Backward-angle Photoproduction of π^0 Mesons on Proton at BL33LEPS

The photoproduction of π^0 mesons from the proton ($\gamma p \rightarrow p\pi^0$) has been measured in order to study the resonances of nucleons (protons or neutrons), which consist of three quarks. Pion photoproduction has been well studied both experimentally and theoretically in the spectroscopy of nucleon resonances. Many nucleon resonances were found and their characteristics were determined at the total energy $W < 1.7$ GeV [1]. However, many higher-mass resonances are still not well established, and the identification of these missing resonances is important for understanding the quark structure of a nucleon. Some weakly excited resonances are obscured by other strong resonances with large decay widths, making it difficult to demonstrate their existence only from cross section data. Alternatively, polarization observables like photon beam asymmetries are useful to extract the missing resonances. At very backward angles, the production mechanism is expected to be dominated by contributions of u-channels, where a proton or a nucleon resonance is exchanged. The data obtained at the LEPS facility provide a good means of understanding the reaction mechanism with u-channel kinematics.

An experiment was carried out at the Laser-Electron Photon beamline **BL33LEPS** [2]. A multi-GeV photon beam was produced by backward Compton scattering (BCS) from the head-on collision between argon ion laser photons with 351-nm wavelength and circulating 8-GeV electrons in the storage ring. The photon energy of the tagged photons ranged from 1.5 GeV to 2.4 GeV. A liquid hydrogen target with a thickness of 5.6 cm was used. The beam intensity was about 10^6 photons/sec. Protons from the target were detected using a forward LEPS spectrometer. Charged particles were momentum analyzed using information from a silicon vertex detector and three drift chambers. The particle mass was determined using the momentum, path length and time-of-flight. π^0 mesons were identified using the missing mass spectrum as the mass of X in the $\gamma p \rightarrow pX$ reaction. Differential cross sections and photon beam asymmetries were obtained. Figure 1 shows the obtained differential cross sections as a

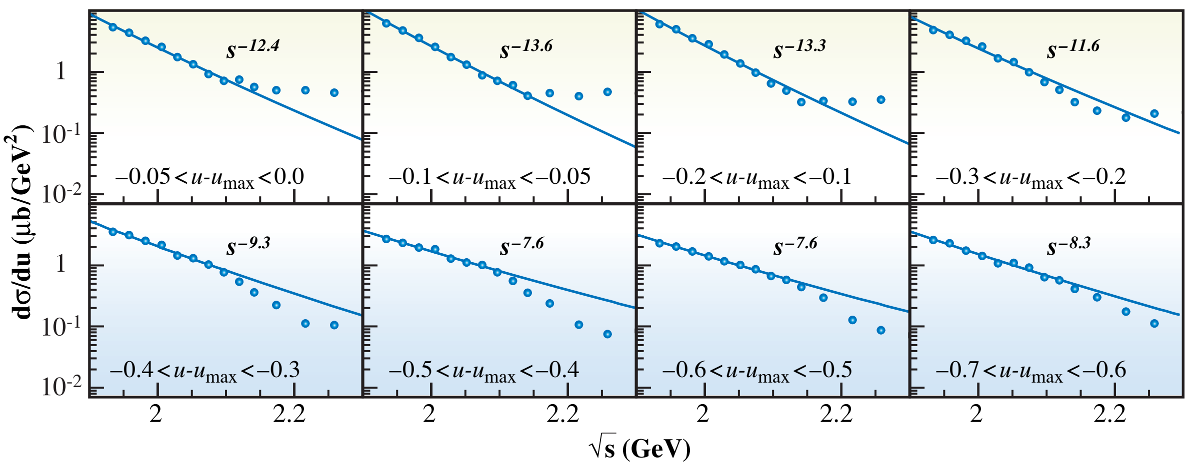

Fig. 1. Differential cross sections as a function of total energy of reaction.

function of the total energy of the reaction. The energy dependent slopes determined by fitting the data are indicated in Fig. 1. The differential cross sections sharply decrease at a total energy below 2.1 GeV. However, above 2.1 GeV, the cross sections do not agree with the fitting curves. To explain the current data in the u-channel kinematics, new mechanisms would be necessary.

Figure 2 shows photon beam asymmetries. Above 2.0 GeV, a dip structure is found around $\cos\Theta_{c.m.}$ =-0.8. Such a strong angular distribution cannot be explained using currently existing theoretical models. In order to explain this structure, we surmise that new high-mass resonances combined with u-channel diagrams are required. The present data were published [3].

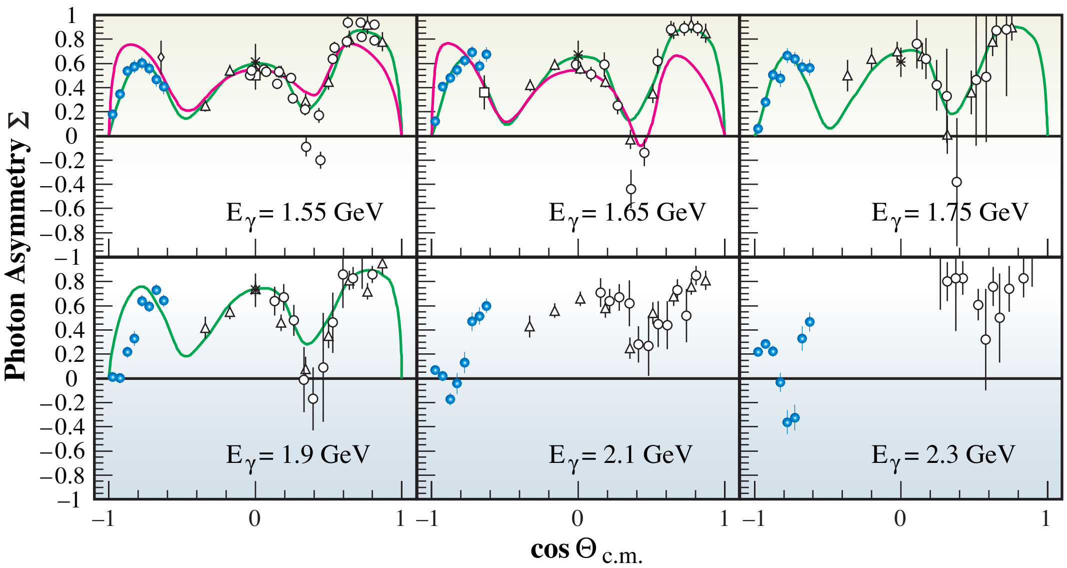

Fig. 2. Photon beam asymmetries. Above 2.0 GeV, a dip structure is found around $\cos\Theta_{c.m.} = -0.8$.

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References

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