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$K_S\Lambda$ PHOTOPRODUCTION ON THE NEUTRON WITHIN THE RESONANCE REGION

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QDC-based models predict many N* states that decay through modes that have yet to be measured or precisely identified. These decay mechanisms give insight into the underlying symmetries of the excited-baryon states. There are competing models for the quark symmetries and dynamics ranging from preferentially paired-quark distributions to hybrid gluonic excitations. Measurement of the differential cross sections and single- and double-polarization observables provide strong constraints on identifying the N* excitation spectrum. In this presentation, we report the preliminary differential cross section measurements of the $\gamma n \to K_S\Lambda$ reaction employing a circularly-polarized photon beam onto unpolarized LD_2. The energy of the photon beam ranged from 1.3 to 2.65 GeV, which spans from threshold to the resonance regimes. With the initial large energy bin, we observe increase in cross section at 1.7 and 1.9 GeV.

Keywords: photoproduction; baryon reconstruction; cross section.

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1. Introduction

As a part of the study for excited baryon states, it is important to study the coupled-channels $\gamma n \to K_S\Lambda$ and $\gamma n \to K_S\Sigma^0$. The neutral nature of these channels allow for the clear analysis of the isospin symmetry of the triplet states, thereby adding significant constraints of the model[1]. This paper reports the first evaluation of the $K_S\Lambda$ channel preliminary differential cross section. Simulation is still being developed for the coupled channels.

In this study, an initial $\gamma n \to K_S\Lambda$ differential cross section is measured at larger energy bins, using the g13a dataset. This dataset was collected with a circularly polarized photon beam incident upon an unpolarized deuterium target. The analysis can be described in three primary stages: yield extraction, flux determination, and acceptance studies. The yield extraction is determined from the selection of events from the data and the reconstruction of the representative missing mass. The photon flux determination is used to determine how many photons were needed to produce the measured events. Finally, the acceptance is determined by performing a Monte

Carlo simulation. All three stages require special corrections for events and the tracks within them, based on the CLAS systems limitations.

2. Yield Extraction

For both the $\gamma n \to K_S\Lambda$ and $\gamma n \to K_S\Sigma^0$ reactions, the intermediate kaon and hyperons (Λ and Σ^0) are neutral and short-lived making their direct detection essentially impossible. Therefore they are reconstructed through their primary decays: $K_S \to \pi^+\pi^-$, $\Lambda \to p\pi^-$ and Σ^0 $\Lambda\gamma \to p\pi^-(\gamma)$. Having no particles directly measured from the production vertex requires a more vigorous analysis, particularly with vertex reconstruction. The pre-skimmed files require an event to have at least two positive and two negative tracks for events consistent with $\pi^+\pi^-\pi^-$p.

Since the final-state particles of this analysis are all pions and protons, the identification of the measured particles is relatively straightforward. Track momentums were corrected for energy lost in the tracks passage through the start counter, using the eloss package developed by Eugene Pasyuk[2]. The moment was also corrected for inefficiencies in the magnetic field using code written by Paul Mattione[3].

Once the candidate events with all the required particles are identified, their tracks are paired to reconstruct the possible K_S and Λ particles. The K_S will decay 69% of the time into a $\pi^+\pi^-$ pair, while the Λ has a 64% branching ratio to the π^-p channel. It cannot be certain which of the two belong to the proton or π^+, so both combinations are introduced into the data. Mass and momentum cuts will remove nearly all of the combinatorial background.

With the reconstruction of the missing mass for the $K_S\Lambda$ channel, we see two peaks survive the systematic cuts (see Fig. 1). The first peak corresponds to the missing mass of a proton, while the second is form a proton plus a gamma, which corresponds to the $K_S\Sigma^0$ channel. Using fits, the yield can be extracted from both

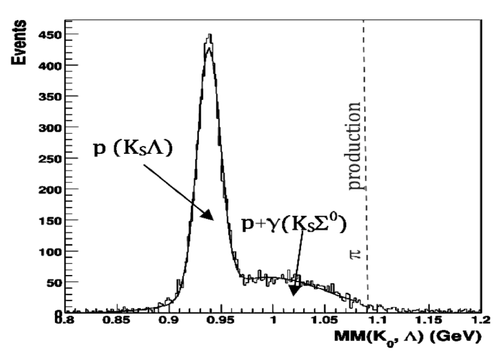

Fig. 1. Missing mass distribution of the proton from $K^+\Lambda$ and with the distribution from the proton plus photon associated with the $K_S\Sigma^0$. Because of the misisng momentum cut (MMom < 1.5 GeV) used in the code, events with Σ^* do not survive.

peaks simultaneously. For the initial study for this paper, only the yield of the $K_S\Lambda$ channel is used for cross section measurement.

3. Flux Determination

Before extracting the cross section, it is necessary to first measure the photon flux incident on the target. The gflux method[5] was used for the g13 dataset. This method counts the number of good electrons in the tagger and compares them with the number of photons measured with the total absorption counter (TAC), which has a well-known efficiency. From these normalization runs, a tagging ratio is produced. This ratio is then applied when the data is cooked to normalize the photon flux. A normalization run was made every few hundred runs.

4. Acceptance Studies

Simulation of the $K_S\Lambda$ channel was made using FSGen for event generation and GSIM[4] for the propagation of those events through the modeled detector. The acceptances for the $K_S\Lambda$ and $K_S\Sigma^0$ channels were calculated by comparing the original number of events generated with the number events that survived after passing through the simulated CLAS detector and reassembled using the same code as the real data. Originally the events are generated isotropically with d(cosθ), with dϕ being uniform in the center of mass frame. With small enough bin size this is a reasonable assumption. However, when bin sizes get larger, the slopes within each bin can cause poor representation of the true functional form of the values within each bin. To reduce the effect from large binning the cross section produced after the first iteration is used to generate the events for the next.

5. Cross Section Development

With the cross section plotted as a function of the center-of-mass energy (seen in Fig.2), it is possible to examine the trends of these energy-dependent distributions. The general distribution is similar to what is seen in the $K^+\Lambda$ channel[6,7]. However, the $K^+\Lambda$ has one peak at 1.8 GeV and, in this study, the $K_S\Lambda$ channel hints at two peaks at 1.7 and 1.9 GeV. The cross section quickly lowers with increased energy. Around 2.3 GeV, some uncertain structure manifests around cosine theta of zero. This is likely due to the overlapping missing mass peaks for the $K_S\Lambda$ and the $K_S\Sigma^0$ channels at these higher energies.

6. Conclusion

The energy binning for these preliminary cross sections is too large for any precise conclusions to be made. However, they do give us an idea for further improvements that need to be made with the analytical method as we move onto the finer energy binning. It is of primary importance that the final cross sections for the γn $\rightarrow K_S\Lambda$

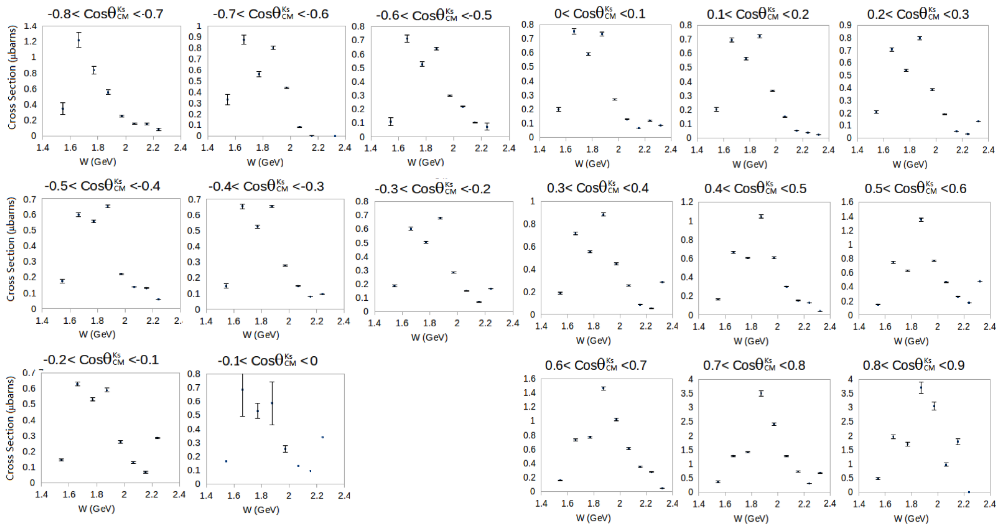

Fig. 2. Differential cross section for the $\gamma n \rightarrow K_S\Lambda$ reaction, binned by cosine theta as a function of the center-of-mass energy. There is clearly a smooth increase at the lower and mid cosine theta angles as the energy bins are increased. The development of these structures can be seen with cm energy as low as 1.7 GeV and becomes more clearly pronounced by 1.9 GeV.

be made in conjunction with the $\gamma n \rightarrow K_S\Sigma^0$ cross section. New simulation with the two coupled channels will likely improve these cross sections above W = 2 GeV. Additionally, new fitting methods will be tested and modified for the extraction of yield from the missing mass peaks, due to the lower statistics. Checks are also being made on the data quality so questionable runs may be removed from the study and, in some cases, data runs recovered.

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