27. 11. 2009
(sheet 3)

Exercise on W-boson production

Consider the production of a W^--boson, which proceeds at LHC through the reaction

$$pp \to W^- + X\,, \tag{1}$$

where X is any allowed final state. At the parton level, this reaction proceeds to lowest order in perturbation theory through

$$\bar{u}d \to W^- \to l^-\bar{\nu}_l\,. \tag{2}$$

Calculate the cross section for W-boson production at LHC ($\sqrt{s} = 14$ TeV) according to the factoriaztion theorem as

$$\sigma_{pp\to W^-\to l^-\bar{\nu}_l} = \sum_{ij}\int dx_1\,dx_2\, f_i(x_1)\, f_j(x_2)\,\hat{\sigma}_{ij\to W^-\to l^-\bar{\nu}_l}(x_1,x_2,s)\,, \tag{3}$$

For the parton distribution function you can assume for simplicity the following functional form

$$f_d(x) = \frac{0.2}{x}\,, \qquad\qquad f_{\bar{u}}(x) = 2\cdot f_d(x)\,. \tag{4}$$

Compare your results for $\sigma_{pp\to W^-\to l^-\bar{\nu}_l}$ with values from the literature.

Hint: Take all necessary ingredients and constants from the *Particle Data Booklet*, `http://pdg.lbl.gov` Eq. (39.18) in the PDG provides you with a formula for the parton cross section $\hat{\sigma}_{ij\to W^-}$.