Electroproduction of Cascade Hyperons in CLAS12 at Jefferson Lab

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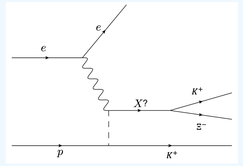
Introduction

- Cascades (Ξ), doubly strange hyperons, were studied in the 1960s–80s using hyperon and kaon beams. Their narrow resonances, embedded in a complex spectrum of overlapping states, make them particularly compelling to study.
- Constituent quark models predicts a Ξ partner for every N^* and Δ^*, yet only 11 Ξ states are listed in the PDG, with just 6 well established.
- The goal of this analysis is to calculate cross sections for $\Xi(1320)$ and $\Xi^-(1530)$ at $E_{beam} = 6.5$ and 7.5 GeV across various Q^2 ranges.

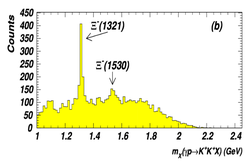


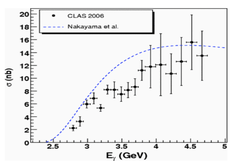
Prior CLAS Analysis for Cascades

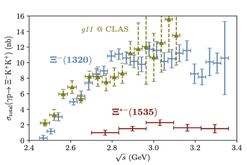
2005: CLAS g6 provided the first-ever exclusive measurement of Ξ^- in $\gamma p \rightarrow K^+K^+\Xi^-$
(J.W.Price et al. Exclusive photoproduction of the cascade hyperons)

2007: g11data, provided cross section results for Ξ^- (1320) and Ξ^-(1530)
(L.Guo et al. Cascade production in the reaction $\gamma p \rightarrow K^+K^+(X)$ and $\gamma p \rightarrow K^+K^+\pi^-(X)$)

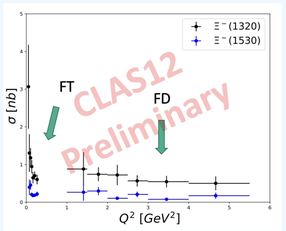
2018: g12 expanded the kinematic region of study (W=3.3GeV) as well as increased statistics
(J.T. Goetz et al. Ξ^* Photoproduction from Threshold to W=3.3 GeV)







Prior CLAS12 Analysis

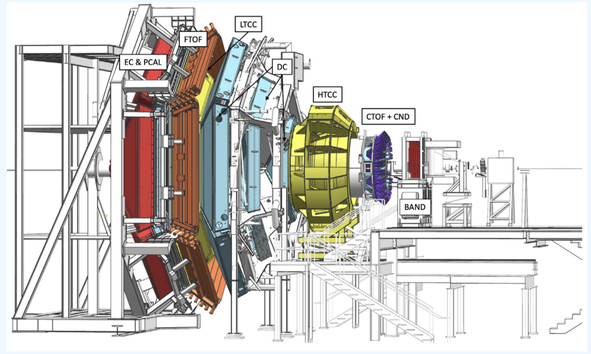


Jose Carvajal Dissertation: "First Time Measurement of Ground State Ξ^- Hyperon Cross Section in Electroproduction"

- $ep \rightarrow e'K^+K^+(\Xi^-)$
- Cross section results from CLAS12 RG-A for $E_{beam} = 10.2$ GeV are shown for both the Forward Tagger and Forward Detector regions
- Gap in Q^2 is due to the polarity of the magnetic fields

Experiment

The data for this analysis was taken in Fall 2018 from RG-K. The electron beam energy was set to 6.5 and 7.5 GeV. Using a 5cm unpolarized LH_2 target. Luminosity was $10^{35} cm^{-2} s^{-1}$.



Event Reconstruction

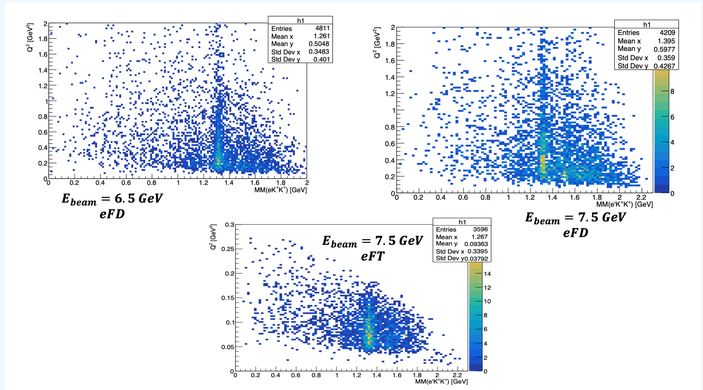
The Ξ signal is reconstructed using the missing mass technique for the following reaction

$$ep \rightarrow e'K^+K^+(\Xi^-)$$

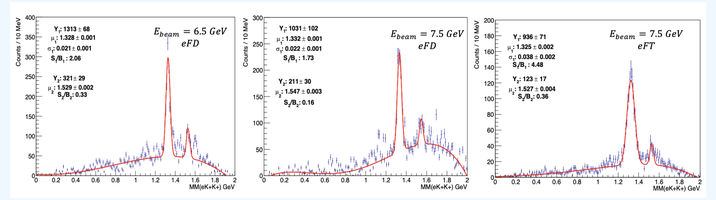
E_{beam} [GeV]	Scattered Electron Region	Q^2 Coverage [GeV^2]
6.5 and 7.5	Forward Detector (FD)	0.2 – 2.0
7.5	Forward Tagger (FT)	0.03 – 0.2

Allowing the scattered electron to be detected in both the Forward Tagger region ($2.5 < \theta_e < 5.0$) and the Forward Detector region ($5.0 < \theta_e < 35.0$) opens up the possibility to probe into the quasi-real photoproduction regime as well as purely electroproduction regime, respectively.

Kinematic Coverage

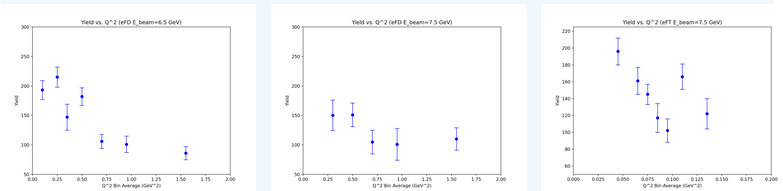


Missing Mass Distributions



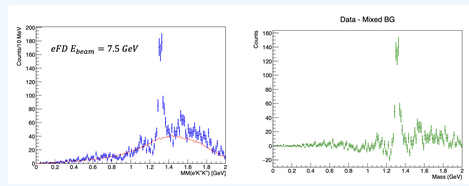
The missing mass distributions are fitted to a 4th order polynomial background, a gaussian for the first signal and a Breit-Wigner for the second signal.

Yield



Mixed Events Background

In $ep \rightarrow e'K^+K^+(\Xi^-)$, the two K^+s originate from different vertices. Using the mixed events technique, the lower-momentum kaon is randomly selected to break signal correlation, producing a background template as shown in red below.



Outlook

Efficiency calculations and simulations are underway as well. Assuming a model in which Ξ^- is a decay product from an intermediate hyperon Y^* via $Y^* \rightarrow \Xi^- K^+$. On average, acceptance is between the range of $0.80 - 1.0\%$. Alongside this, energy corrections to the FT electron are being worked on in addition to FD electron and kaon momentum corrections.

Acknowledgments

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