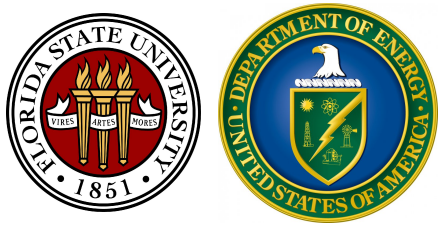
Total Cross section of $\Xi^{*-}(1820)$ at GlueX

Chandrasekhar Akondi

Florida State University, Tallahassee, FL

On behalf of GlueX collaboration.

HYP2022 conference 2022, CZ



Outline

Motivation

- SU(6) flavor-spin symmetry gives
  $6 \otimes 6 \otimes 6 = 20_A \oplus 70_{MS} \oplus 70_{MA} \oplus 56_S$
  $70_M = {}^2 10 \oplus {}^4 8 \oplus {}^2 8 \oplus {}^2 1$
- First excitation: negative parity
- octet: S= 3/2, L=1 gives
  $1/2^-, 3/2^-, 5/2^-$
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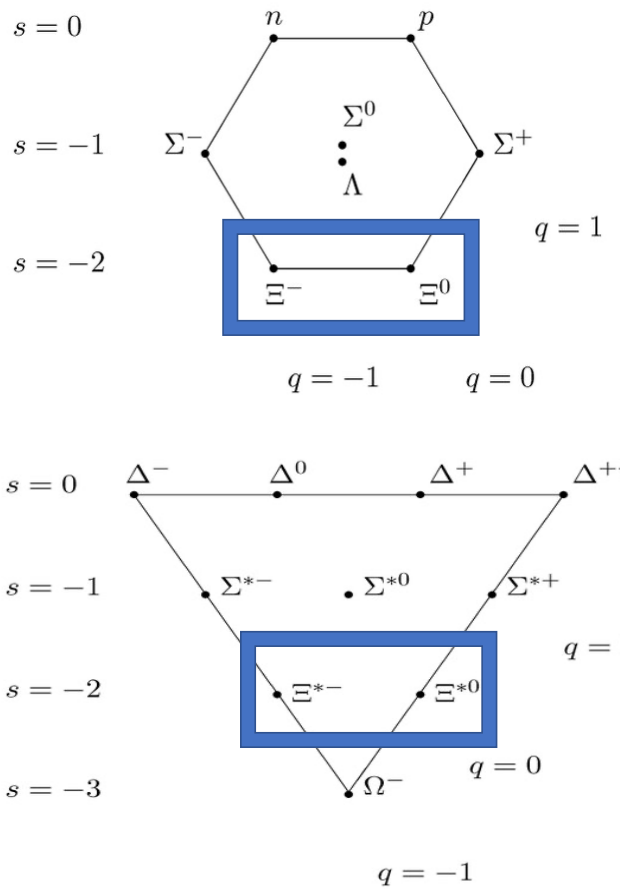

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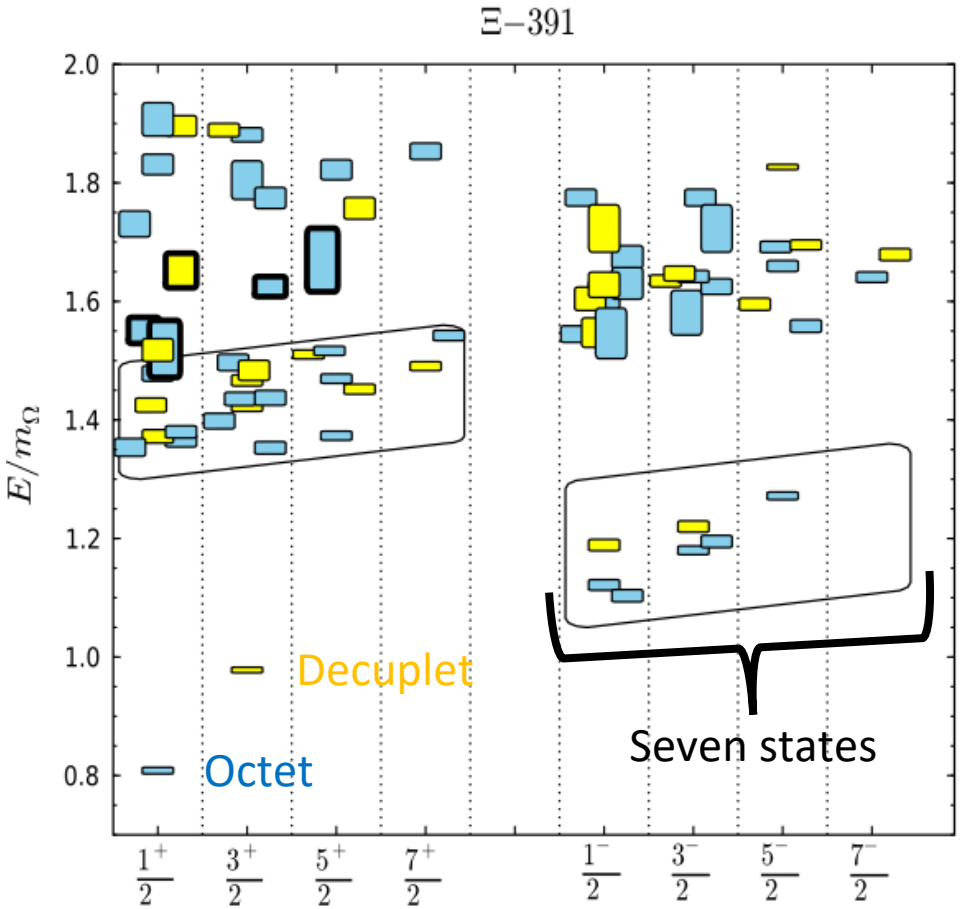
Excited baryon spectra from lattice QCD
Robert P.R.D **87**,054506(2013)



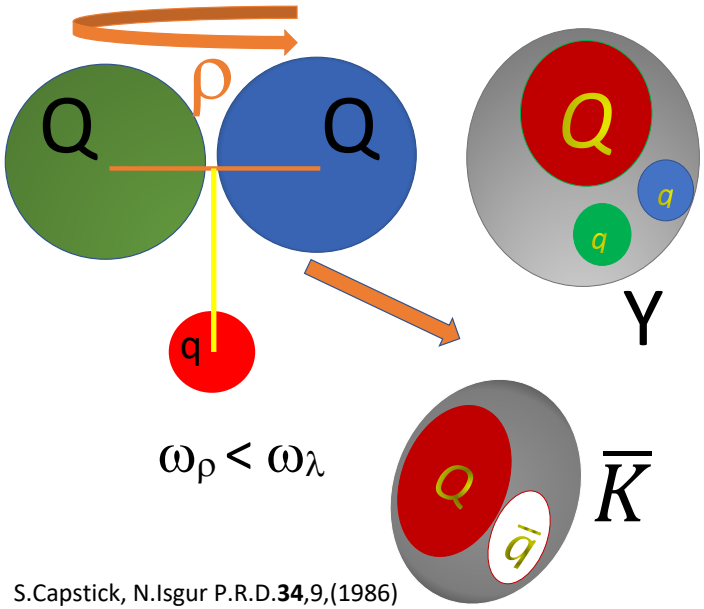
All these seven states are accessible at GlueX energies.

Motivation (cont)

Ξ^* can be seen as two 3D harmonic oscillators

ρ decay mode

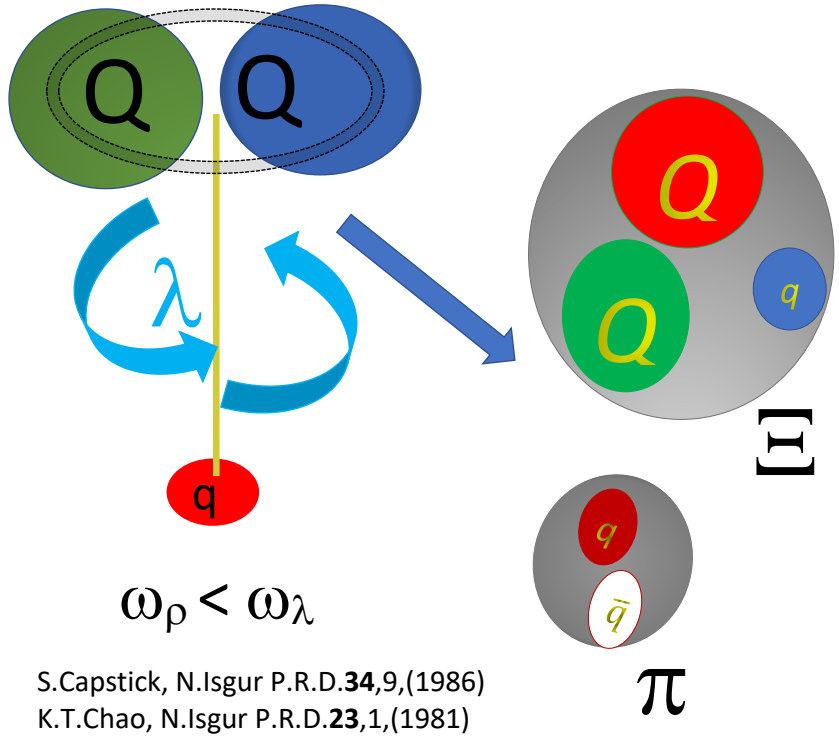
Ξ^* Excitation within the pair



S.Capstick, N.Isgur P.R.D.**34**,9,(1986)
K.T.Chao, N.Isgur P.R.D.**23**,1,(1981)

λ decay mode

Ξ^* Excitation between the pair and the third quark



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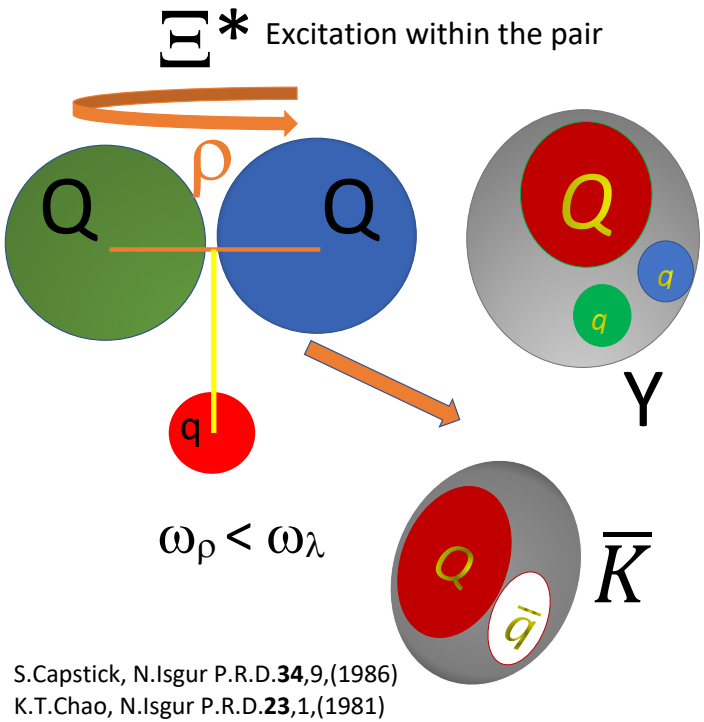

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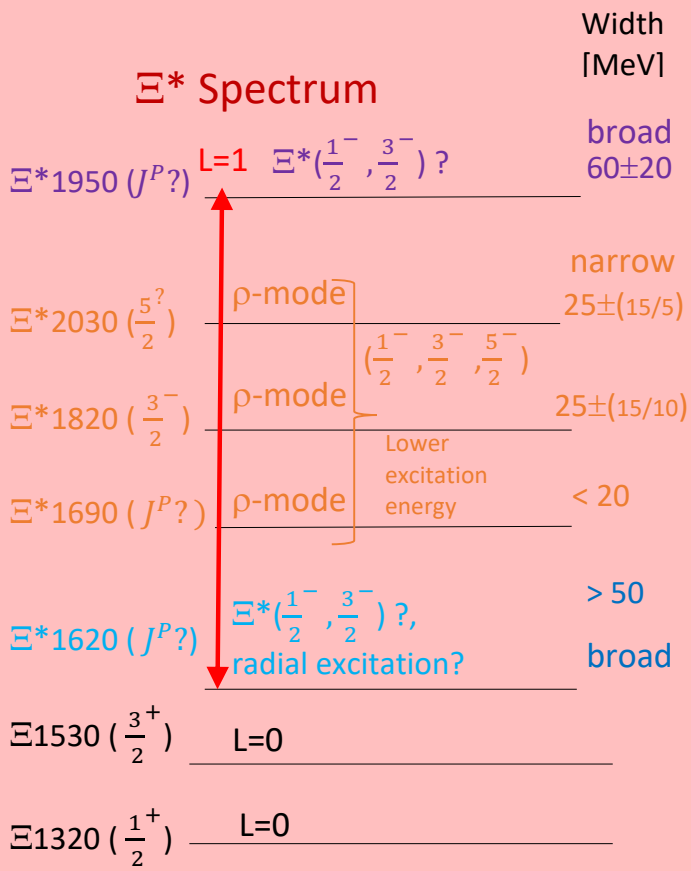
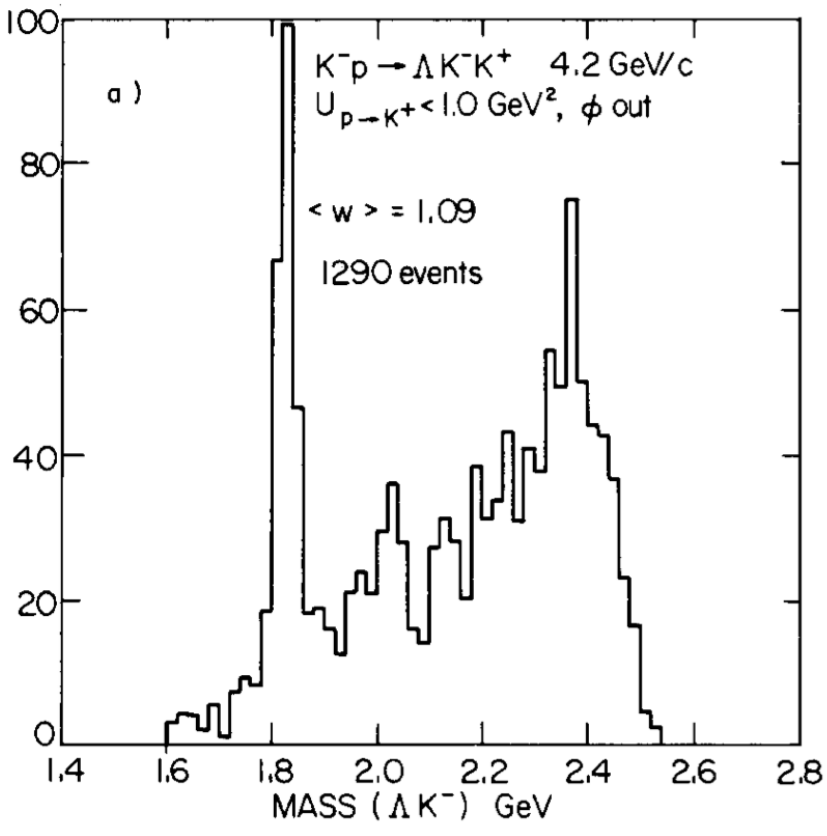


Previous Experiments

D.Teodoro *et al.* P.L.B **77** 451(1978).

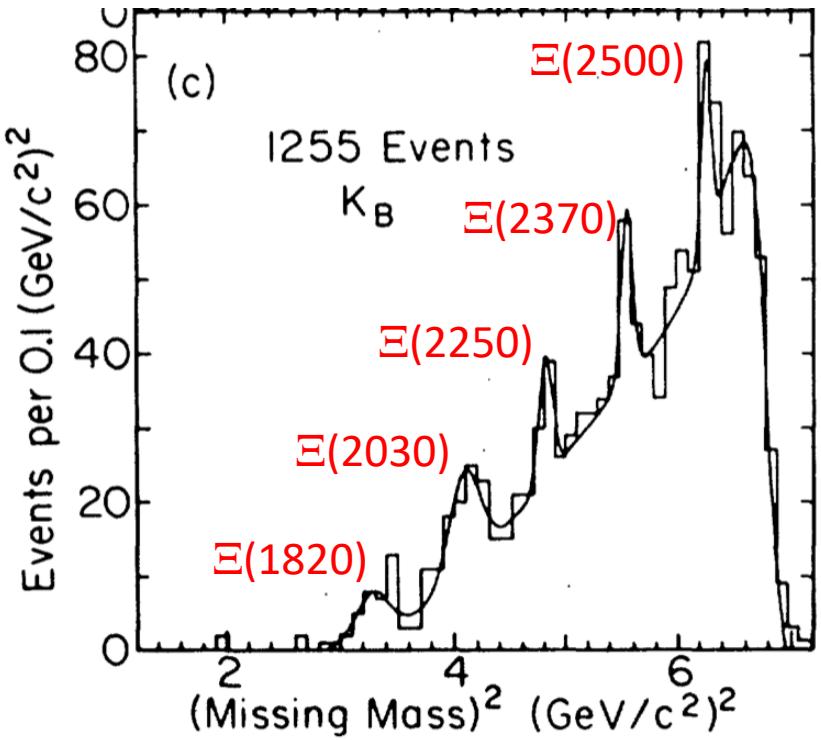
CERN



Previous Experiments

M.Jenkins *et al.* P.R.L. **51** (1983).
$K^- p \to K^+ X^- (B.N.L)$

No indication of Ξ(1620), Ξ(1690).



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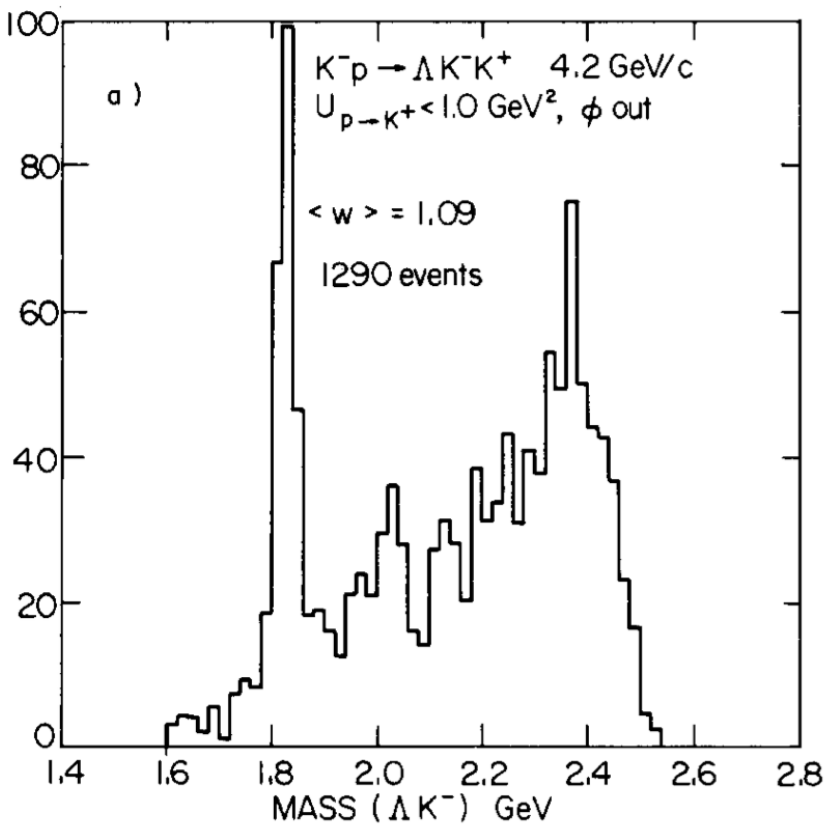
CERN



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$K^- p \rightarrow$

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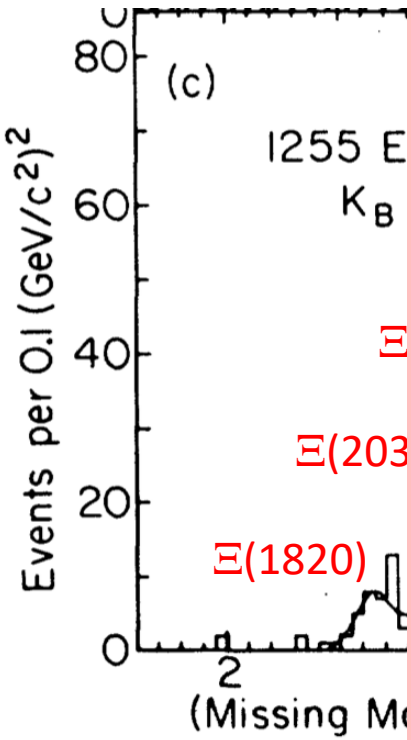
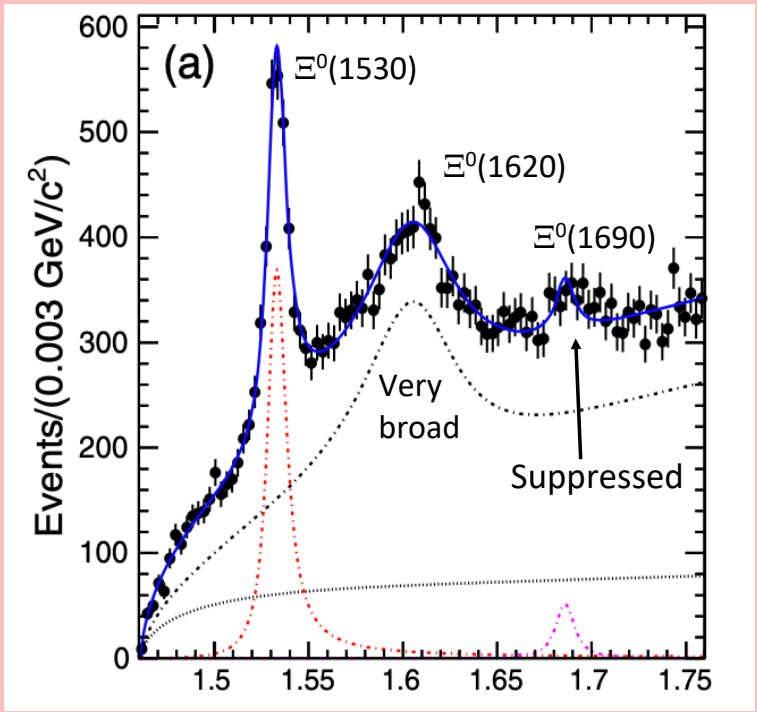
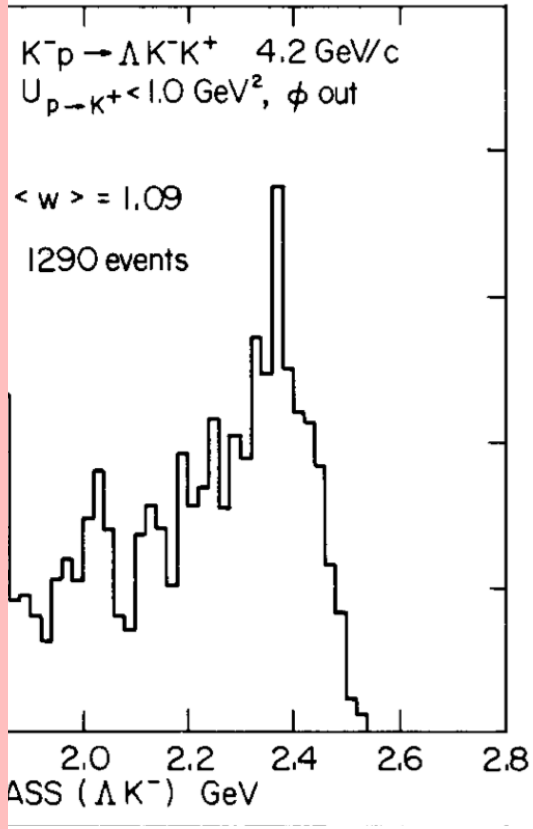




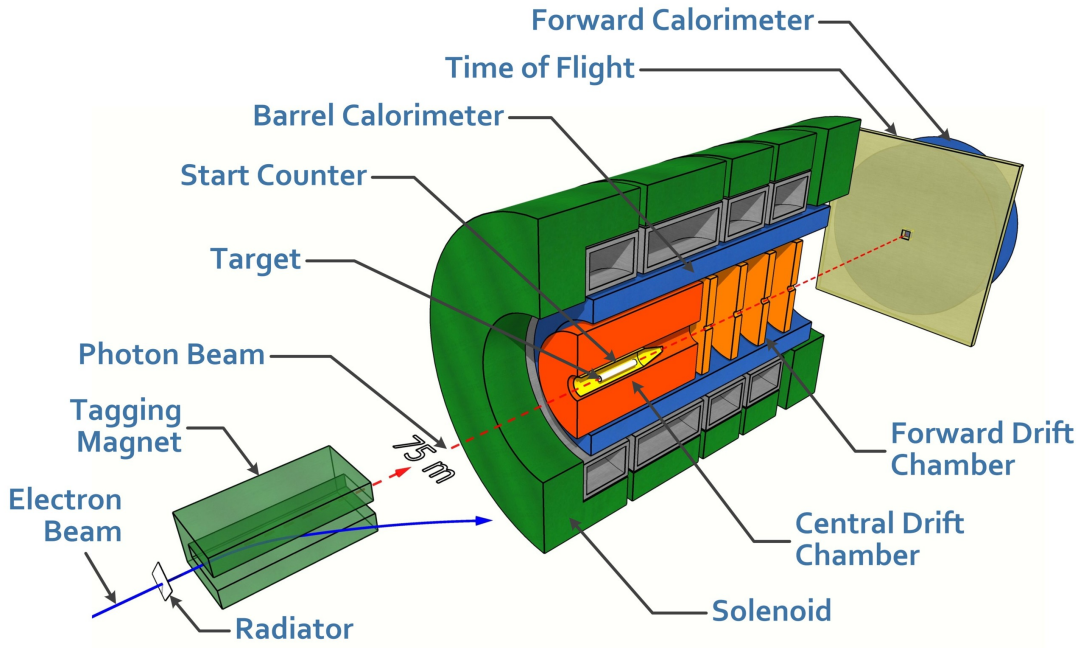
Belle: P.R.L.**122**,072501 (2019)



GlueX Experiment

The GlueX experiment is located in Hall D in JLab.

GlueX started data taking in 2017.



GlueX has nearly hermetic acceptance for charged and neutral particles.

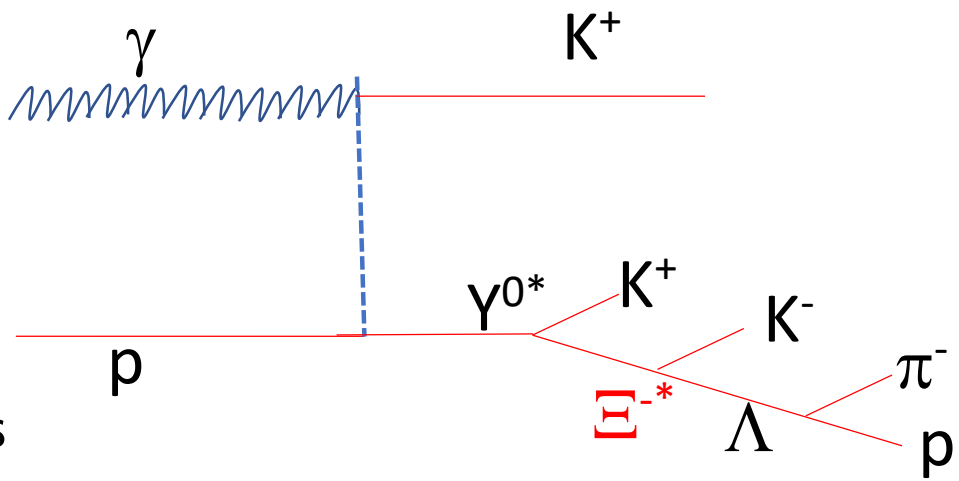
More details: The strangeness program at GlueX by Dr.Peter Pauli on 01/07 at 11:00 -11:20 am.

pictures are taken from https://gluexweb.jlab.org

Event Selection

Event selection for $\gamma p \to K^+K^+\Xi^{*-} \to K^+K^+K^-\Lambda$

- Kinematically fitted.
- GlueX Phase-1 data.
- Selected events after relevant cuts.
- MonteCarlo sample is generated with a single Y^{0*} hyperon of mass 2.75 GeV and width of 0.5 GeV.
- t slope of value 1.4 GeV^2 is used.



Excited Ξ^* states at GlueX energies

Particle	J^P	Overall Status	Status as seen in			
			$\Xi\pi$	$K\Lambda$	$K\Sigma$	$\Xi(1530)\pi$
$\Xi(1318)$	$1/2^+$	****				
$\Xi(1530)$	$3/2^+$	****	****			
$\Xi(1620)$		*	*			
$\Xi(1690)$		***		***	**	
$\Xi(1820)$	**$3/2^-$**	***	**	***	**	**
$\Xi(1950)$		***	**	**		*
$\Xi(2030)$		***		**	***	
$\Xi(2120)$		*		*		
$\Xi(2250)$		**				
$\Xi(2370)$		**				
$\Xi(2500)$		*		*	*	

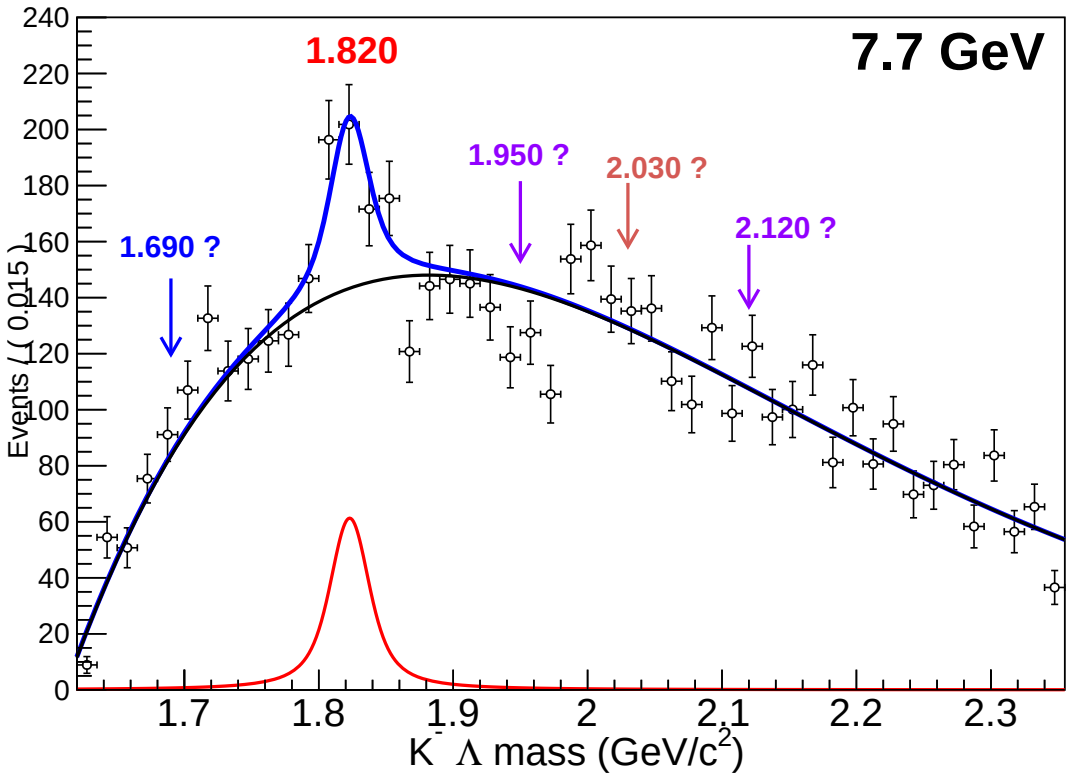


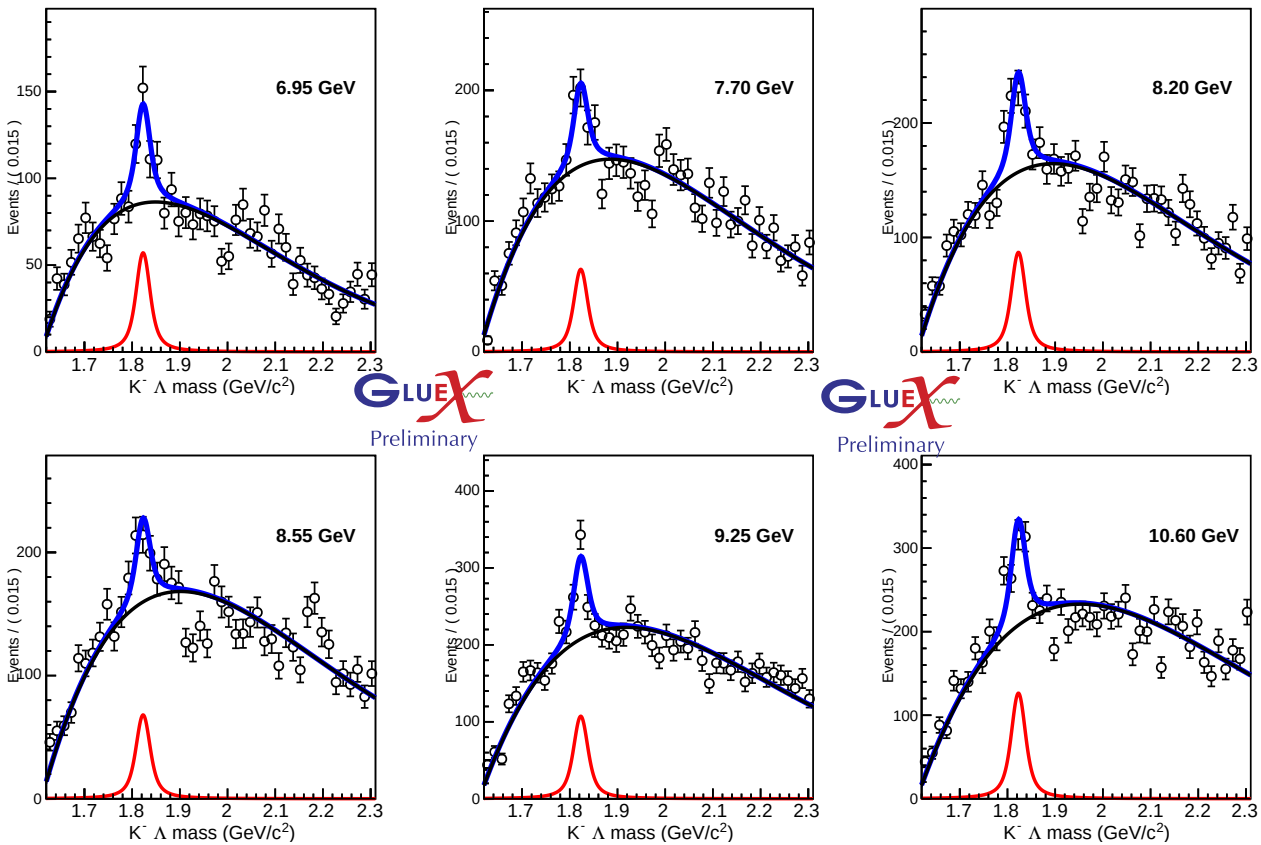
Table taken from Ref. PDG[3]

3. Review of Particle Physics (PDG)(2020)

Results

Invariant mass of $K^-\Lambda$

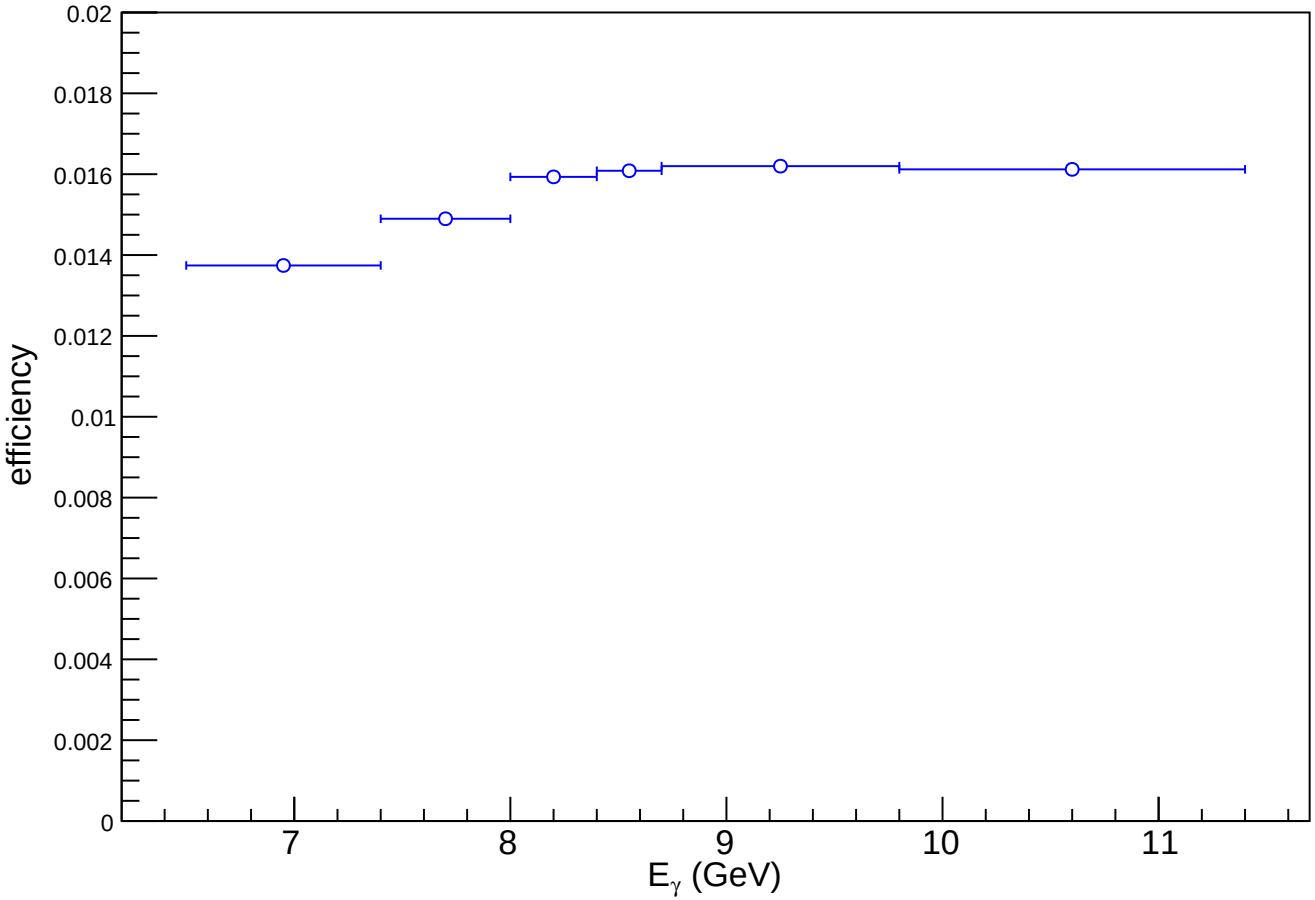
Invariant mass is fitted with a combination of Voigtian and Argus function for signal and background respectively.



Results

$$\text{efficiency} = \frac{\text{reconstructed}}{\text{generated}}.$$

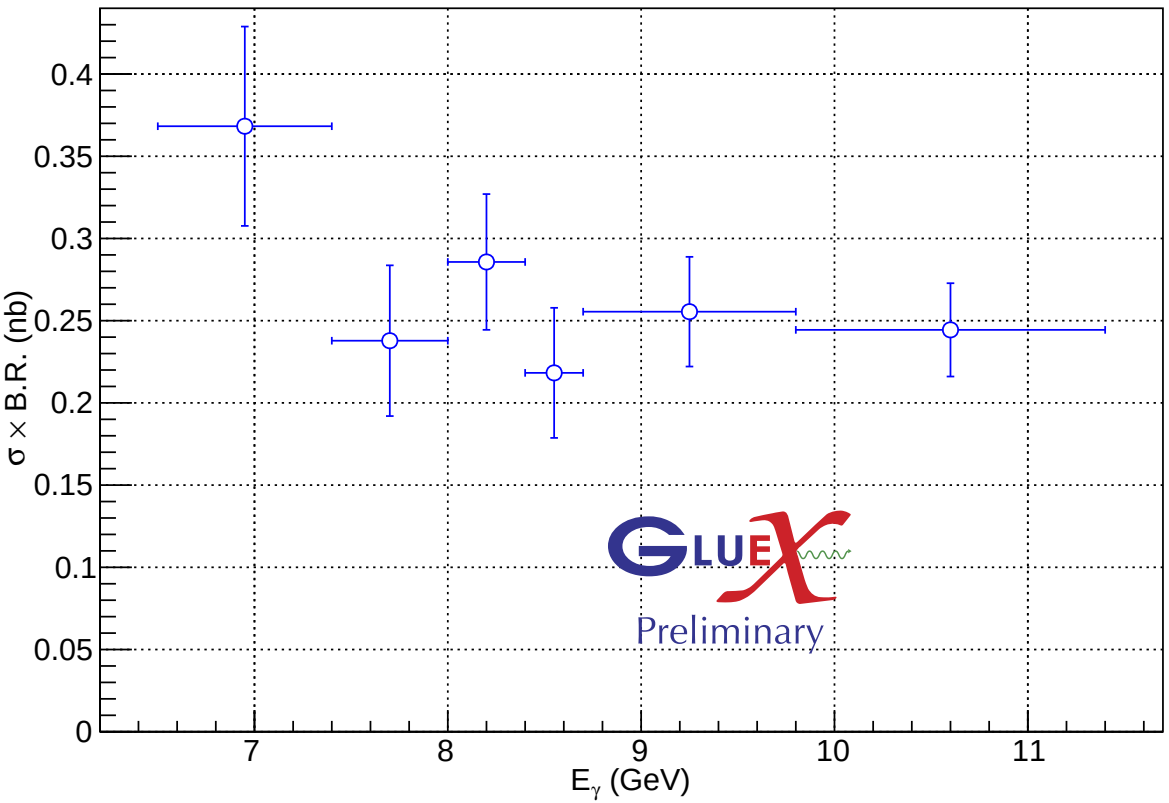
Luminosity $\sim$ 423 pb^{-1}



Results (cont)

Total cross section for $\gamma p \rightarrow K^+K^+\Xi^{*-}$

$$\sigma \times B.R. = \frac{Yield}{Target \times Flux \times efficiency}$$



J.T.Goetz[4] *et al.* at CLAS collaboration estimated the upper limit for the total cross section for the $\Xi(1820)$ is 1.01 nb. CLAS data set is mostly in the energy range of 1.6-3.85 GeV.

4. J.T.Goetz *et al.*Phys.Rev.C **98**,062201(R)(2018).

Summary and Future work

- In $K^-\Lambda$ invariant mass, $\Xi^{*-}(1820)$ is the only dominant signal.
  $\rightarrow$ excitation is likely between the pair of strange quarks.
- Total cross section is below the upper limit estimated by CLAS. CLAS data set is mostly in the energy range of 1.6-3.85 GeV.
- Future Work:

  Measure the differential cross section for different t bins.

  Measure the spin of $\Xi^{*-}(1820)$.

  Include the GlueX Phase-II data.

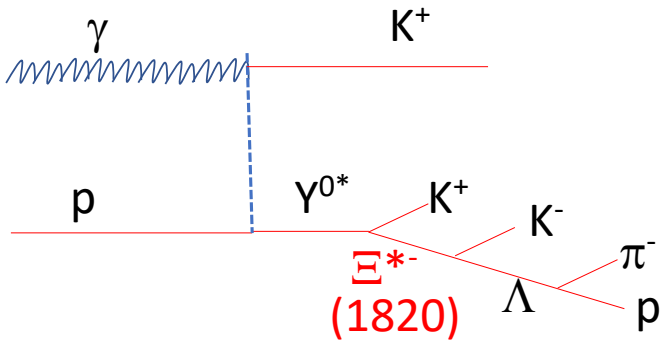
GlueX acknowledges the support of several funding agencies and computing facilities: ▸ gluex.org/thanks

Backup (Event Selection)

Event selection for $\gamma p \to K^+K^+\Xi^{*-} \to K^+K^+K^-\Lambda$

Name of the Cut	Range
χ^2/NDF	≤ 3.5
Missing Mass Square	[-0.04,0.04] GeV^2/c^4
Λ invariant mass	[1.10,1.13] GeV/c^2
K^+K^- invariant mass	≥ 1.05 GeV/c^2
Λ path length significance	$\geq$2
Beam Energy	[6.0,11.4] GeV

Table: Summary of event selection cuts



- P_4 and Vertices are Kinematically fitted.
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