Investigation of the $N \rightarrow \Delta$ Transition via Polarization Observables in Hall A

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Abstract

We propose to make a precise measurement of the p($\vec{e}$,e'$\vec{p}$)π^0 reaction at the Δ resonance. Six individual response functions, $R'^{\ell}_{LT}, R'^{t}_{LT}, R^n_{LT}, R_{LT}, R'^{\ell}_{TT}$ and R'^{t}_{TT}, will be separated at several values of θ_{cm}. This will permit a multipole analysis of the response functions. Five of these response functions have never been measured before. In addition, we will determine the combinations $2\varepsilon R^n_L + R^n_T - \varepsilon R^n_{TT}$ and $2\varepsilon R_L + R_T - \varepsilon R_{TT}$. This high-precision determination of absolute response functions is complementary to the studies planned for CLAS.

Three of the LT-type response functions are highly sensitive to the presence of a resonant quadrupole (S_{1+}) amplitude in the $N \rightarrow \Delta$ transition. Furthermore, the combination $\mathrm{Re}(S^*_{1+}M_{1+})$ only occurs in these three response functions and one other, making the proposed measurement nearly maximal in the sense of obtaining most of the information possible on this term. The normal-polarization LT-type response, R^n_{LT}, along with $2\varepsilon R^n_L + R^n_T - \varepsilon R^n_{TT}$, will characterize the influence of other (resonant and non-resonant) amplitudes since they, like the "fifth" response function R'_{LT}, identically vanish for an isolated resonance. Knowledge of the two TT$'$-type response functions will allow the dominant $|M_{1+}|^2$ term to be accurately determined.

The experiment has two primary goals. One is to provide, via the LT-type response functions, precise information on the $\mathrm{Re}(S^*_{1+}M_{1+})$ interference term. The other is to determine several previously unmeasured response functions which contain both real and imaginary parts of interferences. By doing so, we will significantly test all the dynamical ingredients, resonant and non-resonant, in the elementary pion electroproduction process.