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Checking Michelson Morley with Lorentz Transformation

Lets **again look at MM in the frame in which the sun is at rest, now using the Lorentz Transformation**. Light moves at the speed of light in every frame but the length parallel to motion is reduced [3]. Starting in the parallel direction.

$$ct_1 = L' + vt_1 \qquad \text{time out to mirror}$$

$$ct_2 = L' - vt_2 \qquad \text{time back}$$

$$t = t_1 + t_2 = \frac{L'}{c+v} + \frac{L'}{c-v}$$

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

$$= \frac{2L'c}{c^2 - v^2} = \frac{2L'}{c(1-\beta^2)}$$

$$t_{||} = \frac{2\gamma^2 L'}{c}$$

$$t = \frac{2L_\perp}{c}$$

$$L_\perp = \sqrt{L^2 + v^2 \frac{L_\perp^2}{c^2}} \qquad L_\perp \text{ not changed}$$

$$L_\perp^2 - v^2 \frac{L_\perp^2}{c^2} = L^2$$

$$L_\perp = \frac{L}{\sqrt{1-\beta^2}}$$

$$t_\perp = \frac{2\gamma L}{c}$$

$$L' = \frac{L}{\gamma} \qquad \text{Fitzgerald contraction}$$

$$t_{||} - t_\perp = \frac{2\gamma^2 L'}{c} - \frac{2\gamma L}{c} = (\gamma - 1)\frac{2\gamma L}{c} \qquad \text{using transformed length}$$

$$t_{||} - t_\perp = \frac{2\gamma L}{c} - \frac{2\gamma L}{c} = 0 \qquad \text{no shift}$$

Fitzgerald postulated that the length along the direction of motion changes as we transform to a moving frame. This is confirmed in the Lorentz transformation. With this transformation, the speed of light is the same in any frame and **the Michelson-Morley experiment's null result is expected**.

Subsections

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Jim Branson 2012-10-21