MEASUREMENTS OF THE INCLUSIVE PHOTOPRODUCTION OF η, ρ^0, $f_0(980)$ AND $f_2(1270)$ MESONS AT HERA *

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Measurements are presented of the inclusive photoproduction of the neutral mesons η, ρ^0, $f_0(980)$ and $f_2(1270)$ in ep interactions at HERA at an average γp collision energy of 210 GeV. Inclusive cross-sections are shown differentially as a function of various kinematic variables and a comparison is made with measurements of the photoproduction of other particle species at HERA.

The process by which quarks and gluons convert to colourless hadrons is one of the outstanding problems in particle physics. The theory of perturbative quantum chromodynamics (QCD) is not applicable and phenomenological models based on the laws of thermodynamics are often used [1, 2, 3]. High energy particle collisions which give rise to large multiplicities of particles produced with low values of transverse momentum provide an opportunity to study hadronisation. This paper presents precision measurements made by the H1 experiment of the inclusive photoproduction of η, ρ^0, $f_0(980)$ and $f_2(1270)$ in ep collisions at HERA. The measurements are based on the 2000 running period corresponding to an integrated luminosity of 38.7 pb^{-1}.

The H1 detector is described in detail elsewhere [4]. Photoproduction events are required to lie within the interval $174 < W < 256$ GeV. This corresponds to an average photon-proton collision energy of $W = 210\,\text{GeV}$. The trigger conditions are verified by selecting only multi-hadron events with more than two reconstructed tracks pointing to the common event vertex. In total about 3.7×10^6 events satisfy the above selection criteria.

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The η mesons are reconstructed via their two-photon decay mode. The photons are identified as isolated electromagnetic calorimeter clusters with energy greater than 200 MeV.

In Fig. 1 the spectrum of the invariant mass of the photon pairs is shown. This mass spectrum is fitted using the sum of a Gaussian function for the η meson signal and a polynomial to describe the combinatorial background. In the fit, the resonance mass is fixed to the Particle Data Group (PDG) value, while the width is fixed to the value obtained in the MC calculation. The

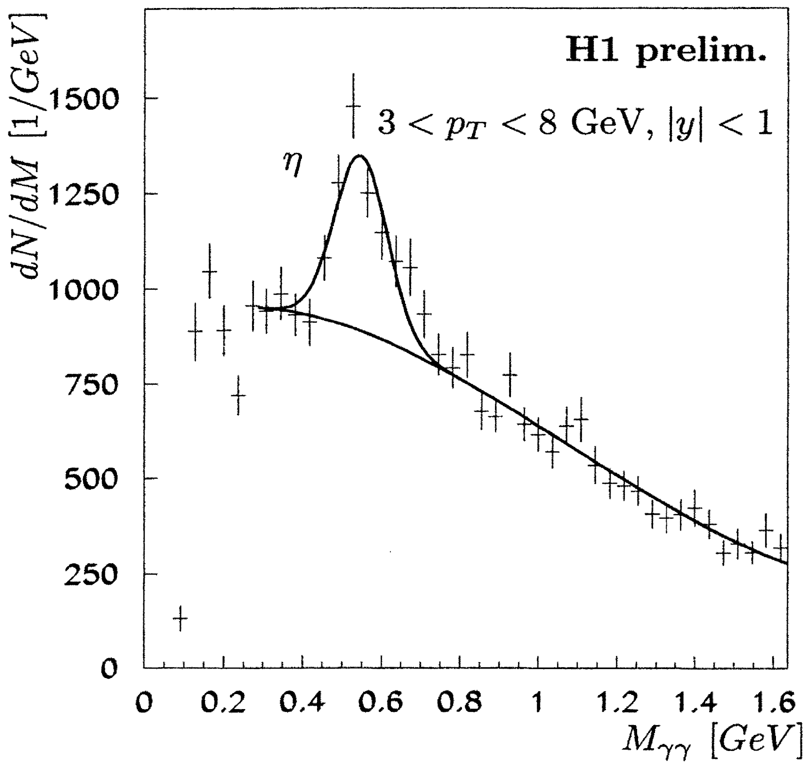

Figure 1: Two-photon mass spectrum after the application of the selection criteria discussed in the text. The smooth curve represents the result of a fit to the sum of a Gaussian and a third order polynomial.

ρ^0, $f_0(980)$ and $f_2(1270)$ mesons are reconstructed through their $\pi^\pm\pi^\mp$ decay mode. Any charged track found in the CJC with $p_T > 0.15$ GeV/c is taken as a charged pion candidate. The kinematical interval for the reconstructed neutral mesons in rapidity space was required $|y_{lab}| < 1$.

To extract the ρ^0, f_0 and f_2 signals, the two-particle invariant mass spectrum for like-sign pions $m(\pi^\pm\pi^\pm)$ is subtracted from the spectrum of for opposite-sign pions $m(\pi^\pm\pi^\mp)$. The resulting distribution is shown in Fig. 2, where the ρ^0, f_0, and f_2 signals are clearly seen above the residual combinatorial background. In order to extract a cross section for a given meson, the subtracted invariant mass distribution is fitted using a function composed of a sum of three relativistic Breit-Wigner functions for the signals and polynomial back ground. In addition a third term represents the sum of the reflections in the two-pion mass spectrum originating from $K^*(982)^0$ and $\omega(782)$ resonance decays.

Fig. 2 shows the result of the fit made in the mass range from 0.55 to 1.7 GeV/c^2. The contribution of the reflections is also shown. The ρ^0 resonance

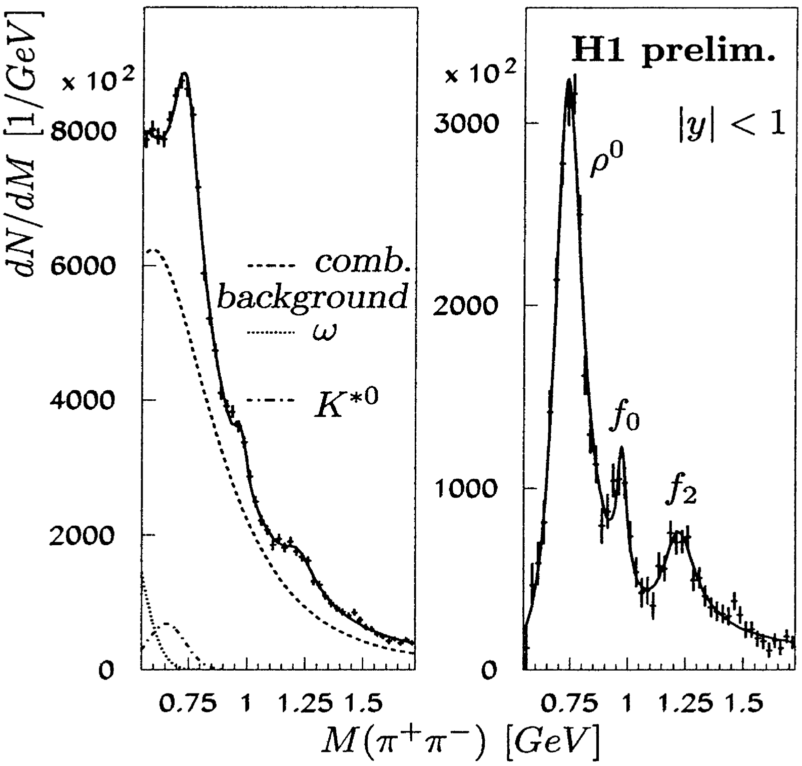

Figure 2: The $\pi^+\pi^-$ invariant mass spectrum following the subtraction of the like-sign spectrum. The full curve shows the results of the fit discussed in the text. In the left plot the dashed curve corresponds to the contribution of residual non-resonant background; the dotted and dash-dotted curves describe the contributions from ω and K^* reflections, respectively. In the right plot the points represent the data after subtraction of the background and the reflections.

in the data is shifted towards low mass. A similar effect has been reported by the LEP experiments [6]. It was conjectured that this arises as a result of final state interactions between the resonance and incoherently produced pions [7].

In Fig. 3, one of the universal features observed in the behaviour of long-lived hadrons [8] is investigated with the light resonances measured here. The double differential cross sections for η, ρ^0, $f_0(980)$ and $f_2(1270)$ production are presented as a function of $m + p_T$, where m is the meson's nominal mass. The cross sections follow closely the same power law function as that observed for pions at the same γp collision energy, once allowance has been made for the different isospin and spin of the various species of hadrons. Within the measured rapidity interval the resonance production rates are flat in rapidity.

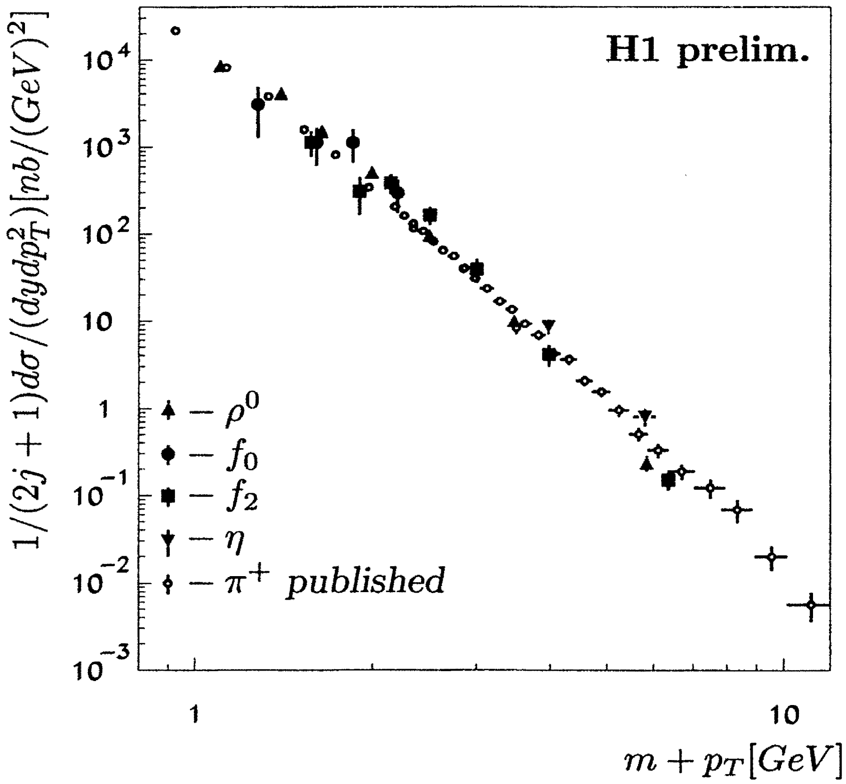

Figure 3: The differential photoproduction cross sections for η, ρ^0, $f_0(980)$ and $f_2(1270)$ mesons plotted as a function of $(m + p_T)$, with m being the nominal meson mass. The open symbols show the π^+ production cross section calculated from measurements of the charged particle spectrum in photoproduction.

The first measurements of cross section for the inclusive photoproduction of the light resonances η, ρ^0, $f_0(980)$, and $f_2(1270)$ at a γp average collision energy of 210 GeV are reported. The measured differential spectra display features similar to those observed in studies of light, long-lived hadrons.

The significant ρ^0 mass shift observed in this experiment and by the OPAL and DELPHI collaborations [6] requires further investigation. It is important to understand the origin of this effect in the context of the expected distortion of the nominal mass and width of hadronic resonances in heavy ion collisions at RHIC, where a similar effect could be attributed to the formation of a quark gluon plasma.

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