F_2 QCD fits, $F_2^{c\bar{c}}$ measurement and F_L extraction in H1

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Abstract. Three topics already published by the H1 Collaboration are described: the gluon determination from a QCD fit to F_2 data, the charm structure function and an extraction of F_L.

INTRODUCTION

This communication begins by a description of the H1 F_2 QCD fit procedure [1,2]. We concentrate on 'technical' details, *i.e.* on the χ^2 expression and the error band calculations. Next, a measurement of the charm structure function [3] and of the DIS cross-section at high-y [4] are described. In the latter case, an extraction of the longitudinal structure function F_L is presented.

I F_2 QCD FIT PROCEDURE IN H1

We have written a program to solve numericaly [5] the DGLAP equations [6] in the Next-to-Leading-Log-Approximation. The $\overline{MS}$ scheme is used and the renormalization and factorization scales are set to Q^2. The charm quark contribution is computed within the Fixed-Flavor-Number-Scheme (FFNS) [7] at Next-to-Leading-Order (NLO). To determined the input parton density functions (pdf) required by the DGLAP equations, a χ^2 is minimized. All correlated systematic uncertainty sources are taken into account within the χ^2 expression:

$$\chi^2 = \sum_{exp.,dat.} \frac{[F_2^{dat.} - F_2^{QCD}(1-\nu_{exp} - \sum_j \delta_j(s_j^{exp}))]^2}{\sigma^2_{stat.} + \sigma^2_{uncor.}} + \sum_{exp} \nu^2_{exp} + \sum_{exp,j} (s_j^{exp})^2,$$

where we assume that all experimental uncertainties are Gaussianly distributed; ν_{exp} is the number of overall normalization standard deviations

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and $\delta_j(s_j^{exp})$ is the relative F_2 shift [8] induced by a change of s_j^{exp} standard deviations of the j^{th} systematic uncertainty source. The gluon density obtained from a fit to the 1994 F_2 data is shown in fig. 1. The error bands of this figure are computed at a each $x - Q^2$ point: $\Delta^{\pm}xg(x,Q^2;\overrightarrow{p}) = xg(x,Q^2;\overrightarrow{p}) \pm xg(x,Q^2;\overrightarrow{p}+\Delta\overrightarrow{p})$. Where $\overrightarrow{p}$ symbolizes the fit parameter ensemble minimizing the χ^2 and $\Delta\overrightarrow{p}$ is given by

$$\overrightarrow{\Delta p} = \frac{(M^{-1} + M^{-1}CC^tM^{-1})\overrightarrow{\partial_p}xg}{\sqrt{\overrightarrow{\partial_p}xg((M^{-1} + M^{-1}CC^tM^{-1})\overrightarrow{\partial_p}xg}}$$

with $M_{ij} = 1/2\partial^2\chi^2/\partial p_i \partial p_j$ and $C_{ij} = 1/2\partial^2\chi^2/\partial p_i \partial s_j^{exp}$. In the H1 analysis [1,2] all the parameters s_j^{exp} were set to zero [1] during the χ^2 minimization and the systematic error bands were computed using the correlation matrix C (C exists only if the parameters s_j^{exp} are not adjusted).

The difficulties we have encountered during the 1993 and 1994 F_2 data analysis have already been reported [8]. The main problem of the 1994 analysis is the behaviour of the gluon density at high-x: $xg(x) \rightarrow 2.24(1-x)^{8.52}$ as $x \rightarrow 1$ at $Q^2 = 4\mathrm{GeV}^2$. Although NMC and BCDMS [10] F_2 data are including in the fit, our result is in disagreement with the MRS and CTEQ fit results [9] at high-x. One way to cure this problem is to include the neutrino DIS cross-section data in the fit procedure [11] and this work is under investigation within H1.

II $F_2^{C\bar{C}}$ MEASUREMENT

The charm structure function has been measured using the 1994 H1 data in the region $10\mathrm{GeV}^2 < Q^2 < 100\mathrm{GeV}^2$ and $y < 0.53$ [3]. 'Charmed' events are

1) Notice that even though $s_j^{exp} = 0$, $\partial\chi^2/\partial s_j^{exp} \neq 0$ *i.e.* $C_{ji} \neq 0$ *a priori.*

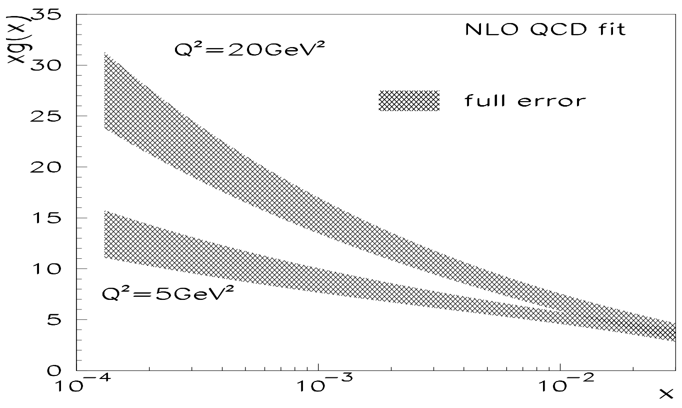

FIGURE 1. Gluon density extracted from the H1 F_2 1994 analysis.

tagged by the presence of a $D^o(\bar{D}^o) \to K\pi$ or a D^{*+} (D^{*-})$\to K\pi\pi$ in the final state. Using the charm fragmentation into D mesons and the branching ratios of the D decays, $\sigma(e^+p \to c\bar{c}X)$ is determined leading finally to $F_2^{c\bar{c}}$. Comparing with the F_2 measurement of [2], we found $F_2^{c\bar{c}}/F_2 = (23.7 \pm 2.1 \pm 4.1)\%$. This large fraction has a very important repercussion on DIS phenomenology: the charm mass effects cannot be ingnored any more and new theoretical schemes must be introduced [7]. The measurement of $F_2^{c\bar{c}}$ is shown in fig. 2 together with some calculations using the NLO BGF process which gives the best decription of the charmed events sample. A good agreement is found with the H1 NLO fit results (shadowed area) and the GRV parametrization (full line). A disagreement is found with MRSH and MRSD0 showing that $F_2^{c\bar{c}}$ is very sensitive to the pdf.

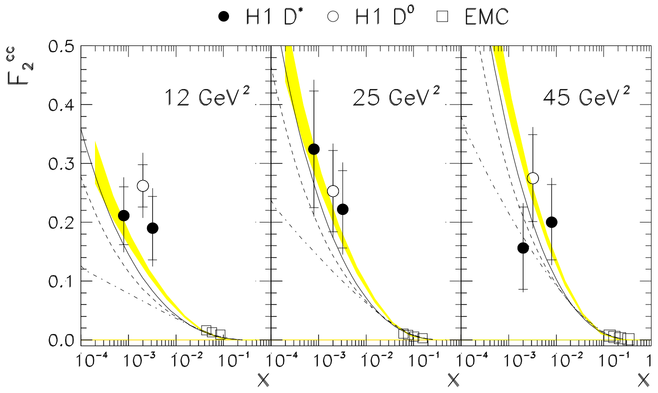

FIGURE 2. $F_2^{c\bar{c}}$ measurement together with some parametrizations, see text.

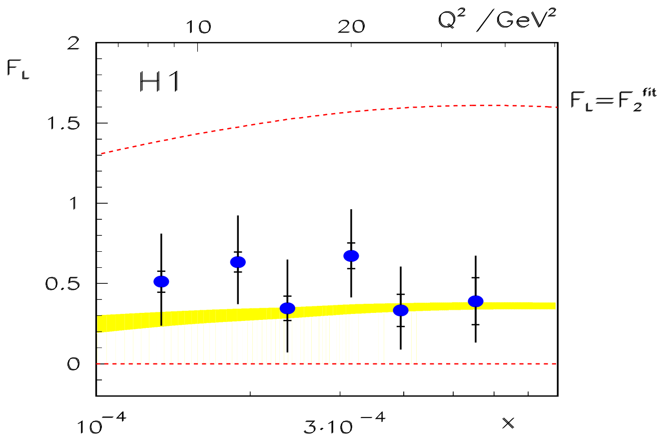

FIGURE 3. F_L extraction, see text.

III F_L EXTRACTION

In [4], the H1 Collaboration has used a new method to extract F_L. The principle of this method can be understood by recalling the expression for the DIS cross-section: $\kappa d\sigma/dx/dQ^2 = F_2 - y^2 Y_+^{-1} F_L$ with $Y_+ = 2(1-y) + y^2$ and $\kappa = Q^2 x (2\pi\alpha_{em}^2 Y_+)^{-1}$. Hence, assuming that F_2 is 'well known', F_L can be determined by measuring $d\sigma/dx/dQ^2$ at high-y. This cross-section measurement has been performed using the 1994 H1 data in the region $0.6 < y < 0.78$ and $0.00014 < x < 0.00055$. A NLO F_2 fit similar to the one of [2] was performed to the data in the restricted region $y < 0.35$. In order to extract F_L, the result of this fit was then extrapolated into the region $0.6 < y < 0.78$. Fig. 3 shows the results together with NLO F_L calculations obtained from the previous fit result: a good agreement between our method and a fit to the cross-section is observed. The systematic error is also indicated and includes an important contribution from the F_2 interpolation choice. One should finally mention that the sensitivity to F_L and the gluon density increases at high-y. This measurement is therefore expected to add new constraints on the gluon density.

IV SUMMARY

The gluon density has been extracted together with some experimental error bands using the H1 F_2 data. A complementary way to constrain the gluon density is to include $F_2^{c\bar{c}}$ and the high-y cross-section (F_L) in the fit procedure. This will be explored in the near future. More accurate measurements are currently being performed by H1 and the results will soon be presented.

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