$$E = \sqrt{(m c^2)^2 + (\vec{p} c)^2}$$

for $v \ll c$ $\quad E \simeq mc^2 + \frac{\vec{p}^2}{2m}$

$V \to c \quad E \to pc$

$$\vec{F}_{grav}(m) = G \frac{M m}{r^2}(-\hat{r})$$

$$U_{grav\ pot}^{(sphere)} = -\frac{3}{5}\frac{G M^2}{r} \quad \text{GR: } E/c^2$$

Chandrasekar Limit

$$M_{rel} = m_0 \cdot \gamma \qquad \gamma = \frac{1}{\sqrt{1 - v^2/c^2}}$$

$M_{rel} = E/c^2$

Remnant Star

A^{Fe}, e^-

p n

$p + e^- \to n + \nu_e$

1-2 $M_\odot$

huge # of n

= neutron star $s = \frac{1}{2}$

~10 km (Pulsar)

Lower limit of size for an object of mass M

$$R_{Schwarzschild} = \frac{2GM}{c^2}$$

$R < R_s \to$ black hole

Wrong calculation:

Escape vel.: $= \frac{m}{2} v^2 > \frac{GMm}{r}$

if $v = c$ $\quad r > \frac{2GM}{c^2}$ for escape

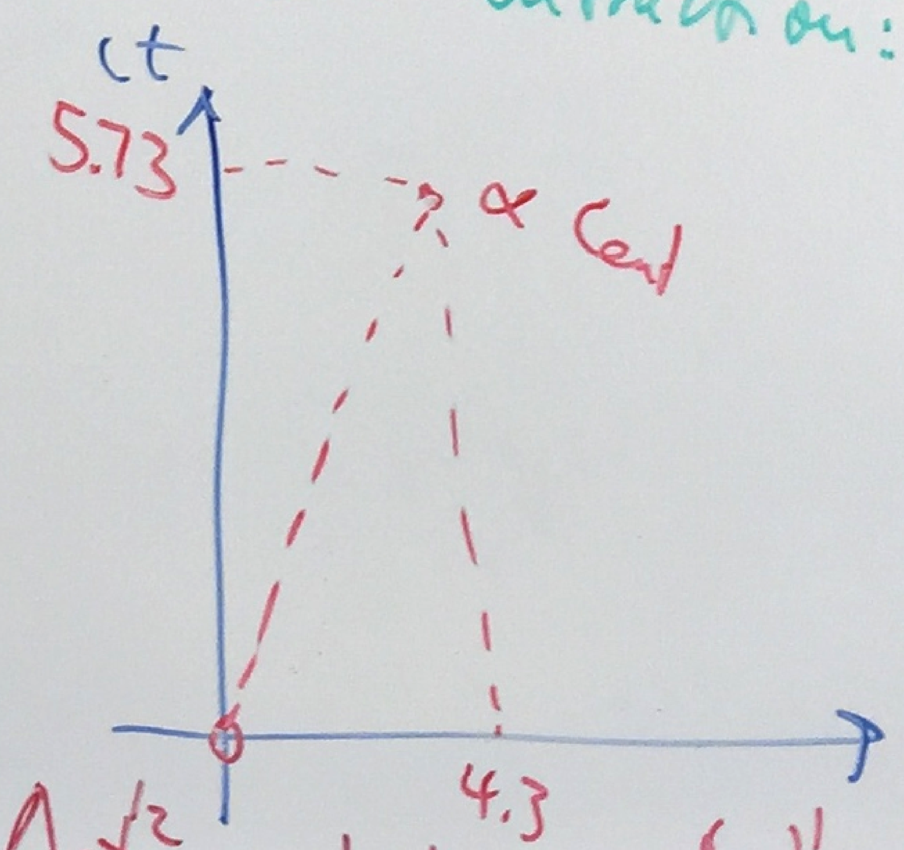
α Centauri $\simeq 4.3$ lyr

$V = \frac{3}{4}c \qquad \Delta t = \frac{4.3 \text{ lyr}}{\frac{3}{4}c}$

$$\gamma = \frac{1}{\sqrt{1 - (3/4)^2}} = \frac{4}{\sqrt{7}} = 1.51 \qquad \Delta ct = 5.73 \text{ lyr}$$

Spaceship $\quad \Delta ct' = \frac{1}{\gamma} ct = 3.79$ lyr

Length contraction: distance $= \frac{\Delta x}{\gamma} = 2.85$ ly



$$\Delta x^\nu = (5.73 \text{ ly}, 4.3 \text{ ly}, 0, 0)$$

$$\Delta s^2 = \Delta x^\nu \Delta x_\nu = \Delta ct^2 - \Delta x^2 - \Delta y^2 - \Delta z^2 = (5.73 \text{ ly})^2 - (4.3 \text{ ly})^2 = 15 \text{ ly}^2$$

$\Delta ct'^2 = 15 \text{ lyr}^2 \to \Delta ct' = 3.79$ lyr