Photopion Production at Jefferson Lab Energies

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The $\gamma n \to \pi^- p$ and $\gamma p \to \pi^+ n$ reactions are essential probes of the transition from meson-nucleon degrees of freedom to quark-gluon degrees of freedom in exclusive processes. The cross sections of these processes are also advantageous, for the investigation of the oscillatory behavior around the quark counting prediction, since they decrease relatively slower with energy compared with other photon-induced processes. Moreover, these photoreactions in nuclei allow the search for the QCD nuclear filtering and color transparency effects. In this talk, I discuss results on these processes from Jefferson Lab experiment E94-104. I also discuss a new experiment in which singles $\gamma p \to \pi^+ n$ measurement from hydrogen, and coincidence $\gamma n \to \pi^- p$ measurements at the quasifree kinematics from deuterium and ^{12}C for photon energies between 2.25 GeV to 5.8 GeV in fine steps and at a center-of-mass angle of 90° are planned. The new experiment will allow the detailed investigation of the oscillatory scaling behavior in the photopion production differential cross-section and the study of the nuclear dependence of rather mysterious oscillations with energy that previous experiments have indicated. The various nuclear and perturbative QCD approaches, ranging from Glauber theory, to quark-counting, to Sudakov-corrected independent scattering, make dramatically different predictions for the experimental outcomes. With possible future energy upgrade to 12 GeV at Jefferson Lab, the photopion production will have a unique role in mapping out the transition from nucleon-meson degrees of freedom to quark-gluon degrees of freedom.