The Scaling Transformations IIIa
On the Experiment of Michelson and Morley

C P Viazminsky,
kayssarv@mail2world.com

The Michelson and Morley's experiment (MM for short) was repeatedly carried out [1], checked for accuracy, over studied and analysed, and much disputed. It was designed to detect the motion of the earth's through the ether by measuring the difference in time taken by light to make, from a point, 2-way trips along two perpendicular axes, one of which points in the direction of the almost translational motion of the earth around the sun and the other is perpendicular to it. The observed effect was much less than the expected one.

In this article we argue that the expected effect in the MM and similar experiments is due to the rotational motion of the earth about its axis, but not to its orbital motion around the sun. This argument is based on the following facts:

- There is no ether in the scaling theory,
- The time we use on earth is the time of the frame *S* translating with the earth in its orbital motion, and hence there can be no fringe displacement due to the earth's orbital motion.
- A frame with origin at the earth surface and rotating with the earth can be considered during a short period of time an inertial frame that is translating relative to *S* with the linear velocity of its origin, and hence its units of length and time are different from those of *S* [4].

In the following treatment, it is assumed that the reader is well informed of the MM experiment which can be found in most text books on special theory of relativity [1-3].

The frame *S* with origin *O* at the earth's center and that does not rotate relative to distant stars can be considered inertial, for it executes within a small period only a translational motion. Relative to *S* the earth spins about its axis with a constant angular velocity, and the linear velocity of the a point *o* of the earth's surface is $u\sin\theta$ where *u* is the linear velocity of a point of the earth's equator, and θ is the azimuth angle of the point *o*. For simplicity we assume temporarily that the experiment is carried out at the earth equator, with one of the arms is pointing eastwards and the other northwards. Let $s \equiv oxy$ be a frame with origin at the source *o* and rotating with the earth; the *x*-axis points to the east and *oy* to the north. For a trip of light along *oy*, southwards or northwards the units of length in *s* and *S* are equal. The units of length (and time) in *s* and *S* are in the proportion $1:\Gamma(u,0)$ for an eastwards trip and in the proportion $1:\Gamma(u,\pi)=1/\Gamma(u,0)$ for an westwards trip [4]. Assuming that the arms are oriented initially eastwards and northwards respectively, and that the length of each arm is *l*, then the difference in the light path will be

(1) $$\Delta = (l.Emeter + l.wmeter) - 2l.meter$$

Or

$$\Delta = l\big(\Gamma(u,0) - \Gamma(-u,0)\big) - 2l$$

(2) $$= \frac{2l}{\sqrt{1-(u/c)^2}} - 2l \approx l\left(\frac{u}{c}\right)^2 meter$$

When the apparatus is rotated by a right angle the difference doubles giving rise to a phase change

(3) $$f = \frac{2l}{\lambda}\left(\frac{u}{c}\right)^2$$

In the MM experiment

(4) $$\lambda = 6\times10^{-7}\, meter\,,\ l = 120\, cm$$

Substituting $u = 0.46425 km/s$ and $c = 298792.5 km/s$ we obtain

(5) $$f \approx 0.00001$$

which is 4000 times less than the predicted value, and 1000 times less than the observed result, which is 0.01 fringe.

Going through the results of various trials of the MM experiments listed in Wikipedia, or in French[1], we note that the observed effect corresponds to a velocity *u* that is always greater than the rotational speed of the earth about its axis. According to the Wikipedia, the least upper limit of u, which is therein the orbital velocity of the earth, while it is the linear rotational speed of the earth in our argument, occurs in the Illingworth's trial (1927) with *u* is less than one kilo meter per second. The second reasonable upper limit is found in Joos' trial (1930), with $u = 1.55 km/s$. In fact the MM experiment yields a fringe shift corresponding to an orbital speed $u = 4.75 km/s$, which is much larger than the rotational speed of the location at which the experiment is carried out, which is $(0.46425 \sin\theta) km/s$.

References

[1] French A P. *Special relativity*. Butler & Tanner Ltd, Frome and London, 1968.Ch.2&3.

[2] Mould Richard A, *Basic Relativity*. Springer-Verlag, London, 1998.Ch.1&2.

[3] Rindler W., *Essential Relativity*. Springer-Verlag, New York, 1977. Ch.3.

[4] C P Viazminsky, The Scaling Transformations II, The General Science Journal (2007).