B. QCD and higher order corrections

The NLO QCD processes that contribute to Drell-Yan scattering are depicted in Fig. III.13. These processes lead to a modification of the Drell-Yan cross section by introducing the so-called K factor:

$$\frac{d\sigma}{dx_b dx_t}(NLO) = K_{NLO}\frac{d\sigma}{dx_b dx_t}(LO). \tag{III.4}$$

With PDFs defined in the DIS factorization scheme, the K_{NLO}-factor is given approximately by (Altarelli *et al.*, 1979)

$$K_{NLO} \approx 1 + \frac{\alpha_s}{2\pi}\left(1 + \frac{4}{3}\pi^2\right) \tag{III.5}$$

and assumes a value between 1.5 and 2. The consideration of NNLO, as well as NLO diagrams, also leads to a simple factorization of the cross-section and an approximate factor of two for K. The factorization scheme dependence of the K-factor is described at length in (van Neerven and Zijlstra, 1992). We note in addition that the K factor depends on kinematics, a fact shown in (Wijesooriya *et al.*, 2005) to be important at very high x for pionic Drell-Yan studies.

C. High-x quark distribution functions

The Drell-Yan process presents a valuable method for measuring parton distribution functions in hadrons at very high x. For example, it can be used to probe the quark distribution in the beam proton. To see how, consider that if s- and c-quarks are neglected and the beam-target kinematics are chosen such that $x_F := x_b - x_t$ is large, then for proton+proton collisions, Eq. (III.4) can be rewritten (Webb, 2003)

$$\frac{d\sigma}{dx_b dx_t} \approx \frac{4\pi\alpha_e^2 K}{81 s}\left[4\, u_b(x_b, Q^2)\bar{u}_t(x_t, Q^2) + d_b(x_b, Q^2)\bar{d}_t(x_t, Q^2)\right] \tag{III.6}$$

because $\bar{q}_b(x_b) \ll q_b(x_b)$ and $q_t(x_t) \ll \bar{q}_t(x_t)$ for large-x_F. Now suppose that the target is a deutron with a similar kinematic setup, then Eq. (III.4) can be written (Webb, 2003)

$$\frac{d\sigma}{dx_b dx_t} \approx \frac{4\pi\alpha_e^2 K}{81 s}\left[4u_b(x_b, Q^2) + d_b(x_b, Q^2)\right]\left[\bar{u}_t(x_t, Q^2) + \bar{d}_t(x_t, Q^2)\right], \tag{III.7}$$

where, as usual herein, $q(x)$ means the distribution of flavor-q-quarks in the proton; and one has assumed isospin symmetry and neglected nuclear binding effects in the weakly-bound deuteron. It is thus apparent that this kinematic setup produces Drell-Yan cross