

Experiment 04-102
(Update of Experiment 01-104)

Helicity Structure of Pion Photoproduction

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This experiment will measure the helicity asymmetry in the two single-pion photoproduction processes $\gamma p \rightarrow \pi^+ n$ and $\gamma p \rightarrow \pi^0 p$ at energies up to 2.3 GeV. Circularly-polarized photons, produced by bremsstrahlung of longitudinally-polarized electrons, strike a longitudinally-polarized hydrogen target, and the desired asymmetry is measured by comparing the production rate with the beam and target polarizations parallel and antiparallel. The parallel and antiparallel combinations can be described as “helicity-3/2” and “helicity-1/2”, and the helicity asymmetry, known as E in the analysis of pion photoproduction, is defined as

$$E = \frac{\left(\frac{d\sigma}{d\Omega}\right)_{1/2} - \left(\frac{d\sigma}{d\Omega}\right)_{3/2}}{\left(\frac{d\sigma}{d\Omega}\right)_{1/2} + \left(\frac{d\sigma}{d\Omega}\right)_{3/2}}$$

where $\left(\frac{d\sigma}{d\Omega}\right)_{1/2, 3/2}$ are the differential cross sections in the two helicity states.

Although an extensive set of helicity-separated measurements on these reactions has been completed at the Mainz microtraon MAMI at energies up to 800 MeV, no helicity-separated exclusive data exist above 800 MeV. The data will be an important input to the partial-wave analyses of pion photoproduction, and the helicity-separated angular distributions will be helpful in understanding the individual contributions to the integrand of the Gerasimov-Drell-Hearn (GDH) sum rule measured by the total cross section method at Bonn. The experiment will run simultaneously with measurements of other processes (Experiments 02-112, 03-105, 05-012) using the frozen-spin target (“FROST”) which is now in the process of construction at JLab. This new target, which is polarized in a high (5 T) magnetic field but operated at a modest holding field of a few tenths of a Tesla, allows the outgoing particles to be detected over a much wider range of angles and momenta than was possible using the dynamically-polarized target previously available at JLab.

Author list for Experiment 04-102

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