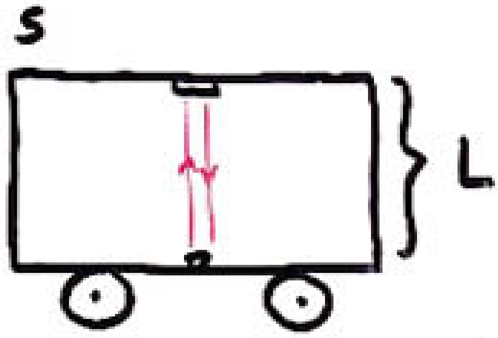
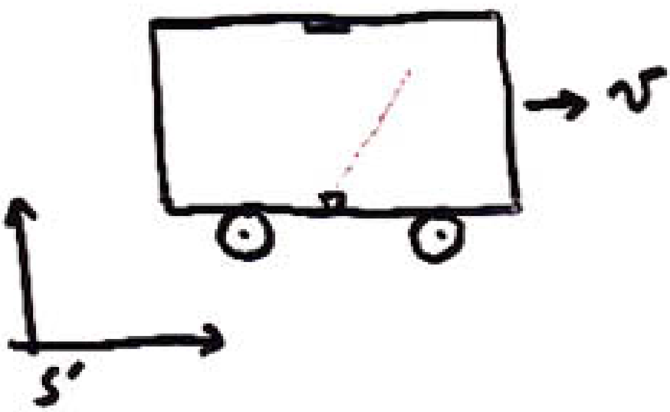
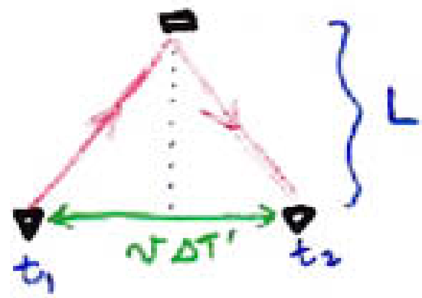
DILATAÇÃO DO TEMPO



Velocidade da luz: $\underline{\underline{c}}$ $\rightarrow$ $\Delta T = \frac{2L}{c}$





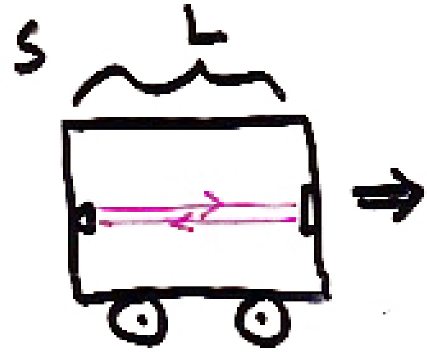
Velocidade da luz: $\underline{\underline{c}}$!

$$\Delta T' = \frac{2\left(L^2 + \left(\frac{v\Delta T'}{2}\right)^2\right)^{1/2}}{c}$$

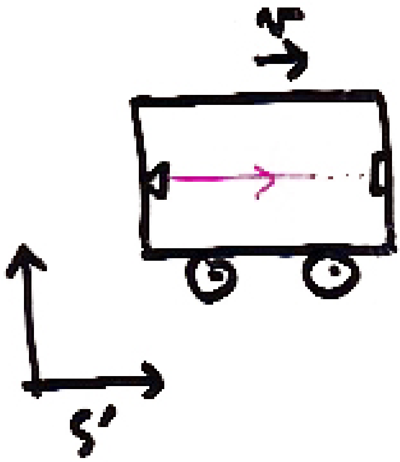
$$\Delta T'^2 = \frac{4L^2}{c^2} + \frac{v^2}{c^2}\Delta T'^2$$

$$\hookrightarrow \boxed{\Delta T' = \frac{\overbrace{2L/c}^{\Delta T}}{\left(1 - \frac{v^2}{c^2}\right)^{1/2}} = \gamma \Delta T} \quad ; \quad \gamma = \frac{1}{\left(1 - \frac{v^2}{c^2}\right)^{1/2}}$$

CONTRAÇÃO DE LORENTZ-FITZGERALD



$$\Delta T = \frac{2L}{c}$$



$$\Delta T' = \frac{L'}{c-v} + \frac{L'}{c+v} = \frac{2L'c}{c^2-v^2}$$

$$\frac{\frac{2L}{c}}{\left(1-\frac{v^2}{c^2}\right)^{1/2}}$$

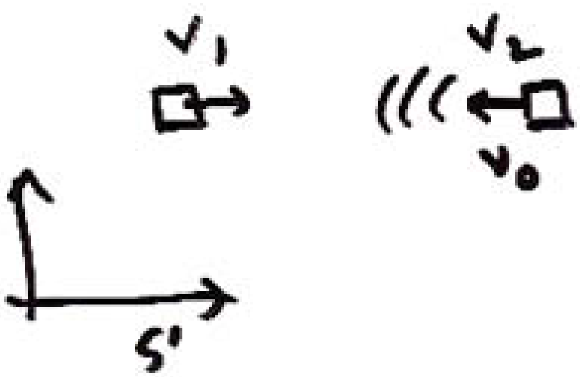
$$\Downarrow$$

$$\boxed{L' = L\left(1-\frac{v^2}{c^2}\right)^{1/2}}$$

ADIÇÃO DE VELOCIDADES

Qual a velocidade de ② em relação à ①?

→ Usando o efeito Doppler:



No laboratório:

$$\nu_L = \nu_0 \left(\frac{1 + v_2/c}{1 - v_2/c}\right)^{1/2}$$

Para ①

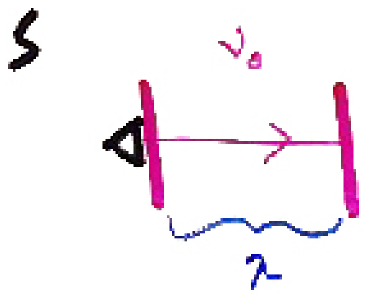
$$\nu_1 = \nu_L \left(\frac{1 + v_1/c}{1 - v_1/c}\right)^{1/2}$$

$$= \nu_0 \left(\frac{1 + v_1/c}{1 - v_1/c}\right)^{1/2} \left(\frac{1 + v_2/c}{1 - v_2/c}\right)^{1/2}$$

$$= \nu_0 \left(\frac{1 + u/c}{1 - u/c}\right)^{1/2}$$

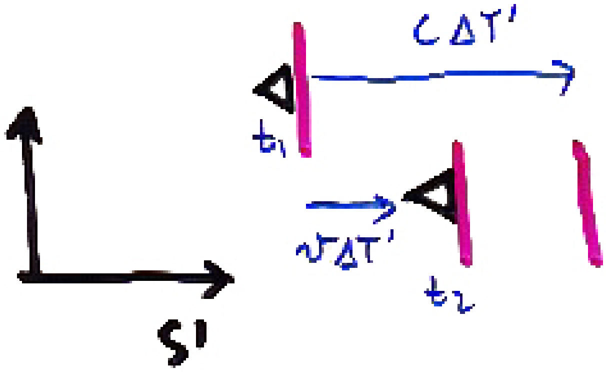
$$\boxed{u = \frac{v_1 + v_2}{1 + \frac{v_1 v_2}{c^2}}}$$

EFEITO DOPPLER



$$\Delta T \rightarrow \lambda = c\,\overbrace{\Delta T}^{1/\nu_0}$$

OBSERVADOR



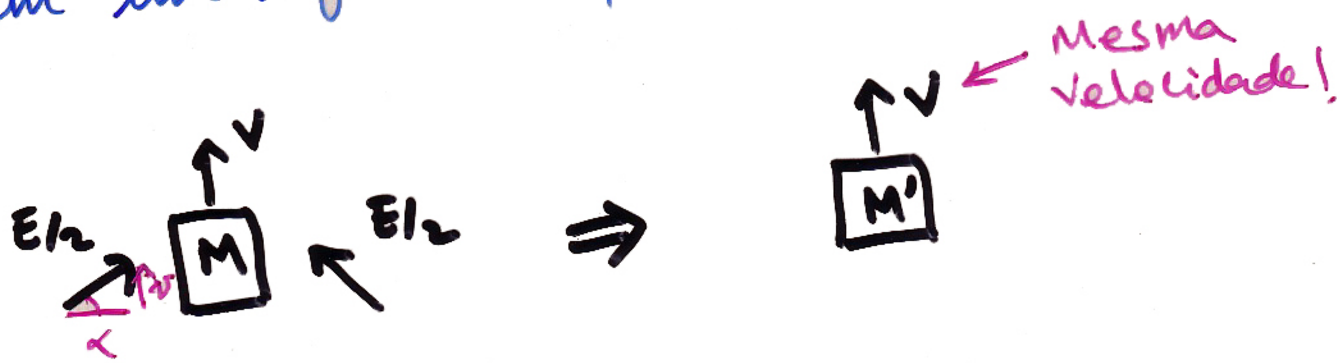
$$\overbrace{\lambda'}^{c/\nu} = (c-v)\,\Delta T'$$

$$= (c-v)\frac{\Delta T}{\left(1-\frac{v^2}{c^2}\right)^{1/2}}$$

$$\frac{c}{\nu} = \frac{c}{\nu_0}\left(\frac{1-v/c}{1+v/c}\right)^{1/2} \rightarrow \boxed{\nu = \nu_0\left(\frac{1\pm v/c}{1\mp v/c}\right)^{1/2}}$$

$E = Mc^2$ (1946)

Em um referencial que se move:



$\sin\alpha = \frac{v}{c}$

$$\underbrace{Mv}_{\text{Momento do corpo}} + 2\,\overbrace{\frac{E/2\,\sin\alpha}{c}}^{\text{momento da radiação}} = \underbrace{M'v}_{\text{momento final}}$$

~~ABERRAÇÃO~~: $\sin\alpha \sim \frac{v}{c}$

$$(M' - M)v = \frac{E}{c} \cdot \frac{v}{c} = \frac{Ev}{c^2}$$

$$\Rightarrow \boxed{(M' - M)c^2 = E}$$