EXCLUSIVE VECTOR MESON PRODUCTION IN H1 AT HERA

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Diffractive leptoproduction of vector mesons (see Fig. 1) has been abundantly studied at low energy, either in photoproduction ($Q^2 \simeq 0$) or in the "deep inelastic" domain ($Q^2 >$ a few GeV^2)[1]. The general features are well described in the framework of (generalized) vector meson dominance models (VDM)[2], with pomeron exchange.

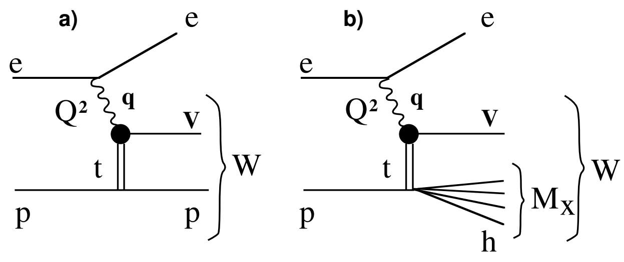

Figure 1: Diffractive vector meson production: a) elastic; b) proton dissociation.

With the HERA experiments, the available energy range has been considerably extended, and the interest is renewed for vector meson production. On the one hand, it is proposed to use a "soft pomeron" approach, based on the exchange of two nonperturbative gluons, predicting a slow rise of the cross section with energy as for the total hadron-hadron cross sections[3]. Another approach is based on perturbative QCD, the scale being given by the γ virtuality (ρ production) or by the meson mass (J/Ψ production); the cross section is predicted to have a strong energy dependence[4]. It is conjectured that the study of vector meson production could provide information on the gluon distribution in the proton.

The H1 experiment has studied the exclusive production of ρ and J/Ψ mesons, in two virtuality domains : $Q^2 \simeq 0$ and $Q^2 > 7\ GeV^2$.

Two measurements are performed of ρ meson photoproduction[5]. The first is based on 358 events obtained from 20 nb^{-1} data taken in 1993. The average W (W is the photon-proton invariant mass) is 55 Gev, and the two decay pions are detected in the central tracking detector, allowing precise ρ mass reconstruction. The proton dissociation background (see Fig. 1b) to the elastic reaction (Fig. 1a) is statistically subtracted with the help of Monte Carlo simulations. The diffractive slope parameter is $b = (9.4 \pm 1.4 \pm 0.7)\ GeV^{-2}$, slightly higher than for fixed target data, in agreement with Regge model predictions. The decay angular distribution indicates that the ρ mesons are essentially transversely polarised.

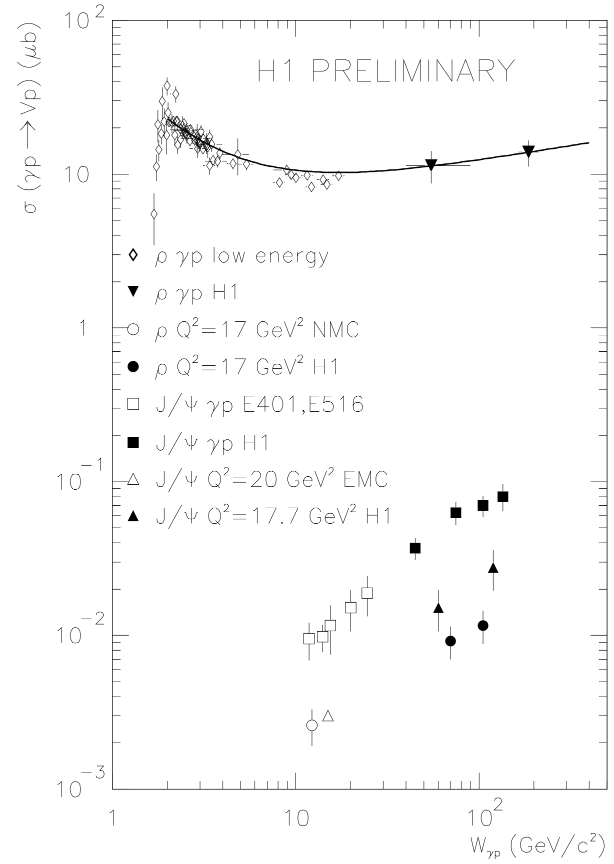

Figure 2: Cross section for vector meson production.

The second measurement, based on 24 nb^{-1} of data taken in 1994 with a shifted interaction point, is performed at higher W (<W> = 187 GeV) and higher y (y is, in the proton rest frame, the fraction of the electron energy transferred to the hadron system); the electron is thus detected in the electron tagger, 33 meters downstream of the interaction point, and the decay pions are detected in the backward electromagnetic calorimeter (BEMC). Most proton dissociation events are discarded using the detectors in the very forward region (along the proton beam direction) : proton tagger (24 m. from the interaction point), forward muon detectors, forward part of the liquid argon calorimeter.

The measured cross sections are shown on Fig. 2, indicating a smooth continuation of lower energy data, well described by VDM and soft pomeron exchange.

High Q^2 (> 7 GeV^2) ρ meson production was studied using 215 events in the ρ mass peak from the 1994 sample (2.9 pb^{-1}) with ($50 < W < 140$) GeV [6]. The electron is detected in the BEMC, and the decay pions in the central tracker. The proton dissociation background is estimated using the forward detectors, and subtracted statistically. The Q^2-distribution is well fitted by a $Q^{-4.8\pm0.8}$ law (see Fig. 3). The study of the angular distribution of the ρ decay pions shows that the ρ mesons are mostly longitudinally polarised. The cross section measurements indicate a significant increase compared to lower energy data (e.g. NMC), as was shown already by the ZEUS results[7]. This is in striking contrast with the W dependence of ρ photoproduction.

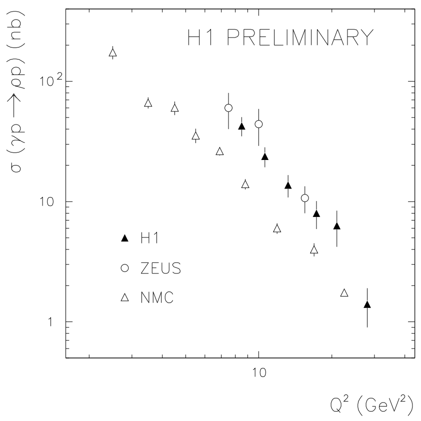

Figure 3: Q^2-dependence of ρ meson production cross section.

Elastic J/Ψ photoproduction has been studied using the 1994 data, with (147 ± 13) e^+e^- events (2.1 pb^{-1}) and (216 ± 17) $\mu^+\mu^-$ events (2.8 pb^{-1}) in the J/Ψ mass peak, with ($30 < W < 180$) GeV [8]. The leptons are identified using the liquid argon calorimeter and the muon chambers. Elastic events are selected using the forward detectors. The cross section is found to increase strongly with $W : \sigma \sim W^{4\epsilon}$, with $\epsilon \simeq 0.25$, which is well described by the Ryskin model[4]. Again, this behaviour is in striking contrast with ρ photoproduction

For high Q^2 J/Ψ production, 43 events (over a background of 9) are selected, consisting of an electron scattered in the BEMC and two particles in the central tracker, giving an invariant mass in the J/Ψ peak[9]. In view of the small statistics, the elastic and proton dissociation components are presently considered together. A significant increase of the cross section with W, comparable to that for photoproduction, is observed.

Conclusion

In conclusion, the energy dependence for vector meson production is highly dependent on the studied channel. Whereas it is slow for ρ meson photoproduction, in agreement with VDM and soft pomeron exchange, it shows a steep rise for high Q^2 ρ production and for low and high Q^2 J/Ψ production; this latter behaviour is predicted by perturbative QCD calculations when a high scale is present, either a high photon virtuality or a high mass of the produced meson.

Acknowledgments

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References

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