SCALING VIOLATION ANALYSIS OF THE H1 F_2 DATA

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Results of NLO QCD fits to the H1 and NMC proton data only provide a very good description of the F_2 scaling violation. Local derivatives of the structure function F_2 with respect to $ln\ Q^2$ are consistent with the NLO QCD DGLAP evolution.

1 Introduction

The cross section [1] of the neutral current deep inelastic (NC DIS) $ep \rightarrow eX$ scattering for 4-momentum transfers $Q^2 << M_Z^2$ is dominated by the single photon exchange and depends on the structure functions F_2 and F_L, $\sigma \sim F_2 - y^2 \cdot F_L / Y_+$. Precision measurements of F_2 and F_L provide important tests of the validity of perturbative QCD and allow the extraction of parton distribution functions. This analysis is based on preliminary low Q^2 data [2] ($Q^2 \leq 150\ GeV^2$) and published high Q^2 data [1] obtained by the H1 collaboration. The low Q^2 data are measured with the upgraded backward part [3] of the H1 detector which enabled to extend the range of the inelasticity y for the NC DIS measurement. At high y this increased the sensitivity to F_L and at low y it provided an overlap with the data of fixed target experiments. F_2 scaling violations were studied with conventional DGLAP NLO QCD fits and also using the 2-dimensional local derivatives of $F_2(x, Q^2)$.

2 NLO QCD Fit

The QCD fit was performed with the H1 program [4] solving in x-space the DGLAP evolution equations in the $\overline{MS}$ renormalization scheme. Light partons were considered massless and c, b contributions were calculated from the NLO boson-gluon fusion [5]. Input parton parametrizations were chosen of the MRS type - $xq(x) = A_q x^{B_q}(1-x)^{C_q}(1 + D_q x + E_q\sqrt{x})$. At the input scale $Q_0^2 = 1.5\ GeV^2$ the gluon was considered to be valence-like, i.e. $D_g, E_g = 0$. A value of $\alpha_S = 0.1175$ was used for the strong coupling constant. Constraints due to the momentum sum rule and quark counting rules were applied. The sea was considered to be flavour symmetric with a fraction of 20% of strange quarks. Two independent functions defining F_2 are chosen as $V = \frac{3}{4}(3U - 2D)$ and $A = \frac{1}{4}(2D - U)$ where $U(D)$ are 3 flavour sums of up (down) quark distributions. Very good agreement of the NLO QCD fit with the data was achieved [2] (Fig.1). A steep rise of the gluon density (Fig.2) with decreasing x and increasing Q^2 was obtained.

3 Local Logarithmic F_2 Derivatives

The precise measurement of F_2 in fixed x-bins reveals a nonlinear $ln\ Q^2$ dependence (Fig. 1), which can be parametrized as $F_2 = a + b \cdot ln\ Q^2 + c \cdot (ln\ Q^2)^2$. For each x-bin the local derivatives $\partial F_2(x, Q^2)/\partial ln Q^2$ are determined from the two F_2 values adjacent in Q^2 (Fig. 3). The Q^2 is defined by the middle of these two values. The corresponding errors are properly propagated. The solid line drawn in Fig.3 is the derivative of the second order polynomial fit to F_2. It is apparent that local derivatives at fixed low x are not constant in $ln\ Q^2$, within errors they are linearly rising. Plotting the results of the calculation as a function of x for fixed values of Q^2, good agreement of the F_2 derivatives with the DGLAP NLO QCD fit is observed (Fig.4). The rise of logarithmic derivatives has been established for $Q^2 \geq 3\ GeV^2$. For $Q^2 < 3\ GeV^2$ further precision F_2 measurements are still needed [6]. The region around $Q^2 \sim 1\ GeV^2$ where the gluon starts to be valence-like is physically very interesting - the validity of DGLAP evolution equations [7], effects of possible screening corrections [8], higher (NNLO) order perturbative [9] and higher twist corrections [10] are intensively discussed. At H1 the range below 1 GeV^2 will be covered with data measured by the VLQ spectrometer, for a recent ZEUS measurement see [11].

References

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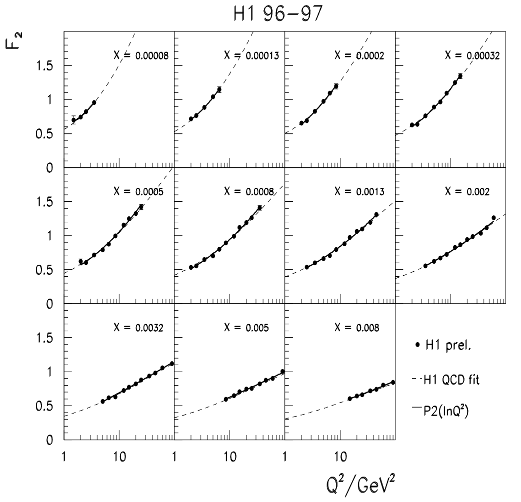

Figure 1: NLO QCD fit (dashed) to H1 data and their 2^{nd} order polynomial parametrization (solid lines).

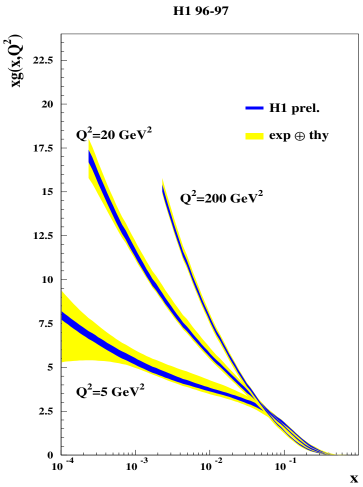

Figure 2: Gluon momentum density extracted from F_2.

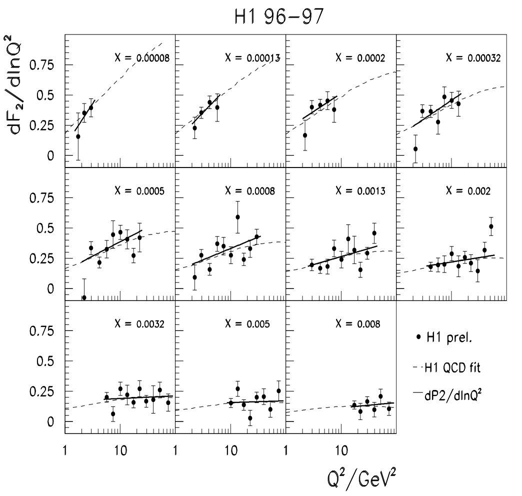

Figure 3: Local logarithmic derivatives calculated from F_2 values of Fig.1

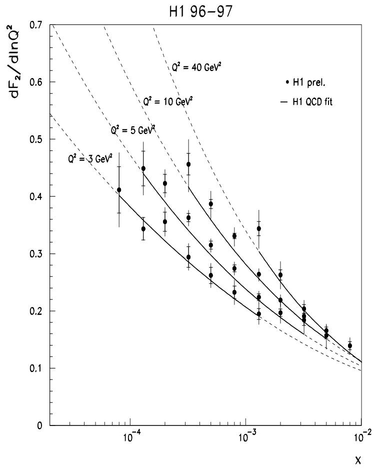

Figure 4: Derivatives of F_2 displayed as a function of x for fixed Q^2 values.