BGK dipole model in xFitter - an update on starting scale

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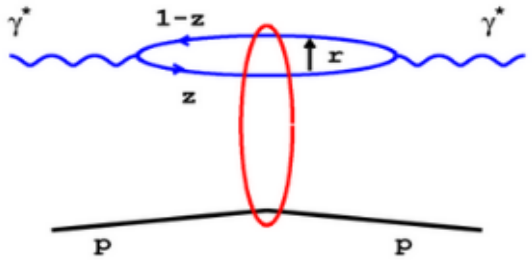
Dipole model of DIS

- Dipole picture of DIS at small x in the proton rest frame:



r - dipole size

z - longitudinal momentum fraction of the quark/antiquark

- Factorization: dipole formation + dipole interaction

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

- Dipole-proton interaction:

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

Dipole cross section: BGK

- BGK (Bartels-Golec-Kowalski) parametrization:

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

- $\mu^2 = C/r^2 + \mu_0^2$ is the scale of the gluon density
- μ_0^2 is a starting scale of the QCD evolution: $\mu_0^2 = Q_0^2$
- gluon density is evolved according to the LO or NLO DGLAP eq.
- soft gluon:

$$x g(x,\mu_0^2) = A_g\, x^{\lambda_g}\, (1-x)^{C_g}$$

- soft + hard gluon:

$$x g(x,\mu_0^2) = A_g\, x^{\lambda_g}\, (1-x)^{C_g} (1 + D_g x + E_g x^2)$$

BGK dipole model with a new scale of the gluon density

- BGK (Bartels-Golec-Kowalski) parametrization:

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

- A slighty different choice of the scale μ :

$$\mu^2 = \frac{\mu_0^2}{1 - exp(-\mu_0^2 r^2/C)}$$

- which interpolates smoothly between the C/r^2 behaviour for small r and the constant behaviour, $\mu^2 = \mu_0^2$ for $r \to \infty$

Results of the Fits

- Dipole model BGK fit with fixed valence quarks

TABLE I. BGK fit with fixed valence quarks for σ_r for H1ZEUS-NC data in the range $Q^2 \geq 3.5$ or 8.5 GeV^2 and $x \leq 0.01$. NLO fit. *Soft gluon*. $m_{uds} = 0.14$, $m_c = 1.3$ GeV. $Q_0^2 = 1.9$ GeV^2.

$Q^2_{\min}$ [GeV^2]	$\sigma_0[mb]$	A_g	λ_g	C_g	N_{df}	χ^2	χ^2/N_{df}
3.5	87.0 ± 8.9	2.32 ± 0.009	-0.056 ± 0.11	8.21 ± 0.80	534	551.1	1.03
8.5	72.4 ± 7.4	2.77 ± 0.009	-0.042 ± 0.123	6.54 ± 0.632	448	452.5	1.01

- Dipole model BGK fit with fixed valence quarks: new scale μ

TABLE II. BGK fit with fitted valence quarks for σ_r for H1ZEUS-NC data in the range $Q^2 \geq 3.5$ GeV^2 and $x \leq 0.01$. NLO fit. *Soft gluon*. $m_{uds} = 0.14, m_c = 1.3$ GeV. $Q_0^2 = 1.9$ GeV^2.

$Q^2_{\min}$ [GeV^2]	$\sigma_0[mb]$	A_g	λ_g	C_g	N_{df}	χ^2	χ^2/N_{df}
3.5	89.99 ± 9.2	2.44 ± 0.145	-0.079 ± 0.099	7.24 ± 0.61	530	540.35	1.02

Results of the Fits

- BGK dipole model fit for $Q^2 \geq 0.35\ GeV^2$, saturation ansatz

TABLE XI. BGK fit with valence quarks for σ_r for H1ZEUS-NC data in the range $Q^2 \geq 0.35$ GeV^2 and $x \leq 0.01$. NLO fit. *Soft+hard gluon*. $m_{uds} = 0.14, m_c = 1.3$ GeV, saturation ansatz. $Q_0^2 = 1.9$ or 1.1 GeV^2.

Q_0^2 [GeV^2]	σ_0 [mb]	A_g	λ_g	C_g	D_g	E_g	N_{df}	χ^2	χ^2/N_{df}
1.9	38.2 ± 4.1	2.80 ± 0.14	-0.063 ± 0.006	46.3 ± 4.58	12.1 ± 6.00	1970.4 ± 566.0	653	790.4	1.21
1.1	196.1 ± 105	6.24 ± 0.53	0.098 ± 0.012	52.3 ± 6.5	-22.0 ± 10.64	2145.0 ± 835.7	653	894.1	1.37

- BGK dipole model fit for $Q^2 \geq 0.35\ GeV^2$, new scale μ

Q_0^2	σ_0	A_g	λ_g	C_g	D_g	Eg	Ndf	χ^2	χ^2/Np
1.9	42.2	1.90	-0.043	39.1	11.9	1784.2	653	770.2	1.18