt{c^2 - v^2}} \tag{4}$$

which is the same for the backward transverse journey: $T_4 = T_3$, then the total travel time in the transversal displacement would be

$$T_t = T_3 + T_4 = 2T_3 = \frac{2L}{\sqrt{c^2 - v^2}} = \frac{2L}{c}\frac{1}{\sqrt{1-\frac{v^2}{c^2}}} \tag{5}$$

From (3) and (5), we see that $T_l > T_t$ instead of be equal, which was the real result of the experiment. To obtain this equality, we use the contracted electric field.

The electrostatic field is

$$E = \frac{q}{4\pi\varepsilon_0 r^2} \tag{6}$$

E being the electric field, q the electric charge, ε_0 the electric permittivity of the vacuum and r the radial distance.

But for a moving electric charge with speed v, from the retarded time $t' = t - r/c$ [1] (p. 244-245) and, multiplying by v, $r' = r - \boldsymbol{r}\cdot\boldsymbol{v}/c$ [1] (p. 345), with $r' = vt'$ and $r = vt$, it is [1] (p. 346)

$$E' = \frac{q}{4\pi\varepsilon_0 r^2}\frac{1-\dfrac{v^2}{c^2}}{\left(1-\dfrac{v^2}{c^2}\sin^2\theta\right)^{\frac{3}{2}}} \tag{7}$$

(7) was obtained by Heaviside in 1888. In the longitudinal direction, $\theta = 0$ or $\theta = \pi$ (radians), it is $\sin\theta = 0$. Then

$$E' = \frac{q}{4\pi\varepsilon_0 r^2}\left(1-\frac{v^2}{c^2}\right) \tag{8}$$

and the electric field is contracted.

The electric forces are respectively

$$F = qE = \frac{q^2}{4\pi\varepsilon_0 r^2} \tag{9}$$

and

$$F' = qE' = \frac{q^2}{4\pi\varepsilon_0 r^2}\left(1-\frac{v^2}{c^2}\right) \tag{10}$$

Then

$$\frac{F'}{F} = \left(1-\frac{v^2}{c^2}\right) \tag{11}$$

and $F' < F$. The electric force is inversely proportional to the square of the distance, but as the lesser the force of repulsion between the electrons, the lesser the separation distance between them, then we can put

$$\frac{L'^2}{L^2} = \frac{F'}{F} = \left(1 - \frac{v^2}{c^2}\right) \tag{12}$$

and

$$L' = L\sqrt{1 - \frac{v^2}{c^2}} \tag{13}$$

and the length of the longitudinal arm is contracted. (13) was proposed by FitzGerald in 1889 and Lorentz in 1892. (13) cannot correspond to the length contraction of the special relativity (SR) of Einstein of 1905. In the SR it would be $L' = L$, because the observer is co-moving with the arm, which implies that $v = 0$. Substituting L by L' in (3), we have that

$$T_l = \frac{2L\sqrt{1 - \frac{v^2}{c^2}}}{c} \frac{1}{1 - \frac{v^2}{c^2}} = \frac{2L}{c} \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{14}$$

and $T_l = T_t$, which gives the null result.

In summary, the null result of the Michelson-Morley experiment would be due to that the electric field is contracted in the line of motion.

[1] Wolfgang K. H. Panofsky and Melba Phillips, Classical Electricity and Magnetism, second edition, Addison-Wesley, Reading, Massachusetts, 1962.