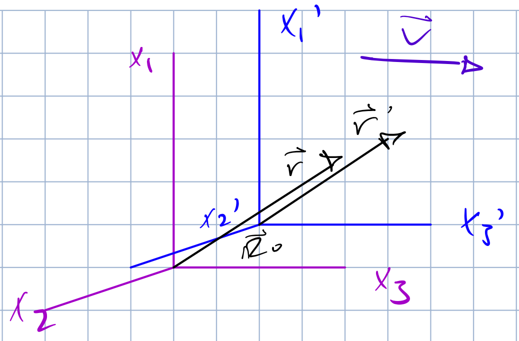

$x_1' = x_1$
$x_2' = x_1$
$x_3' = x_3 - vt$

$t' = t$

$$\partial_x^2 \psi = \frac{1}{c^2} \partial_t^2 \psi$$

$$\partial_x \psi = \partial_{x'} \psi$$

$$\partial_t \psi = -v \partial_{x'} \psi + \partial_{t'} \psi$$

$$(c^2 - v^2) \partial_{x'}^2 \psi = \partial_{t'}^2 \psi - 2v\, \partial_x \partial_{t'} \psi$$

$$\psi(t, x') = \psi_0\, e^{ik'(x' - u't')}$$

$$(u')^2 = (v \mp c)^2 + 2v(\pm c - v + u')$$

$$u' = v \mp c$$

Galileo Transf.

Lorentz Transformation

$$t' = \gamma(t - \tfrac{\beta}{c} x_3)$$

$x_1' = x_1$
$x_2' = x_2$

$$x_3' = \gamma(x_3 - \beta c t)$$

$\beta \equiv v/c$

$\gamma^2 = (1 - \beta^2)^{-1}$

4 vector: $x^\mu = (ct, x, y, z) = (ct, x^1, x^2, x^3) = (x^0, x^1, x^2, x^3)$

$x^{\mu'} = (ct', x^{1'}, x^{2'}, x^{3'})$

new rules!
how do x^μ transform?

$$x^{\mu'} = \Lambda^{\mu'}_{\nu}\, x^\nu$$

ν - generic index

how indices ν of x^ν transform to $x^{\mu'}$

2 indices contract (up & down)
contra & co variant

$$\Lambda^{\mu'}{}_{\nu} = \begin{pmatrix} \gamma & 0 & 0 & -\gamma\beta \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ -\gamma\beta & 0 & 0 & \gamma \end{pmatrix}$$

generalized vector

$$a^{0'} = \gamma(a^0 - \beta a^3)$$
$$a^{1'} = a^1$$
$$a^{2'} = a^2$$
$$a^{3'} = \gamma(a^3 - \beta a^0)$$

doesn't have to describe a position

$$B_i = \frac{1}{c} \epsilon_{ijk} E_j$$

$$a^{\mu'} = \Lambda^{\mu'}_{\nu} a^{\nu}$$

define dot product

$$A^2 = A^{\mu} A_{\mu} = -A^0 A^0 + A^1 A^1 + A^2 A^2 + A^3 A^3$$

the metric: how big space is

metric tensor: $\eta_{\mu,\nu}$

$$\eta_{\mu,\nu} = \begin{pmatrix} -1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

$$A^2 = A^{\mu} \cdot \eta_{\mu\nu} \cdot A^{\nu}$$