Confusions in the strange baryons sector

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September 8. Nstar 2026. Sevilla

Based on: 2606.27572 [hep-ph]
2608.27236 [hep-ph]

Collaborators:

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Lisheng Geng
A. Hosaka
H. Nagahiro

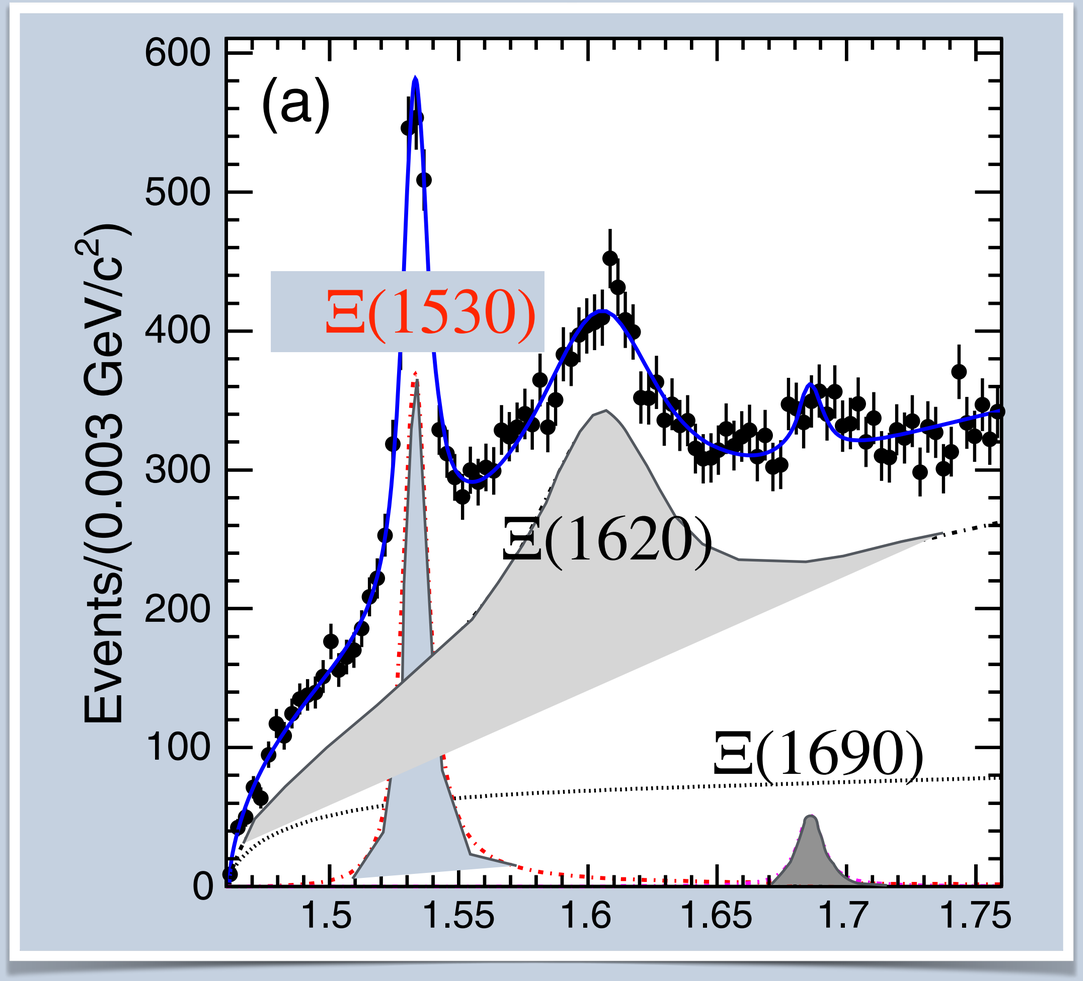
Confusions: the good, bad, and the ugly side

- Having confusions implies someone has dedicated time to study from a particular perspective.
- As I will discuss, we have new data sets being reported on the multistrange sector. This is good!
- It could, of course, simply be our problem. That could be bad!
- But I can give a talk and get help from the experts here.
- Or perhaps…
- I can motivate some of you to become confused as well. This is good!
- Now, the ugly side?
- Well, there isn't any! If the problem is interesting enough to get confused and we have experts around: I would say: **We are good!**

Let's begin!

- Belle:

- $\Xi(1620)$: seen for the first time in the $\pi\Xi$ spectrum, 25 σ signal.
- Mass and width: $1610 \pm 6^{+5.9}_{-3.5}$ MeV and $59.9 \pm 4.5^{+2.8}_{-3.0}$ MeV
- Mass & width of $\Xi(1690)$ not provided (signal 4.5- 5 σ signal)



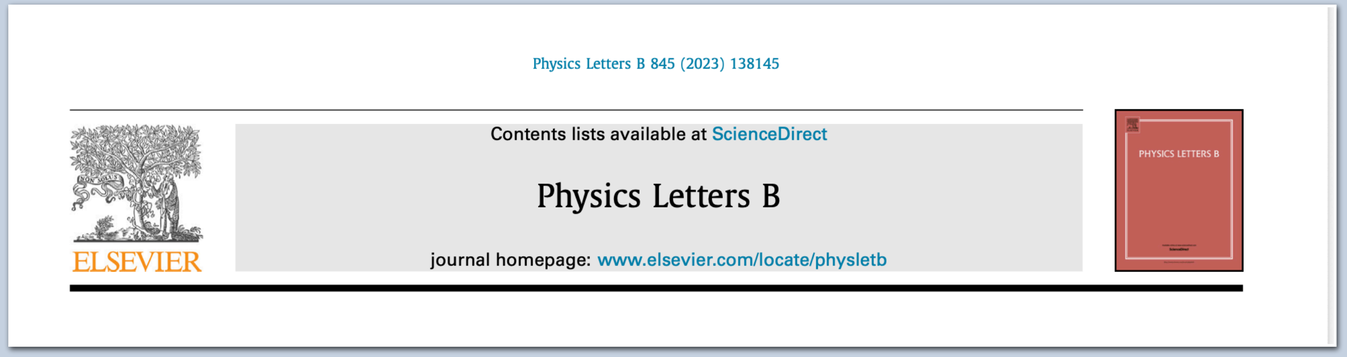
PHYSICAL REVIEW LETTERS **122,** 072501 (2019)

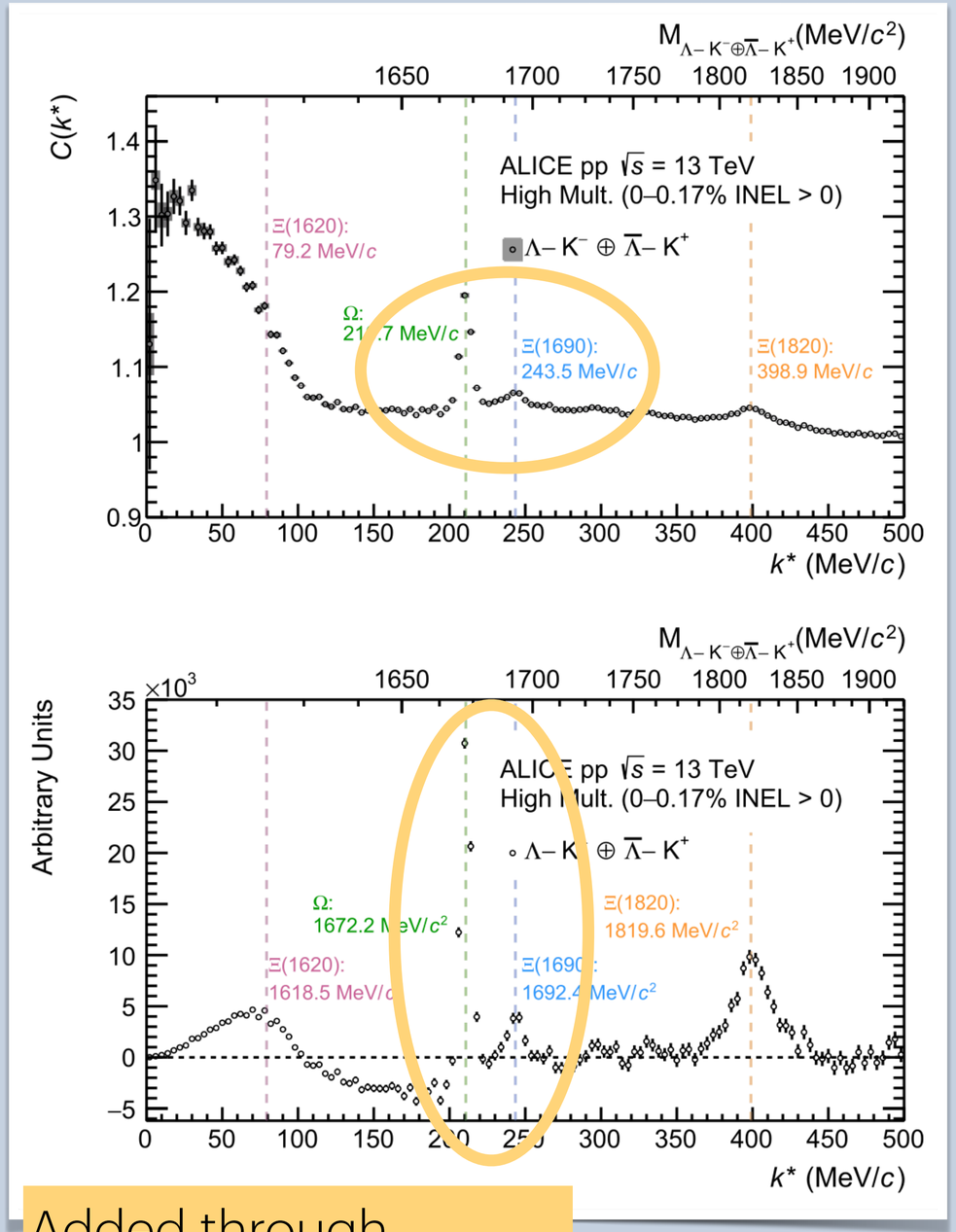
Observation of $\Xi(1620)^0$ and Evidence for $\Xi(1690)^0$ in $\Xi_c^+ \to \Xi^-\pi^+\pi^+$ Decays

Continuing .....

- Belle: $\Xi(1620)$: $1610 \pm 6^{+5.9}_{-3.5}$ MeV and $59.9 \pm 4.5^{+2.8}_{-3.0}$

- Alice: CF from pp collisions
  - $C(p) = \mathcal{N}\, C_{\text{model}}(p) \times B(p)$
  - $C^{K^-\Lambda}_{\text{model}}(p) = 1 + 0.51(C^{K^-\Lambda}_{\text{gen}}(p) - 1)$
  - Mass and width of $\Xi(1620)$: $1616.34^{+0.01}_{-0.05}$ MeV and 12.0 ± 1.24 MeV
  - $\Xi(1690)$ added to the background.

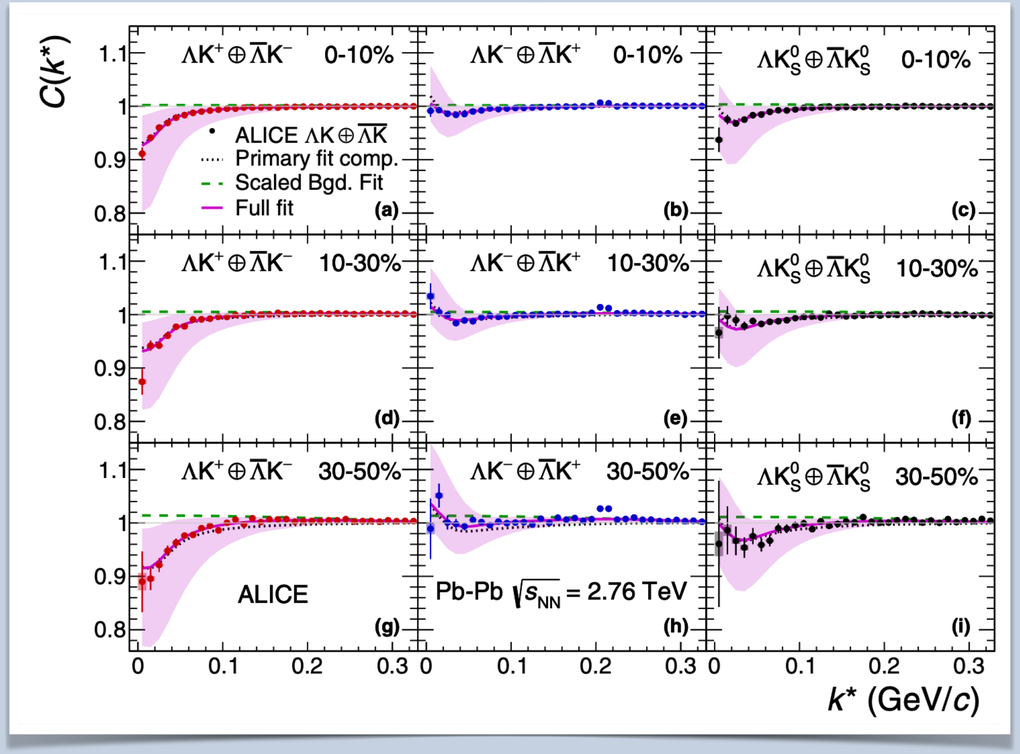




Added through background

Continuing .....

- More Alice: CF from *PbPb* collisions
- $C^{K^-\Lambda}_{\text{model}}(p) = 1 + \lambda(C^{K^-\Lambda}_{\text{gen}}(p) - 1),\ \lambda = 0.51$
- Resonance properties not available



PHYSICAL REVIEW C **103**, 055201 (2021)

ΛK femtoscopy in Pb-Pb collisions at $\sqrt{s_{NN}}$ = 2.76 TeV

S. Acharya *et al.**
(ALICE Collaboration)

Continuing .....

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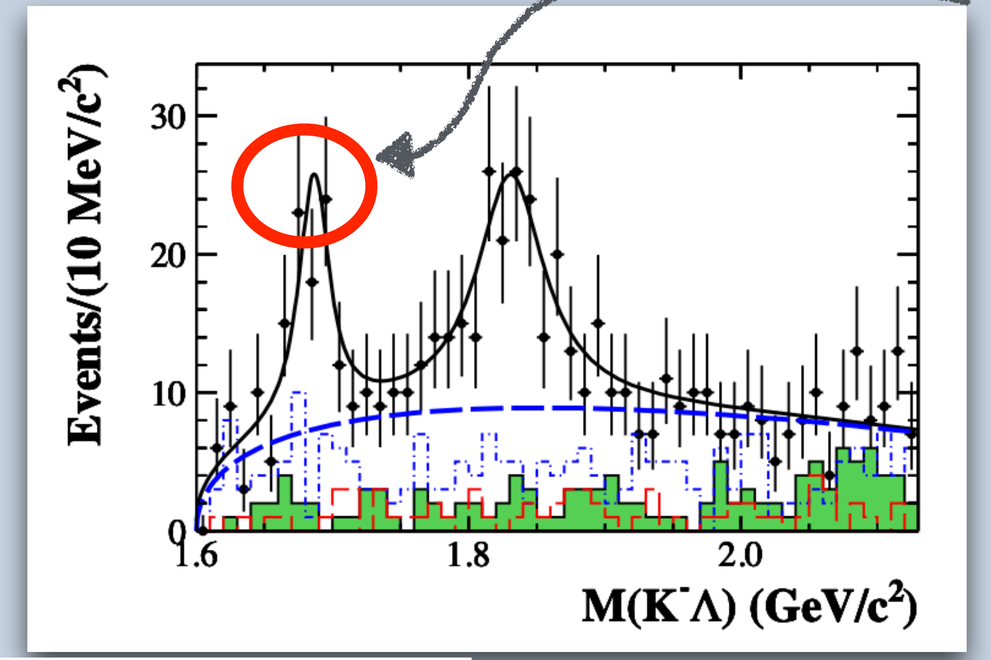
- Alice: $1616.34^{+0.01}_{-0.05}$ MeV and 12.0 ± 1.24 MeV

- NO SIGNAL of $\Xi(1620)$ is found!

BESIII

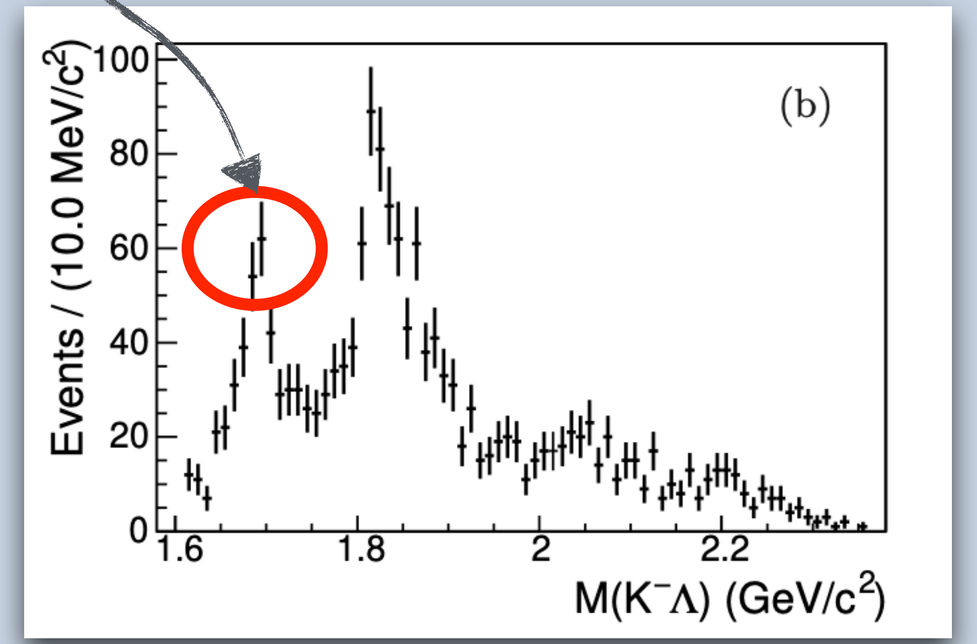
$\Xi(1690)$

- AGAIN: NO SIGNAL of $\Xi(1620)$ is found!



Phys.Rev.D 91 (2015) 9, 092006

4 TIMES LARGER STATISTICS



Phys.Rev.D 109 (2024) 7, 072008

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

Continuing .....

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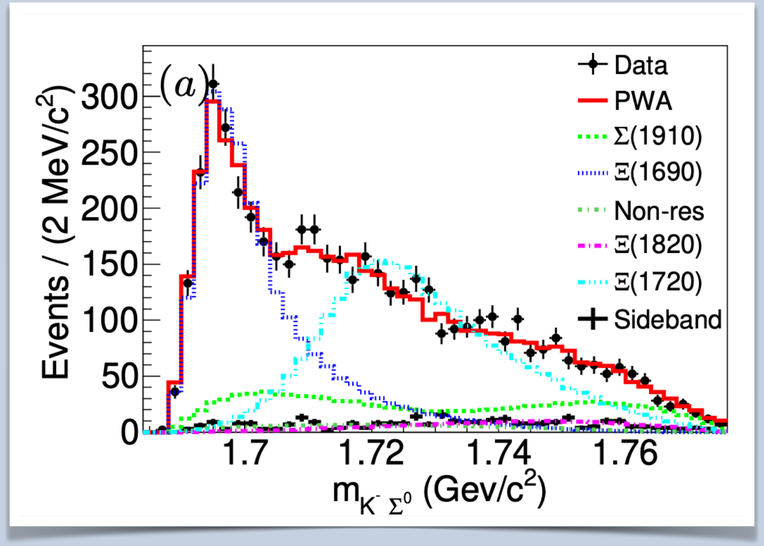
BESIII

	Mass (MeV)	Width (MeV)
Phys.Rev.D 91 (2015) 9, 092006	$1687.7 \pm 3.8 \pm 1.0$	$27.1 \pm 10.0 \pm 2.7$
Phys.Rev.D 109 (2024) 7, 072008	$1685^{+3}_{-2} \pm 12.0$	$81^{+10}_{-9} \pm 20$

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

arXiv:2604.27028



Continuing .....

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BESIII

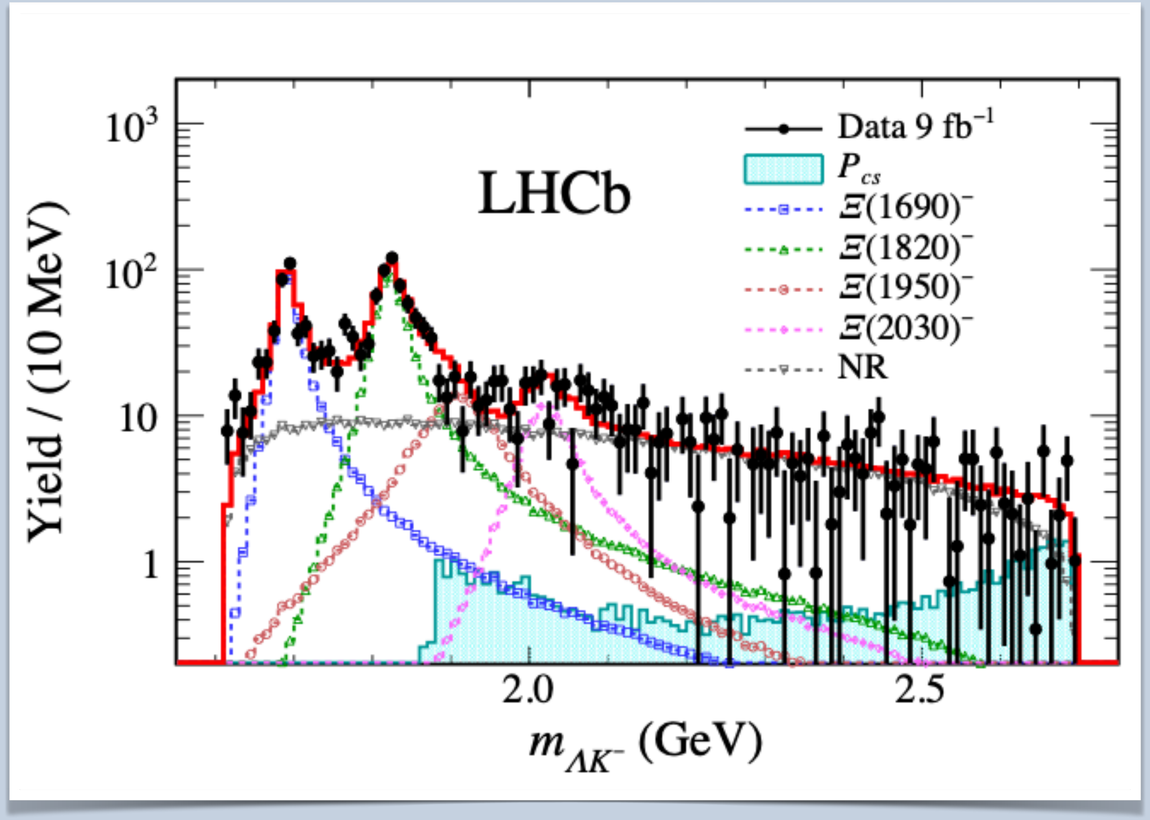
Mass (MeV)	Width (MeV)
$1687.7 \pm 3.8 \pm 1.0$	$27.1 \pm 10.0 \pm 2.7$
$1685^{+3}_{-2} \pm 12.0$	$81^{+10}_{-9} \pm 20$
1695.0 ± 9	12.8 ± 1.8

LHCb

Sci.Bull. 66 (2021) 1278-1287

- NO SIGNAL of $\Xi(1620)$ is found!

Also mentioned by A. Feijoo, V. M. Sarti, J. Nieves, A. Ramos, and I. Vidaña, Phys. Rev. D 111, 014022 (2025),



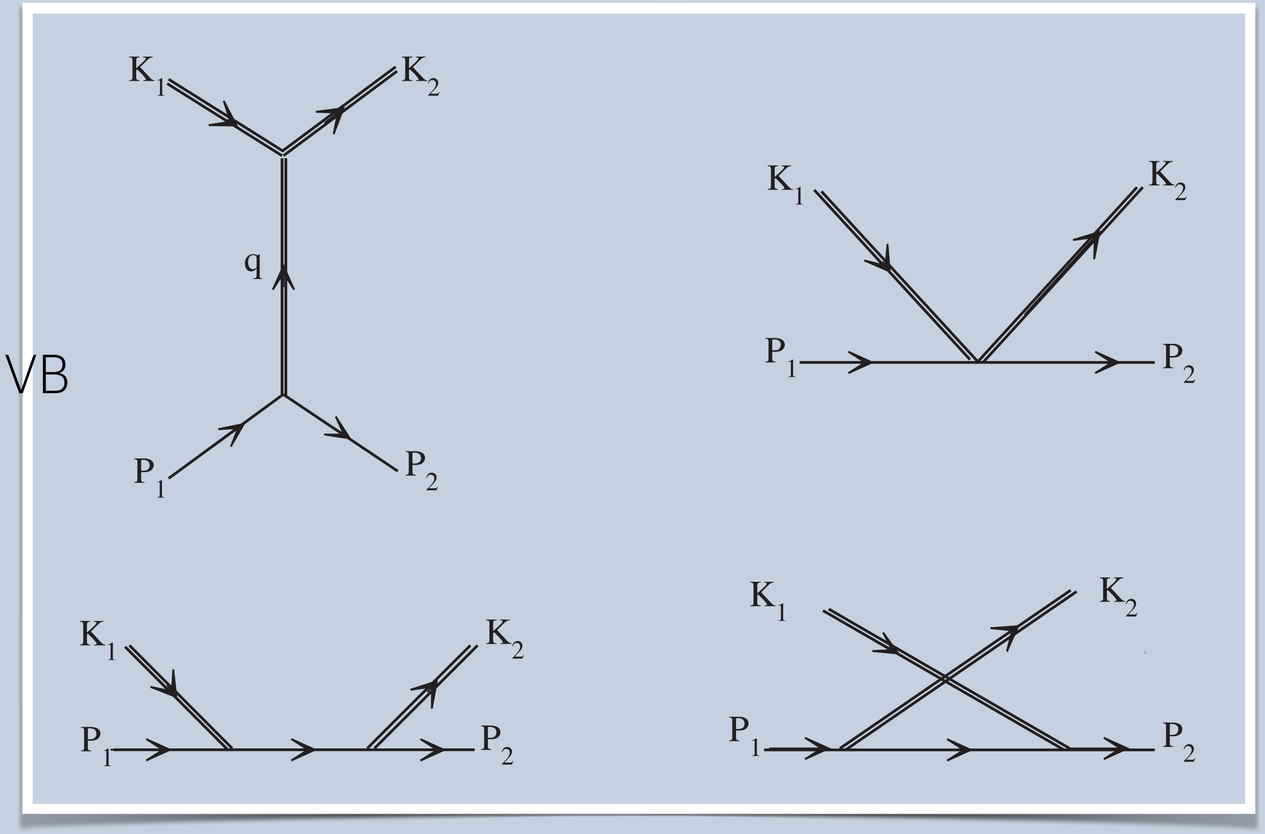
$M = 1692.0 \pm 1.3^{+1.2}_{-0.4}$ MeV, $\quad \Gamma = 25.9 \pm 9.5^{+14.0}_{-13.5}$ MeV

Let us try to see if our model can describe these data

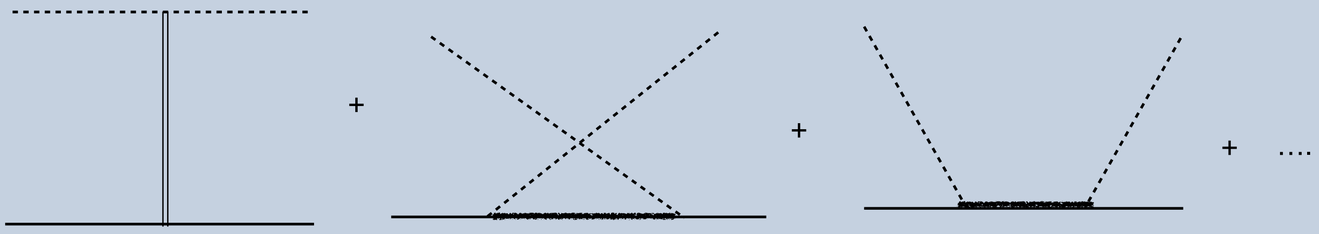
- **As Alberto mentioned in his talk…**

- **Pseudoscalar-baryon, vector-baryon coupled channel interactions**

VB



PB



More details

2608.27236 [hep-ph]

Enigmatic properties of Ξ(1620) and Ξ(1690)

Taísa Veloso,[1,*] K. P. Khemchandani,[1,†] A. Martínez Torres,[2,‡] Luciano M. Abreu,[3,§] and Li-Sheng Geng[4,5,6,7,¶]

- Coupled channels: $\pi\Xi, \eta\Xi, \bar{K}\Sigma, \bar{K}\Lambda, \rho\Xi, \omega\Xi, \phi\Xi, \bar{K}^*\Sigma,$ and $\bar{K}^*\Lambda$.

- We treat the regularization parameters (subtraction constants) as free parameters that can be varied to make a fit to the data.

- The correlation function is calculated as

$$C_{\text{gen}}^{K^-\Lambda}(p) = = 1 + 4\pi\Theta(q_{max} - p)\int_0^\infty dr\, r^2 \mathcal{S}(r,R)\Big\{ \sum_j \omega_j \,|j_0(p\,r)\delta_{(K^-\Lambda)\,j} + T_{j\to K^-\Lambda}(\sqrt{s})\tilde{G}_j(r,\sqrt{s},q_{max})\,|^2 - j_0^2(p\,r)\Big\},$$

- where the source function is taken as a sum of two Gaussians, following the ALICE Collaboration

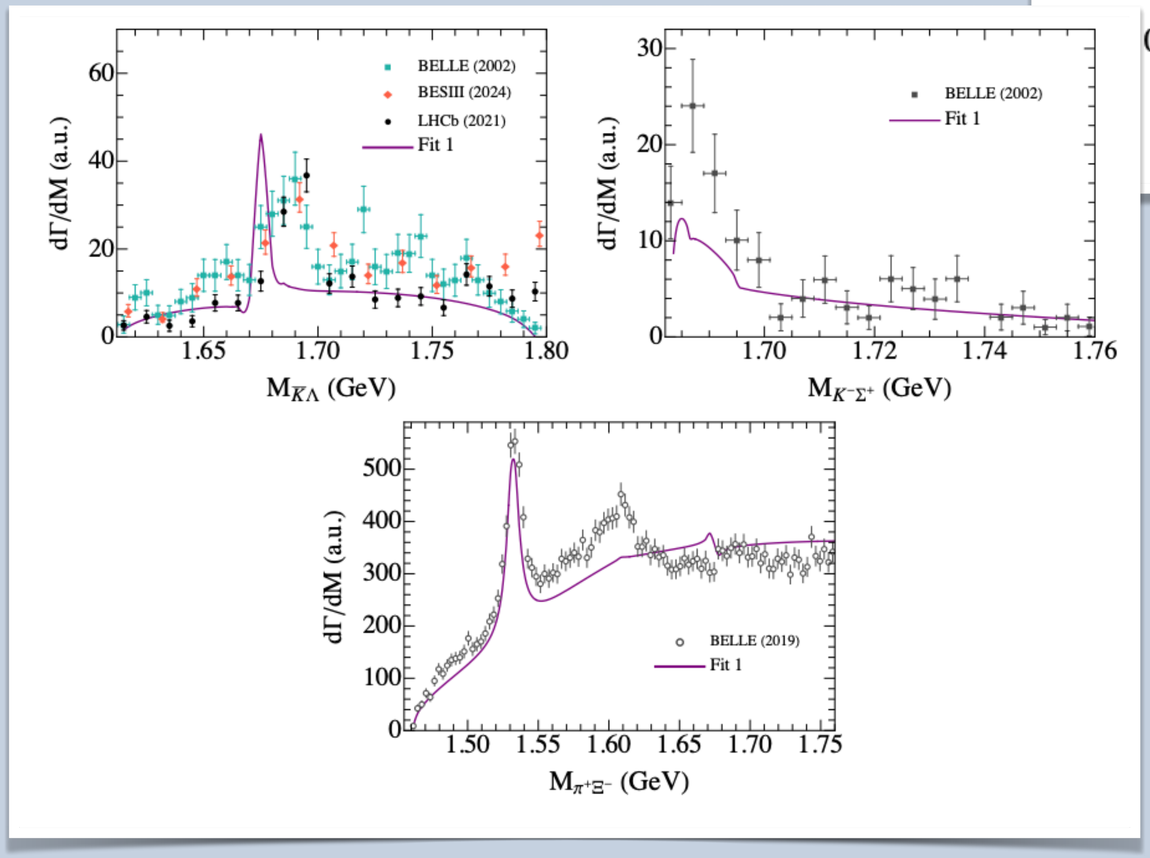
$$\mathcal{S}(r,R_1,R_2) = \lambda_{\mathcal{S}}\left[\omega_{\mathcal{S}}\,\mathcal{S}_1(r,R_1) + (1-\omega_{\mathcal{S}})\,\mathcal{S}_2(r,R_2)\right], \text{ with } \lambda_{\mathcal{S}} = 0.9806 \text{ and } \omega_{\mathcal{S}} = 0.7993$$

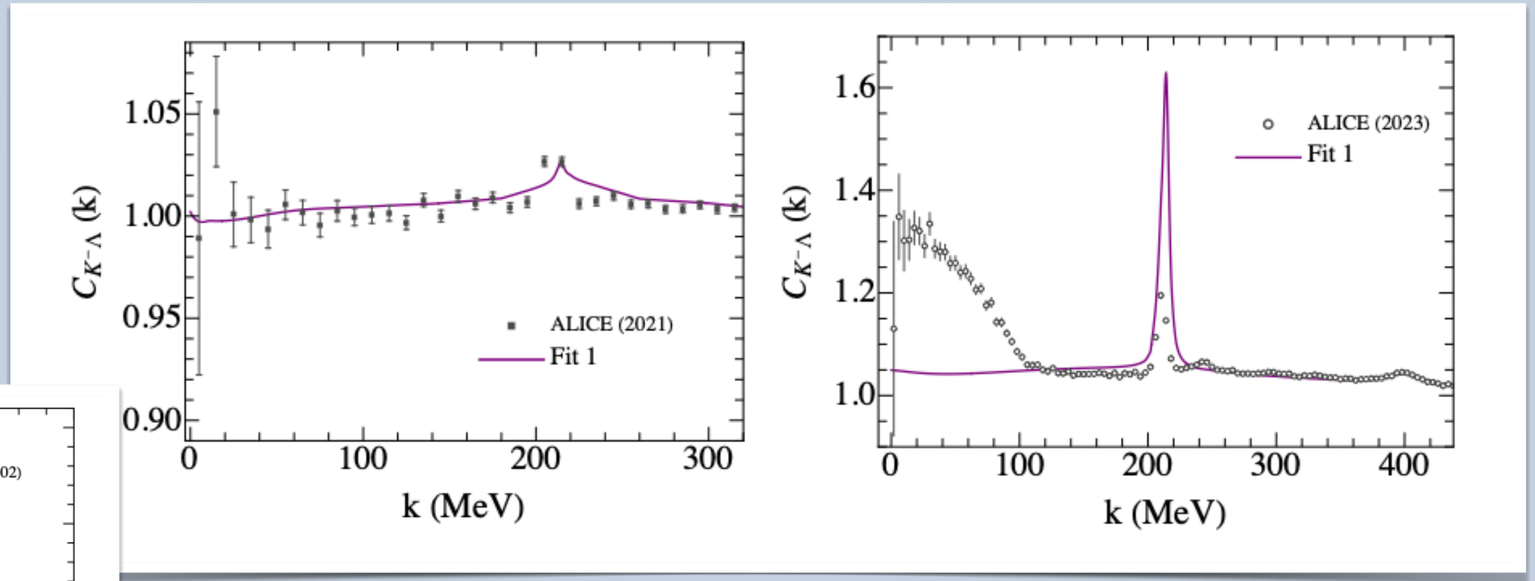
- And the weights are calculated as $\omega_j = \dfrac{N_j^B N_j^M}{N_{K^-\Lambda}}$, using the fireball statistical model

- $$\frac{dN}{m_\perp dm_\perp\, dy\, d\phi} \sim m_\perp \cosh(y)\exp\left(-\frac{m_\perp\cosh(y)}{T_{ch}}\right)$$ ➡ Ask questions to Luciano Abreu!

Model and data disagreements

- First attempt: make a universal fit.
- We fail miserably!





- NEXT: we tried to fit CF and data on invariant masses seprarately

2608.27236 [hep-ph]

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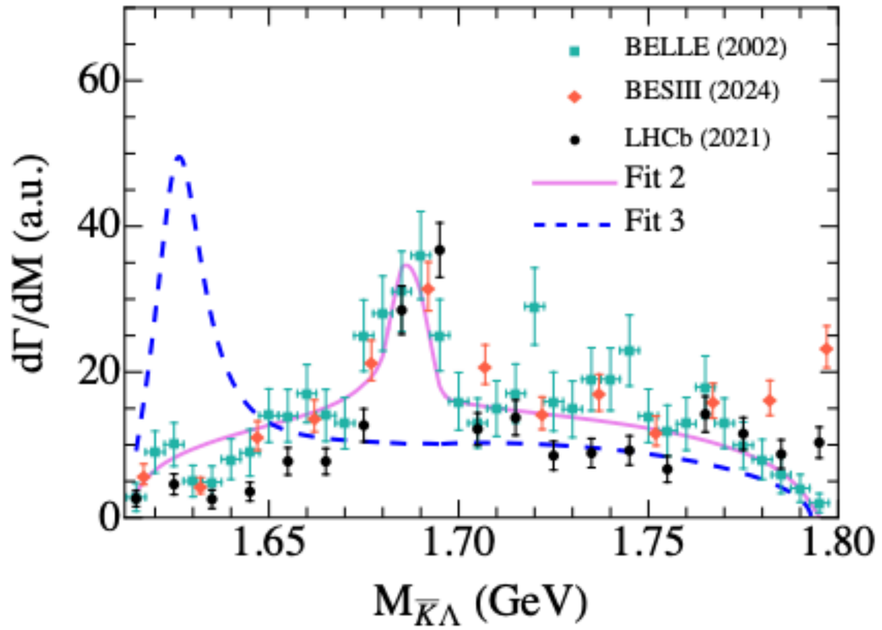
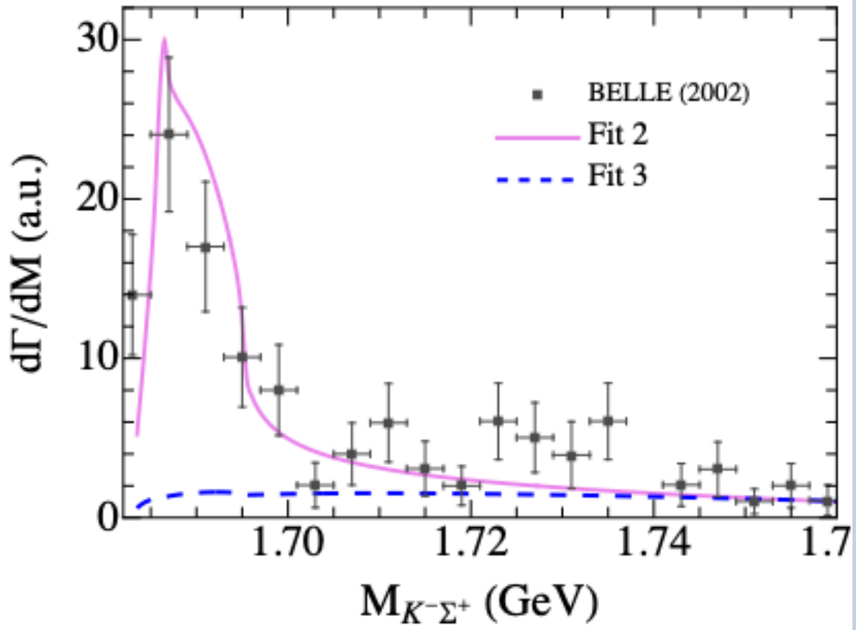
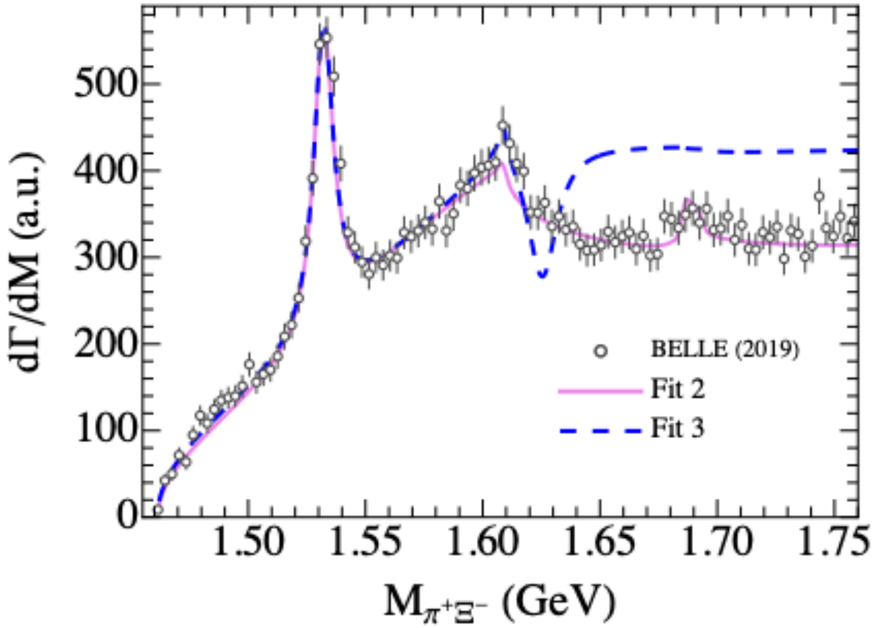
- Fit 2—> considers inv mass data set only
- Fit 3—> considers CF data only (from pp collisions)







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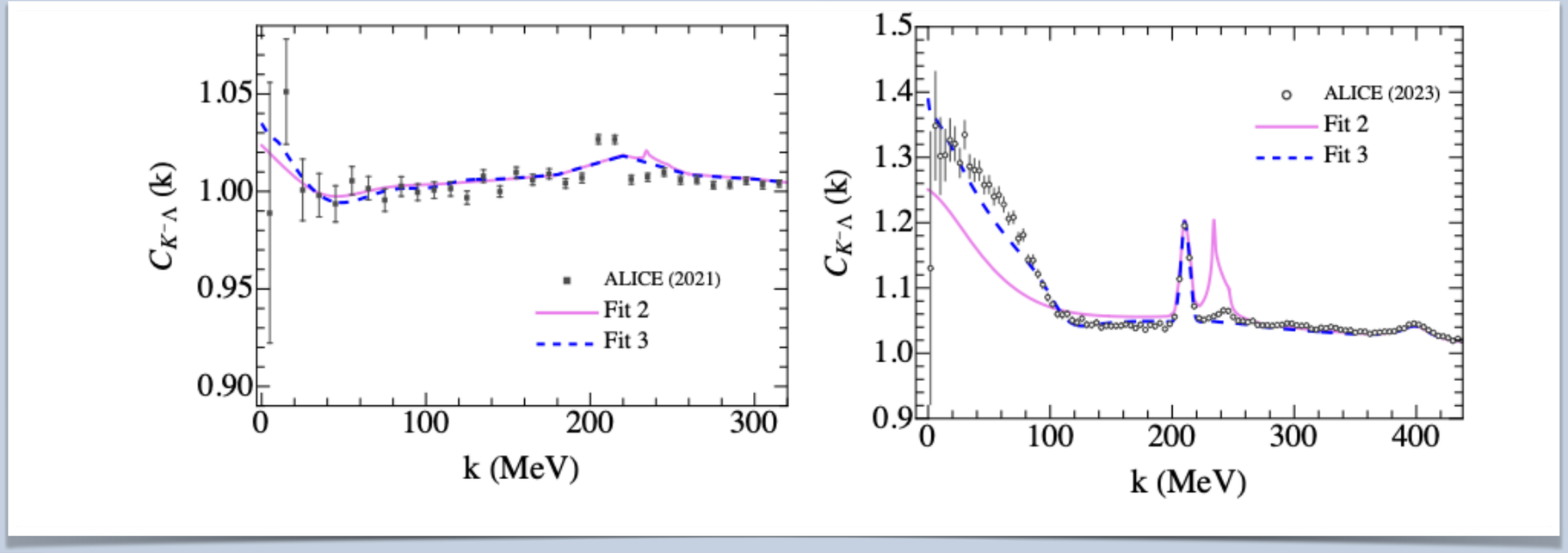

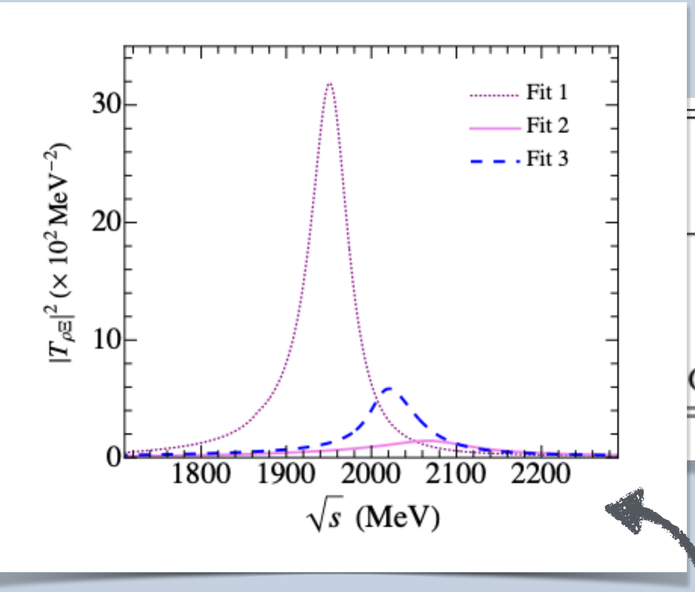

	Fit 1			Fit 2			Fit 3		
	Pole 1	Pole 2	Pole 3	Pole 1	Pole 2	Pole 3	Pole 1	Pole 2	Pole 3
Mass (MeV)	1557.5	1670.0	1960.0	1576.0	1687.0	2086.5	1561.0	1620.0	2047.0
Width (MeV)	251.0	3.0	35.0	241.0	6.0	16.0	265.0	15.0	50.0
Correspondence with a known state	–	$\Xi(1690)$	$\Xi(1950)$	–	$\Xi(1690)$	–	–	$\Xi(1620)$	–

- Fit 2 parameters

Parameter	Fit 1	Fit 2	Fit 3
χ^2/p.d.f	4.51	1.21	8.94
$a_{\pi\Xi}$	-1.2230	-2.0362	-1.3911
$a_{\eta\Xi}$	-2.3155	-3.0103	-3.7624
$a_{\bar{K}\Sigma}$	-2.5021	-1.4647	-2.5056
$a_{\bar{K}\Lambda}$	-3.2314	-2.1205	-3.0199
$a_{\rho\Xi}$	-3.1613	-2.1636	-2.6482
$a_{\omega\Xi}$	-3.1061	-2.1926	-2.5897
$a_{\phi\Xi}$	-2.4546	-3.4180	-3.0640
$a_{\bar{K}^*\Sigma}$	-2.6552	-2.8598	-2.5856
$a_{\bar{K}^*\Lambda}$	-1.9825	-3.4921	-2.0750
Λ (MeV)	954	600	500
q_{max} (MeV)	868	–	1000
g_{KR}	$0.9647 \times \frac{m_V}{\sqrt{2}f_P f_V}$	$0.8478 \times \frac{m_V}{\sqrt{2}f_P f_V}$	$0.6298 \times \frac{m_V}{\sqrt{2}f_P f_V}$

2608.27236 [hep-ph]

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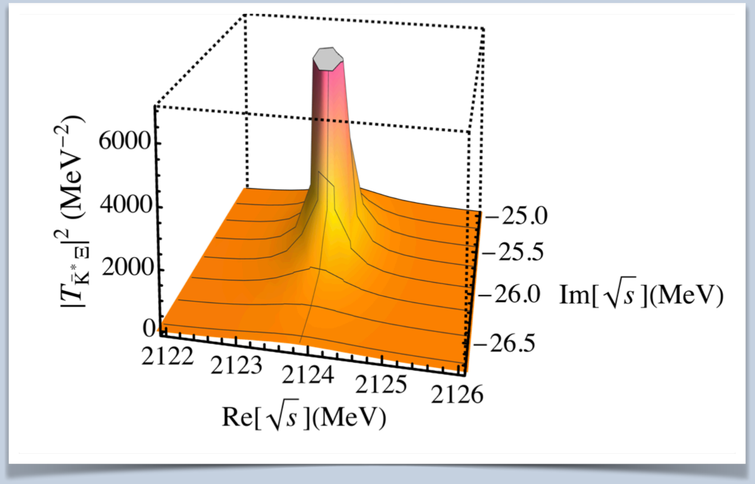
S=-3: A new state $\Omega(2109)$

- BesIII measured $e^+e^- \to \Omega\bar{\Omega}$ and found the existence of $\Omega(2109)$.

- They report that no signal is seen in the $\bar{K}\Xi$ invariant mass spectrum.

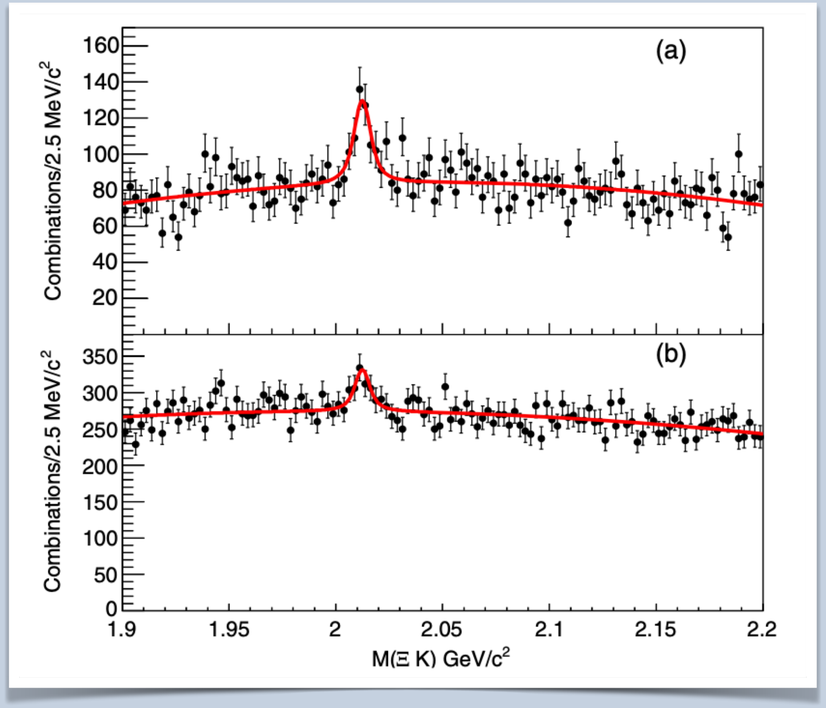
- Our coupled-channel study shows that the $\bar{K}^*\Xi$ interaction is strongly attractive, producing a pole that can be related to the new Ω. And $\bar{K}\Xi$ couples weakly to the pole.



arXiv:2606.27572v2

Nature of the newly found $\Omega(2109)$

Taísa Veloso,[1,*] K. P. Khemchandani,[1,†]
A. Martínez Torres,[2,‡] H. Nagahiro,[3,4,§] and A. Hosaka[4,¶]



A new state **Ω(2109)**

arXiv:2606.27572v2

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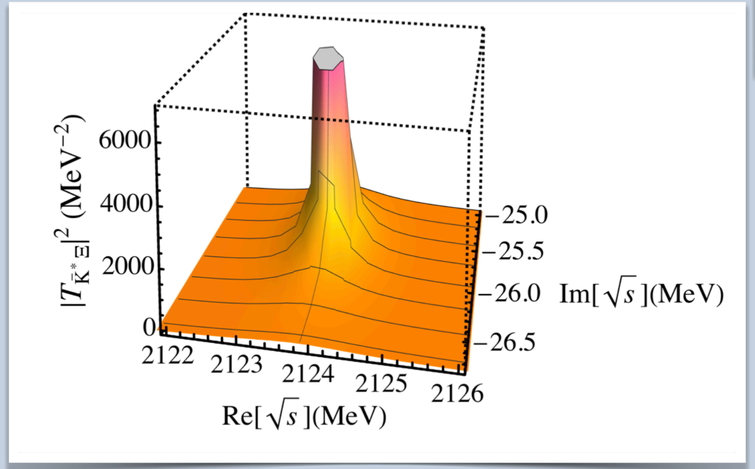
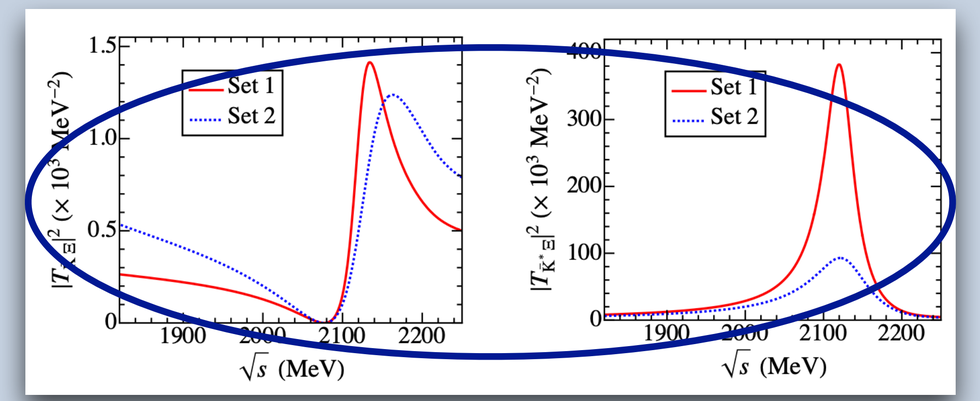
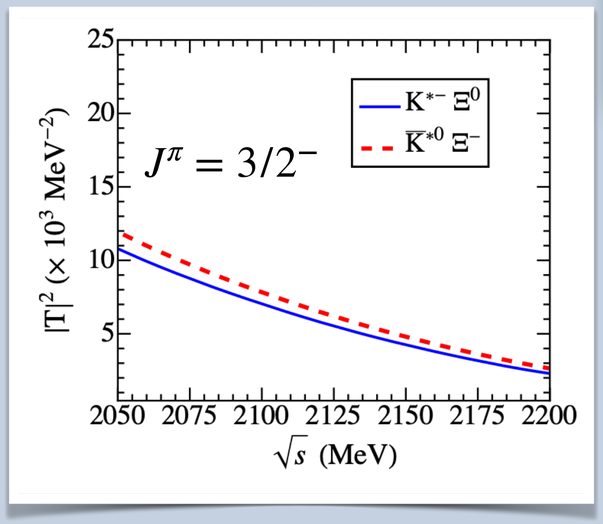
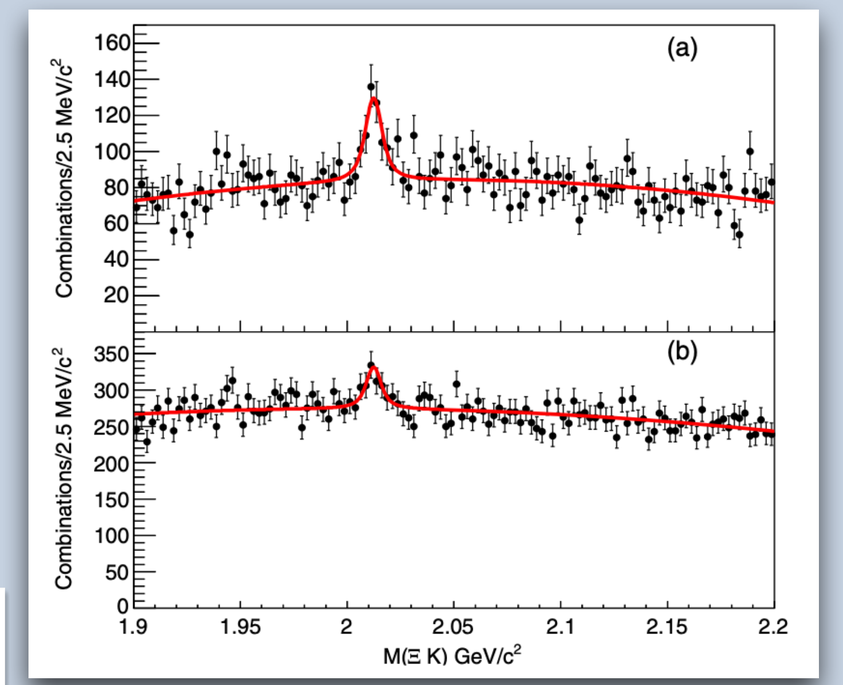




Uncertainties from regularization parameters





-Kolomeitsev and Lutz, PL B 585, 243 (2004).
-S. Sarkar, E. Oset, and M. J. Vicente Vacas, Nucl. Phys. A 750, 294 (2005),
-Li, Feijoo, Oset, Ω(2380) as a partner of the Ω(2012), PRD 113 (7) (2026)
-L¨u, H. Nagahiro, A. Hosaka, Understanding the nature of Ω(2012) in a coupled-channel approach, PRD 107 (1) (2023) 014025.

A new state $\Omega(2109)$

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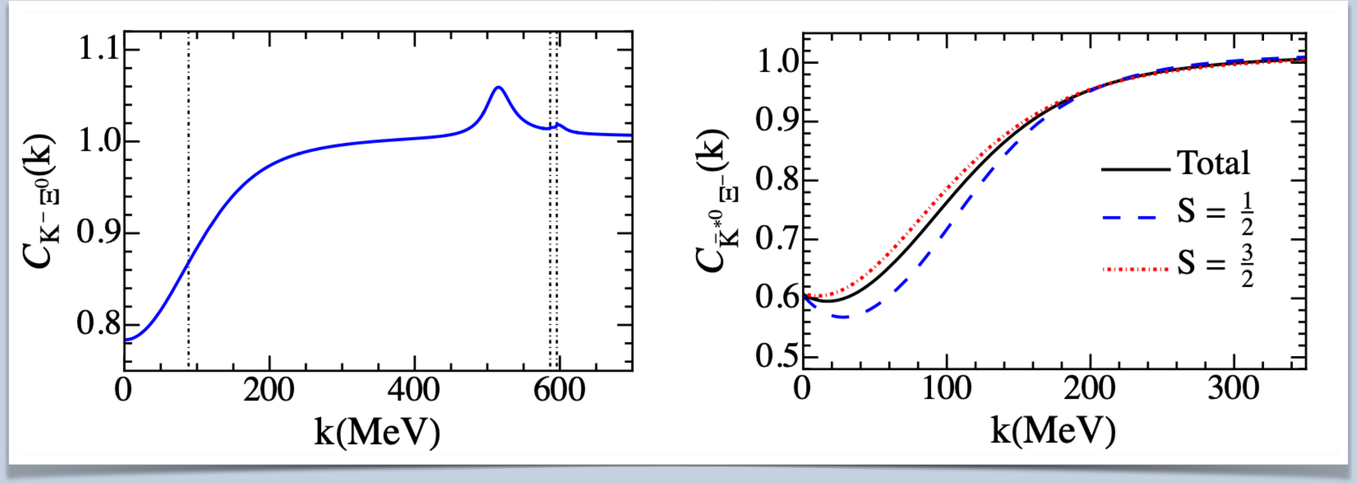

- Prediction for measuring data on Femtoscopic correlation functions

- Test of our model

Conclusions

- Strangeness -2 sector is full of confusion.
- A good fit to the invariant mass spectra cannot describe the data on the correlation function. Such a fit generates a state that can be associated with Ξ(1690).
- A reasonable fit to the correlation-function data fails to describe the invariant-mass data. Such a fit generates a state that can be associated with Ξ(1620).
- A lower energy state, with large width, always appears. Also, a state with mass around $K^*\Sigma$
- Ω(2109) can be understood as moleculelike state.

- A few informal announcements:
  - Charm 2027 will be held in Rio de Janeiro, May10-14 (https://indico.cern.ch/event/1720270/); organizers: Carla Göbel, Ignacio, ...
  - Hadron 2027 will be held in Santos (São Paulo), hopefully in September (organizers: Alberto Martinez Torres, Bruno El-Bennich, Kanchan, Fernando Navarra, Patricia Magalhães, Diogo Boito, Luciano Abr Arlene Cristina Aguilar)
  - QNP 2028 will be held in Salvador d (organizers: Luciano Abreu, Alberto Torres, Kanchan, Fernando Navarra.

THANK YOU!