$P_1^\mu = (E_1, +P)$

$P_2^\mu = (E_2, -P)$

$P_{12}^\mu = (E_1 + E_2, 0)$

$$\boxed{B\, P_2^\mu = (m_2\, 0)}$$

$$\begin{pmatrix} \gamma & \gamma\beta \\ \gamma\beta & \gamma \end{pmatrix} \begin{pmatrix} E_2 \\ -P \end{pmatrix} = \begin{pmatrix} m_2 \\ 0 \end{pmatrix}$$

$$\begin{pmatrix} \gamma E_2 - \gamma\beta P \\ \gamma\beta E_2 - P\gamma \end{pmatrix} = \begin{pmatrix} m_2 \\ 0 \end{pmatrix}$$

$\cancel{\gamma}\beta E_2 = P\cancel{\gamma}$

$\beta E_2 = P$

$$\boxed{\beta = \frac{P}{E_2}}$$

$\gamma E_2 - \gamma P \frac{P}{E_2} = m_2$

$\gamma \left(\frac{E_2^2 - P^2}{E_2} \right) = m_2$

$\gamma \left(\frac{m_2^{\cancel{2}}}{E_2} \right) = \cancel{m_2}$

$$\boxed{\gamma = \frac{E_2}{m_2}}$$

$\gamma = \frac{1}{\sqrt{1-\beta^2}} = \frac{1}{\sqrt{1 - \frac{P^2}{E_2^2}}}$

$= \frac{1}{\sqrt{\frac{E_2^2 - P^2}{E_2^2}}} = \frac{1}{\sqrt{\frac{m^2}{E_2^2}}}$

$= \frac{E_2}{m_2}$

$B = \begin{pmatrix} \cosh & +\sinh \\ +\sinh & \cosh \end{pmatrix}$

$R = \begin{pmatrix} \cos & -\sin \\ +\sin & \cos \end{pmatrix}$

$B\, P_2^\mu = (m_2\, \vec{0})$

$B\, P_1^\mu = (E', P')$

$\xrightarrow{P_1} \quad \xleftarrow{\quad} P_2$

$P_1^\mu = (E\ +P) \quad P_1^{\mu 2} = E^2 - P^2 = m^2$

$P_2^\mu = (E\ -P) \quad P_2^{\mu 2} = E^2 - P^2 = m^2$

$P_{12}^\mu = (2E, 0) \quad \boxed{P_{12}^2 = S = 4E^2}$

$pp \to ppp\bar{p}$

$P_3^\mu = (m\ 0\ 0\ 0)$
4 "
5 "
6 "

$P_{3456}^\mu = (4m, 0)$

$$\boxed{P_{3456}^2 = S = 16m^2}$$

$S_{before} = S_{After}$

$4E^2 = 16m^2$

$E = 2m$

$S_{before} = 4E^2$

$$\boxed{pp \to pp\, H}$$

$P_3^\mu = (m\ 0)$

$P_4^\mu = (m\ 0)$

$P_5^\mu = (M, 0)$

$P_{345}^\mu = (2m + M, 0)$

$S_{After} = P_{345}^2 = (2m + M)^2 = 4E^2$

$2m + M = 2E$

$\xrightarrow{P_1} \quad P_2$

$P_1^\mu = (E, P)$

$P_2^\mu = (m, 0)$

$P_{12}^\mu = (E + m, P)$

$S = P_{12}^2 = (E+m)^2 - P^2$

$= \underbrace{E^2 + 2Em + m^2 - P^2}_{m^2}$

$S_{before} = 2m^2 + 2Em = S_{After} =$

$= (2m + M)^2$

$v = \begin{pmatrix} t \\ x \end{pmatrix}$

$B = \gamma \begin{pmatrix} 1 & \beta \\ \beta & 1 \end{pmatrix}$

$B\, v = \gamma \begin{pmatrix} 1 & \beta \\ \beta & 1 \end{pmatrix} \begin{pmatrix} t \\ x \end{pmatrix} = v'$

$= \gamma \begin{pmatrix} t + \beta x \\ \beta t + x \end{pmatrix} = v'$

$\|v'\|^2 = v' \circ g \circ v'$

$\begin{pmatrix} t \\ x \end{pmatrix} \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix} \begin{pmatrix} t \\ x \end{pmatrix}$

$(t\ x) \begin{pmatrix} t \\ -x \end{pmatrix} = \boxed{t^2 - x^2}$

$[\gamma(t + \beta x)]^2 - [\gamma(\beta t + x)]^2$

$\gamma^2 = \frac{1}{1-\beta^2} \quad \to t^2 - x^2$

$v = (x\, y) \quad g = \begin{pmatrix} 1 & 1 \\ 1 & 1 \end{pmatrix}$

$\|v\|^2 = v \circ g \circ v$

$= (x\, y) \begin{pmatrix} 1 & 1 \\ 1 & 1 \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix}$

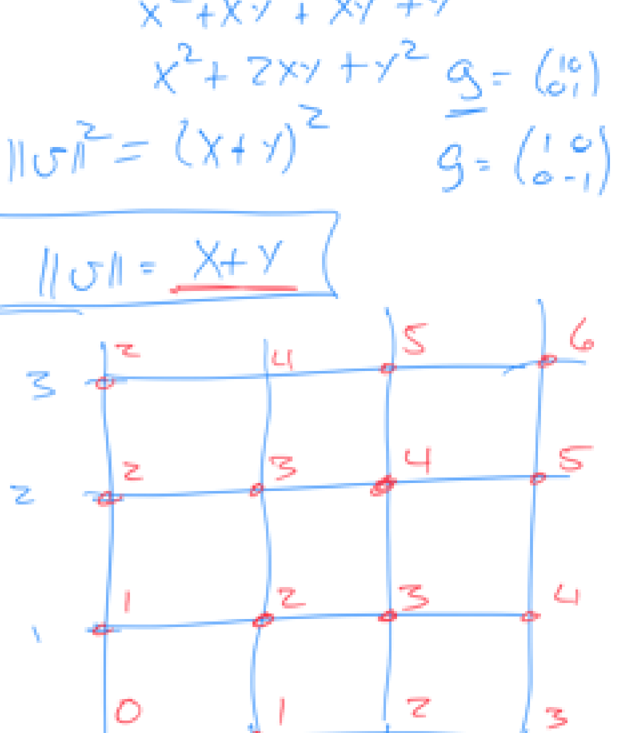
$(x\ y) \begin{pmatrix} x + y \\ x + y \end{pmatrix} \quad g = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$

$x^2 + xy + xy + y^2$

$x^2 + 2xy + y^2 \quad g = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$

$\|v\|^2 = (x + y)^2 \quad g = \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$

$$\boxed{\|v\| = x + y}$$



$B_{\mu\nu}\, v_\nu = \gamma \begin{pmatrix} 1 & \beta \\ \beta & 1 \end{pmatrix} \begin{pmatrix} t \\ x \end{pmatrix} = \begin{pmatrix} \cdot \\ \cdot \end{pmatrix}$

2 2 1

$F_{\mu\nu} = \begin{pmatrix} 0 & E & E & E \\ & 0 & B & B \\ E & B & 0 & B \\ E & B & B & \end{pmatrix}$

$B_{\mu\mu'}\, F_{\mu'\nu'}\, B^T_{\nu'\nu}$