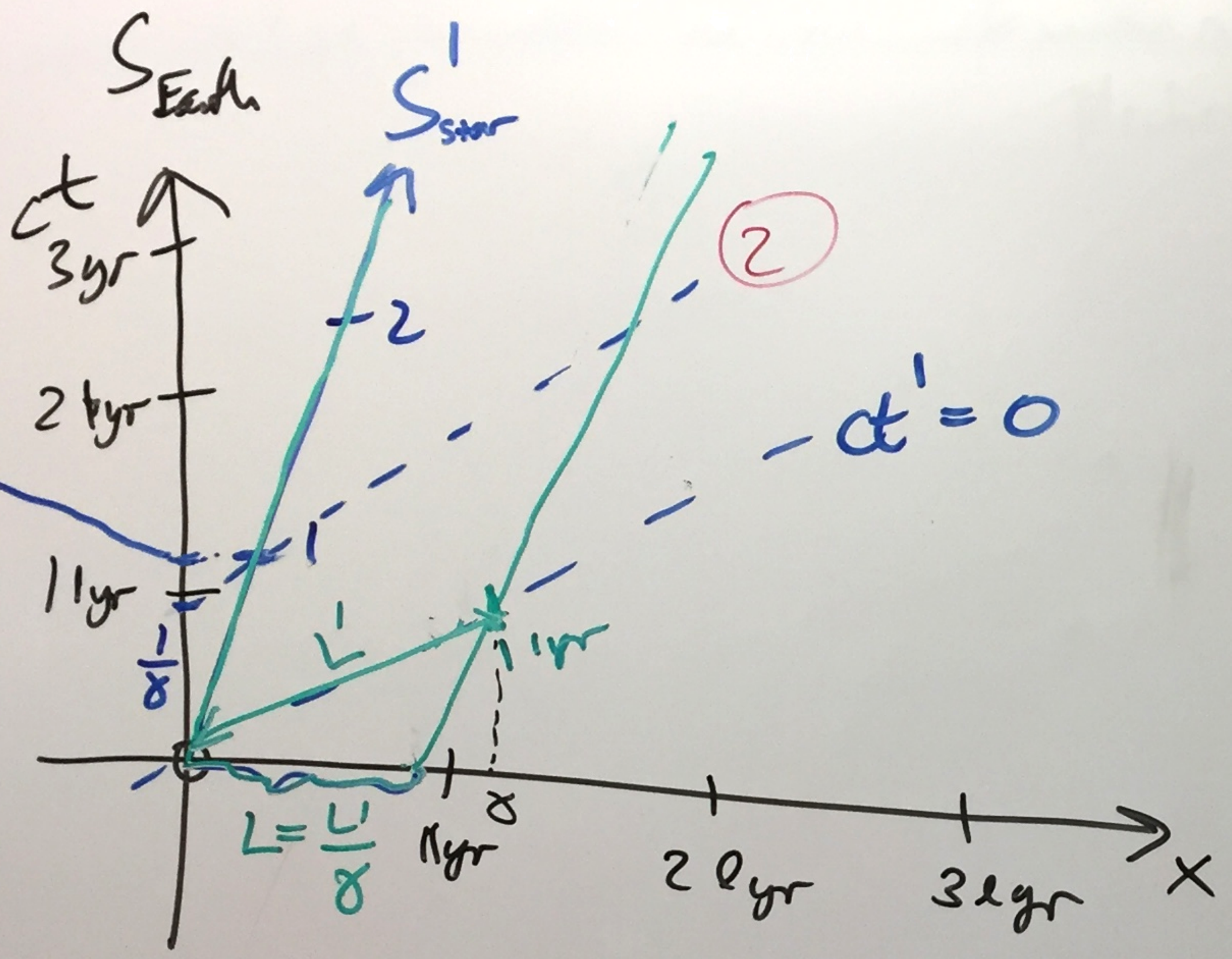
$$x' = \gamma\left(x - \frac{v}{c}ct\right)$$

$$ct' = \gamma\left(ct - \frac{v}{c}x\right)$$

Lorentz transformation



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

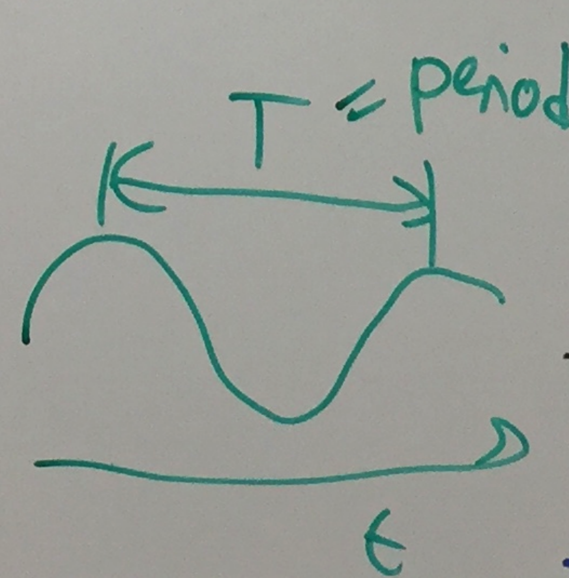
(ct, x, y, z)

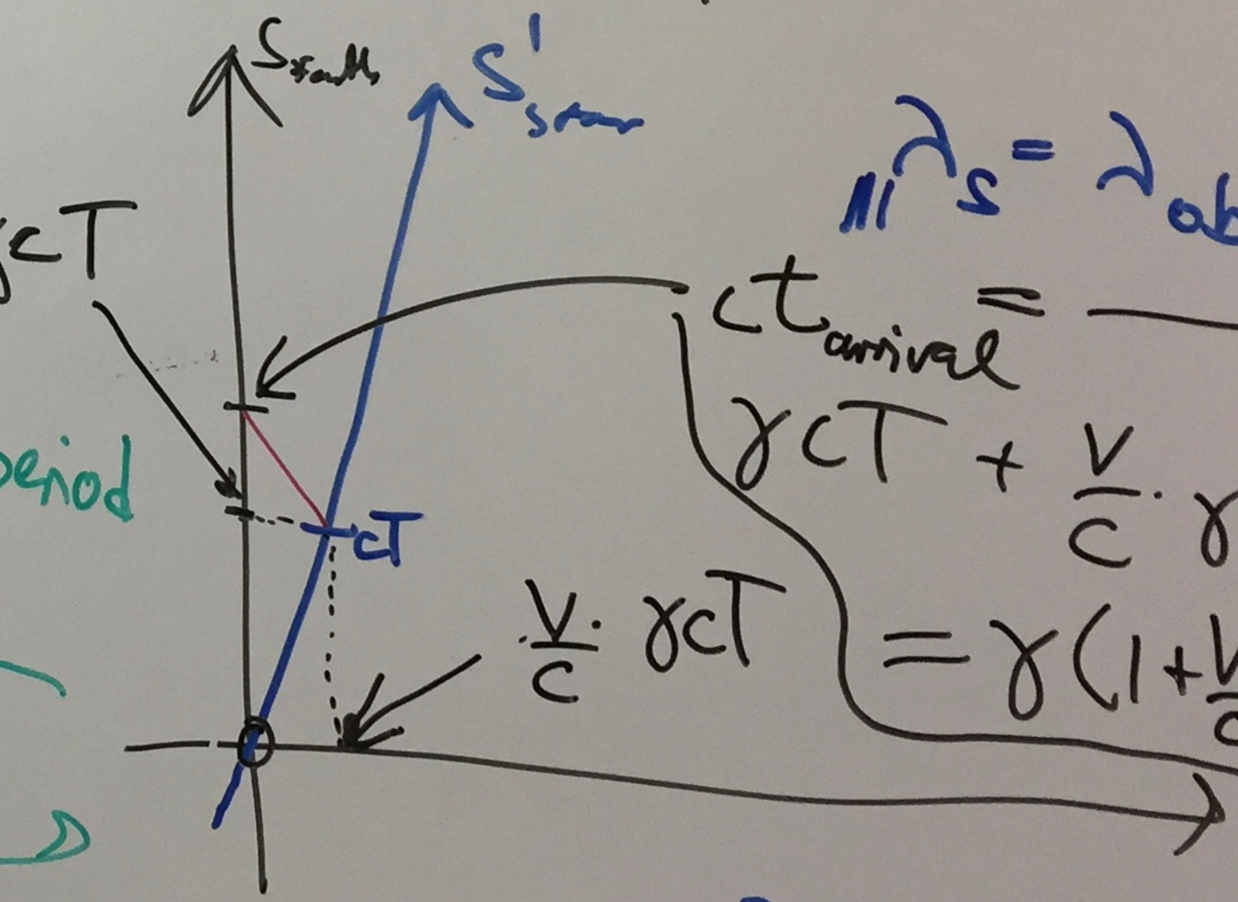
① Time dilation

② Relativity of simultaneity

③ Length contraction

→ Doppler Shift





"λ_s" = λ_{obs}

$$ct_{arrival} = \gamma cT + \frac{v}{c}\cdot\gamma cT = \gamma\left(1+\frac{v}{c}\right)\cdot cT$$

$$cT = \lambda \qquad T = \frac{\lambda}{c}$$

$$\lambda_{obs} = \gamma\left(1+\frac{v}{c}\right)\lambda_{emit} \quad \text{Doppler shift}$$

↑ $\frac{v}{c}$ in x-direction

$$\gamma = \frac{1}{\sqrt{1-\vec{v}^2/c^2}}$$

$$z = \left[\gamma\left(1+\frac{v}{c}\right) - 1\right] \quad \text{the redshift}$$

"$E=mc^2$" = rest energy

Apparent inertia mass $= \gamma m$

(m = rest mass)

Momentum: $\vec{p} = \gamma m \vec{v}$

Total Energy $= \gamma mc^2 \simeq$ rest energy + kinetic

$$\frac{E^2}{c^2} - \vec{p}^2 = \gamma^2 m^2 c^2 - \gamma^2 m^2 \vec{v}^2$$

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

$$= m^2 c^2$$

Photon: $E = hf$

$$p = \frac{E}{c} = \frac{hf}{c} = \frac{h}{\lambda}$$

→ Photon pressure

$$= \frac{F}{c}\cdot$$

$P \cdot V = nRT$ P = gas pressure

+ radiation pressure