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HARD PQCD JETS AND CHARM IN DIFFRACTIVE DIS*

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A two gluon model of diffractive DIS is used to describe diffractive D^* production and diffractive dijets. Using three different unintegrated gluon densities a comparison with H1 data is made. The 2-gluon model fairly well describes both processes at $x_{\mathbb{P}} < 0.01$.

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1. The 2-gluon model of diffraction

The process of inclusive DIS in the proton rest frame is to lowest order the interaction of a $q\bar{q}$ pair with the proton (color dipole picture). It seems natural to think of diffraction as a $q\bar{q}$ state (and $q\bar{q}g$, $q\bar{q}gg$, $\ldots$) representing the photon, interacting with the proton and then hadronizing into the diffractive system.

In the 2-gluon model the photon fluctuates into massive $q\bar{q}$ and $q\bar{q}g$ states that interact with the proton by the exchange of 2 gluons in a color singlet [1, 2]. The proton structure enters via the unintegrated gluon density $\mathcal{F}(x_{\mathbb{P}}, \boldsymbol{l}^2)$ which is taken from inclusive DIS. The calculations are made in the region of large diffractive mass M using the leading $\log(1/x_{\mathbb{P}})$ approximation. With the usual definitions $x_{\mathbb{P}} = (Q^2 + M^2)/(M^2 + W^2_{\gamma p})$ and $\beta = Q^2/(Q^2 + M^2)$ this is:

$$\beta\,,\ x_{\mathbb{P}} \ll 1 \qquad \text{or} \qquad Q^2 \ll M^2 \ll W^2_{\gamma p}\,.$$

To avoid soft divergencies a lower cutoff $k_{\mathrm{T}}^{\mathrm{cut}}$ on the outgoing gluon momentum is introduced which has to be fixed.

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The applicability of this pQCD model must be justified by the presence of hard scale (apart from Q^2 which should not be too small). The hard scale can be provided by high k_{T} of the final partons (hard jets) or by the mass of heavy quarks (D^* production); these two cases have been discussed in [2] and will be adressed here.

2. Diffractive D^* production

We have applied the 2-gluon model to diffractive D^* meson production measured at H1.

We used 3 different unintegrated gluon densities which have to be convoluted with the scattering matrix element. In case of the NLO GRV gluon density [3] which is defined down to $Q_0^2 = 0.4$ GeV^2 we introduced a lower integration limit of 0.4 GeV^2. We also took $\mathcal{F}(x_{\mathbb{P}}, \boldsymbol{l}^2)$ from the saturation model [4] which is defined for all $\boldsymbol{l}^2$. As a third alternative we used a CCFM based unintegrated gluon density [5], also defined down to $\boldsymbol{l}^2 = 0$.

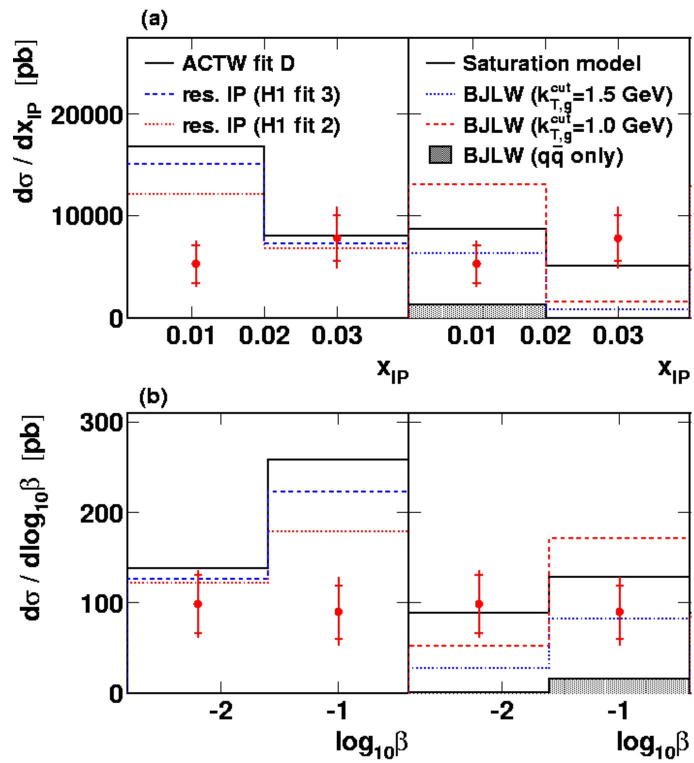

Fig. 1. Diffractive D^* production from H1 [6], compared with different models. The 2-gluon model (BJLW) uses $\mathcal{F}$ from NLO GRV.

The H1 measurements [6] are shown in Fig. 1. To reconstruct the D^* the channel $D^{*+}(c\bar{d}) \to K^-\pi^+\pi^+_{\rm slow}$ (and c.c.) has been used. The results of the 2-gluon model with two different cuts on the outgoing gluon $k_{\rm T}^{\rm cut}$ show (Fig. 1): The cutoff mainly affects the overall height of the distributions; we fix $k_{\rm T}^{\rm cut}$ such that the lower $x_{\mathbb{P}}$-bin is reproduced ($k_{\rm T}^{\rm cut} = 1.5$ GeV), because here our calculation is most reliable. In the upper $x_{\mathbb{P}}$-bin we then undershoot the datapoint; here, probably, the exchange of subleading Regge trajectories is present, but not included in the model. The calculated β-distribution shows good agreement in the upper β-bin whereas it is too low in the lower β-bin. This might also be due to the missing subleading exchange, because the main contribution to large diffractive masses (small β) comes from the large $x_{\mathbb{P}}$-region. In addition, the $c\bar{c}gg$ state is probably important here.

Also shown in Fig. 1 are the results of the resolved pomeron model which assumes a partonic content in the pomeron, determined from measurements of inclusive diffraction ($F_2^{\rm D(3)}$). Whereas the upper $x_{\mathbb{P}}$- and the lower β-bin are well reproduced this model gives by a factor 2–3 too large results at small $x_{\mathbb{P}}$.

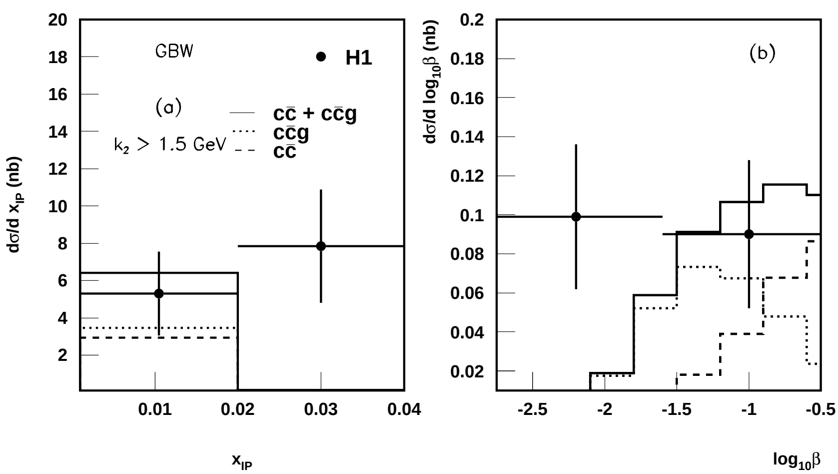

Fig. 2. D^* from H1, compared with the 2-gluon model using $\mathcal{F}(x_{\mathbb{P}}, \boldsymbol{l}^2)$ from the saturation model.

Using an unintegrated gluon density based upon the saturation model leads to the results shown in Fig. 2. Qualitatively the situation here is the same as in case of the GRV unintegrated gluon density. The same holds for a model where the unintegrated gluon density is based upon the CCFM-equation [5].

3. Hard diffractive dijets

The definition of a diffractive event of 2(3) hard jets used by H1 allows for the presence of a (soft) Pomeron remnant. So one can apply the 2-gluon model with $q\bar{q}$ and $q\bar{q}g$ final state to dijet production, because *e.g.* the gluon can provide the remnant. However to describe 3-jet configurations one would have to include also the $q\bar{q}gg$ contribution.

Fig. 3 shows the H1 measurement of hard diffractive dijets [7]. The same cutoff as in case of D^* has been used ($k_T^{\rm cut} = 1.5$ GeV). With input from either the saturation model or the GRV fit the data are fairly well described, except for small discrepancies in the $z_{\mathbb{P}}^{(\rm jets)}$ distribution. CCFM leads to results that are, in general, too large.

The results from the resolved pomeron model in hard dijet production are in very good agreement with all measured differential cross sections shown in Fig. 3 [7].

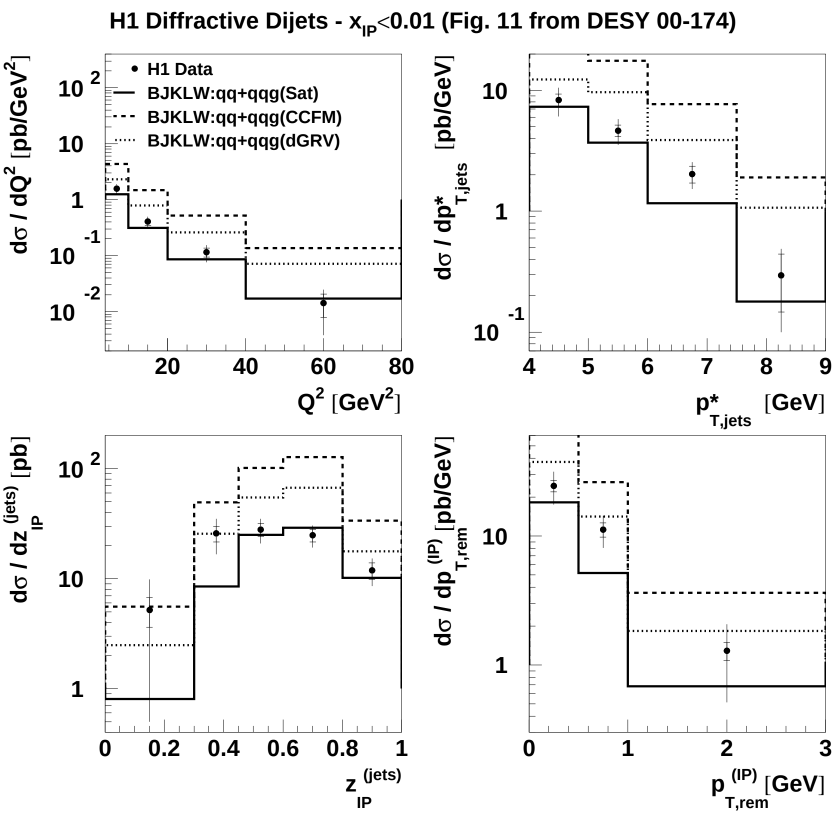

Fig. 3. H1 dijets, compared with the 2-gluon model and different gluon densities ($k_T^{\rm cut} = 1.5$ GeV).

4. Conclusion

The 2-gluon model takes non-perturbative input from inclusive DIS. With the gluon density based upon the saturation model and a lower cutoff on the final state gluon $k_{\mathrm{T}}^{\mathrm{cut}} = 1.5$ GeV the model gives at $x_{\mathbb{P}} < 0.01$ a rather good description of both hard dijets and D^* production.

To improve the description in the large M^2 region, and to be able to describe the 3 diffractive jets of H1 the $q\bar{q}gg$ contribution should be included. A subleading reggeon exchange could be modelled by a $q\bar{q}$ exchange.

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