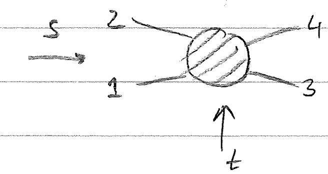
# Kinematics for Regge theory

$$z_s = \frac{s^2 + s(2t - \sum m^2) + (m_1^2 - m_2^2)(m_3^2 - m_4^2)}{4s\,|\vec{p}_i||\vec{p}_f|}$$




replace $\sum_i m^2 = s + t + u$

$$z_s = \frac{s^2 + s(2t - (s+t+u)) + (\Delta m^2)_{12}(\Delta m^2)_{34}}{4s\,|\vec{p}_i||\vec{p}_f|}$$

$$= \frac{\cancel{s^2} + s(\cancel{-s} + t - u) + (\Delta m^2)_{12}(\Delta m^2)_{34}}{4s\,|\vec{p}_i||\vec{p}_f|}$$

$$= \frac{s(t-u) + (\Delta m^2)_{12}(\Delta m^2)_{34}}{4s\,|\vec{p}_i||\vec{p}_f|}$$

$$\boxed{= \frac{t-u}{4|\vec{p}_i||\vec{p}_f|} + \frac{(\Delta m^2)_{12}(\Delta m^2)_{34}}{4s\,|\vec{p}_i||\vec{p}_f|}}$$

$|p_i|$ & $|p_f|$ functions of $s$.

In Regge theory, one is interested in the crossed channel to take Regge limit:

$$z_t = \frac{s-u}{4|\vec{p}_{13}||\vec{p}_{24}|} + \frac{(\Delta m^2)_{13}(\Delta m^2)_{24}}{4s\,|\vec{p}_{13}||\vec{p}_{24}|}$$

$|\vec{p}_{13}|$ & $|\vec{p}_{24}|$ are functions of $t$.

In the case of elastic scattering in the s-channel ($m_1 = m_3$, $m_2 = m_4$), second term vanishes, leaving:

$$\boxed{z_t = \frac{s-u}{4|\vec{p}_{13}||\vec{p}_{24}|} = \frac{\nu}{s_0} \qquad \text{(s-channel elastic)}}$$

$\nu = \frac{1}{2}(s-u)$

$s_0 = 2|\vec{p}_{13}||\vec{p}_{24}|$ characteristic energy scale of process.

$|\vec{p}_{13}|$ & $|\vec{p}_{24}|$ are funtions of $t$. ⟵ not to worry, $|\vec{p}|$'s vanish only outside of s,t,u-channel physical regions