Fermilab Library
0 1160 0018338 8

DO-TH-92-19

DO-TH 92/19
August 1992

Comparing Radiatively Generated Parton Distributions with Recent Measurements of $F_2^{\mu p}(x,Q^2)$ in the Small-x Region

M. Glück, E. Reya and A. Vogt

Institut für Physik, Universität Dortmund
D-4600 Dortmund 50, FRG

Abstract

It is pointed out that the predictions of radiatively (dynamically) generated parton distributions are in satisfactory agreement with recent small-x measurements.

WOLBERS 120

The NMC collaboration has presented, on various occasions [1,2], their most recent measurements of $F_2(x,Q^2)$ in the small x-region. In comparing various suggested parton densities with these measurements down to $x \lesssim 10^{-2}$ it has been concluded [2] that none of these distributions are compatible with most recent data, in particular not with the observed increase of $F_2(x,Q^2)$ as $x \to 0$.

In the Figure we compare[†] our predictions (not fits!) of the radiatively generated parton distributions [3] with the very recent NMC small-x data [2]. Radiatively generated parton distributions are characterized by a rather unique (steep) behavior in the small-x region. This behavior is mainly due to the QCD dynamics, since any artificial dependence on the assumed input parametrizations as $x \to 0$ is removed due to choosing [3] valence-like gluon and light-sea inputs (which vanish as $x \to 0$) at some low input scale. This is in contrast to simply fitted parton distributions whose small-x behavior below the fitted x-range strongly depends on the assumed $x \to 0$ ansatz for the parametrizations utilized in the fitting procedure.

[†]The reason for the discrepancy found in [1,2] is related to the fact that just f=3 flavors have been used [1] in connection with the GRV distributions, whereas in [2] an inadequate gluonic Wilson coefficient function was used in connection with the distributions of Ref. [4] - using instead the appropriate one stated in [4], most of the discrepancy between GRV and the data disappears. Moreover, as emphasized in our more recent analysis [3], a vanishing light-quark sea [4] at the input scale does not suffice for a detailed quantitative comparison with experiment.

It might be questionable whether the massless evolution of $c(x,Q^2)$, with $c(x,m_c^2)=0$, represents a reasonable estimate of the charm contribution already at $Q^2=5\,\mathrm{GeV}^2$ where, in the relevant small-x region in the Figure, $W^2 \equiv Q^2(1/x-1)$ is not always very far above threshold $W_{th}^2=(2m_c)^2$. For this reason we have also calculated the charm contribution via the massive $\gamma^* g \to c\bar{c}$ fusion process with $m_c=1.5$ GeV which, when added to the 'light' (u,d,s) quark contributions, is shown by the dotted curve. The changes are, however, small. In view of having not readjusted any parameter, our predictions are in satisfactory agreement with recent low-x data, despite of lying somewhat too low around $x \simeq 0.05$. If these NMC results are confirmed by future experiments, such immaterial discrepancies could be accounted for by slight modifications of the valence-like gluon and light-sea input distributions [5].

The satisfactory agreement of our predictions with recent small-x data for $F_2^p(x,Q^2)$ appears to support the idea that parton distributions are generated radiatively [3,6] from valence densities and finite valence-like gluon and light-sea input distributions at some low resolution scale.

References

[1] E. Kabuss, Zeuthen Workshop on 'Deep Inelastic Scattering', Teupitz (FRG), April 1992;

A. Brüll, Int. Workshop on 'QCD - 20 Years Later', Aachen, June 1992.

[2] E. Rondio, XXVI Int. Conf. on High Energy Physics, Dallas, August 1992.

[3] M. Glück, E. Reya and A. Vogt, Z. Phys. C53 (1992) 127.

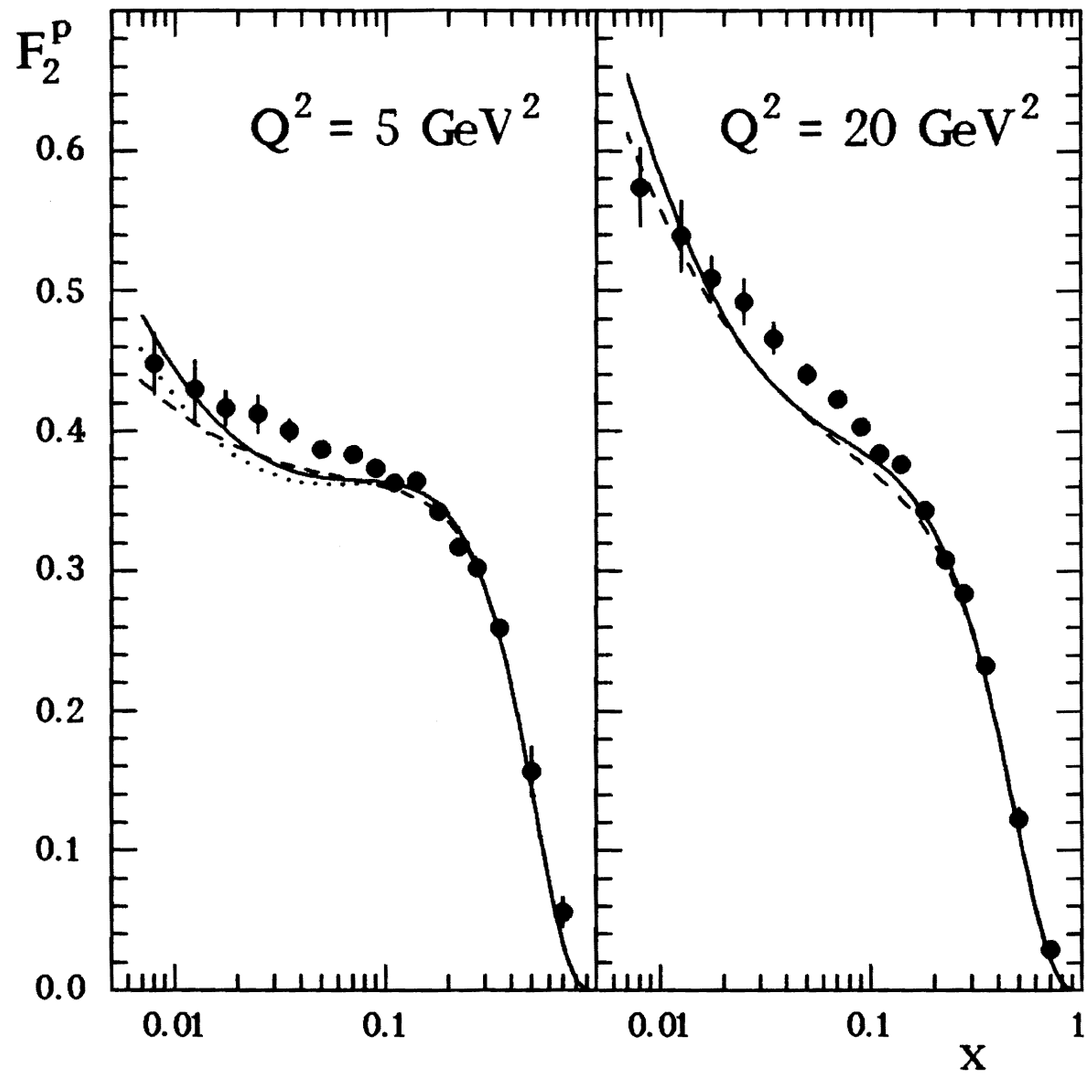
[4] M. Glück, E. Reya and A. Vogt, Z. Phys. C48 (1990) 471.

[5] M. Glück, E. Reya and A. Vogt, work in progress.

[6] N.N. Nikolaev, Tokyo Univ. INS-Rep.-539 (1985), unpublished.

Figure Caption

Radiative next-to-leading order ($\overline{MS}$) predictions [3] for f=4 massless flavors compared with recent low-x NMC data [2]. The dotted curve corresponds to calculating the charm contribution via $\gamma^* g \to c\bar{c}$, using $m_c=1.5$ GeV, and adding it to the u,d,s contributions. The very similar leading order (f=4) radiative predictions [3] are shown by the dashed curves.


F_2^p
$Q^2 = 5\ GeV^2$
$Q^2 = 20\ GeV^2$
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.01
0.1
0.01
0.1
1
x