

Structure of the $\Lambda(1405)$ from Photoproduction at GlueX

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The well-established $\Lambda(1405)$ hyperon with $J^\pi = \frac{1}{2}^-$ may be a dual structure consisting of two overlapping $I = 0$ resonances. Each resonance may couple to $\Sigma\pi$ and $N\bar{K}$ final states, but a direct measurement of these two decays for each resonance has not previously been done. Using the GlueX detector system at Jefferson Lab we have obtained high statistics samples for the $\Lambda(1405)$ structure decaying to both final states. The photoproduction measurement in the beam energy range 6.5 – 11.6 GeV used a liquid hydrogen target together with a large-acceptance charged particle tracking and electromagnetic calorimeter system. The experiment obtained the differential cross sections $d\sigma/dM_{\Sigma^0\pi^0}$ and $d\sigma/dM_{pK^-}$ in the $-(t-t_{min})$ range 0.0 – 1.5 (GeV/c)² from analyzing the reaction $\gamma p \rightarrow K^+\Lambda^*$, collected during the first phase of GlueX running. The $\Sigma^0\pi^0$ data exhibited both the dual $\Lambda(1405)$ states and the $\Lambda(1520)$ hyperon. The pK^- data were dominated by the $\Lambda(1520)$ hyperon sitting atop the tails of the $\Lambda(1405)$ states decaying to the pK^- final state.

The data were subjected to K -matrix fits to both final state channels from one or two $\Lambda(1405)$ plus the $\Lambda(1520)$ resonances. The two-resonance hypothesis for the $\Lambda(1405)$ region resulted in much better matching to the experimental results. The complex T -matrix pole positions of the dual $\Lambda(1405)$ resonances as well as the $\Lambda(1520)$ were extracted, and the results will be presented. The results also include first-time measurements of the mass- and beam-energy- integrated photoproduction cross sections in the stated energy range for the dual $\Lambda(1405)$ and the $\Lambda(1520)$ states. Within the framework of the K -matrix fits to the $\Lambda(1405)$ states, the branching ratio and branching fractions to the $N\bar{K}$ and $\Sigma\pi$ final states were obtained for the first time and will also be presented.

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