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QCD analysis of the diffractive longitudinal structure functions

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We investigate the effect of the diffractive longitudinal structure function F_L^D in global parton analyses of most recent H1 and ZEUS diffractive deep inelastic scattering data. We perform next-to-leading-order (NLO) analyses which include the reduced cross section HERA data at high y, as well as direct measurements of F_2^D and F_L^D. We demonstrate that our NLO analyses yield good agreement with new available observables.

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1. Introduction

Assuming the validity of QCD hard scattering collinear factorization, the dominant role played by gluons in the diffractive parton densities implies that the leading twist F_L^D, which is approximately proportional to the diffractive gluon density, must be relatively large. A measurement of F_L^D provides a very powerful independent tool to verify our understanding of the underlying dynamics of diffraction up to NLO in QCD and to test the DPDFs [1]. Measurements of F_L^D became possible following the reduced proton beam energy runs at the end of HERA operation and first results are recently presented in Ref. [2].

2. Theoretical basis

We perform a QCD analysis on all HERA diffractive observables. To get detailed information about DPDFs and agreement between our results and experimental data refer to Ref. [3].

Figure 1 shows the reduced diffractive cross section as a function of β at fixed values of Q^2 and $x_{I\!P}$ for different proton beam energies [2]. Also shown is the prediction of our model, which in general describes the data well. Deviations of the measured cross sections from the F_2^D predictions at low β are evident in the low and medium energy (LME) data with proton beam energies of E_p=460 and 575 GeV, where the highest y values are accessed, notably at $Q^2 = 11.5\,\mathrm{GeV}^2$ and $x_{I\!P} = 0.003$. This shows the sensitivity of the LME data to F_L^D.

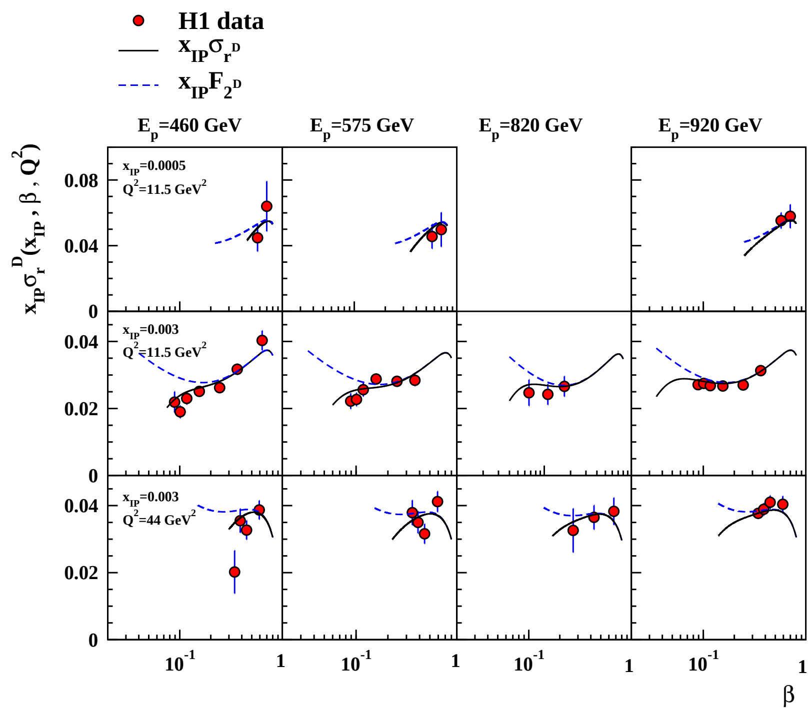

Figure 1: The reduced diffractive cross section, multiplied by $x_{I\!P}$, $x_{I\!P}\sigma_r^{D(3)}$, as a function of β at fixed Q^2 and $x_{I\!P}$ for (from left to right) the 460, 575, 820 and 920 GeV data sets [2]. The curves show our model reduced by a global factor 0.97, 0.99 and 0.97 for E_p=460, 575 and 920 GeV, respectively.

The measurements of F_L^D [2], at fixed values of Q^2 and $x_{I\!P}$, are shown as a function of β in Figure 2. The data are compared with the predictions of our model and H1 DPDF Fits A and B [4]. As shown in this figure, we have predicted the leading twist part of F_L^D which is increasing at small values of β and tends to 0 when β tends toward 1. Although there is a tendency for the measurements to lie above the predictions, all three models are consistent with the data i.e. there is a good agreement with the NLO QCD picture of diffraction.

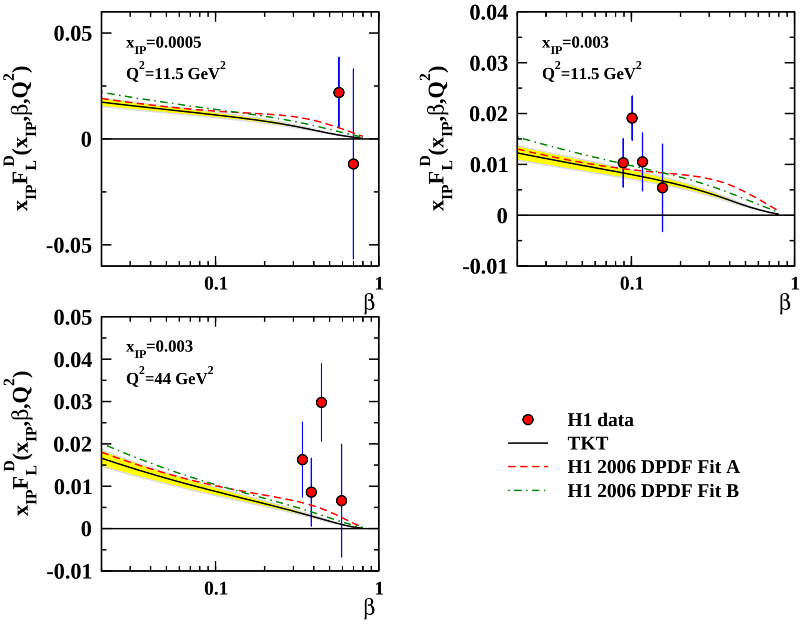

Figure 2: $x_{I\!P}F_L^D$ measurement [2] as a function of β measured at fixed Q^2 and $x_{I\!P}$. The present fit is the solid curve. Also shown are the results of H1 2006 Fit A (dashed) and and Fit B (dashed-dotted) [4].

3. Conclusion

The measurement of $F_L^D(x,Q^2)$ seems to be the best way to determine reliably the gluon distribution at low x, particularly at low Q^2. We performed a global fit to all available data which are both directly, and indirectly, sensitive to F_L^D. Having extracted the diffractive PDFs, we compute longitudinal diffractive structure function. In general, we find good agreement with the experimental data, and our results are in accord with other determinations from the literature.

References

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