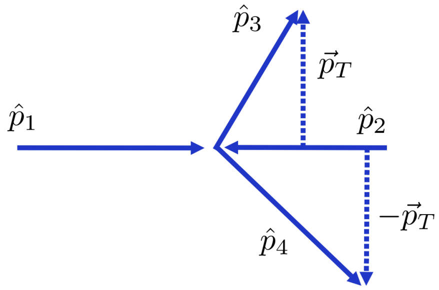
Problem set 2 – Quark Gluon Plasma Physics – SS 2023

Discussion in the lecture: Friday May 5

2.1 Parton scattering

In a collision of two protons, the interaction of two (approximately massless) partons with momentum fractions x_1 and x_2 results in two outgoing partons 3 and 4:



The proton four-momenta can be written as $P_1 = (E_\mathrm{b}, 0, 0, E_\mathrm{b})$ and $P_2 = (E_\mathrm{b}, 0, 0, -E_\mathrm{b})$ where E_b is the beam energy. The parton four-momenta are given by

$$\begin{aligned}
\hat{p}_1 &= x_1 P_1, \\
\hat{p}_2 &= x_2 P_2, \\
\hat{p}_3 &= (p_T \cosh y_3, \vec{p}_T, p_T \sinh y_3), \\
\hat{p}_4 &= (p_T \cosh y_4, -\vec{p}_T, p_T \sinh y_4).
\end{aligned}$$

a) Show that $x_1 = \frac{p_T}{\sqrt{s}}(e^{y_3} + e^{y_4})$ and $x_2 = \frac{p_T}{\sqrt{s}}(e^{-y_3} + e^{-y_4})$.
(hint: $\hat{p}_1 + \hat{p}_2 = \hat{p}_3 + \hat{p}_4$)

b) Show that the center-of-mass rapidity of the parton system is given by $\frac{1}{2} \ln \frac{x_1}{x_2}$.