Astronomy 111

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Special Relativity

The absolute space + time of Newton were crumbling in the 19th century - Michelson-Morley experiment had shown no evidence of any "aether" – no dependence of observed speed of light on direction of the light.

Einstein pondered all this and concluded that the speed of light will always be measured by all observers as constant.

Important assumptions of special relativity (inertial frames - no acceleration)

- speed of light in vacuum always c
- laws of physics same in all inertial frames
- no object can ever achieve $v \geq c$

If c = constant for all inertial frames, then for moving frames, time must slow (time intervals are greater; clock times are earlier) by:

$$t' = \frac{t}{\sqrt{1 - \frac{v^2}{c^2}}}$$

t: stationary clock

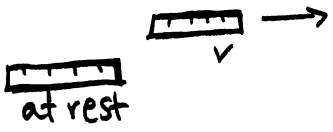
t': moving clock

Lengths shrink by the same factor that clocks slow.

$$l' = \frac{l}{\gamma} = l\sqrt{1-\frac{v^2}{c^2}}$$

so moving rulers are shorter in the direction of motion

$$\gamma \equiv \frac{1}{\sqrt{1-\frac{v^2}{c^2}}}$$



Observations of muons confirm this -
More reach the ground than should - explanation of observer is that μ's clock has slowed; μ's explanation is that distance has shrunk.

Mass is increased at high velocity.

$$m' = m\gamma$$

These effects are real, not illusory.
And all have been experimentally confirmed.