COLOUR DIPOLES AND VIRTUAL COMPTON SCATTERING

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lanl hep-ph/next week

OUTLINE

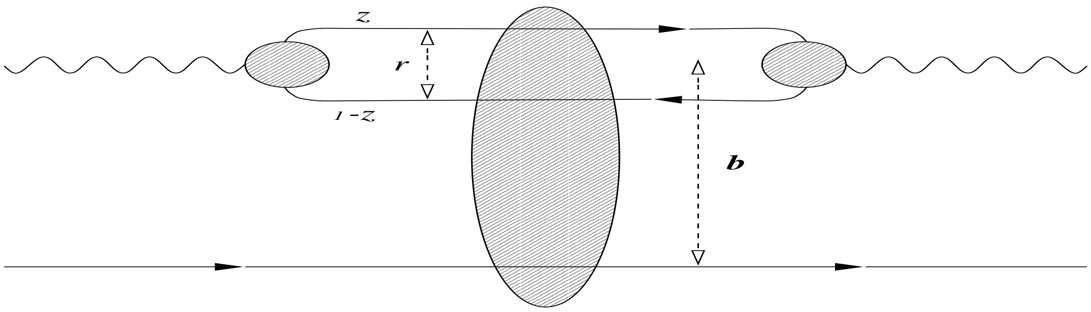
- Dipole model of diffractive photoprocesses
  - FKS model

    Forshaw, Kerley, and Shaw
  - MFGS model

    McDermott, Frankfurt, Guzey and Strikman
- Virtual Compton scattering

THE COLOUR DIPOLE MODEL

The proton structure function



$$\sigma^{T,L}_{\gamma^*,p} = \int \mathrm{d}z\mathrm{d}^2r \; |\psi^{T,L}_{\gamma}(z,r,Q^2)|^2 \sigma(s,r,z)$$

where:

$\sigma(s,r,z) =$ dipole cross-section

$\psi^{T,L}_{\gamma} =$ light cone photon wavefunction

Common features.

Dipole cross-section $\sigma(z,r)$

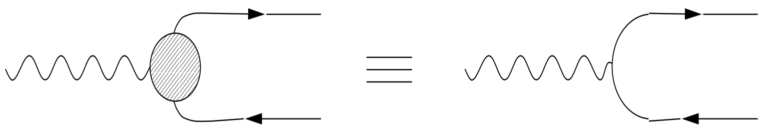
Flavour and z independent(geometrical)

Colour transparency $\sigma \propto r^2$ as $r \to 0$

Hadronic behaviour for large $r \approx 1\mathrm{f}$

Form of the photon wavefunctions

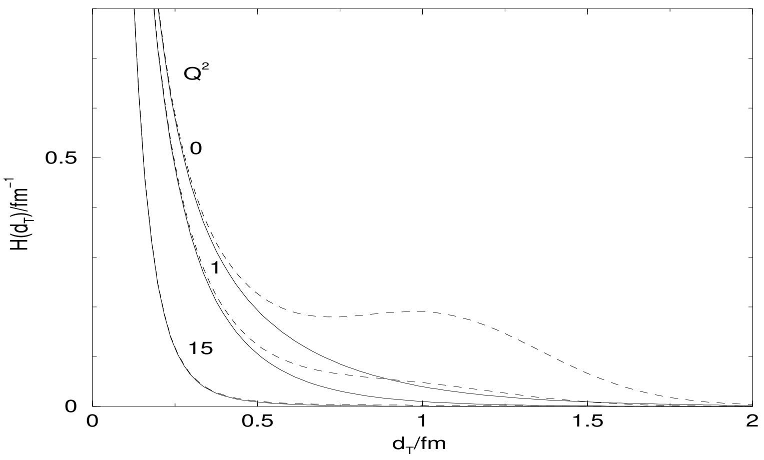
Small r : pure perturbative



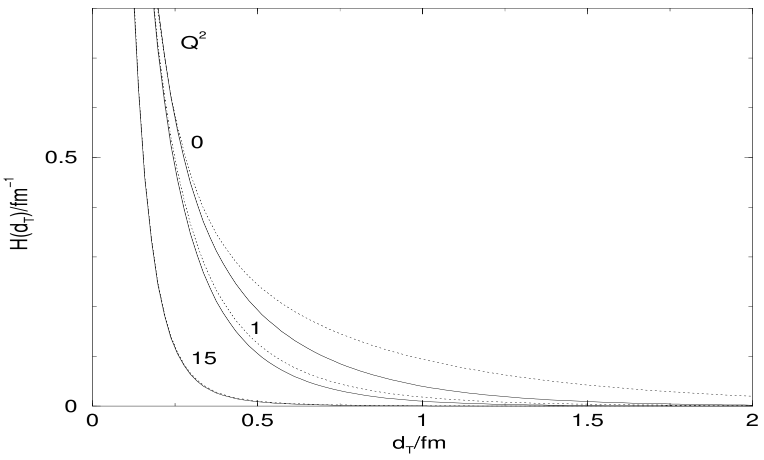
$$|\psi_{L,T}(z,r)|^2 = |\psi^0_{L,T}(z,r)|^2$$

Non-perturbative effects at large $r \approx 1\mathrm{f}$.

The weight function $H(r) \propto |\psi(z, r)|^2$.



The weight function for $m_q^2 = 0.08$ with(dashed line) and without (solid line) the confinement factor of FKS.



The weight function corresponding to QED photon wavefunctions with $m_q^2 = 0.08$ (solid lines) and $m_q^2 = 0.02$ (dotted lines)

FKS model

1. Phys.Rev. D60(1999)74012; 2. Nucl.Phys. A675(2000)80; 3. lanl-ph/0009235

Assumes process and Q^2 independent parametric form

$$\sigma(s,r) = \sigma_{soft}(s,r) + \sigma_{hard}(s,r)$$

with: colour transparency as $r \to 0$:

$$\sigma \to \sigma_{hard} \to a_2^H r^2 (r^2 s)^{\lambda_H}$$

Hadronic behaviour for large $r \approx 1$f

$$\sigma \to \sigma_{soft} \to a_0^S (r^2 s)^{\lambda_S}$$

Fit values: $\lambda_S = 0.07$ $\lambda_H = 0.42$

MFGS model

1. Eur.Phys.J. **C16**(2000)641;
2. JHEP **0103**(2001)045.

Perturbative region $0 < r < r_c \approx 0.25$ fm.

$$\hat{\sigma}_{pQCD}(x,r) = \frac{\pi^2 r^2}{3}\alpha_s(\bar{Q}^2)xg(x',\bar{Q}^2)$$

x' is estimated gluon momentum fraction and $\bar{Q}^2 = \lambda/r^2$.

Hadronic region $r > r_\pi = 0.65$ fm

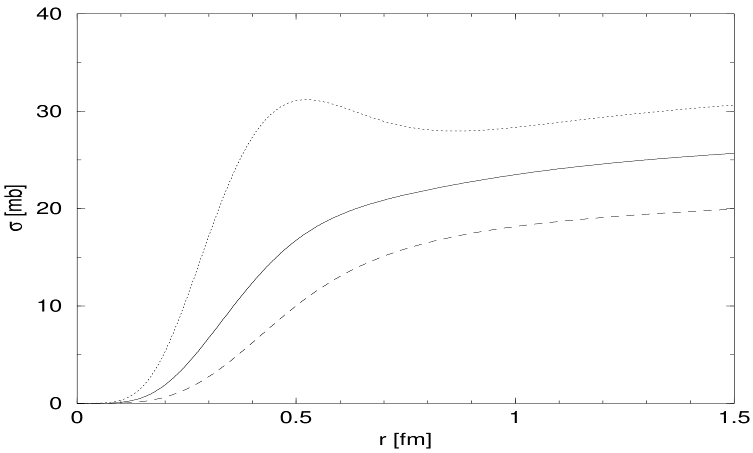
In this region MFGS use an estimated σ, comparable to $\sigma_{\pi N}$ at $r = r_\pi$

Here restrict ourselves to $Q^2 > 1$ GeV^2
- so not too sensitive to this region!

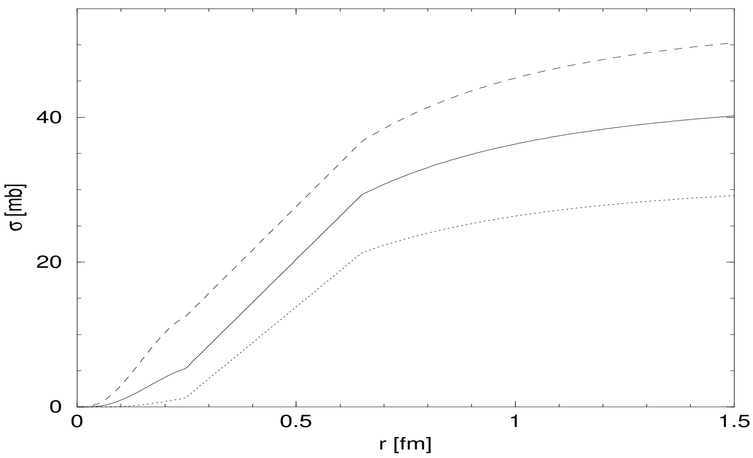
Intermediate region $r_c < r < r_\pi$

where σ is linearly interpolated between $r = r_\pi$ and $r = r_c$

The dipole cross-sections

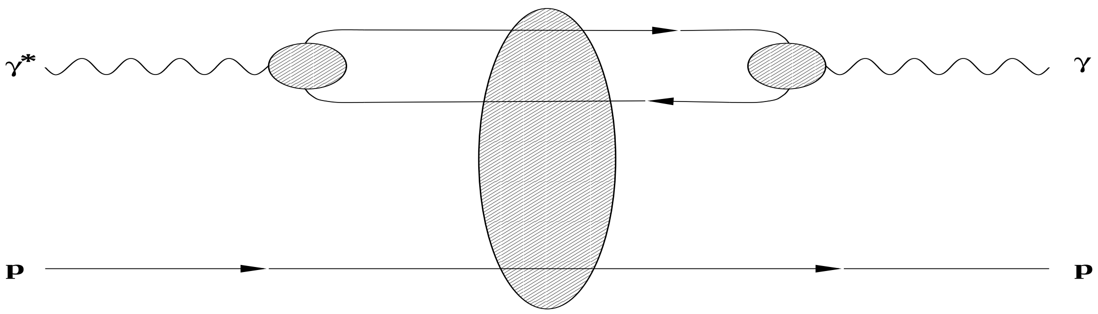


The FKS dipole cross section at $W = 10, 74, 300$ GeV (dashed, solid and dotted lines, respectively)



The MFGS dipole at $W = 10, 74, 300$ GeV (dotted, solid dashed respectively) at fixed $Q^2 = 1$ GeV^2.

VIRTUAL COMPTON SCATTERING



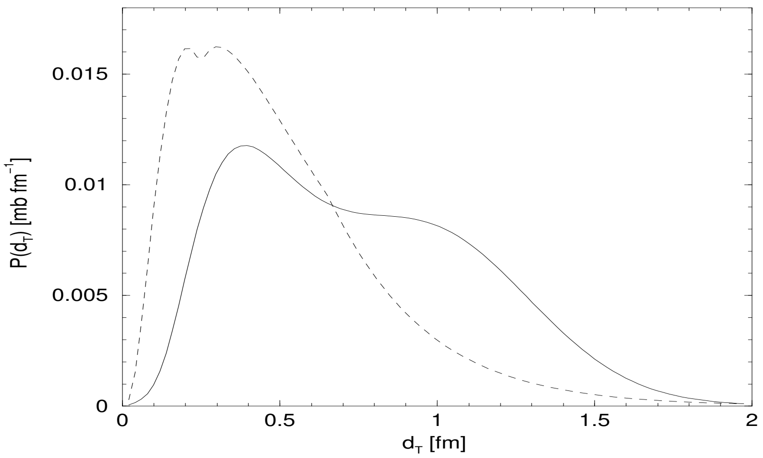
$$Im\ \mathcal{A}(W^2, Q^2, t = 0) = 2\pi \int dr\ p(r, s, Q^2)\,,$$

where

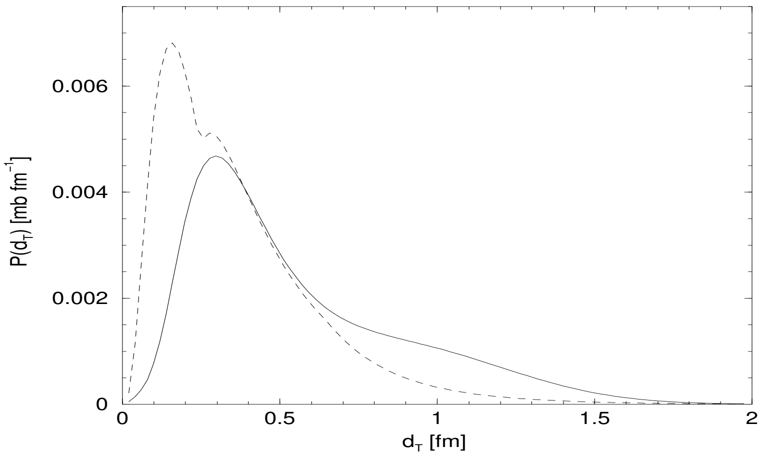
$$p(r, s^*, Q^2) =$$

$$\int dz\ r\ \psi_T^*(z, r, Q^2)\ \sigma(s, z, r)\ \psi_T(z, r, 0)$$

The profile functions

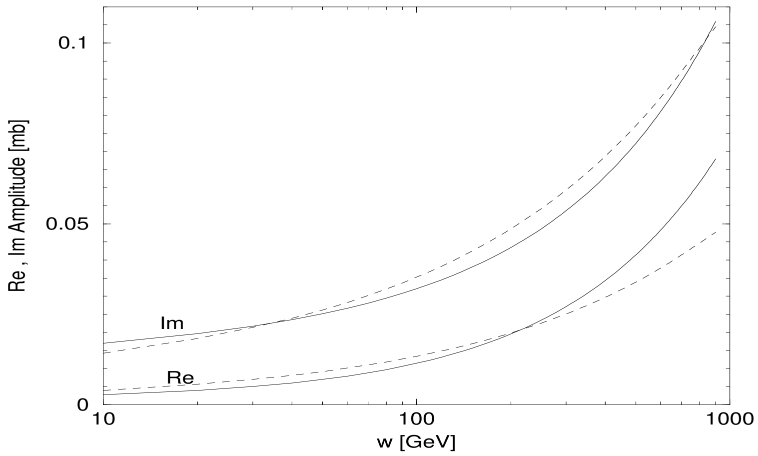


Profile in transverse dipole size for $Q^2 = 1$ and $W = 74$ GeV, employing the FKS (solid line) and MFGS (dashed line) models for the dipole cross section.

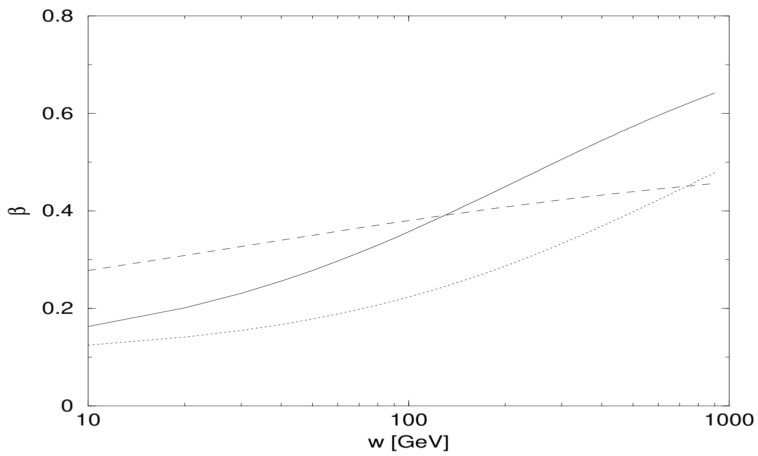


Profile in transverse dipole size for $Q^2 = 10$ GeV^2 and $W = 74$ GeV, employing the FKS (solid line) and MFGS (dashed line) models for the dipole cross section.

Forward real and imaginary parts

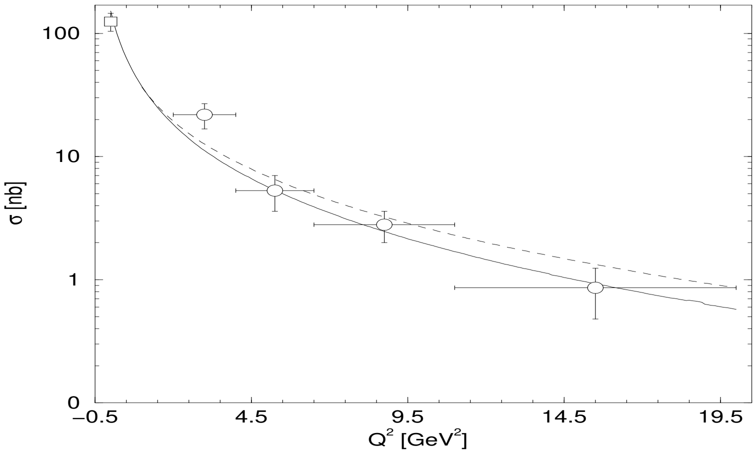


Real and Imaginary parts of the DVCS amplitude for the FKS (solid lines) and MFGS (dotted lines) dipole models for $Q^2 = 4.5$ GeV^2.

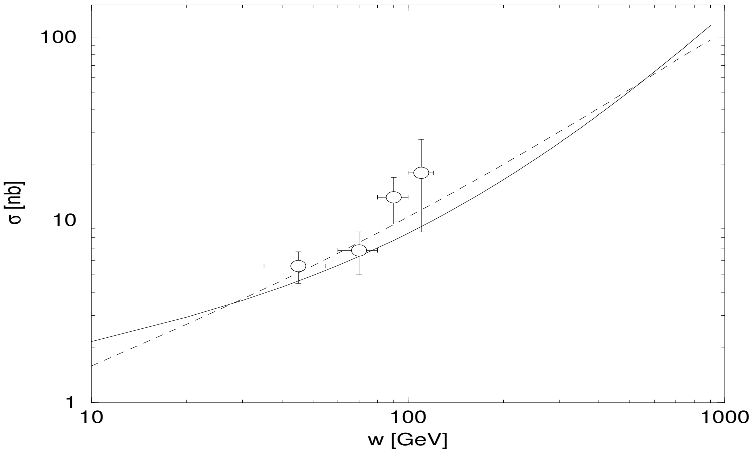


The ratio, β, of the real to imaginary part of the DVCS forward amplitude at $Q^2 = 4.5$, solid line: FKS; dashed line MFGS; and dot-dash line FKS at $Q^2 = 0$.

$\sigma(\gamma^* + p \to \gamma + p)$



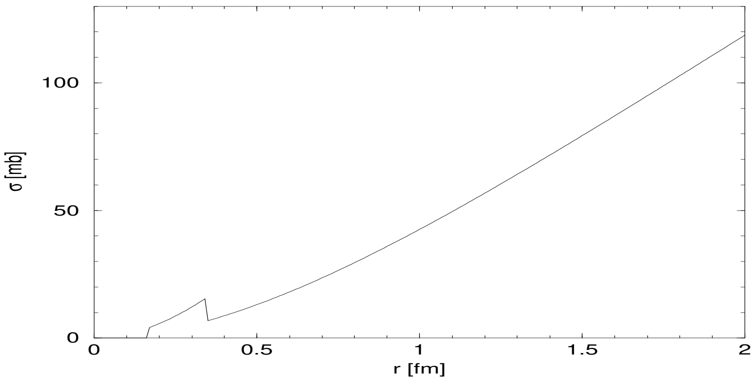
The Q^2-dependence of the H1 DVCS cross section at fixed $W = 74$ GeV. ($B = 7$ GeV^{-2})



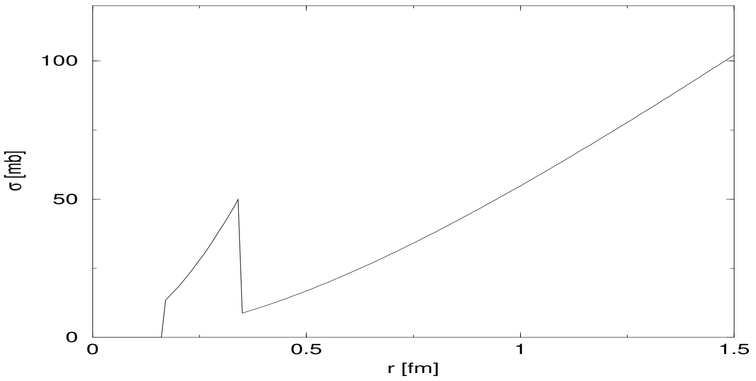
The energy dependence of the H1 DVCS cross section at fixed $Q^2 = 4.5$. ($B = 7$ GeV^{-2})

Donnachie-Dosch

W=74

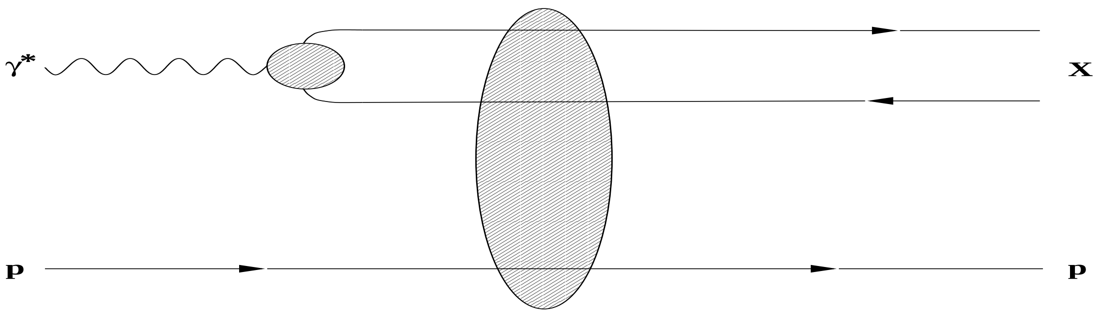


W=300



Other $\gamma^* p$ Processes

Diffractive Dissociation



Vector Meson Production