Relativistik und invariante Masse

$$\mathcal{P}^\mu = (E/c, p^\mu); \quad \mathcal{P}^{\nu'} = \Lambda^{\nu'}_\mu \mathcal{P}^\mu$$

a)

$$\langle \mathcal{P} | \mathcal{P} \rangle = \mathcal{P}^\mu \mathcal{P}^\nu g_{\mu\nu} = \frac{E^2}{c^2} - p_x^2 - p_y^2 - p_z^2 = \frac{E^2}{c^2} - p^2$$

$$\begin{aligned}\left\langle \mathcal{P}' \middle| \mathcal{P}' \right\rangle &= \Lambda^{\nu'}_\mu \mathcal{P}^\mu \Lambda^{\nu'}_\mu \mathcal{P}^\nu g_{\mu\nu} = (\gamma \tfrac{E}{c} + \gamma\beta p_x)^2 - (\gamma\beta \tfrac{E}{c} + \gamma p_x)^2 - p_y^2 - p_z^2 \\ &= (\gamma^2 - \gamma^2\beta^2)\tfrac{E^2}{c^2} - (\gamma^2 - \gamma^2\beta^2)p_x^2 - p_y^2 - p_z^2 \\ &= \tfrac{E^2}{c^2} - p_x^2 - p_y^2 - p_z^2 = \tfrac{E^2}{c^2} - p^2\end{aligned}$$

b) $\mathcal{P}^\mu = (E/c, p^\mu) = (m_0 c, 0)$

$$\langle \mathcal{P} | \mathcal{P} \rangle = m_0^2 c^2 \overset{a)}{=} \frac{E^2}{c^2} - p^2$$

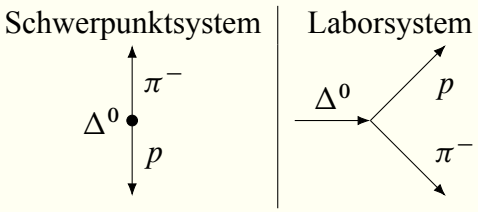
$$\Rightarrow E^2 = p^2 c^2 - m_0^2 c^4$$

Pionen-Erzeugung

$$\mathcal{P}^\mu_{p1} = (m_p c, 0); \quad \mathcal{P}^\mu_{p2} = (E/c, p^\mu); \quad \mathcal{P}^\mu_\pi = (m_\pi c, 0)$$

Teilchenzerfall im Laborsystem

a)



b) $E_\Delta = 1.35$ GeV

$$E_\Delta = \gamma m_\Delta c^2 = \frac{m_\Delta c^2}{\sqrt{1-\beta^2}}$$

$$\Rightarrow \beta = \sqrt{1 - \frac{m_\Delta^2 c^4}{E_\Delta^2}} =$$

c)

$$\mathcal{P}_p^\mu = ()$$
$$\mathcal{P}_\pi^\mu = ()$$

d)

$$\mathcal{P}_p^{\nu'} = \Lambda_\mu^{\nu'} \mathcal{P}_p^\mu = ()$$
$$\mathcal{P}_\pi^{\nu'} = \Lambda_\mu^{\nu'} \mathcal{P}_\pi^\mu = ()$$

e)

f)