Homework Exercises for QCD and Collider Physics II

Summer 2006

Exercises for Lecture 2 (26. April 2006)

Calculation of Equivalent Photon Approximation:

- calculate EPA keeping terms with electron mass up to m_e^2. Hint: derive formula in terms of $\hat{s} - m_e^2$ etc.
- calculate Q^2_{min} for EPA, keeping terms with electron mass.

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

- calculate splitting function P_{qq} using BGF matrix element and cross section, as has been done for QCDC. This is the procedure done in Halzen/Martin

Calculation for evolution equations:

- Repeat the calculation leading to the Sudakov form factor and show that this is equivalent with the plus-prescription of the splitting functions.
- Write a small program using the brute-force method to solve DGLAP. Use only gluons and the gluon splitting P_{gg}. Calculate gluon distribution at $Q^2 = 10$ GeV^2 from a starting distribution $xg(x, \mu_0^2) = 3(1-x)^5$ at a starting scale $\mu^2 = 1$ GeV^2.

Parton Showers:

- Set up a small program to calculate the gluon density as a function of x and Q^2, using the parton shower approach. Use only a very simple gluon splitting fct: $P(z) \sim 1/z+1/(1-z)$. Use the Sudakov form factor to calculate the next t in the branching. Start from a low scale $\mu_0^2 = 1\ GeV^2$ with a starting distribution: $xG_0(x) = (1-x)^4$ and evolve up to $\mu^2 = 10\ GeV^2$