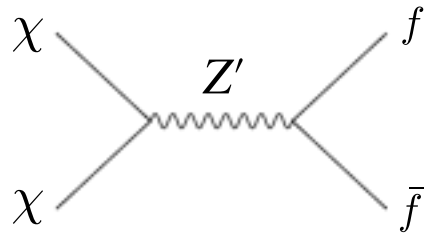
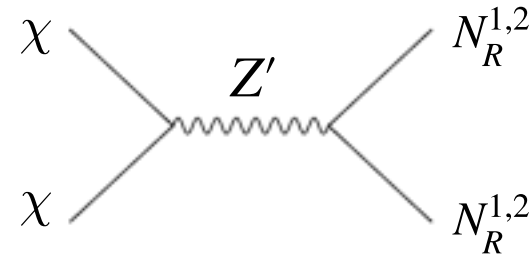


DM annihilation cross section

DM annihilation processes



and



Total annihilation cross section: $\sigma(s) = \sigma_{SM}(s) + \sum_{i=1}^2 \sigma_{N^i N^i}(s)$

$$\sigma_{SM}(s) = \frac{25\pi}{3} \alpha_X^2 \frac{\sqrt{s(s - 4m_\chi^2)}}{(s - m_{Z'}^2)^2 + m_{Z'}^2 \Gamma_{Z'}^2} F(x_H),$$

$$\begin{aligned} \sigma_{N^i N^i}(s) = & \frac{400\pi}{3} \alpha_X^2 \sqrt{\frac{s - 4m_{N^i}^2}{s - 4m_\chi^2}} \frac{1}{(s - m_{Z'}^2)^2 + m_{Z'}^2 \Gamma_{Z'}^2} \\ & \times \frac{1}{s} \left((s - 4m_\chi^2)(s - 4m_{N^i}^2) + 12 \frac{m_\chi^2 m_{N^i}^2}{m_{Z'}^4} (s - m_{Z'}^2)^2 \right) \theta(s - 4m_{N^i}^2) \end{aligned}$$

$$F(x_H) = 13 + 16x_H + 10x_H^2 = 10 \left(x_H + \frac{4}{5} \right)^2 + \frac{33}{5}$$