Introductory Astronomy

Week 6: Relativity and Black Holes

Clip 3: Maxwell and c

Duke UNIVERSITY

Maxwell's Problem

- Maxwell's equations predict the speed c of electromagnetic waves in terms of measured properties of electric and magnetic interactions
- Electromagnetism is not invariant under Galilean relativity

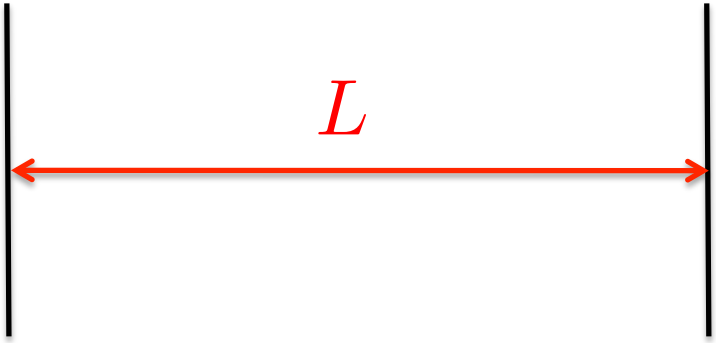
Two Possible Solutions

- Light propagates at c through aether
- Maxwell's equations hold for observers at rest relative to aether
- Moving at v measure $c' = c \pm v$

- Light propagates at c through space
- Maxwell's equations hold for all inertial observers
- Moving at v measure $c' = c$

Looking for the Aether

- A light clock is two mirrors at distance L
- Light bounces between them in time $T = 2L/c$
- Moving light clock relative to aether will change its rate



Duke UNIVERSITY

Two Motions

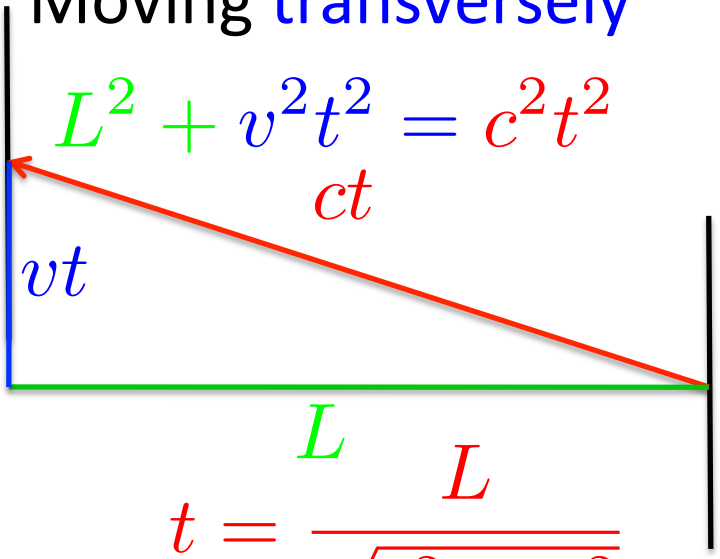
- Moving along axis

$$T_L = \frac{L}{c-v} + \frac{L}{c+v}$$

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

$$T_T = 2t = \frac{2L}{c}\frac{1}{\sqrt{1-v^2/c^2}}$$

- Moving transversely



$$t = \frac{L}{\sqrt{c^2-v^2}}$$

Duke UNIVERSITY

The Answer

- Michelson-Morley 1887: $T_T = T_L$
- Viscous aether dragged by Earth?
- Einstein 1905: No Aether. Maxwell's equations hold in any inertial frame
- Galilean relativity is wrong.