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Hand-in exercises in the course QCD@Colliders, HT 2006

4. Deep inelastic scattering

A. **Show that** Eq. (4.8) follows from (3.4) by crossing. (First rewrite (3.4) on the form (4.9) in terms of the Mandelstam variables. Remember $\hat{t} = -\hat{s}(1 - \cos\theta)/2$ and $\hat{u} = -\hat{s}(1 + \cos\theta)/2$.)

B. **Calculate** K in Eq. (4.70) using the plus-prescription.

C. **Give** the NLO expression for $q^{\mathrm{DIS}}(x, Q^2)$ in terms of $q^{\overline{\mathrm{MS}}}(x, Q^2)$ and $g^{\overline{\mathrm{MS}}}(x, Q^2)$

D. **Calculate** the renormalisation scale to be used in the LO splitting functions to include the NLO corrections in Eq. (4.123). (This is sometimes called the gluon bremsstrahlung scheme or MC scheme and is used in the Herwig MC.)

E. **Plot** the DLLA approximation to $xg(x, \mu^2)$ given in Eq. (4.180) for $\Lambda = 0.2$ GeV, $\mu_0 = 1.4$ GeV, and $\mu = 2$ and 10 GeV respectively in the range $0.0001 < x < 0.01$. Compare to the form $xg(x, \mu^2) \propto x^{-\lambda}$ and determine approximate values of λ in the two cases.