$\Delta^{++}(1232)$ photoproduction for the study of $u\bar{u}$ quark pair production from the proton

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The photoproduction of various hadrons is important for unified understanding of hadron productions. The photoproduction of $d\bar{d}$ and $s\bar{s}$ quark pairs from the proton in the final state has been extensively studied by the $\gamma p \to \pi^+ n$ [1] and $K^+\Lambda$ and $K^+\Sigma^0$ [2] reactions, respectively. However, the photoproduction of $u\bar{u}$ quark pair has not been studied well. The $\gamma p \to \pi^-\Delta^{++}$ reaction is a unique reaction to study pure $u\bar{u}$ quark pair production from the proton.

We carried out an experiment to measure high-momentum charged pions at SPring-8/LEPS. The linearly polarized photon beams with energies of 1.5 to 2.95 GeV were used to measure photon-beam asymmetries for the $\vec{\gamma}p \to \pi^-\Delta^{++}$ reaction. The asymmetries are sensitive to the reaction mechanism, therefore the measurement of the asymmetries plays an important role in clarifying reaction dynamics.

Figure 1 shows the missing mass of the $\gamma p \to \pi^- X$ reaction. A clear $\Delta^{++}(1232)$ peak is observed. The fit to the missing mass was performed and the Δ^{++} yields were obtained. The number of the Δ^{++} events is about 400 k and this is the first-ever high-statistics data in this kinematical region.

Figure 2 shows the photon-beam asymmetries for the $\pi^-\Delta^{++}$ reaction for E_γ=1.5-2.9 GeV. The asymmetries are found to be negative in most of our kinematical regions [3], which suggests π exchange in the t-channel is dominant in the reaction mechanisms. We have observed positive asymmetries for the $\vec{\gamma}p \to \pi^+ n$ [1], $K^+\Lambda$, and $K^+\Sigma^0$ [2] reactions. In addition, the $\vec{\gamma}p \to \pi^0 p$ [4] and ηp [5] reactions also have positive asymmetries at forward meson angles. It is quite interesting that only pure $u\bar{u}$ quark pair production has negative asymmetries.

Similar results were obtained in the measurements of the single-spin asymmetries for the pp and ep [6] reactions. The inclusive production of π^- has negative asymmetries, while that of π^+ and K^+ has positive asymmetries. The π^- production is unusual and inferred to have a different reaction mechanism from the π^+ and K^+ productions. The present unexpected result is important to achieve unified understanding of the hadron photoproduction with the framework of flavor SU(3) symmetry.

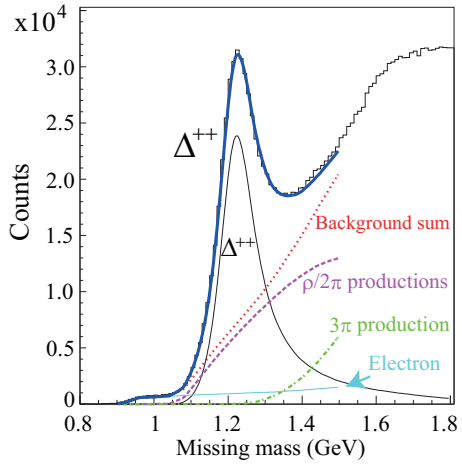

Figure 1: Missing mass of the $p(\gamma,\pi^-)X$ reaction for E_γ=1.5-2.95 GeV. The thick solid curve is the result of the fit. The dotted curve is the sum of the background contributions. The dashed and dotted-dashed curves are the contributions from the $\rho/2\pi$ and 3π productions, respectively.

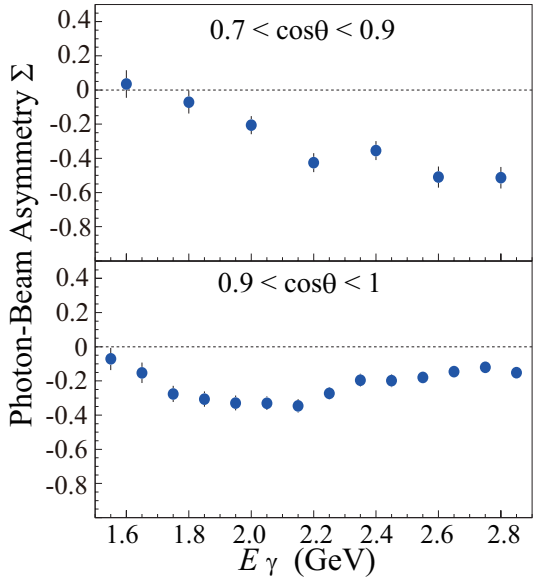

Figure 2: Photon-beam asymmetries (Σ) for the $\vec{\gamma}p \to \pi^-\Delta^{++}$ reaction for 0.7< $\cos\theta$ <0.9 and 0.9< $\cos\theta$ <1 for E_γ=1.5-2.9 GeV.

References

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