The Logarithmic slope of the F_2 Structure Function

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We show that when screening corrections are included $\frac{\partial F_2(x,Q^2)}{\partial ln(Q^2/Q_0^2)}$ is consistent with the behaviour that one expects in pQCD. Screening corrections explain the enigma of the Caldwell plot.

1. INTRODUCTION

The Caldwell plot [1] of $\frac{\partial F_2(x,Q^2)}{\partial ln(Q^2/Q_0^2)}$ presented at the DESY Workshop in November 1997 surprised the community. The results appeared to indicate that we have reached a region in the x and Q^2 where pQCD was no longer valid. DGLAP evolution lead us to expect that $\frac{\partial F_2(x,Q^2)}{\partial ln(Q^2/Q_0^2)}$ at fixed Q^2 would be a monotonic increasing function of $\frac{1}{x}$, whereas a superficial glance at the data suggests that the logarithmic derivative of F_2 deviates from the expected pQCD behaviour, and has a turnover in the region of $2 \leq Q^2 \leq 4$ GeV^2 (see fig.1 where the ZEUS data and the GRV'94 predictions are shown). Opinions were also voiced that the phenomena was connected with the transition from "hard" to "soft" interactions.

Amongst the problems that one faces in attempting to comprehend the data, is the fact that due to kinematic constraints that data is sparse, and each point shown pertains to a different pair of values of x and Q^2. We miss the luxury of having measurements at several different values of x for fixed values of Q^2, which would allow one to deduce the detailed behaviour of $\frac{\partial F_2(x,Q^2)}{\partial ln(Q^2/Q_0^2)}$.

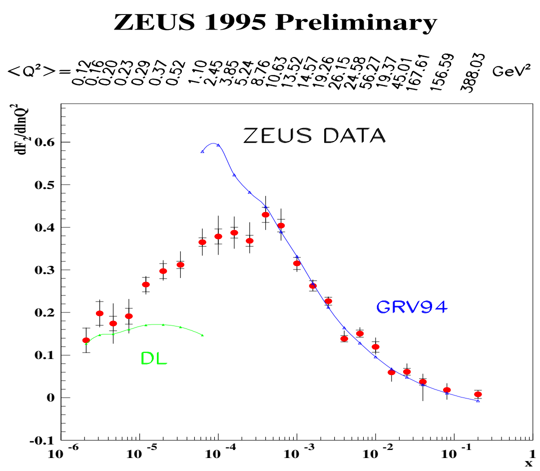

Figure 1. ZEUS data and GRV'94 predictions for F_2 slope

2. RESULTS

We show that the Caldwell plot is in agreement with the pQCD expectations, once screening corrections (SC) (which become more important as one goes to lower values of x and Q^2), are included. To provide a check of our calculations, we compare with the results one derives using the ALLM'97 parametrization [2], which we use as a "pseudo data base".

Following the method suggested by Levin and Ryskin [3] and Mueller [4] we calculate the SC pertaining to $\frac{\partial F_2(x,Q^2)}{\partial ln(Q^2/Q_0^2)}$ for both the quark and gluon sector. In fig.2 we show the results as well as those of ALLM compared with the experimental results.

In fig.3 and 4 we display our calculations for the logarithmic derivative of F_2 after SC have been incorporated, as well as the ALLM results. In fig.3 for fixed values of Q^2 and varying values of x, and in fig.4 for fixed x and varying values of Q^2. In fig.4 we show our results as well as those of ALLM compared with the experimental results.

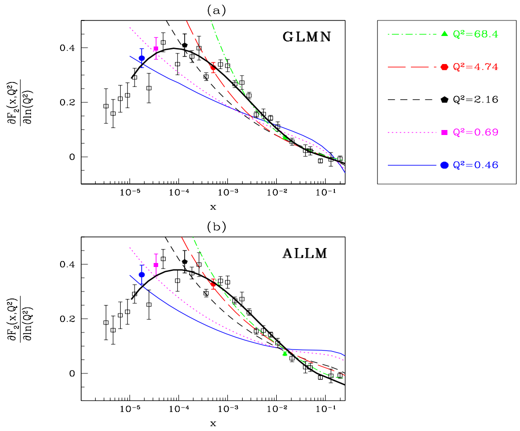

Figure 2. The F_2 slope in our QCD calculation incorporating SC, and in the ALLM"97 parametrization.

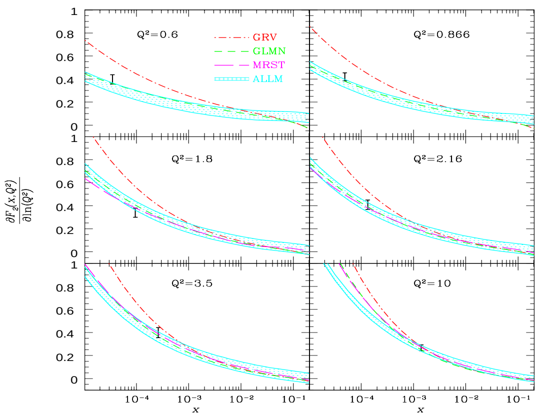

Figure 3. $\frac{\partial F_2(x,Q^2)}{\partial ln(Q^2/Q_0^2)}$. In addition to the ALLM band we show a typical data point with its error.

We note that $\frac{\partial F_2(x,Q^2)}{\partial ln(Q^2/Q_0^2)}$ at fixed Q^2 both in our

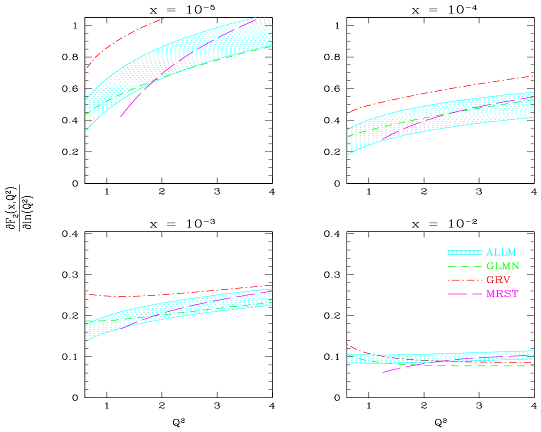

Figure 4. $\frac{\partial F_2(x,Q^2)}{\partial ln(Q^2/Q_0^2)}$ at fixed x.

calculations and in the "psuedo data" (ALLM), remains a **monotonic** increasing function of $\frac{1}{x}$.

From fig.4 we note that for fixed x, $\frac{\partial F_2(x,Q^2)}{\partial ln(Q^2/Q_0^2)}$ decreases as Q^2 becomes smaller. The decrease becomes stronger as we go to lower values of x. This phenomena which is due to SC adds to the confusion in interpreting the Cadwell plot.

3. CONCLUSIONS

1) We have obtained a good description of $\frac{\partial F_2(x,Q^2)}{\partial ln(Q^2/Q_0^2)}$ for $x \leq 0.1$.

2) At low Q^2,

$$\frac{\partial F_2(x,Q^2)}{\partial ln(Q^2/Q_0^2)} \propto Q^2$$

both in the pseudo data and in our calculations.

3) Our results suggest that there is a smooth transition between the "soft" and "hard" processes.

4) The apparent turn over of $\frac{\partial F_2(x,Q^2)}{\partial ln(Q^2/Q_0^2)}$ is an illusion, created by the experimental limitation in measuring the logarithmic derivative of F_2 at particular correlated values of Q^2 and x.

The detailed calculations and results that this talk was based on appear in [5] and [6]

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