DIS 97
CHICAGO

SUMMARY : WG 1

HADRON STRUCTURE

THEORY

J. BLÜMLEIN

DESY

1) PARTON PARAMETRIZATIONS, HEAVY FLAVOUR

2) STRUCTURE FUNCTIONS AT SMALL x

3) α_s IN DIS

4) THE HIGH Q^2 HERA EVENTS :
   PHENOMENOLOGICAL ASPECTS

17 TALKS

1. PARTON PARAMETRIZATIONS, HEAVY FLAVOUR

LAI (CTEQ) RECENT GLOBAL ANALYSIS BY CTEQ

R.G. ROBERTS → PLENARY TALK

- NEW TREATMENT OF HEAVY FLAVOR
  - CTEQ : ACOT SCHEME
  - MRRS

FIGS

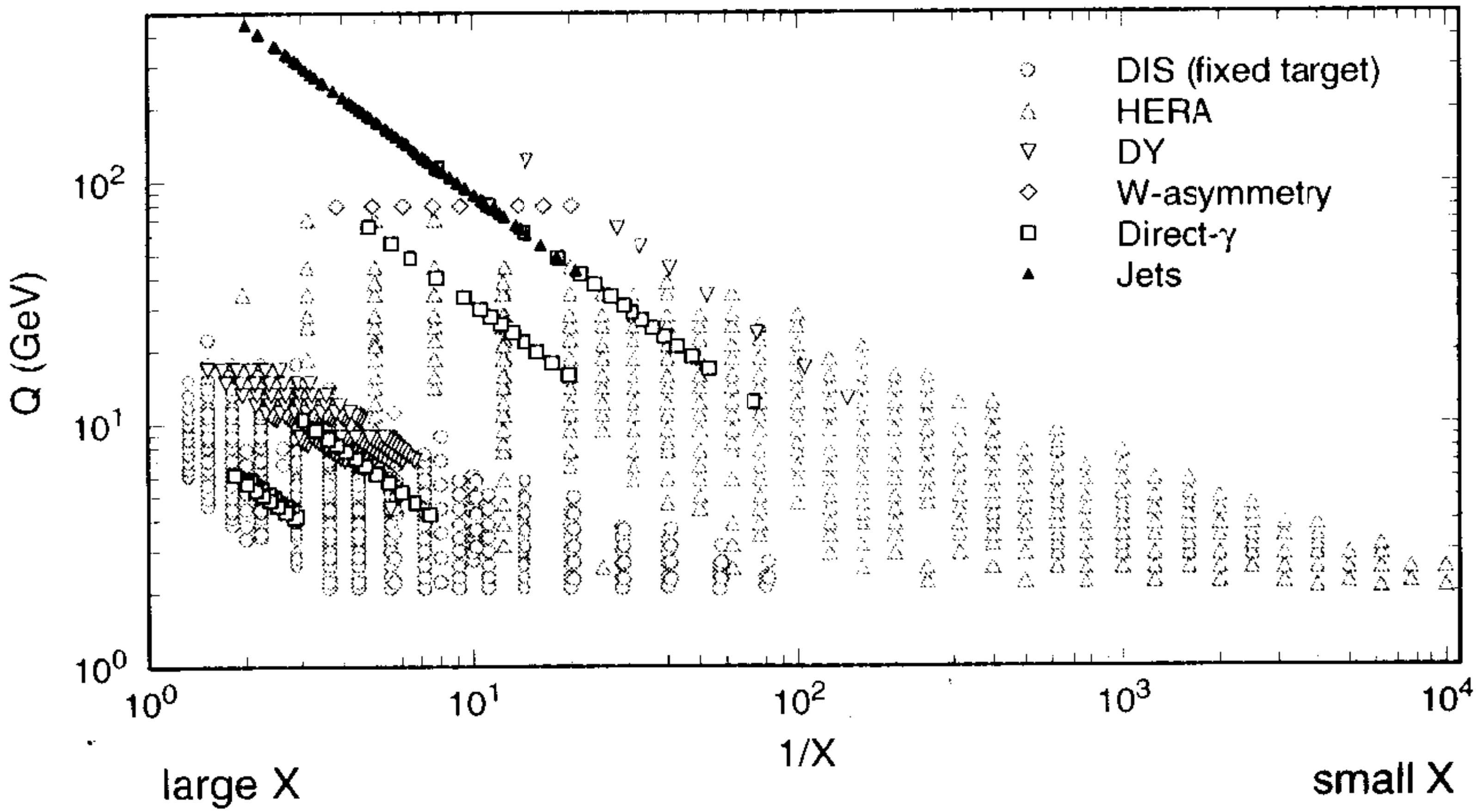
— SIGNIFICANT HF CONTRIBUTION @ SMALL x

— STILL LARGER STRANGE SEE PREFERED

— NLO RESULTS WILL BE IMPLEMENTED IN FUTURE

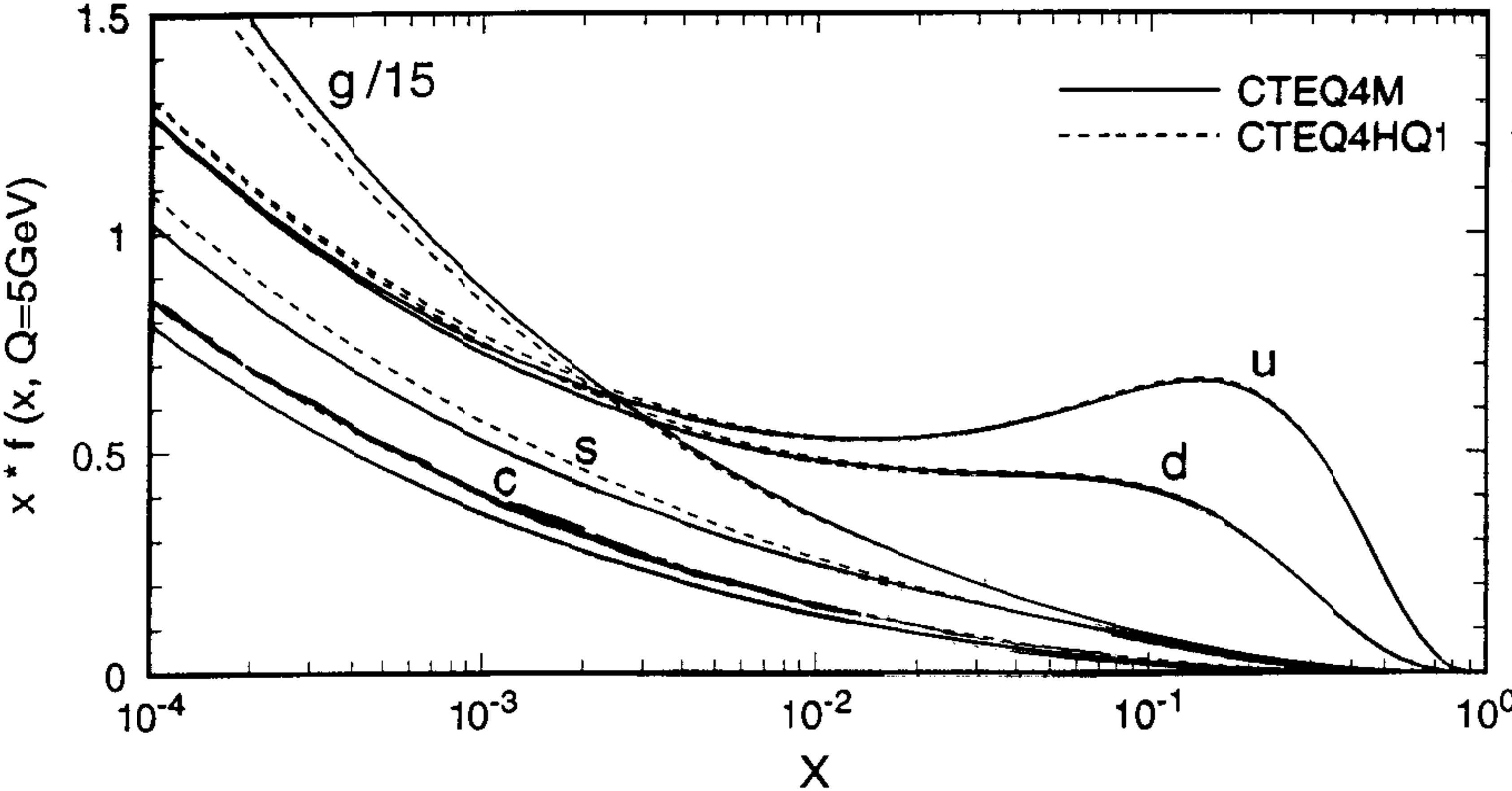
Experimental Input

Distribution of data points on X-Q kinematic map



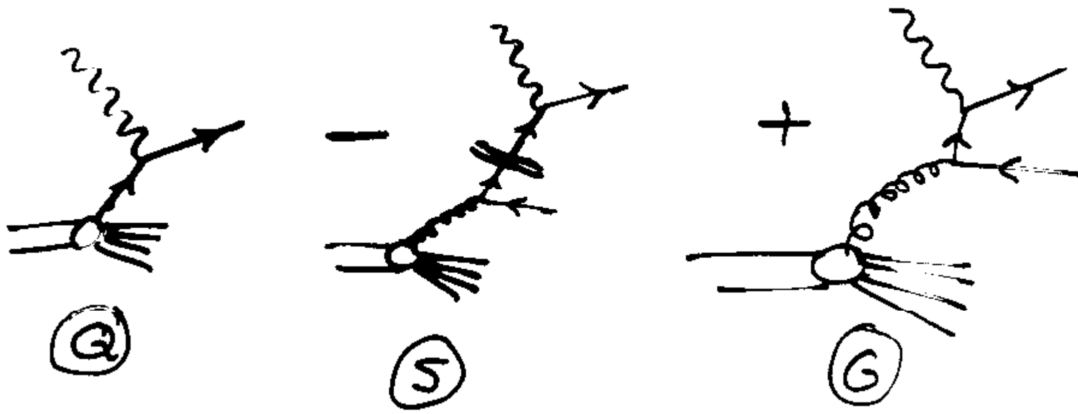
LAi

Change in PDFs due to different treatment of M_c



ACOT SCHEME

C. SCHMIDT - 1
F. OLNESS



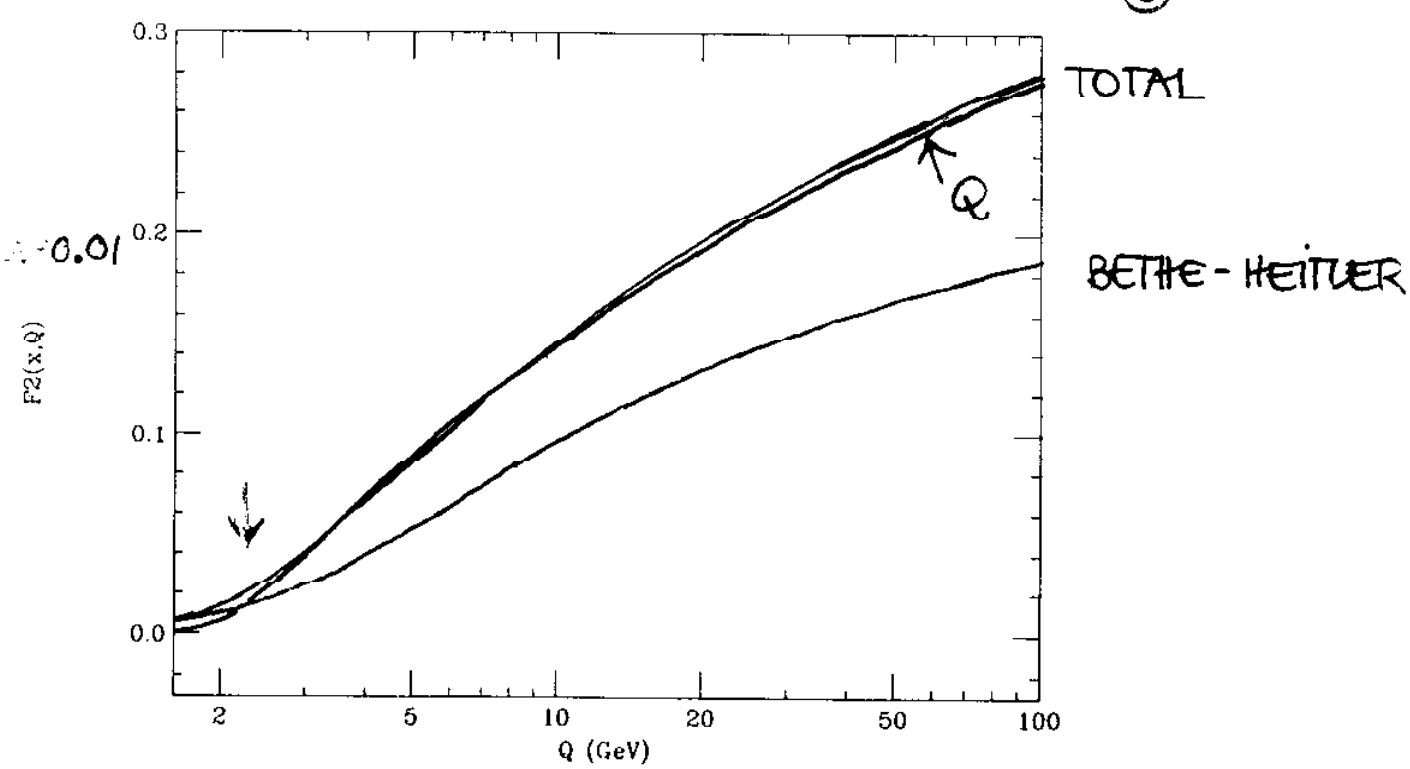
OLNESS, TUNG, '80ie

Near threshold Q + S cancel $\Longrightarrow$ Agrees with FFN

At Large Q^2 G + S cancel $\Longrightarrow$ Agrees with zero-mas

LEADING ORDER

— total
— Q
— G



- VARIOUS CALCULATIONS OF HEAVY FLAVOR EFFECTS IN DIS AVAILABLE AND IN PROGRESS
  - MRRS (LO)
  - TUNG et al.
  - VAN NEERVEN, SMITH et al. (NLO)

$\longrightarrow$ DIFFERENT SCHEMES !

INTERESTING QUESTION IN FUTURE ANALYSIS :
COMPARISON OF DIFFERENT NLO RESULTS $\leftrightarrow$ DATA.

D. HAIDT EFFECTIVE $F_2(x, Q^2)$ PARAMETRIZATION @ LOW X

$$F_2(x, Q^2) = m \log\left(\frac{x_0}{x}\right) \log\left(1 + \frac{Q^2}{Q_0^2}\right)$$

$m = 0.455 \quad x = 0.04 \quad Q_0^2 = 0.55\ \mathrm{GeV}^2$

- NO INDICATION OF A POWERLIKE RISE @ SMAL X !

⟶ DESCRIBES F_2, PERTURBATIVE AND NON-PERTURBATIVE CONTRIBUTIONS ARE NOT SEPARATED.

$\boxed{F_2(x, Q^2) \text{ AND } F_L(x, Q^2) \text{ @ LOW } Q^2}$ B. BADELEK

$Q^2 \to 0$

$F_2 \propto Q^2 \qquad F_L = \left(1 + \frac{4M^2x^2}{Q^2}\right) F_2 - 2x F_1 \propto Q^4$

$$F_2(x, Q^2) = Q^2 \int_0^\infty dQ'^2 \frac{\phi(Q'^2, x)}{(Q'^2 + Q^2)^2}$$

$$\phi(Q^2, x) = \sum_r c_r \delta(Q^2 - M_r^2) + \theta(Q^2 - Q_0^2)\, \phi_c(Q^2, x)$$

$$c_r = \frac{M_r^4}{4\pi \gamma_r^2} \sigma_{rp}$$

↑ "VDM"

- PRESENT PARAMETRIZATION DOES NOT FIT THE LOW Q^2 DATA OF H1 EXACTLY YET

A. MEYER

→ ROOM FOR IMPROVEMENT

DIFFICULT TASK TO INCORPORATE ALL RELEVANT RESONANCES ! CF. E.G. TIMELIKE CASE:

$\sigma(e^+e^- \longrightarrow \text{hadrons})$

F. JEGERLEHNER.

2. STRUCTURE FUNCTIONS AT SMALL X

- UNIFIED BFKL + GLAP DESCRIPTION OF DIS — KWIECINSKI, MARTIN, STASTO

$$F_2(x,Q^2) = \int_x^1 \frac{dz}{z} \int_{\underline{0}}^{k_{\perp,max}^2} \frac{dk_\perp^2}{k_\perp^2}\; F_2^{\gamma g}(z, k_\perp^2, Q^2)\, f\left(\frac{x}{z}, k_\perp^2\right)$$

- FORMER AKMS APPROACHES (1993, 94): CUT-OFF IN THE INFRARED REGION (INITIAL STATE)

- DIFFERENT SOLUTION: JB, J. PHYS. G19 (1993) 1623

  - THE UNINTEGRATED GLUON DENSITY $f(z, k_\perp^2)$ CAN BE RELATED TO $G(z, k_0^2)$ WITH k_0^2 IN THE PERTURBATIVE RANGE.
    F_2 DEPENDS ONLY THROUGH $O((k_0^2/Q^2)^n)$ OF $k_0^2 \longleftrightarrow$ NO 'CUT OFF' DEPENDENCE, IFF $Q^2 \gg k_0^2$.

THIS PRESCRIPTION IS APPLIED.

SIMILAR SOLUTION:
$c\bar{c}$: COLLINS, ELLIS '9

- MODIFY ALSO BFKL KERNEL BY LO P_{gg}.

$$\int_0^{k^2_{\perp,max}} F_2^{\gamma g}(z,k_\perp^2,Q^2)\, f\left(\frac{x}{z},k_\perp^2\right)\frac{dk_\perp^2}{k_\perp^2}$$

$$= F_2(z,0,Q^2)\,\frac{x}{z}\, g\left(\frac{x}{z},k_0^2\right)$$

$$+ \int_{k_0^2}^{k^2_{\perp max}} dk_\perp^2\, \frac{1}{k_\perp^2}\, F_2^{\gamma g}(z,k_\perp^2,Q^2)\, f\left(\frac{x}{z},k_\perp^2\right) + O\left(\frac{k_0^2}{Q^2}\right)$$

MODIFIED UNINTEGRATED GLUON DENSITY:

$$f(x,k^2) = \tilde{f}^{(0)}(x,k^2) + \bar{\alpha}_s(k^2)\Big[k^2\, L[f,k_0^2]$$

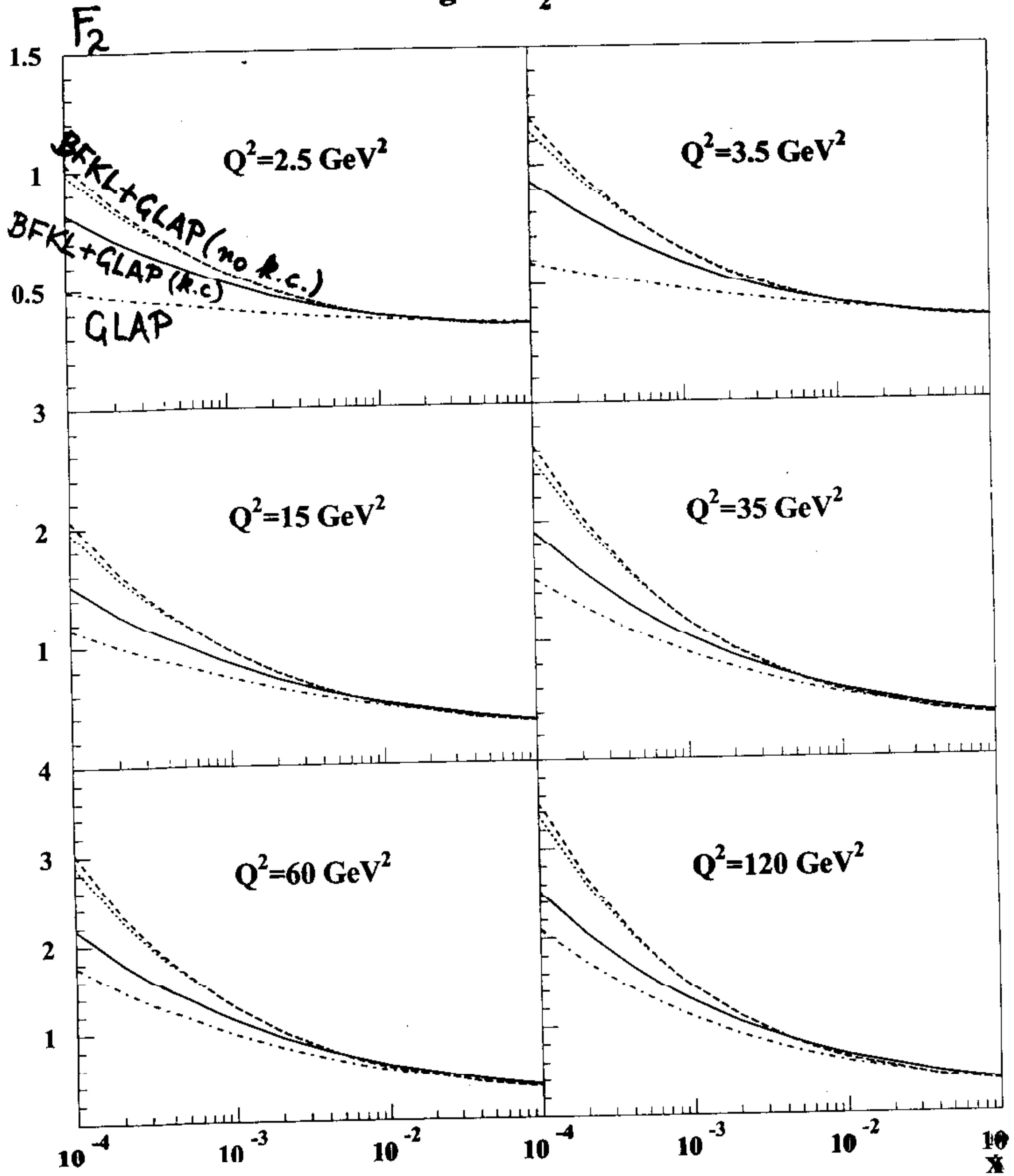
$$+ \left(\frac{x}{6} P_{gg}(x) - 1\right) \otimes \int_{k_0^2}^{k^2} \frac{dk'^2}{k'^2} f(x,k'^2)$$

$$+ \frac{\alpha_s(k^2)}{2\pi}\int_x^1 dz\, P_{gq}(z)\, \Sigma\left(\frac{x}{z},k^2\right)$$

L - BFKL KERNEL WITH LOWER CUT-OFF
& KIN CONSTRAINT

$$\tilde{f}^{(0)}(x,k^2) = f^{(0)}(x,k^2) + \frac{\alpha_s(k^2)}{2\pi}\int_x^1 dz\, P_{gg}(z)\,\frac{x}{z}\, g\left(\frac{x}{z},k_0^2\right).$$

Fig.5.: $F_2^{p(l)}$ vs x



------ BFKL+GLAP (without kin. constraint)

.... GLAP(g) + full k_T-fac (q)

—— BFKL+GLAP (with kin. constraint)

-·-·-· GLAP

SCHEME – INDEPENDENT EVOLUTION EQUS. (FACTORIZATION) R. THORNE

SINGLET CASE:

$$\frac{d}{d\log Q^2}\begin{pmatrix} F_2^S(N,Q^2) \\ \hat{F}_L^S(N,Q^2) \end{pmatrix} = \mathbb{\Gamma}(N,\alpha_S) \begin{pmatrix} F_2^S(N,Q^2) \\ \hat{F}_L^S(N,Q^2) \end{pmatrix}$$

$$\hat{F}_L = F_L \,/\, (\alpha_S/2\pi)$$

~ CATANI '95

$$\mathbb{\Gamma} = \begin{pmatrix} \Gamma_{22} & \Gamma_{2L} \\ \Gamma_{L2} & \Gamma_{LL} \end{pmatrix}$$

CORRESPONDENCE TO PDF's:

$$F_2^S = C_2^S \cdot \Sigma + C_2^g \cdot G$$

$$F_L^S = C_L^S \cdot \Sigma + C_L^g \cdot G$$

USE: $\frac{d}{d\log}\begin{pmatrix}\Sigma \\ G\end{pmatrix} = \mathbb{P} \cdot \begin{pmatrix}\Sigma \\ G\end{pmatrix}$

EXPRESS : $(\Sigma, G) \rightarrow (F_2^S, F_L^S)$

- ACCOUNT FOR RESUMMED TERMS IN $\mathbb{\Gamma}$ AT SMALL X

QCD ANALYSIS: FIT TO $F_2(x,Q_0^2)$, $F_L(x,Q_0^2)$

ASSUMING A PERTURBATIVE LEVEL FOR $\mathbb{\Gamma}$

F

Table 1

Comparison of quality of fits using the full leading–order (including leading–ln$(1/x)$ terms) renormalization–scheme–consistent expression, **LO(x)**, and the two–loop fits $\mathbf{MRSR_1}$, $\mathbf{MRSR_2}$, $\mathbf{NLO_1}$ **and** $\mathbf{NLO_2}$. For the LO(x) fit the H1 **data** chooses a normalization of **1.00**, **the ZEUS data of 1.015**, and the BCDMS data of 0.975. **The** CCFR data is fixed **at a** normalization of 0.95, **and the rest** is **fixed** at 1.00. Similarly, for the $\mathrm{NLO_1}$ fit the H1 data is fixed at a normalization of 0.985, the ZEUS chooses a normalization of 0.99, and the BCDMS data of 0.975. Again the CCFR data is fixed at a normalization of 0.95, and the rest fixed at 1.00. Also, for the $\mathrm{NLO_2}$ fit the H1 data is fixed at a normalization of 0.985, the ZEUS chooses a normalization of 0.985, and the BCDMS data of 0.97. Again the CCFR data is fixed at a normalization of 0.95, and the rest fixed at 1.00. In the $\mathrm{R_1}$ and $\mathrm{R_2}$ fits the BCDMS data has a fixed normalization of 0.98, the CCFR data of 0.95 and the rest of 1.00.

Experiment	data	χ^2				
	points	LO(x)	$\mathrm{NLO_1}$	$\mathrm{NLO_2}$	$\mathrm{R_1}$	$\mathrm{R_2}$
H1 $\mathcal{F}_2^{ep}$	193	123	145	145	158	149
ZEUS $\mathcal{F}_2^{ep}$	204	253	281	296	326	308
BCDMS $\mathcal{F}_2^{\mu p}$	174	181	218	192	265	320
NMC $\mathcal{F}_2^{\mu p}$	129	122	131	148	163	135
NMC $\mathcal{F}_2^{\mu d}$	129	114	107	125	134	99
NMC $\mathcal{F}_2^{\mu n}/\mathcal{F}_2^{\mu p}$	85	142	137	138	136	132
E665 $\mathcal{F}_2^{\mu p}$	53	63	63	63	62	63
CCFR $\mathcal{F}_2^{\nu N}$	66	59	48	40	41	56
CCFR $\mathcal{F}_2^{\bar\nu N}$	66	48	39	36	51	47
	1099	1105	1169	1184		

Table 2

Comparison of quality of fits using the full leading–order (including leading–ln$(1/x)$ terms) renormalization–scheme–consistent expression, LO(x), and the two–loop fits $\mathrm{NLO_1}$ and $\mathrm{NLO_2}$. The fits are identical to above, but the data are presented in terms of whether x is less than 0.1 or not.

	data	χ^2		
	points	LO(x)	$\mathrm{NLO_1}$	$\mathrm{NLO_2}$
$x \geq 0.1$	551	622	615	595
$x < 0.1$	548	483	554	589
total	1099	1105	1169	1184

EVOLUTION OF F_2^p, F_L^p, F_2^γ AT SMALL x

JB, A. VOGT

- DIS SCHEME, COLL. FACTORIZATION
- NLO, LDx, NLx

$\longrightarrow$ SUBLEADING TERMS (e.g. $N_f = 4$)

$$\gamma_{qq,1} = -\frac{123.3}{N} + 405.9$$

$$\gamma_{qg,1} = -\frac{277.3}{N} + 846.2 \qquad \text{NLO}$$

$$\gamma_{gq,1} = \frac{91.3}{N} - 453.5$$

$$\gamma_{gg,1} = \frac{245.3}{N} - 988.3$$

MODEL:

A: $\gamma_{ij} \to \gamma_{ij} - \delta_{ij}\, \gamma_{ij}(1, a_s)$.

B: $\gamma_{ij} \to \gamma_{ij}\,(1-N)$

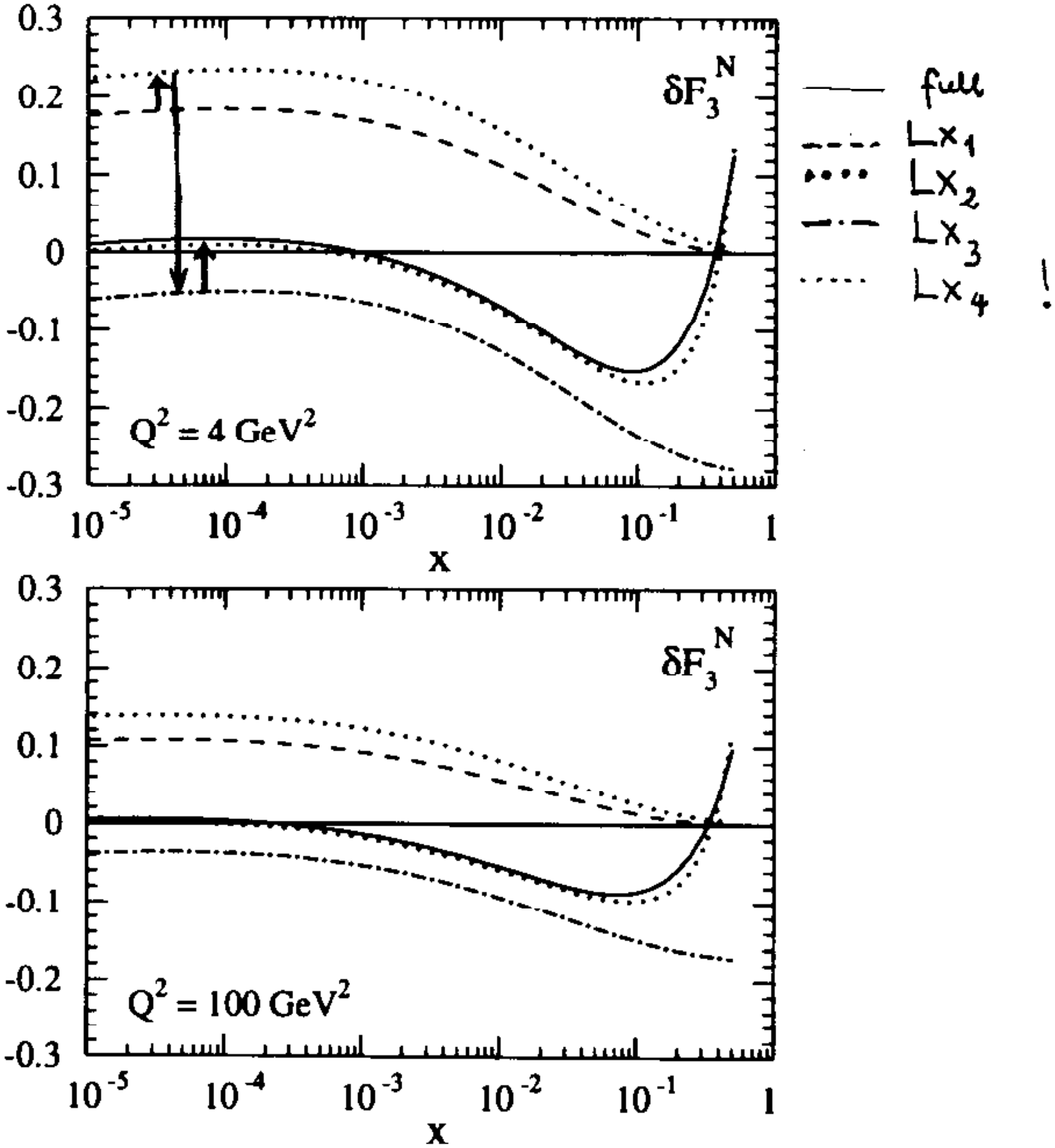
C: $\gamma_{ij} \to \gamma_{ij}\,(1-N)^2$

D: $\gamma_{ij} \to \gamma_{ij}\,(1-2N+N^3)$.

AN EXAMPLE IN NLO:

JB, A.VOG

$$\delta F_3^{NLO} = \frac{a_s \cdot C_3 \otimes x(u_v + d_v)}{x(u_v + d_v)}$$



$Lx_1 = Lx$

$Lx_2 = Lx + NLx$

$Lx_3 = Lx + NLx + NNLx$

$\vdots$

CAMICI
CIAFALONI 96

$$\gamma_{gg,\mathrm{NL}}^{q\bar{q},Q_0} = -\alpha_s \frac{\chi_1^{(\mathrm{a})}(\gamma_L) + \chi_1^{(\mathrm{na})}(\gamma_L)}{\chi'(\gamma_L)} - \frac{C_F}{C_A}\gamma_{gg,\mathrm{NL}}^{Q_0} .$$

$$\begin{aligned}
\alpha_s\chi_1^{(\mathrm{a})}(\gamma_L) &= \frac{2}{\gamma_L^2}\frac{C_F}{C_A}\gamma_{qg,\mathrm{NL}}^{Q_0}(\gamma_L)\\
\alpha_s\chi_1^{(\mathrm{na})}(\gamma_L) &= \frac{\alpha_s N_f}{6\pi}\left\{\frac{1}{2}\left[\chi'(\gamma_L) + \chi^2(\gamma_L)\right] - \frac{5}{3}\chi(\gamma_L)\right\} - \frac{1}{\gamma_L^2}\frac{C_F}{C_A}\gamma_{qg,\mathrm{NL}}^{Q_0}(\gamma_L) .
\end{aligned}$$

$$\begin{aligned}
\gamma_{gg,\mathrm{NL}}^{q\bar{q},Q_0} = & -\frac{N_f\alpha_s}{6\pi}\left\{1 + \frac{23}{6}\frac{\overline{\alpha}_s}{N} + \left[\frac{71}{18} - \frac{\pi^2}{6}\right]\left(\frac{\overline{\alpha}_s}{N}\right)^2 + \left[\frac{233}{27} - \frac{13}{36}\pi^2 - 8\zeta(3)\frac{C_F}{\underline{C_A}}\right]\left(\frac{\overline{\alpha}_s}{N}\right)^3\right.\\
& + \left[\frac{1276}{81} - \frac{71}{108}\pi^2 + \frac{79}{3}\zeta(3) - \frac{7}{120}\pi^4 - \frac{52}{3}\zeta(3)\frac{C_F}{C_A}\right]\left(\frac{\overline{\alpha}_s}{N}\right)^4 \quad \uparrow\,!\\
& + \left[\left(\frac{8384}{243} - \frac{233}{162}\pi^2 + \frac{284}{9}\zeta(3) - \frac{91}{720}\pi^4 + 2\zeta(5) - \frac{4}{3}\zeta(3)\pi^2\right)\right.\\
& \left. + \left(\frac{4}{3}\zeta(3)\pi^2 - \frac{284}{9}\zeta(3) - 16\zeta(5)\right)\frac{C_F}{C_A}\right]\left(\frac{\overline{\alpha}_s}{N}\right)^5\\
& + \left[\left(\frac{45928}{729} - \frac{638}{243}\pi^2 - \frac{65}{18}\zeta(3)\pi^2 - 2\zeta(3)^2 - \frac{497}{2160}\pi^4 + \frac{125}{3}\zeta(5) + \frac{2330}{27}\zeta(3)\right.\right.\\
& \left.\left. - \frac{31}{3024}\pi^6\right) + \left(\frac{26}{9}\pi^2\zeta(3) - \frac{104}{3}\zeta(5) - \frac{1864}{27}\zeta(3) - 80\zeta(3)^2\right)\frac{C_F}{C_A}\right]\left(\frac{\alpha_s}{N}\right)^6\\
& \left. + O\left(\frac{\overline{\alpha}_s}{N}\right)^7\right\} .
\end{aligned}$$

In the DIS–$\overline{\mathrm{MS}}$ scheme $\gamma_{gg,\mathrm{NL}}^{q\bar{q}}$ is given by, cf. [15],

$$\begin{aligned}
\gamma_{gg,\mathrm{NL}}^{q\bar{q},\mathrm{DIS}} &= \gamma_{gg,\mathrm{NL}}^{q\bar{q},Q_0} + \beta_0\alpha_s^2\frac{d\ln R(\alpha_s)}{d\alpha_s} + \frac{C_F}{C_A}\left[1 - R(\alpha_s)\right]\gamma_{gg,\mathrm{NL}}^{Q_0}\\
&\equiv \alpha_s\sum_{k=1}^{\infty}\left[\frac{N_f}{6\pi}\left(\underline{d_{gg,k}^{q\bar{q},(1)}} + \frac{C_F}{C_A}\underline{d_{gg,k}^{q\bar{q},(2)}}\right) + \frac{\beta_0}{4\pi}\underline{\hat{r}_k}\right]\left(\frac{\overline{\alpha}_s}{N}\right)^{k-1} .
\end{aligned}$$

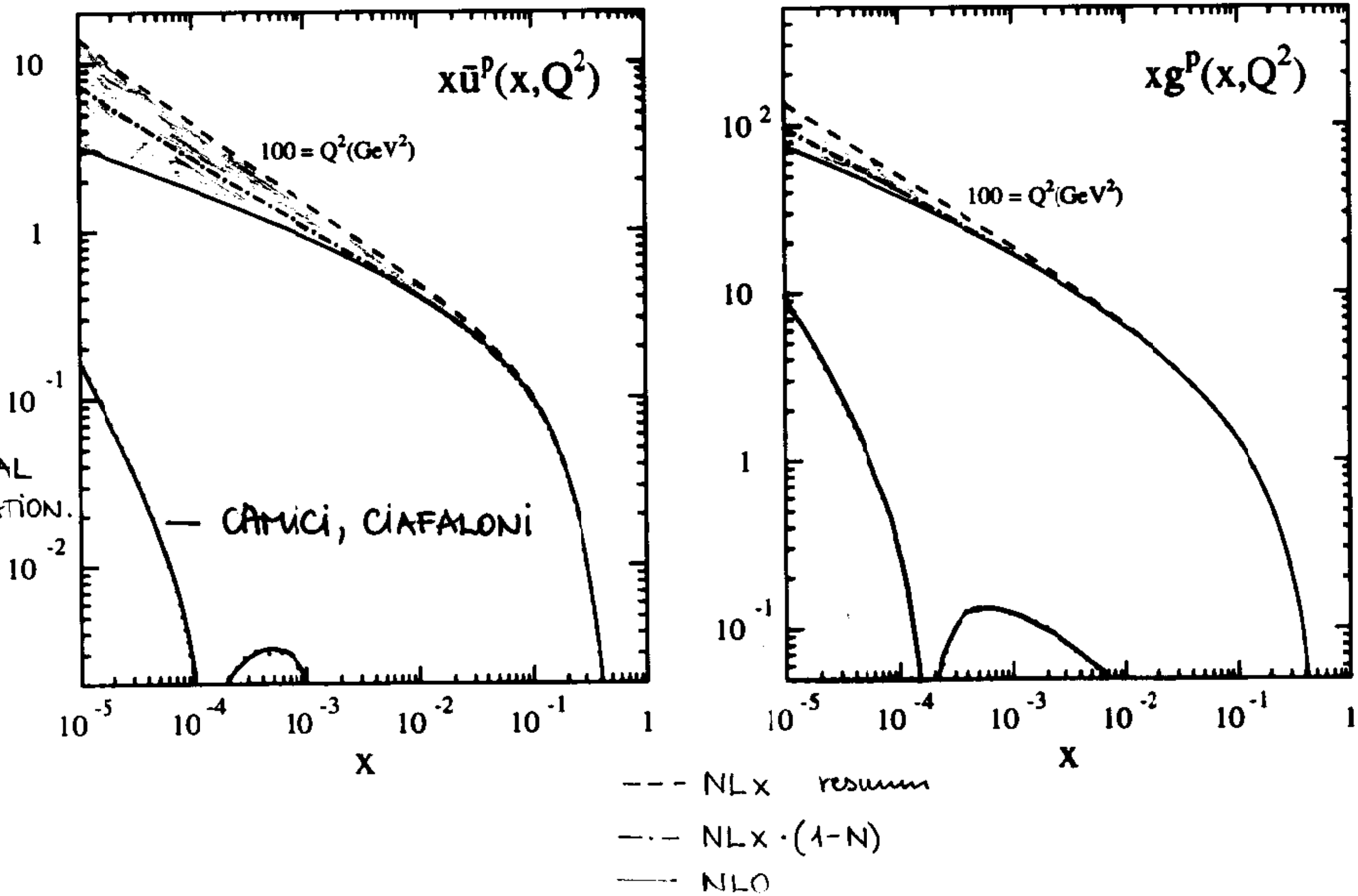
$\uparrow$ DIS.

F_L:

$$\begin{aligned}
C_L^g &= \frac{\alpha_s}{3\pi}T_F h_L(\gamma_L)R(\gamma_L) = \frac{2\alpha_s}{3\pi}T_F\sum_{k=1}^{\infty}c_k^L\left(\frac{\overline{\alpha}_s}{N}\right)^k ,\\
C_L^q &= \frac{C_F}{C_A}\left[C_L^g - \frac{2\alpha_s}{3\pi}T_F\right] ,
\end{aligned}$$

$$h_L(\gamma) = \left(\frac{1-\gamma}{3-2\gamma}\right)\frac{\left[B(1-\gamma, 1+\gamma)\right]^3}{B(2-2\gamma, 2+2\gamma)} .$$

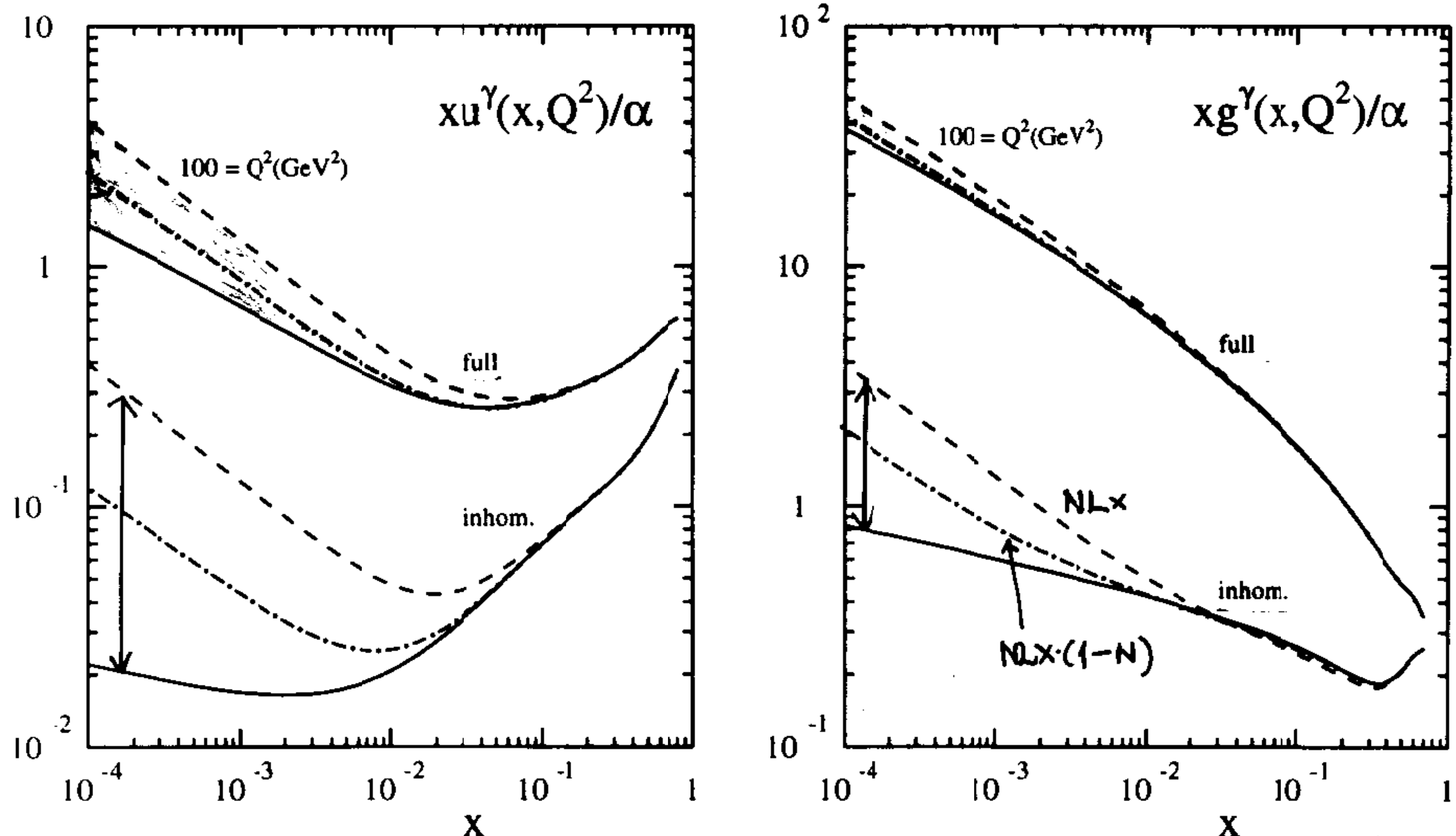
JB, A.VOGT



ↄ
SSENTIAL
ODIFICATION.

PHOTON STRUCTURE FUNCTIONS

JB, A.VOGT



$Q_0^2 = 4$ GeV

GRV_γ ; DIS

- HADRONIC PART DOMINATES
- UP TO NLx THE INHOMOGENEITY DOES RECEIVE RESUMMED CONTRIBUTIONS IN THE DIS-x SCHEME.

3. α_s IN DIS

(WITH WG 3)

T. VAN RITBERGEN,
S. LARIN, J. VERMASEREN

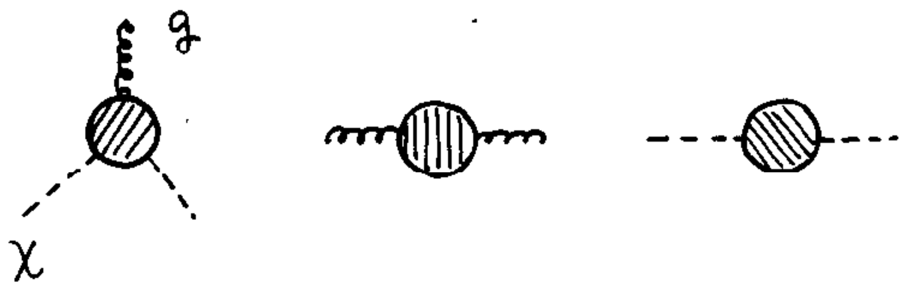
β_{QCD} IN $O(\alpha_s^4)$

$\int_0^1 dx\, g_1^{p,n}(x,Q^2)$ IN $O(\alpha_s^3)$

(RECENTLY ALSO: NS & S MOMENTS $O(\alpha_s^3)$, γ_m $O(\alpha_s^4)$

$\longrightarrow$ CRUCIAL STEPS ON THE WAY TO TEST QCD AT HIGH PRECISION $\longleftarrow$

$$\beta: \qquad g_0 = \frac{\tilde{Z}_1}{\tilde{Z}_3} \frac{1}{\sqrt{Z_3}}\, g$$



30.834 18.794 2.334 DIAGRAMS

(OPTIMAL CHOIC

$V_{ggg} \sim$ 150 000
diagrams
$V_{gggg} \sim$ 500 000

The Result:

$$\frac{\partial a_s}{\partial \ln \mu^2} \equiv \beta(a_s) = -\beta_0 a_s^2 - \beta_1 a_s^3 - \beta_2 a_s^4 - \beta_3 a_s^5 + O(a_s^6),$$

$$\begin{aligned}
\beta_0 &= \frac{11}{3}C_A - \frac{4}{3}T_F n_f \\
\beta_1 &= \frac{34}{3}C_A^2 - 4C_F T_F n_f - \frac{20}{3}C_A T_F n_f \\
\beta_2 &= \frac{2857}{54}C_A^3 + 2C_F^2 T_F n_f - \frac{205}{9}C_F C_A T_F n_f \\
&\quad -\frac{1415}{27}C_A^2 T_F n_f + \frac{44}{9}C_F T_F^2 n_f^2 + \frac{158}{27}C_A T_F^2 n_f^2 \\
\beta_3 &= C_A^4\left(\frac{150653}{486} - \frac{44}{9}\zeta_3\right) + C_A^3 T_F n_f\left(-\frac{39143}{81} + \frac{136}{3}\zeta_3\right) \\
&\quad +C_A^2 C_F T_F n_f\left(\frac{7073}{243} - \frac{656}{9}\zeta_3\right) + C_A C_F^2 T_F n_f\left(-\frac{4204}{27} + \frac{352}{9}\zeta_3\right) \\
&\quad +46 C_F^3 T_F n_f + C_A^2 T_F^2 n_f^2\left(\frac{7930}{81} + \frac{224}{9}\zeta_3\right) + C_F^2 T_F^2 n_f^2\left(\frac{1352}{27} - \frac{704}{9}\zeta_3\right) \\
&\quad +C_A C_F T_F^2 n_f^2\left(\frac{17152}{243} + \frac{448}{9}\zeta_3\right) + \frac{424}{243}C_A T_F^3 n_f^3 + \frac{1232}{243}C_F T_F^3 n_f^3 \\
&\quad +\frac{d_A^{abcd} d_A^{abcd}}{N_A}\left(-\frac{80}{9} + \frac{704}{3}\zeta_3\right) + n_f \frac{d_F^{abcd} d_A^{abcd}}{N_A}\left(\frac{512}{9} - \frac{1664}{3}\zeta_3\right) \\
&\quad +n_f^2 \frac{d_F^{abcd} d_F^{abcd}}{N_A}\left(-\frac{704}{9} + \frac{512}{3}\zeta_3\right)
\end{aligned}$$

with:

$$\begin{aligned}
d_F^{abcd} &= \frac{1}{6}\mathrm{Tr}\left[T^a T^b T^c T^d + T^a T^b T^d T^c + T^a T^c T^b T^d \right. \\
&\qquad \left. +T^a T^c T^d T^b + T^a T^d T^b T^c + T^a T^d T^c T^b\right] \\
d_A^{abcd} &= \frac{1}{6}\mathrm{Tr}\left[C^a C^b C^c C^d + C^a C^b C^d C^c + C^a C^c C^b C^d \right. \\
&\qquad \left. +C^a C^c C^d C^b + C^a C^d C^b C^c + C^a C^d C^c C^b\right]
\end{aligned}$$

$$T^a T^b - T^b T^a = i f^{abc} T^c$$

$$[C^a]_{bc} \equiv -i f^{abc}$$

Results:

for $n_f = 3$ we find

$$\int_0^1 dx g_1^{p(n)} = \left[1 - \left(\frac{\alpha_s}{\pi}\right) - 3.583\left(\frac{\alpha_s}{\pi}\right)^2 - 20.215\left(\frac{\alpha_s}{\pi}\right)^3\right]\left(\pm\frac{1}{12}|g_A| + \frac{1}{36}a_8\right)$$
$$+ \left[1 - 0.333\left(\frac{\alpha_s}{\pi}\right) - 0.550\left(\frac{\alpha_s}{\pi}\right)^2 - 4.447\left(\frac{\alpha_s}{\pi}\right)^3\right]\frac{1}{9}\hat{a}_0$$

for $n_f = 4, 5, 6$:

n_f	non-singlet		singlet	
	$(\alpha_s/\pi)^2$	$(\alpha_s/\pi)^3$	$(\alpha_s/\pi)^2$	$(\alpha_s/\pi)^3$
3	-3.58333	-20.21527	-0.54959	-4.44725
4	-3.25000	-13.85026	1.08153	4.87423
5	-2.91667	-7.84019	2.97845	13.07103
6	-2.58333	-2.18506	5.27932	20.73034

Table 1. Second and third-order coefficients for the Ellis-Jaffe sum rule.

CAN ONE FIND β_3 EXTRAPOLATING BY A PADE APPROXIMATION ?   J. ELLIS et al. '96

$$\frac{\beta_3}{\beta_3^{PADE}} = 0.627 \quad , \quad 2.174, \quad 8.978$$

$$N_f = 3, \quad 4, \quad 5$$

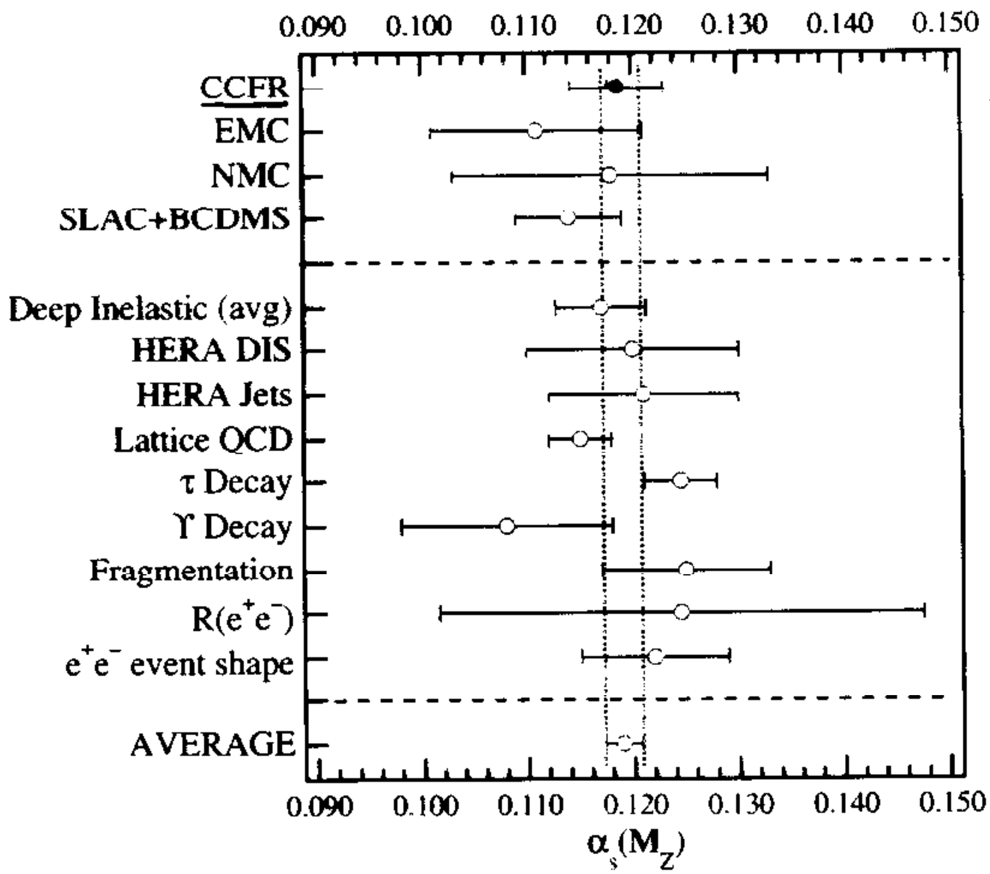
NEW CASIMIR OPERATORS !

CCFR "Global Systematic" QCD fit Results

$$\Lambda_{\overline{MS}}^{(4),NLO} = 337 \pm 28(\text{stat.} + \text{syst.}) \pm 13(\text{HT})MeV$$

$$(\chi^2/DOF = 157/164)$$

$$\alpha_s^{NLO}(M_Z^2) = 0.119 \pm 0.002(\text{exp}) \pm 0.001(HT) \pm 0.004(\text{scale})$$



α_s FROM POL. DIS DATA

G. RIDOLFI et al.

- NLO QCD ANALYSIS

$$\alpha_s(M_Z) = 0.120^{+0.004}_{-0.005}\,\mathrm{exp}\;{}^{+0.009}_{-0.006}\,\mathrm{thy}$$

- BJ (POL) SUMRULE

$$\alpha_s(M_Z) = 0.118^{+0.010}_{-0.024}$$

α_s FROM GLS SUM RULE

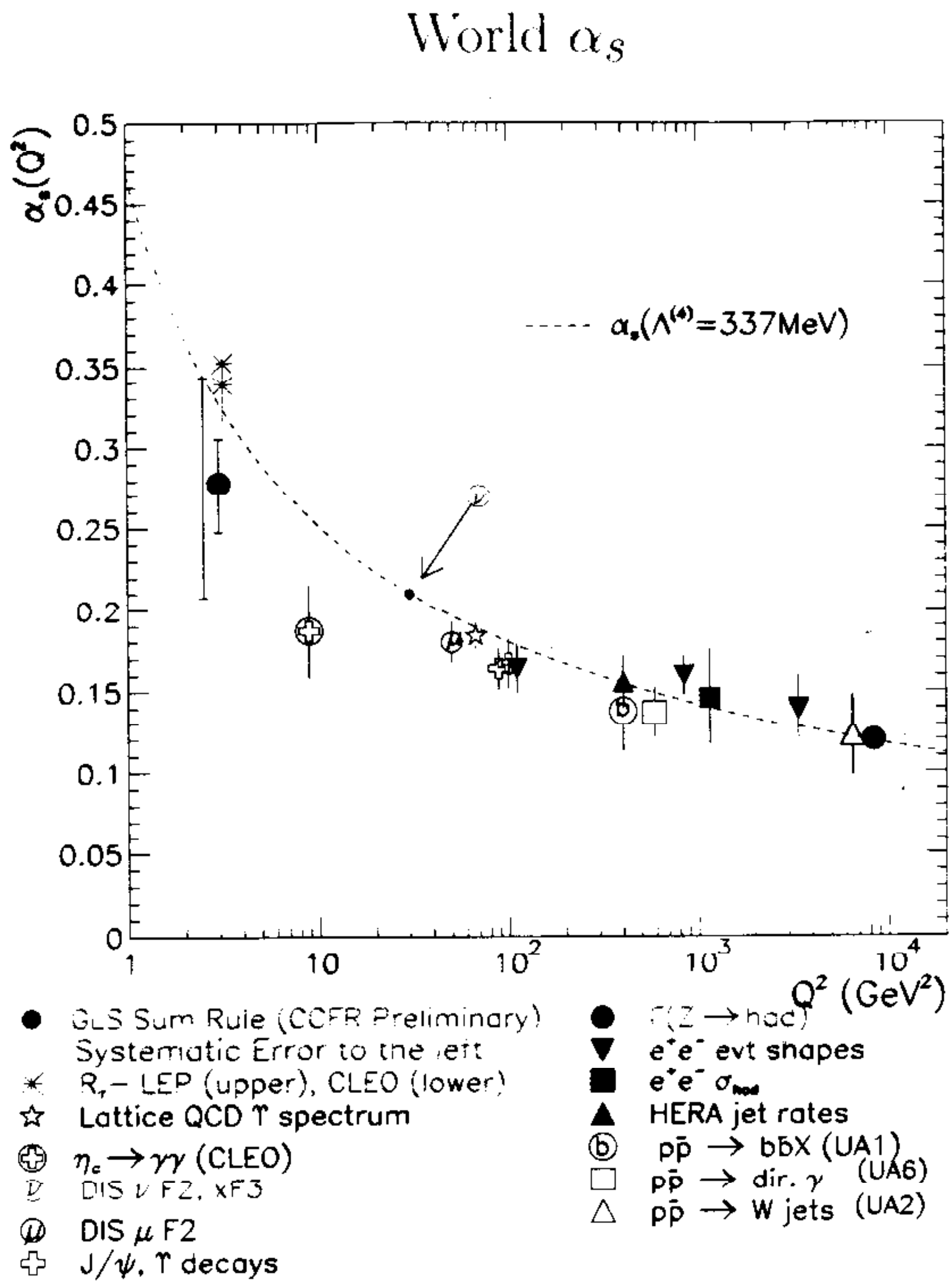
P. SPENTZOURIS
CCFR

$$\int_0^1 dx\, F_3(x,Q^2) = 3\left[1 - \frac{\alpha_s}{\pi} - a\left(\frac{\alpha_s}{\pi}\right)^2 - b\left(\frac{\alpha_s}{\pi}\right)^3\right] - \Delta HT$$

PRELIMINARY:

$$\alpha_s(M_Z) = 0.112^{+0.004}_{-0.005}\Big|_{stat}\;{}^{+0.006}_{-0.005}\Big|_{syst} \pm 0.008\ (\mathrm{Model})\;{}^{+0.004}_{-0.005}\,{}_{H}$$

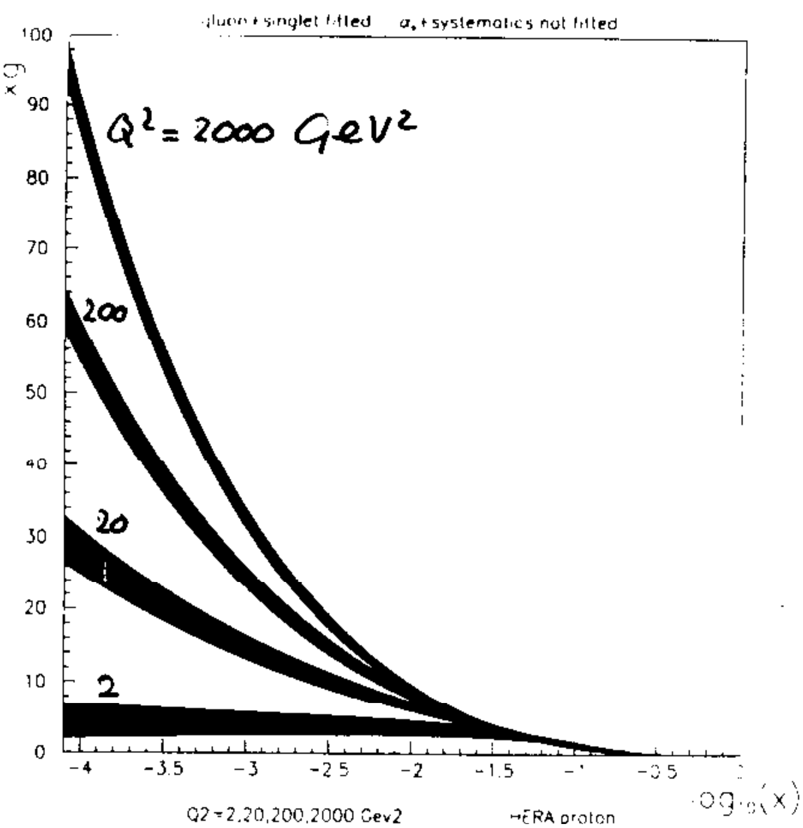
$\uparrow$


World α_S
$\alpha_s(Q^2)$
$\alpha_s(\Lambda^{(4)}=337\text{MeV})$
Q^2 (GeV^2)
GLS Sum Rule (CCFR Preliminary)
Systematic Error to the left
R_τ – LEP (upper), CLEO (lower)
Lattice QCD Υ spectrum
$\eta_c \to \gamma\gamma$ (CLEO)
DIS ν F2, xF3
DIS μ F2
J/ψ, Υ decays
$\Gamma(Z \to$ had)
e^+e^- evt shapes
e^+e^- σ_{had}
HERA jet rates
$p\bar{p} \to b\bar{b}X$ (UA1)
$p\bar{p} \to$ dir. γ (UA6)
$p\bar{p} \to$ W jets (UA2)

- Power: $xg(x)$ from HERA I

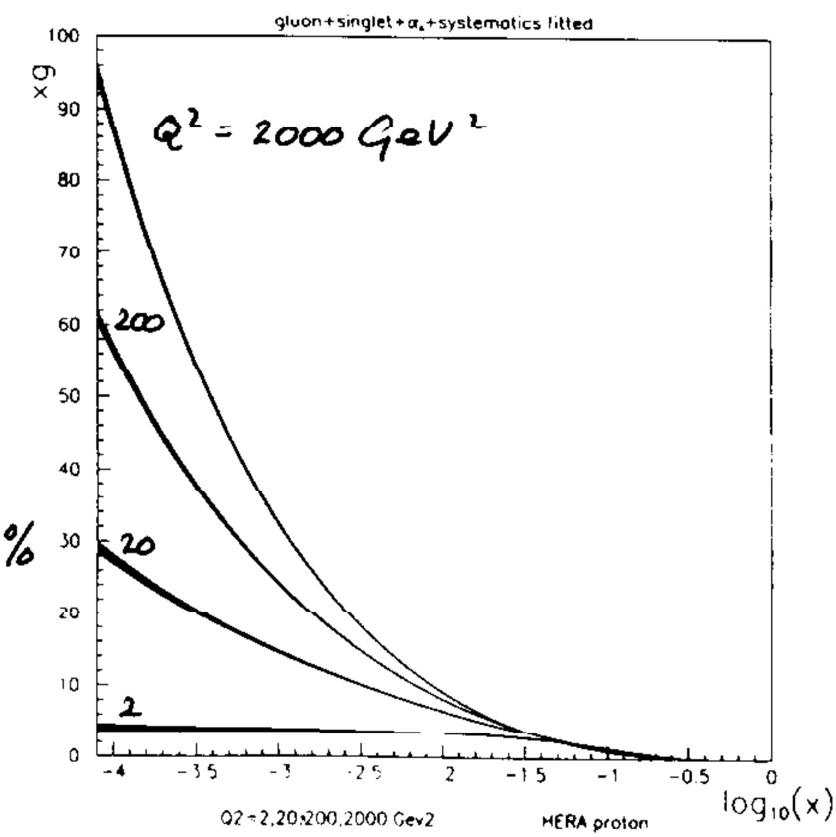
M.BOTJE

$\Delta g/g \simeq 10\%$



Systematics fixed.

$\Delta g/g \simeq 3\%$



Systematics fitted.

PROSPECTS TO MEASURE α_s AT HERA

M. BOTJE et al.

- TOOLS : $\pm$ 0.5 ‰ AGREEMENT OF 4 QCD EVOLUTION CODES FOR F_2^{NLO} (H1, ZEUS, AV, SR et al.)

- PROSPECTS FOR $\delta\alpha_s^{exp}$:

$\delta\alpha_s(M_Z) =$ 0.0025 ... 0.0035 SYSTEMATICS FIXED

$\delta\alpha_s(M_Z) =$ 0.0015 ... 0.0020 SYSTEMATICS FITTED

- THEORETICAL ERROR

$\Delta\alpha_s = 0.003$ REPRESENTATION OF α_s

NLO: $\Delta\alpha_s \simeq \pm 0.005$ (REN) $\pm$ 0.003 (FACT)

$Q^2 > 50$ GeV^2.

$\longrightarrow$ 3 LOOP ANOMALOUS DIMENSIONS NEEDED TO LINE UP WITH $\delta\alpha_s^{exp}$

4. THE HIGH Q^2 HERA EVENTS: PHENOMENOLOGICAL ASPECTS

(WITH WG 5)

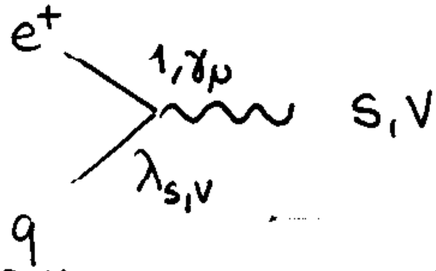
JB	LEPTOQUARKS, ep & $p\bar{p}$
G. WANG	LQ LIMITS FROM TEVATRON
J. KALINOWSKI	IMPLICATIONS FOR e^+e^-
D. ZEPPENFELD	CONTACT TERMS
S. LOLA	$\not{R}$ SUSY
S. KUHLMANN	UNCERTAINTY OF PDF'S @ LARGER x
A. WHITE	6_c QUARKS

- NO THOROUGH THEORETICAL CONCEPT YET TO EXPLAIN THE EFFECT
- NO PREDICTION

— INVESTIGATE SEVERAL POSSIBLE SOURCES ON THE BACKGROUND OF THE WORLDDATA.

LEPTOQUARKS

JB



$M = \sqrt{xS}$

WUDKA, BUCHMÜLLER et al. 87
DOBADO et al.

$$\sigma = \frac{\pi^2}{2} \alpha \left(\frac{\lambda}{e}\right)^2 q(x, \langle Q^2 \rangle) \begin{cases} 2 : V \\ 1 : S \end{cases} \times Br(\phi \to eq)$$

$\frac{\lambda}{e \cdot Br} \sim$ 0.075 (u), 0.15 (d)   H1; S $\lambda_V = \lambda_S / \sqrt{2}$

$\lambda_{ZEUS} \sim 0.55 \, \lambda_{H1}$.

- WELL COMPATIBLE WITH LOW ENERGY DATA (EG. DAVIDSON et al)

JB 97

$e^+ u \longrightarrow \phi \quad \Longrightarrow \quad Br(\phi \to eq) = 1 \; : \; S \,\&\, V$

<u>BUT:</u> H1 CC - SIGNATURES !?

$SU_{2L} \times U_{1Y}$

$e^+ d \longrightarrow \phi \quad \Longrightarrow \quad Br(\phi \to eq) = 1 \; : \; S$

$Br(\phi \to eq) = \frac{1}{2} \; : \; \mathcal{U}^0_{3\mu}, \; U_{1\mu}$

!   VECTORS.

K - FACTOR: S: $\sim$ 1.22 ... 1.24   PLEHN et al. 9
KUNSZT, STIRLING 9

SPIN OF ϕ $\langle y \rangle_{H1} = \begin{cases} 0.65 & S \\ 0.55 & V \end{cases}$ EXPECTED

$\langle y \rangle_{H1} = 0.59 \pm 0.02$: BG : 0.54.

JB 97

1st Gen. SLQ: Mass limits

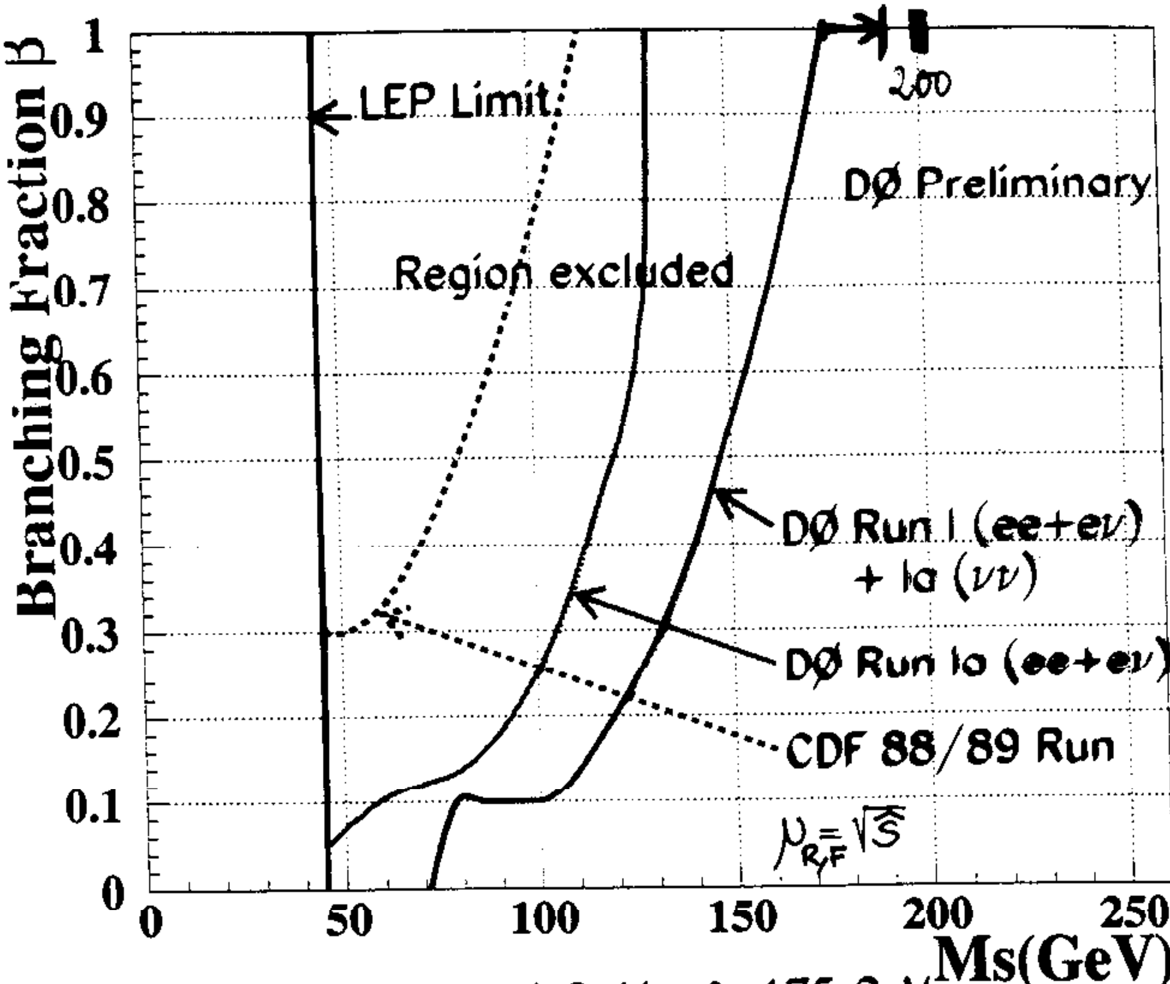
DO

SCALARS

$\mu = \sqrt{s} \rightarrow \mu = M$

K-FACTOR

KRÁMER et al. 97



For β = 1.0, M_{SLQ} > 175 GeV

For β = 0.5, M_{SLQ} > 147 GeV

For β = 0.0, M_{SLQ} > 71 GeV

$\varepsilon \sim 0.2$

- Cross section: Blümlein, Boos, Kryukov, DESY 96-174 $Q^2 = \hat{s}$

Z. PHYS. C IN PRINT

CROSS SECTIONS :

$p\bar{p} \to S\bar{S}$ $\qquad \sqrt{s} = 1.8\,\mathrm{TeV}$ $\qquad \sigma \approx 0.2\,\mathrm{pb}$ $\boxed{\mathrm{FIG}}$

$\mu_{R/F} = M$.

$p\bar{p} \to V\bar{V}$ $\qquad \sigma \approx 0.3\,\mathrm{pb}$

min κ_G, λ_G

↑ GOOD HIGH EN. BEHAVIOR

JB, BOOS, KRYUKOV Oct. 96

JB, BOOS, KRYUKOV Oct. 96
PL B292 (1997) 150

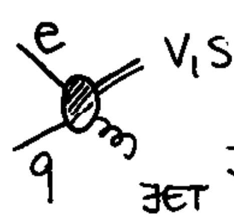
MORE DATA FROM TEVATRON : • 1999

CDF RESULTS expected soon.

REMEMBER , $Br\,(V \to eq) = \frac{1}{2}$!

VECTORS ARE STILL IN THE GAME.

CAN HERA STUDY ALSO OTHER SIGNATURES UNTIL 1999 ?



M_ϕ

$+ \ldots$

JB, KRYUKOV DESY 97-067

$\sigma_S \sim 0.09\,\mathrm{pb}$, $p_\perp > 5\,\mathrm{GeV}$

~ 3 EVENTS UNTIL DECEMBER?

'PROPAGATING' LEPTOQUARK ⟷ CONTACT INT.

CONTACT INTERACTIONS

D. ZEPPENFELD

$$\mathcal{L}_{eff} = \sum_{q=u,d} \sum_{h_1,h_2=L,R} \eta^{eq}_{h_1h_2} \, \bar{e}_{h_1} \gamma^\mu e_{h_1} \bar{q}_{h_2} \gamma_\mu \bar{q}_{h_2}$$

$[\eta_{ij}] \sim GeV^{-2}$ $\quad e^+p$: SENSITIVE TO η_{LR}, η_{RL}

$$\eta = \pm \frac{4\pi}{\Lambda^2}$$

FIG

$\Lambda \sim 3\,TeV$ MAY PROVIDE AN ACCEPTABLE DESCRIPTIO OF THE CURRENT DATA.

$\cancel{R}$ SUSY

S. LOLA

- SCALAR LQ STATES EMERGE

$$e^+q \to \tilde{q} \to \begin{cases} e^+ q \\ q\,\chi \hookrightarrow e^\pm jj \\ q\,\chi \hookrightarrow \nu\bar{\nu} \end{cases}$$

MAY YIELD: $Br(eq) \neq 1$

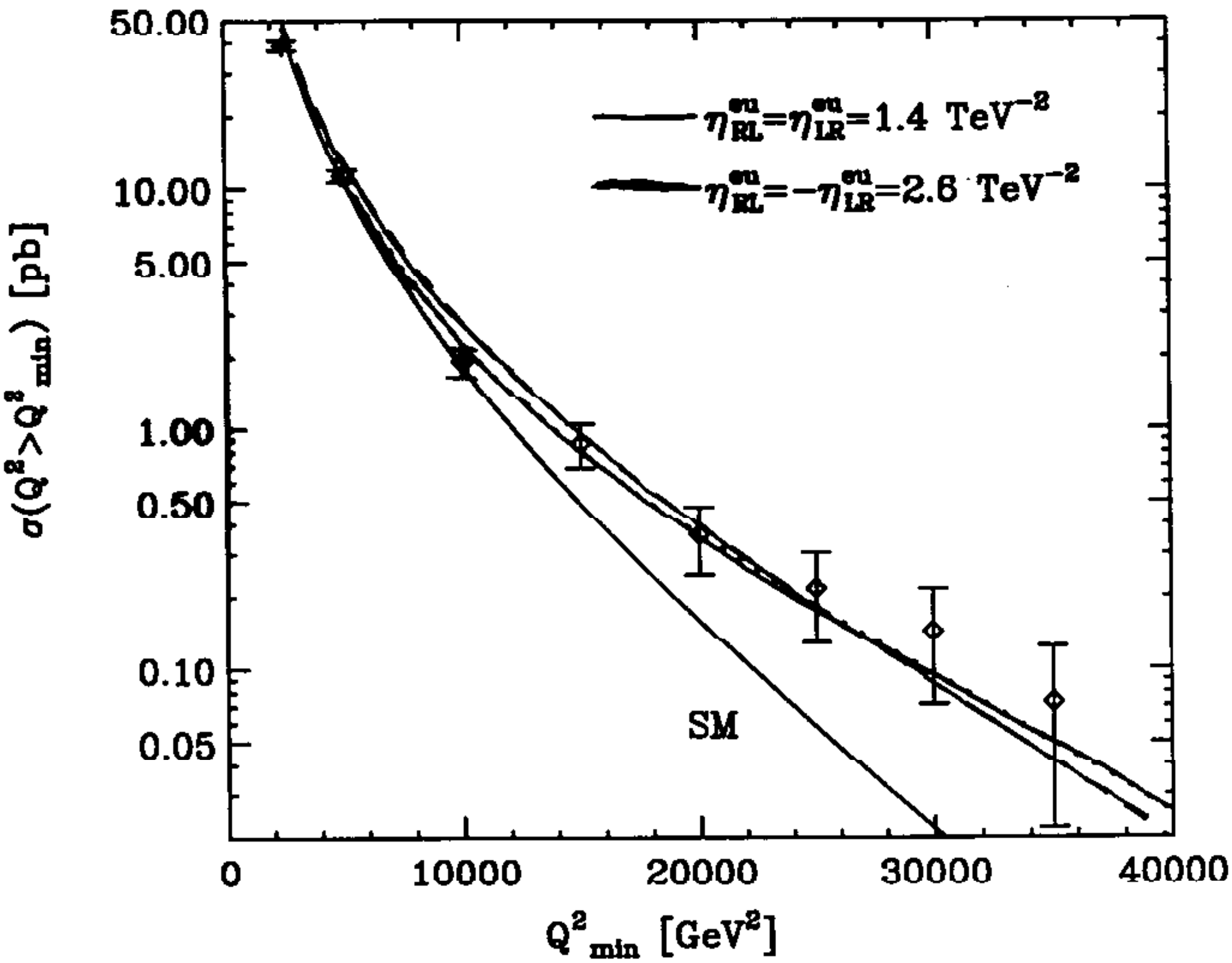
TESTS : $\tilde{q}\bar{\tilde{q}}$ PRODUCTION @ TEVATRON

$Br(K^+ \to \pi^+ \bar{\nu}\nu)$ FINITE

Two examples:

$$\eta_{RL}^{eu} = \eta_{LR}^{eu} = 1.4\ \mathrm{TeV}^{-2} \quad \hat{=} \quad \Lambda \approx 3\ \mathrm{Te}$$

$$\eta_{RL}^{eu} = -\eta_{LR}^{eu} = 2.6\ \mathrm{TeV}^{-2} \quad \hat{=} \quad \Lambda \approx 2.2$$



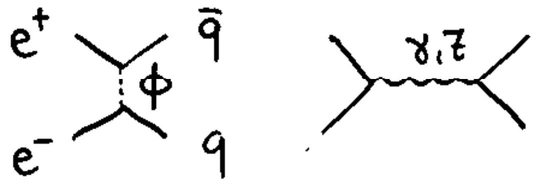
Shape is "better" for $\eta_{RL}^{eu} = -\eta_{LR}^{eu}$:

interference with γ-exchange exactly cancels

D. ZEPPENFELD

IMPLICATIONS FOR e^+e^- SCATTERING

J. KALINOWSKI



$\frac{\lambda}{e} \rightarrow$ HERA, $M \sim 200$ GeV $\qquad \frac{\delta\sigma}{\sigma} \lesssim 1\%$

$\therefore$ LEP2 SYSTEMATICS, $\mathcal{L}$

$\longrightarrow$ PROBABLY NOT DETECTABLE

CONTACT INTERACTIONS : $\Lambda \gtrsim 1.5 - 2.5$ TeV

END OF 1997 $\quad \Lambda \gtrsim 4 - 6.5$ TeV

UNCERTAINTIES OF PARTONDENSITIES @ LARGE x

S. KUHLMANN

ESTIMATES BY THE EXPERIMENTS: O(5%)

$\longrightarrow$ EFFECT MAY BE LARGER $\longleftrightarrow$ LESS EXCESS.

- FEED BACK FROM THE VERY LARGE x RANGE?

$\longrightarrow$ FURTHER DETAILED STUDIES ARE REQUESTED.