... THE TROUBLE WITH THIS PERIOD IS THAT, (AS WITH ALL PREVIOUS REVOLUTIONS), THE THEORISTS GET MUCH TOO MUCH CREDIT. ... WHAT GETS ME IS THAT THEY ARE SO OVER-CONFIDENT. THEORETICAL OVERCONFIDENCE IS PROBABLY THE WORST PROBLEM WE FACE. SHORTAGE OF FUNDING COMES NEXT...

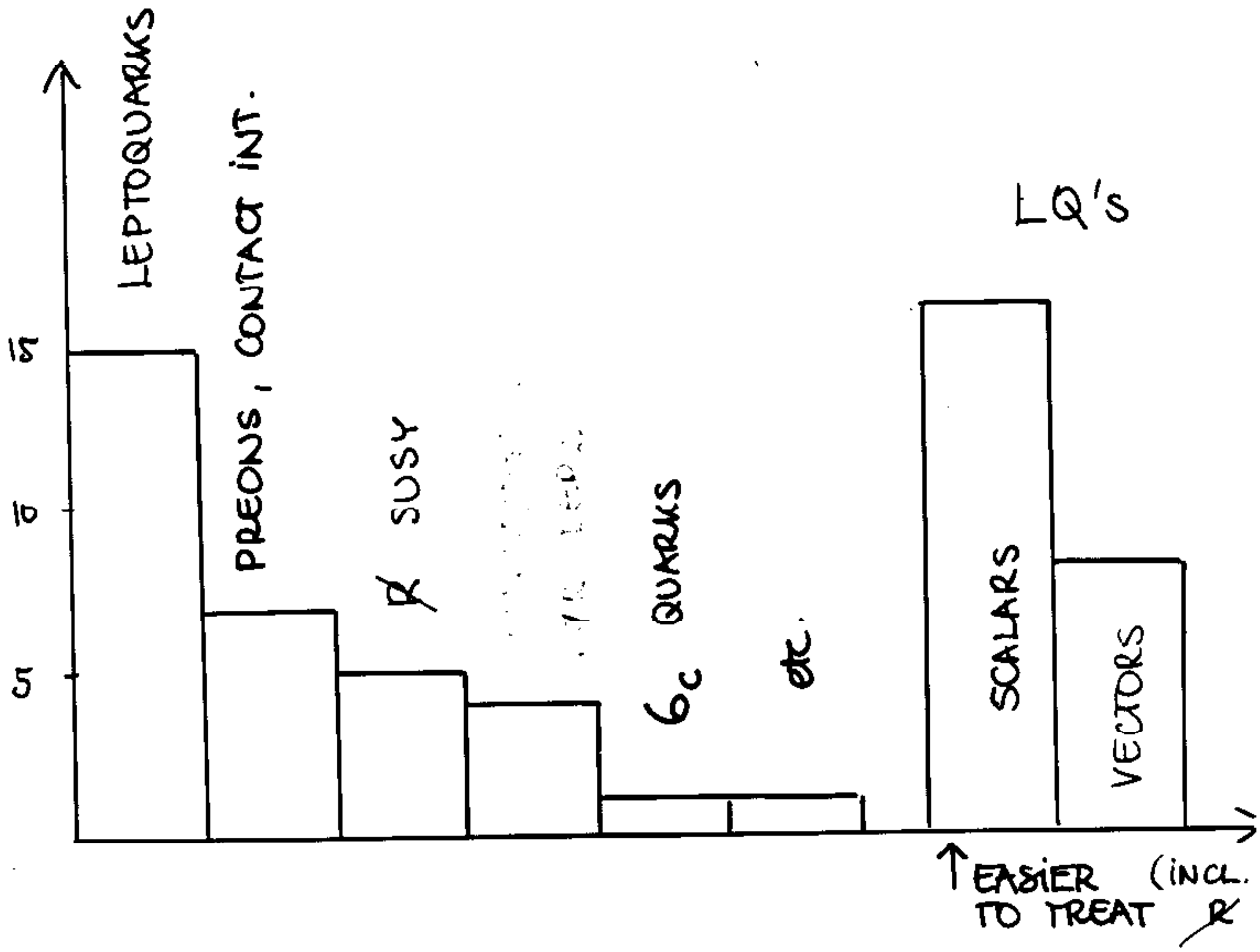
L. LEDERMAN, SEPT. 5 198(

RECENT PHENOMENOLOGICAL PAPERS

	Preprint	Authors	Title
1	hep-ph/9702387	S.L. Adler	$SU(4)$ Preonic Interpretation of the HERA Positron-Jet Events
2	hep-ph/9702392	D. Choudhury, S. Raychaudhuri	R Parity violation at HERA?
3	hep-ph/9703255	T.K.Kuo, T. Lee	Rapidity Gap of Weakly Coupled Leptoquark
4	hep-ph/9703276	G. Altarelli, J. Ellis et al.	Pursuing Interpretations of the HERA Large-Q^2 Data
5	hep-ph/9603279	H. Dreiner, P. Morawitz	High Q^2-Anomaly at HERA and Supersymmetry
6	hep-ph/9703285	M.A. Doncheski, S. Godfrey	What can we Learn About Leptoquarks At LEP 200?
7	hep-ph/9703287	J. Blümlein	On the Expectations for Leptoquarks in the Mass Range of $O(200\,\mathrm{GeV})$
8	hep-ph/9703288	J. Kalinowski, R. Rückl et al.	Leptoquark/Squark Interpretation of HERA Ev.: Virtual Effects in e^+e^- Annihilation to Hadr.
9	hep-ph/9703299	K.S. Babu et al.	Comments on the high-Q^2 HERA anomaly
10	hep-ph/9703311	V. Barger, K. Cheung et al.	Contact interactions and high-Q^2 events in e^+p collisions at HERA
11	hep-ph/9703316	M. Suzuki	Removing flavour changing neutral interactions from leptoquark exchange
12	hep-ph/9703332	M. Drees	Are the H1 and ZEUS "High Q^2 Anomalies" Consistent with Each Other?
13	hep-ph/9703337	J.L. Hewett, T.G. Rizzo	Much Ado About Leptoquarks: A Comprehensive Analysis
14	hep-ph/9703338	G.K. Leontaris, J.D. Vergados	Constraints on Leptoquark Masses and Coupl. from Rare Processes and Unification
15	hep-ph/9703346	M.C. Garcia, S.F. Novaes	Bounds on Contact Interactions from LEP1 Data and the High-Q^2 HERA Events
16	hep-ph/9703369	D. Choudhury, S. Raychaudhuri	Like-Sign Dileptons at the FERMILAB Tevatron Revisited in the Light of the HERA ...
17	hep-ph/9703372	C. Papadopoulos	Leptoquark Production at LEP2
18	hep-ph/9703375	N. Di Bartolomeo, M. Fabbrichesi	Four Fermion Contact Interactions from LEP1 Data and the High-Q^2 HERA Events
19	hep-ph/9703379	A. Nelson	Contact Terms, Compositeness, and APV
20	hep-ph/9703427	Z. Kunszt, W.J. Stirling	QCD Corrections and the Leptoquark Interpr. of the HERA High-Q^2 Events
21	hep-ph/9703427	T. Plehn, H. Spiesberger et al.	Formation and Decay of Scalar Leptoquarks/ Squarks in ep Collisions
22	hep-ph/9704214	C. Friberg et al.	QCD aspects of leptoquark production at HERA
23	hep-ph/9704221	T. Kon, T. Kobayashi	Stops in R-parity Breaking Model for High-Q^2 Events at HERA
24	hep-ph/9704241	S. Jadach, B. Ward et al.	e^+e^- Annihilation into Hadrons at LEP2 in the Presence of the Anomalous DESY ...
25	hep-ph/9704248	A.R. White	Electroweak-Scale Excess Cross-Sections in the Sextet Quark "Standard Model"
26	hep-ph/9704275	R. Barbieri et al.	The high-Q^2 HERA anomaly and SUSY unific.
27	hep-ph/9704280	I. Montvay	Leptoquarks and vector-like strong interactions ...
28	hep-ph/??	M. Krämer, T. Plehn et al.	Pair Production of Scalar Leptoquarks at the Tevatron
29		W. BUCHMÜLLER, D. WYLER	... CONTACT INTERACTIONS

ISSUES

(LAST THURSDAY 8pm)



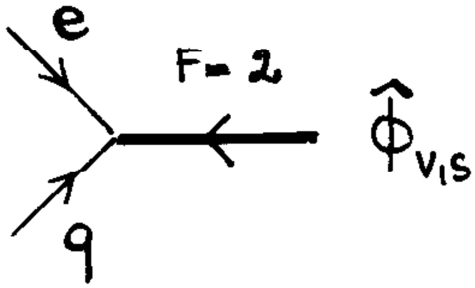
OF LEPTOQUARK PAPERS BEFORE X-MAS 1996: $\sim$ 181 THY $\oplus$ EXP

SPIRES / TITLE

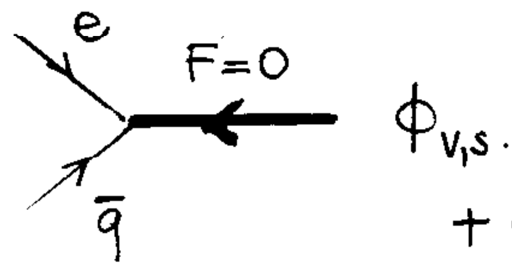
(SINCE 7/1978)

$<$ 1 / MONTH.

LEPTOQUARKS



1 : S
γ_μ : V

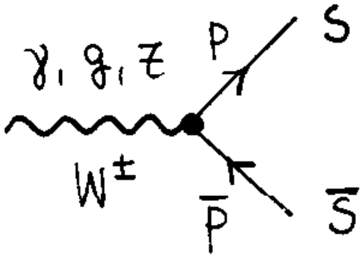


+ cc.

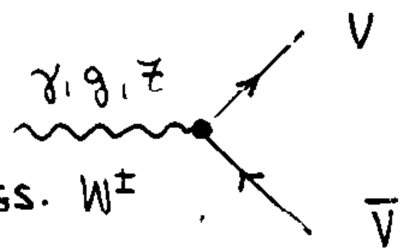
1 : S
γ_μ : V

FERMIONIC COUPLINGS

BUCHMÜLLER, RÜCKL, WYLER 1987



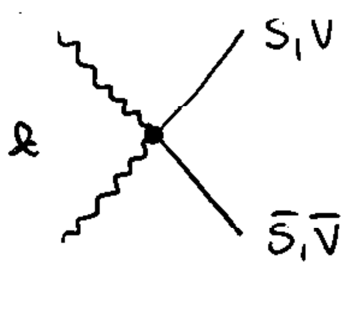
BOSONIC (GAUGE) COUPLINGS.



K_i, λ_i

POMAROL et al. 1993 K

JB, E. BOOS, A. KRYUKOV
≥ 1994 ; K, λ



OFTEN CONSIDERED:
- B & L CONSERVING COUPLINGS
- FAMILY DIAGONAL
- $SU_{2L} \times U_{1Y} \times SU_{3C}$ INVARIANT
- DIMENSIONLESS COUPLINGS

$\Phi_{V,S}$ EITHER 3_c OR $\bar{3}_c$

EXCLUDED MASS RANGES

→ NEXT TALK

CURRENTLY
- BEST LIMITS: TEVATRON

1ST GENERATION LQ'S:

D0 S: $M > 175, 147, 71$ GeV 95% CL.

$Br(eq)$: 1, 0.5, 0

$\mu \equiv \sqrt{\hat{s}}$, ! (BORN)

V: LARGER BOUNDS, DEPENDING ON κ_G, λ_G.

CDF or D0:

2nd GEN. S: $M < 141$ GeV 95% CL

3rd GEN. S: $M < 99$ GeV — " —

V: $M < 170$ GeV (MC case only

LOW ENERGY BOUNDS ON THE FERMIONIC COUPLINGS

BUCHMÜLLER, WYLER '8
DAVIDSON et al. '9
LEURER '9

$\lambda = \lambda_L, \lambda_R$

<u>1ST GENERATION</u>:

S: $\frac{\lambda}{e} \lesssim 0.4 \frac{M}{200\ \text{GeV}}$ $S_0, \tilde{S}_0, \tilde{S}_{1/2}$

V: $\frac{\lambda}{e} \lesssim 0.2 \frac{M}{200\ \text{GeV}}$ $V_1, V_{1/2}$

$(e \sim 0.3)$

SOMETIMES $\lambda_L \gg \lambda_R$ or $\lambda_R \gg \lambda_L$ REQUESTED

- MESON DECAYS, MESON-ANTIMESON MIXING, LEPTON DECAYS etc.

INTERPRETING THE HIGH Q^2 EXCESS @ HERA AS $\sigma(S,V \to eq)$

$$\Gamma_S = \frac{\lambda_S^2}{16\pi} M_S \quad , \quad \Gamma_V = \frac{\lambda_V^2}{24\pi} M_V$$

WUDKA
BWR
DOBADO et al } '8

$$\Gamma \ll M$$

$$\sigma(eq) = \frac{\pi^2}{s} \alpha \left(\frac{\lambda}{e}\right)^2 q\left(x = \frac{M^2}{s}, \langle Q^2 \rangle\right) J(\phi) b(\phi)$$

$$J(\phi) = \begin{cases} 1 : S \\ 2 : V \end{cases} \qquad b(\phi) = Br(\phi_{V,S} \to eq)$$

$$\sigma(eq) = 338\,pb \; b(\phi) \left(\frac{\lambda}{e}\right)^2 \begin{cases} V : 2 \\ S : 1 \end{cases} \begin{cases} u : x \; 0.56 \ldots 0.25 \\ \bar{u} : x \; 0.005 \ldots 0.00 \\ d : x \; 0.15 \ldots 0.05 \\ \bar{d} : x \; 0.014 \ldots 0.007 \end{cases}$$

$x : 0.4 \ldots 0.5$

$\langle Q^2 \rangle \sim 20000 \, GeV$

$\mathcal{L}_{H1} = 14 pb^{-1}$, $\mathcal{L}_{ZEUS} = 20 pb^{-1}$, $\varepsilon = 0.8$

H1:	$\frac{\lambda_S}{e\sqrt{6}}$:	0.06 ... 0.09	0.61 ... 1.36	0.11 ... 0.19	0.36 ... .79 (BORN)
7# NC		u ↑	$\bar{u}$ #4 NC	d ↑	$\bar{d}$

$\lambda_V = \lambda_S / \sqrt{2}$. $\qquad \lambda_{ZEUS} = 0.55 \, \lambda_{H1}$

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

F = 0.

				ℓq	νq	
$e^+ u \longrightarrow$	$Q_{em} = \frac{5}{3}$	S:	R_2^+	λ_L	0	
		V:	$\tilde{U}_{1\mu}$	λ_R	0	
		:	$U_{3\mu}^+$	$\sqrt{2}\,\lambda_L$	0	

$$Br\,(\phi_{S,V} \to e^+ q)_{BORN} = 1$$

$e^+ d \longrightarrow$	$Q_{em} = \frac{2}{3}$	S:	R_2^-	$-\lambda_R$	λ_L	$Br(e^+q)$
			$\tilde{R}_2^+$	λ_L	0	
		V:	$U_{1\mu}$	λ_L, λ_R	λ_L	
			$U_{3\mu}^0$	$-\lambda_L$	λ_L	

π^0-**decay**: BUCHMÜLLER, WYLER 1986 : R_2^- : $\lambda_L \lambda_R \ll 1$

$U_{3\mu}^0$: $\quad Br\,(e^+q) = \frac{1}{2}$

$U_{1\mu}$: $\quad Br\,(e^+q) \geq \frac{1}{2}$

$O(\alpha_s)$ K- FACTOR

KUNSZT
STIRLING, '9

PLEHN et al.
'97

($\Gamma \ll M$)

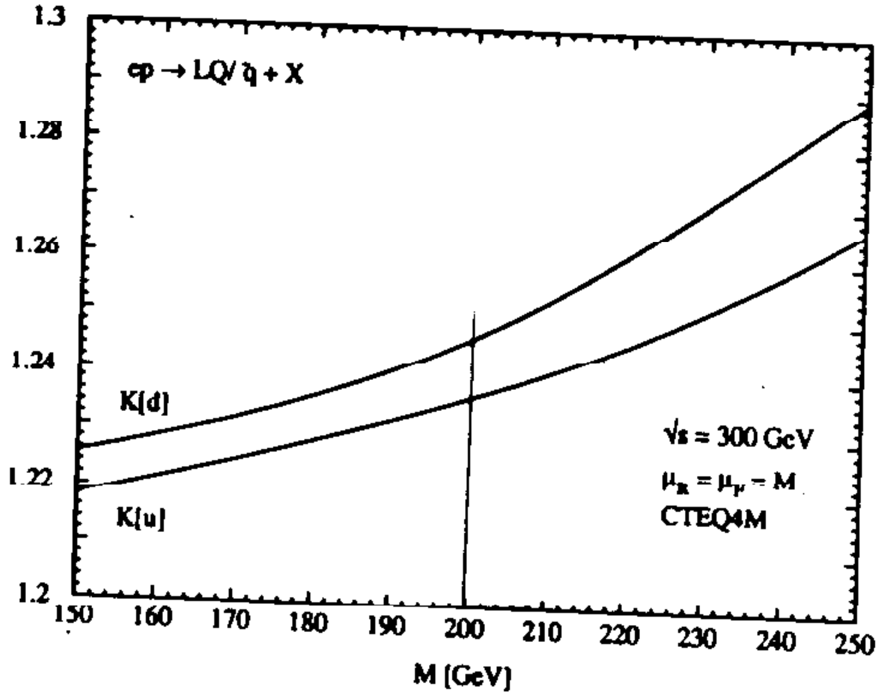
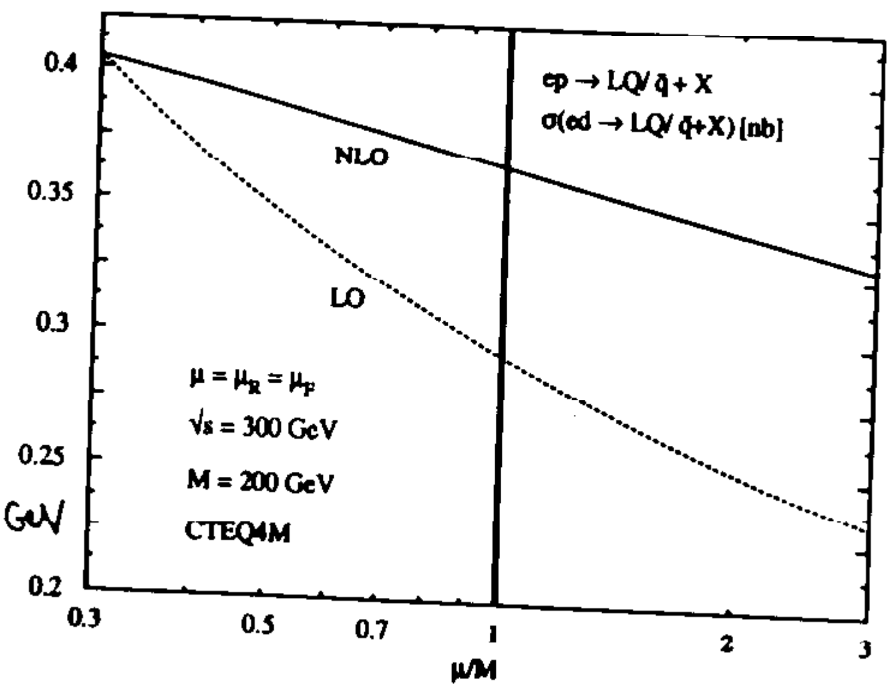


Figure 2: *K-factors for ed, eu → $LQ/\tilde{q}$ as a function of the leptoquark/squark mass.*



$\sqrt{\langle k_\perp^2 \rangle_\phi} \sim 3 \ldots 4$ GeV

i.e. $\frac{\lambda}{e}$ IS EVEN SMALLER THAN ESTI- MATED @ BORN LEVEL

Figure 3: *Comparison of the renormalization and factorization scale dependence in LO and NLO for the cross section for $\sigma(e + d \to LQ/\tilde{q})$.*

$\langle y \rangle$:

BUCHMÜLLER, RÜCKL
WYLER '87.

S : const.

V : $\propto (1-y)^2$

$\therefore$ H1 : $\langle y \rangle = 0.59 \pm 0.02$ $\quad y \in [0.4, 0.9]$

S : $\langle y \rangle_S = 0.65$

V : $\langle y \rangle_V = 0.55$; $\langle y \rangle^{e^+p}_{DIS} = 0.54$!

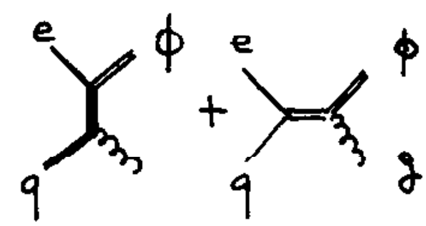
JB '97

HOW CAN HERA FIND OUT WHETHER THE EVENTS WERE DUE TO LEPTOQUARKS ?

$\longrightarrow$ HIGHER $\mathcal{L}$

LOOK FOR : $eq \to \phi g$ BY FAR DOMINANT.

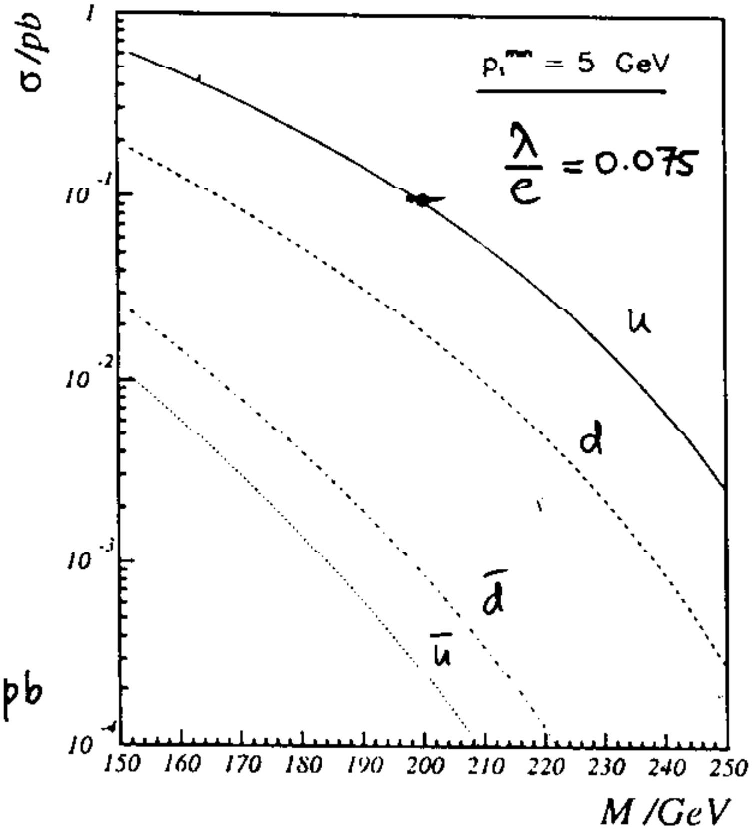
$eg \to \phi q$



e.g.
$p_\perp > 5$ GeV : M(e jet) ~ '200 GeV'

+ 1 jet

TEST OF LQ PROPAGATION !



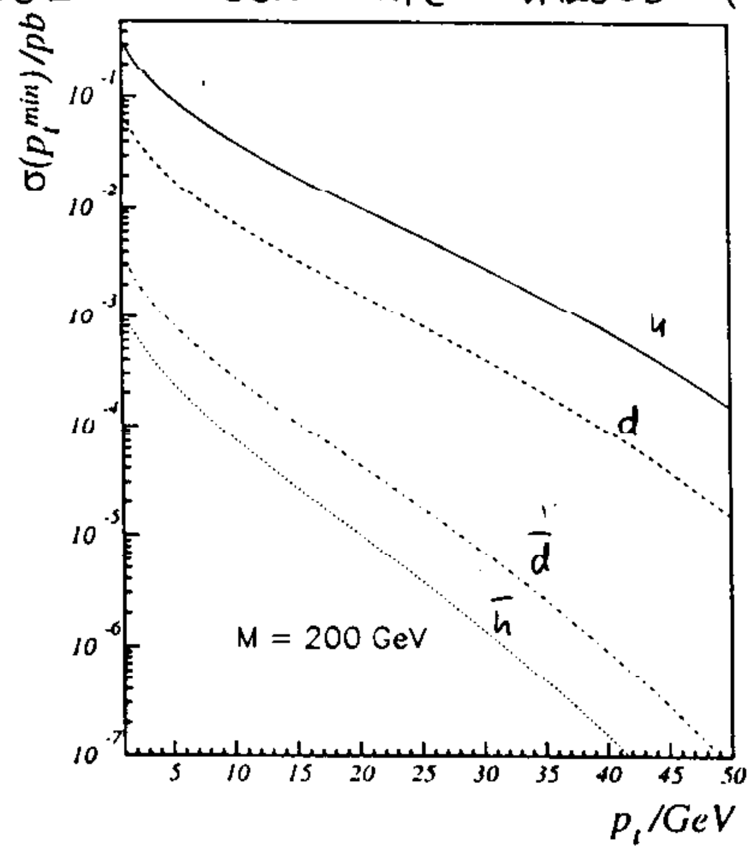
$\sigma(eq \to Sq) \sim 0.09$pb
q=u

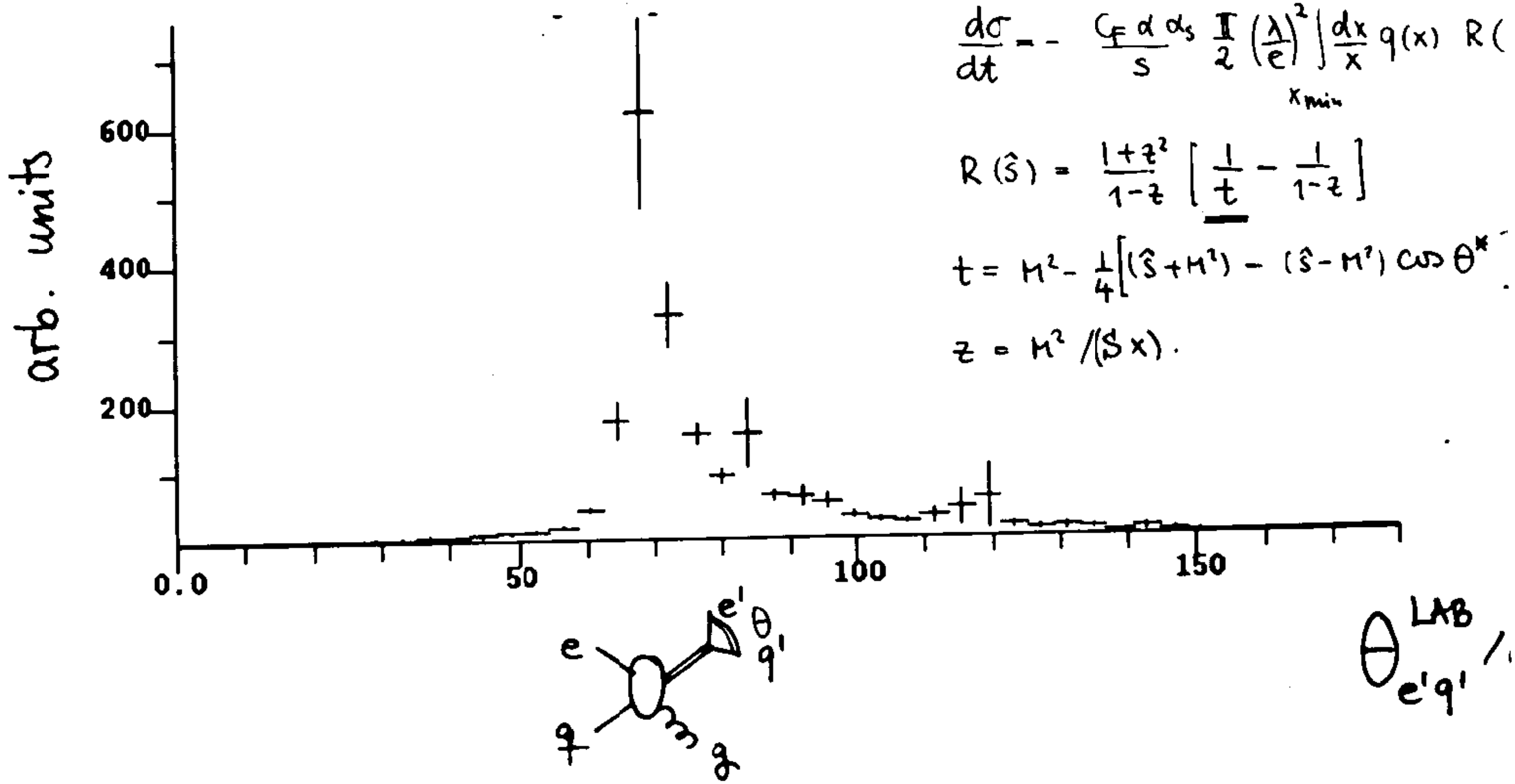
JB, A.KRYUKO
DESY 97-067.

(eq)
DOBADO et al.
'87

CTEQ3 LO
$\mu = M$

THE ABOVE CURVES FOR $d, \bar{d}, \bar{u}$ SCALE UP FOR CORRESPONDINGLY LARGER λ/e – VALUES (cf. ABOVE).





$$\frac{d\sigma}{dt} = -\frac{C_F\,\alpha\,\alpha_s}{s}\,\frac{\pi}{2}\left(\frac{\lambda}{e}\right)^2\int_{x_{min}}^{1}\frac{dx}{x}\,q(x)\;R($$

$$R(\hat{s}) = \frac{1+z^2}{1-z}\left[\frac{1}{t} - \frac{1}{1-z}\right]$$

$$t = M^2 - \frac{1}{4}\left[(\hat{s}+M^2) - (\hat{s}-M^2)\cos\theta^*\right.$$

$$z = M^2/(\hat{s}\,x).$$

JB, E.BOOS, A. KRYUKOV
Oct. 1996

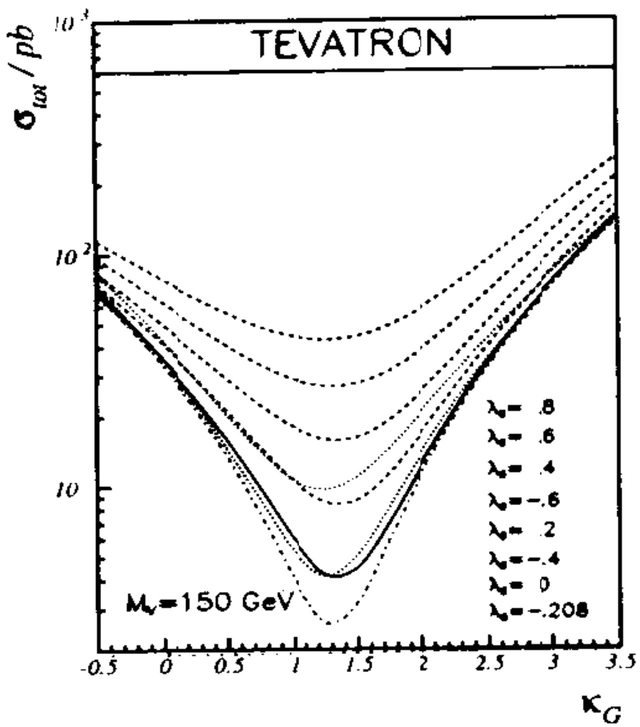


Figure 6a. Dependence of the integrated cross sections for vector leptoquark pair production on the anomalous couplings κ_G and λ_G at the TEVATRON, $\sqrt{S}$ = 1.8 TeV for M_V = 150 GeV. The order of the values of λ_G follows the position of the respective minimum. Dashed lines: $\lambda_G > 0$, dotted lines: $\lambda_G < 0$, full line: $\lambda_G = 0$, dash-dotted line: $\lambda_G = -0.208$.

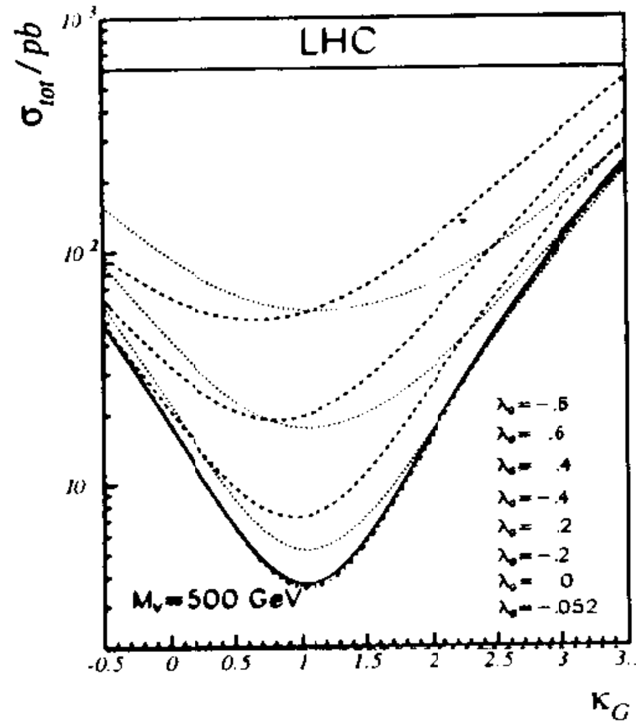
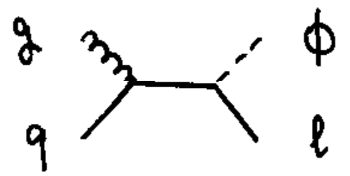


Figure 6b: Dependence of the integrated cross sections for vector leptoquark pair production on the anomalous couplings κ_G and λ_G at LHC, $\sqrt{S}$ = 14 TeV for M_V = 500 GeV. The dash-dotted line corresponds to $\lambda_G = -0.052$. The other parameters are the same as in figure 6a

$p\bar{p}$ PRODUCTION

1) SINGLE PRODUCTION



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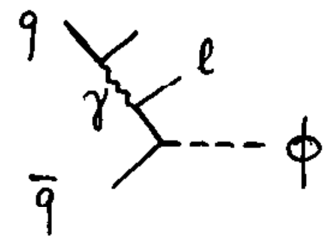

HEWETT, PAKVASA '89
(MANY OTHERS LATER cf. JB '97)
$\sigma \propto \lambda^2 \ll 1.$

OHNEMUS et al. '94
REYA (priv. comm.)

$\sigma \approx 0.7 \ldots 1.3\,fb$

$\sigma \sim 0.4\,fb$, $M \sim 200$ GeV

$\therefore \frac{\lambda}{e}\sqrt{b} = 0.075.$

2) PAIR PRODUCTION

$\frac{\lambda}{e} \ll 1$: DECOUPLING OF FERMIONIC VERTICES

→ g_s KNOWN COUPLING
COMPLETE PREDICTION FOR SCALARS

→ VECTOR LEPTOQUARKS ARE NOT NECESSARILY COUPLING YANG-MILLS LIKE TO GLUONS

κ_G, λ_G - ANOMALOUS COUPLINGS

$\exists \min \sigma_{V\bar{V}} > 0$. JB, BOOS, KRYUKOV '96.

$\lambda = 0, \; \kappa \neq 0$ POMAROL et al. '93

$\lambda, \kappa \neq 0$ JB, BOOS, KRYUKOV '96.

$\boxed{\lambda = 0}$ DOES NOT YIELD THE SMALLEST CROSS SECT

- $\min\limits_{\kappa, \lambda} \sigma_{q\bar{q}}$ DOES NOT CONTAIN $\left(\frac{s}{M^2}\right)^{\alpha}$ TERMS ANYMORE !

JB, BOOS, KRYUKOV '96A

$\sigma_{s\bar{s}} \; (\mu = M = 200 \text{ GeV}) \sim 0.16 \text{ pb}$

$\min\limits_{\kappa, \lambda} \sigma_{V\bar{V}} \; (\mu = M = 200 \text{ GeV}) \sim 0.3 \text{ pb}$

$(\sigma_{MC} \; (\kappa = 1, \lambda = 0) \sim 0.4 \text{ pb}).$

B Coefficients of the production cross section of vector leptoquarks

The functions $F_i(\hat{s},\beta,\cos\theta)$ which determine the differential pair production cross section for $gg \to V\overline{V}$ are:

$$F_0 = \left[19 - 6\beta^2 + 6\beta^4 + \left(16 - 6\beta^2\right)\beta^2\cos^2\theta + 3\beta^4\cos^4\theta\right]\cdot\left(7 - 9\beta^2\cos^2\theta\right) \quad (85)$$

$$F_1 = -4\cdot\left(77 + 143\beta^2\cos^2\theta + 36\beta^4\cos^4\theta\right) \quad (86)$$

$$F_2 = -8\cdot\left(7 + 11\beta^2\cos^2\theta - 18\beta^4\cos^4\theta\right) \quad (87)$$

$$\begin{aligned} F_3 &= 2\cdot\left(117 + 185\beta^2\cos^2\theta + 18\beta^4\cos^4\theta\right) + 2\frac{\hat{s}}{M_V^2}\left(8 - \beta^2\cos^2\theta - 7\beta^4\cos^4\theta\right) \\ &+ \frac{7}{4}\frac{\hat{s}^2}{M_V^2}\left(1 - \beta^2\cos^2\theta\right)^2 \end{aligned} \quad (88)$$

$$F_4 = -4\cdot\left(19 + 27\beta^2\cos^2\theta + 18\beta^4\cos^4\theta\right) + 10\frac{\hat{s}}{M_V^2}\left(1 - \beta^2\cos^2\theta\right)\left(7 - \beta^2\cos^2\theta\right) \quad (89)$$

$$\begin{aligned} F_5 &= 2\cdot\left(19 + 27\beta^2\cos^2\theta + 18\beta^4\cos^4\theta\right) - \frac{\hat{s}}{M_V^2}\left(1 - \beta^2\cos^2\theta\right)\left(55 + 29\beta^2\cos^2\theta\right) \\ &+ \frac{1}{8}\frac{\hat{s}^2}{M_V^2}\left(1 - \beta^2\cos^2\theta\right)\left(97 + 2\beta^2\cos^2\theta - 115\beta^4\cos^4\theta\right) + \frac{\hat{s}^3}{M_V^2}\frac{9}{4}\left(1 - \beta^2\cos^2\theta\right)^3 \end{aligned} \quad (90)$$

$$\begin{aligned} F_6 &= -61 - 67\beta^2\cos^2\theta - \frac{1}{2}\frac{\hat{s}}{M_V^2}\left(1 - \beta^2\cos^2\theta\right)\left(39 + 14\beta^2\cos^2\theta\right) \\ &- \frac{1}{4}\frac{\hat{s}^2}{M_V^2}\left(1 - \beta^2\cos^2\theta\right)^2 \end{aligned} \quad (91)$$

$$\begin{aligned} F_7 &= 127 + 129\beta^2\cos^2\theta - \frac{1}{2}\frac{\hat{s}}{M_V^2}\left(1 - \beta^2\cos^2\theta\right)\left(19 + 3\beta^2\cos^2\theta\right) \\ &+ \frac{1}{4}\frac{\hat{s}^2}{M_V^2}\left(1 - \beta^2\cos^2\theta\right)^2\left(-23 + 18\beta^2\cos^2\theta\right) \end{aligned} \quad (92)$$

$$\begin{aligned} F_8 &= -71 - 57\beta^2\cos^2\theta + \frac{1}{2}\frac{\hat{s}}{M_V^2}\left(1 - \beta^2\cos^2\theta\right)\left(170 + 21\beta^2\cos^2\theta\right) \\ &+ \frac{1}{4}\frac{\hat{s}^2}{M_V^2}\left(1 - \beta^2\cos^2\theta\right)\left(-50 + 40\beta^2\cos^2\theta + 27\beta^4\cos^4\theta\right) - \frac{1}{4}\frac{\hat{s}^3}{M_V^2}\left(1 - \beta^2\cos^2\theta\right)^3 \end{aligned} \quad (93)$$

$$\begin{aligned} F_9 &= 8\left(1 - \beta^2\cos^2\theta\right) - \frac{\hat{s}}{M_V^2}\left(1 - \beta^2\cos^2\theta\right)\left(21 + 2\beta^2\cos^2\theta\right) \\ &+ \frac{1}{4}\frac{\hat{s}^2}{M_V^2}\left(1 - \beta^2\cos^2\theta\right)^2\left(74 + 9\beta^2\cos^2\theta\right) \\ &+ \frac{1}{4}\frac{\hat{s}^3}{M_V^2}\left(1 - \beta^2\cos^2\theta\right)^3\left(-15 + 8\beta^2\cos^2\theta\right) \end{aligned} \quad (94)$$

$$\begin{aligned} F_{10} &= 3 + 5\beta^2\cos^2\theta + \frac{5}{4}\frac{\hat{s}}{M_V^2}\left(1 - \beta^2\cos^2\theta\right)\left(4 - \beta^2\cos^2\theta\right) \\ &+ \frac{1}{32}\frac{\hat{s}^2}{M_V^2}\left(1 - \beta^2\cos^2\theta\right)^3\left(25 + 13\beta^2\cos^2\theta\right) \end{aligned} \quad (95)$$

$$\begin{aligned} F_{11} &= -4\cdot\left(3 + 5\beta^2\cos^2\theta\right) - 5\frac{\hat{s}}{M_V^2}\left(1 - \beta^2\cos^2\theta\right)^2 \\ &+ \frac{1}{4}\frac{\hat{s}^2}{M_V^2}\left(1 - \beta^2\cos^2\theta\right)^3\left(35 - 13\beta^2\cos^2\theta\right) \end{aligned} \quad (96)$$

$$\begin{aligned} F_{12} &= 8\cdot\left(3 + 5\beta^2\cos^2\theta\right) - \frac{15}{2}\frac{\hat{s}}{M_V^2}\left(1 - \beta^2\cos^2\theta\right)\left(3 + \beta^2\cos^2\theta\right) \\ &+ \frac{1}{16}\frac{\hat{s}^2}{M_V^2}\left(1 - \beta^2\cos^2\theta\right)\left(-23 + 54\beta^2\cos^2\theta - 30\beta^4\cos^4\theta\right) \\ &+ \frac{1}{64}\frac{\hat{s}^3}{M_V^2}\left(1 - \beta^2\cos^2\theta\right)^3\left(113 - 49\beta^2\cos^2\theta\right) \end{aligned} \quad (97)$$

$$\begin{aligned} F_{13} &= -4\cdot\left(3 + 5\beta^2\cos^2\theta\right) + 5\frac{\hat{s}}{M_V^2}\left(1 - \beta^2\cos^2\theta\right)\left(3 + \beta^2\cos^2\theta\right) \\ &- \frac{1}{8}\frac{\hat{s}^2}{M_V^2}\left(1 - \beta^2\cos^2\theta\right)^2\left(119 + 13\beta^2\cos^2\theta\right) \\ &+ \frac{1}{32}\frac{\hat{s}^3}{M_V^2}\left(1 - \beta^2\cos^2\theta\right)^3\left(79 - 15\beta^2\cos^2\theta\right) \end{aligned} \quad (98)$$

$$\begin{aligned} F_{14} &= 3 + 5\beta^2\cos^2\theta - \frac{5}{4}\frac{\hat{s}}{M_V^2}\left(1 - \beta^2\cos^2\theta\right)\left(8 + \beta^2\cos^2\theta\right) \\ &+ \frac{1}{32}\frac{\hat{s}^2}{M_V^2}\left(1 - \beta^2\cos^2\theta\right)\left(321 - 324\beta^2\cos^2\theta - 13\beta^4\cos^4\theta\right) \\ &+ \frac{11}{64}\frac{\hat{s}^3}{M_V^2}\left(1 - \beta^2\cos^2\theta\right)^2\left(-23 + 7\beta^2\cos^2\theta\right) \\ &+ \frac{1}{256}\frac{\hat{s}^4}{M_V^2}\left(1 - \beta^2\cos^2\theta\right)^3\left(135 - 22\beta^2\cos^2\theta + 15\beta^4\cos^4\theta\right). \end{aligned} \quad (99)$$

The coefficients $\bar{F}_i(\hat{s},\beta)$ for the integrated cross section for $gg \to V\overline{V}$ are:

$$\bar{F}_0 = \beta\left(\frac{523}{4} - 90\beta^2 + \frac{93}{4}\beta^4\right) - \frac{3}{4}(65 - 83\beta^2 + 19\beta^4 - \beta^6)\log\left|\frac{1+\beta}{1-\beta}\right|$$

$$\bar{F}_1 = -4\beta(41 - 9\beta^2) - \frac{87}{2}(1 - \beta^2)\log\left|\frac{1+\beta}{1-\beta}\right| \quad (100)$$

$$\bar{F}_2 = 30\beta(1 - \beta^2) - 25(1 - \beta^2)\log\left|\frac{1+\beta}{1-\beta}\right| \quad (101)$$

$$\bar{F}_3 = \beta(75 - 9\beta^2) + \frac{7}{4}\beta\frac{\hat{s}}{M_V^2} - \frac{3}{4}(1 - 61\beta^2)\log\left|\frac{1+\beta}{1-\beta}\right| \quad (102)$$

$$\bar{F}_4 = -2\beta(20 - 9\beta^2) + \frac{1}{2}(91 - 31\beta^2)\log\left|\frac{1+\beta}{1-\beta}\right| \quad (103)$$

$$\bar{F}_5 = \beta\left(\frac{209}{6} - 9\beta^2\right) + \frac{263}{12}\beta\frac{\hat{s}}{M_V^2} + \frac{3}{2}\beta\frac{\hat{s}^2}{M_V^2} - \left(\frac{219}{4} - \frac{31}{4}\beta^2 + \frac{\hat{s}}{M_V^2}\right)\log\left|\frac{1+\beta}{1-\beta}\right| \quad (104)$$

$$\bar{F}_6 = -9\beta - \frac{7}{4}\beta\frac{\hat{s}}{M_V^2} - \left(\frac{103}{8} + \frac{3}{8}\beta^2\right)\log\left|\frac{1+\beta}{1-\beta}\right| \quad (105)$$

$$\bar{F}_7 = \frac{55}{2}\beta - \frac{17}{4}\beta\frac{\hat{s}}{M_V^2} - \left(\frac{185}{8} - \frac{1}{8}\beta^2\right)\log\left|\frac{1+\beta}{1-\beta}\right| \quad (106)$$

SCALARS :

$$\sigma_{S\bar{S}}^{q\bar{q}} = \frac{2\pi\alpha_s^2}{27\hat{s}}\beta^3$$

$$\sigma_{S\bar{S}}^{gg} = \frac{\pi\alpha_s^2}{96 s}\left\{\beta(41-31\beta^2) - (17-18\beta^2+\beta^4)\, L(\beta)\right.$$

∴ SUSY : SQUARKS

CORRECT IN :

GRIFOLS, MENDEZ '82

ANTONIADIS et al. '84

EHLQ '84

ALTARELLI, RÜCKL '84

DAWSON, EICHTEN, QUIGG '85

JB, KRYUKOV, BOOS '96

HARRISON, LLEWELLYN SMITH '83 (E!)

VECTORS :

$$\sigma_{V\bar{V}}^{q\bar{q}} = \frac{4\pi\alpha_s^2}{9M_V^2}\sum_{i=0}^{5} \chi_i^q(\kappa,\lambda)\,\tilde{G}_i(\hat{s},\beta)$$

$$\sigma_{V\bar{V}}^{gg} = \frac{\pi\alpha_s^2}{96 M_V^2}\sum_{i=0}^{14} \chi_i^g(\kappa,\lambda)\,\tilde{F}_i(s,\beta)$$

$\lambda = \kappa = 0$:

(Y-M-type)

$$\sigma_{V\bar{V}}^{q\bar{q}} = \frac{4\pi\alpha_s^2}{9M_V^2}\left[\frac{1}{24}\frac{\hat{s}}{M_V^2} + \frac{23-3\beta^2}{24}\right]$$

!

$$\sigma_{V\bar{V}}^{gg} = \frac{\pi\alpha_s^2}{96 M_V^2}\left[\beta A - L(\beta)\cdot B\right]$$

$$A = \frac{523}{4} - 90\beta^2 + \frac{93}{4}\beta^4$$

$$B = \frac{3}{4}\left(65 - 83\beta^2 + 19\beta^4 - \beta^6\right).$$

ARNOLD, WENDT '86.

BORISOV et al '87.

JB, BOOS, KRYUKOV '9.

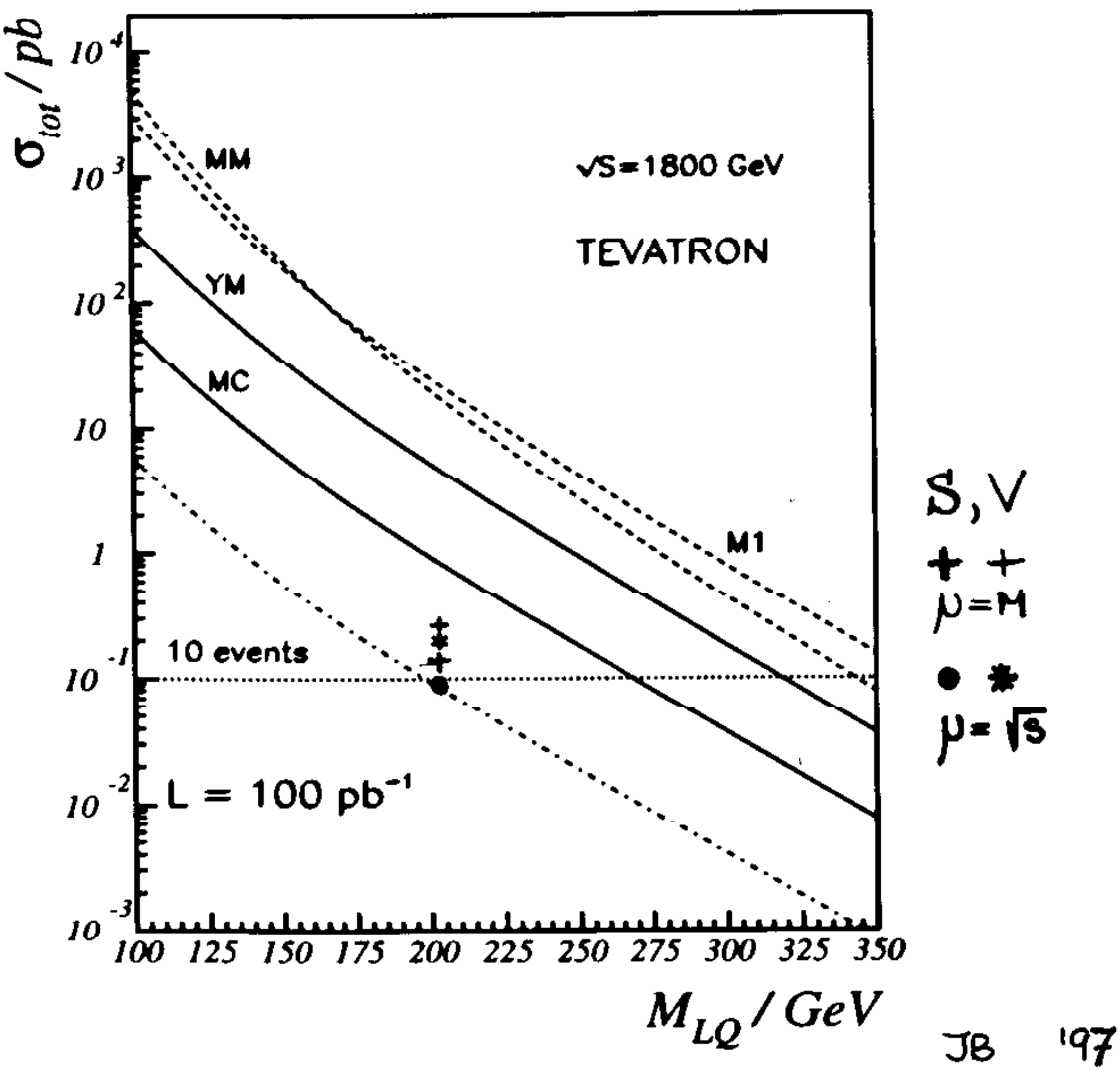

Figure 1: Integrated cross sections for scalar vector leptoquark pair production at the TEVATRON, $\sqrt{s}$ = 1.8 TeV choosing the renormalization and factorization scale by $\mu = \sqrt{s}$. Dash-dotted line : scalar leptoquarks; fill lines : YM : Yang-Mills type coupling $\kappa_G = \lambda_G \equiv 0$; MC : minimal vector coupling $\kappa_G = 1, \lambda_G = 0$; dashed lines : other choices for the anomalous couplings : MM : $\kappa_G = \lambda_G = -1$, M1 : $\kappa_G = -1, \lambda_G = +1$. The asterisk denotes the minimum of the pairproduction cross section for vector leptoquarks with respect to the anomalous couplings at $M_V = 200$ GeV.

K-FACTOR: M. KRÄMER et al. (to appear)

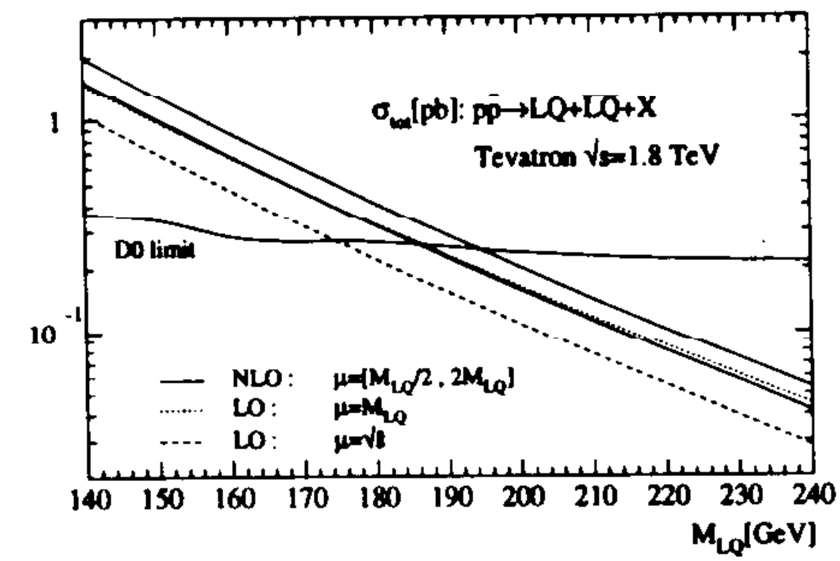

Figure 4: *Total cross section $p+\bar{p}\to LQ+\overline{LQ}+X$ at the Tevatron energy $\sqrt{s}=1.8$ TeV as a function of the leptoquark mass M_{LQ}. Parameters as described in the text. Also shown is the 95% cross section limit for pair production of first generation scalar leptoquarks (branching fraction into charged leptons $BR(eq)=1$) as obtained by the D0 collaboration, Refs.[10].*

$\approx \sigma(\tilde{q}\bar{\tilde{q}})\,\big|_{M_{\tilde{g}}\to\infty}$

$M=\mu=200$ GeV

$K\sim 1.12$

SUMMARY

- AN INTERPRETATION OF THE HERA EXCESS EVENTS AS DUE TO SINGLE LEPTOQUARK PRODUCTION IS CONSISTENT WITH THE CURRENT BOUNDS FROM ALL OTHER PROCESSES.

- TEVATRON COMES ALREADY TIGHT TO THE RANGE OF $M \sim 200$ GeV PROBING DIFFERENT COUPLINGS.
  IF THE EVENTS ARE DUE TO LQ'S PAIRPRODUCTION HAS TO BE OBSERVED AT TEVATRON AT ONLY A SOMEWHAT LARGER STATISTICS.

- AT HERA ALSO $eq \to S, V\, g$ SHOULD BE MEASURED SOON IN THIS CASE ((eq) + JET SHOWING <u>PROPAGATION</u> OF A PARTICLE – UNLIKE 4 - FERMION INTERACTIONS.

... IT BECOMES AN EXCITING YEAR.