Homework Exercises for
QCD and Collider Physics

2005/2006

Exercises for Lecture 4 (30. Nov 2005)

Calculation of Matrix Elements and $\mathcal{O}(\alpha_s)$ corrections to DIS:

- obtain the relation $\hat{t} = k^2 = (p_1 - p_3)^2 = -\xi \frac{Q^2}{z} = \frac{-k_\perp^2}{1-\xi} - Q^2 \xi$

- derive $k_\perp^2 = \frac{\hat{t}\hat{u}\hat{s}}{(\hat{s}+Q^2)^2}$ and $k_\perp^2 = \frac{-\hat{t}\hat{s}}{\hat{s}+Q^2} = -t(1-z)$ in the small t limit

- calculate Matrix Element squared for QCDC and BGF using $-g_{\mu\nu}$ for the sum over polarization states of the virtual (real) photon. This is the procedure done in Halzen/Martin (exercise 6.19)

- calculate splitting function P_{qq} using BGF matrix element and cross section, as has been done for QCDC.

- find out the procedure to sum tranverse and longitudinal photons separately (look at the expressions of the leptonic and hadronic tensor, cf the discussion in R. Field Applications of Perturbative QCD, Chapter 4, p116 ff)

- repeat the calculation of the Matrix Element squared for QCD and BGF, but now using polarization sums for transverse and longitudinal photons separately. Compare your results to the one using $-g_{\mu\nu}$.