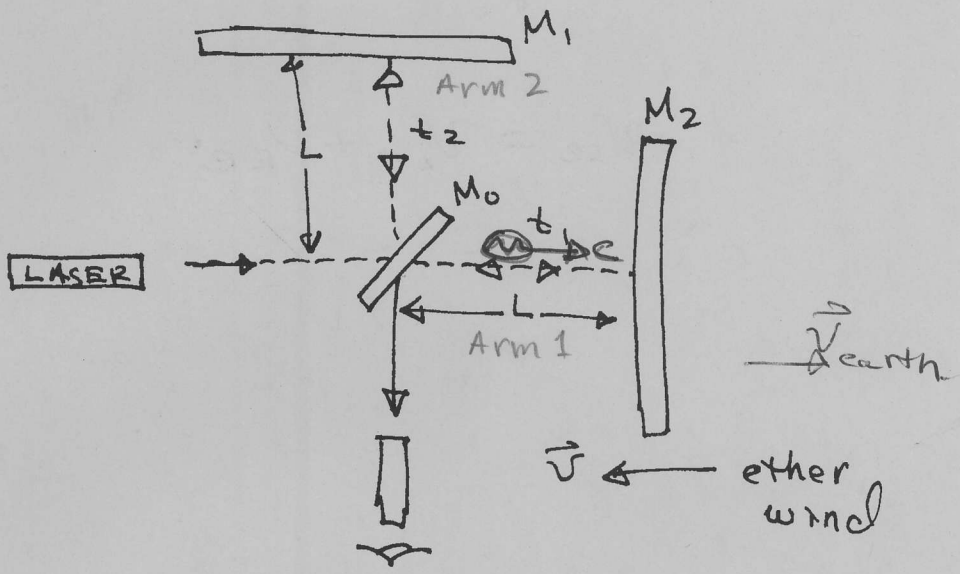
Michelson - Morley Experiment

The purpose of the MME was to detect the small change in the speed of light due to the motion of earth thru the ether medium. The instrument is called the Michelson interferometer.



- One of the arms of the interferometer is aligned in the direction of the motion of earth thru the ether.
- The two beams recombine and an interference pattern of dark and bright fringes is observed due to the path difference of both beams.
- If the interferometer is ^then rotated ~~thru 90~~° then one should be able to observe the interference pattern to shift. due to the change in the speed of light. along both arms.

Phase Difference Calculation

$$\frac{\Delta\sigma}{\lambda} = \frac{\Delta\phi}{2\pi}$$

phase difference → $\Delta\phi$; path difference → $\Delta\sigma$

$$\Delta\phi = \frac{2\pi}{\lambda}\Delta\sigma$$

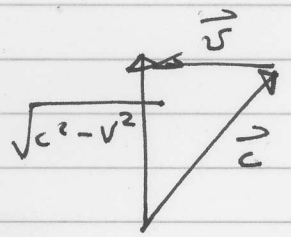
$$\Delta\sigma = c\Delta t$$

$$\Delta t = t_1 - t_2$$

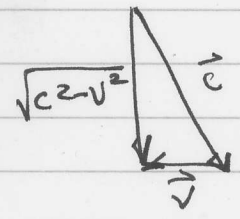
$$t_1 = \frac{L}{c-v} + \frac{L}{c+v} = \frac{L(c+v)+L(c-v)}{c^2-v^2} = \frac{2Lc}{c^2-v^2}$$

$$t_1 = \frac{2Lc}{c^2\left(\frac{c^2-v^2}{c^2}\right)} = \frac{\frac{2L}{c}}{1-\frac{v^2}{c^2}} = \frac{2L}{c}\left(1-\frac{v^2}{c^2}\right)^{-1}$$

$$t_2 = \frac{2L}{(c^2-v^2)^{1/2}}$$



$$t_2 = \frac{2L}{c\left(\frac{c^2-v^2}{c^2}\right)^{1/2}}$$



$$t_2 = \frac{\frac{2L}{c}}{\left(1-\frac{v^2}{c^2}\right)^{1/2}}$$

$$t_2 = \frac{2L}{c}\left(1-\frac{v^2}{c^2}\right)^{-1/2}$$

$$\Delta t = \frac{2L}{c}\left(1-\frac{v^2}{c^2}\right)^{-1} - \frac{2L}{c}\left(1-\frac{v^2}{c^2}\right)^{-1/2}$$

$$(1-x)^n \approx 1 - nx \quad \text{if } x \ll 1$$

$$\Delta t = \frac{2L}{c}\left[\left(1-(-1)\frac{v^2}{c^2}\right) - \left(1-\left(-\frac{1}{2}\right)\frac{v^2}{c^2}\right)\right]$$

$$= \frac{2L}{c}\left[1 + \frac{v^2}{c^2} - 1 - \frac{1}{2}\frac{v^2}{c^2}\right]$$

$$= \frac{2L}{c}\left(\frac{1}{2}\frac{v^2}{c^2}\right)$$

$$\Delta t = \frac{Lv^2}{c^3}$$

$$\therefore \Delta\sigma = c\Delta t = \frac{Lv^2}{c^2}$$

$$\boxed{\Delta\phi = \frac{2\pi}{\lambda}\frac{Lv^2}{c^2}}$$ Phase Difference

This phase difference gives rise to an interference pattern of dark and bright fringes. When the interferometer is rotated <u>no</u> shift in the fringes was observed.

Result: No ether medium existed and thus the speed of light is constant in all inertial RF's!