Low x, low Q^2 A_1^p and g_1^p status report

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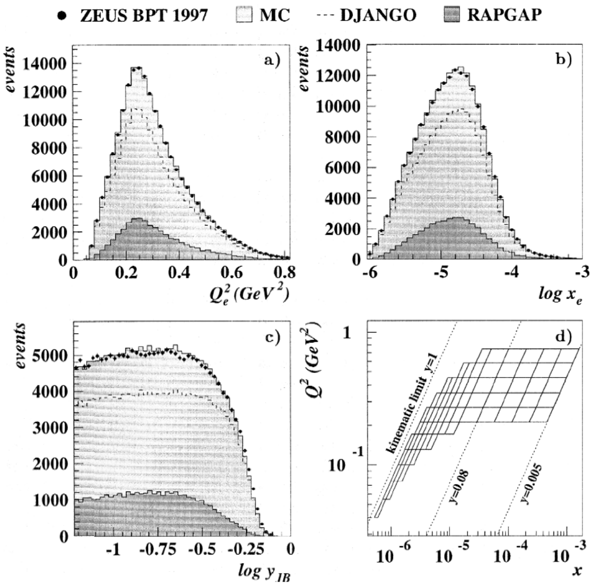
Low x, low Q^2 ZEUS fits to F_2^p

- "Measurement of the proton structure function F_2 at very low Q^2 at HERA", J. Breitweg *et al.* (ZEUS Collaboration), Phys.Lett. B487 (2000) 53
- ZEUS 1997 data
- $0.045\ \text{GeV}^2 < Q^2 < 0.65\ \text{GeV}^2$
- $6 \cdot 10^{-7} < x < 1 \cdot 10^{-3}$
- rise of F_2 at low x slower than observed in HERA data at higher Q^2
- data can be described by Regge theory with a constant logarithmic slope $\partial \ln F_2 / \partial \ln(1/x)$
- dependence of F_2 on Q^2 stronger than at higher Q^2 values, aproaching, at the lowest Q^2 valies of this measurement, a region where F_2 becomes nearly proportional to Q^2

ZEUS low x, low Q^2 kinematics



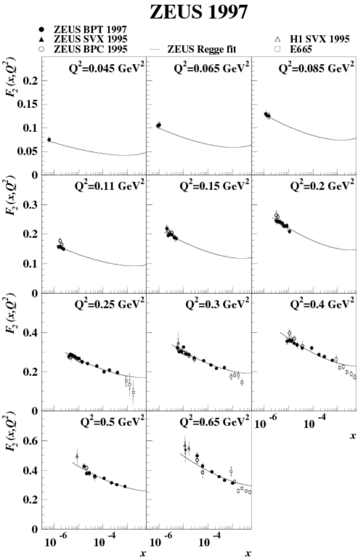
Phenomenological parameterization

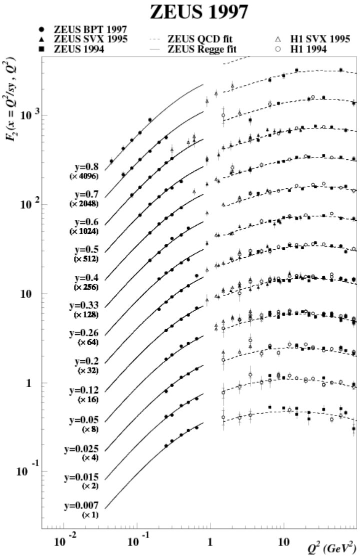
- Based on the combination of a simplified version of the generalized vector meson dominance model for the description of the Q^2 dependence and Regge theory for the description of the x dependence of F_2.

$$\text{Fit 1: } F_2(x, Q^2) = \left(\frac{Q^2}{4\pi^2\alpha}\right) \cdot \left(\frac{M_0^2}{M_0^2+Q^2}\right) \cdot \left(A_{\mathbb{R}} \cdot \left(\frac{Q^2}{x}\right)^{\alpha_{\mathbb{R}}-1} + A_{\mathbb{P}} \cdot \left(\frac{Q^2}{x}\right)^{\alpha_{\mathbb{P}}-1}\right)$$

- assuming $R = 0.165 \cdot Q^2/m_\rho^2$, w/ $m_\rho = 0.77$ GeV $\Rightarrow F_L = 0$.
- $A_{\mathbb{R}} = 147.8 \pm 4.6\ \mu\text{b}$
- $\alpha_{\mathbb{R}} = 0.5$
- $A_{\mathbb{P}} = 62.0 \pm 2.3\ \mu\text{b}$
- $\alpha_{\mathbb{P}} = 1.102 \pm 0.007$
- $M_0^2 = 0.52 \pm 0.04\ \text{GeV}^2$

F_2 and fits


ZEUS 1997
ZEUS BPT 1997
ZEUS SVX 1995
ZEUS BPC 1995
ZEUS Regge fit
H1 SVX 1995
E665
Q²=0.045 GeV²
Q²=0.065 GeV²
Q²=0.085 GeV²
Q²=0.11 GeV²
Q²=0.15 GeV²
Q²=0.2 GeV²
Q²=0.25 GeV²
Q²=0.3 GeV²
Q²=0.4 GeV²
Q²=0.5 GeV²
Q²=0.65 GeV²
F₂(x,Q²)
x


ZEUS 1997
ZEUS BPT 1997
ZEUS SVX 1995
ZEUS 1994
ZEUS QCD fit
ZEUS Regge fit
H1 SVX 1995
H1 1994
F₂(x = Q²/sy , Q²)
y=0.8 (× 4096)
y=0.7 (× 2048)
y=0.6 (× 1024)
y=0.5 (× 512)
y=0.4 (× 256)
y=0.33 (× 128)
y=0.26 (× 64)
y=0.2 (× 32)
y=0.12 (× 16)
y=0.05 (× 8)
y=0.025 (× 4)
y=0.015 (× 2)
y=0.007 (× 1)
Q² (GeV²)

Other fits

- "ZEUS results on the measurement and phenomenology of F_2 at low x and low Q^2", J. Breitweg *et al.* (ZEUS Collaboration), Eur.J.Phys. C7 (1999) 609
- New data presented for the first time: $0.6 < Q^2 < 17$ GeV^2, $1.2 \times 10^{-5} < x < 1.9 \times 10^{-3}$ (ZEUS 1995)
- **"The data at very low $Q^2 < 0.65$ GeV^2 are described successfully by a combination of generalised vector meson dominance and Regge theory."**

Other fits (2)

Fit 2: $\sigma^{\gamma p}_{\text{tot}}(W^2) = A_{\mathbb{R}}(W^2)^{\alpha_{\mathbb{R}}-1} + A_{\mathbb{P}}(W^2)^{\alpha_{\mathbb{P}}-1}$

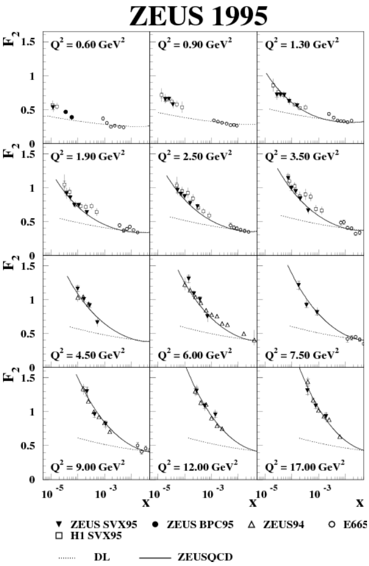
- $\alpha_{\mathbb{R}}$ fixed to 0.5 (as the original DL model and other previous estimates)
- $\alpha_{\mathbb{P}} = 1.141 \pm 0.020(\text{stat}) \pm 0.044(\text{syst})$
- $\alpha_{\mathbb{P}} = 1.101 \pm 0.002(\text{stat}) \pm 0.012(\text{syst})$, fitting both terms to the real photoproduction data (with $W^2 > 3$ GeV^2) and BPC $\sigma_0^{\alpha p}$ data
- $\alpha_{\mathbb{P}} = 1.100 \pm 0.002(\text{stat}) \pm 0.012(\text{syst})$, including in addition two direct measurements from HERA
- At HERA energies the Reggeon contribution is negligible
- The results are compatible with the DL value of 1.08 and the then best estimate of $1.0964^{+0.0115}_{-0.0094}$ (Cudell et al., hep-ph/9701312)

Other fits (3)

$$\text{Fit 3: } \sigma_{tot}^{\gamma^p}(W^2, Q^2) = \left(\frac{M_0^2}{M_0^2 + Q^2}\right)\left[A_{\mathbb{R}}(W^2)^{\alpha_{\mathbb{R}}-1} + A_{\mathbb{P}}(W^2)^{\alpha_{\mathbb{P}}-1}\right]$$

- M_0^2 fixed to 0.53 found before
- $\alpha_{\mathbb{R}}$ fixed at 0.5
- Parameters found by fitting the photoproduction data (with $W^2 > 3$ GeV^2, but without the two original HERA measurements) and the measured BPC data:
  - $A_{\mathbb{R}} = 145 \pm 0.2$ μb
  - $A_{\mathbb{P}} = 63.5 \pm 0.9$ μb
  - $\alpha_{\mathbb{P}} = 1.097 \pm 0.002$
  - $\chi^2/ndf = 1.12$
- Parameters do not change (within errors with the two HERA measurements)

ZEUS fits


ZEUS 1995
F_2
$Q^2 = 0.60$ GeV^2
$Q^2 = 0.90$ GeV^2
$Q^2 = 1.30$ GeV^2
$Q^2 = 1.90$ GeV^2
$Q^2 = 2.50$ GeV^2
$Q^2 = 3.50$ GeV^2
$Q^2 = 4.50$ GeV^2
$Q^2 = 6.00$ GeV^2
$Q^2 = 7.50$ GeV^2
$Q^2 = 9.00$ GeV^2
$Q^2 = 12.00$ GeV^2
$Q^2 = 17.00$ GeV^2
x
ZEUS SVX95
ZEUS BPC95
ZEUS94
E665
H1 SVX95
DL
ZEUSQCD

Current status

- N.B.: the χ^2 scan to a combined fit of type $g_1^p(Q^2, x) = x^{-\alpha_\mathbb{R}} \cdot \beta$ had yielded $\alpha_\mathbb{R} = 0.31 \pm 0.14$ [https://compassvm03.cern.ch/elog/Low_x_low_Q2/39]

- Started to fit models of the same type of ZEUS to the $g_1^p(x, \nu)$ from COMPASS

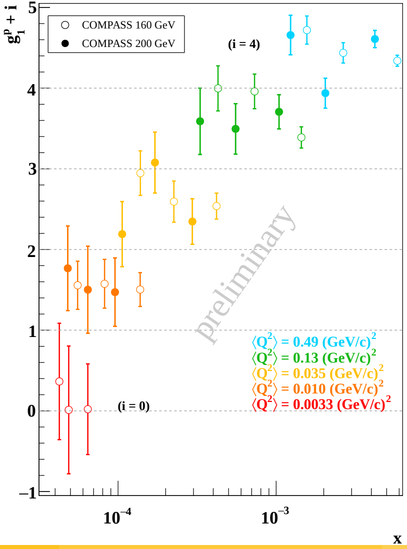
- Fit of type 2: $g_1^p(W^2) = A_\mathbb{R}(W^2)^{\alpha_\mathbb{R}} + A_\mathbb{P}(W^2)^{\alpha_\mathbb{P}}$
  - $\alpha_\mathbb{R}$ fixed at 0.5
  - $A_\mathbb{R} = -12.358 \pm 0.044$
  - $A_\mathbb{P} = 0.9978 \pm 0.0032$
  - $\alpha_\mathbb{P} = 1.03483 \pm 0.00016$
  - $\chi^2/ndf = 174/(210 - 24 * 3) \simeq 1.26$ (Prob=2.0%)

- Fit of type 3: $g_1^p(W^2, Q^2) = \left(\frac{M_0^2}{M_0^2 + Q^2}\right)\left[A_\mathbb{R}(W^2)^{\alpha_\mathbb{R}} + A_\mathbb{P}(W^2)^{\alpha_\mathbb{P}}\right]$
  - $\alpha_\mathbb{R}$ fixed at 0.5
  - $A_\mathbb{R} = -11.3 \pm 0.1$
  - $A_\mathbb{P} = 1.421 \pm 0.013$
  - $\alpha_\mathbb{P} = 1.0020 \pm 0.0006$
  - $\chi^2/ndf = 183/(210 - 24 * 3) \simeq 1.32$ (Prob=0.65%)

- Work ongoing

BACKUP

g_1^p in bins of Q^2 and x



Regge fits to $g_1^p(Q^2, x)$

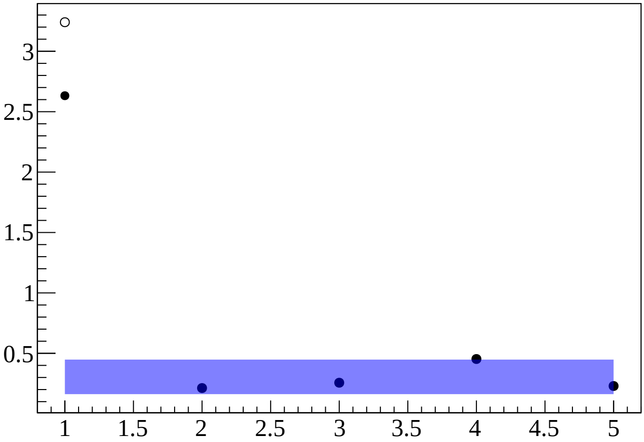
fit function: $g_1^p(Q^2, x) = x^{\alpha} \cdot \beta(Q^2)$

Q^2 bin	χ^2 (ndf=4)	α	$\delta\alpha$	β	$\delta\beta$
1	2.04721	$-2.63223 \cdot 10^{+0}$	$1.50840 \cdot 10^{+0}$	$1.07052 \cdot 10^{-12}$	$1.83932 \cdot 10^{-11}$
2	0.153038	$-2.11852 \cdot 10^{-1}$	$6.04754 \cdot 10^{-1}$	$7.49732 \cdot 10^{-2}$	$4.25486 \cdot 10^{-1}$
3	4.59496	$-2.56519 \cdot 10^{-1}$	$3.26944 \cdot 10^{-1}$	$7.15864 \cdot 10^{-2}$	$1.96088 \cdot 10^{-1}$
4	4.63522	$-4.52824 \cdot 10^{-1}$	$2.46074 \cdot 10^{-1}$	$2.56648 \cdot 10^{-2}$	$4.58531 \cdot 10^{-2}$
5	14.1419	$-2.29338 \cdot 10^{-1}$	$2.08887 \cdot 10^{-1}$	$1.17238 \cdot 10^{-1}$	$1.39249 \cdot 10^{-1}$

fit function: $g_1^p(Q^2, x) = x^{-\alpha} \cdot \beta(Q^2)$

Q^2 bin	χ^2 (ndf=4)	α	$\delta\alpha$	β	$\delta\beta$
1	2.03244	$3.24061 \cdot 10^{+0}$	$1.10475 \cdot 10^{+0}$	$2.49855 \cdot 10^{-15}$	$3.00028 \cdot 10^{-14}$
2	0.153039	$2.12433 \cdot 10^{-1}$	$7.80963 \cdot 10^{-1}$	$7.45638 \cdot 10^{-2}$	$5.46468 \cdot 10^{-1}$
3	4.59496	$2.56530 \cdot 10^{-1}$	$3.90718 \cdot 10^{-1}$	$7.15798 \cdot 10^{-2}$	$2.34315 \cdot 10^{-1}$
4	4.63522	$4.52837 \cdot 10^{-1}$	$2.64183 \cdot 10^{-1}$	$2.56623 \cdot 10^{-2}$	$4.89501 \cdot 10^{-2}$
5	14.1419	$2.29363 \cdot 10^{-1}$	$2.25731 \cdot 10^{-1}$	$1.17223 \cdot 10^{-1}$	$1.50459 \cdot 10^{-1}$

Values of α per bin



χ^2 scan to a combined fit of type $g_1^p(Q^2, x) = x^{-\alpha_0} \cdot \beta$