DIS Rome 96 – Chicago 97
Theory / Developments

Yu. Dokshitzer
INFN, Milan
INP, St. Petersburg

Physical <u>Theory</u> is a theory of physical <u>Phenomena</u>

However : Phenomenological Theory

Theoretical Phenomenology

PT : [at equilibrium] = internal logic of self-deployment
Beauty, "predict–check–feed back" relation with P.

TP : [turbulent]
for an insider : painful search for new principles
triggered by some "out-of-order" P.
for an outsider – an easy target since the first ideas
and constructions are bound to look naive,
cumbersome, unnatural , ...

Drama of a transition period to nowhere / PT

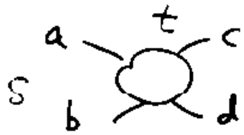
The Main Weakness : "a Theory of 1 Phenomenon"

Illustration: eq. from "Whaler's Book" (discovered high up and deep inside Pamir mountains By S.V. Maleev (70

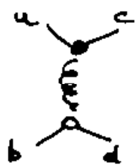
$V = \pi R^2 L$ where

numerical constant π for GREENLAND Whales is appr. 3.14

The core of the problem –
DIS at very small x_B is similar to
hadron–hadron interactions at large S.



$s \ggg m^2 \Rightarrow$
t = fixed



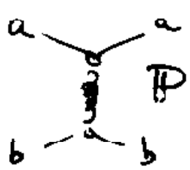
Reggeon – an object (particle) with as if t-dependent spin

$\alpha_{(a\bar{c})}(t) \leftarrow$ trajectory

$\sigma_{ab} \sim (S)^{2(\alpha(t)-1)}$ quantum numbers of the $a\bar{c}$ system (t-channel)

Underlying physics : Analiticity (causality)
Crossing (CPT) and
Unitarity in t^+

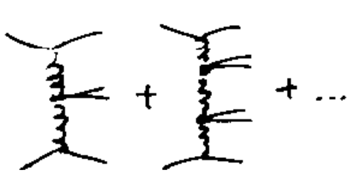
Peculiar trajectory – vacuum pole (singularity) (Grib
or Pomeron (Gell-Mann)



- total Xsections
- elastic
- diffractive

$\alpha_{I\!P}(t) = 1 + \alpha' t + \dots$

Was found to be an UNSTABLE problem :



$\sim (\ln s)^N \Rightarrow$ Bigger than σ_{tot} !?

Large-M^2 bunches $\Rightarrow$ "enhanced" Reggeon diagrams

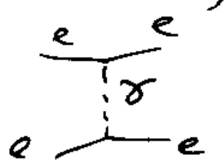
A =  $\Rightarrow$ σ =  $\Rightarrow$  ;  etc.

"Critical" system ~ boiling pot

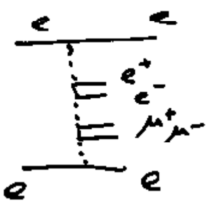
Allowing for $-1+\alpha_{\mathbb{P}} > \emptyset$ did not make it any Better: supercritical Pomeron intrinsically may be more consistent but violently violates Froissart Bound $\sigma \sim s^{\Delta} \gg \ln^2 s$.
(Problem of S-channel Unitarity)

in Field Theory:

QED



photon ($C=-1$)
does not Reggeize (electron does)
$\alpha_{\gamma}(t) \equiv 1$

$\sigma = \Big|$  $\Big|^2$

Vacuum trajectory (Perturbatively)
a branch (·) $\alpha_P > 1$ $\quad O(\alpha^2_{e.m.})$

QCD Gluons and quark Reggeize nicely
Vacuum $\simeq$ BFKL

Additional headache: Perturbation Theory, strictly speaking, is NOT APPLICABLE!

DIS: X-dependence of SFs at small X cannot be predicted (and never could, at $X \sim 1$) from 1st principles (PT principles, that is)

Still, in special circumstances (squeezed systems)
Mueller-Navelet jet pairs ($\hat{s} \gg p_\perp^2$)
Onium-Onium Xsection
(Large) Rapidity Gap events $\quad (\hat{s})^{\Delta}$ for large but limited $\hat{s}$

CU-TP-799

Limitations on using the operator product expansion at small values of x*

A.H. Mueller
Department of Physics, Columbia University
New York, New York 10027, USA

Abstract

Limits on the regions of Q^2 and x where the operator product expansion can be safely used, at small values of x are given. For a fixed large Q^2 there is an $x_0(Q^2)$ such that for Bjorken x-values below x_0 the operator product expansion breaks down with significant nonperturbative corrections occurring in the leading twist coefficient and anomlous dimension functions due to diffusion of gluons to small values of transverse momentum.

1 Introduction

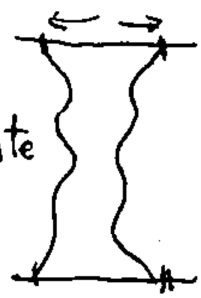
For hard scattering processes involving two transverse momentum scales, one of which is the hard scattering scale, factorization and the Dokshitzer, Gribov, Lipatov, Altarelli, Parisi (DGLAP) equation[1-3] furnish the basis for a systematic description of the dependence of cross sections on the hard scale. For example, in deep inelastic lepton proton scattering the two scales are the inverse size of the proton, proportional to the QCD Λ-parameter, and the virtuality, Q, of the

*This research is supported in part by the Department of Energy under GRANT DE-FG02-94ER40819.

Diffusion in Onium-Onium scattering and OPE Breaking

inverse size of Onium: $k_0 \sim 1/R$

moderate Y



too large Y

$k_\perp \leq \Lambda_{QCD}$

Limiting value

$$Y < Y^{OPE}_{max}(k_0) \simeq \frac{\pi}{14 N_c \zeta(3) b^2} \cdot \frac{1}{\alpha_s^3(k_0)} \simeq \left(\frac{1}{2\alpha_s(k_0)}\right)^3$$

Unitarity problem comes in at

$$Y^{UN.} = \frac{2}{\alpha_{I\!P} - 1} \ln \frac{1}{\alpha_s(k_0)} \sim \frac{1}{\alpha_s(k_0)}$$

For a tiny object, $\boxed{1 \ll Y^{UN.} \ll Y^{OPE}}$

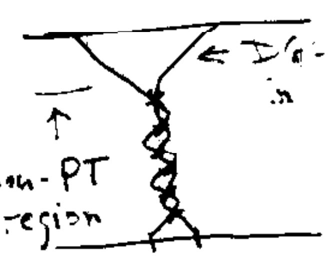
$\Rightarrow$ theoretical laboratory

DIS at small x – a much darker picture

Start evolution from Q_0, then

$$\ln \frac{\bar{x}}{x} \lesssim \frac{\pi}{14 N_c \zeta(3) \alpha_s} \ln^2 \frac{Q_0}{\Lambda} \simeq \left(\frac{1}{2\alpha_s(Q_0)}\right)^3$$

$\bar{x} \sim 0.1$



k-Factorization and Small-x Anomalous Dimensions

G. Camici and M. Ciafaloni

Dipartimento di Fisica, Università di Firenze

and INFN, Sezione di Firenze

Largo E. Fermi, 2 - 50125 Firenze

DFF 264/01/97

Abstract

We investigate the consistency requirements of the next-to leading BFKL equation with the renormalization group, with particular emphasis on running coupling effects and NL anomalous dimensions. We show that, despite some model dependence of the bare hard Pomeron, such consistency holds at leading twist level, provided the effective variable $\alpha_s(t) \log(1/x)$ is not too large. We give a unified view of resummation formulas for coefficient functions and anomalous dimensions in the Q_0-scheme and we discuss in detail the new one for the $q\bar{q}$ contributions to the gluon channel.

PACS 12.38.Cy

Model (In)dependent Features of the Hard Pomeron

hep-ph/9612235

BFKL equation for ω-partial wave

$$f(t) = f_0(t) + \frac{\bar{\alpha}_s(t)}{\omega} \int dt' \, K(t,t') \, f(t')$$

$t = \ln(k^2/\Lambda^2)$
$t' = \ln(k'^2/\Lambda^2)$

Spectral representation $K(t,t') = \int \frac{d\gamma}{2\pi i} \, e^{(\gamma-\frac{1}{2})(t-t')} \, \chi(\gamma)$

$\gamma = \frac{1}{2}$ a critial point ; $\chi_{min} = \chi(\frac{1}{2})$ $\quad \sim \left(\frac{k^2}{k'^2}\right)^{\gamma}$

$\Rightarrow$ singularity in ω

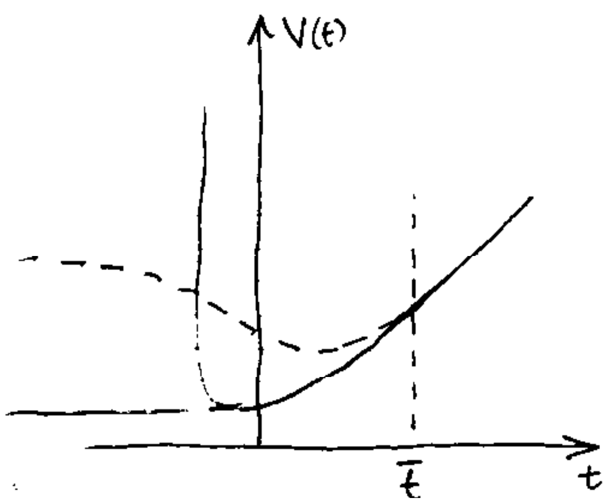
Locality in $(t-t') \Rightarrow$

$$K(t\,t') \approx \chi(\tfrac{1}{2}) \left(1 + \frac{1}{2} \frac{\chi''(\frac{1}{2})}{\chi(\frac{1}{2})} \partial_t^2 + \dots \right) \delta(t-t')$$

$$f(t) - f_0(t) = \frac{\alpha_s(t)}{\omega} \left(1 + a^2 \partial_t^2\right) f(t) \,, \qquad a = \chi''/\chi \qquad (*)$$

Schrödinger eq. for the homegeneous part of $(*)$

$$\left(\partial^2 + V(t)\right) f \,, \qquad \text{"potential"} \quad V \sim \frac{\omega}{\alpha_s(t)} \sim \ln \frac{k^2}{\Lambda^2}$$



—— sharp cutoff $\alpha_s = \emptyset$, discrete spectrum, $\mathbb{P}$ = pole

—— α_s frozen, continuum, = Branch

- - - - α_s with maximum ... it depends ...

Explicit solution(s) : $\sqrt{k^2} F(k^2, Q^2) \sim f_+(\omega, t) \left[\underline{f}(\omega, t_0) + \overset{\text{soft } \mathbb{P}}{R_\omega} f_+(\omega, t_0) \right]$
$t > \bar{t}$

"nature and location free driven but soft hadronic interactio

BUDKERINP/96-92
December 1996

GLUON PAIR PRODUCTION IN THE QUASI-MULTI-REGGE KINEMATICS *

V.S. Fadin†

Budker Institute for Nuclear Physics and Novosibirsk State University, 630090 Novosibirsk, Russia

M.I. Kotsky†

Budker Institute for Nuclear Physics 630090 Novosibirsk, Russia

L.N. Lipatov‡

Petersburg Nuclear Physics Institute Gatchina, 188350 St.Petersburg, Russia

Abstract

To find the region of applicability of the leading log(1/x) approximation for parton distributions in the small x region and to fix the argument of the QCD running coupling it is necessary to know radiative corrections to the kernel of the BFKL equation. The next-to-leading corrections to the BFKL kernel are expressed in terms of the two-loop correction to the gluon Regge trajectory, one-loop correction to the Reggeon-Reggeon-gluon vertex, and contributions from two-gluon and quark-antiquark production in the quasi-multi-Regge kinematics. We calculate differential and total cross sections of the two gluon production. Differentia cross section can be applied for description of two jet production in the quasi-multi-Regge kinematics; the total cross section defines corresponding correction to the BFKL kernel. To escape the infrared divergencies we use dimensional regularization of the Feynman integrals.

---

* *Work supported by the Russian Fund of Basic Researches, grants 95-02-04609 and 96-02-19299a.*

† *email address:* FADIN, KOTSKY @INP.NSK.SU

‡ *email address:* LIPATOV@THD.PNPI.SPB.RU

One $\log\frac{1}{x}$ down:

—— gluon (Particle)

—— reggeized gluon (Reggeon)

V_{PPR}

R-trajectory

Fadin, Fiore, Kotsky, Quartarolo (95-96

Γ_{RRP}

Real contributions: "2-loop" addition to the BFKL kernel

Camici, Ciafaloni

Fadin, Kotsky, Lipatov

α_s runs, as expected, with $K^{\perp}_{q\bar{q},gg}$

Important subleading effects:

$x_1 \sim x_2$; kinematical restrictions (t_{min})

Angular structure of the final state glue

consequence of QCD coherence

BMSS : physically motivated NL effects

$\Rightarrow$ $\gamma_{cr} > 1/2$, singularity softer,

diffusion reduced (competing with $\alpha_s(k)$)

important: framework for analysis of the final state structure (BFKL = too inclusi

!! Particles in the FS are mainly those which do not affect σ (SF). Watch out !!

BFKL DGLAP CCFM

hep-ph/9702418
IFUM 552-FT
February, 1997

Structure functions and angular ordering at small x[1]

G. Bottazzi, G. Marchesini, G.P. Salam, and M. Scorletti

Dipartimento di Fisica, Università di Milano,
INFN, Sezione di Milano, Italy

Abstract

We compute the gluon distribution in deep inelastic scattering at small x by solving numerically the angular ordering evolution equation. The leading order contribution, obtained by neglecting angular ordering, satisfies the BFKL equation. Our aim is the analysis of the subleading corrections. Although not complete — the exact next-to-leading contribution is not yet available — these corrections are important since they come from the physical property of coherence of QCD radiation. In particular we discuss the subleading correction to the BFKL characteristic function and the gluon distribution's dependence on the maximum available angle. Conformal invariance of the BFKL equation is lost, however this is not enough to bring the small-x gluon distribution into the perturbative regime: although large momentum regions are enhanced by angular ordering, the small momentum regions are not fully suppressed. As a consequence, the gluon anomalous dimension is finite and tends to the BFKL value $\gamma = 1/2$ for $\alpha_S \to 0$. The main physical differences with respect to the BFKL case are that angular ordering leads to 1) a larger gluon anomalous dimension, 2) less singular behaviour for $x \to 0$ and 3) reduced diffusion in transverse momentum.

[1] Research supported in part by the Italian MURST and the EC contract CHRX-CT93-0357

DTP/97/18
March 1997

A unified BFKL and GLAP description of F_2 data

J. Kwiecinski[a,b], A.D. Martin[a] and A.M. Stasto[a,b]

[a] Department of Physics, University of Durham, Durham, DH1 3LE, UK.
[b] H. Niewodniczanski Institute of Nuclear Physics, Department of Theoretical Physics, ul. Radzikowskiego 152, 31-342 Krakow, Poland.

Abstract

We argue that the use of the universal *unintegrated* gluon distribution and the k_T (or high energy) factorization theorem provides the natural framework for describing observables at small x. We introduce a coupled pair of evolution equations for the unintegrated gluon distribution and the sea quark distribution which incorporate both the resummed leading $\ln(1/x)$ BFKL contributions and the resummed leading $\ln(Q^2)$ GLAP contributions. We solve these unified equations in the perturbative QCD domain using simple parametic forms of the nonperturbative part of the *integrated* distributions. With only two (physically motivated) input parameters we find that this k_T factorization approach gives an excellent description of the measurements of $F_2(x,Q^2)$ at HERA. In this way the unified evolution equations allow us to determine the gluon and sea quark distributions and, moreover, to see the x domain where the resummed $\ln(1/x)$ effects become significant. We use k_T factorization to predict the longitudinal structure function $F_L(x,Q^2)$ and the charm component of $F_2(x,Q^2)$.

hep-ph/9612425

Hard diffractive electroproduction, transverse momentum distribution and QCD vacuum structure

Igor Halperin and Ariel Zhitnitsky

Physics and Astronomy Department
University of British Columbia
6224 Agriculture Road, Vancouver, BC V6T 1Z1, Canada
e-mail addresses: higor@axion.physics.ubc.ca
arz@physics.ubc.ca

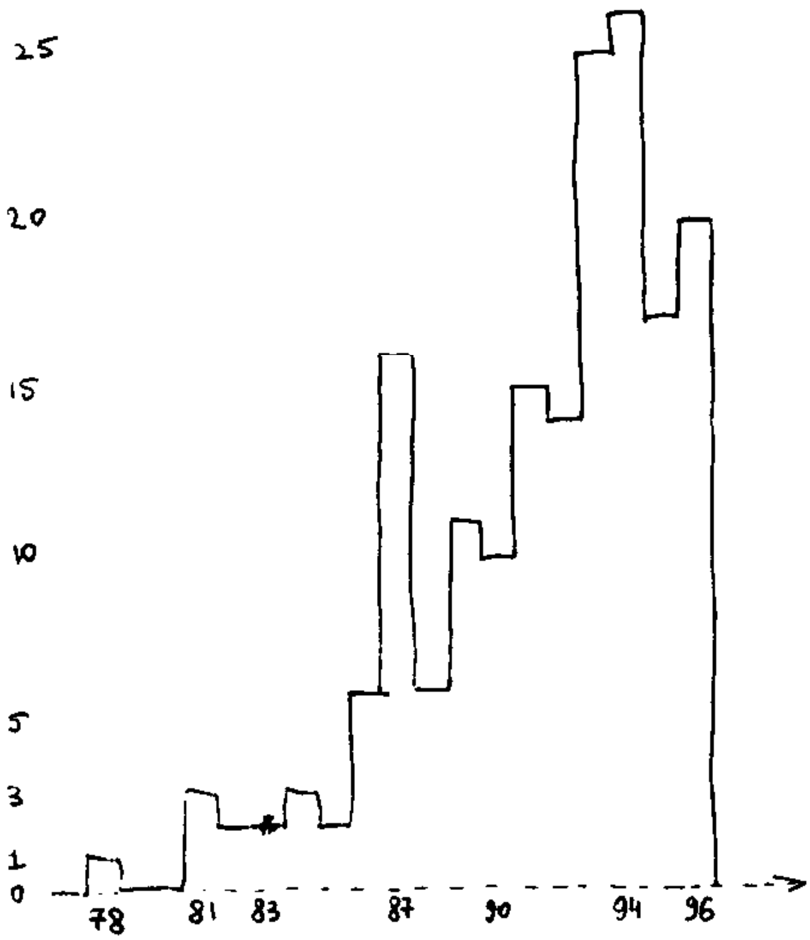
hep-ph/9612425 19 Dec 96

Abstract:

We study the impact of the "intrinsic" hadron transverse momentum on the pre-asymptotic behavior of the diffractive electroproduction of longitudinally polarized ρ-meson. Surprisingly, we find the onset of the asymptotic regime in this problem to be rather low, $Q^2 \simeq 10\ GeV^2$ where power corrections due to the transverse momentum do not exceed 20 % in the amplitude. This drastically contrasts with exclusive amplitudes where the asymptotics starts at much higher $Q^2 = 50 - 100\ GeV^2$. The sources of such unexpected behavior are traced back to some general (the quark-hadron duality) as well as more silent (properties of higher dimensional vacuum condensates) features of QCD.

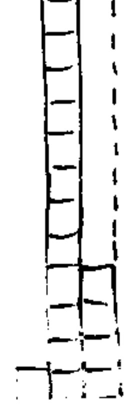
submitted to Phys. Rev. D

LeptoQuark : 20 years of



96

97



28. hep-ph/9704275
The high-Q^2 Hera anomaly and supersymmetric unification
Authors: Riccardo Barbieri, Zurab Berezhiani, Alessandro Strumia

27. hep-ph/9704248
Electroweak-Scale Excess Cross-Sections in the Sextet Quark "Standard Model"
Author: Alan R. White

26. hep-ph/9704241
e^+e^- Annihilation into Hadrons at LEP2 in the Presence of the Anomalous DESY Positron-Jet Event Phenomenon
Authors: S. Jadach, B. F. L. Ward, Z. Was

25. hep-ph/9704221
Stops in R-parity Breaking Model for High-Q^2 Events at HERA
Authors: T. Kon, T. Kobayashi

24. hep-ph/9704214
QCD aspects of leptoquark production at HERA
Authors: C. Friberg, E. Norrbin, T. Sjöstrand

23. hep-ph/9703460
HERA high Q^2 events as indications of excited leptons with weak isotopic spin 3/2
Author: B. A. Arbuzov

22. hep-ph/9703444
R-Parity Violating Supersymmetry at HERA
Authors: Herbi Dreiner, Emanuelle Perez, Yves Sirois

21. hep-ph/9703436
Supersymmetry with R-Parity Breaking: Contact Interactions and Resonance Formation in Leptonic Processes at LEP2
Authors: J. Kalinowski, R. Rueckl, H. Spiesberger, P. M. Zerwas

20. hep-ph/9703433
Formation and Decay of Scalar Leptoquarks/Squarks in ep collisions
Authors: T. Plehn, H. Spiesberger, M. Spira, P. M. Zerwas

19. hep-ph/9703427
QCD Corrections and the Leptoquark Interpretation of the HERA High Q^2 Events
Authors: Z. Kunszt, W. J. Stirling

18. hep-ph/9703379
Contact Terms, Compositeness, and Atomic Parity Violation
Author: Ann E. Nelson

17. hep-ph/9703375
Four-Fermion Effective Interactions and Recent Data at HERA
Authors: Nicola Di Bartolomeo, Marco Fabbrichesi

16. hep-ph/9703372
Leptoquark production at LEP2
Author: Costas G. Papadopoulos

15. hep-ph/9703369
Like-Sign Dileptons at the Fermilab Tevatron Revisited in the Light of the HERA High-Q^2 Anomaly
Authors: Debajyoti Choudhury, Sreerup Raychaudhuri

14. hep-ph/9703346
Bounds on Contact Interactions from LEP1 Data and the High-Q^2 HERA Events
Authors: M. C. Gonzalez-Garcia, S. F. Novaes

13. hep-ph/9703338
Constraints on Leptoquark Masses and Couplings from Rare Processes and Unification
Authors: G. K. Leontaris, J. D. Vergados

12. hep-ph/9703337
Much Ado About Leptoquarks: A Comprehensive Analysis
Authors: JoAnne L. Hewett, Thomas G. Rizzo

11. hep-ph/9703316
Removing flavor changing neutral interactions from leptoquark exchange
Author: M. Suzuki

10. hep-ph/9703311
Contact Interactions and high-Q^2 events in e^+p collisions at HERA
Authors: V. Barger, Kingman Cheung, K. Hagiwara, D. Zeppenfeld

9. hep-ph/9703290
Comments on the high-Q^2 HERA anomaly
Authors: K.S. Babu, Christopher Kolda, John March-Russell, Frank Wilczek

8. hep-ph/9703288
Leptoquark/Squark Interpretation of HERA Events: Virtual Effects in e+e- Annihilation to Hadrons
Authors: J. Kalinowski, R. Rueckl, H. Spiesberger, P. M. Zerwas

7. hep-ph/9703287
On the Expectations for Leptoquarks in the Mass Range of O(200 GeV)
Author: J. Blmlein

6. hep-ph/9703285
What Can We Learn About Leptoquarks At LEP200?
Authors: Michael A. Doncheski, Stephen Godfrey

5. hep-ph/9703279
High Q2-Anomaly at HERA and Supersymmetry
Authors: H. Dreiner, P. Morawitz

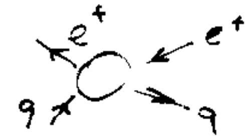
4. hep-ph/9703276
Pursuing interpretations of the HERA large-Q2 data
Authors: G. Altarelli, J. Ellis, S. Lola, G. F. Giudice, M. L. Mangano

3. hep-ph/9703255
Rapidity Gap of Weakly Coupled Leptoquark Production in ep Collider
Author: T. K. Kuo, Taekoon Lee

2. hep-ph/9702392
R-Parity Violation at HERA ?
Authors: Debajyoti Choudhury, Sreerup Raychaudhuri

1. hep-ph/9702378
SU(4) Preonic Interpretation of the HERA Positron-Jet Events
Author: Stephen L. Adler

0. hep-ph/9701285
Scalar Leptoquark Pair Production at the CERN LHC: Signal and Backgrounds
Authors: B. Dion, M. de Montigny, L. Marleau, G. Simon

Starting point: news hidden in 

New exchange Boson?

[9][2][7][4]

(I) IF TOO HEAVY then

$$\mathcal{L} = \sum_{i,j=L,R} \frac{4\pi}{(\Lambda^q_{ij})^2}\, \eta^q_{ij} \left(\bar{e}_i \gamma_\mu e_i\right)\left(\bar{q}_j \gamma_\mu q_j\right)$$

$$L/_R \times L/_R \times u/d \quad \times \quad \eta = \pm 1 = 16 \text{ options}$$

α). no SCALAR effective interaction ALLOWED
strongly suppressed by helicity violating (π) decays

β). direct limits on Λ^q_{ij}
OPAL + CDF , typically $\Lambda \sim 0.8 - 3$ TeV

γ). Strong constraints from Atomic Parity Violation

Cesium ($Z = 55$, $N \approx 78$) $\qquad Q_W^{exp} = -71.04 \pm 1.81$

$$Q_W^{SM} = -73.12 \pm 0.09$$

Contact interaction contributes

$$\Delta Q_W = -2\left[C_{1u}(2Z+N) + C_{1d}(Z+2N)\right]$$

with $$C_{1q} = \frac{\sqrt{2}\pi}{G_F}\left(\frac{\eta^q_{RL}}{(\Lambda^q_{RL})^2} - \frac{\eta^q_{LL}}{(\Lambda^q_{LL})^2} - \frac{\eta^q_{LR}}{(\Lambda^q_{LR})^2} + \frac{\eta^q_{RR}}{(\Lambda^q_{RR})^2}\right)$$

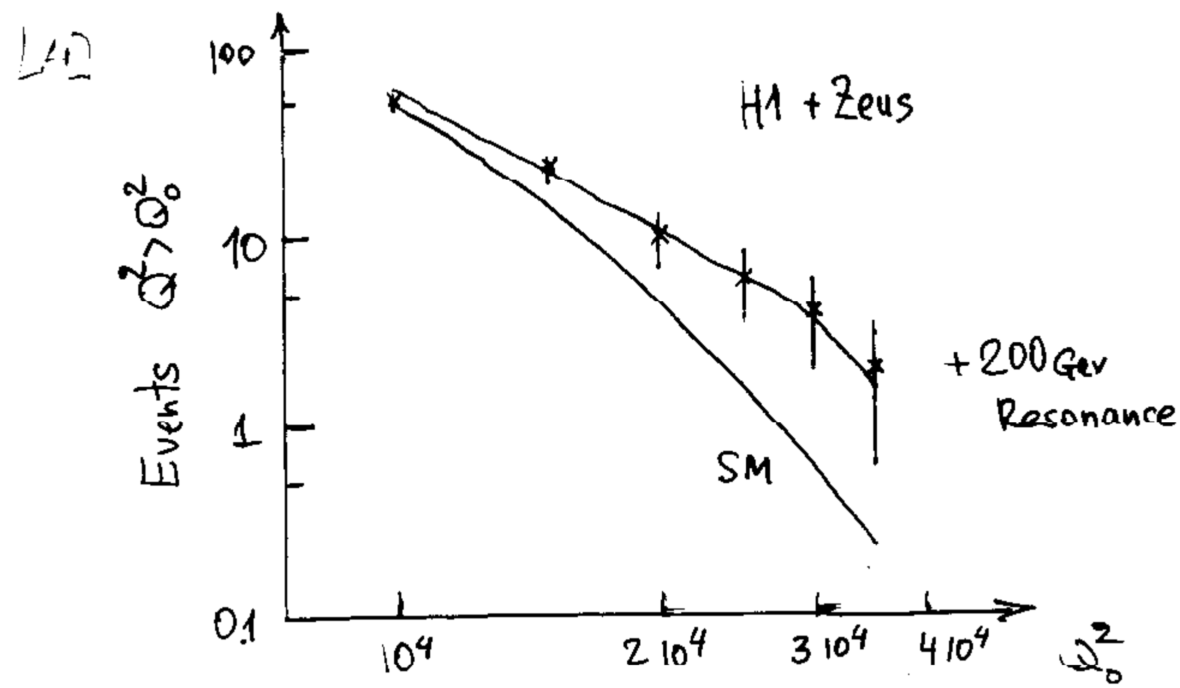
A single term with $\Lambda < 3$ TeV would produce

$$\Delta Q_W = \pm 20$$

However, Conspiracy [18]

δ). Actual fits to Q^2-distribution are not spectacul.

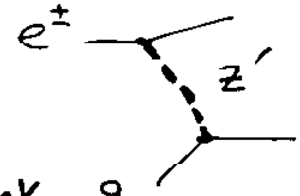
[4] $\quad \Lambda^{-d}_{LR} \quad \Lambda^{+d}_{RL} \quad \Lambda^{+u}_{LR} \quad \Lambda^{+u}_{RL}$



LAD
100
10
1
0.1
Events $Q^2 > Q_0^2$
H1 + Zeus
+ 200 GeV
Resonance
SM
10^4
$2\ 10^4$
$3\ 10^4$
$4\ 10^4$
Q_0^2

Dynamics : a new boson in

t^+

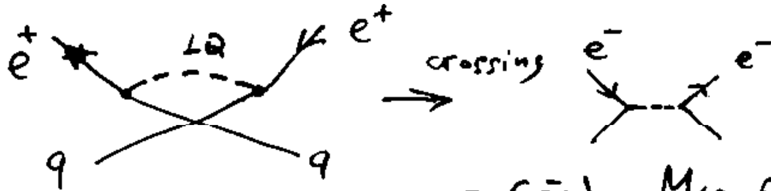


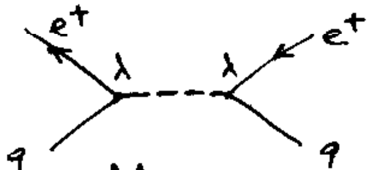
DØ + CDF : $M_{Z'} > 650$ GeV

$q\bar{q} \to Z' \to e^+e^-, \mu^+\mu^-$

moreover, would provoke a signal in (e^-p)

$\left.\begin{matrix} u^+ \\ s^+ \end{matrix}\right\}$ LQ





$M_{LQ} = 200$ GeV

$\sigma(e^-p) \sim \frac{M_{LQ}}{\Gamma_{LQ}} \sigma(e^+p)$

given typical $\Gamma \sim 10$ MeV

$\Rightarrow 10^3$ e^-p events

Quantum numbers

LQ = lepton and baryon charges, colour,
$J = 0, 1, \dots$; fermion nmb. $(F = 0, 2)$,
SU(2) isospin

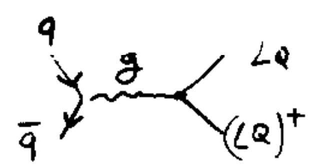
a. $F = 0$ Valence quark production

arguments : $x \sim 0.5$; sea suppressed as $d/50$, $u/200$

otherwise, $\left\{\begin{matrix}\text{few events in } (e^-p) \\ \text{dangerously large coupling } \lambda\end{matrix}\right.$

b. $J = 0$ (scalar LQ)

arguments : Tevatron pair production



DØ : $\sigma \leq 0.4$ pb

while, allowing <u>maximal</u> conspiracy between normal QCD-charge and <u>anomalous</u> colour coupling still pushes . $M_{LQ}^{J=1} > 215$ (240) GeV [9]

[4] estimate Tevatron scalar LQ production

$\sigma \simeq 0.2$ pb (Vector overshooting by 10)

Mind the gap!

Combined CDF + DØ exclusion limit

$19\cancel{4}$ (143) GeV for $B(e^+q) = 1 \ (\frac{1}{2})$

Another decay channels

<u>Neutrino?</u>

1). $e^+u \to LQ \to e^+u + \bar{\nu}_e$? $+5/3$

2). $e^+d \to LQ \to e^+d + \bar{\nu}_e u$??

"No-Go" for 2)

Doublet structure of the $LQ \to L + Q$ coupling:

$$e^+_L\ (u_L, d_L) \quad (e^+_R, \bar{\nu}_R)\, u_R \quad (e^+_R \bar{\nu}_R)\, d_R$$

$\Rightarrow$ LQ must couple to R and L leptons
forbidden by π - decays

(May be) Good News: no signal in CC

A Special Offer

- R-parity violating SUSY object = squark

(no signal in e^-p and e^+p-CC, room for other than e^+q decay modes)

$$R = (-1)^{3B+L+2S} = \begin{cases} +1 & \text{for quarks, leptons, ...} \\ -1 & \text{for s-partners} \end{cases}$$

[22] Depending on the nature of the lightest χ_0 (one of $\tilde{\gamma}, \tilde{Z}, 2\tilde{H}_0$), 8 distinctive final state signals (high-$P_\perp$ $e^\pm$ and/or missing $P_\perp$ and jet(ss))

Dynamics

Minimal SUSY extension of the SM + R-parity violation

$$W_{\not R} = \lambda_{ijk} L_i L_j e^c_k + \lambda'_{ijk} L_i Q_j d^c_k + \lambda''_{ijk} u^c_i d^c_j d^c_k$$

SU(2) doublets and singlets – superfields

$\lambda'_{111} \cdot e^-_L \, \tilde{u}_L \, d^c_R \quad \Rightarrow \quad e^+_R d_R \to \tilde{u}_L \qquad \lambda'_{111}$

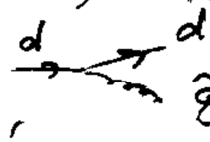
$\tilde{u}_L$ – squark $\qquad \to \tilde{c}_L \qquad \lambda'_{121}$

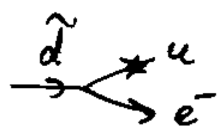
$\qquad \to \tilde{t}_L \qquad \lambda'_{131}$

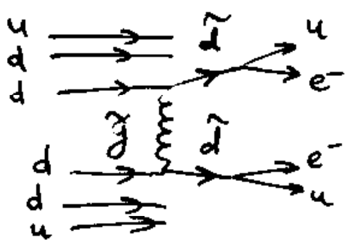
Good Old Physics

$$|\lambda'_{111}| < 7 \cdot 10^{-3} \left(\frac{m_{\tilde{q}}}{200\,\mathrm{GeV}}\right)^2 \left(\frac{m_{\tilde{g}}}{1\,\mathrm{TeV}}\right)^{1/2}$$

(while $\lambda' \gtrsim 0.03$ is needed)

Normal SUSY converts  gluino

then  via λ'_{111}, as a result



= 0ν double-β decay

$e^+ d \to \tilde{c} \; (\tilde{t})$

$\tilde{c}$ – scenario $\Rightarrow$ discoveries around the corner:

(restricted by FCNC)

$K^+ \to \pi^+ \nu \bar{\nu}$

new effects in D^0-$\bar{D}^0$ mixing and $D^0 \to e^+ e^-$, $D^+ \to \pi^+ e^+ e^-$

$\tilde{t}$ – scenario $\Rightarrow$ potentially large contribution to ρ

Products of two λ's severely restricted :

Δm_K $(\lambda'_{i12}\lambda'_{i21})$ Δm_B $(\lambda'_{i13}\lambda'_{i31})$

$\mu Ti \to e Ti$ $(\lambda'_{11k}\lambda'_{21k}$ and $\lambda'_{1j1}\lambda'_{2j1})$

$K_L \to \mu e$ $(\lambda'_{1j1}\lambda'_{2j2})$

ϵ_K $(\lambda'_{i12}\lambda'_{i21})$ etc., ect.

Under scrutiny :
FCNC, CC universality, ν mass(es), rare decays, mixing

Also under focus :
virtual effects in e^+e^- (~1%)
prospects for LEP-2 and NLC studies,
e^+D at HERA

"... possible backgrounds come from the production and decay of top quark pairs, ..." [4]

Conceptual problem $\lambda \cdot LLe$ ← FCNC
$\lambda'' \cdot udd$ ← proton decay

"Naturalness" ?

[28] GUT initial conditions providing peace and calm down here ...
MSSM ? [12]

[1] SU(4) preons

[27] a model "more standard" than the SM (SQM)

New Physics ? About time

We are living through hist_ric times now

o, e