Cascade Production in RG-K

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OUTLINE

- Goal of analysis
- Previous photoproduction cascade analysis
- Previous electroproduction cascade analysis
- Forward Detector results
- Forward Tagger results
- Outlook

GOALS

- This analysis aims to measure the cross section of Ξ^- within $E_{beam} = 6.5$ and 7.5 GeV
- Extend Q^2 region for cross section results for electroproduction of Ξ^-
- Gain further insight on the production mechanism of cascades

n $E_{beam} = 6.5$ and 7.5 GeV ction of Ξ^-

Cascade Hyperons

 Hadron spectroscopy is a key tool to understand QCD 	$S \\ 0$
 Studying cascades in the baryon 	
spectrum has many interesting attributes:	$^{-1}$
 Cascades are relatively underexplored; low cross sections due to doubly strange nature 	-2
2. Cascades should have the same number of excited states as $N^{*'s}$ and $\Delta^{*'s}$ but only 11 states in PDG but only 6 have *** rating or better	e
3. Cascades have a narrow resonance compared to some other excited states due to their "longer" lifetime; $\Delta E \Delta t \ge \frac{\hbar}{2}$	_





Previous Photoproduction Cascade Studies

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

Previous Electroproduction Studies



B. Gualtieri CLAS Collaboration Meeting Nov.'24

Current Work

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

Pass 2, RG-K

(all available data)

Forward Detector

 $E_{beam} = 6.5 \ and \ 7.5 \ GeV$

Selection Criteria and Cuts for FD

- Require one electron in FD region and require two $K^{+'}s$ in FD
- Fall 2018, out bending
 - All data currently available for 6.5 and 7.5 GeV

Cuts (Forward Detector)	K+	
Track status	$2000 \leq status < 4000$	
$V_z[cm]$	$-10 \le V_z \le 2$	
$ heta[\circ]$	$5 \leq \theta_{K^+} \leq 35$	
P [GeV]	$0.4 \le P \le 7.5$	
ToF [ns]	$20 \le ToF \le 35$	
$\chi^2 PID$	$-6 \leq \chi^2 \leq 6$	
β	$0.4 \leq \beta < 1.1$	



FD Electron Kinematics



FD Electron Kinematics Comparison



<u>Jose Carvajal, Ph.D. thesis</u> "First Time Measurement of Ground State Ξ^- Hyperon Cross Section in Electroproudction"

FD Electron Kinematics



FD Electron Kinematics Comparison



Hyperon Cross Section in Electroproudction"

Missing Mass off of $e'K^+K^+(\Xi^-)$ ($E_{beam} = 6.5 \ GeV$)

- Fitted to gaussian(1320) + gaussian(1530) + 4th order polynomial
- Shows well defined ground state signal as well as potential to explore 1st excited state



Missing Mass off of $e'K^+K^+(\Xi^-)$ ($E_{beam} = 7.5 \ GeV$)

- 7.5 has more runs than 6.5
- Higher statistics
- Fitted to gaussian(1320) + gaussian(1530) + 4th order polynomial



FD Electron Comparison

• Q^2 range comparison to previous electroproduction study shows that we will be able to fill in unexplored region of cross section with respect to Q^2





FD Electron Comparison for Different Energies

 RG-K data shows clear peak without a very complication background compared to higher energy results





Jose Carvajal, Ph.D. thesis "First Time Measurement of Ground State Ξ⁻ Hyperon Cross Section in Electroproudction"

Forward Tagger

 $E_{beam} = 7.5 \ GeV$

Selection Criteria and Cuts for FT

- Require one electron in FT region and require two $K^+{}'s$ in FD
- Fall 2018, out bending
- All data currently available 7.5 GeV

Cuts (Forward Tagger)	K+	e'
Track status	$2000 \le status < 4000$	$1000 \leq status < 2000$
$V_z[cm]$	$-10 \le V_z \le 2$	$-10 \le V_z \le 2$
$\theta[\circ]$	$5 \leq \theta_{K^+} \leq 35$	$2.5 \le \theta_{e'} \le 4.5$
P [GeV]	$0.4 \le P \le 7.5$	P > 1.0
ToF [ns]	$20 \leq ToF \leq 35$	N/A
$\chi^2 PID$	$-4 \leq \chi^2 \leq 3$	N/A
β	$0.4 \leq \beta < 1.1$	N/A

Forward Tagger Kinematics



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- Fitted to gaussian(1320)+gaussian(1530) + 4th order polynomial
- Larger width than FD



Mixed Events Background

- Data driven approach to mimic background shape •
- Mixed event background takes one K^+ from one event and one K^+ from another event and computes the missing mass
 - Background is not from correlated kaon pairs lacksquare





Jose Carvajal, Ph.D. thesis "First Time Measurement of Ground State Ξ^- Hyperon Cross Section in Electroproudction"

Summary and Outlook

• Exploratory study for cascade in lower energy regions look promising!

	$eFD (E_{beam} = 6.5 GeV)$	$eFD (E_{beam} = 7.5 GeV)$	$eFT (E_{beam} = 7.5 GeV)$
Yield	829 ± 4	1070 ± 41	737 ± 44
Mean [GeV]	1.327 ± 0.0007	1.332 ± 0.0009	1.324 ± 0.001
$\sigma ~[{ m GeV}]$	0.018 ± 0.0006	0.021 ± 0.0007	0.038 ± 0.001

- Apply mixed events background
- Improve overall analysis with timing and fiducial cuts
- Apply momentum and energy loss corrections for RG-K
- Acceptance correction
- Preliminary cross section results for all 3 data sets by end of semester!



Thank you!



