

$$\Delta s^2 = c^2 \Delta t^2 - \Delta x^2 = \left(3 \times 10^8 \frac{m}{s} \times 10^{-7} \text{ sec}\right)^2 - (30)^2 m^2 = 3600 m^2 < 0$$

↓
Doesn't change with frame

$\begin{cases} s \\ s' \end{cases} \rightarrow v$

$\Delta s^2 > 0$ time separated events $\Delta x' = 0$
 $\Delta s^2 < 0$ space " like events $\Delta t' = 0$
 $\Delta s^2 = 0$ light " $\Delta x' = \sqrt{\Delta x^2 - v \Delta t^2}$
 $210 \quad \left\{ \Delta x = 60 \text{ m}$
 $150 \quad \Delta t = 0.1 \mu\text{s}$

Can choose a $v (< c)$
 s.t. $\Delta x' = 0$
 $\Delta x = v \Delta t$
 $\Delta x < c \Delta t$
 $0 < \Delta s^2$

S

$u_x = ?$

S'

$\rightarrow v_n = u_x'$

$u_x' = \frac{u_x - v}{1 - u_x v/c^2}$

moving waffer

$u_x = \frac{u_x' + v}{1 + u_x' v/c^2}$

$u_x' = \frac{\Delta x'}{\Delta t'} = \frac{\Delta x - v \Delta t}{\Delta t - \frac{v}{c^2} \Delta x}$
 $= \frac{u_x - v}{1 - \frac{v}{c^2} u_x}$

$x' = \frac{x - vt}{\sqrt{1 - \beta^2}}$

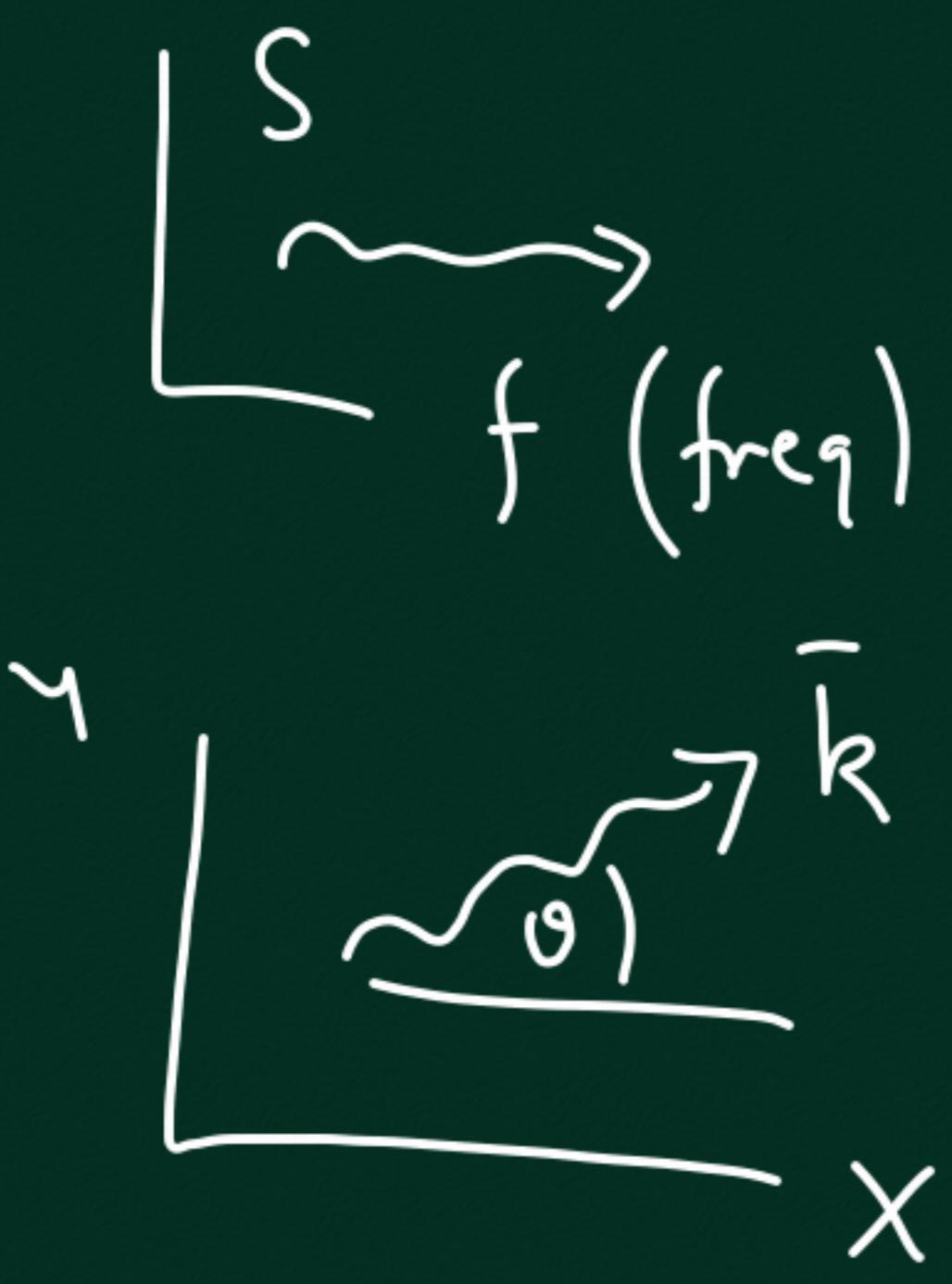
$u_y' = \frac{\Delta y'}{\Delta t'} = \frac{\Delta y}{\Delta t - \frac{v}{c^2} \Delta x} = \frac{u_y \sqrt{1 - \beta^2}}{1 - \frac{v u_x}{c^2}}$

$y' = y$

$t' = -$

$u_x' = \frac{u_x - v}{1 - u_x v/c^2}$

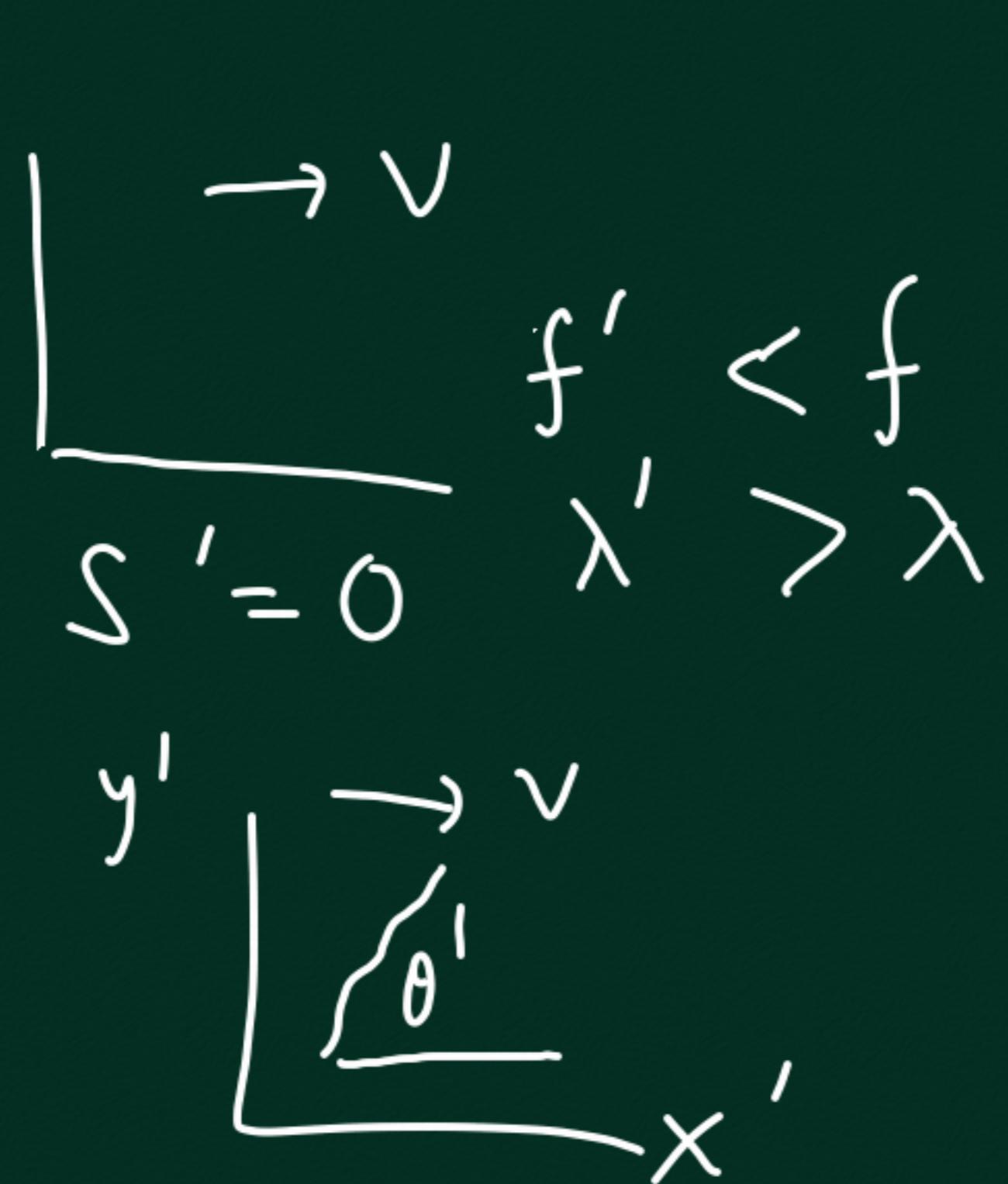
$\Delta t' = \frac{\Delta t - \frac{v}{c^2} \Delta x}{\sqrt{1 - \beta^2}}$



$$\bar{k} = \frac{2\pi}{\lambda} (\omega_0 \hat{i} + \sin\theta \hat{j})$$

$$\left. \begin{array}{l} f \\ \lambda \end{array} \right\} f\lambda = c = f'x'$$

$$\omega = 2\pi f$$



$$S: A \cos(\bar{k} \cdot \bar{r} - \omega t)$$

$$A \cos \left[\frac{2\pi}{\lambda} (\omega_0 x + \sin\theta y) - \omega t \right]$$

$$(\cdot)x + (\cdot)y + (\cdot)t$$

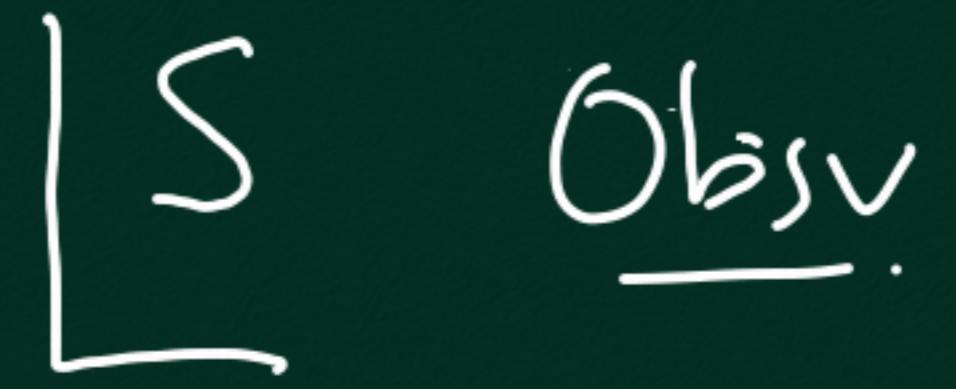
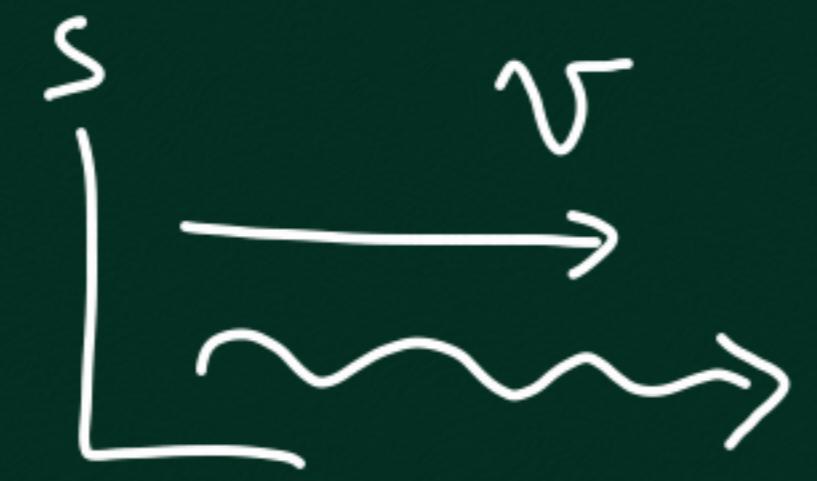
1) \rightsquigarrow along x in S

 $\theta = 0 \Rightarrow \theta' = 0 \text{ same in } S'$

2) $f = \frac{1+\beta}{\sqrt{1-\beta^2}} f' \quad f' = \sqrt{\frac{1+\beta}{1-\beta}} f'$

 $\theta' = 0 \quad f' < f$

Newtonian

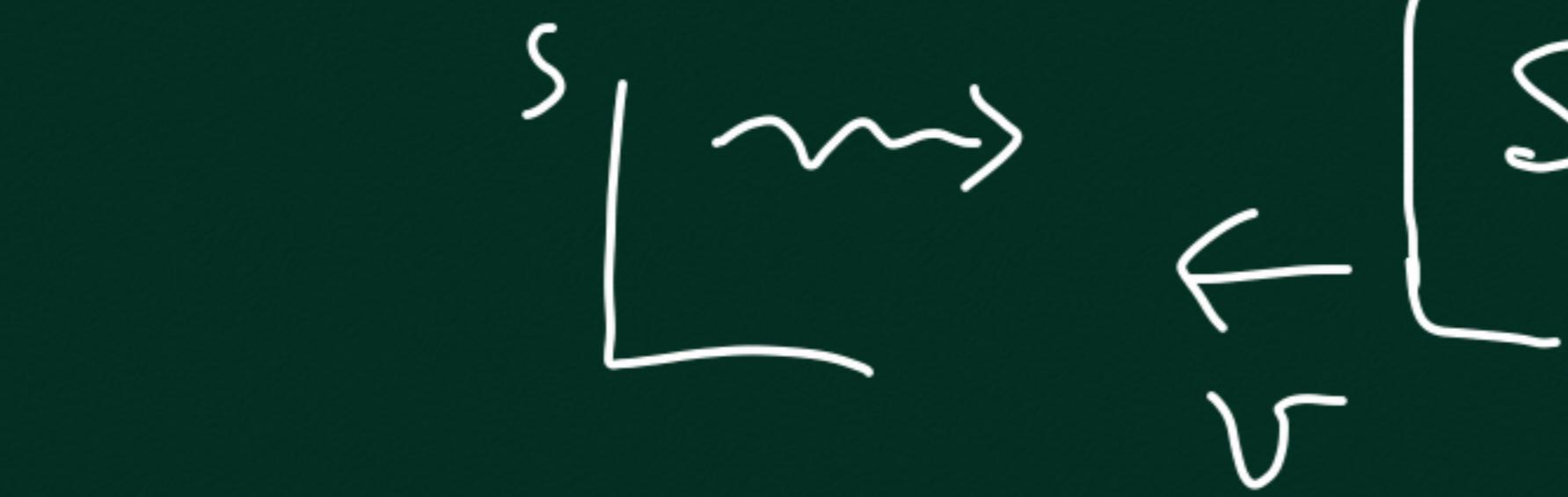


Source moving towards stationary observer

$$f_{\text{obs}} = \frac{f}{1 - v/c} \rightarrow \text{could be sound spd.}$$

$u_y' \neq u_y$

Observer moving towards source



$$f_{\text{obs}} = f \left(1 + \frac{v}{c} \right)$$

Two small diagrams at the bottom right show the geometry of the angles. The first shows a horizontal line with an upward-pointing arrow labeled 'v'. A wavy line labeled 'S' extends upwards and to the left at an angle θ relative to the vertical. The second diagram shows a horizontal line with an upward-pointing arrow labeled 'v'. A wavy line labeled 'S'' extends upwards and to the right at an angle θ' relative to the vertical.

$$\tan \theta < \tan \theta'$$

$$p_x = m u_x = \frac{m_0}{\sqrt{1 - \frac{u^2}{c^2}}} u_x$$

$$p_x' = \frac{(p_x - v(E/c^2))}{\sqrt{1 - \beta^2}}$$

$$\begin{aligned} p_y' &= p_y \\ p_z' &= p_z \\ \frac{E}{c^2} &= \frac{(E/c^2) - \frac{p_x}{c^2}}{\sqrt{1 - \beta^2}} \end{aligned}$$

$$p_x' = \frac{m_0}{\sqrt{1 - \frac{u'^2}{c^2}}} u_x'$$

$$\boxed{E = \frac{m c^2}{\sqrt{1 - \frac{u^2}{c^2}}} = (m_0 + \Delta m) c^2}$$

$$K = \left(\frac{1}{\sqrt{1 - \frac{u^2}{c^2}}} - 1 \right) m_0 c^2 = (m - m_0) c^2$$

$$\begin{aligned} x' &= \frac{x - vt}{\sqrt{1 - \beta^2}} \\ t' &= \gamma \\ z' &= z \\ t' &= \frac{t - vx/c^2}{\sqrt{1 - \beta^2}} \end{aligned}$$

$$K(u) = m u v$$

$$K = \frac{m}{2} u^2$$

$$f(u,v) = u' = \frac{u-v}{1-vu/c^2}$$

$$\frac{\partial K}{\partial v} = mu$$

$$\text{Hallin: } f' = \frac{\partial f}{\partial v} = -1$$

$$x' = x - vt$$

$$x =$$

