STUDY OF $D^{*\pm}$ MESON PRODUCTION IN DIFFRACTIVE ep SCATTERING AT HERA

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$D^{*\pm}$ production in the diffractive interactions was measured with the ZEUS detector at HERA using integrated luminosities of 44 pb^{-1} in deep inelastic scattering and 38 pb^{-1} in photoproduction processes. Diffractive interactions were identified by a large gap in the rapidity distribution of final states. $D^{*\pm}$ mesons were reconstructed from the decay $D^{*+} \to D^0\pi_s^+$ with $D^0 \to K^-\pi^+$ (+c.c.). Integrated and differential cross sections were compared to theoretical expectations.

$D^{*\pm}$ production was measured in the diffractive dissociation of the photon into a hadronic system X[1,2]. Photoproduction (PhP) reactions with photon virtualities $Q^2 < 1$ GeV^2 and deep inelastic scattering (DIS) at $Q^2 > 4$ GeV^2 were studied separately. Kinematic regions for different cross sections were defined by W, y, $p_T(D^*)$, $\eta(D^*)$, $x_{I\!P}$ and β, where W is the photon-proton center-of-mass energy, y is the fraction of the positron energy, carried by the exchanged photon in the proton rest frame, $p_T(D^*)$ and $\eta(D^*)$ are the transverse momentum and pseudorapidity of $D^{*\pm}$, respectively, $x_{I\!P}$ is the fraction of the proton's momentum carried by the Pomeron ($I\!P$) and β is the fraction of the Pomeron momentum participating in a hard subprocess.

Diffractive events were identified by a large rapidity gap (LRG) between the scattered proton and the hadronic system, X. The LRG was tagged by a cut on η_{max}, the pseudorapidity of the most forward deposit of energy greater than 400 MeV in the detector. In PhP, the fraction of non-diffractive events, left after requiring $\eta_{max} \leq 1.75$, was estimated from a non-diffractive MC and subtracted. In DIS, the requirement $\eta_{max} \leq 2$ was used, where the non-diffractive admixture is negligible. The fraction of events with a dissociated proton, which was not rejected by the cut on η_{max}, was estimated[3] to be 0.31 ± 0.15 and subtracted from all the measured cross sections.

The integrated cross section for diffractive PhP of $D^{*\pm}$ in the kinematic region defined by $Q^2 < 1$ GeV^2, $130 < W < 280$ GeV, $p_T(D^*) > 2$ GeV, $|\eta(D^*)| < 1.5$ and $0.001 < x_{I\!P} < 0.018$ was found to be

$$\sigma(ep \to D^* Xp)^{diff}_{PhP} = 0.74 \pm 0.21(stat.)^{+0.27}_{-0.18}(syst.) \pm 0.16(p.diss.)\ nb.$$

This value, while only a fraction of the total diffractive $D^{*\pm}$ contribution, corresponds to ~ 4 % of the inclusive PhP[4] of $D^{*\pm}$ in the same kinematic range.

The integrated cross section for diffractive $D^{*\pm}$ production in DIS in the kinematic range defined by $4 < Q^2 < 400\ \mathrm{GeV}^2$, $0.02 < y < 0.7$, $p_T(D^*) > 1.5$ GeV, $|\eta(D^*)| < 1.5$, $x_{I\!P} < 0.016$ and $\beta < 0.8$ was measured to be

$$\sigma(ep \to D^* Xp)^{diff}_{DIS} = 0.281 \pm 0.041(stat.)^{+0.079}_{-0.073}(syst.)\ nb.$$

The fraction of diffractively produced $D^{*\pm}$ was determined to be $\mathcal{R}_{\mathcal{D}} = 6.1 \pm 0.9(stat.)^{+1.5}_{-1.4}(syst.)\%$, consistent with the corresponding fraction for inclusive diffraction[3]. The ratio is found to be independent of Q^2 and W.

The measured fractions of diffractively produced $D^{*\pm}$ mesons indicate that charm production is not suppressed in diffractive processes.

Both cross sections were compared with calculations, based on the resolved-Pomeron model[5], using the BGF mechanism for charm production and gluon-dominated parameterizations of the Pomeron structure: the LO H1 FIT2[6] for PhP and the ACTW[7] for DIS. The PhP cross section, calculated with the RAPGAP MC[8], is 1.42 nb, while the calculated DIS cross section approximately coincides with the measured one. The calculations of the DIS cross section using the quark-dominated parameterizations of the Pomeron structure do not reproduce the measurement.

The shapes of the differential cross sections for $D^{*\pm}$ diffractive production (Figs 1 and 2) are in qualitative agreement with the predictions based on the gluon-dominated Pomeron. The DIS data also agree with the calculations in normalization. Figure 2 shows that neither the $q\bar{q}$ nor the $q\bar{q}g$ component of the two-gluon model [9] is able to describe the data adequately. However, an appropriate combination of the two components may well do so. The present statistics and systematics of the measurements do not discriminate between the models.

References

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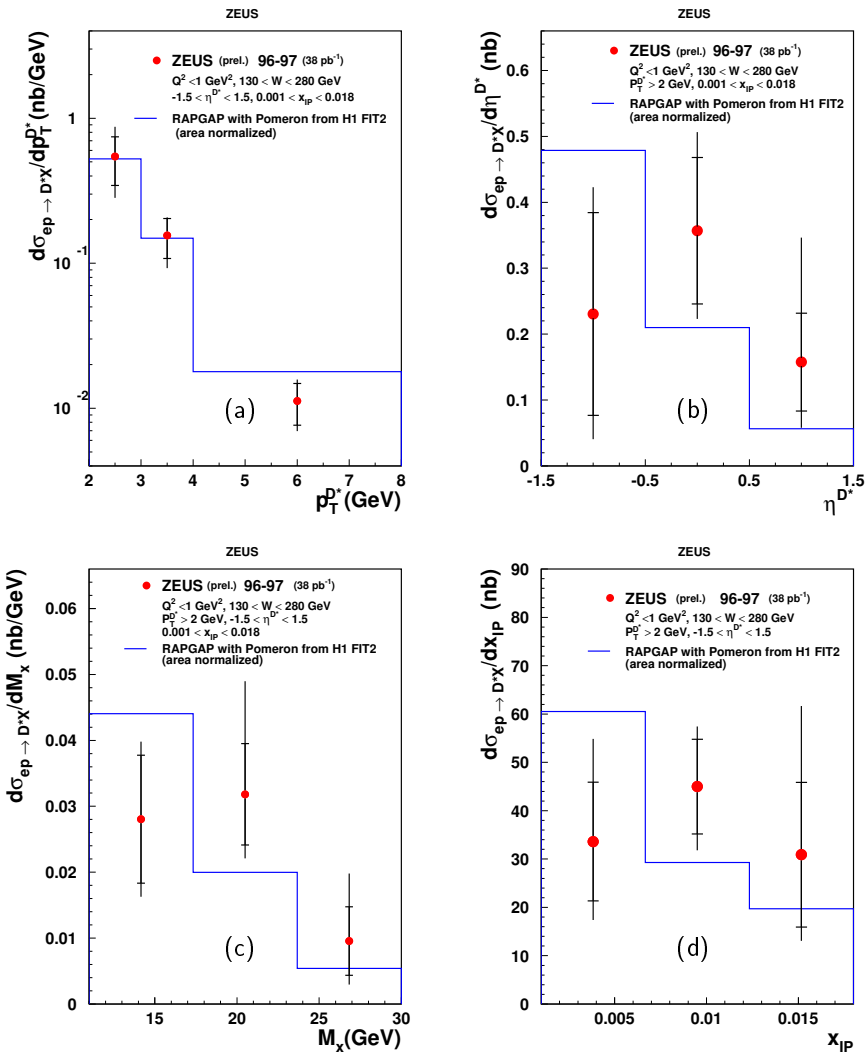

Figure 1. Differential cross sections (solid points) for the diffractive photoproduction reaction $ep \to D^* Xp$: (a) $d\sigma/dp_T(D^*)$, (b) $d\sigma/d\eta(D^*)$, (c) $d\sigma/dM_x$ and (d) $d\sigma/dx_{I\!P}$. The inner bars show statistical errors, and the outer bars correspond to statistical and systematic uncertainties added in quadrature. The data are compared with the distributions (histogram) of RAPGAP, normalized to the data, calculated in the framework of the resolved-Pomeron model using the H1 FIT2 Pomeron parameterization, which was obtained from fits to HERA data.

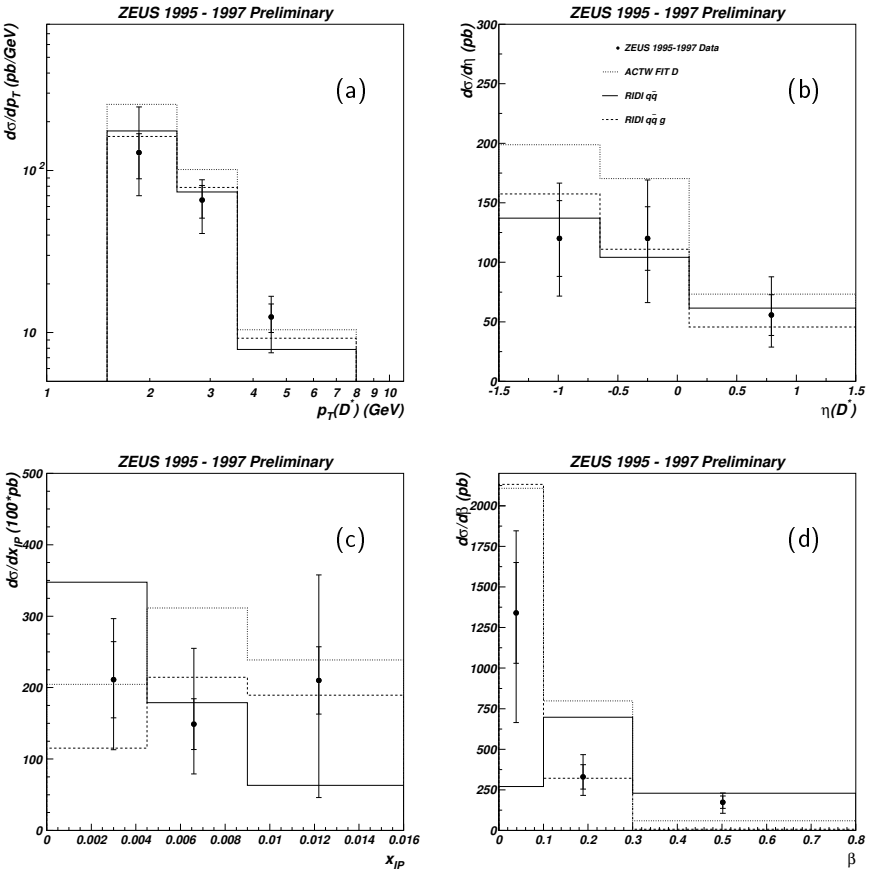

Figure 2. Differential cross sections (solid points) for the diffractive DIS reaction $ep \to D^{*\pm}Xp$: (a) $d\sigma/dp_T(D^{*\pm})$, (b) $d\sigma/d\eta(D^{*\pm})$, (c) $d\sigma/dx_{I\!P}$ and (d) $d\sigma/d\beta$. The inner bars show statistical errors, and the outer bars correspond to statistical and systematic uncertainties added in quadrature. The data are compared to the distributions of RAPGAP based on the resolved-Pomeron model with the ACTW parameterization (dotted histogram). The data are also compared to the distributions of RIDI using the two-gluon model (solid and dashed histograms representing the $q\bar{q}$ and $q\bar{q}g$ components, respectively).