PHY132S Relativity
Class 2 - March 25, 2009

Loose end:

No absolute space

What is an IRF?
Circular argument.

Physics is true only in frames where physics is true!

§37.4 Events & Measurements

Some event happens

Specify where & when it occurs.

Lattice of rods & clocks

where: with meter sticks

when: time nearest clocks

1 m away from clocks,
Later than 3:00 by

$$t = \frac{d}{c} = \frac{1\ m}{3\times10^8\ m/s} = 3.3\times10^{-9}\ s$$

1 light year (ly) away.
Later by 1 year.

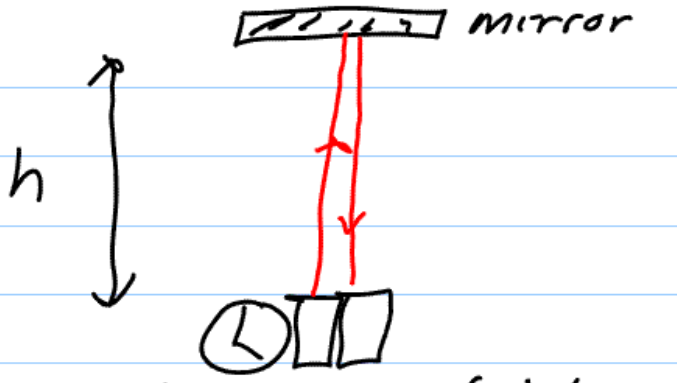
§37.5 Simultaneity

defer until after
§37.7

§37.6 Time Dilation

Pre 1905

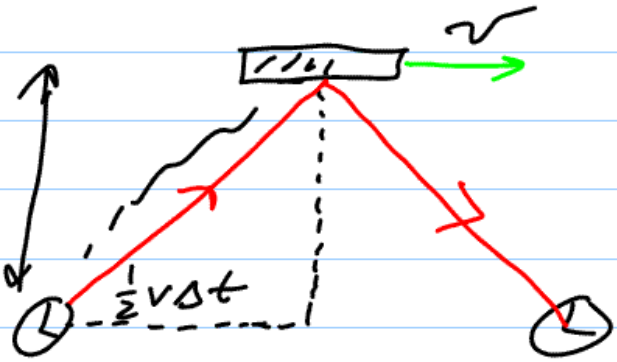
Stationary wrt ether



2 events! (1) light emitted
(2) reflected ray detected

$$\Delta t' = \frac{2h}{c}$$

Frame moving to left speed v wrt ether



Speed of light $\sqrt{c^2 + v^2}$

Distance $= 2 \times \sqrt{h^2 + (\frac{1}{2} v \Delta t)^2}$

$$\Delta t = \frac{2\sqrt{h^2 + (\frac{1}{2}v\Delta t)^2}}{\sqrt{c^2 + v^2}}$$

$$\Delta t = \frac{2h}{c} = \Delta t'$$

Yawn .....

Post 1905

Speed of light is c in both frames

$$\Delta t = \frac{2\sqrt{h^2 + (\frac{1}{2}v\Delta t)^2}}{c}$$

$$\Delta t = \frac{1}{\sqrt{1 - v^2/c^2}}\,\Delta t' \neq \Delta t'$$

Moving clocks run slowly

$$\beta \equiv \frac{v}{c}$$

$$\Delta t = \frac{1}{\sqrt{1-\beta^2}}\,\Delta t'$$

$$\gamma \equiv \frac{1}{\sqrt{1-\beta^2}} > 1$$

$$\Delta t = \gamma\,\Delta t' > \Delta t'$$

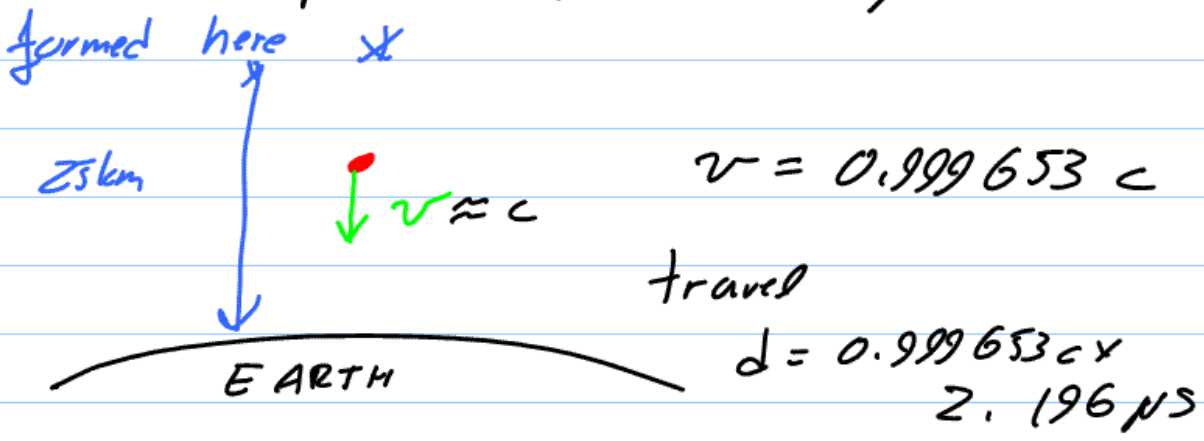
Example (similar to text)

Muon μ elementary particle

μ at rest wrt us, decays

mean lifetime $\Delta t = 2.196\,\mu s$

Component of cosmic rays.



$v = 0.999653\,c$

travel

$d = 0.999653\,c \times 2.196\,\mu s$

$d = 658\,m$

Muons are seen on Earth.
Live longer

For us $\Delta t = \frac{1}{\sqrt{1 - v^2/c^2}} \times 2.196\,\mu s$

$= 83.37\,\mu s$

Travels $d = 0.999653c \times 83.37\,\mu s$

$= 25.00\,km$

Twin "paradox"

2 twins: born at same time.