

Measuring the Charged Pion Polarizability in the $\gamma\gamma \rightarrow \pi^+\pi^-$ Reaction

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Plans are underway at Jefferson Laboratory to make a new measurement of the charged pion polarizability $\alpha_\pi - \beta_\pi$ through measurements of $\gamma\gamma \rightarrow \pi^+\pi^-$ cross sections using the newly constructed GlueX detector in Hall D. Electromagnetic polarizabilities are fundamental properties of composite systems [Ho90], and they provide an important test point for effective field theories, dispersion theories, and lattice calculations. *The charged pion polarizability ranks among the most important tests of low-energy QCD presently unresolved by experiment*. Analogous to precision measurements of $\pi^0 \rightarrow \gamma\gamma$ that test the intrinsic odd-parity (anomalous) sector of QCD, the pion polarizability tests the intrinsic even-parity sector of QCD.

Hadron polarizabilities are best measured in Compton scattering experiments, where one looks for a deviation of the cross section from the prediction of scattering from a structureless particle with charge and magnetic moment. Because a free pion target doesn't exist, the measurements to date of the charged pion polarizability have been plagued by large experimental and theoretical uncertainties. Fig. 1 shows the wide range of experimental values that have been obtained for $\alpha_\pi - \beta_\pi$. A new precision measurement for $\alpha_\pi - \beta_\pi$ is clearly needed.

The Jefferson Lab experiment will measure $\gamma\gamma \rightarrow \pi^+\pi^-$ cross sections in the Primakoff reaction, and by utilizing crossing symmetry, the $\gamma\gamma \rightarrow \pi\pi$ amplitude can be related to the $\gamma\pi \rightarrow \gamma\pi$ Compton scattering amplitude. Fig. 2 shows the experimental data for $\gamma\gamma \rightarrow \pi^+\pi^-$ from MARK-II [Bo92], where there are probably less than 400 events in the region of interest, $W_{\pi\pi} < 0.5$ GeV. The figure clearly shows that the MARK-II data do not have the statistical precision, nor the coverage in $W_{\pi\pi}$, to provide a useful constraint on $\alpha_\pi - \beta_\pi$. An experiment using GlueX has the capability of delivering tens of thousands of $\gamma\gamma \rightarrow \pi^+\pi^-$ events in the threshold region in a running time of a few 100's of hours. A physics proposal will be submitted to PAC40.

[Bo92] J. Boyer et al., Phys. Rev. D 42, 1350 (1990).

[Ho90] B. Holstein, Comm. Nucl. Part. Phys. 19, 221 (1990)

[Pa08] B. Paquini, et al., Phys. Rev. C 77, 06521 (2008).

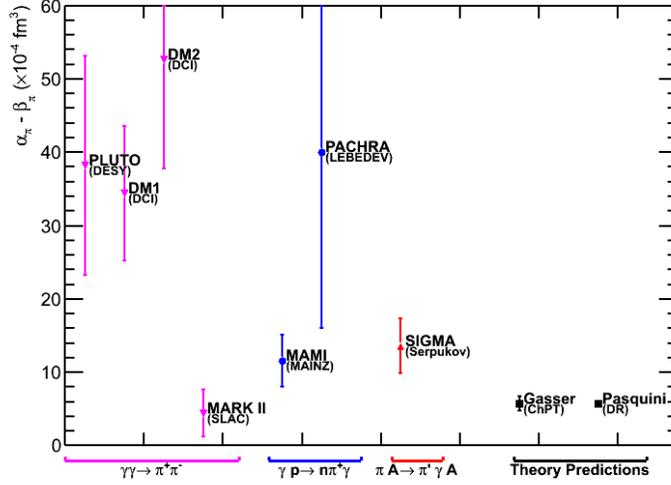


Figure 1: Measurements of $\alpha_\pi - \beta_\pi$.

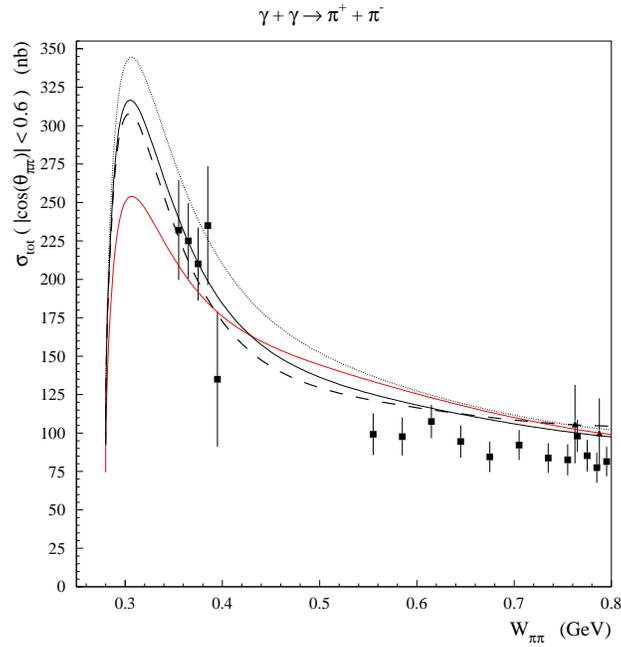


Figure 2: $\gamma\gamma \rightarrow \pi^+\pi^-$ cross sections. The curves are dispersion model calculations [Pa08] for several values of $\alpha_\pi - \beta_\pi$.