PROTON DISSOCIATIVE J/ψ PRODUCTION AT HIGH-|t| AT HERA

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ON BEHALF OF THE H1 COLLABORATION

A measurement of the diffractive production of J/ψ mesons at large four-momentum transfers squared (t) is presented in photoproduction at HERA. The J/ψ meson is identified via its decay into two unlike-sign muons. The differential cross section dσ/d|t| as a function of |t| as well as $\sigma(\gamma p \to J/\psi X)$ as a function of the photon proton centre-of-mass energy $W_{\gamma p}$ in two intervals of $|t|$ are presented. The results are compared with perturbative QCD calculations.

1 Introduction

Important aspects of the strong interaction, in particular the interplay between Regge theory and QCD calculations, can be studied in kinematical regions where more than one hard scale applies. A particularly interesting process is the diffractive production of the J/ψ meson at large $|t|$ since the mass of the J/ψ and the largeness of $|t| \geq 1.0$ GeV^2 both provide relevant scales. Predictions for the diffractive production of the J/ψ meson, through the exchange of the hard BFKL pomeron, have been completed in leading order. [1,2] The only parameter in the leading-order model is $\overline{\alpha}_s$, which is treated as a free parameter.

2 Event Selection and Data Analysis.

Proton dissociative, diffractive J/ψ events are selected from data collected by the H1 detector at HERA during 1999. The analysis is based on a total integrated luminosity of 19.1 pb^{-1}. The measurement is performed in the kinematic region of photoproduction ($Q^2 < 1.0$ GeV^2) in the photon-proton centre-of-mass energy range $50 < W_{\gamma p} < 160$ GeV. The J/ψ mesons are selected via their decays to two unlike-sign muons and both are identified in the polar angular range $30° < \theta < 160°$ either in the calorimeter and/or in the instrumented iron yoke. Two different triggers which use muon requirements are used to collect the events. The proton final state (with mass $M_X > 1.6$ GeV) is selected by requiring either secondary scattering or energy deposits in the H1 forward detectors. A detailed description of the H1

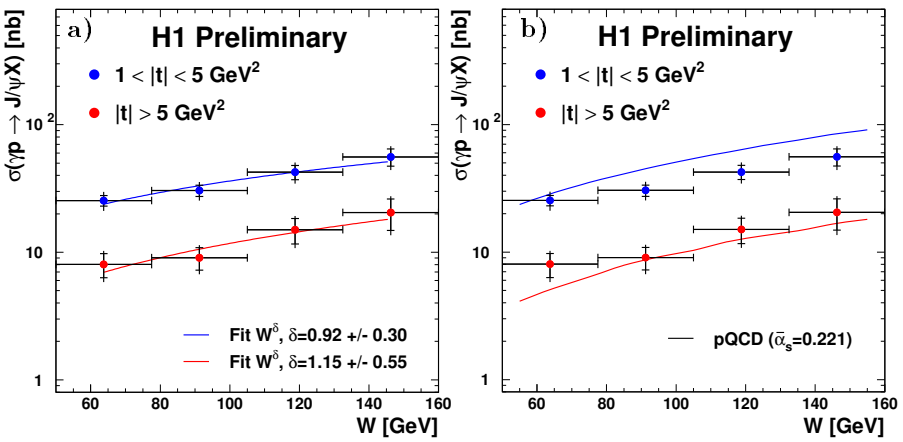

Figure 1. The photon-proton differential cross-section $\sigma(\gamma p \to J/\psi X)$ for J/ψ production with proton dissociation in the kinematic range $Q^2 < 1.0$ GeV^2 for two different intervals of $|t|$. The cross sections are a) fitted using a function of the form $N(W/W_0)^\delta$ where $W_0 = 90$ GeV and b) compared to the predictions in perturbative QCD for $\bar{\alpha}_s = 0.221$.

detector has been published. [3] The proton remnant is restricted to the range $\theta \leq 20°$, corresponding to roughly a maximum $M_X = 30$ GeV, so that the expected contribution (from Monte Carlo studies) of events produced with elasticities $z = (E - P_z)_{J/\psi} / \sum (E - P_z) < 0.9$ (where the sum runs over all final state particles excluding the scattered lepton) is restricted to about 1%. The momentum transfer squared is approximated by the squared transverse momentum of the J/ψ meson.

The event generator HITVM is used to generate proton dissociative, diffractive J/ψ events at large $|t| > 1.0$ GeV^2 according to the pQCD calculation with an input value $\overline{\alpha}_s = 0.2$. [4] At large $|t|$ the proton is expected to predominantly dissociate. The generated events were passed through a full simulation of the H1 detector response. A good agreement between the Monte Carlo simulation and the data is obtained. The distributions also agree with those of the event generator DIFFVM [5] in the region of overlap $1.0 < |t| < 4.0$ GeV^2.

The differential cross section $\sigma(\gamma p \to J/\psi X)$ is shown as a function of $W_{\gamma p}$ for $1.0 < |t| < 5.0$ GeV^2 and $|t| > 5.0$ GeV^2 in figure 1a). The inner error bars comprise the statistical uncertainty in the data, and the outer error bars include all the various systematic contributions, added to the statistical error

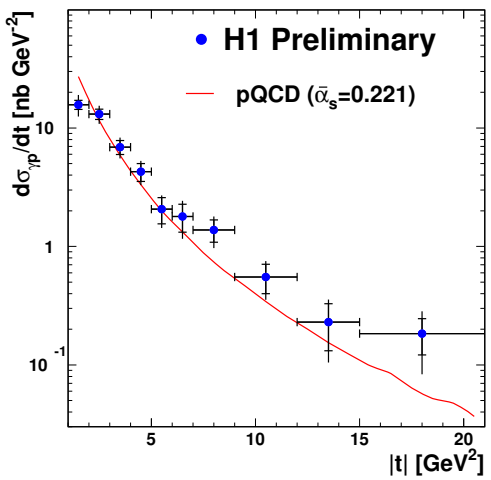

Figure 2. The photon-proton differential cross-section $d\sigma/d|t|$ for J/ψ production with proton dissociation in the kinematic range $Q^2 < 1.0$ GeV^2, $50 < W_{\gamma p} < 160$ GeV, $|t| > 1.0$ GeV^2. The measurement is compared to the prediction in perturbative QCD for $\bar{\alpha}_s = 0.221$.

in quadrature. The estimates of the systematic uncertainties are supported by the results from earlier analyses of elastic J/ψ production in diffraction at smaller values of $|t|$. [6,7] The most significant systematic uncertainties arise from the trigger efficiency (6%), the lepton identification efficiency (5%) and the track reconstruction efficiency (4%). A correction factor of 4% is subtracted and an error of $\pm 4\%$ is attributed to the measured cross sections to allow for the maximum 8% of the selected sample which is expected to originate through the decay of the $\psi(2S)$ meson. The contribution to the sample through events in which an additional initial state photon is emitted by the incoming lepton is found to be neglible. The cross sections are fitted using a function of the form $N(W/W_0)^{\delta}$ in both $|t|$-ranges. A central value of $W_0 = 90$ GeV is chosen for the fit and the statistical and uncorrelated systematical errors are included. In the low $|t|$-range a best extracted value of $\delta = 0.92 \pm 0.30$ is obtained, and in the high $|t|$-range $\delta = 1.15 \pm 0.55$.

The behaviour of the photon-proton cross section in $W_{\gamma p}$ and in $|t|$ (in the range $1.0 < |t| < 21.0$ GeV^2) is compared to the pQCD prediction for an input value $\bar{\alpha}_s = 0.221$ in figures 1b) and 2. The magnitude of the cross section in $W_{\gamma p}$ is very sensitive to the input value of $\bar{\alpha}_s$ whereas the shape of the predicted differential cross section in $|t|$ is not sensitive to its value.

3 Summary.

A similar rise in the total cross section as a function $W_{\gamma p}$ is obtained, for both investigated $|t|$ ranges, as previously measured for proton-elastic and proton-dissociative J/ψ production at smaller values of $|t|$. [7] The measurement is in good agreement with previous measurements of the lepton-proton differential cross section [8] and the photon-proton differential cross section of the ZEUS collaboration. [9] The pQCD prediction for $\bar{\alpha}_s = 0.221$ is compared to the measurement and gives a reasonable description, within experimental errors, of the $W_{\gamma p}$ and $|t|$-dependencies, in particular for larger $|t| > 3.0$ GeV^2.

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