

Dipole model analysis of $F_2^{c\bar{c}}$ derived from the new D^* data in DIS at HERA

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Abstract. I analyse the new D^* deep inelastic scattering data from HERA with the help of dipole models. I calculate $F_2^{c\bar{c}}$ from the GBW [1] and BGK [2] saturation models. I compare results with the last values determined by H1 at low Q^2 . I find good agreement with the data.

1 Introduction

In the dipole models : GBW and BGK the heavy quark contribution to F_2 was considered in the form of the $c\bar{c}$ pair production. I show results from fits to the last σ_r data from HERA, where charm contribution as $F_2^{c\bar{c}}$ is taken into account. These results depend on the mass of charm quark. The correct treatment of effects related to the charm quark contribution in perturbative QCD calculations, is important for the determination of parton distribution functions (PDFs).

2 Dipole model of DIS

For dipole model description of DIS we use following factorization :

$$\sigma^{\gamma p} = \frac{4\pi^2\alpha_{em}}{Q^2} F_2 = \sum_f \int d^2r \int_0^1 dz |\Psi^\gamma(r, z, Q^2, m_f)|^2 \hat{\sigma}(r, x) \quad (1)$$

where dipole cross section is :

$$\hat{\sigma}(r, x) = \sigma_0 (1 - \exp\{-\hat{r}^2\}), \quad \hat{r} = r/R_s(x). \quad (2)$$

2.1 Dipole cross section with GBW parametrization

GBW (Golec-Biernat, Wüsthoff) parametrization :

$$\hat{\sigma}(r, x) = \sigma_0 (1 - \exp(-r^2/R_s^2)), \quad R_s^2 = 4 \cdot (x/x_0)^\lambda \text{ GeV}^2. \quad (3)$$

The dipole scattering amplitude in such a case reads :

$$\hat{N}(\mathbf{r}, \mathbf{b}, x) = \theta(b_0 - b) (1 - \exp(-r^2/R_s^2)) \quad (4)$$

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where :

$$\hat{\sigma}(r, x) = 2 \int d^2b \hat{N}(\mathbf{r}, \mathbf{b}, x). \quad (5)$$

Parameters b_0 , x_0 , and λ are from fits of \hat{N} to F_2 data :

$$\lambda = 0.288, \quad x_0 = 4 \cdot 10^{-5}, \quad 2\pi b_0^2 = \sigma_0 = 29 \text{ mb}. \quad (6)$$

2.2 Dipole cross section with BGK parametrization

BGK (Bartels-Golec-Kowalski) parametrization :

$$\hat{\sigma}(r, x) = \sigma_0 \{1 - \exp[-\pi^2 r^2 \alpha_s(\mu^2) x g(x, \mu^2) / (3\sigma_0)]\}. \quad (7)$$

R_s^2 : from GBW dipole model is replaced by a gluon density with explicit DGLAP evolution
 $\mu^2 = C/r^2 + \mu_0^2$: is the scale of the gluon density
 gluon density is evolved according to the (LO) DGLAP equation :

$$xg(x, \mu_0^2) = A_g x^{-\lambda_g} (1-x)^{C_g}. \quad (8)$$

2.3 Charm structure functions in dipole models

Standard dipole model formula with $m_c = 1.4$ GeV and $e_c = 2/3$ is :

$$F_T^{(c\bar{c})} = \frac{3Q^4 e_c^2}{64\pi^4} \int_{z_c}^{1/2} dz z(1-z) \times \{[z^2 + (1-z)^2] Q_c^2 \phi_1^2 + m_c^2 \phi_0^2\} \quad (9)$$

with $z_c = (1 - \sqrt{1 - 4m_c^2/M^2})/2$.

For the heavy quark contributions we modified x in $\hat{\sigma}(r, x)$:

$$x \rightarrow x(1 + \frac{4m_f^2}{Q^2}) = \frac{Q^2 + 4m_f^2}{Q^2 + W^2}. \quad (10)$$

3 Results of the Fits

In this section I show dipole model BGK fit for reduced cross section: σ_r with quark masses: $m_{ch} = 1.4$ GeV, $m_{ud} = 0.03$ GeV for the energy: $E = 460, 575$ and 920 GeV in Table 1. In Table 2 I show charm fit for $F_2^{c\bar{c}}$ function with $m_{ch} = 1.4$ GeV and $m_{ud} = 0.03$ GeV.

Table 1. Fit parameters from BGK dipole model to H1 and ZEUS data [4].

No	Data	Q^2	Npoints	χ^2	A_g	λ_g	μ_0	$\chi^2/Npoints$
1	H1 and ZEUS	$Q^2 \geq 0.40$	456	628.94	2.795	-0.017	1.108	1.37
2	H1 and ZEUS	$Q^2 \geq 1.5$	402	401.36	2.281	0.065	1.723	0.99
3	H1 and ZEUS	$Q^2 \geq 3.5$	356	344.27	2.175	0.086	1.994	0.97
4	H1 and ZEUS	$Q^2 \geq 8.5$	287	229.76	2.167	0.084	1.944	0.80

Table 2. Charm fit for $F_2^{c\bar{c}}$ function, $m_{ch} = 1.4$ GeV, $m_{ud} = 0.03$ GeV.

No	Data	Q^2	Npoints	χ^2	A_g	λ_g	μ_0	χ^2/N_{points}
1	H1 and ZEUS	$Q^2 \geq 2.5$	41	32.36	4.917	-0.349	0.415	0.79

4 Predictions for $F_2^{c\bar{c}}$ from BGK dipole model

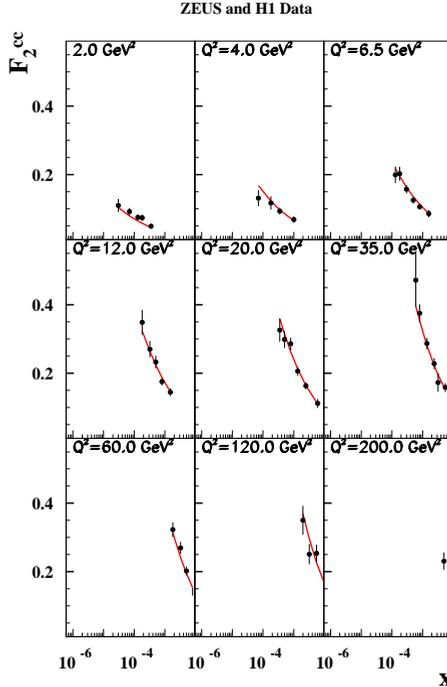


Fig. 1. Charm fit for $F_2^{c\bar{c}}$ function from Table 2.

5 Summary

I calculate $F_2^{c\bar{c}}$ from the GBW [1] and BGK [2] saturation model. I compare results with the last values determined by H1 and ZEUS [4] at low Q^2 . I find good agreement with the data. The mass effects, are important for the determination of parton distribution functions (PDFs).

References

1. K. Golec-Biernat and M. Wusthoff, Phys. Rev. **D59**, (1999) 24
2. J. Bartels, K.Golec-Biernat and H. Kowalski, Phys. Rev. **D66**, (2002) 19
3. K. Golec-Biernat and A. Luszczak, Phys. Rev. **D79**, (2009) 114010
4. H1 Collaboration, Eur. Phys. J. **C71**, (2011) 1769
5. H1 and ZEUS Collaboration, JHEP **1001**, (2010) 109