Special Relativity Notes

energy of Neutrino → ?

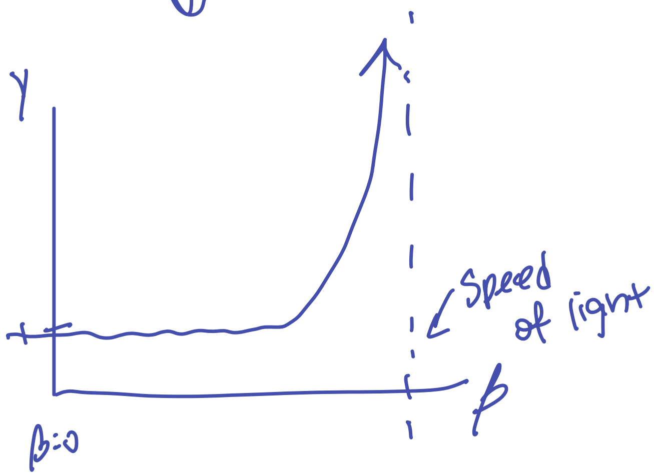
Lorentz Transformations (Motion in x-dir)

$t' = \gamma(t - \frac{vx}{c^2})$ $\quad \gamma = \frac{1}{\sqrt{1-\beta^2}}$ $\quad \beta = \frac{v}{c}$

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

$y' = y$

$z' = z$



What to know ab particles

- momentum p
- energy → E_k
- Force F

Momentum p

Classical: $p = mv$

relativistic: $\boxed{p = \gamma m v}$

Force F

$p_f - p_i = (F_f - F_i)\Delta t$

$\boxed{F = \frac{dp}{dt}}$

Energy E_k

$E_k = \frac{1}{2} m v^2$

$$E_k = \int_0^v F\,dx = \int_0^v \frac{dp}{dt}\,dx$$

$$= \int_0^v \frac{d(\gamma m v)}{dt}\,dx \rightarrow \int_0^v d(\gamma m v)\frac{dx}{dt} \rightarrow \int_0^v \underbrace{v\,d(\gamma m v)}$$

$$d(\gamma m v) = m\left(1 - \frac{v^2}{c^2}\right)^{-\frac{3}{2}} \cdot dv$$

$$= \int_0^v v m\left(1 - \frac{v^2}{c^2}\right)^{-\frac{3}{2}} dv = mc^2\left(\underbrace{\frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}}_{\gamma} - 1\right) = \boxed{(\gamma - 1)mc^2}$$

Total energy E

$E = E_k + E_0$

$E_0 = mc^2$

$\boxed{E = \gamma m c^2}$

$E_K = \frac{1}{2}mv^2$

$p^2 = (mv)^2 \rightarrow p^2 = m^2v^2$

$\frac{1}{2}\frac{m^2v^2}{m} = \frac{1}{2}mv^2$

$\hookrightarrow E_K = \frac{p^2}{2m}$

$(p)^2 = (\gamma mv)^2 \Rightarrow p^2 = \gamma^2 m^2 v^2 = \frac{m^2v^2}{\left(1-\frac{v^2}{c^2}\right)}$

solve for v^2:

$\gamma = \sqrt{1+\left(\frac{p}{mc}\right)^2}$

Plug in for E:

$\boxed{E = \sqrt{m^2c^4 + p^2c^2}}$ Energy-momentum 4 vector relation