Multiple Interaction in DIS from AGK rules

Evaluation within a Dipole Model

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Impact Parameter Dipole Saturation Model

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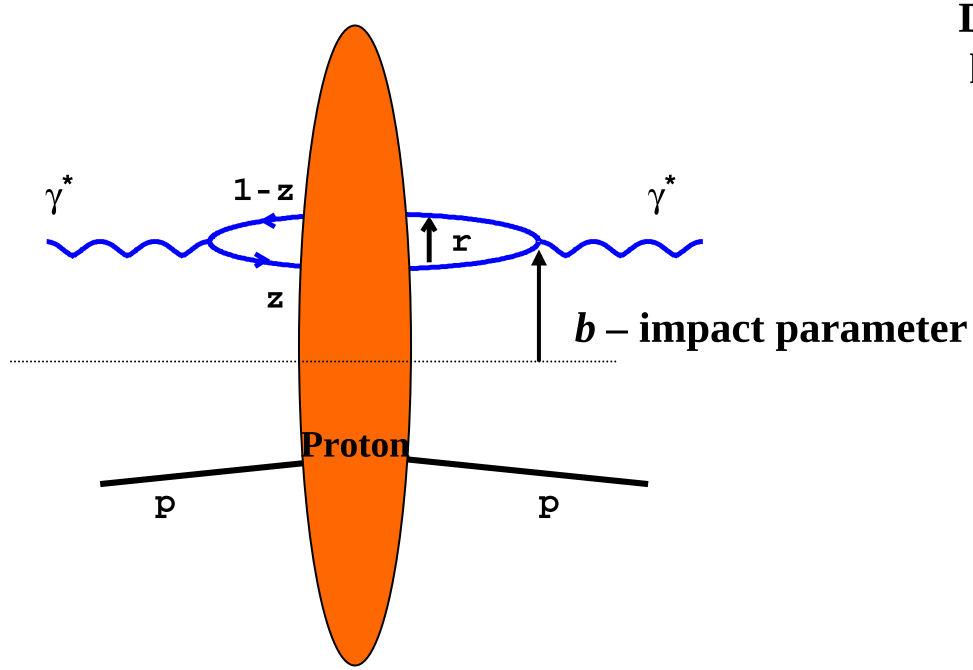


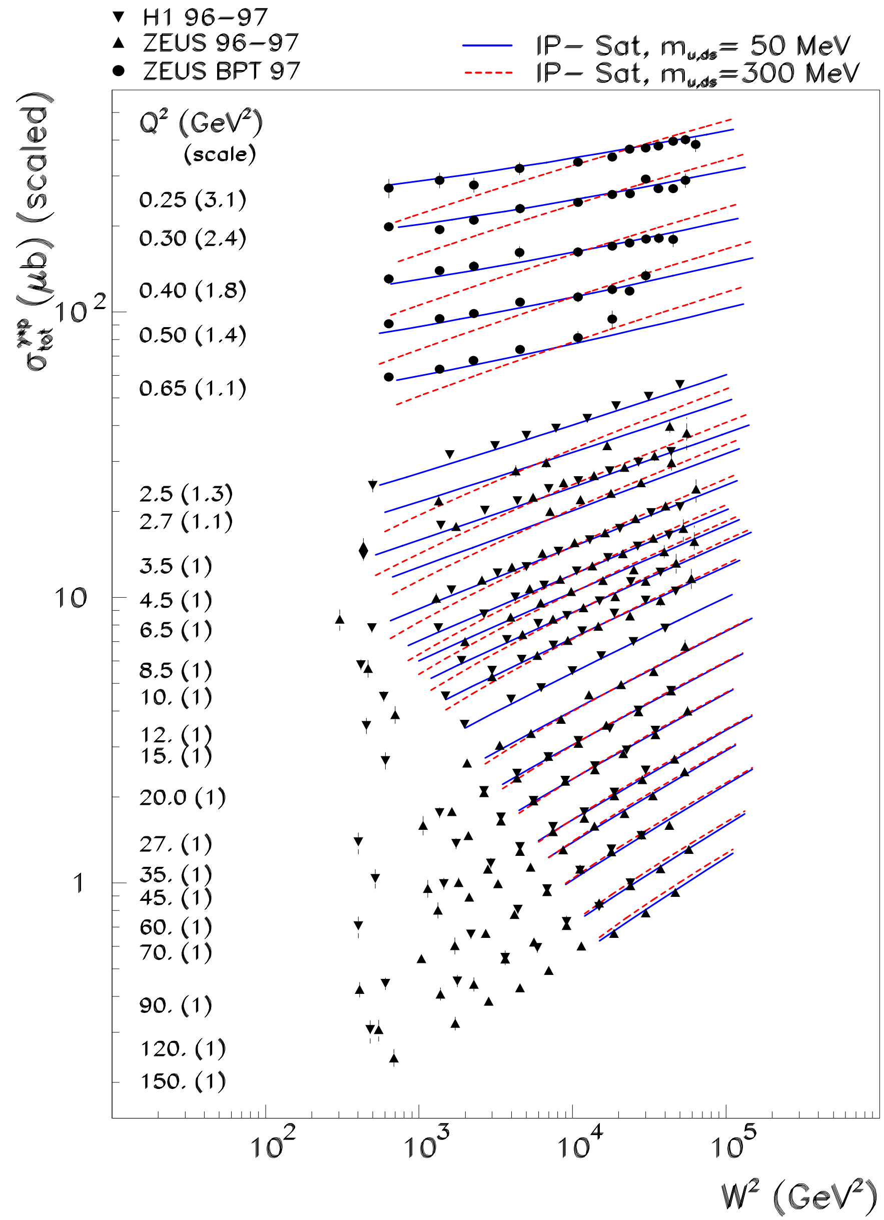
$$\sigma_{tot}^{\gamma^* p} = \int d^2\vec{b}\, d^2\hat{\vec{r}} \int_0^1 dz\, \Psi(Q^2, z, \vec{r})^* \sigma_{q\bar{q}}(x, r^2, b) \Psi(Q^2, z, \vec{r})$$

$$\frac{d\sigma_{qq}(x,r)}{d^2 b} = 2 \cdot \left\{ 1 - \exp(-\frac{\pi^2}{2\cdot 3} r^2 \alpha_s(\mu^2) xg(x,\mu^2) T(b)) \right\}$$

$$T(b) = \frac{1}{2\pi B_G} \exp(-b^2/2B_G)$$

***T(b)* - proton shape**

$$\sigma^{\gamma^* p} = \sum_f \int d^2\vec{r} \int d^2 b \int_0^1 dz \Psi_f^*(Q^2, z, \vec{r})\ 2\left\{1 - \exp\left(-\frac{\pi^2}{2\cdot 3} r^2 \alpha_s x g(x, \mu^2) T(b)\right)\right\} \Psi_f(Q^2, z, \vec{r})$$



$$\mu^2 = \frac{C}{r^2} + \mu_0^2$$

$$xg(x, \mu_0^2) = A_g \left(\frac{1}{x}\right)^{\lambda_g} (1-x)^{5.6}$$

$Q^2 > 0.25$ GeV^2

$m_u = 0.05$ GeV

$m_c = 1.30$ GeV

Fit parameters

$\lambda_g = -0.12$ $C = 4.0$

$Q_0^2 = 0.8$ GeV^2

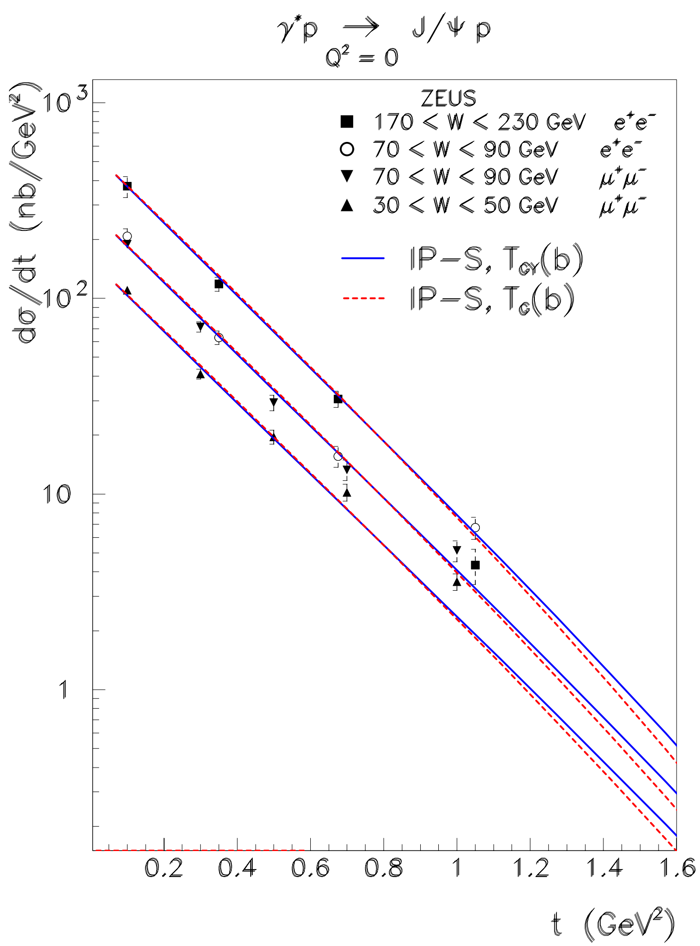
$\chi^2/N = 0.8$

$x < 10^{-2}$

t-dependence of the diffractive cross sections determines the b distribution

$t = -\vec{\Delta}^2 \qquad \vec{\Delta}$ - transv. momentum (2-d) $\qquad \vec{b}$ - impact parameter (2-d)

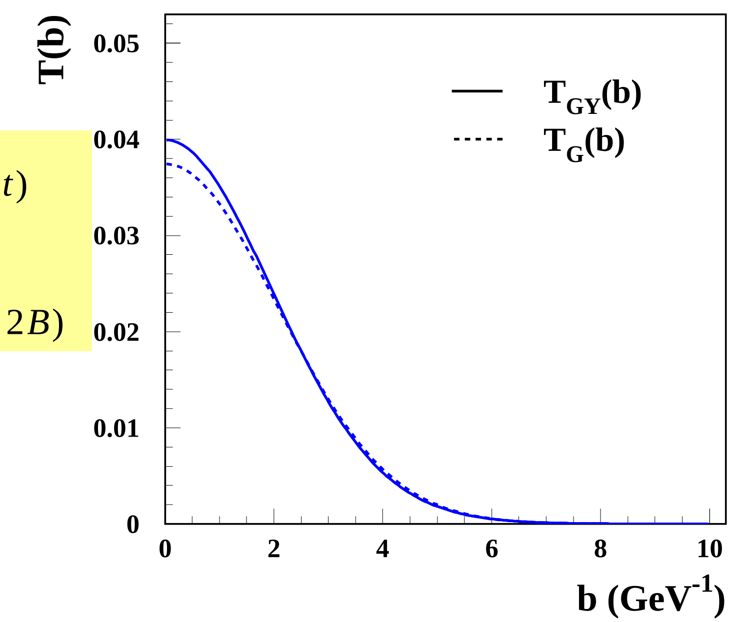
$$\frac{d\sigma_{VM}^{\gamma^* p}}{dt} = \frac{1}{16\pi} \left| \int d^2\vec{r} \int d^2b e^{-i\vec{b}\vec{\Delta}} \int_0^1 dz \Psi_{VM}^*(Q^2,z,\vec{r})\ 2\left\{1-\exp\left(-\frac{\pi^2}{2\cdot 3} r^2 \alpha_s xg(x,\mu^2) T(b)\right)\right\} \Psi(Q^2,z,\vec{r}) \right|^2$$



$$\frac{d\sigma^{diff}}{dt} \sim \exp(B\cdot t)$$

$\Rightarrow$

$$T(b) \sim \exp(-\vec{b}^2/2B)$$



$$T_G(b) \propto \exp(-\vec{b}^2/2B_G) \qquad B_G = 4.25 \text{ GeV}^2$$

$$T_{GY}(b) \propto \int d^2b' \exp(-(\vec{b}-\vec{b}')^2/2w_G) K_0(b'/w_E)$$

AGK Rules

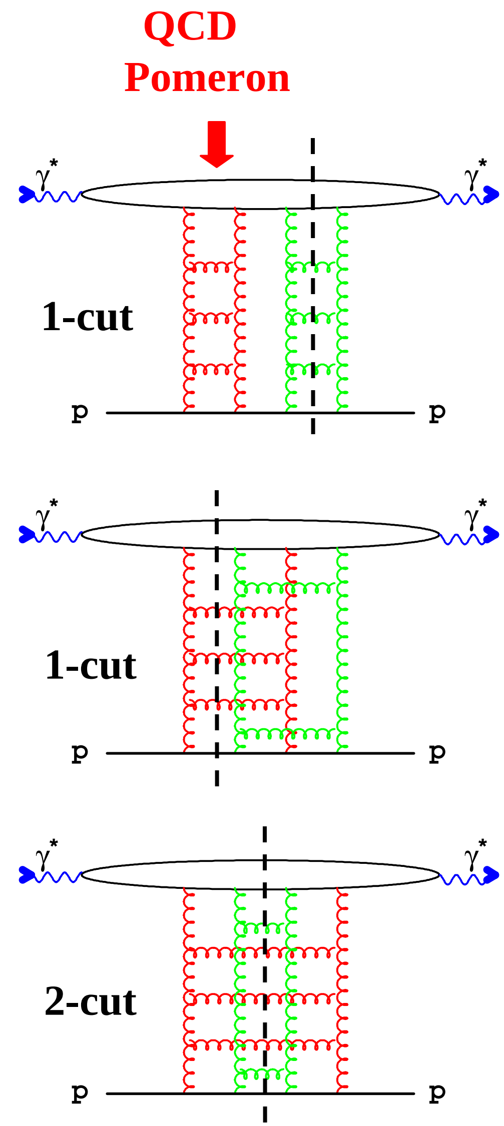
The cross-section for k-cut pomerons:

Abramovski, Gribov, Kancheli

Sov. ,J., Nucl. Phys. 18, p308 (1974)

$$\sigma_k = \sum_{m=k}^{\infty} (-1)^{m-k} 2^m \frac{m!}{k!(m-k)!} F^{(m)}$$

$F^{(m)}$ - amplitude for the exchange of m pomerons



AGK Rules in the Dipole Model

Total cross section

Mueller-Salam (NP B475, 293)

$$\sigma_{tot} = 2\sum_{m=1}^{\infty}(-1)^{m-1}F^{(m)}$$

Dipole cross section

$$\frac{d\sigma}{d^2b} = 2(1-\exp(-\Omega/2)) = 2\sum_{m=1}^{\infty}(-1)^{m-1}\left(\frac{\Omega}{2}\right)^m \frac{1}{m!}$$

Amplitude for the exchange of *m* pomerons in the dipole model

$$\Rightarrow \quad F^{(m)} = \left(\frac{\Omega}{2}\right)^m \frac{1}{m!} \qquad \Omega = \frac{\pi^2}{N_C} r^2 \alpha_s(\mu^2) x g(x,\mu^2) T(b)$$

KT model

AGK rules

$$\frac{d\sigma_k}{d^2b}=\sum_{m=k}^{\infty}(-1)^{m-k}2^m\frac{m!}{k!(m-k)!}F^{(m)}$$

Dipole model

$$\frac{d\sigma_k}{d^2b}=\sum_{m=k}^{\infty}(-1)^{m-k}2^m\frac{m!}{k!(m-k)!}\left(\frac{\Omega}{2}\right)^m\left(\frac{1}{m!}\right)=\frac{\Omega^k}{k!}\sum_{m=k}^{\infty}(-1)^{m-k}\frac{\Omega^{m-k}}{(m-k)!}$$

$$\Longrightarrow \quad \boxed{\frac{d\sigma_k}{d^2b}=\frac{\Omega^k}{k!}\exp(-\Omega)}$$

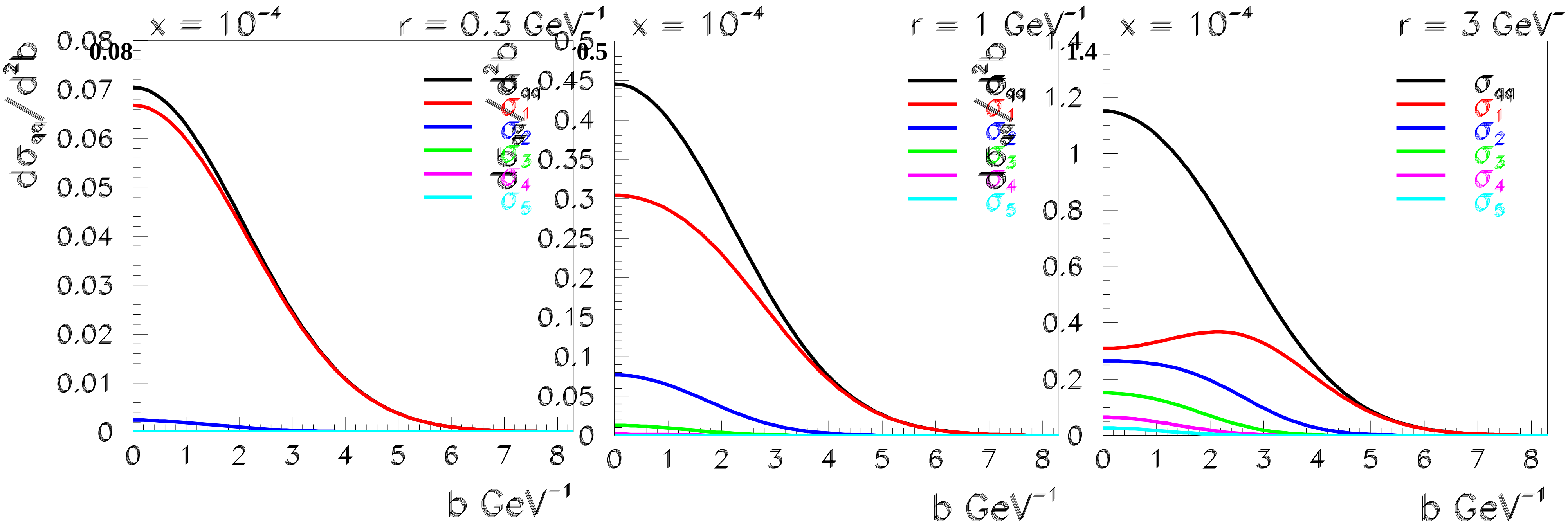
Diffraction from AGK rules

$$\frac{d\sigma_{diff}}{d^2b}=\frac{d\sigma_{qq}}{d^2b}-\sum_{k=1}^{\infty}\frac{d\sigma_k}{d^2b}=2(1-\exp(-\Omega/2))-(1-\exp(-\Omega))$$

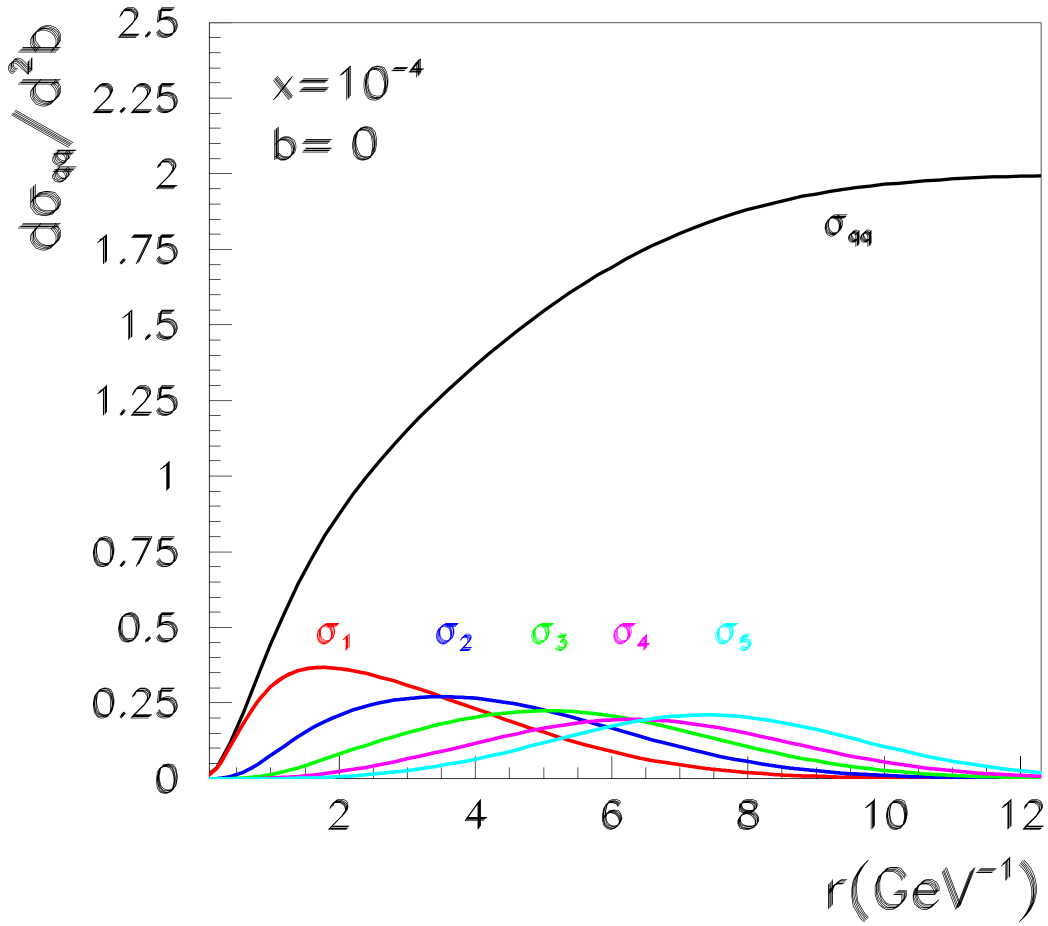
$$=1-2\exp(-\Omega/2)+\exp(-\Omega)=(1-\exp(-\Omega/2))^2$$

$$\frac{d\sigma_{qq}}{d^2b} = 2 \cdot \left\{ 1 - \exp\left(-\frac{\Omega}{2}\right) \right\}$$

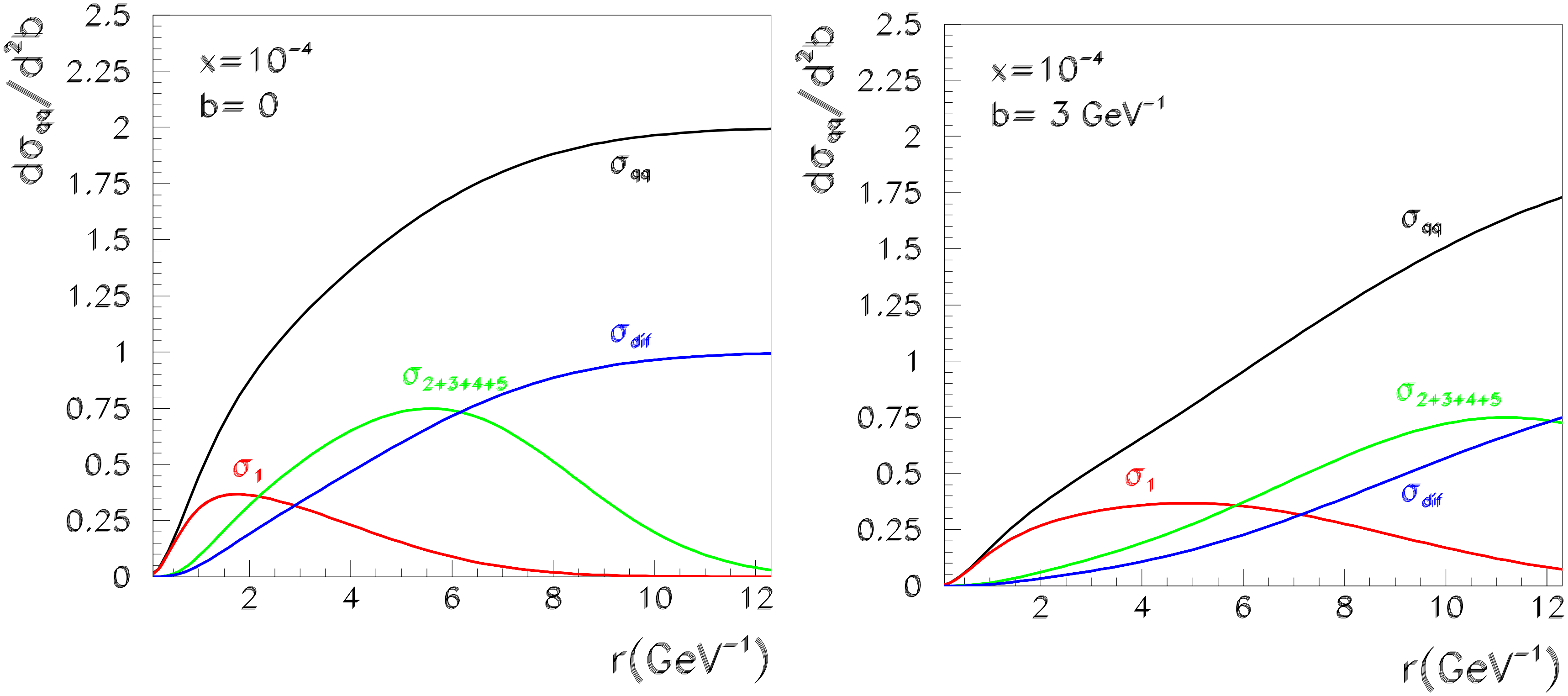
$$\frac{d\sigma_k}{d^2b} = \frac{\Omega^k}{k!}\exp(-\Omega)$$



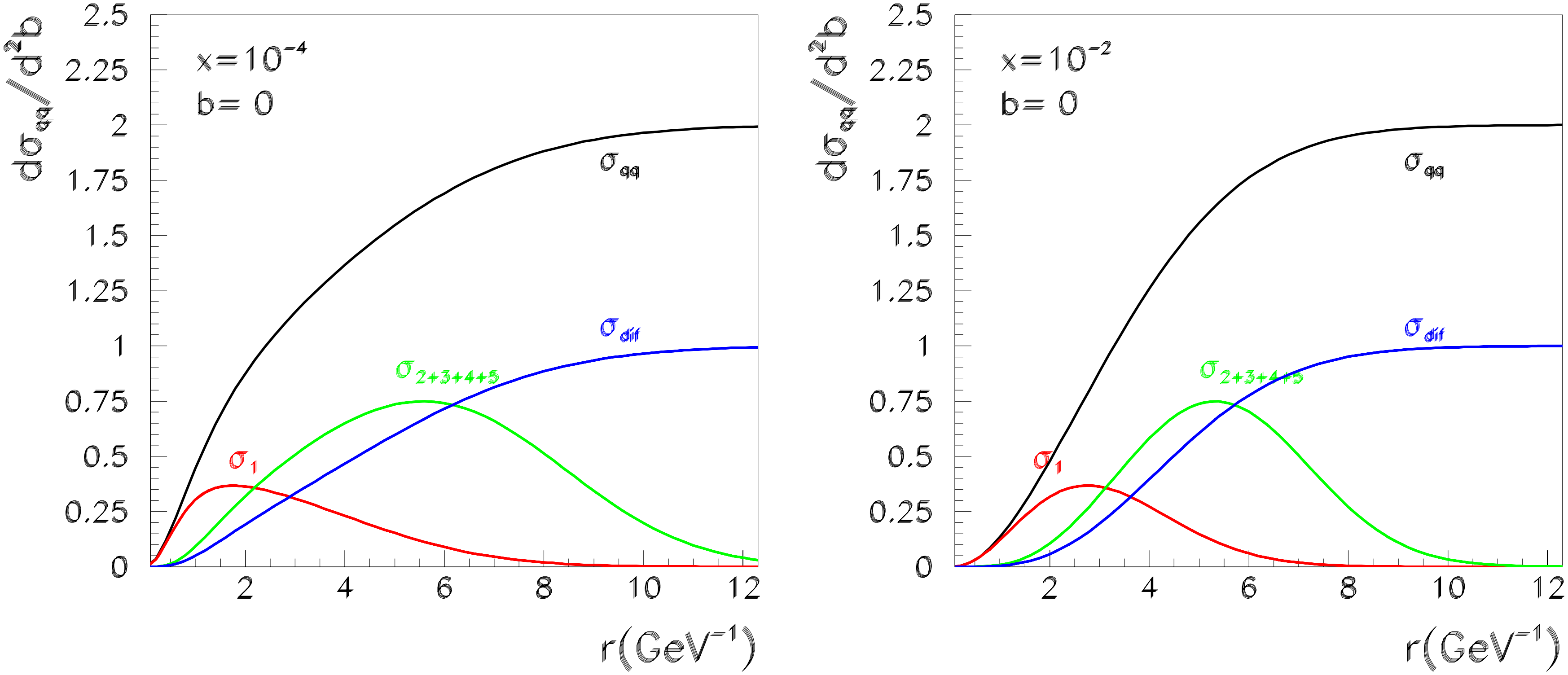
$$\Omega = \frac{\pi^2}{N_C} r^2 \alpha_s(\mu^2) x g(x,\mu^2) T(b)$$



$d\sigma_{qq}/d^2b$
$x=10^{-4}$
$b=0$
σ_{qq}
σ_1
σ_2
σ_3
σ_4
σ_5
$r(GeV^{-1})$



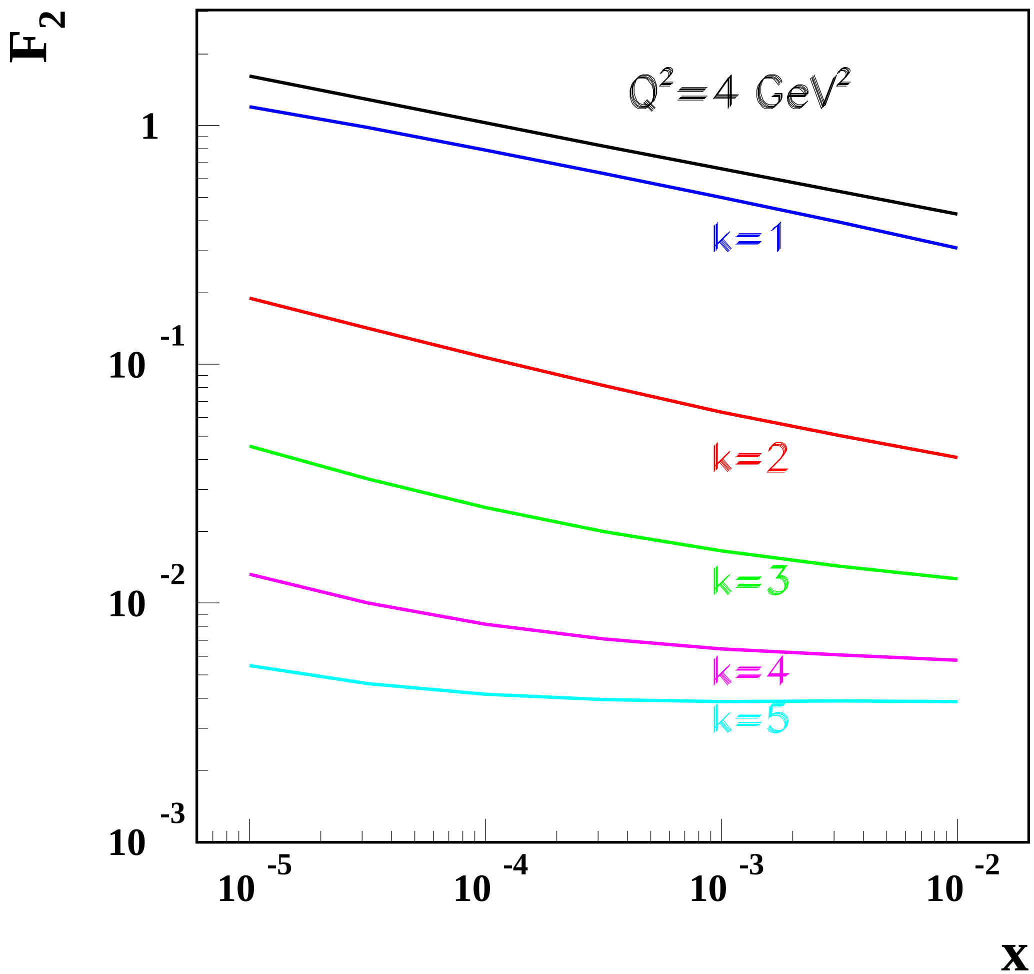
x=10^-4
b= 0
σ_qq
σ_dif
σ_2+3+4+5
σ_1
dσ_qq/d²b
r(GeV^-1)
x=10^-4
b= 3 GeV^-1
σ_qq
σ_2+3+4+5
σ_1
σ_dif
dσ_qq/d²b
r(GeV^-1)

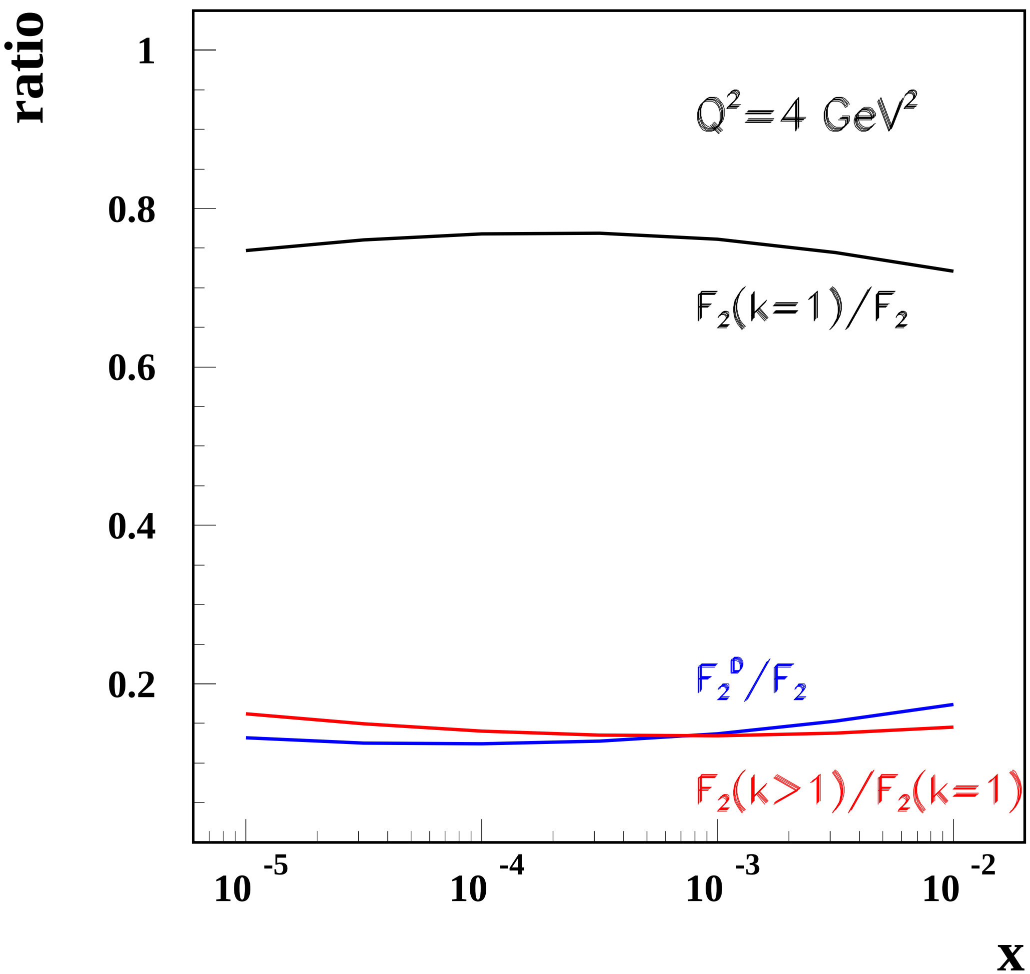


$d\sigma_{qq}/d^2b$
$x = 10^{-4}$
$b = 0$
σ_{qq}
σ_{dif}
$\sigma_{2+3+4+5}$
σ_1
$r(GeV^{-1})$
$x = 10^{-2}$
$b = 0$
σ_{qq}
σ_{dif}
$\sigma_{2+3+4+5}$
σ_1
$r(GeV^{-1})$

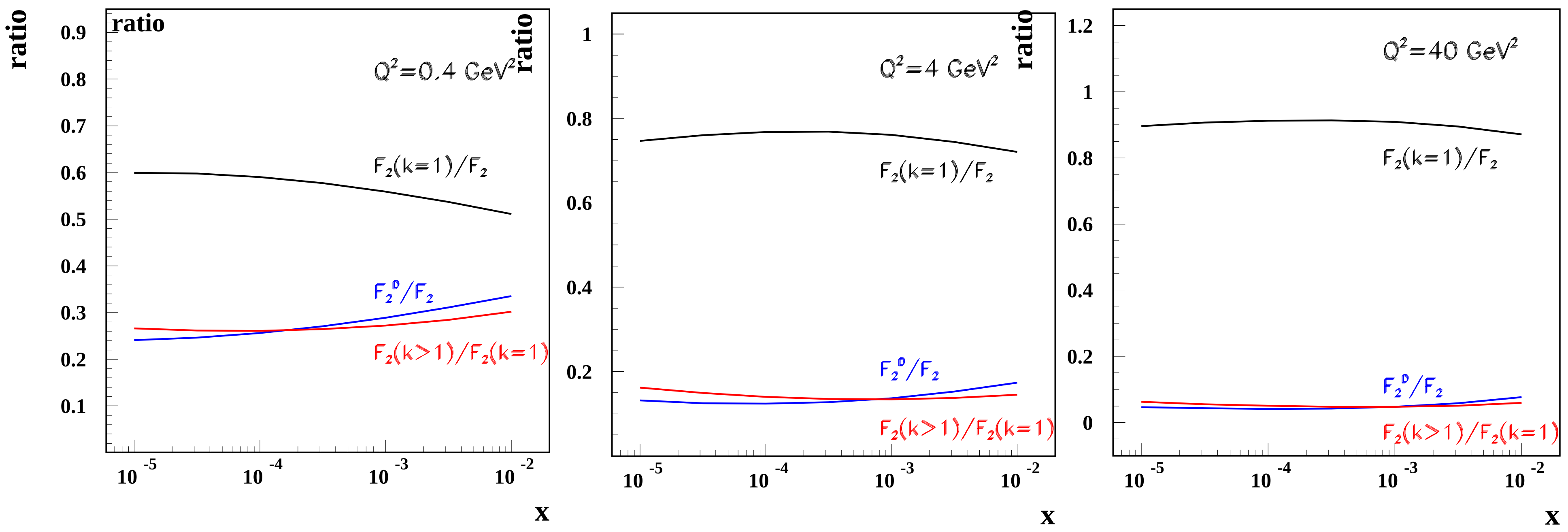
$$\sigma^{\gamma^* p} = \sum_f \int d^2\vec{r} \int d^2 b \int_0^1 dz \Psi_f^*(Q^2, z, \vec{r}) \; 2\left\{1 - \exp(-\frac{\Omega}{2})\right\} \Psi_f(Q^2, z, \vec{r})$$

$$\sigma_k^{\gamma^* p} = \sum_f \int d^2\vec{r} \int d^2 b \int_0^1 dz \Psi_f^*(Q^2, z, \vec{r}) \; \frac{\Omega^k}{k!} \exp(-\Omega) \Psi_f(Q^2, z, \vec{r})$$





ratio
1
0.8
0.6
0.4
0.2
$Q^2=4\ GeV^2$
$F_2(k=1)/F_2$
F_2^D/F_2
$F_2(k>1)/F_2(k=1)$
10^{-5}
10^{-4}
10^{-3}
10^{-2}
x



Note: AGK rules underestimate the amount of diffraction in DIS

Outlook: Monte Carlo Feynman diagrams for 3, 4, 5 cut-pomerons
Sum up contribution of uncut-pomerons to infinity