

The Cascade Spectrum

What we've learned so far

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Outline

- Overview of the spectrum
- Details on the individual states
- Discussion of the star-rating system

Note: No "new" information/results

Jumping-off point for the rest of the workshop



Overview of the Cascades

- 22 N^* ; 14 well-established
- 22 Δ^* ; 10 well-established
- Only 11 Ξ^* ; 6 "well-established"
- We're missing 13-33 Ξ 's
- Those we know aren't known well
 - Only have J^P for three states (and a guess of a fourth)
- Much to learn from a survey of the Ξ spectrum

	N^*		Δ^*	
p	P_{11}	****		
n	P_{11}	****	$\Delta(1232)$	P_{33} ****
$N(1440)$	P_{11}	****	$\Delta(1600)$	P_{33} ***
$N(1520)$	D_{13}	****	$\Delta(1620)$	S_{31} ****
$N(1535)$	S_{11}	****	$\Delta(1700)$	D_{33} ****
$N(1650)$	S_{11}	****	$\Delta(1750)$	P_{31} *
$N(1675)$	D_{15}	****	$\Delta(1900)$	S_{31} **
$N(1680)$	F_{15}	****	$\Delta(1905)$	F_{35} ****
$N(1700)$	D_{13}	***	$\Delta(1910)$	P_{31} ****
$N(1710)$	P_{11}	***	$\Delta(1920)$	P_{33} ***
$N(1720)$	P_{13}	****	$\Delta(1930)$	D_{35} ***
$N(1900)$	P_{13}	**	$\Delta(1940)$	D_{33} *
$N(1990)$	F_{17}	**	$\Delta(1950)$	F_{37} ****
$N(2000)$	F_{15}	**	$\Delta(2000)$	F_{35} **
$N(2080)$	D_{13}	**	$\Delta(2150)$	S_{31} *
$N(2090)$	S_{11}	*	$\Delta(2200)$	G_{37} *
$N(2100)$	P_{11}	*	$\Delta(2300)$	H_{39} **
$N(2190)$	G_{17}	****	$\Delta(2350)$	D_{35} *
$N(2200)$	D_{15}	**	$\Delta(2390)$	F_{37} *
$N(2220)$	H_{19}	****	$\Delta(2400)$	G_{39} **
$N(2250)$	G_{19}	****	$\Delta(2420)$	$H_{3,11}$ ****
$N(2600)$	$I_{1,11}$	***	$\Delta(2750)$	$I_{3,13}$ **
$N(2700)$	$K_{1,13}$	**	$\Delta(2950)$	$K_{3,15}$ **

	Ξ^*	
Ξ^0	P_{11}	****
Ξ^-	P_{11}	****
$\Xi(1530)$	P_{13}	****
$\Xi(1620)$		*
$\Xi(1690)$		***
$\Xi(1820)$	D_{13}	***
$\Xi(1950)$		***
$\Xi(2030)$		***
$\Xi(2120)$		*
$\Xi(2250)$		**
$\Xi(2370)$		**
$\Xi(2500)$		*

The Cascade spectrum

- Arranged by star ratings
- From RPP:
 - **** = existence is certain, and properties are at least fairly well explored
 - *** = existence ranges from very likely to certain, but further confirmation is desirable
 - ** = evidence of existence is only fair
 - * = evidence of existence is poor



Four-star States



The $\Xi(1321)^{1/2^+} (***)$

- Only state to decay primarily weakly
 - Mainly $\Lambda\pi$ (>99%)
 - Other decays test selection rules (SQ, S2), χ PT
- Parity never measured
- Isospin mass difference well-measured, but using separate experiments
- Magnetic moment measured well for both states

Ground-state parity

- From RPP: "The parity has not actually been measured, but + is of course expected."
- "Conventional wisdom" (Frauenfelder & Henley, Subatomic Physics) seems to say we can't:
 - "...the relative parity of two system [sic] is measurable only if the two systems have equal quantum numbers Q, A, and Y."
- But, "system" can be multiple particles
 - Treiman (PR 113, 355): $\Xi^- p \rightarrow \Lambda$, $\Xi^- p \rightarrow \Xi^0 n$

The $\Xi(1530)^3/2^+ (***)$

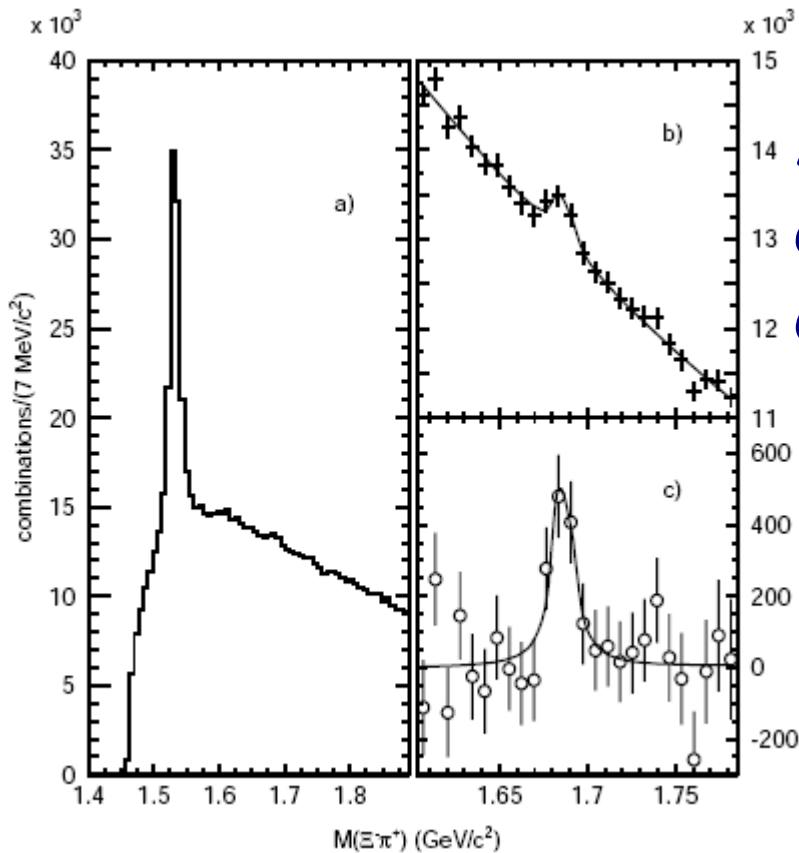
- $J^P=3/2^+$ not "measured", but "favored by data"
 - only two attempts; ~100, and ~200 events
- Mass difference determination raises flags
 - e.g. Baltay et al. (Phys. Lett. B42, 129) used for $m_{\Xi(1530)}$ and $\Delta m_{\Xi(1530)}$, but not for $m_{\Xi(1530)}$

Three-star States



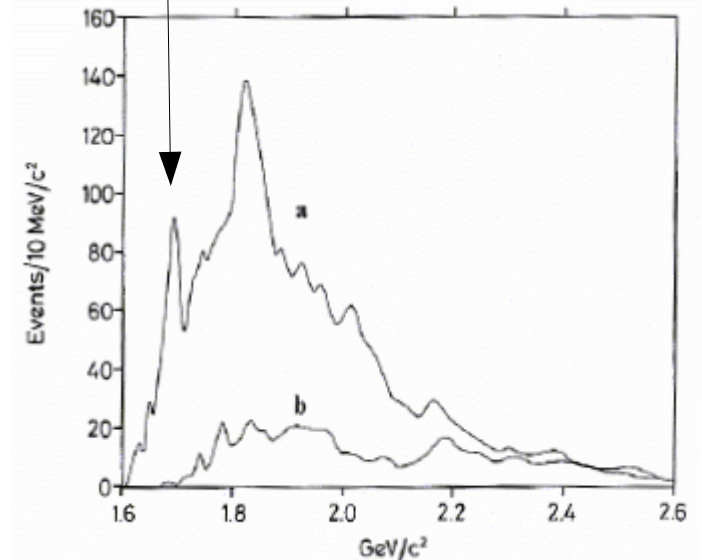
The $\Xi(1690)$ (***)

- Seen by four experiments
 - no Δm ; only one experiment sees both



Adamovich
et al., EPJ
C5, 621

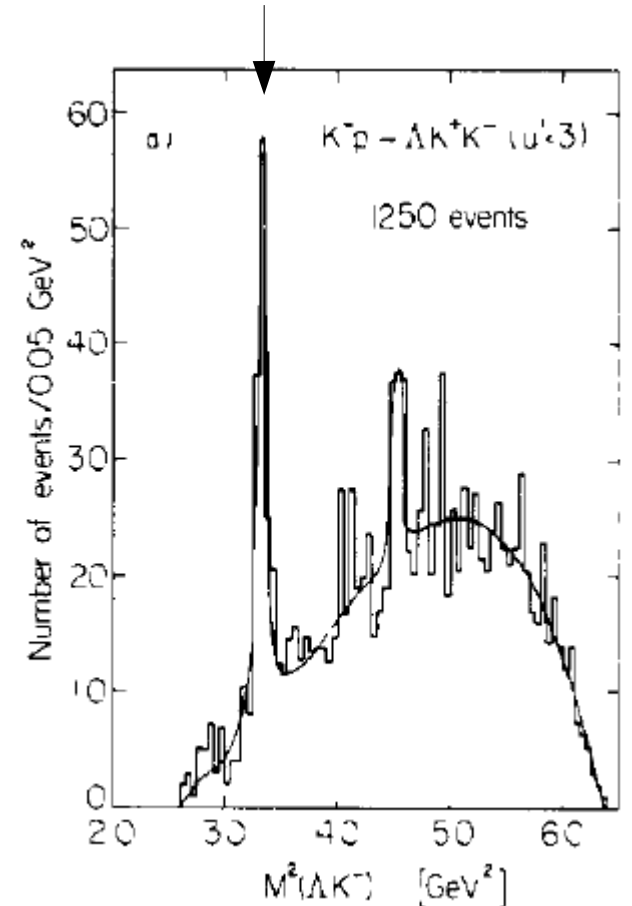
Biagi et al., Z.
Phys C34, 15



The $\Xi(1820)^{3/2^-}$ (***)

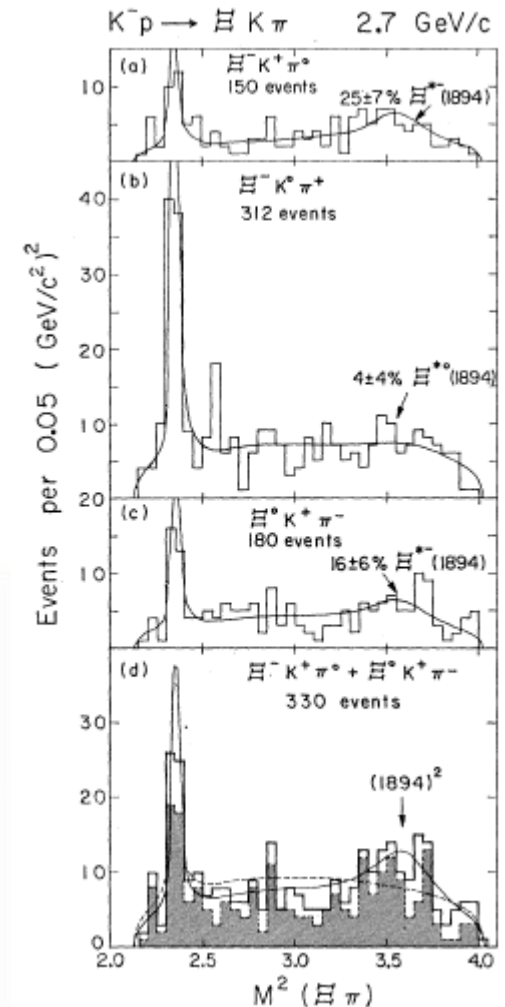
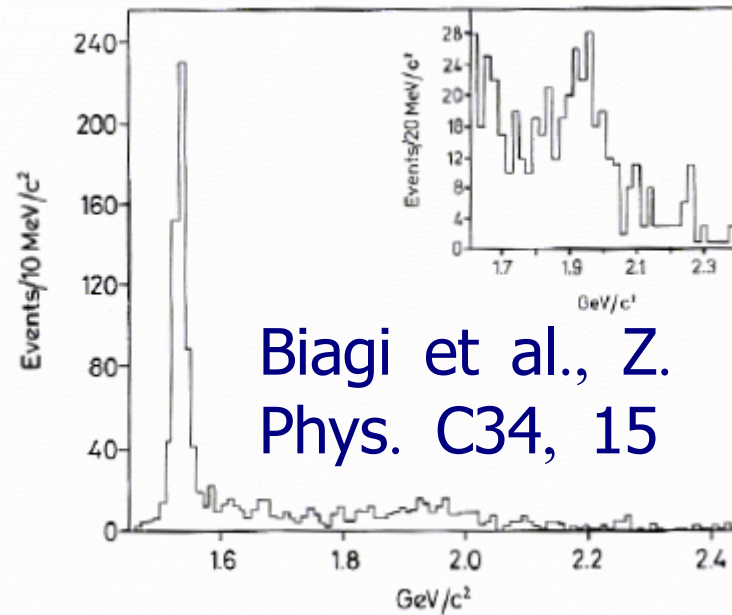
- Seen as a strong peak in $K^- p \rightarrow \Lambda K^+ K^-$
- J determined by comparing ΛK and $\Xi(1530)\pi$ decays; moments analysis used for parity
- Branching ratios poorly known

Gay et al.,
PLB62, 477



The $\Xi(1950)$ (***)

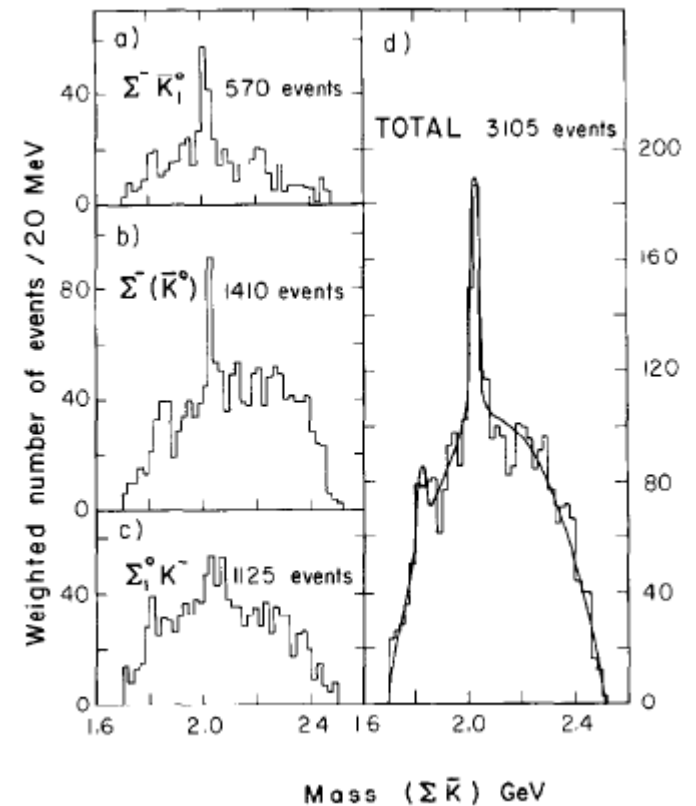
- Mass, width at best “poorly” determined
- PDG lumps 1875-2000 MeV together as “1950”
- “...there may be more than one Ξ near this mass.”



The $\Xi(2030) \rightarrow \Sigma^5/2^?$ (***)

- Charged state clearly seen
- Neutral much less clear
- Parity unknown
- Spin needs confirmation

Hemingway et al.,
PLB 68, 197



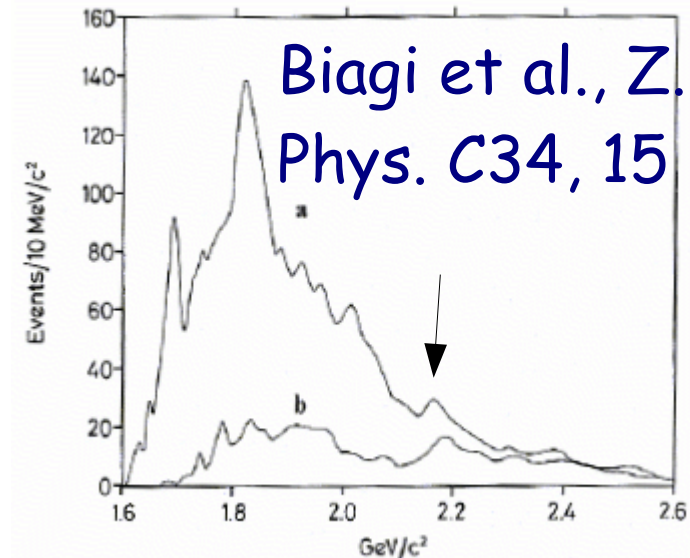
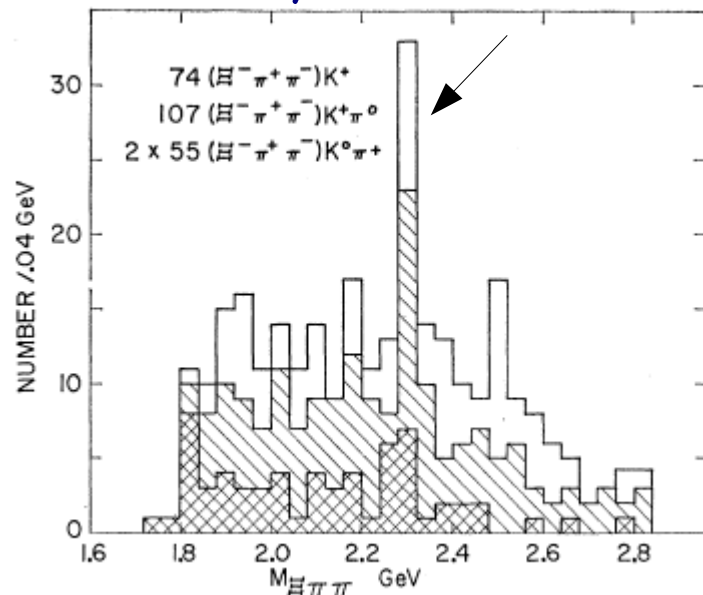
Two-star States



The $\Xi(2250)$ (**)

- Mixed evidence for existence
 - Four mass measurements span 2189-2295 MeV

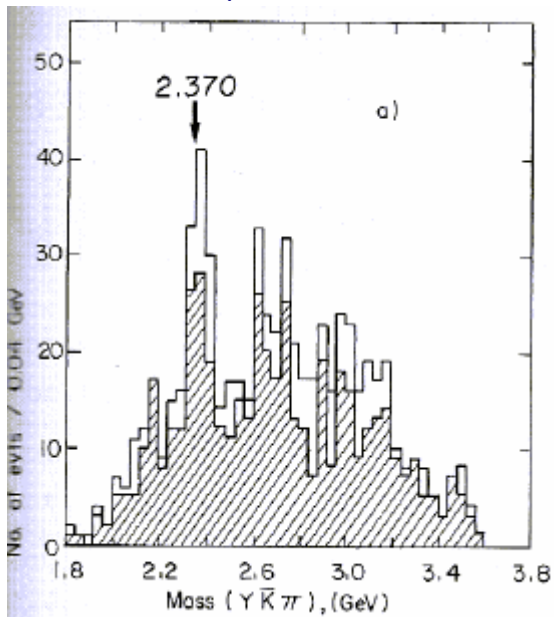
Goldwasser et al.,
PRD 1, 1960



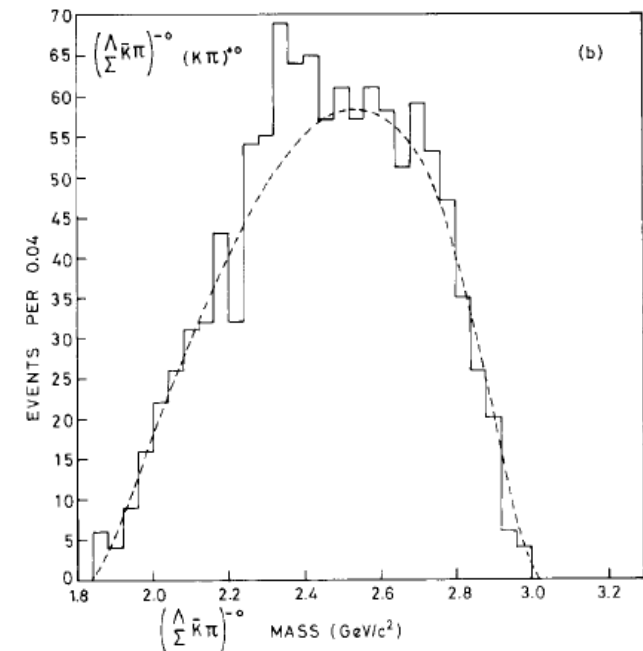
The $\Xi(2370)$ (**)

- Four measurements spanning 40 MeV

Amirzadeh et al.,
PLB 90, 324



Hassall et al.,
NPB 189, 397

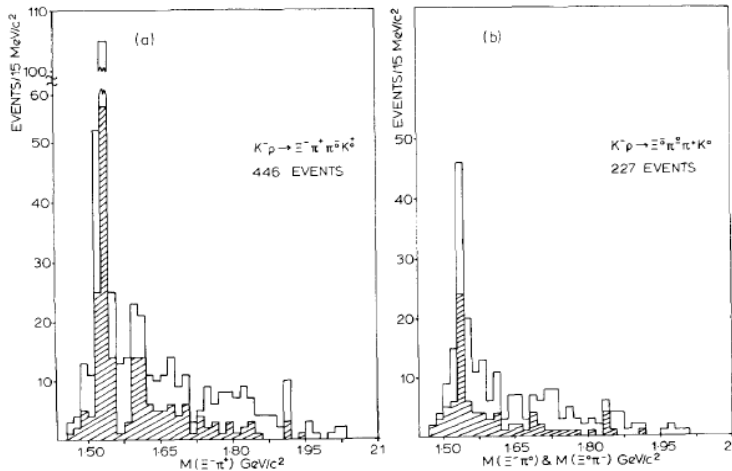
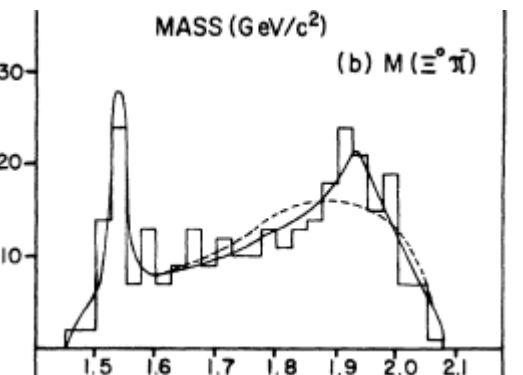
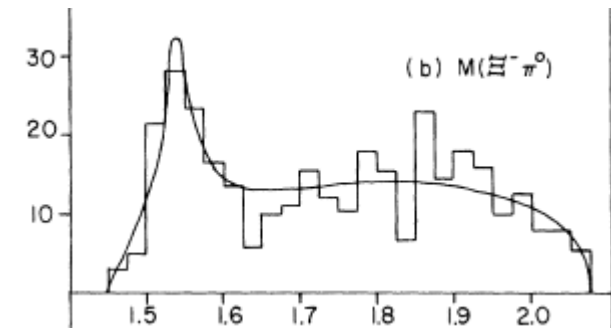
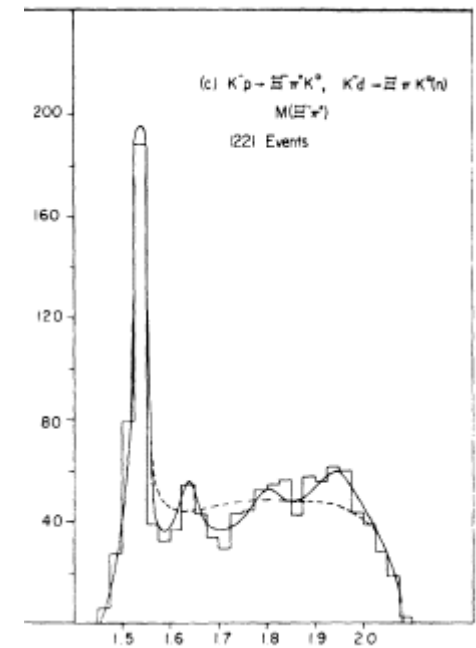


One-star States



The $\Xi(1620)$ (*)

- Existence questionable
- Shows up in some dynamical models
- Ross, Briefel see only one charge
- de Bellefon text inconsistent

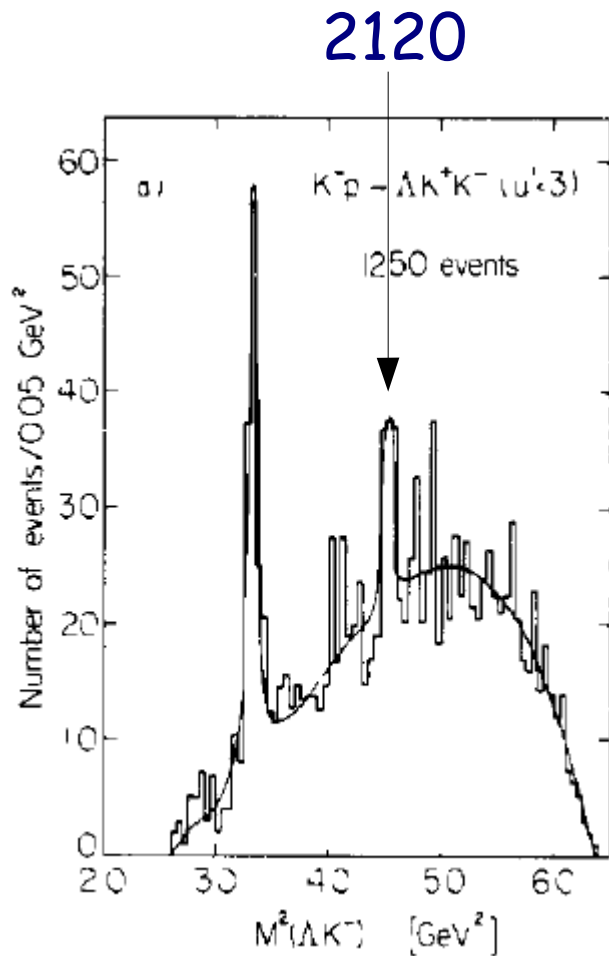


Ross et al.,
 PLB 38, 177

Briefel et al.,
 PRD 16, 2706

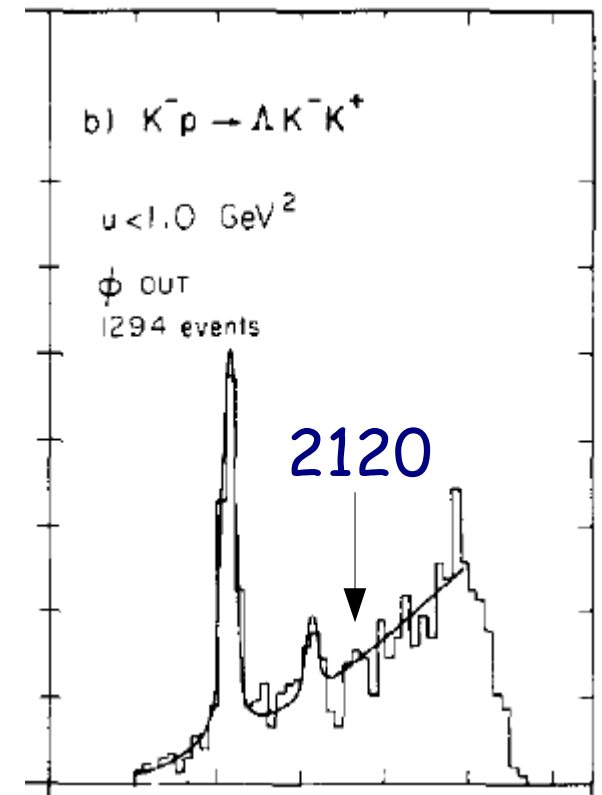
The $\Xi(2120)$ (*)

- Evidence extremely spotty



Gay et al.,
PLB 62, 477

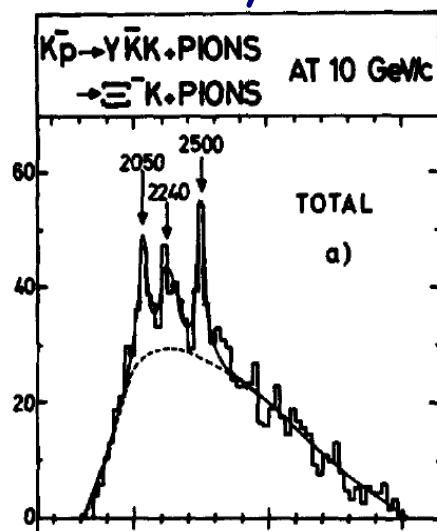
Hemingway et
al., PLB 68, 197
(same exp., more
data)



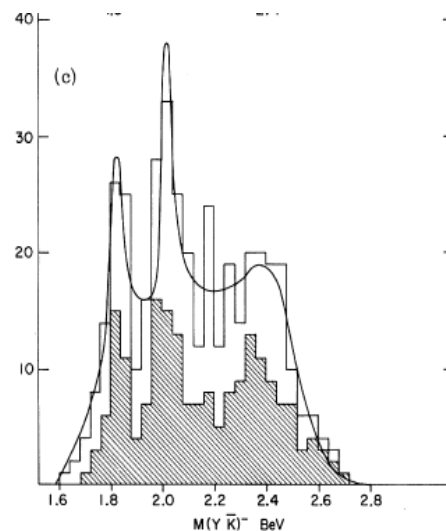
The $\Xi(2500)$ (*)

- Not much available...

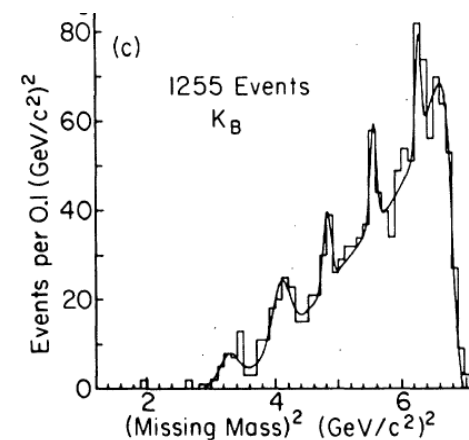
Bartsch et al.,
PLB 28, 439



Alitti et al.,
PRL 22, 79



Jenkens et al.,
PRL 51, 951



Star Rating System

- Star assignments for the Ξ^* 's are fundamentally different from the N^* , Δ^* , Λ^* , and Σ^* states
 - no PWA for cascades
- Need reliable criteria, consistently applied
 - I have some suggestions along those lines...



Proposed criteria

- **** criteria
 - J^P values “reliable”
 - 1321, 1530
- *** criteria (still in Summary Table)
 - both charge states must have clear signals
 - reasonable consensus on mass
 - 1690, 1820, 2030

One- and Two-star criteria

- ** criteria
 - Strong, undisputed statistical significance
 - 1950, 2370
- * criteria
 - Dispute over existence
 - 1620, 2250, 2500
- Remove 2120 from table (Gay result refuted)
- 3 changes: 1950, 2120, 2250

Summary

- We don't know much about the cascades
 - Most J^P measurements missing
 - Many missing states
- Of the information we do have, much improvement needed
 - Masses, widths, and existence need confirmation
- A more systematic approach to the star ratings is desirable; first steps toward a proposed change