Homework Exercises for QCD and Collider Physics

2005/2006

Exercises for Lecture 9 (18. Jan 2006)

Calculation for Matrix Elements:

- calculate BGF diagram using massless quarks and $g_{\mu\nu}$ for the polarization sum of gluons and photons (but keeping photon virtual). Assigne a mass $p_g^2 = -m_g^2$ for the gluon. Compare with :

$$\begin{aligned}\frac{d\sigma_\Sigma(\gamma^* g \to q\bar{q})}{d\hat{t}} &= \frac{\pi\alpha\alpha_s e_q^2 z^2}{Q^4} 2\left(\frac{\hat{u}}{\hat{t}} + \frac{\hat{t}}{\hat{u}} - \frac{2Q^2}{\hat{t}\hat{u}}(\hat{t}+\hat{u}+Q^2)\right. \\ &\left. + \frac{2m_g^2}{\hat{t}\hat{u}}(\hat{t}+\hat{u}+m_g^2) - Q^2 m_g^2\left(\frac{1}{\hat{u}^2} + \frac{1}{\hat{t}^2} - \frac{4}{\hat{t}\hat{u}}\right)\right)\end{aligned}$$

- calculate the upper and lower limit of the t integration for BGF in case the gluon has a mass $p_g^2 = -m_g^2$. (Obtain $t_{\min} = -m_g^2 z$, $t_{\max} = -Q^2/z$).
- calculate QCDC diagram using massless quarks and $g_{\mu\nu}$ for the polarization sum of gluons and photons (but keeping photon virtual). Assigne a mass $p_g^2 = m_g^2$ for the gluon. Compare with:

$$\begin{aligned}\frac{d\sigma_\Sigma}{d\hat{t}} &= \frac{\pi\alpha\alpha_s e_q^2 z^2}{Q^4}\frac{16}{3}\left[-\frac{\hat{t}}{\hat{s}} - \frac{\hat{s}}{\hat{t}} - \frac{2(Q^2-m_g^2)(\hat{s}+\hat{t}+Q^2-m_g^2)}{\hat{s}\hat{t}}\right. \\ &\left. - m_g^2 Q^2\left(\frac{1}{\hat{t}^2} + \frac{1}{\hat{s}^2}\right)\right]\end{aligned}$$

- Show that for the QCDC case the integration limits are:

$$\hat{t}_{\min} = -\frac{\beta z Q^2}{1-z}\ , \quad \hat{t}_{\max} = -\frac{Q^2}{z} + \beta Q^2\ , \quad \beta = \frac{m_g^2}{Q^2}$$

-