NYU Physics I

- send Qs to TAs
- Scope of Exam 6
- Physics in the News: Benny
- Q's (in ~~your~~ scope)
- SR (things get weirder)

2018-12-04

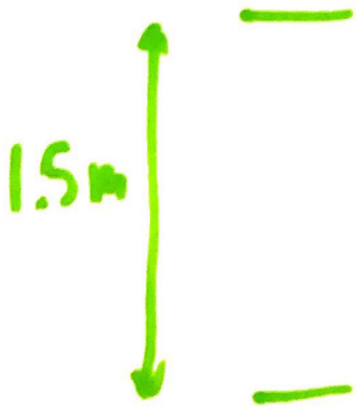
- time dilation
- length contraction

(SR Notes Chap 2)

RELATIVITY

① velocities are relative
(no absolute)

② c = const, max

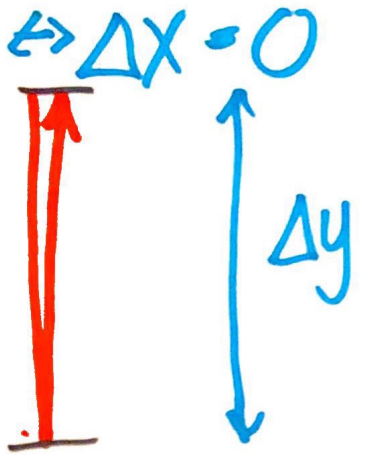


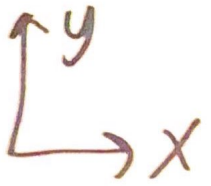
dist = vel · time

$3m = 3 \cdot 10^8 m/s \; t$

$t = 10^{-8} s = 10 ns$

P's frame



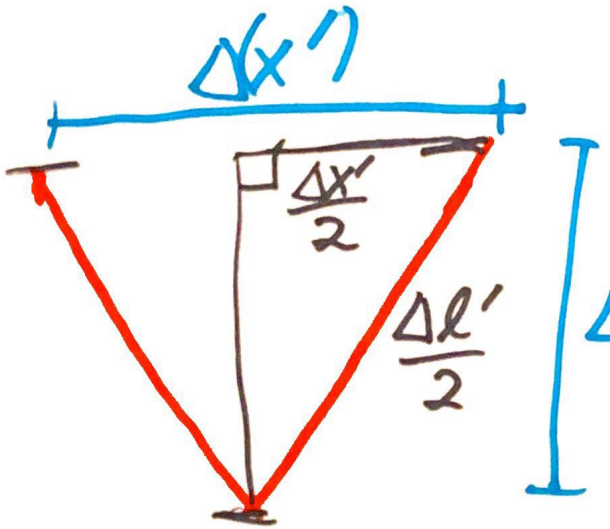


$$\Delta \ell = c\Delta t = 2\Delta y$$

$$\Delta y = \Delta y'$$

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

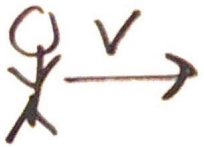
K's frame



$$\Delta x' = v(\Delta t')$$

$$\Delta \ell' = c\Delta t'$$

$$\left(\frac{\Delta \ell}{2}\right)^2 = \left(\frac{\Delta x'}{2}\right)^2 + (\Delta y')^2$$



$$\frac{c^2(\Delta t')^2}{4} = \frac{v^2(\Delta t')^2}{4} + \frac{c^2(\Delta t)^2}{4}$$

$$c^2(\Delta t)^2 = v^2(\Delta t')^2 + c^2(\Delta t)^2$$

$$(c^2 - v^2)(\Delta t')^2 = c^2(\Delta t)^2$$

$$(\Delta t')^2 = (\Delta t)^2 \frac{c^2}{c^2 - v^2} = (\Delta t)^2 \frac{c^2}{c^2\left(1 - \frac{v^2}{c^2}\right)}$$

$$(\Delta t')^2 = (\Delta t)^2 \frac{1}{1 - \frac{v^2}{c^2}} \Rightarrow \boxed{\Delta t' = \Delta t\,\gamma}$$

$0 < \frac{v^2}{c^2} < 1$

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

γ

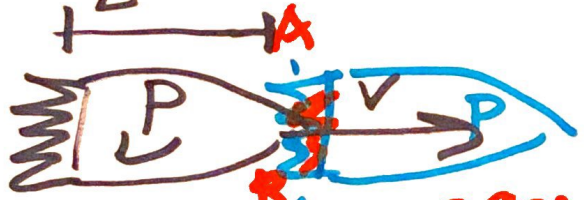
"moving clocks run slow"

$\gamma > 1 \quad \Delta t' > \Delta t$

TIME DILATION

$$\text{dist} = \underbrace{\text{vel}}_{c} \cdot \text{time}$$

stay same changes!



(t_0) $t_K = t_f - t_i$ 3 9 13

proper time: events @ same place! $t_p = \gamma t_K$

$t' = \gamma t_0$

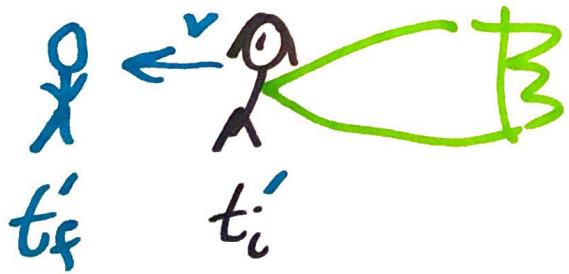
KS frame

$t_p > t_K$?

LENGTH CONTRACTION

L_0: proper length: events @ same time

P's frame

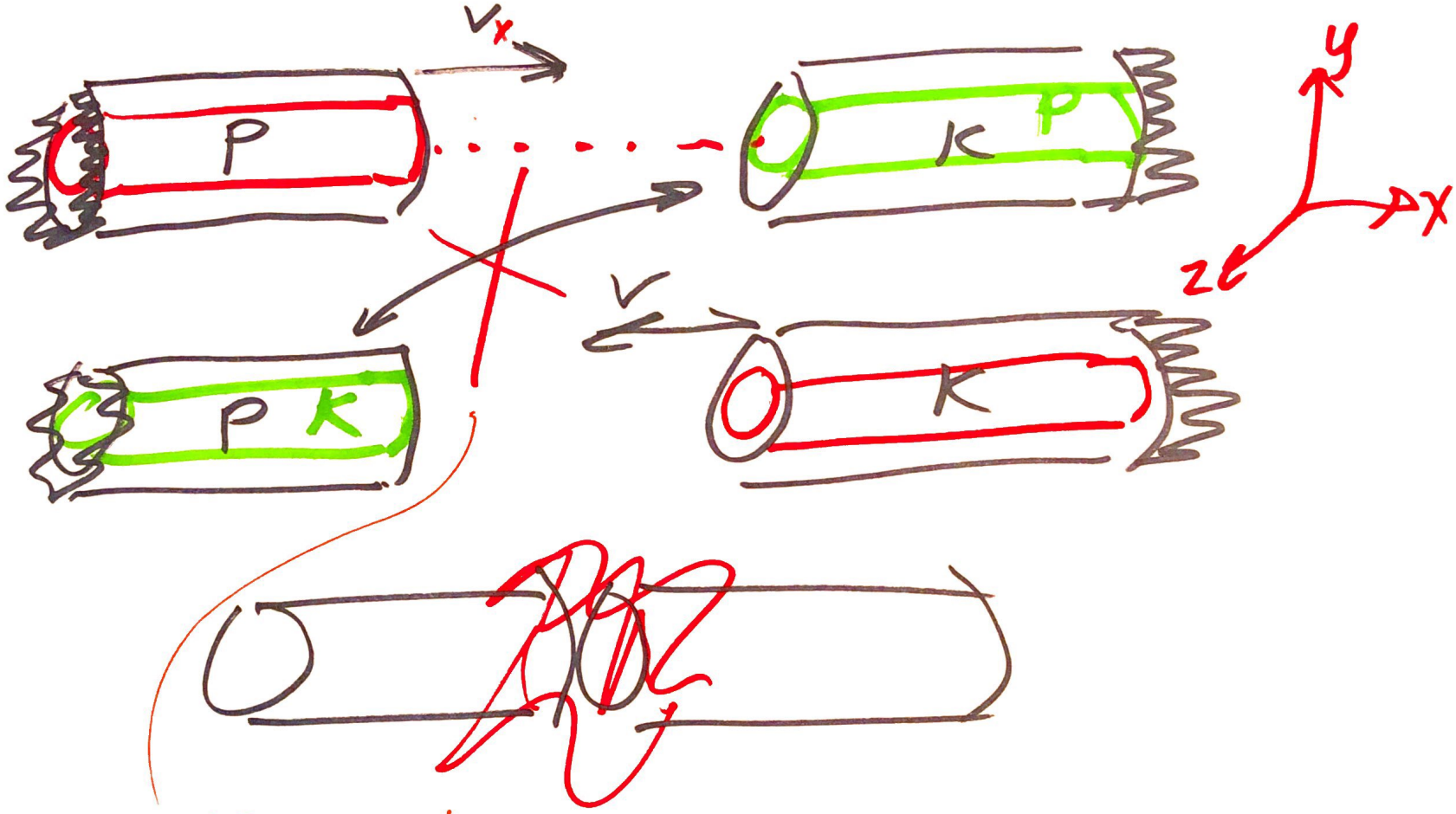


$t_p = t_f' - t_i'$

$L' = v t_K = \underline{v t_0}$

$\underline{L_0} = v t_p = \underline{v \gamma t_0} = \underline{\gamma L'}$

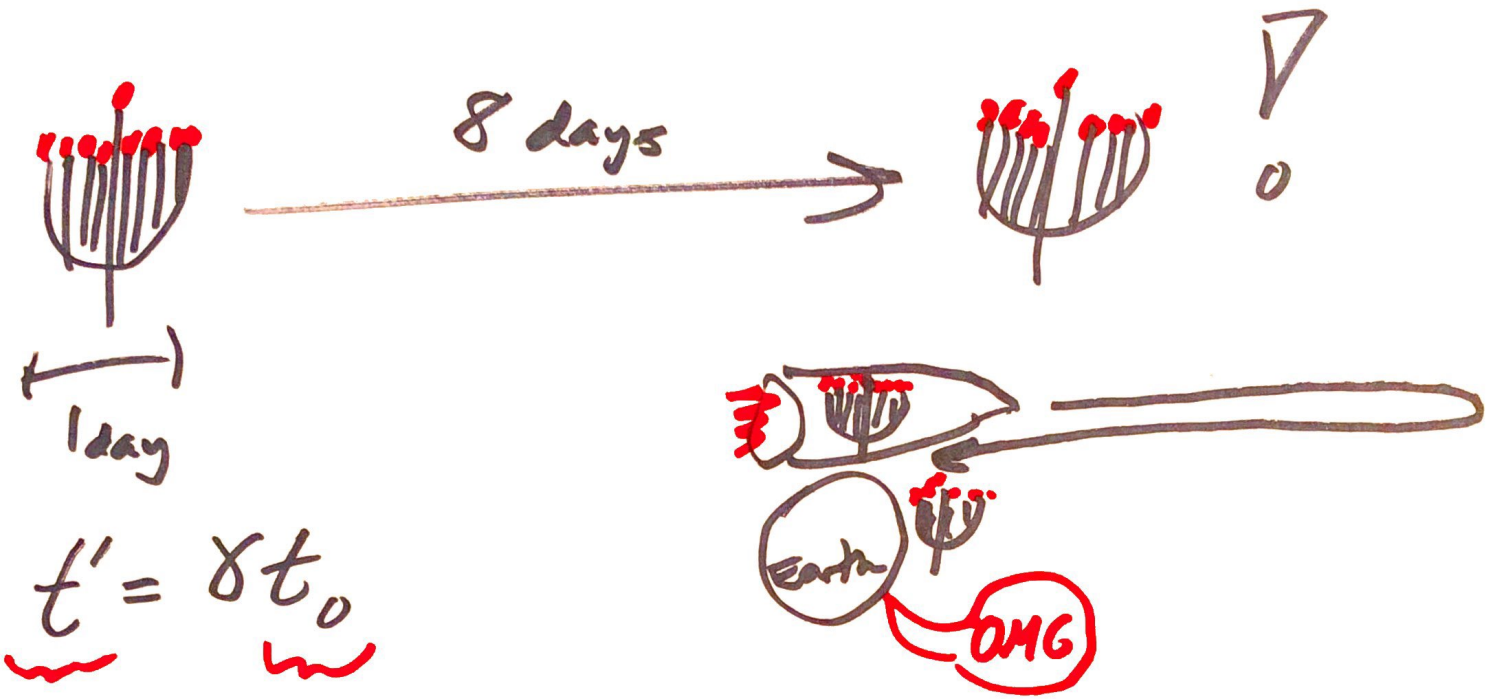
$$L' = \frac{L_0}{\gamma}$$



CONTRADICTION!

⇓

ONLY CONTRACTION ALONG AXIS OF MOTION



$$t' = \gamma t_0$$

8 days 1 day

$$8 = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}} \Rightarrow 1-\frac{v^2}{c^2} = \frac{1}{64} \Rightarrow \frac{v^2}{c^2} = \frac{63}{64}$$

$$\frac{v}{c} = \sqrt{\frac{63}{64}} = 0.992$$

$$\boxed{v = 0.992c}$$