Excited Hyperon States at BESIII

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第九届强子谱和强子结构研讨会

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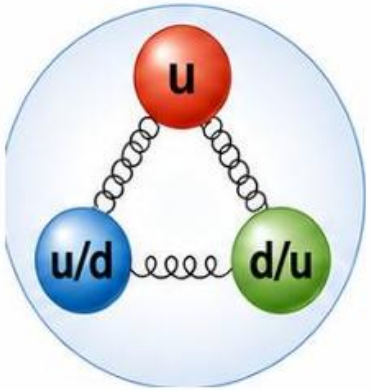
Outline

- Introduction
- Excited hyperon states at BESIII
  - Confirmation of $\Lambda(2325)$
  - Observation of new state $\Sigma(2330)$
  - Measurement of $\Xi(1690)$ & $\Xi(1820)$
  - Observation of New state $\Xi(1720)$
  - Observation of new state $\Omega(2109)$
  - New radiative decay modes of $\Lambda(1520)$ and $\Lambda(1690)$
- Summary

From Nucleons to SU(3) Flavor Sector

Nucleon sector (SU(2))

Nucleons (p, n)

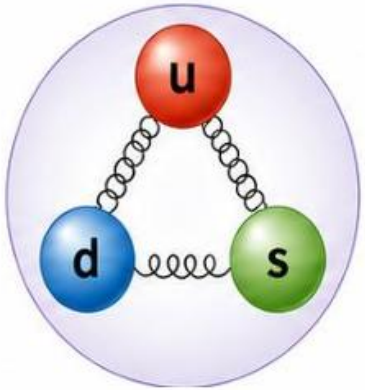


- Well-established spectrum
- Many states observed
- Quantum numbers relatively well determined

Extend to SU(3) flavor sector

Strange baryons (SU(3))

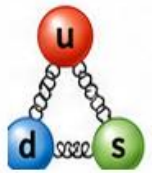
Hyperons (Λ, Σ, Ξ, Ω, ...)



- Rich predicted spectrum
- Many states unobserved
- Quantum numbers & decays poorly determined

What we learn

Flavor symmetry breaking



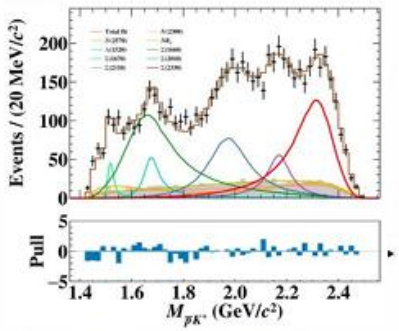
Quark dynamics

Baryon structure

Strange baryons probe flavor-symmetry breaking and quark dynamics in the SU(3) sector.

Two Complementary Questions

Which excited states exist?



Mass spectrum

Missing states

J^P

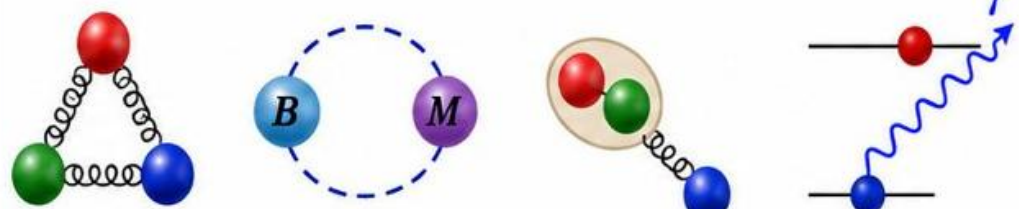
$\frac{1}{2}^+, \frac{3}{2}^-,$

$\frac{5}{2}^+, \frac{7}{2}^-, \cdots$

Spin–parity J^P

- Many predicted hyperons remain unobserved
- Masses, widths, J^P and decay modes require PWA

How are they structured?



qqq core | meson–baryon cloud | diquark correlation | electromagnetic transition

- Transition amplitudes probe wave functions
- Radiative decays test quark models and SU(3)

Spectroscopy + decays ⇒ spectrum and internal structure

Status of excited Hyperons: Λ^* & Σ^*

9 four-star Λ^*, 5 four-star Σ^*, many states to be confirmed, measured, and observed. $\Lambda(1405)$ puzzle, $\Sigma(1385)$ and $\Sigma(1380)$

- Two-pole structure of $\Lambda(1405)$

Table 83.1: Comparison of the pole positions of $\Lambda(1405)$ in the complex energy plane from next-to-leading order chiral unitary coupled-channel approaches including the SIDDHARTA constraint. The lower two results also include the CLAS photoproduction data.

approach	pole 1 [MeV]	pole 2 [MeV]
Refs. [14, 15], NLO	$1424^{+7}_{-23} - i\ 26^{+3}_{-14}$	$1381^{+18}_{-6} - i\ 81^{+19}_{-8}$
Ref. [17], Fit II	$1421^{+3}_{-2} - i\ 19^{+8}_{-5}$	$1388^{+9}_{-9} - i\ 114^{+24}_{-25}$
Ref. [18], solution #2	$1434^{+2}_{-2} - i\ 10^{+2}_{-1}$	$1330^{+4}_{-5} - i\ 56^{+17}_{-11}$
Ref. [18], solution #4	$1429^{+8}_{-7} - i\ 12^{+2}_{-3}$	$1325^{+15}_{-15} - i\ 90^{+12}_{-18}$

- Pentaquark models predict a possible Σ^* around 1360MeV with $J^P=1/2^-$

- Evidences for $\Sigma(1380)$ @ BESIII

  Phys. Rev. Lett. **134**, 021901

Table 82.1: The status of the Λ resonances. Only those with an overall status of *** or **** are included in the main Baryon Summary Table. Decay channels other than $N\overline{K}$ and $\Sigma\pi$ are only given for *** and **** resonances.

Particle	J^P	Overall status	Status as seen in — $N\overline{K}$	$\Sigma\pi$	Other channels
$\Lambda(1116)$	$1/2^+$	****			$N\pi$ (weak decay)
$\Lambda(1380)$	$1/2^-$	**	**	**	
$\Lambda(1405)$	$1/2^-$	****	****	****	
$\Lambda(1520)$	$3/2^-$	****	****	****	$\Lambda\pi\pi, \Lambda\gamma, \Sigma\pi\pi$
$\Lambda(1600)$	$1/2^+$	****	***	****	$\Lambda\pi\pi, \Sigma(1385)\pi$
$\Lambda(1670)$	$1/2^-$	****	****	****	$\Lambda\eta$
$\Lambda(1690)$	$3/2^-$	****	****	***	$\Lambda\pi\pi, \Sigma(1385)\pi$
$\Lambda(1710)$	$1/2^+$	*	*	*	
$\Lambda(1800)$	$1/2^-$	***	***	**	$\Lambda\pi\pi, N\overline{K}^*$
$\Lambda(1810)$	$1/2^+$	***	**	**	$N\overline{K}^*$
$\Lambda(1820)$	$5/2^+$	****	****	****	$\Sigma(1385)\pi$
$\Lambda(1830)$	$5/2^-$	****	****	****	$\Sigma(1385)\pi$
$\Lambda(1890)$	$3/2^+$	****	****	**	$\Sigma(1385)\pi, N\overline{K}^*$
$\Lambda(2000)$	$1/2^-$	*	*	*	
$\Lambda(2050)$	$3/2^-$	*	*	*	
$\Lambda(2070)$	$3/2^+$	*	*	*	
$\Lambda(2080)$	$5/2^-$	*	*	*	
$\Lambda(2085)$	$7/2^+$	**	**	*	
$\Lambda(2100)$	$7/2^-$	****	****	**	$N\overline{K}^*$
$\Lambda(2110)$	$5/2^+$	***	**	**	$N\overline{K}^*$
$\Lambda(2325)$	$3/2^-$	*	*		
$\Lambda(2350)$	$9/2^+$	***	***	*	
$\Lambda(2585)$		*	*		

Table 82.2: The status of the Σ resonances. Only those with an overall status of *** or **** are included in the main Baryon Summary Table. Decay channels other than $N\overline{K}$, $\Lambda\pi$ and $\Sigma\pi$ are only given for *** and **** resonances.

Particle	J^P	Overall status	Status as seen in — $N\overline{K}$	$\Lambda\pi$	$\Sigma\pi$	Other channels
$\Sigma(1193)$	$1/2^+$	****				$N\pi$ (weak decay)
$\Sigma(1385)$	$3/2^+$	****		****	****	$\Lambda\gamma$
$\Sigma(1580)$	$3/2^-$	*	*	*	*	
$\Sigma(1620)$	$1/2^-$	*	*	*	*	
$\Sigma(1660)$	$1/2^+$	***	***	***	***	
$\Sigma(1670)$	$3/2^-$	****	****	****	****	
$\Sigma(1750)$	$1/2^-$	***	***	**	***	$\Sigma\eta$
$\Sigma(1775)$	$5/2^-$	****	****	****	**	
$\Sigma(1780)$	$3/2^+$	*	*	*	*	
$\Sigma(1880)$	$1/2^+$	**	**	*		
$\Sigma(1900)$	$1/2^-$	**	**	*	**	
$\Sigma(1910)$	$3/2^-$	***	*	*	**	
$\Sigma(1915)$	$5/2^+$	****	***	***	***	
$\Sigma(1940)$	$3/2^+$	*	*		*	
$\Sigma(2010)$	$3/2^-$	*	*	*		
$\Sigma(2030)$	$7/2^+$	****	****	****	**	$\Delta(1232)\overline{K}, N\overline{K}^*, \Sigma(1385)\pi$
$\Sigma(2070)$	$5/2^+$	*	*		*	
$\Sigma(2080)$	$3/2^+$	*		*		
$\Sigma(2100)$	$7/2^-$	*	*	*	*	
$\Sigma(2110)$	$1/2^-$	*	*	*	*	
$\Sigma(2230)$	$3/2^+$	*	*	*	*	
$\Sigma(2250)$		**	**	*	*	
$\Sigma(2455)$		*	*			
$\Sigma(2620)$		*	*			
$\Sigma(3000)$		*	*	*		
$\Sigma(3170)$		*				

Status of excited Hyperons: Ξ* & Ω*

Even less information about Ξ*. **Only 1** four-star Ξ* well established, Ξ(1530).

Table 1. Our estimate of the status of the Ξ resonances. Only those with an overall status of *** or **** are included in the Baryon Summary Table.

Particle	J^P	Overall status	Status as seen in — $\Xi\pi$	ΛK	ΣK	$\Xi(1530)\pi$	Other channels
Ξ(1318)	1/2+	****					Decays weakly
Ξ(1530)	3/2+	****	****				
Ξ(1620)		**	**				
Ξ(1690)		***	**	***	**		
Ξ(1820)	3/2−	***	**	***	**	**	
Ξ(1950)		***	**	**		*	
Ξ(2030)		***		**	***		
Ξ(2120)		*		*			
Ξ(2250)		**					3-body decays
Ξ(2370)		**					3-body decays
Ξ(2500)		*		*	*		3-body decays

**** Existence is certain, and properties are at least fairly well explored.
*** Existence ranges from very likely to certain, but further confirmation is desirable and/or quantum numbers, branching fractions, *etc.* are not well determined.
** Evidence of existence is only fair.
* Evidence of existence is poor.

Few information about Ω*

Ω BARYONS ($S = -3$, $I = 0$)

$\Omega^- = s\,s\,s$

Ω^-	$3/2^+$	****
$\Omega(2012)^-$	$?^-$	***
$\Omega(2250)^-$		***
$\Omega(2380)^-$		**
$\Omega(2470)^-$		**

measurement of the mass, width and production of Ξ(1820) need to be improved; spin-parity of Ξ(1690) to be determined, the existence of Ξ(1620) to be investigated, new states to be found…

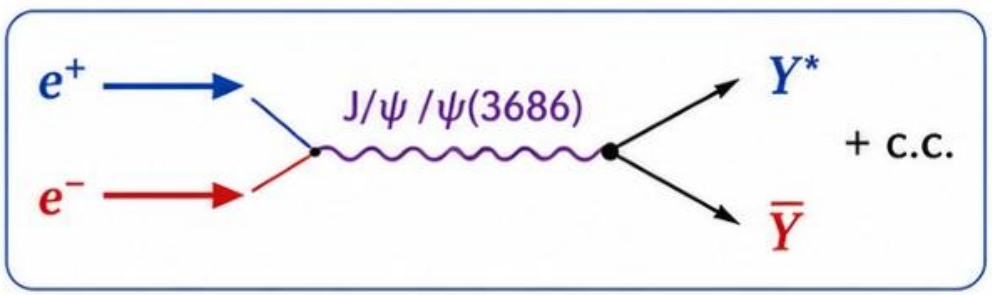
BESIII: Hyperon Factory

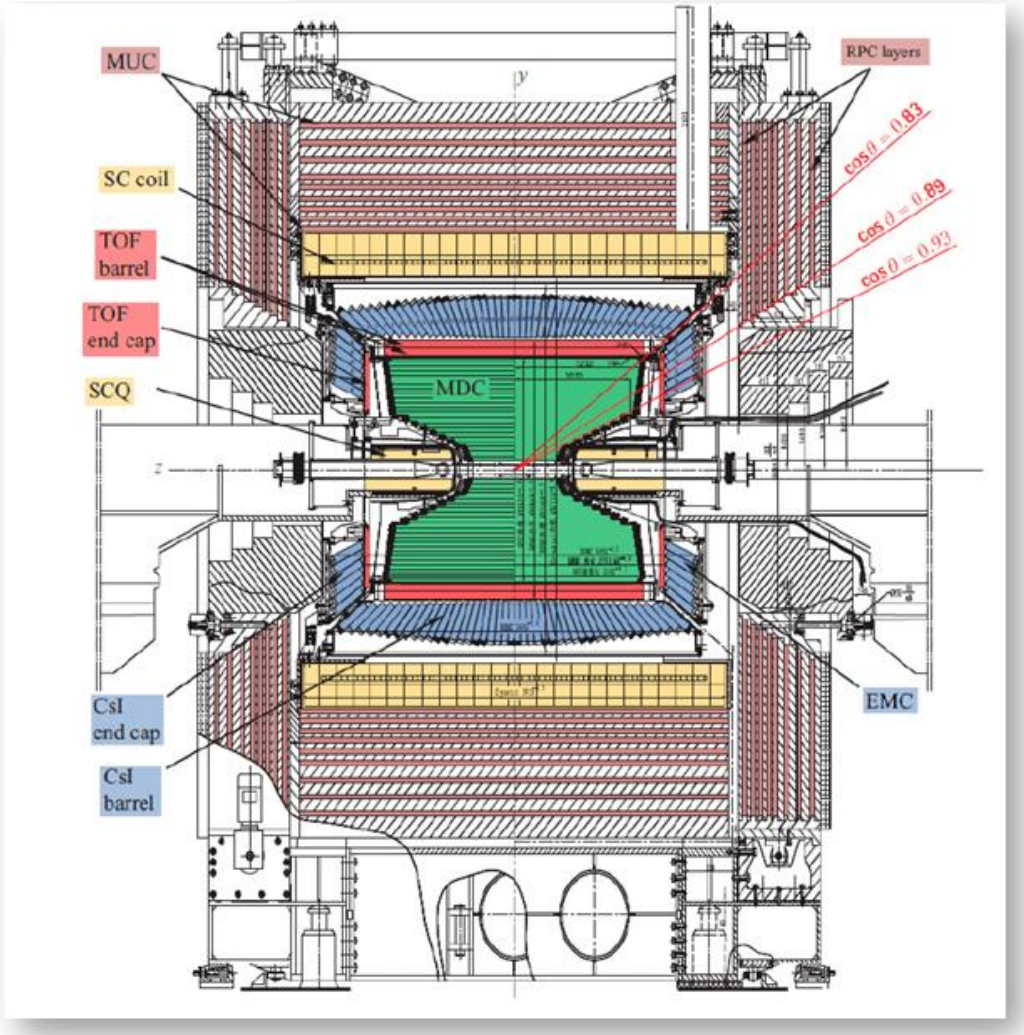
10.1 billion J/ψ events

2.7 billion $\psi(3686)$ events

e^+e^- clean environment

Excellent tracking, PID and photon detection





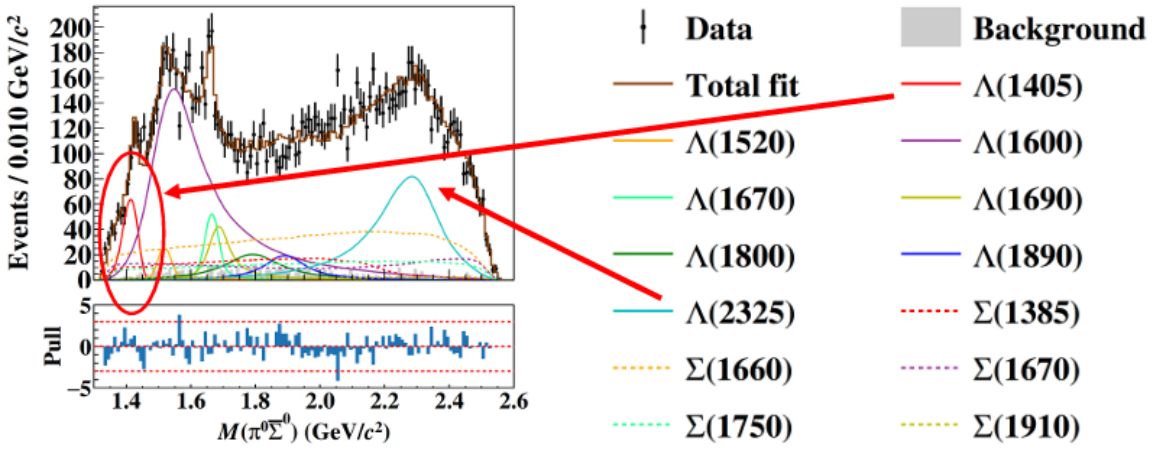
Large data samples enable rare channels and amplitude analyses.

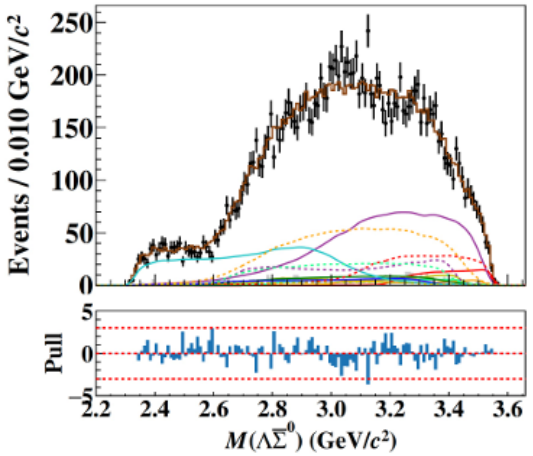
J. High Energ. Phys. **2025**, 212 (2025)

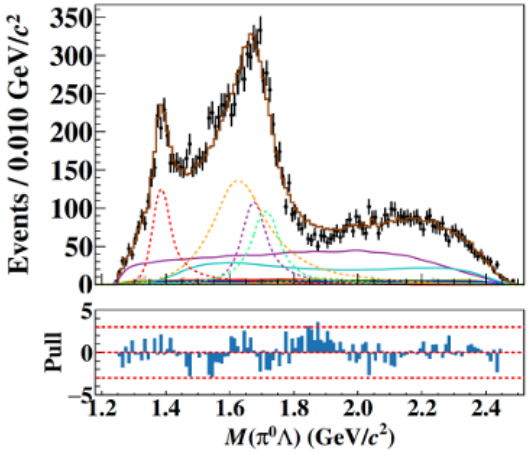
Λ^* @BESIII 272 M $\psi(3686)$ sample

Partial wave analysis of $\psi(3686) \to \Lambda\bar{\Sigma}^0\pi^0 + \text{c.c.}$

Confirmation of $\Lambda(2325)$ 19.5σ







$\Lambda(2325)\ 3/2^-$ $I(J^P) = 0(\frac{3}{2}^-)$ Status: *

Resonance	Mass (MeV/c^2)	Width (MeV)	$\mathcal{B}$ ($\times 10^{-5}$)
$\Lambda(1405)$	...	...	$0.44 \pm 0.05 \pm 0.12$
$\Lambda(1520)$	$1519.9 \pm 1.6 \pm 4.8$	$20.6 \pm 1.9 \pm 0.6$	$0.19 \pm 0.05 \pm 0.05$
$\Lambda(1600)$	$1570.5 \pm 4.6 \pm 12.1$	$228.1 \pm 11.9 \pm 34.8$	$4.49 \pm 0.25 \pm 1.23$
$\Lambda(1670)$	$1667.5 \pm 2.3 \pm 3.6$	$30.2 \pm 4.2 \pm 8.7$	$0.33 \pm 0.07 \pm 0.09$
$\Lambda(1690)$	$1691.1 \pm 4.4 \pm 15.7$	$72.3 \pm 4.7 \pm 18.3$	$0.55 \pm 0.11 \pm 0.10$
$\Lambda(1800)$	$1800.9 \pm 13.3 \pm 12.6$	$208.8 \pm 14.5 \pm 36.7$	$0.60 \pm 0.15 \pm 0.18$
$\Lambda(1890)$	$1897.2 \pm 9.6 \pm 6.2$	$149.2 \pm 13.5 \pm 4.1$	$0.47 \pm 0.10 \pm 0.09$
$\Lambda(2325)$	$2306.5 \pm 6.3 \pm 17.1$	$227.1 \pm 12.2 \pm 47.8$	$2.93 \pm 0.20 \pm 0.26$
$\Sigma(1385)$	$1388.2 \pm 1.9 \pm 3.3$	$60.5 \pm 3.6 \pm 6.3$	$1.30 \pm 0.11 \pm 0.19$
$\Sigma(1660)$	$1643.2 \pm 4.5 \pm 7.6$	$221.3 \pm 13.1 \pm 41.1$	$3.53 \pm 0.29 \pm 0.63$
$\Sigma(1670)$	$1679.7 \pm 3.4 \pm 4.3$	$87.0 \pm 6.4 \pm 8.9$	$1.60 \pm 0.25 \pm 0.38$
$\Sigma(1750)$	$1714.9 \pm 4.2 \pm 7.3$	$97.2 \pm 9.8 \pm 9.7$	$1.39 \pm 0.23 \pm 0.32$
$\Sigma(1910)$	$1912.1 \pm 10.6 \pm 33.6$	$225.1 \pm 24.5 \pm 46.0$	$0.23 \pm 0.10 \pm 0.06$

- 13 resonances detected
- **Strong existence of $\Lambda(2325)$: $J^P = \frac{3^-}{2}$**
- Flatté-like and chiral dynamics model for $\Lambda(1405)$ dipole structure ⇒ distinguishable due to the limited statistics

https://doi.org/10.48550/arXiv.2602.11501

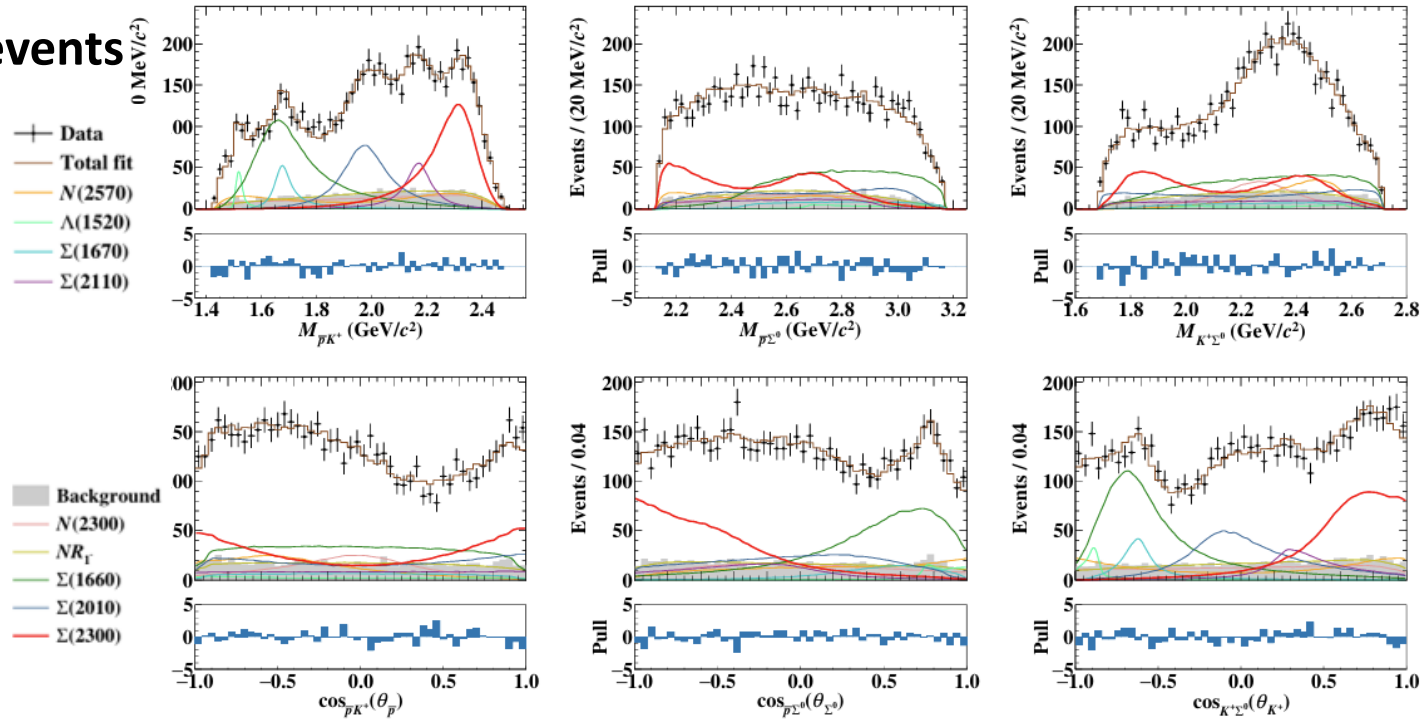
Σ* @BESIII 272 M ψ(3686) sample

Observation of a New Excited Σ State in $\psi(3686) \to \bar{p}K^+\Sigma^0 + c.c.$

- PWA on 6100 ± 86 ψ(3686) → $\bar{p}$ K^+ Σ^0 + c.c. events
  - $\mathrm{Br} = (2.44 \pm 0.20 \pm 0.08) \times 10^{-5}$
    or $(1.73 \pm 0.29 \pm 0.06) \times 10^{-5}$
- N* and Σ* states are measured in PWA
- New excite state observed: Σ(2330)
  - $m = 2334.7 \pm 7.9 \pm 16.0\ \mathrm{MeV/c^2}$
  - $\Gamma = 206.3 \pm 9.5 \pm 18.4\ \mathrm{MeV}$
  - $J^P = \frac{3^-}{2}$
  - $\mathrm{Br} = (4.47 \pm 0.58 \pm 1.52) \times 10^{-6}$
  - **Significance: 11.9σ**
  - Compatible with the predicted 1F(3/2) state

Significance of Σ(2330) with different J^P hypotheses

J^P	ΔNLL	ΔN_{dof}	S (σ)
$1/2^-$	20.1	6	5.1
$1/2^+$	48.9	6	8.9
$3/2^-$	85.7	8	11.9
$3/2^+$	71.2	8	10.7
$5/2^-$	74.1	8	11.0
$5/2^+$	53.7	8	9.1
$7/2^-$	44.3	8	8.0

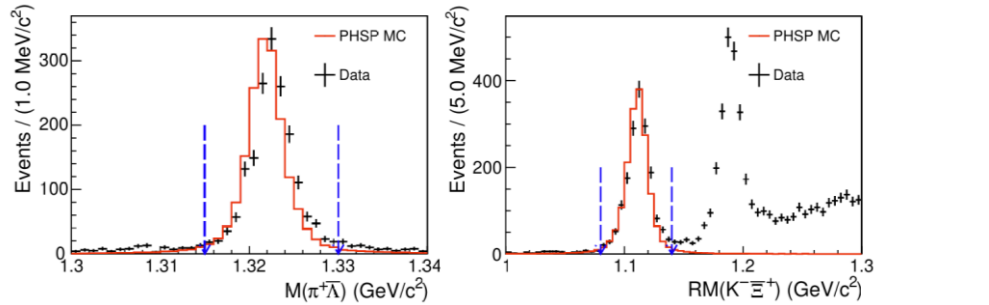


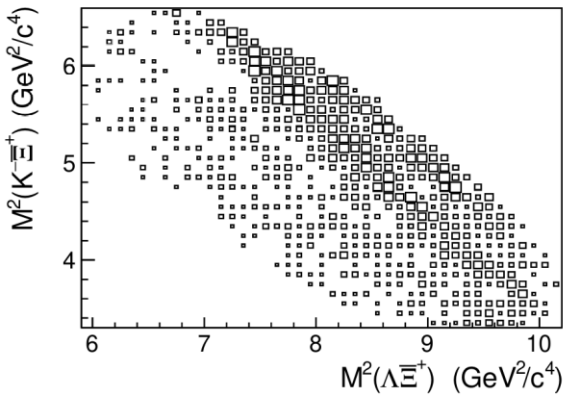
Resonance	Mass (MeV/c^2)	Width (MeV)	$\mathcal{B}$ ($\times 10^{-6}$)
$N(2300)$	$2285.3 \pm 13.8 \pm 26.1$	$335.9 \pm 14.6 \pm 21.6$	$1.95 \pm 0.53 \pm 0.58$
$N(2570)$	$2577.9 \pm 14.8 \pm 33.2$	$255.1 \pm 14.6 \pm 19.7$	$2.28 \pm 0.53 \pm 0.67$
$\Lambda(1520)$	—	—	$0.49 \pm 0.10 \pm 0.14$
$\Sigma(1660)$	$1680.5 \pm 13.8 \pm 21.3$	$247.7 \pm 15.8 \pm 18.8$	$5.84 \pm 0.69 \pm 1.55$
$\Sigma(1670)$	$1680.5 \pm 4.1 \pm 11.0$	$73.4 \pm 9.1 \pm 7.1$	$1.22 \pm 0.38 \pm 0.28$
$\Sigma(2010)$	$1980.1 \pm 10.0 \pm 18.1$	$192.5 \pm 13.3 \pm 13.3$	$3.11 \pm 0.50 \pm 0.92$
$\Sigma(2110)$	$2172.4 \pm 6.3 \pm 10.9$	$107.2 \pm 9.3 \pm 10.2$	$1.17 \pm 0.23 \pm 0.38$
$\Sigma(2330)$	$2334.7 \pm 7.9 \pm 16.0$	$206.3 \pm 9.5 \pm 18.4$	$4.47 \pm 0.58 \pm 1.52$

Ξ* @BESIII 448M ψ(3686) events

Study of excited Ξ states in $\psi(3686) \to K^- \Lambda \bar{\Xi}^+ + c.c.$

- **PWA of ψ(3686)→ $K^- \Lambda \bar{\Xi}^+$ + c.c. 1572 ± 45 events**
- **1st PWA on Ξ* states**
- **1st measurement of J^P of Ξ (1690) & Ξ (1820)**
- **Learn more about the excited hyperon spectrum.**





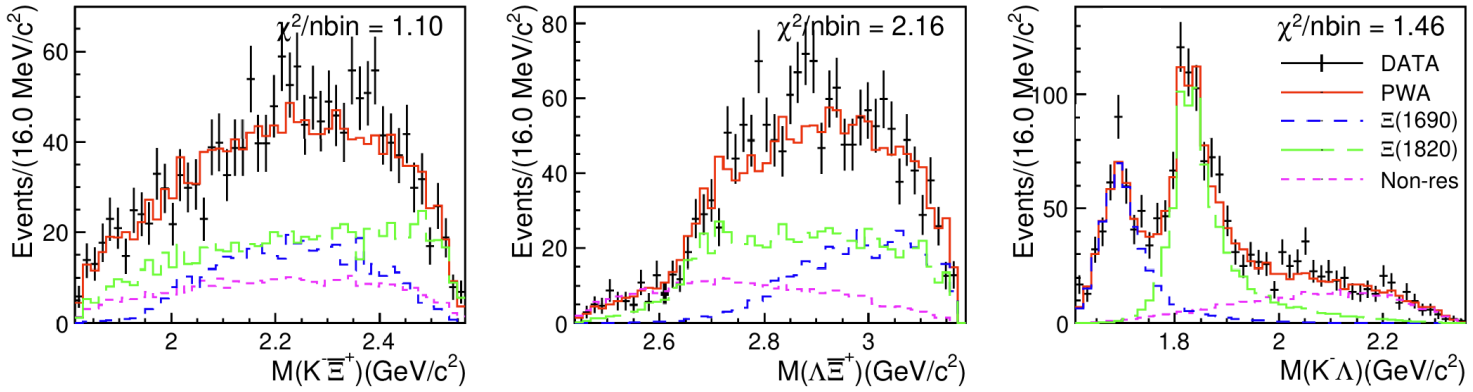


TABLE VI. Results obtained for $I(J^P)$, mass and width for each component. The first (second) uncertainty is statistical (systematic).

Resonance	$I(J^P)$	M (MeV/c^2)	Γ (MeV)
$\Xi(1690)^-$	$1/2(1/2^-)$	$1685^{+3}_{-2} \pm 12$	$81^{+10}_{-9} \pm 20$
$\Xi(1820)^-$	$1/2(3/2^-)$	$1821^{+2}_{-3} \pm 3$	$73^{+6}_{-5} \pm 9$

TABLE VII. Branching fraction results; the first (second) uncertainty is statistical (systematic).

Resonance	Branching fraction
$\mathcal{B}(\psi(3686) \to \Xi(1690)^- \bar{\Xi}^+ + c.c.) \times \mathcal{B}(\Xi(1690)^- \to K^- \Lambda)$	$(1.06 \pm 0.10 \pm 0.31) \times 10^{-5}$
$\mathcal{B}(\psi(3686) \to \Xi(1820)^- \bar{\Xi}^+ + c.c.) \times \mathcal{B}(\Xi(1820)^- \to K^- \Lambda)$	$(1.78 \pm 0.10 \pm 0.32) \times 10^{-5}$
$\psi(3686) \to K^- \Lambda \bar{\Xi}^+ + c.c.$	$(3.60 \pm 0.10 \pm 0.24) \times 10^{-5}$

https://doi.org/10.48550/arXiv.2604.27028

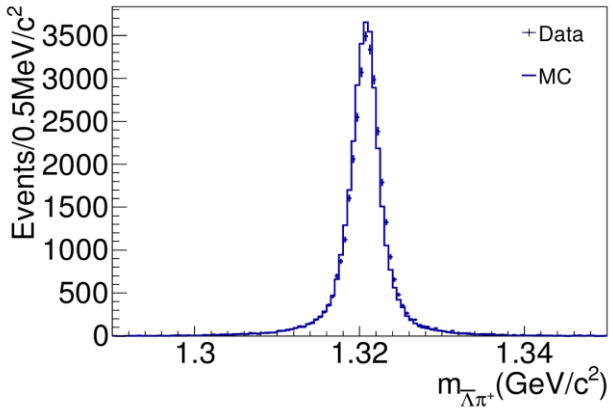
Ξ* @BESIII 10087 M J/ψ sample

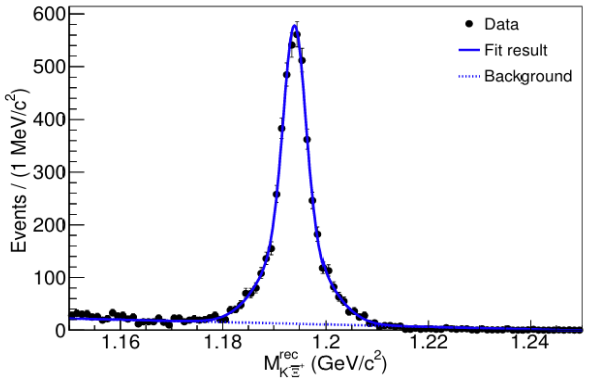
Observation of a Doubly-strange Hyperon $\Xi(1720)$ in $J/\psi \to K^-\Sigma^0\bar{\Xi}^+ + c.c.$

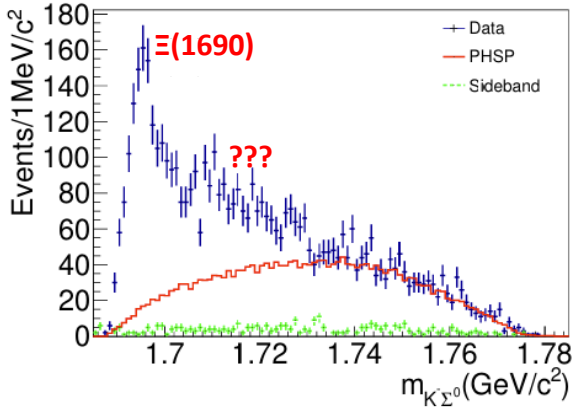
$$J/\psi \to \bar{\Xi}^+ \Xi^{*-}, \quad \Xi^{*-} \to K^-\Sigma^0$$

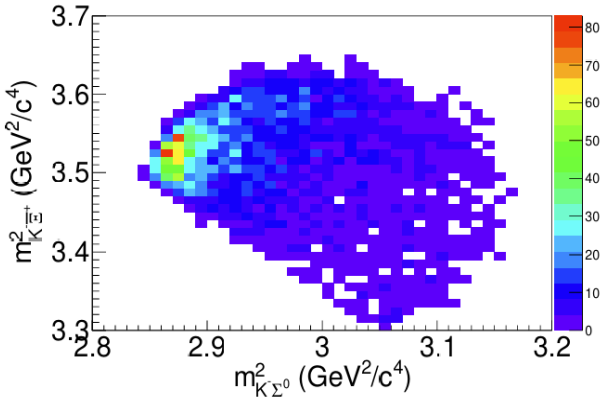
- **1st observation** of the decay **J/ψ → K⁻ Σ⁰ $\bar{\Xi}^+$ + c.c..** with Significant **excited states**.

4545 ± 73 events



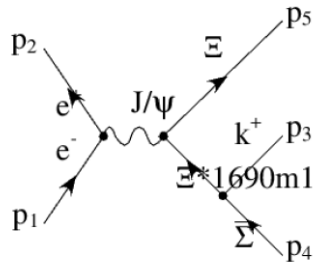




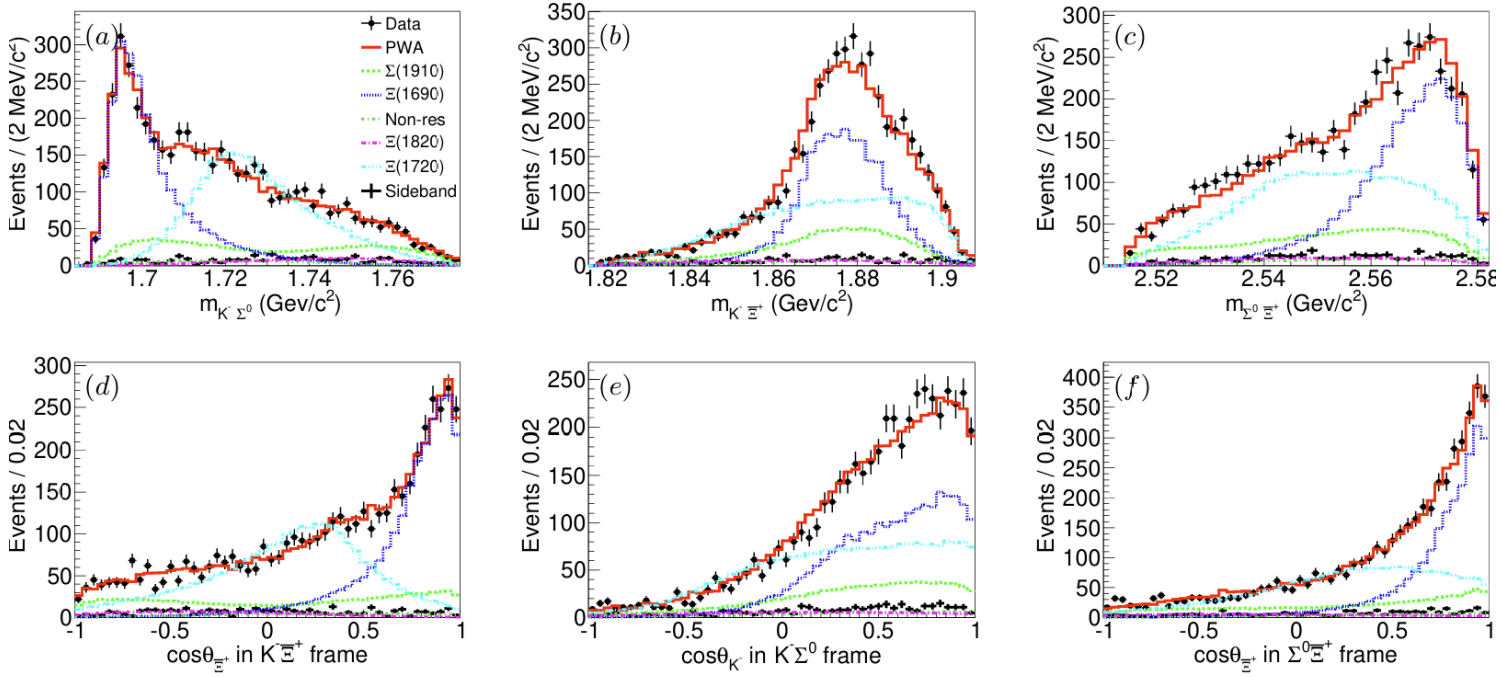


$$Br\left(J/\psi \to K^-\,\Sigma^0\,\bar{\Xi}^+ + c.c.\right) = (2.68 \pm 0.04 \pm 0.17) \times 10^{-5}$$

Partial Wave Analysis result



- **Precise** measurement **of Ξ(1690)**
  - $\mathbf{m} = 1695 \pm 0.9 \pm 0.9\ \mathbf{MeV/c^2}$
  - $\boldsymbol{\Gamma} = 12.8 \pm 1.8 \pm 7.6\ \mathbf{MeV}$
  - $\mathbf{J^p} = \frac{1}{2}^-$
  - $\mathbf{Br} = (1.86 \pm 0.54 \pm 0.68) \times 10^{-5}$
- **New** doubly-strange hyperon **Ξ(1720)**
  - $\mathbf{m} = 1721 \pm 5.2 \pm 3.4\ \mathbf{MeV/c^2}$
  - $\boldsymbol{\Gamma} = 31.3 \pm 18.3 \pm 15.4\ \mathbf{MeV}$
  - $\mathbf{J^p} = \frac{3}{2}^+$
  - $\mathbf{Br} = (1.22 \pm 0.42 \pm 0.83) \times 10^{-5}$
  - **Significance: >10σ**



J^P	$\frac{1}{2}^-$	$\frac{1}{2}^+$	$\frac{3}{2}^-$	$\frac{3}{2}^+$
ΔS for Ξ(1690)	-	76	333	85
ΔS for Ξ(1720	59	57	71	-

Ξ(1720): 200 MeV/c^2 below the lowest $\frac{3}{2}^+$ state predicted by theoretical models

TABLE VI. Masses of the positive-parity Ξ states (in MeV).

	Experiment [1]			Theory	
J^P	State	Status	Mass	$NLnl_j$	Mass
$\frac{1}{2}^+$	Ξ	****	1321.71 ± 0.07	$1S1s_1$	1330
				$2S1s_1$	1886
				$1D1s_1$	1993
				$1P1p_1$	2012
				$1S2s_1$	2091
				$1P1p_1$	2142
				$3S1s_1$	2367
				$2S2s_1$	2456
				$2D1s_1$	2510
				$1D2s_1$	2565
				$2P1p_1$	2598
				$2P1p_1$	2624
$\frac{3}{2}^+$	Ξ(1530)	****	1531.80 ± 0.32	$1S1s_1$	1518
				$2S1s_1$	1966
				$1D1s_1$	2100
				$1S2s_1$	2121
				$1D1s_1$	2122
				$1P1p_1$	2144
				$1P1p_1$	2149

Ξ(1720)

relativistic quark-diquark bound systems

Table 6. Comparison of masses with other predictions based on J^P value for Ξ baryon (in MeV).

J^P	$Mass_{cal}1$	$Mass_{cal}2$	[27]	[28]	[29]	[30]	[46]	[47]	[31]	[2]	[48]	[49]
$\frac{1}{2}^+$	1322	1321	1330	1310	1305	1334	1348	1317	1318	1325	1317	1303 ± 13
	1884	1891	1886	1876	1840	1727	1805	1772	1932	1891	1750	2178 ± 48
	2310	2322	1993	2062	2040	1932	1868				1980	2231 ± 44
	2361	2372	2012	2131	2100			1874			2054	2408 ± 45
	2874	2899	2091	2176	2130						2107	
	2935	2954	2142	2215	2150						2149	
	3527	3562	2367	2249	2230						2254	
	3591	3620			2345							
$\frac{3}{2}^+$	1531	1524	1518	1539	1505	1524	1528	1552	1539	1520	1526	1553 ± 18
	1971	1964	1966	1988	2045	1878		1653	2120	1934	1952	2228 ± 40
	2270	2281	2100	2076	2065	1979					1970	2398 ± 52
	2283	2295	2121	2128	2115						2065	2574 ± 52
	2457	2459	2122	2170	2165						2114	
	2819	2842	2144	2175	2170						2174	
	2838	2861	2149	2219	2210						2184	
	3029	3041	2421	2257	2230						2218	
	3455	3489		2279	2275						2252	
	3479	3513										
	3679	3702										

Ξ(1720)

Spectroscopic investigation of light strange S = −1 Λ and Σ and S = −2 Ξ baryons

Phys. Rev. Lett. **134**, 131903 – **Published 4 April, 2025**

Ω* @BESIII 4.13-4.70 GeV 19 fb^{-1}

Evidence for Two Excited Ω^- Hyperons

- **New** state observed: **Ω(2109)**

  with a significance of 4.1σ

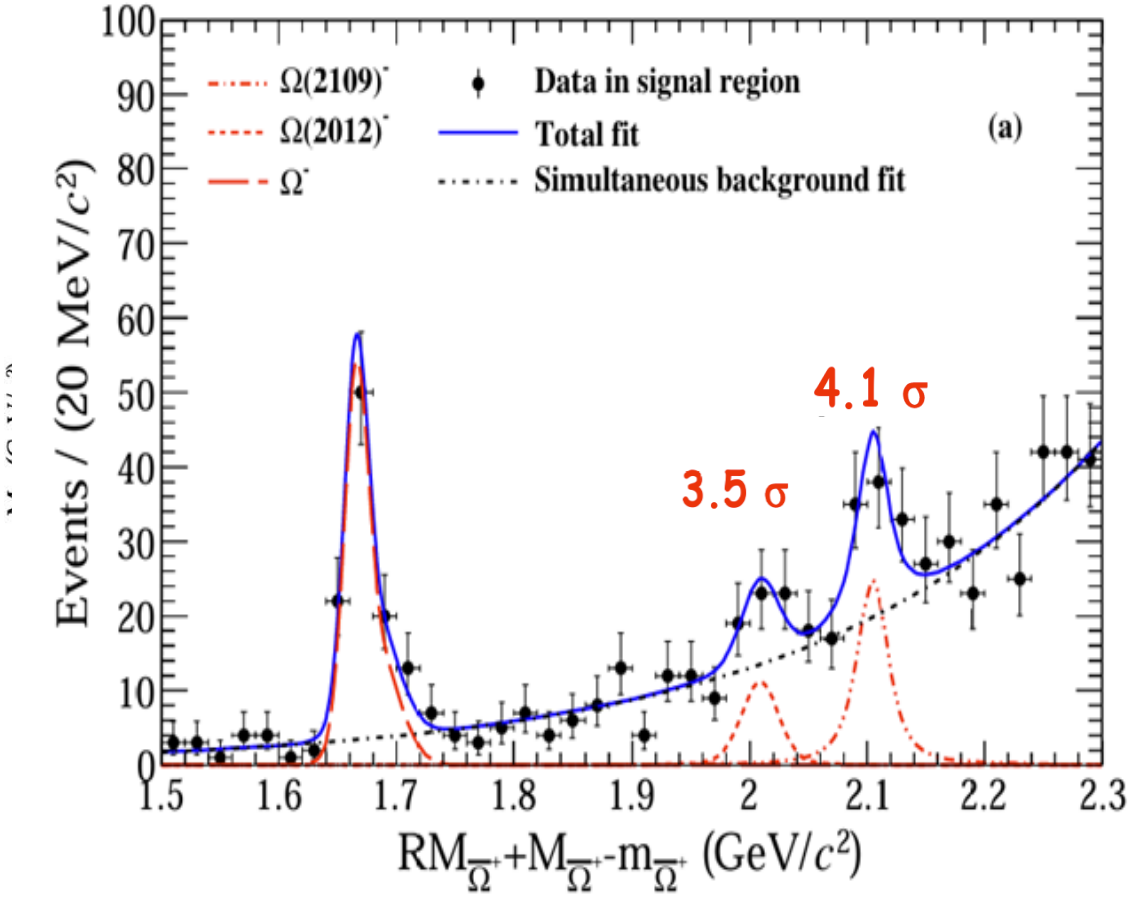
  mass : $2108.5 \pm 5.2_{\rm stat} \pm 0.9_{\rm syst}\ {\rm MeV}/c^2$
  width: $18.3 \pm 16.4_{\rm stat} \pm 5.7_{\rm syst}\ {\rm MeV}$

- **New production** mechanism of **Ω(2012)**

  with a significance of 3.5σ

$$e^+e^- \to \Omega(2109)^-\bar{\Omega}^+$$

Ω^-	1672.45 ± 0.29	$\frac{3}{2}^+$	****
$\Omega(2012)^-$	2012.4 ± 0.9		***
$\Omega(2250)^-$	2252 ± 9		***
$\Omega(2380)^-$	2380		**
$\Omega(2470)^-$	2474 ± 12		**



https://journals.aps.org/prl/pdf/10.1103/l6g2-2wg6

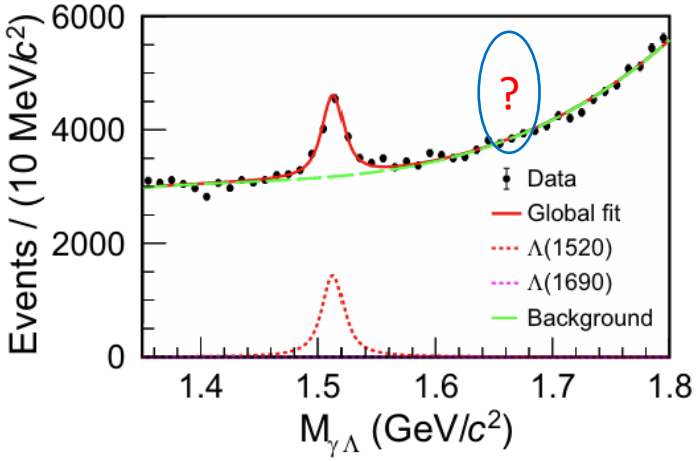
Radiative decays of Λ* @BESIII 10087 M J/ψ sample

Observation of the Electromagnetic Radiative Decays of the $\Lambda(1520)$ and $\Lambda(1690)$ to $\gamma\Sigma^0$

Study resonant structure in $J/\psi \to \gamma\Lambda\bar{\Lambda}$ and $\gamma\bar{\Lambda}\Sigma^0$

- $\Lambda(1520)\to\gamma\Lambda$

  4043 ± 247 events



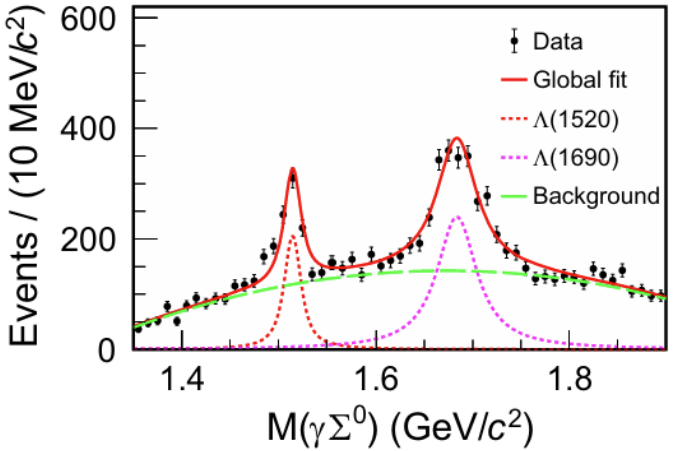
- $\Lambda(1690)\to\gamma\Lambda$?

  No signal observed!

- $\Lambda(1520)\to\gamma\Sigma^0$ **First Observation**

  621 ± 53 events

$$\frac{\Gamma(\Lambda(1520)\to\gamma\Sigma^0)}{} = \left(46.8 \pm 6.6(\text{stat.}) \pm 9.3(\text{syst.})\right)\text{keV}$$



- $\Lambda(1690)\to\gamma\Sigma^0$ **First Observation**

  1754 ± 122 events

Deviation from theoretical predictions

$$\mathcal{R} \equiv \frac{\mathcal{B}(\Lambda(1520)\to\gamma\Lambda)}{\mathcal{B}(\Lambda(1520)\to\gamma\Sigma^0)} = 3.19 \pm 0.34(\text{stat.}) \pm 0.19(\text{syst.})$$

~7σ larger than the SU(3) prediction:

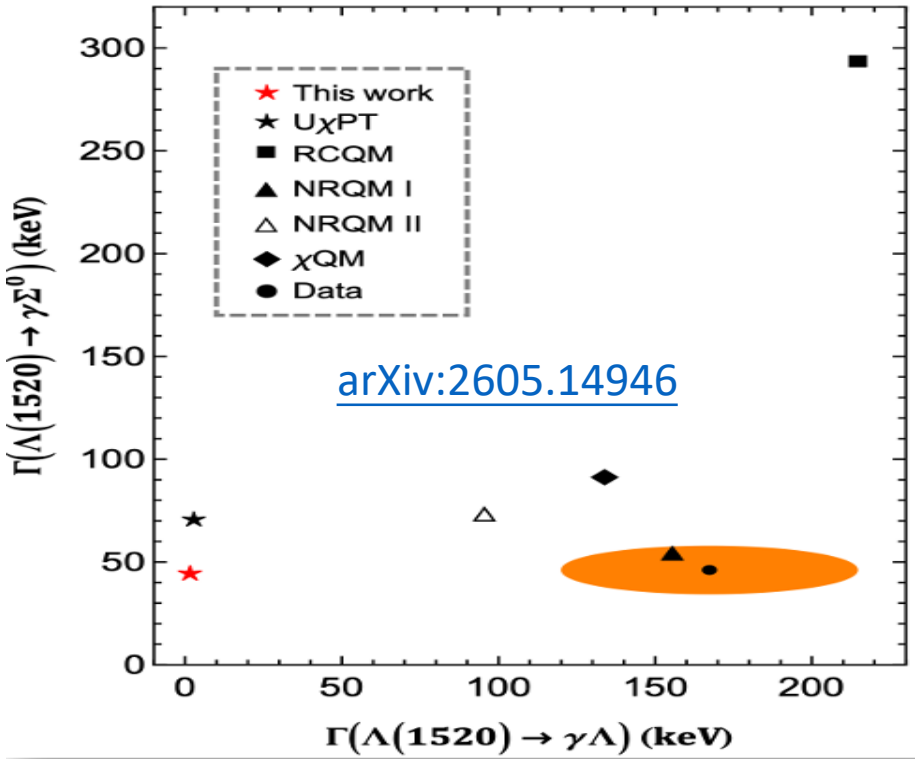
Assuming Λ(1520) to be a SU(3) singlet

$$\mathcal{R} \equiv \frac{\mathcal{B}(\Lambda(1520)\to\gamma\Lambda)}{\mathcal{B}(\Lambda(1520)\to\gamma\Sigma^0)} \approx 0.3$$

Phys. Rev. D **73**, 114001 (2006)

$B_i \to B_f + \gamma$	$\Lambda(1520) \to \gamma\Lambda$	$\Lambda(1520) \to \gamma\Sigma^0$
χQM [3]	134	92
NRQM	156 [6],96 [7]	55 [6], 74 [7]
RCQM[8]	215	293
MIT Bag[6]	46	17
Chiral Bag[9, 10]	32	51
Algebraic model[11]	85.1	180.4
CLAS [5]	$167 \pm 43^{+26}_{-12}$	

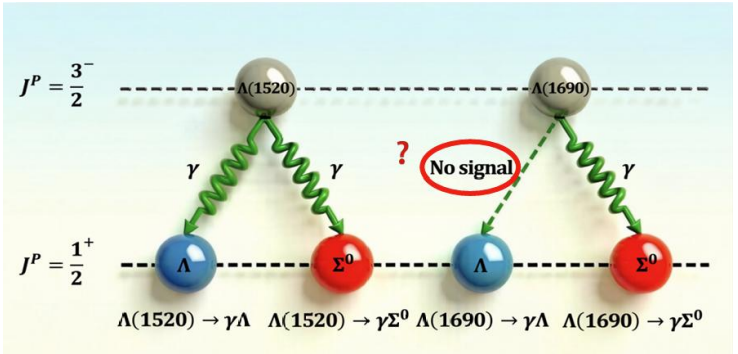
New theoretical calculation: chiral unitary coupled-channel



$$\mathcal{B}(J/\psi \to \bar{\Lambda}\Lambda(1690))\times\mathcal{B}(\Lambda(1690) \to \gamma\Sigma^0) = (6.05 \pm 0.42(\text{stat.}) \pm 0.39(\text{syst.}))\times10^{-6}$$

$$\mathcal{B}(J/\psi \to \bar{\Lambda}\Lambda(1690))\times\mathcal{B}(\Lambda(1690) \to \gamma\Lambda) < 5.08\times10^{-7} \quad (90\%\ \text{C.L.})$$

$$\mathcal{R} \equiv \frac{\mathcal{B}(\Lambda(1690)\to\gamma\Lambda)}{\mathcal{B}(\Lambda(1690)\to\gamma\Sigma^0)} < 0.08 \quad (90\%\ \text{C.L.})$$



summary

- excited hyperon states have been observed and measured @BESIII
  - 1 one* state confirmed: $\Lambda(2325)$
  - 3 new states observed: $\Sigma(2300)$, $\Xi(1720)$, $\Omega(2109)$
  - some states measured…

- New Radiative decays observed in $J/\psi \to \gamma\Lambda\bar{\Lambda}$ and $\gamma\bar{\Lambda}\Sigma^0$

  1st observation of $\Lambda(1520)\to\gamma\Sigma^0$ and $\Lambda(1690)\to\gamma\Sigma^0$

- More analysis on excited hyperon states in progress…

  new states, new decays, confirmation, precise measurement…

Thank you for your attention!