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XVI International Workshop on Deep-Inelastic Scattering and Related Subjects

Discussion session : What can HERA still provide ?

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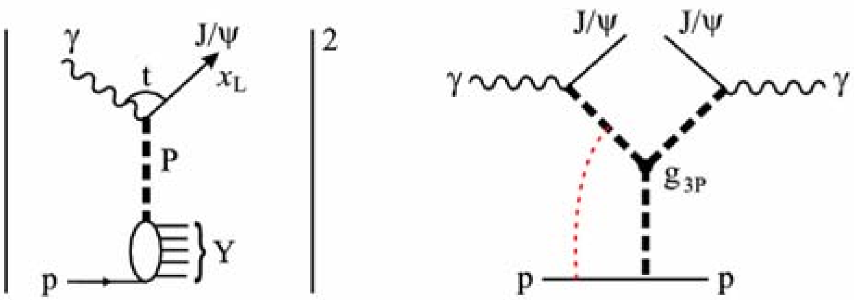
Selected topics

(based on works with A. Kaidalov, A. Martin and M. Ryskin)

- More detailed data on proton dissociation in diffractive J/ψ and Υ production (better statistics, M^2-slicing).
- Improved statistics on exclusive Υ- production (not sufficient at the moment).
- The ratio of diffractive to exclusive dijets.
- Transverse momentum distribution of secondaries in the 'Pomeron fragmentation'.

The Extraction of the Bare Triple-Pomeron Vertex



The process of proton dissociation in diffractive J/ψ photoproduction, $\gamma + p \to J/\psi + Y$, which is described by a diagram with a triple-Pomeron vertex in which the rescattering effects are small. The dotted line would mean the diagram became an enhanced diagram—this contribution is small.

Existing (ZEUS) data on J/ψ -still fragmentary

$$(M_Y = 2.5 GeV - 0.3W)$$

Needed: - improved statistics;
-distributions over M_Y^2 ;
- inelast. diffractive Υ data;

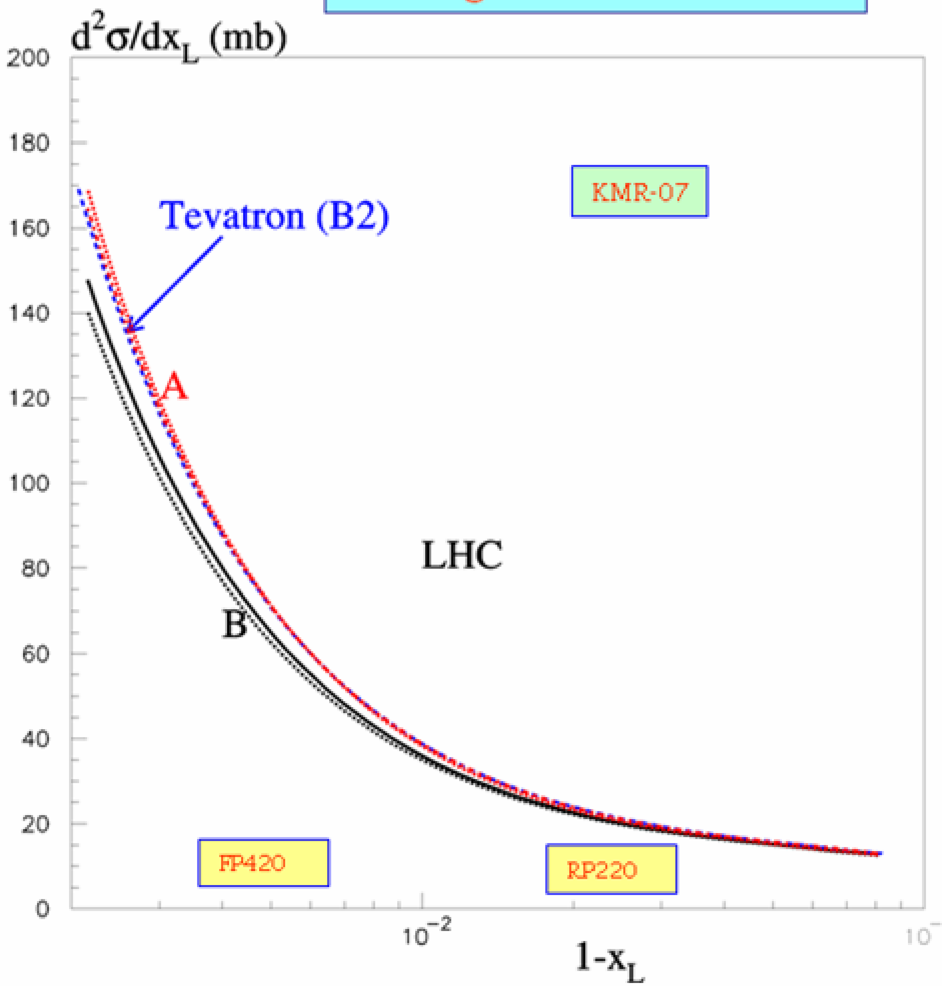
-more accurate measurements of $\sigma_Y / \sigma_{el}(J/\psi)$;

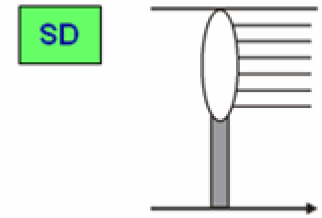
-data on $\sigma_Y / \sigma_{el}(\Upsilon)$.

(small size comp. of the proton w.f.)

- Bare g_{3P} -a crucial ingredient for understanding diffraction (e.g. S^2 calc.)
- A way to extract the information on g_{3P} → $\gamma + p \to J/\psi(\Upsilon) + Y$ (small rescatter. effects)
- KMR-06 $g_{3P}^{\text{bare}}(0) \,/\, g_N(0) \;\simeq\; 1/3.$ (by integration over ZEUS M_Y range)
- Importance of an explicit measurement of the Y-system mass spectrum.
  To perform a full triple-Regge analysis with different contributions quantified.

Leading Protons at the LHC





growth due to Pomeron interactions compensated by stronger absorption, i.e. decrease of S^2

$$\frac{1}{\sigma_{\rm tot}}\frac{d\sigma^{\rm SD}}{dt\,dx_L} = \frac{g_N^2(t)\,g_{3P}(t)}{16\pi^2 g_N(0)}\,(1-x_L)^{\alpha_P(0)-2\alpha_P(t)}\;S^2_{\rm SD}(s,t)$$

(+ RRP+PPR)

Also a crucial ingredient of calculations of the overlap (PU)- backgrounds to CED production.

Exclusive Υ production as a probe of f_g

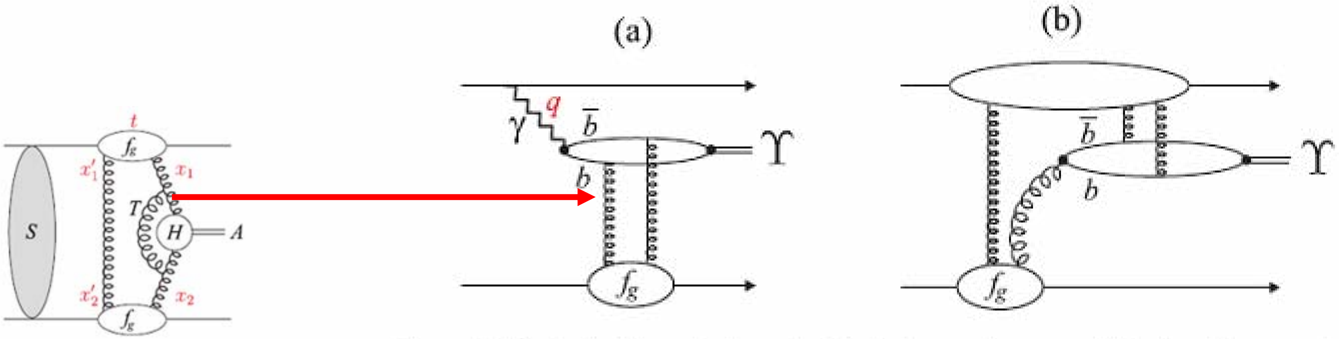


Figure 6: Exclusive Υ production via (a) photon exchange, and (b) via odderon exchange.

(CMS studies, S. Ovyn)

$$d\sigma / dy(pp \to p + \Upsilon + p) \sim 50\, pb$$

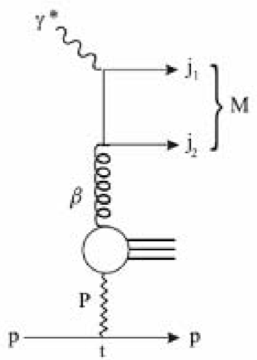
The cross section for γ +p→Y +p is given in terms of the same generalized gluon distribution fg that occurs in the CED Higgs production.

The odderon contribution (if it exists) can be separated and measured.

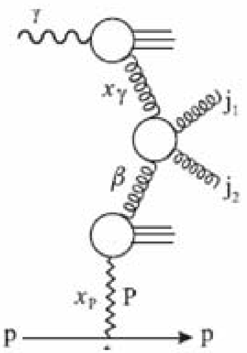
Tagging the lower proton will be very useful. (to remove proton excitations)

A way to reduce uncertainties in the predictions for CED processes associated with fg.

Revisiting diffractive dijet photoproduction



'Direct'



'Resolved'

H1-ZEUS- NLO THEORY → STILL UNRESOLVED

Difficult to draw a definite conclusion.

Factorization breaking caused by absorptive (rescattering) corrections. (CDF-00)

Expectation: Small size component-unsuppressed
Large size component-suppressed.
In the '*ideal theoretical limit*' $R(\text{photoprod.}) \simeq 0.34\, R(\text{high } Q^2)$ (KKMR-03) (agreem. with lead. neutrons)

Experimental analysis: x_γ ranges, within NLO QCD. (Bill Scmidke)

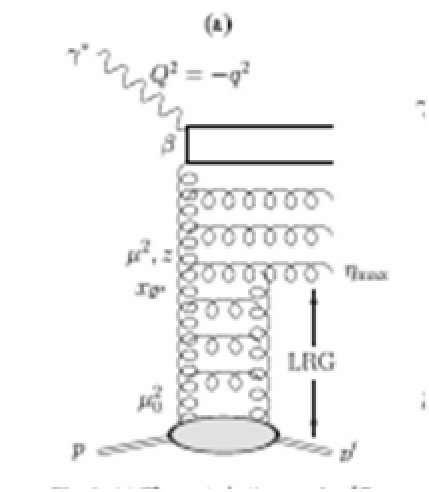
A word of caution: at large x_γ, the NLO may not be sufficient:
large $\alpha_s \ln^2(1/(1-x_\gamma))$ (Sudakov-like) effects.

KKMR-03 proposal: to measure the ratio of the diffractive process to the inclusive production
(similar to the CDF diffractive studies) $R = \sigma(diffr)/\sigma(incl)$ as a funct. of Q^2

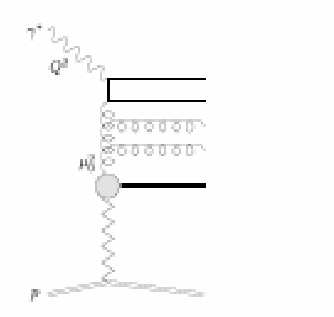
(various theoretical and experimental uncertainties may cancel)

Exposing the contribution of the Perturbative Pomeron to DDIS

(G. Watt, A.Martin and M. Ryskin (2006))



The perturbative .resolved Pomeron contribution.



Nonperturbative resolved Pomeron.

Measurements of the kt of secondaries in the ‘Pomeron fragmentation’ (edge of LRG).

The kt distribution of the lowest jet should obey the power law – in marked contrast with the expectations based on Regge-factorization.

Larger kt of the secondaries with the long power-like tail should be observed.

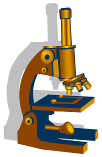
Main Tests of the CED formalism with HERA data at a glance

Better evaluation of the bare 3P vertex → Inelastic diffractive J/ψ(Υ) (photo)production

Generalized Gluon Distributions → Exclusive Υ- (photo)production

Probing the rescattering effects (**S^2**) → Diffractive dijets ($R = \sigma(diffr)/\sigma(incl)$).

Manifestation of Perturbative Pomeron → Transverse momentum distr. at the edge of LRG.



CONCLUSION

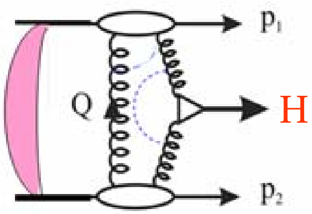
LET HERA DATA TALK !

Backup

KMR pred^n of $\sigma(pp \to p + X + p)$ (symbolically)

$$L_{eff}^{PP} \sim \langle S^2 / b^2 \rangle * \left| N \int \frac{dQ_t^2}{Q_t^4} f_g(x_1, x_1', Q_t^2, \mu^2) f_g(x_2, x_2', Q_t^2, \mu^2) \right|^2,$$

contain Sudakov factor T_g which exponentially suppresses infrared Q_t region → pQCD



(High sens. to str. functs)

$$f_g(x, x', Q_t^2, \mu^2) = R_g \frac{\partial}{\partial \ln Q_t^2} \left[\sqrt{T_g(Q_t, \mu)}\, x g(x, Q_t^2) \right]$$

$\langle Qt \rangle_{SP} \sim M/2 \exp(-1/\bar{\alpha}_s)$, $\bar{\alpha}_s = N_c/\pi\ \alpha_s\ C_\gamma$

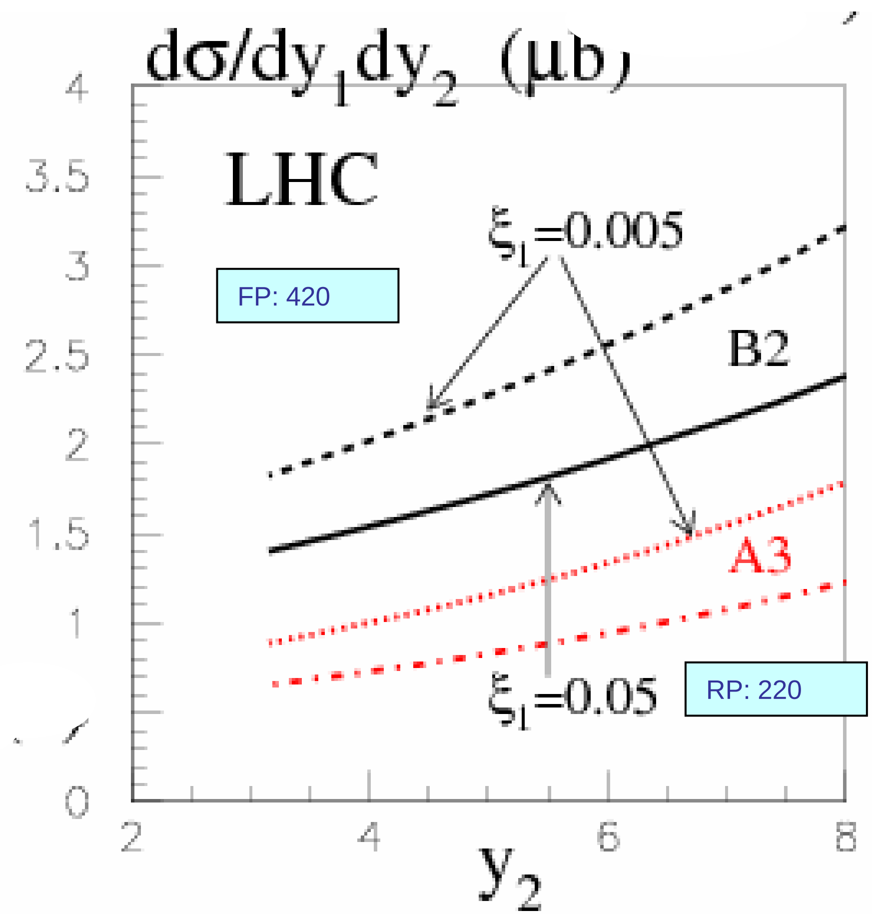
SM Higgs, $\langle Qt \rangle_{SP} \sim 2$ GeV $\gg \Lambda_{QCD}$

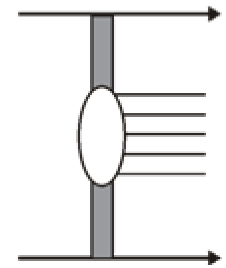
$\langle S^2 \rangle$ - effect. quantity, character. prob. that rapidity gaps survive population by secondary hadrons → soft diffraction physics (model dependend.)

$\sigma(pp \to p + H + p) \sim 3$ fb at LHC for SM 120 GeV Higgs
(factor ~ 3 uncertainty after 'sanity checks')

Implemented in ExHume MC with default $\langle S^2 \rangle_{Exh} \approx 0.03$, KMR- bt-space integration with exact ME

Higher sensitivity to the parameters of models for Soft Diffraction





$y = -\ln \xi$, $\xi = (1-x)$

(d) the y_2 dependence of $d\sigma_{\rm DPE}/dy_1 dy_2$ for $\xi_1 = 0.05$ and 0.005, corresponding, respectively, to proton taggers at 220 m and 420 m from the interaction point in the LHC experiments.

(essential also for calculations of the overlap (Pile-Up) backgrounds)