

Main Points: • since u in x direction,

$$y' = y, \quad z' = z$$

• x' definitely gets changed,

if $t = 0$

"GALILEAN"

$$x' = x$$

LATER T , S' moves a distance ut

$$x' = x - ut$$

"LORENTZ" $\beta = \frac{v}{c}$ $\gamma = \frac{1}{\sqrt{1-\beta^2}}$

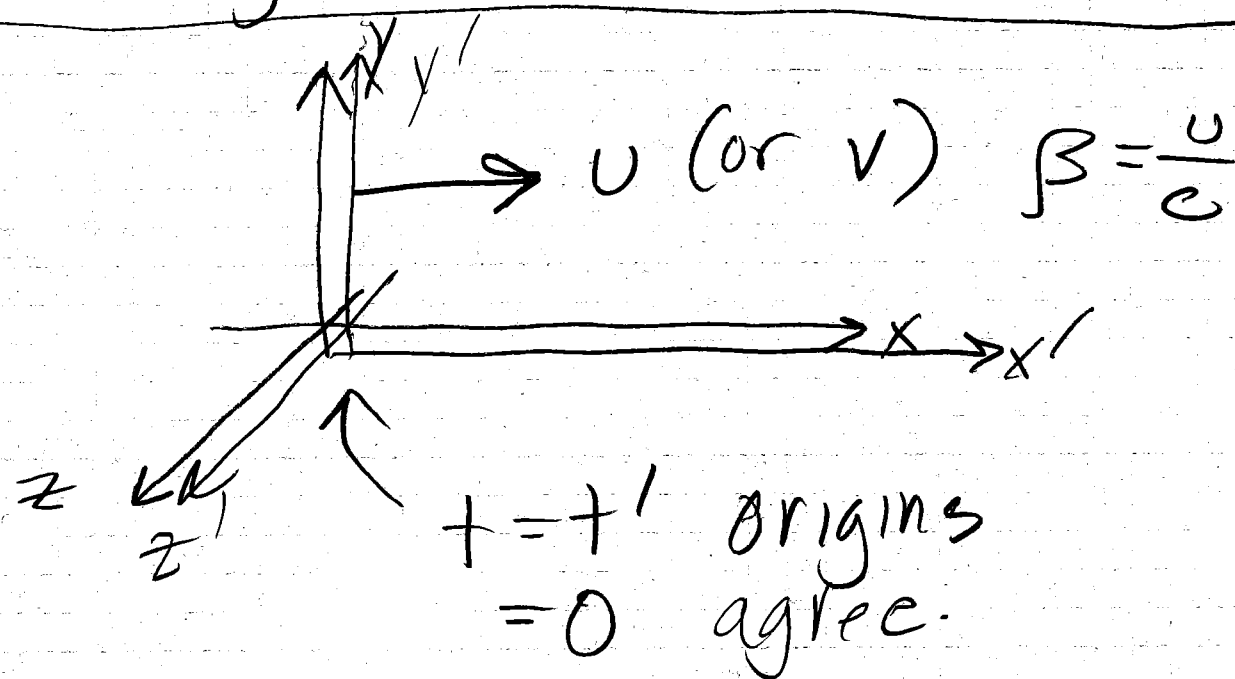
$$x' = \gamma(x - ut)$$

shocker

$$t' = \gamma\left(t - \frac{ux}{c^2}\right)$$

Huh?

Using Lorentz Transformations



event: t, x, y, z

$$x' = \gamma(x - \beta ct)$$

$$x = \gamma(x' + vt')$$

$$y' = y$$

$$y = y'$$

$$z' = z$$

$$z = z'$$

$$t' = \gamma\left(t - \frac{xv}{c^2}\right)$$

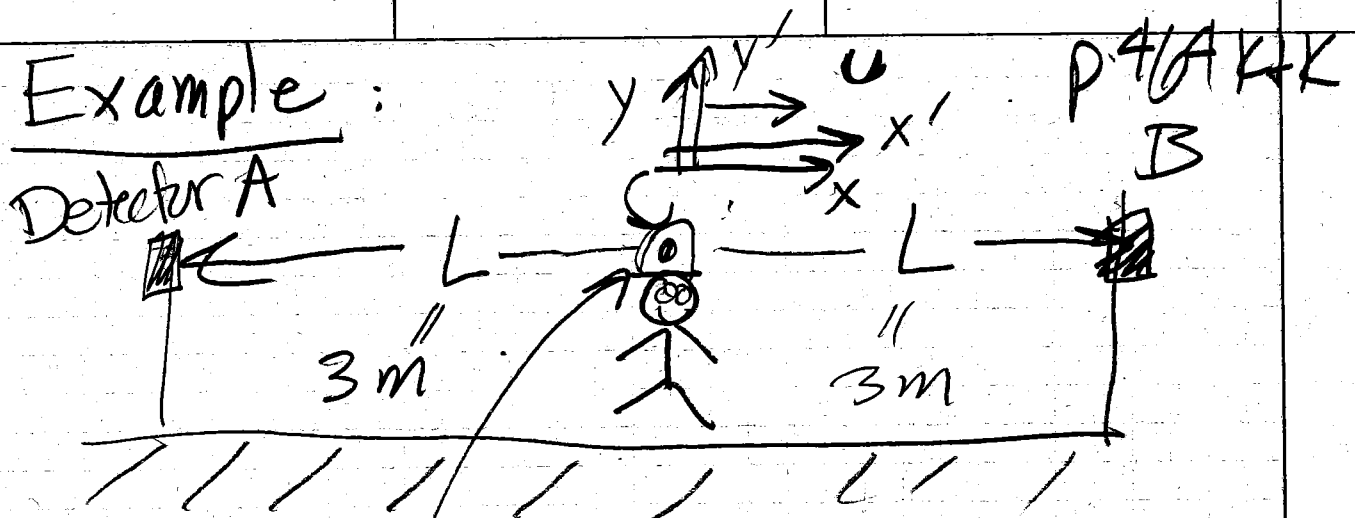
$$t = \gamma\left(t' + \frac{x'v}{c^2}\right)$$

Subtle point... must imagine distributed networks of synchronized clocks... HARD p.476 RHK4

Simultaneity: true in one frame only

Example :

Detector A



$$\frac{u}{c} = \sqrt{\frac{3}{4}} = \beta$$

$$\gamma = \frac{1}{\sqrt{1 - \frac{3}{4}}} = 2 \text{ LIGHT}, \quad \begin{aligned} x &= x' = 0 \\ y &= y' = 0 \\ t &= t' = 0 \end{aligned}$$

In rest frame,

$$x_A = -L = -3m \quad t_A = \frac{L}{c} = 10ns$$

$$x_B = L = 3m \quad t_B = \frac{L}{c} = 10ns$$

Simultaneous

In moving frame...

expect $|x'_A| > |x'_B|$

$|t'_B| < |t'_A|$

$$x'_A = \gamma(x_A - \beta c t_A) = 2(-L - \sqrt{\frac{3}{4}} \cdot c \cdot \frac{L}{c})$$

$$= -2 \cdot (1 + \sqrt{\frac{3}{4}}) L = -3.73 L$$

$$x'_A = -11.2 m$$

$$x'_B = \gamma(x_B - \beta ct_A)$$

$$= 2 \cdot (L - \sqrt{\frac{3}{4}} c \cdot \frac{L}{c})$$

$$x'_B = 2(1 - \sqrt{\frac{3}{4}}) L = \underline{\underline{0.804 m}}$$

$$t'_A = \gamma(t_A - \frac{x_A u}{c^2}) = \gamma(t_A - \frac{x'_A}{c} \beta)$$

$$= \gamma(\frac{L}{c} - \frac{L}{c} \beta) = \gamma(1 - \beta) \frac{L}{c}$$

$$= 2(1 + \sqrt{\frac{3}{4}}) 10 \text{ ns} = \underline{\underline{37.3 \text{ ns}}}$$

$$t'_B = \gamma(t_B - \frac{x_B u}{c^2}) = \gamma(t_B - \frac{x'_B}{c} \beta)$$

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

$$= 2(1 - \sqrt{\frac{3}{4}}) 10 \text{ ns} = \underline{\underline{2.67 \text{ ns}}}$$

Deeper Thinking (p. 465 K&K)

Timelike and
Spacelike Intervals

suppose
first →

A
 x_A, t_A

B
 x_B, t_B