2026年超级陶粲装置装置研讨会

e^+e^-对撞过程中寻找超子激发态 $\Sigma(1/2^-)$

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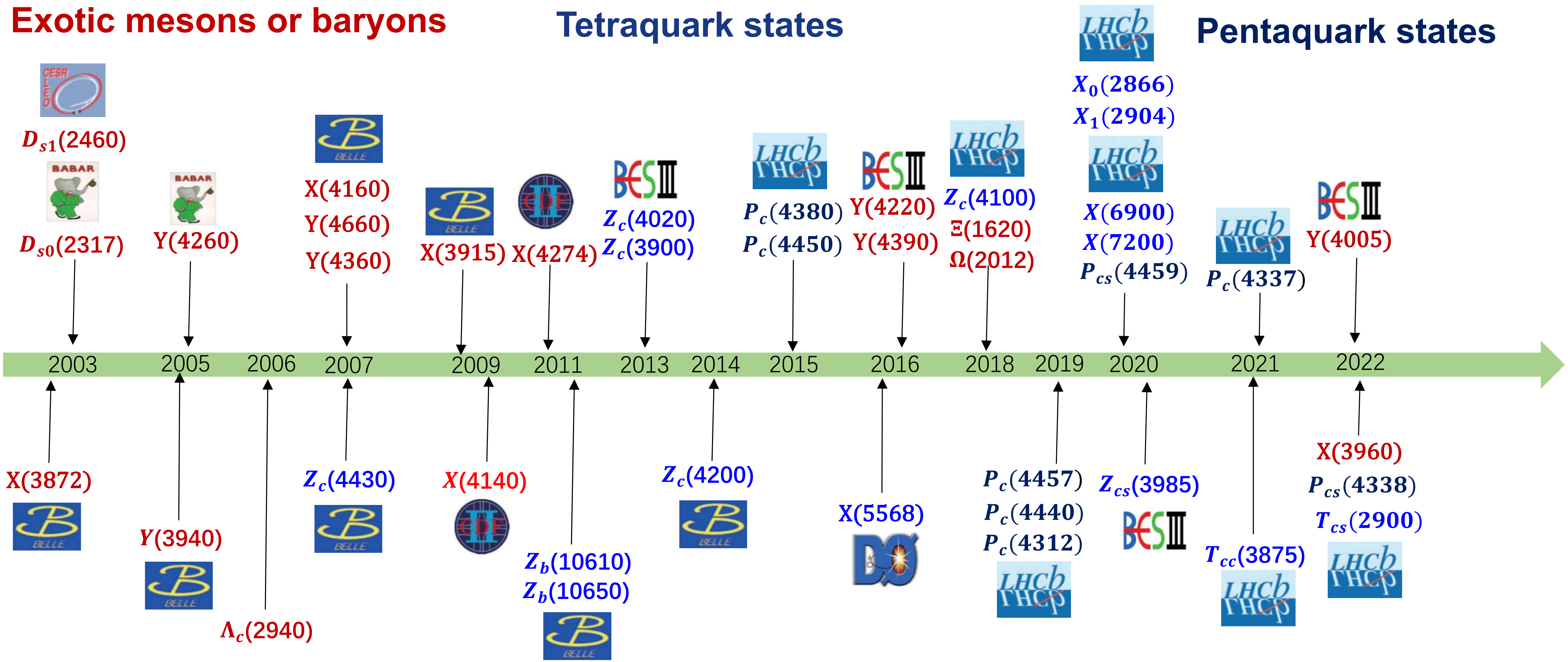
郑州大学物理学院

2026年7月2日

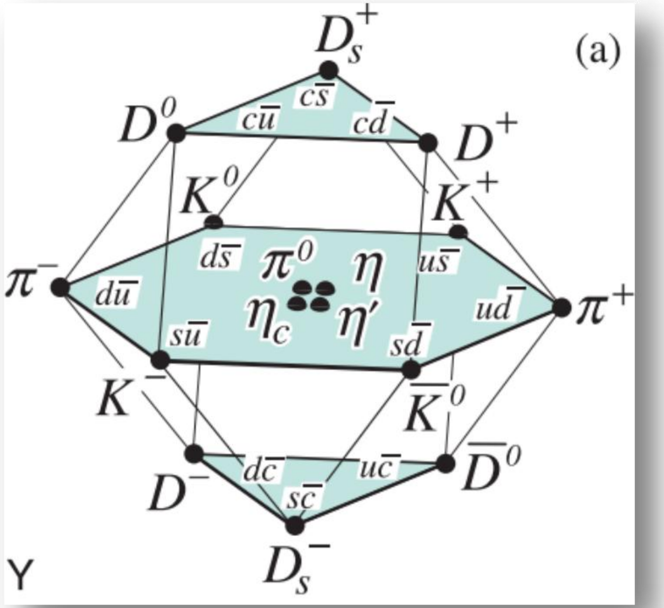
Exotic states

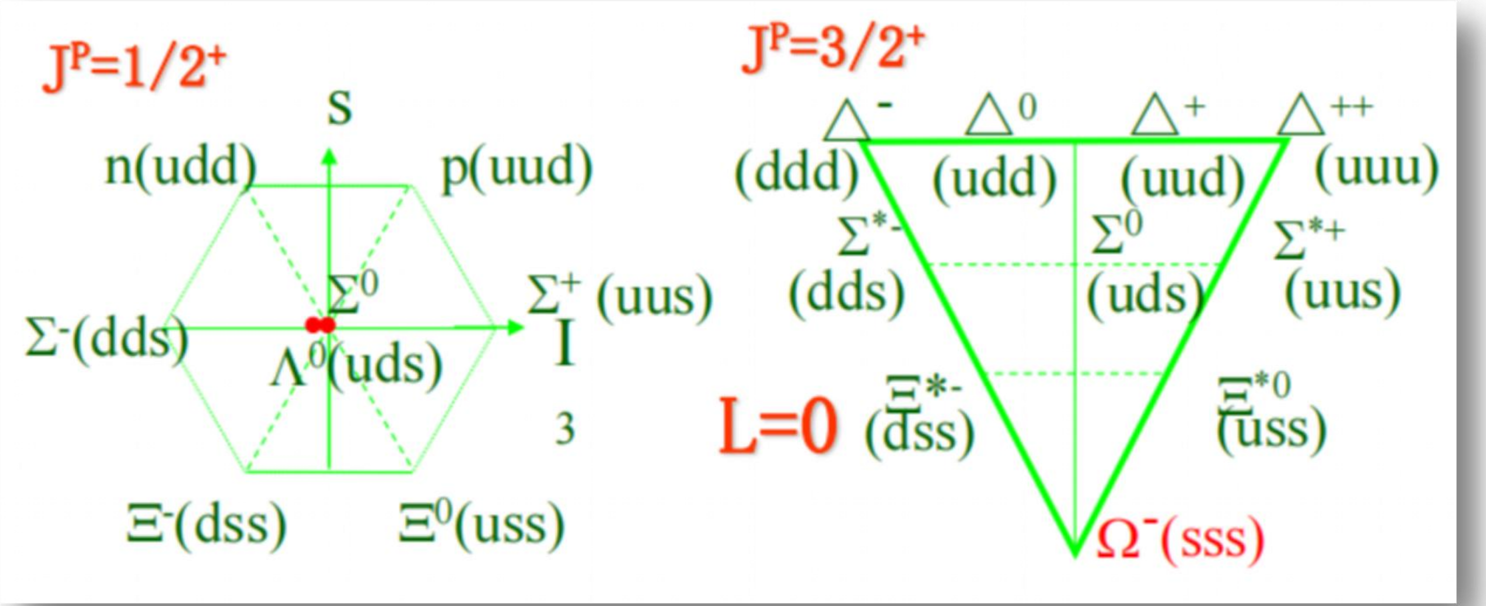
耿立升报告

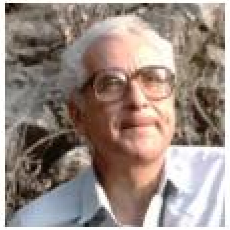


Ground light baryons

□Ground light mesons and baryons







盖尔曼-大久保质量:

$$M = a + bY + c\left[I(I+1) - \frac{1}{4}Y^2\right]$$

质量公式预言：m_Ω=1670 MeV

实验：m_Ω=1672.45±0.29 MeV

Low-lying baryons with $J^P=1/2^-$

- Two poles of $\Lambda(1405)$
- mass reverse problem
- Large couplings of N(1535) to $N\eta$, $K\Lambda$
- Different lineshapes of $\Lambda(1670)$
- Missing $\Sigma(1/2^-)$

Citation: R.L. Workman *et al.* (Particle Data Group), Prog.Theor.Exp.Phys. **2022**, 083C01 (2022)

$\Sigma(1620)$ $1/2^-$ $I(J^P) = 1(\frac{1}{2}^-)$ Status: *

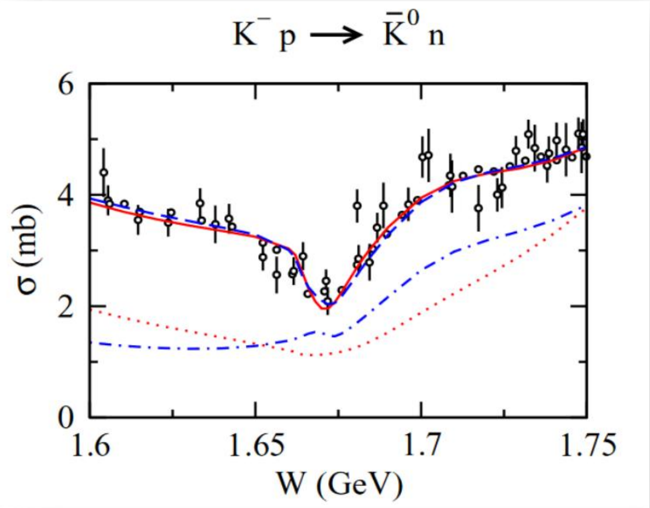
OMITTED FROM SUMMARY TABLE

Citation: M. Tanabashi *et al.* (Particle Data Group), Phys. Rev. D **98**, 030001 (2018) and 2019 updat

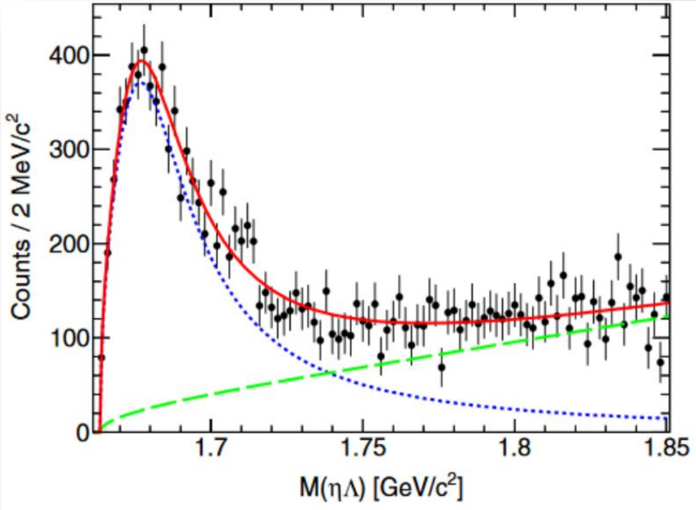
$\Sigma(1480)$ Bumps $I(J^P) = 1(?^?)$ Status: *

OMITTED FROM SUMMARY TABLE

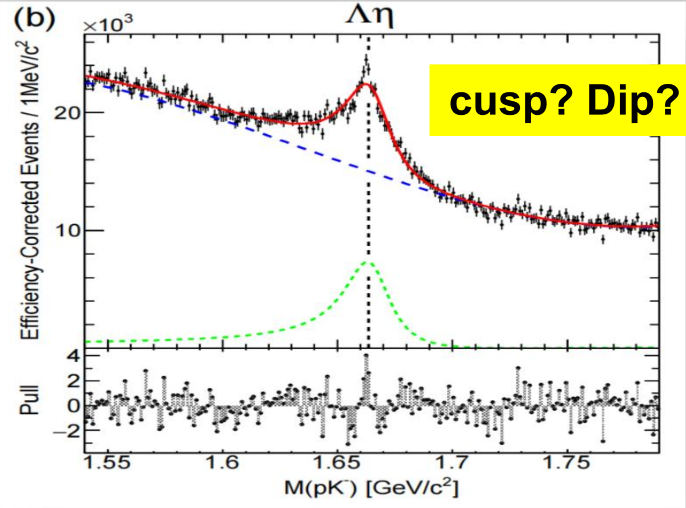
These are peaks seen in $\Lambda\pi$ and $\Sigma\pi$ spectra in the reaction $\pi^+ p \to (Y\pi)K^+$ at 1.7 GeV/c. Also, the Y polarization oscillates in the same region.



PLB527(2002) 99



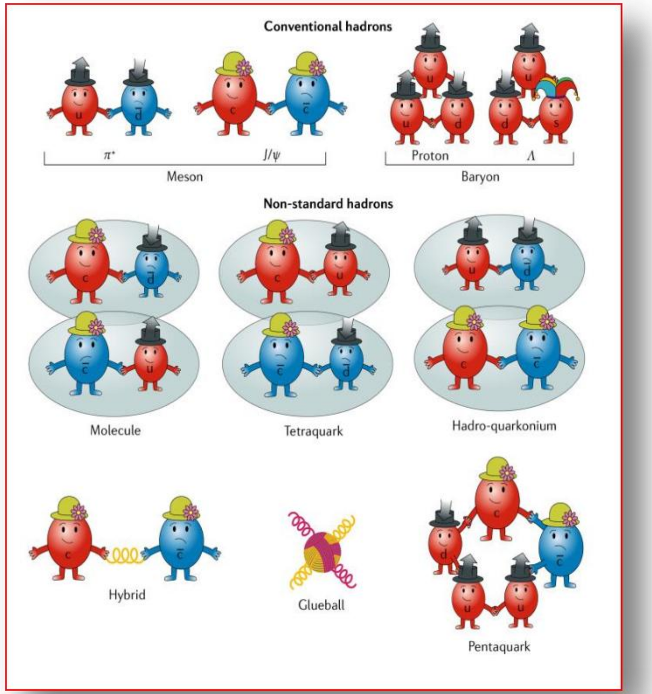
Belle, PRD103(2021)052005

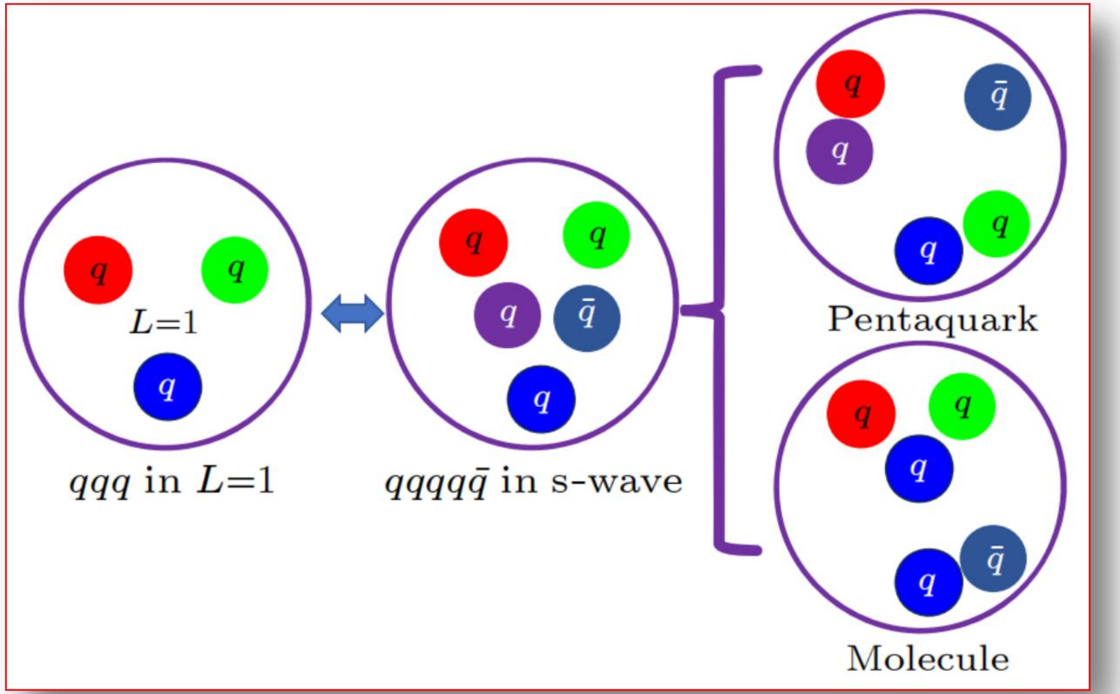


cusp? Dip? peak?

Belle: PRD108 (2023) L031104

Exotic structures of Hadrons





C.Z.Yuan, Nature Rev. Phys. 1 (2019) 480

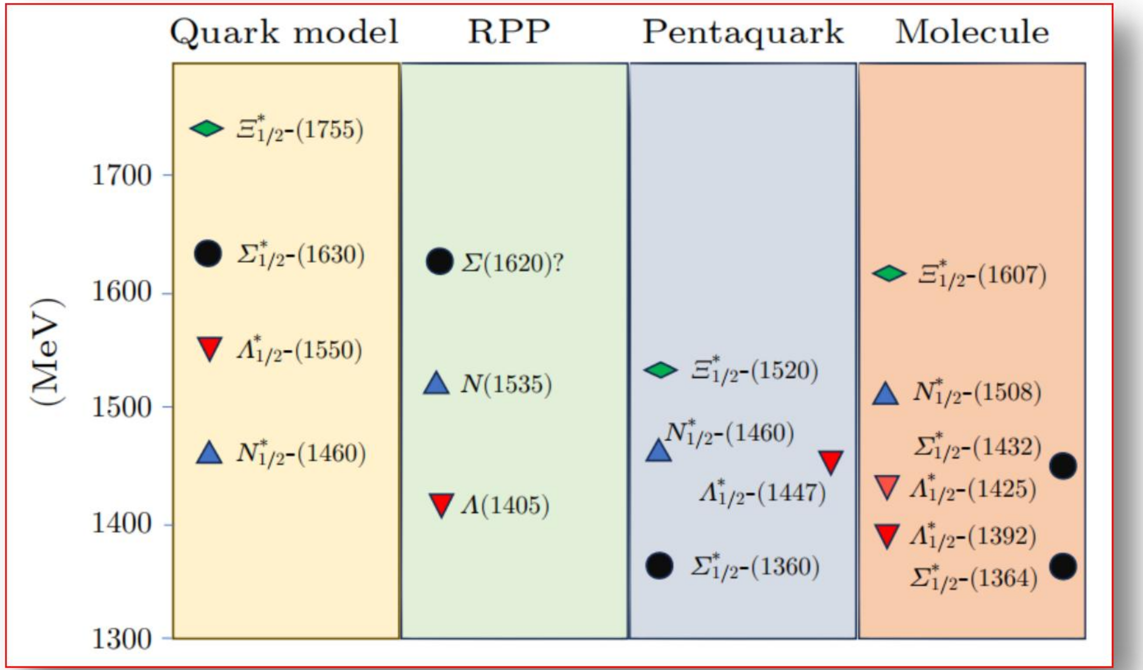
The low-lying excited baryons with $J^P=1/2^-$ have different explanations, such as compact pentaquark, or the molecular.

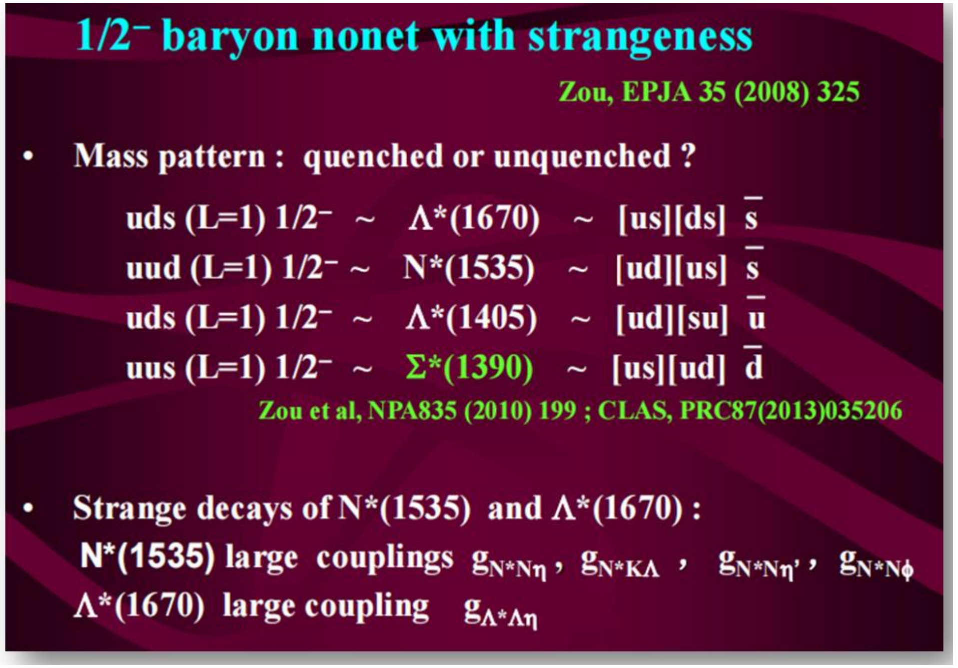
Low-lying baryons

Review on $\Sigma(1/2^-)$, EWang, LSGeng, JJWu, JJXie, and BSZou, CPL41(2024)101401

☐mass reverse problem

邹冰松老师报告



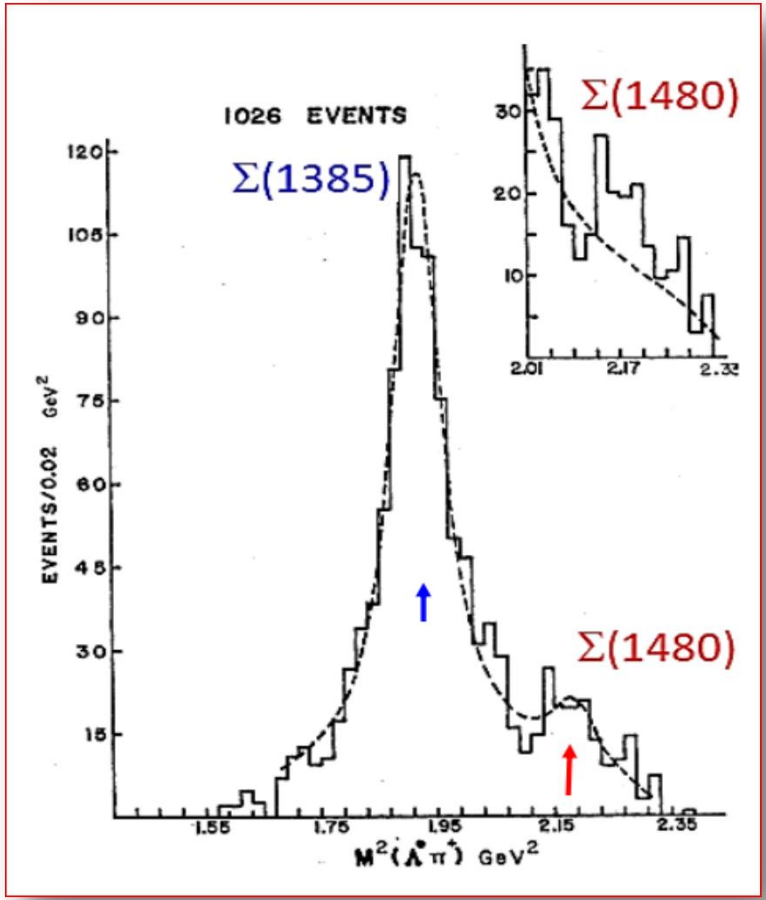


- The mass of Λ(1405) has an s qurak, but its mass is smaller that the N(1535).
- The radial excited N(1440) with $J^P = 1/2^+$ is smaller than the mass of the N(1535) (1/2-).

Exp. signals of $\Sigma(1480)$

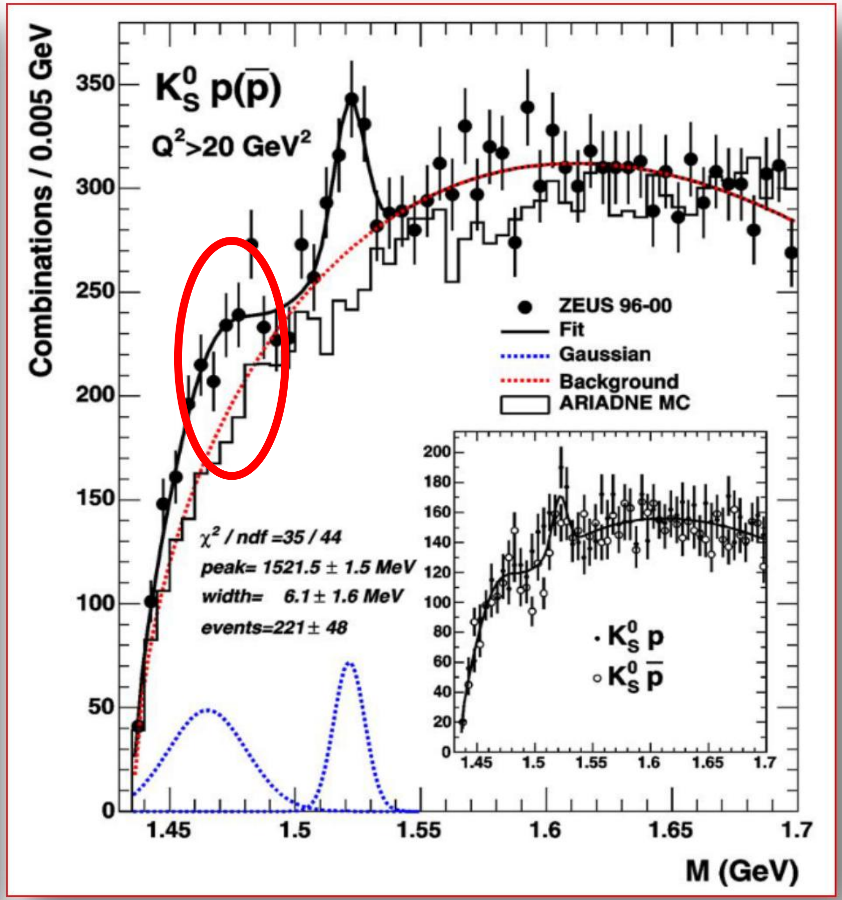
$\pi^+ p \to \pi^+ K^+ \Lambda$

Yu-Li Pan et al, PRD2, 449 (1970)



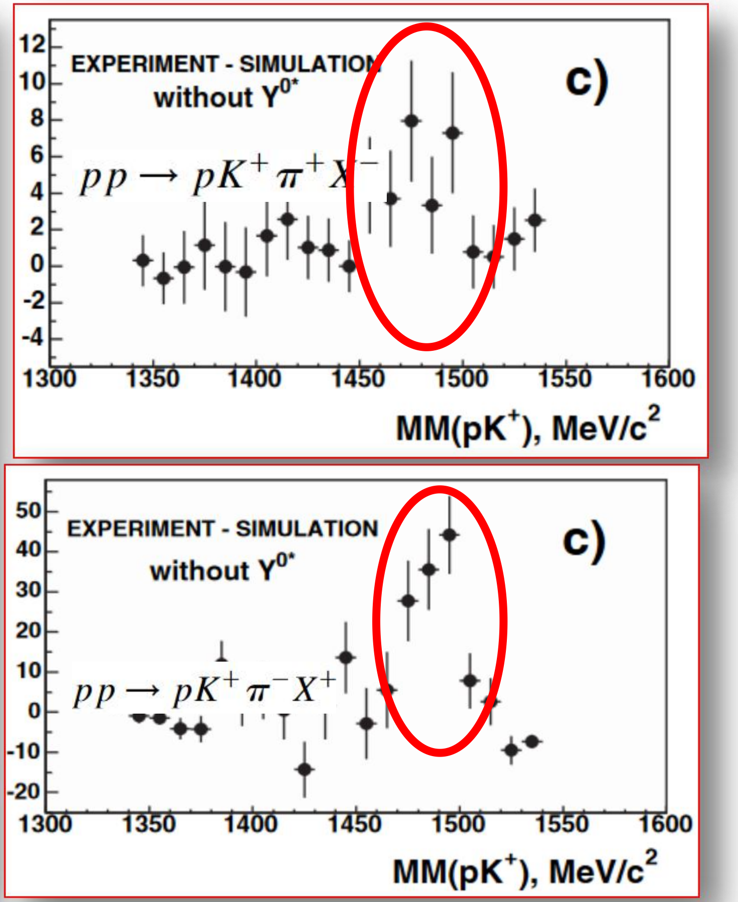
$e^+ p \to e^+ K^0 \mathrm{pX}$

ZEUS PLB591 (2004) 7–22



$pp \to pK^+ Y^{0*}$

COSY-Ju;ich PRL 96, 012002 (2006)

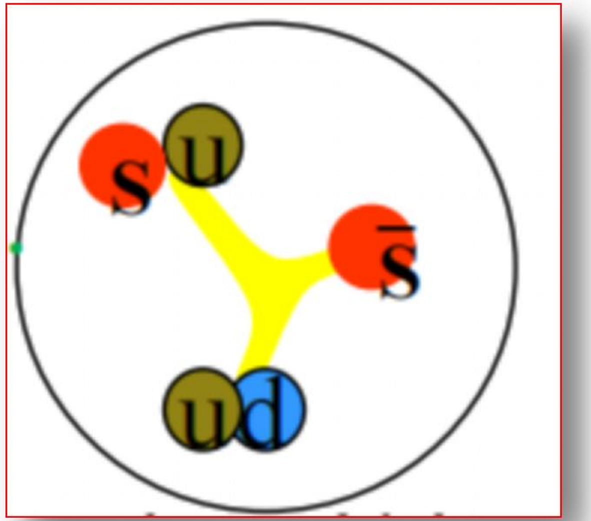


Low-lying baryons with $J^P=1/2^-$

- **Pentaquark**, S. L. Zhu, etc. High Energy Phys. Nucl. Phys. 29, 250(2005).

Table 2. Flavor wave functions and masses of the $\frac{1}{2}^-$ pentaquark octet and singlet.

	(Y, I)	I_3	flavor wave functions	masses (MeV)
p_8	$(1, \frac{1}{2})$	$\frac{1}{2}$	$[su][ud]_{\bar{s}}$	1460
n_8		$-\frac{1}{2}$	$[ds][ud]_{\bar{s}}$	1460
Σ_8^+	$(0, 1)$	1	$[su][ud]_{\bar{d}}$	1360
Σ_8^0		0	$\frac{1}{\sqrt{2}}([su][ud]_{\bar{u}} + [ds][ud]_{\bar{d}})$	1360
Σ_8^-		-1	$[ds][ud]_{\bar{u}}$	1360
Λ_8	$(0, 0)$	0	$\frac{[ud][su]_{\bar{u}} + [ds][ud]_{\bar{d}} - 2[su][ds]_{\bar{s}}}{\sqrt{6}}$	1533
Ξ_8^0	$(-1, \frac{1}{2})$	$\frac{1}{2}$	$[ds][su]_{\bar{d}}$	1520
Ξ_8^-		$-\frac{1}{2}$	$[ds][su]_{\bar{u}}$	1520
Λ_1	$(0, 0)$	0	$\frac{[ud][su]_{\bar{u}} + [ds][ud]_{\bar{d}} + [su][ds]_{\bar{s}}}{\sqrt{3}}$	1447



Low-lying baryons with $J^P=1/2^-$

- **Pentaquark,** C. Helminen and D. O. Riska, NPA699, 624(2002).

$[4]_X[1111]_{CFS}[211]_C$ $[f]_{FS}[f]_F[f]_S$	Energy (MeV)	J^P	Λ (emp.)	Σ (emp.)
$[31]_{FS}[211]_F[22]_S$	1509	$\frac{1}{2}^-$	$\Lambda(1405)$	$\Sigma(1560)(^{**})$
$[31]_{FS}[211]_F[31]_S$	1565	$\frac{1}{2}^-$		$\Sigma(1560)(^{**})$, $\Sigma(1620)(^{**})$
		$\frac{3}{2}^-$	$\Lambda(1520)$	$\Sigma(1580)(^{**})$

unknown. If indeed the $\Lambda(1405)$ is partly a 5-quark state, it would be natural to expect the $\Sigma(1560)$ to be the analog of the $\Lambda(1405)$, and thus that it has $J^P = \frac{1}{2}^-$. This is indeed what the structure of the $qqqq\bar{q}$ spectrum shown in Table 7 indicates. This would also explain why the usual quark-model description of the baryons as 3-quark states cannot predict sufficiently low energies for the $\Lambda(1405)$ and $\Sigma(1560)$ [4]. The $\Sigma(1480)(^*)$

PDG2001

$\Sigma(1560)$ Bumps $I(J^P) = 1(?^?)$ Status: $**$

OMITTED FROM SUMMARY TABLE

This entry lists peaks reported in mass spectra around 1560 MeV without implying that they are necessarily related.

VALUE (MeV)	*EVTS*
≈ 1560 OUR ESTIMATE	
1553 ± 7	121
1572 ± 4	40

VALUE (MeV)
79 ± 30
15 ± 6

Low-lying baryons with $J^P=1/2^-$

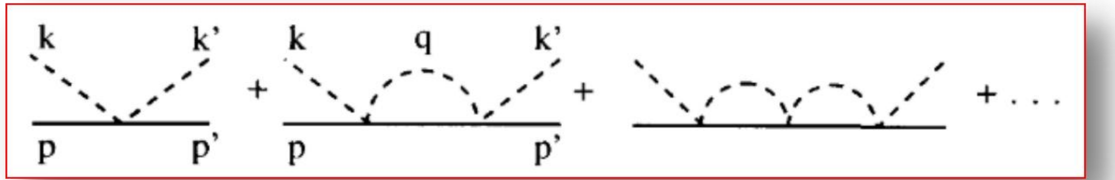
□Chiral Lagrangian

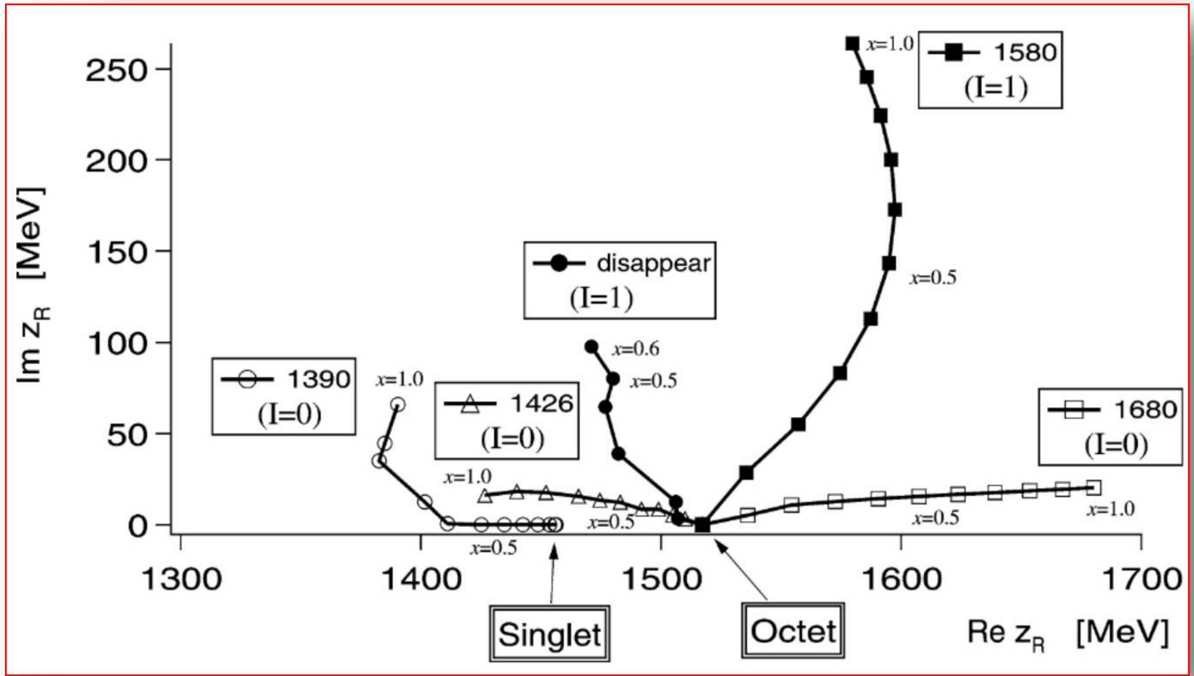
$$L_1^{(B)} = \langle \bar{B} i\gamma^\mu \nabla_\mu B\rangle - M_B\langle \bar{B}B\rangle + \tfrac{1}{2}D\langle \bar{B}\gamma^\mu\gamma_5\{u_\mu, B\}\rangle + \tfrac{1}{2}F\langle \bar{B}\gamma^\mu\gamma_5[u_\mu, B]\rangle$$

$$V_{ij} = -C_{ij}\frac{1}{4f^2}(k^0 + k'^0)$$

$$T = [1 - VG]^{-1}V \qquad T_{ij} = \frac{g_i g_j}{z - z_R}.$$

$$G_l = i\int \frac{d^4q}{(2\pi)^4}\frac{M_l}{E_l(\boldsymbol{q})}\frac{1}{k^0+p^0-q^0-E_l(\boldsymbol{q})+i\epsilon}\frac{1}{q^2-m_l^2+i\epsilon}$$
$$= \int \frac{d^3q}{(2\pi)^3}\frac{1}{2\omega_l(q)}\frac{M_l}{E_l(\boldsymbol{q})}\frac{1}{p^0+k^0-\omega_l(\boldsymbol{q})-E_l(\boldsymbol{q})+i\epsilon},$$

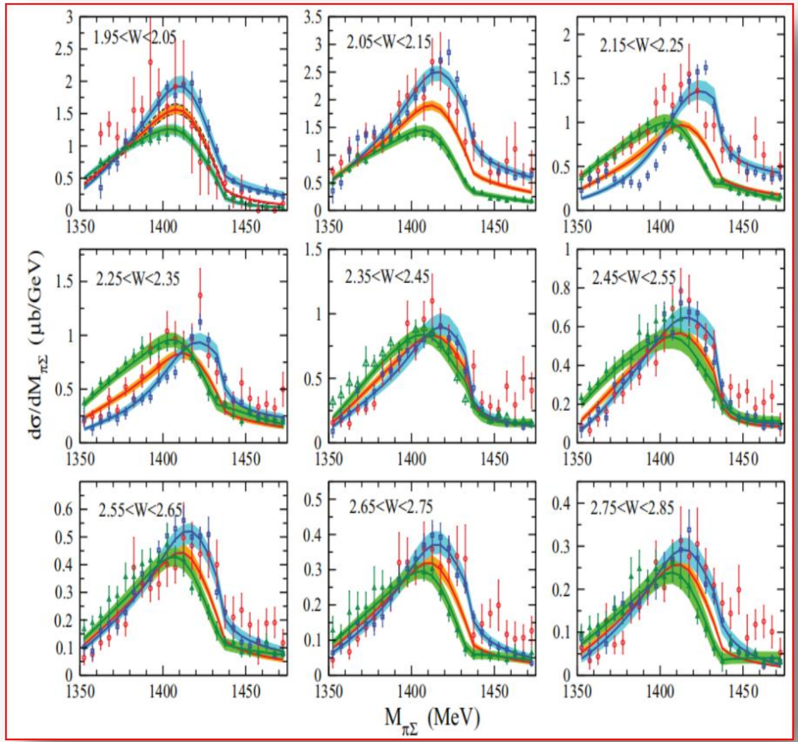




Jido Oller Oset Ramos Meissner NPA725 (2003) 181

γ-production

□ $\pi\Sigma$ photoproduction, Roca-Oset, PRC 88, 055206 (2013)



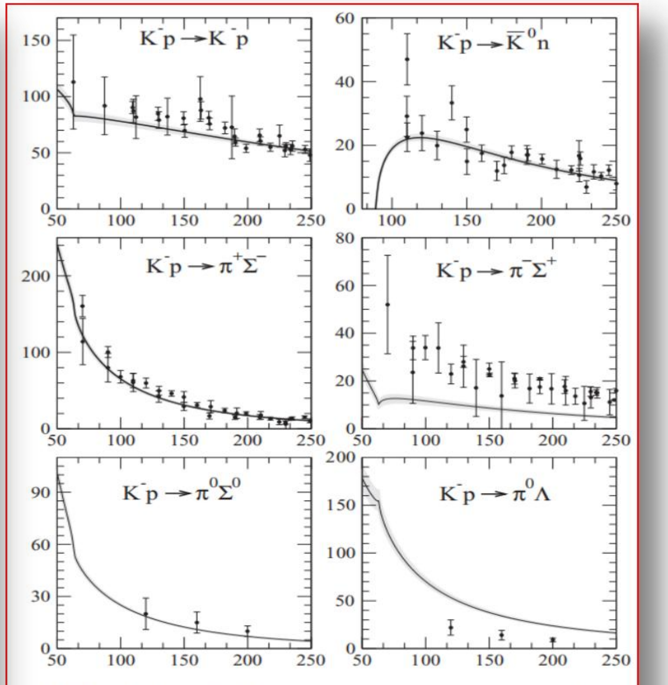
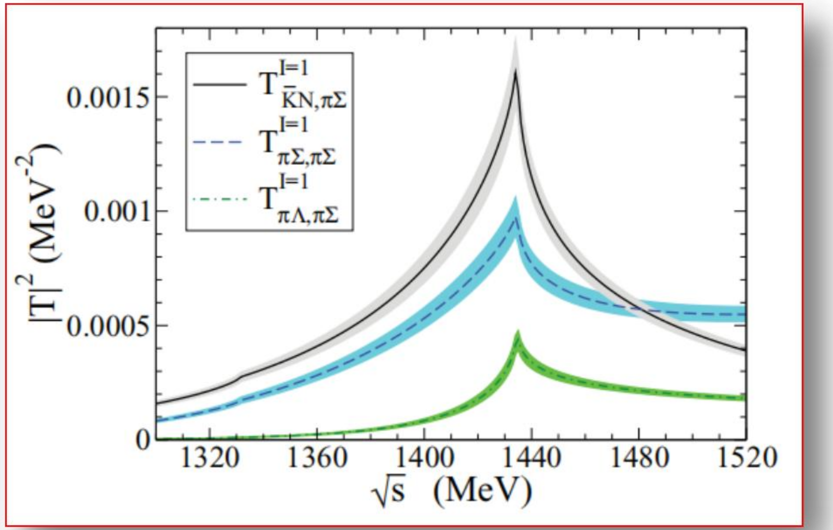


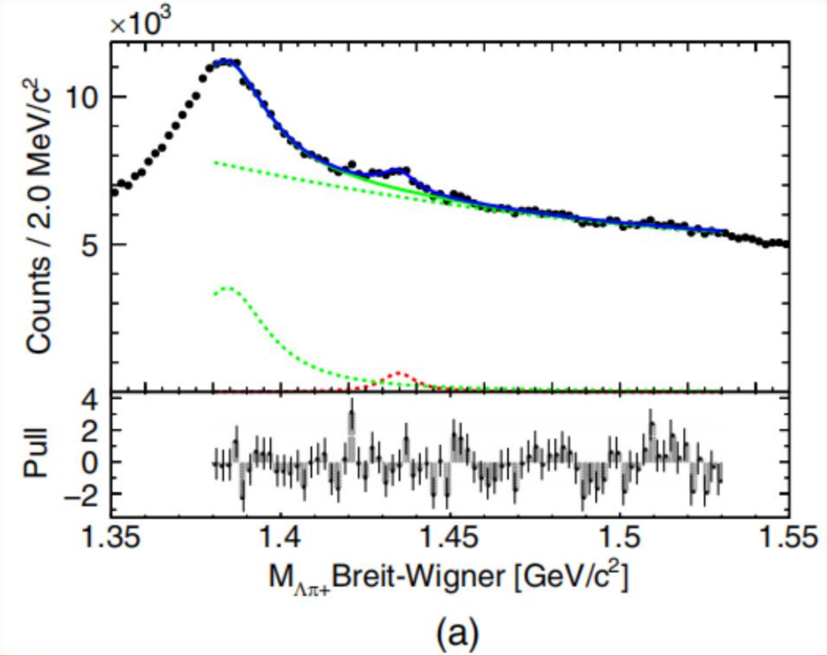
FIG. 6. Predicted K^-p cross sections (in millibarns). Experimental data are from Ref. [46].

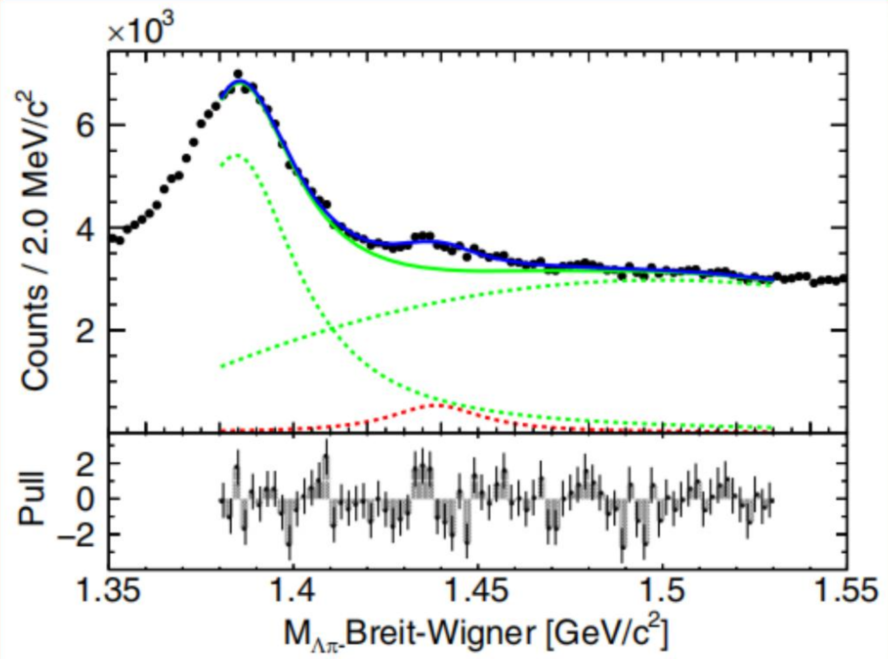


Oset-Ramos, NPA635 (1998)
PB,VB, Hosaka, PRD 85, 114020 (2012)
Oller-Meißner, Phys. Lett. B 500 (2001) 263

$\Sigma(1/2^-)$-like structure

- $\Lambda_c \to \Lambda\pi^+\pi^+\pi^-$, Belle, PRL130, 151903 (2023)



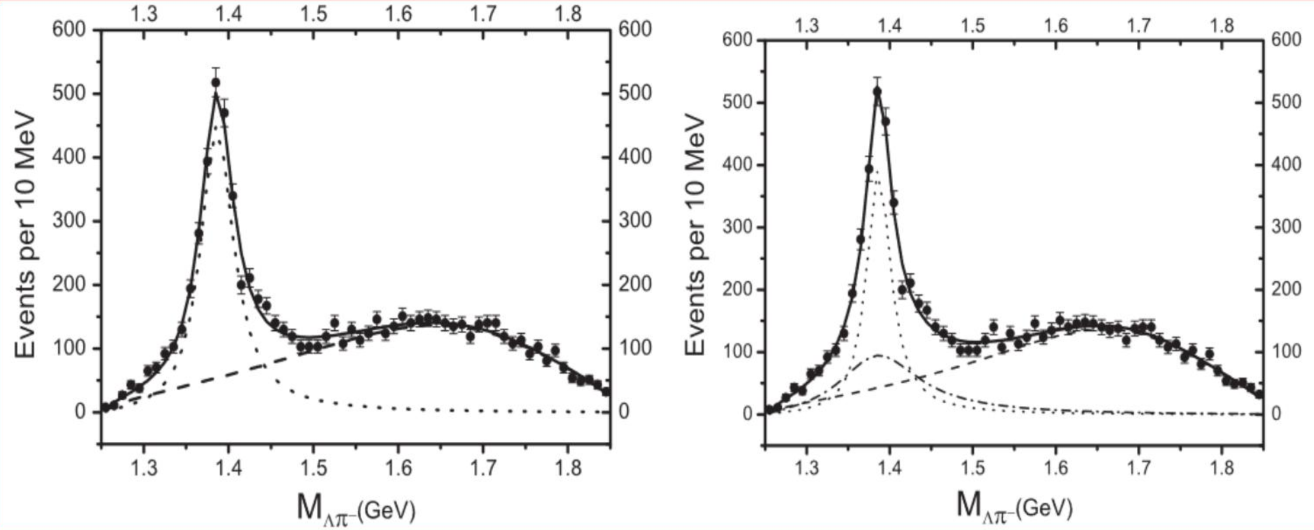


Mode	E_{BW} (MeV/c^2)	Γ (MeV/c^2)	χ^2/NDF
$\Lambda\pi^+$	1434.3 ± 0.6	11.5 ± 2.8	74.4/68
$\Lambda\pi^-$	1438.5 ± 0.9	33.0 ± 7.5	92.3/68

Y. Y. Li, J. Song, E. Oset, W. H. Liang and R. Molina, Eur. Phys. J. C 85 (2025) no.9, 1086
J. He, Phys. Rev. C 112 (2025) no.1, 015205

Hadron-hadron scattering

□ $K^- p \to \Lambda\pi^+\pi^-$, Wu-Dulat-Zou, PRD80(2009)017503



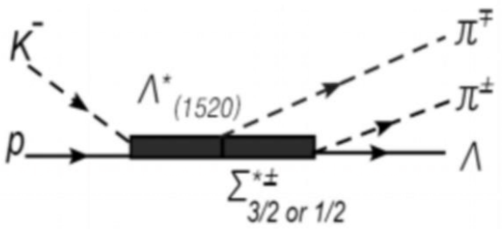
$$\frac{dN}{dm_{\Lambda\pi^-}} \propto p_1 \times p_2 \times \sum_{i=1}^{3} \frac{|a_i|}{(m^2_{\Lambda\pi^-} - m_i^2)^2 + m_i^2 \times \Gamma_i^2},$$

Here we reexamine some old data of the $K^- p \to \Lambda\pi^+\pi^-$ reaction and find that besides the well-established $\Sigma^*(1385)$ with $J^P = 3/2^+$, there is indeed some evidence for the possible existence of a new Σ^* resonance with $J^P = 1/2^-$ around the same mass but with broader decay width. There are also indications for such a possibility in the $J/\psi \to \bar{\Sigma}\Lambda\pi$ and $\gamma n \to K^+\Sigma^{*-}$ reactions. At present, the evidence is not strong. Therefore, high statistics studies

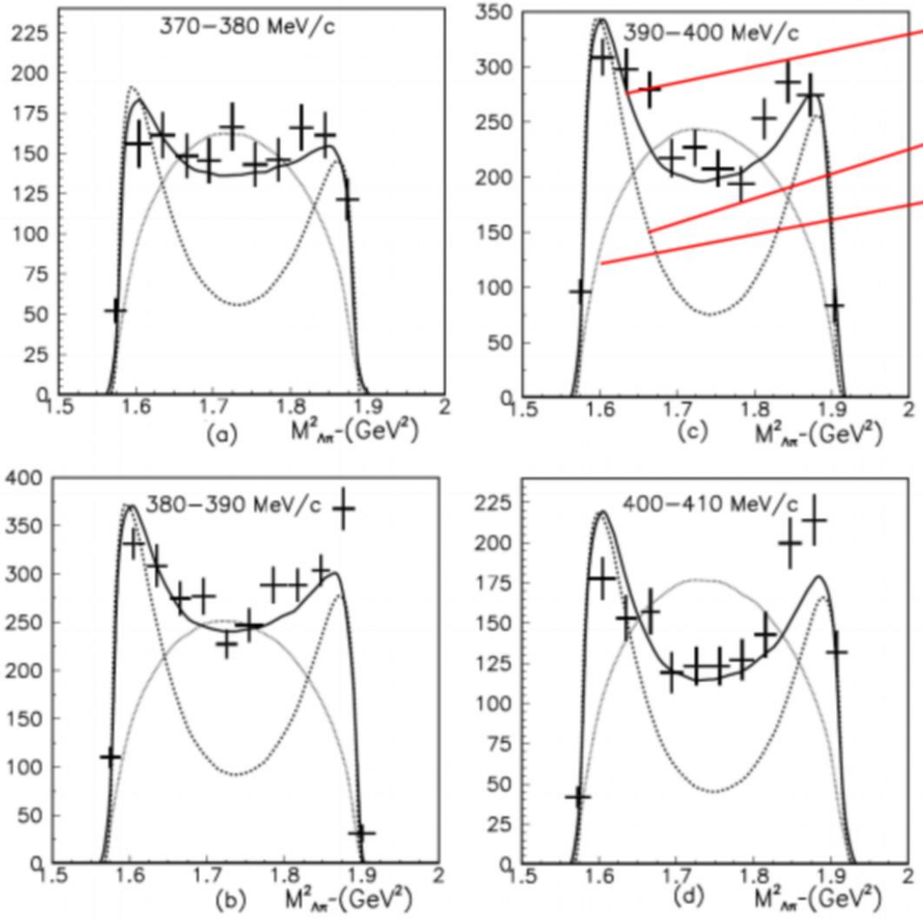
	$M_{\Sigma^*(3/2)}$	$\Gamma_{\Sigma^*(3/2)}$	$M_{\Sigma^*(1/2)}$	$\Gamma_{\Sigma^*(1/2)}$	χ^2/ndf (Fig. 1)	χ^2/ndf (Fig. 2)
Fit1	1385.3 ± 0.7	46.9 ± 2.5			68.5/54	10.1/9
Fit2	$1386.1^{+1.1}_{-0.9}$	$34.9^{+5.1}_{-4.9}$	$1381.3^{+4.9}_{-8.3}$	$118.6^{+55.2}_{-35.1}$	58.0/51	3.2/9

J.J.Wu's slide

$K^- p \to \Lambda\pi^+\pi^-$



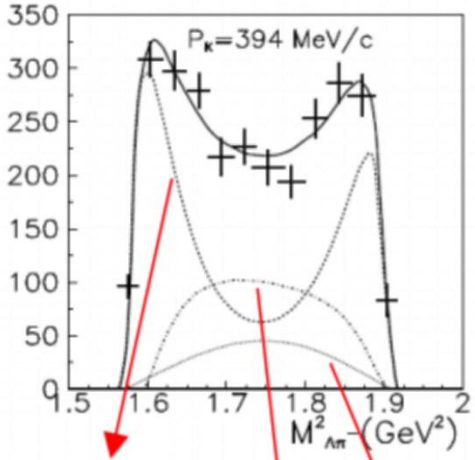
P_K=0.3-0.6 GeV J. J. Wu, S. Dulat and B. S. Zou PRC 81,045210



59% Σ*(3/2⁺)+ 41% Σ*(1/2⁻)

100% Σ*(3/2⁺)

Phase space

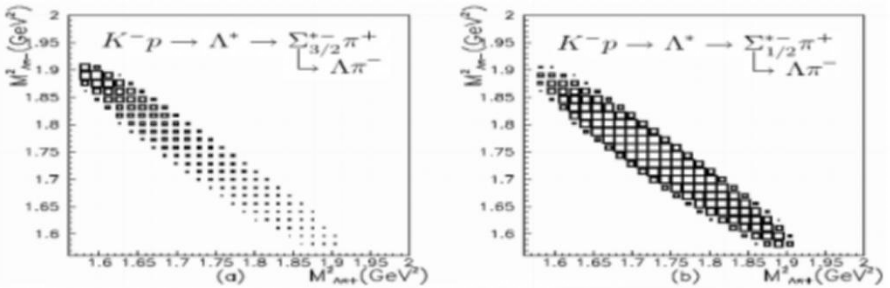


59% Σ*(3/2⁺)

Interference

12. 5% Σ*(1/2⁻)

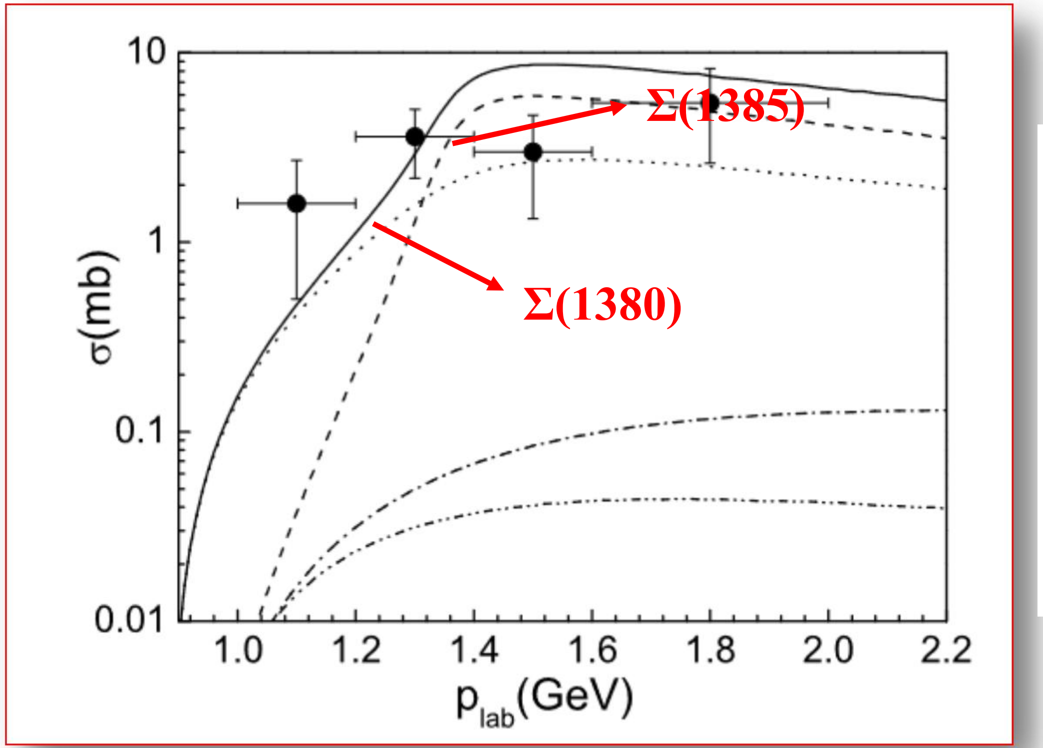
First reason: S-wave between the Σ*⁻(3/2⁺) and π⁺ ; but P-wave between the Σ*⁻(1/2⁻) and π⁺ .



Second reason: the width of Σ*⁻(3/2⁺) is 35.5MeV; but that of Σ*⁻(1/2⁻) is 118.6MeV from fit before.

Hadron-hadron scattering

- $\Lambda p \to \Lambda p \pi^0$, **JJXie, JJWu, and BSZou, PRC90(2014)055204**

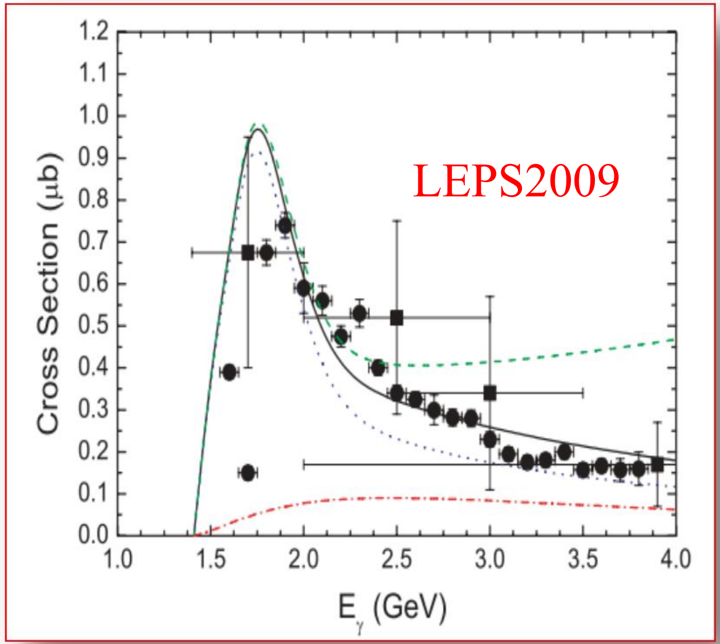


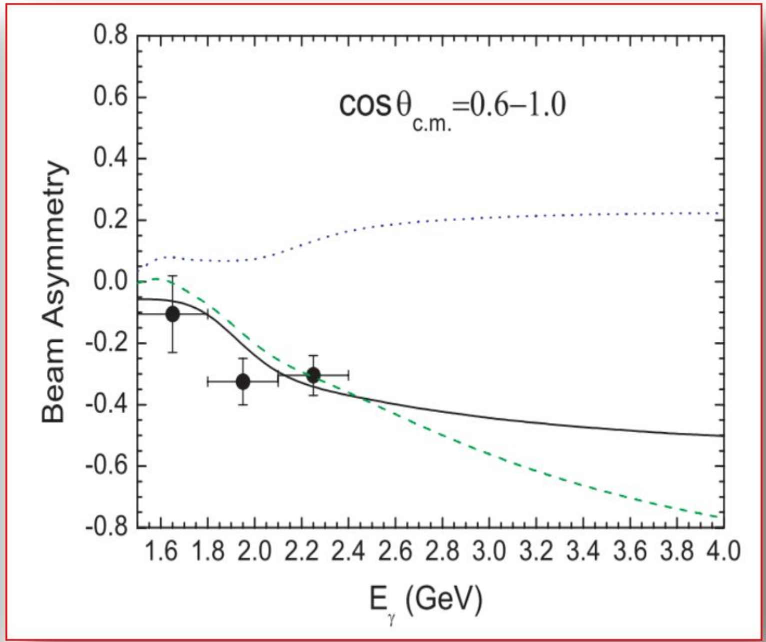
strong Λp FSI.

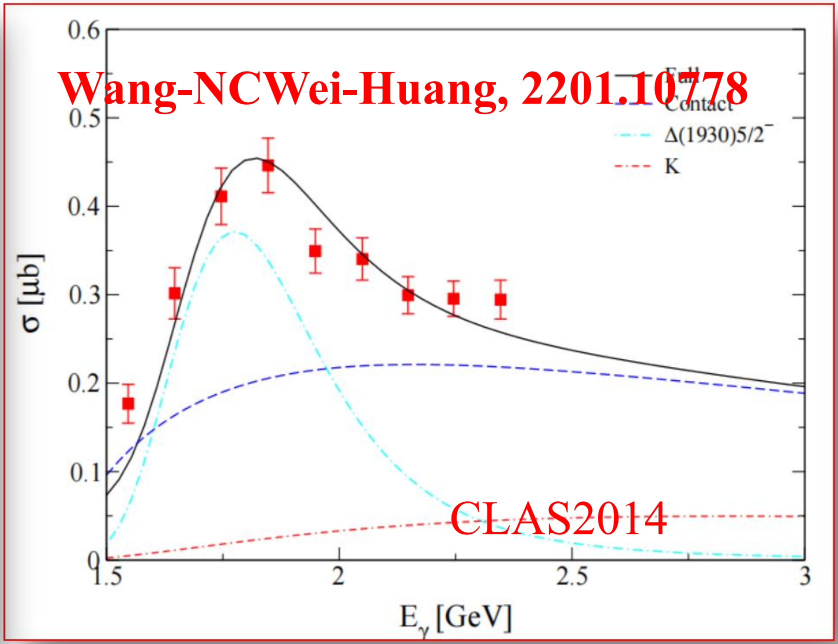
The $\Sigma^*(1385)$ resonance can not reproduce the near threshold enhancement for the $\Lambda p \to \Lambda p \pi^0$ reaction because it decays to $\pi\Lambda$ in relative P-wave and is suppressed at low energies. On the contrary, the newly $\Sigma^*(1380)$ state decays to $\pi\Lambda$ in relative S-wave, and can describe the near threshold enhancement fairly well, which indicate that the $\Lambda p \to \Lambda p \pi^0$ data support the existence of this $\Sigma^*(1380)$ state, and more accurate data for this reaction can be used to improve our knowledge on the

γ/ν-production

- $\gamma N \to K\Sigma(1385)$, Gao-Wu-Zou, PRC 81(2010) 055203







the case that the $\Sigma(\frac{1}{2}^-)$ may contribute to the observables of the $K\Sigma^*(1385)$ photoproduction in our experiments. Our results show that the $\Sigma(\frac{1}{2}^-)$ production can provide a large negative contribution to beam asymmetry, which helps to explain the large negative linear beam asymmetry observed by the LEPS experiment. With a portion of the $\Sigma(\frac{1}{2}^-)$, the same set of parameters can reproduce both the data for $\gamma n \to K^+\Sigma^{*-}$

and, in particular, to figure out which one of the $N(1895)1/2^-$, $\Delta(1900)1/2^-$, and $\Delta(1930)5/2^-$ resonances is really capable for a simultaneous description of the data for both $K^+\Sigma^0(1385)$ and $K^+\Sigma^-(1385)$ photoproduction reactions. The results show that the available data on differential and total cross sections and photo-beam asymmetries for $\gamma n \to K^+\Sigma^-(1385)$ can be reproduced only with the inclusion of the $\Delta(1930)5/2^-$ resonance rather than the other two. The generalized

Two poles of $\Sigma(1/2^-)$

PHYSICAL REVIEW LETTERS **130,** 071902 (2023)

Cross-Channel Constraints on Resonant Antikaon-Nucleon Scattering

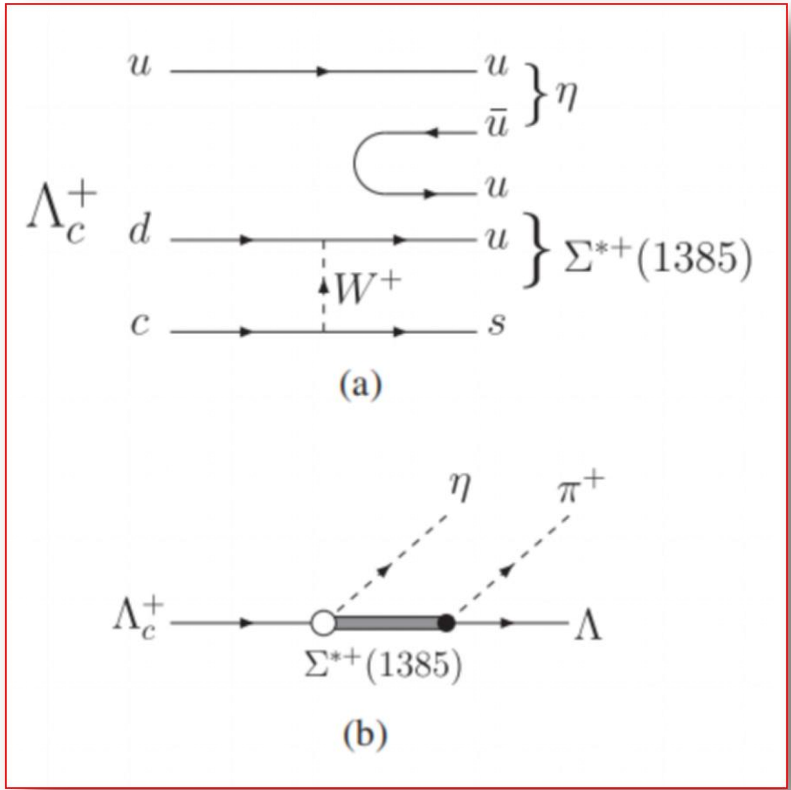
Jun-Xu Lu,[1,2] Li-Sheng Geng,[3,2,4,5,*] Michael Doering,[6,7] and Maxim Mai[8,6]
[1]*School of Space and Environment, Beijing 102206, China*
[2]*School of Physics, Beihang University, Beijing 102206, China*

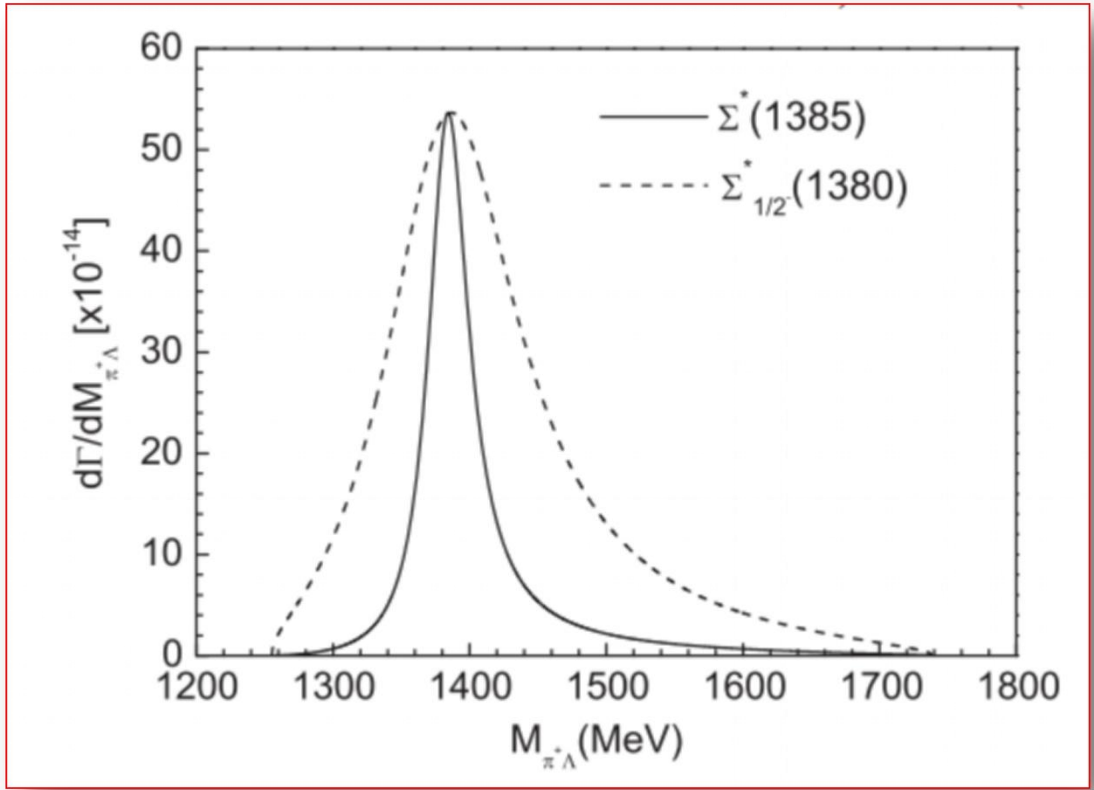
It is interesting to note that in our NNLO fit there exist two $I = 1$ states around the $\bar{K}N$ threshold located at $(1435, -39)$ MeV and $(1440, -135)$ MeV on the $(--++++)$ sheet, the order of which corresponds to $\pi\Lambda, \pi\Sigma, \bar{K}N, \eta\Lambda, \eta\Sigma, K\Xi$ respectively. Both states are well above the K^-p threshold and appear as cusps on the real axis. In the Fit "NNLO*" in which the constraints from baryon masses are omitted, the two $I = 1$ states are located at $(1364, -110)$ MeV and $(1432, -18)$ MeV also on the $(--++++)$ sheet. In this case, the narrower state still shows up as a cusp but the broader one becomes a broad enhancement on the $I = 1$ amplitude on the real axis. We note that the existence of a $\Sigma^*(\frac{1}{2}^-)$ state has been predicted in a number of UChPT

Are there two poles of $\Sigma(1/2^-)$?

Charmed baryon decays

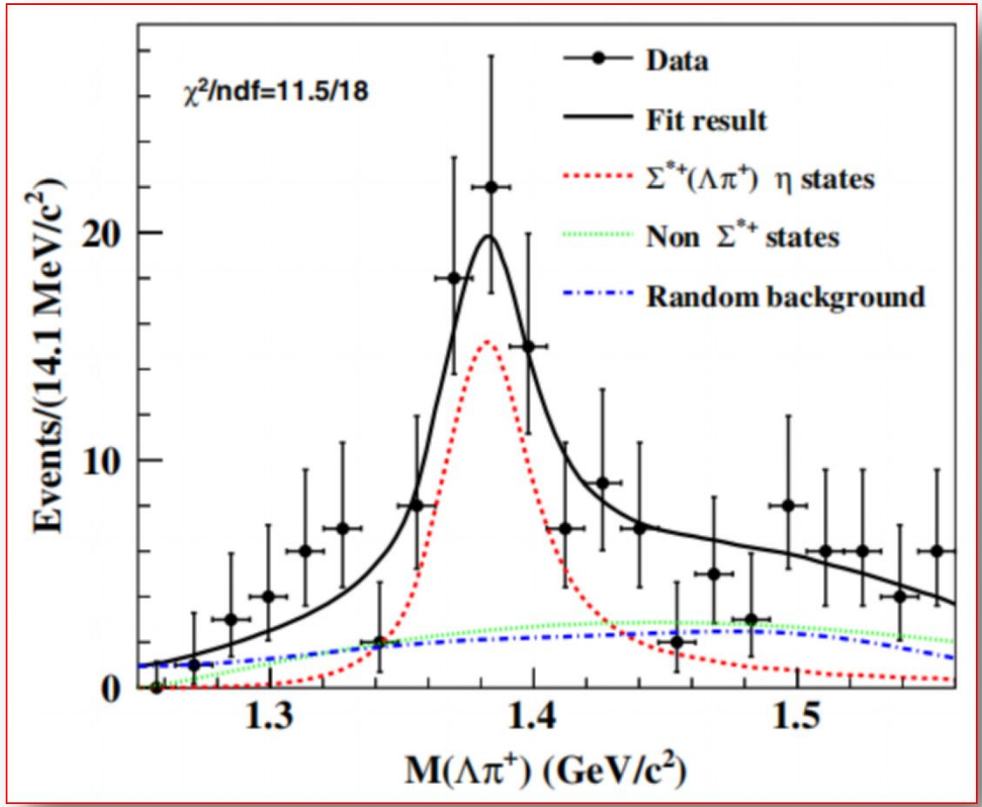
□ $\Lambda_c \to \Lambda\eta\pi$, J.J.Xie, L.S.Geng, EPJC76(2016) 496, PRD95(2017) 074024



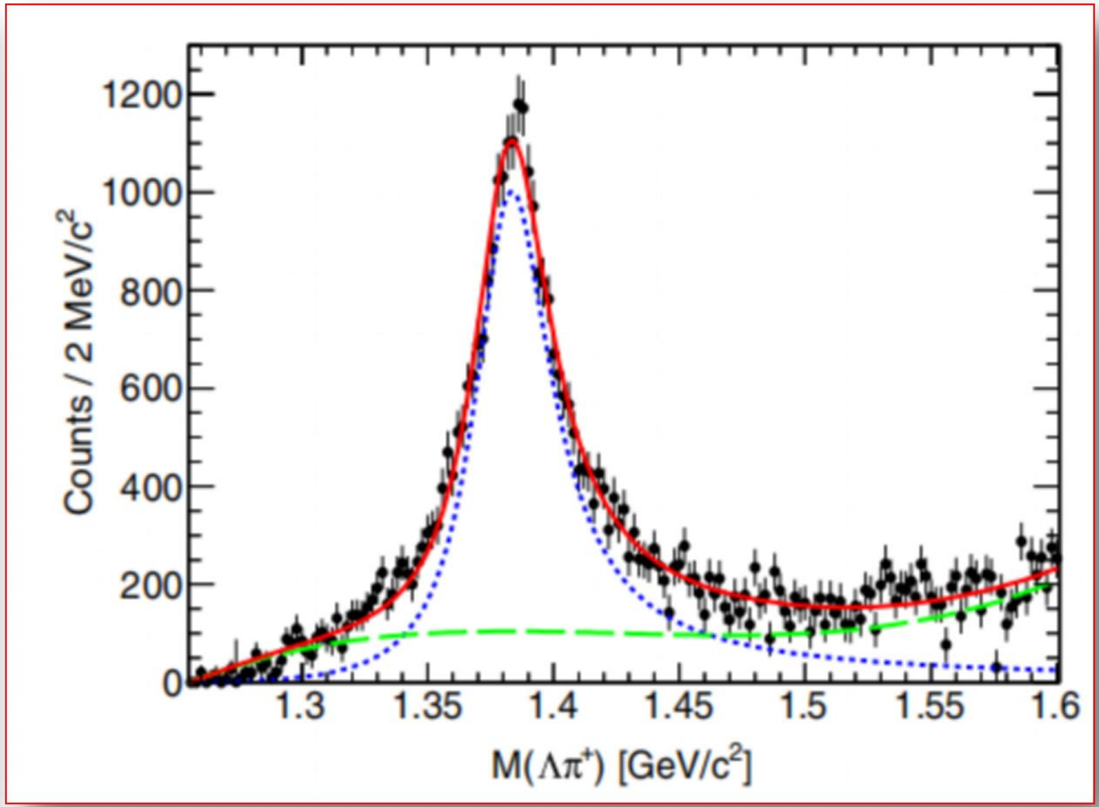


Belle and BESIII measurements

□ $\Lambda_c \to \Lambda\eta\pi$

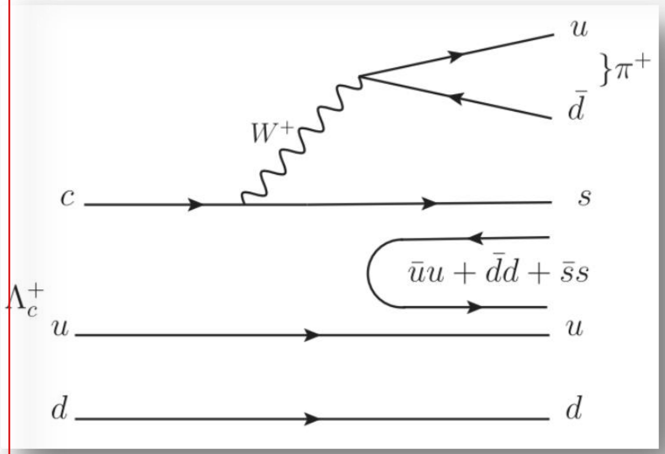


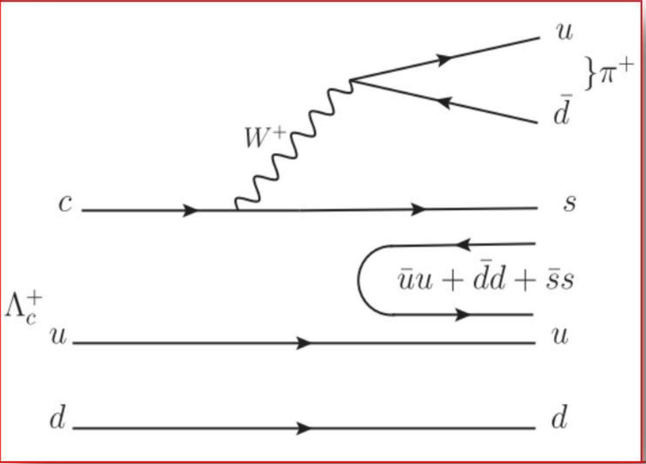
BESIII: PRD99, 032010 (2019)

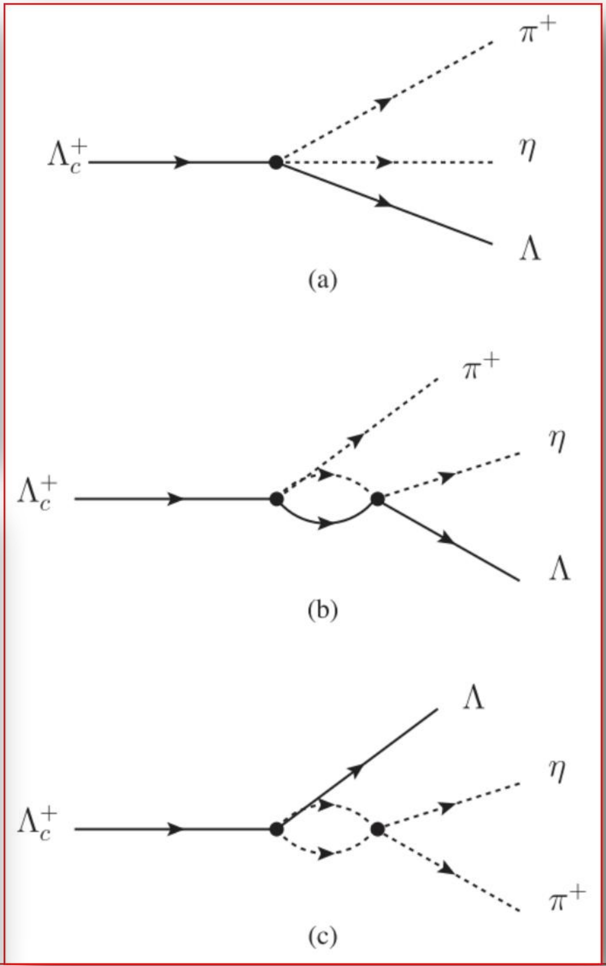


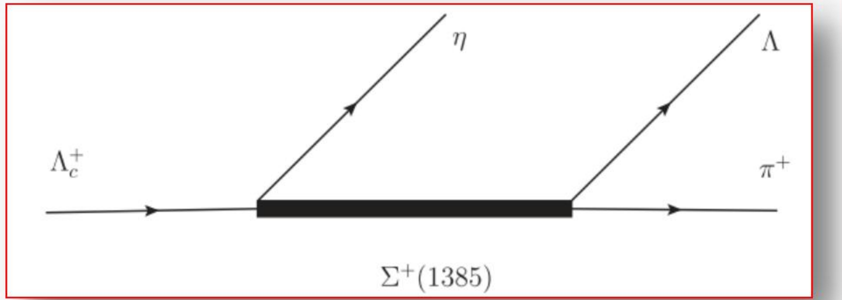
Belle: PRD103(2021)052005

Mechanism of $\Lambda_c \to \eta\Lambda\pi$









$$T^{\Sigma^*}(M_{\pi^+\Lambda}) = V_P'' \frac{|\vec{p}_\pi| \cdot |\vec{p}_\eta| \cdot \cos\theta}{M_{\pi^+\Lambda} - M_{\Sigma^*} + i\frac{\Gamma_{\Sigma^*}}{2}},$$

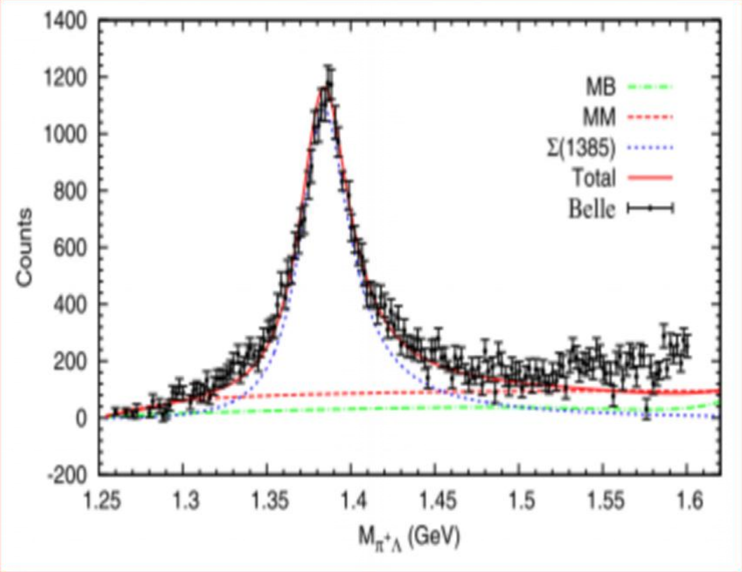
$$T^{\rm MB}(M_{\eta\Lambda}) = V_P\Big\{-\frac{\sqrt{2}}{3} + G_{K^-p}(M_{\eta\Lambda})t_{K^-p\to\eta\Lambda}(M_{\eta\Lambda}) + G_{\bar{K}^0n}(M_{\eta\Lambda})t_{\bar{K}^0n\to\eta\Lambda}(M_{\eta\Lambda}) - \frac{\sqrt{2}}{3}G_{\eta\Lambda}(M_{\eta\Lambda})t_{\eta\Lambda\to\eta\Lambda}(M_{\eta\Lambda})\Big\},$$

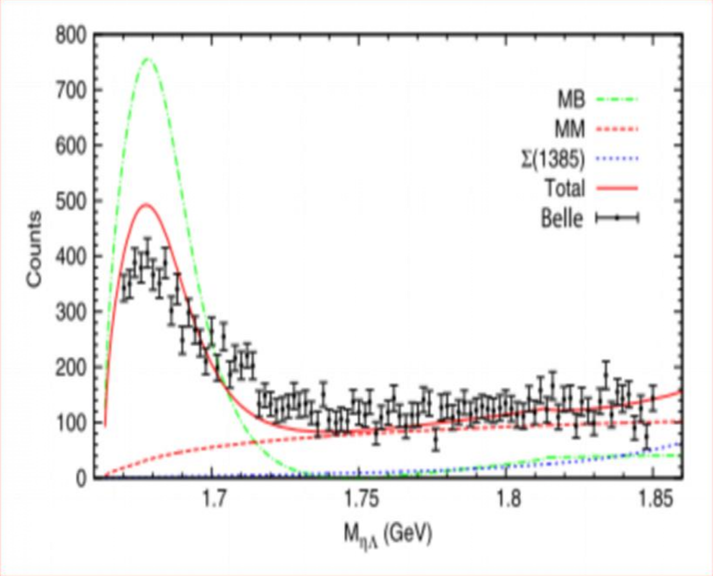
$$T^{\rm MM}(M_{\pi^+\eta}) = V_P'\frac{2\sqrt{2}}{3}\Big\{1 + G_{\pi^+\eta}(M_{\pi^+\eta})t_{\pi^+\eta\to\pi^+\eta}(M_{\pi^+\eta}) + \frac{\sqrt{3}}{2}G_{K^+\bar{K}^0}(M_{\pi^+\eta})t_{K^+\bar{K}^0\to\pi^+\eta}(M_{\pi^+\eta})\Big\}, \quad ($$

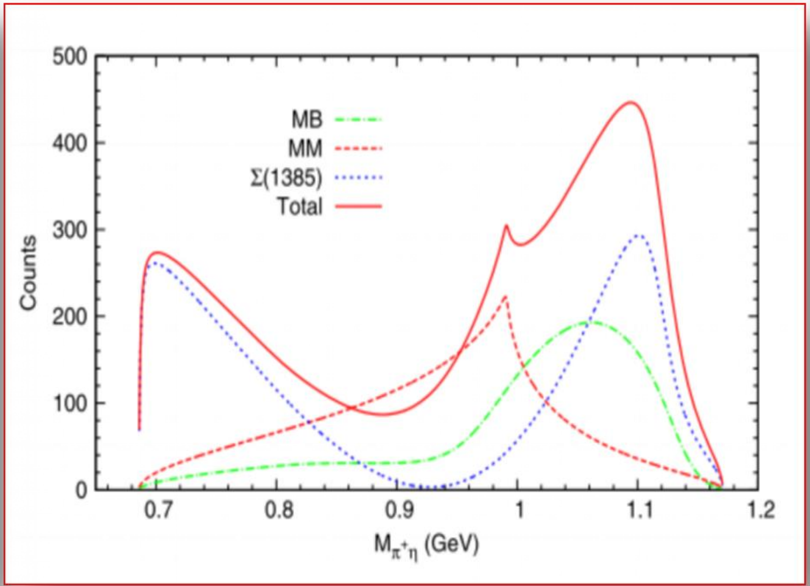
GYW-EW-Xie-Geng-Wei, PRD 106, 056001 (2022)

Analysis the Belle data

□ $\Lambda_c \to \Lambda\eta\pi$, GYW-EW-Xie-Geng-Wei, PRD 106, 056001 (2022)

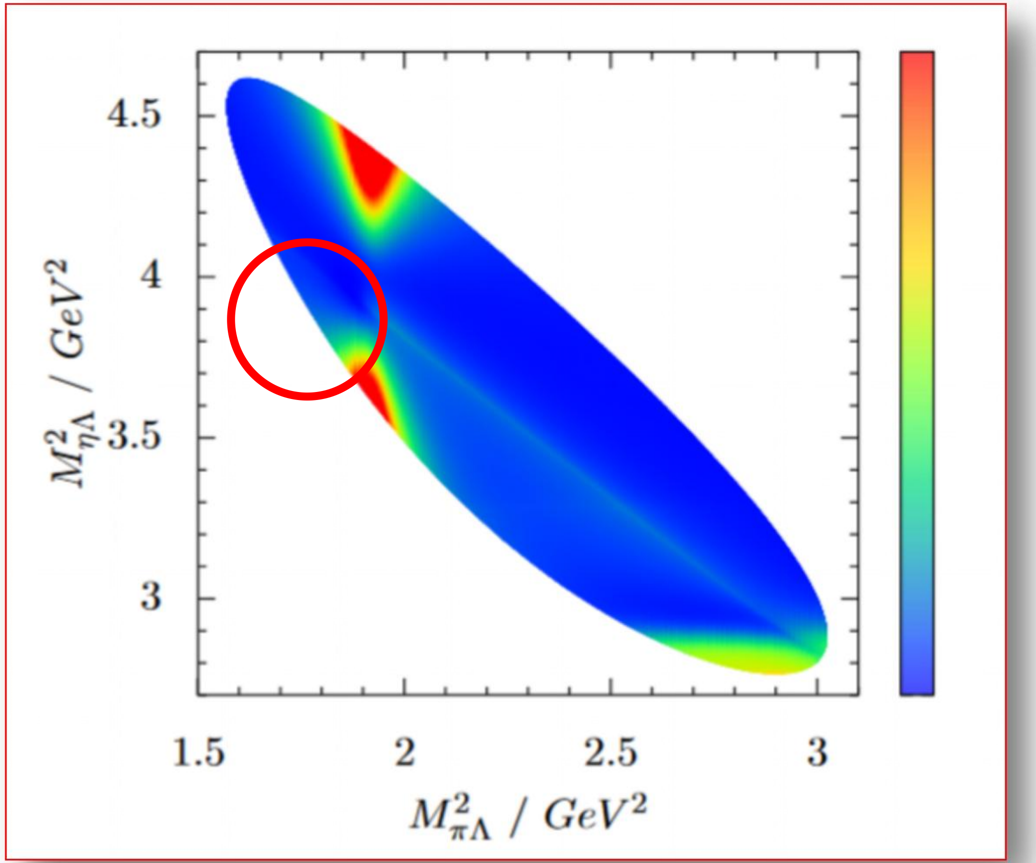


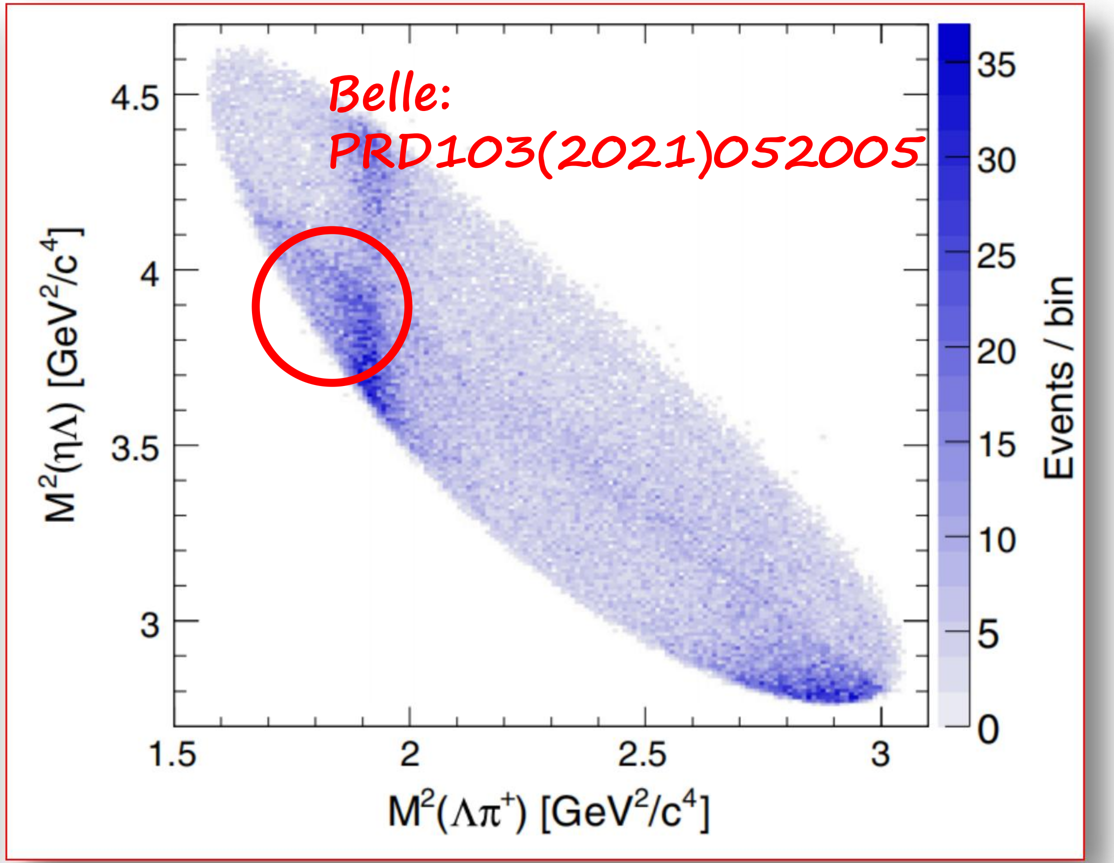




By regarding the $\Lambda(1670)$ as the molecule, we could well reproduce the Belle data of the mass distributions.

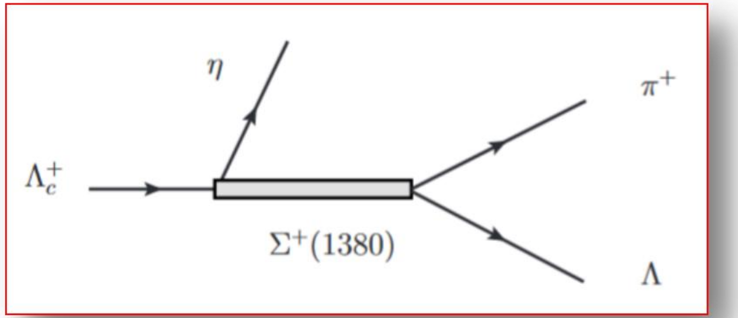
Dalitz plot of $\Lambda_c \to \eta\Lambda\pi$

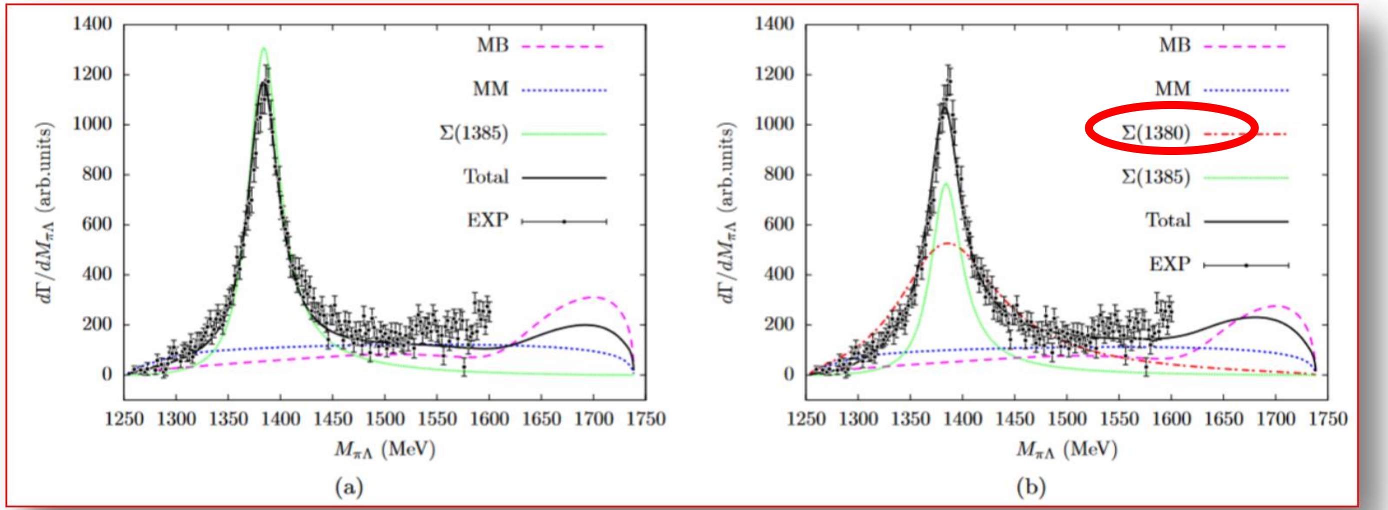


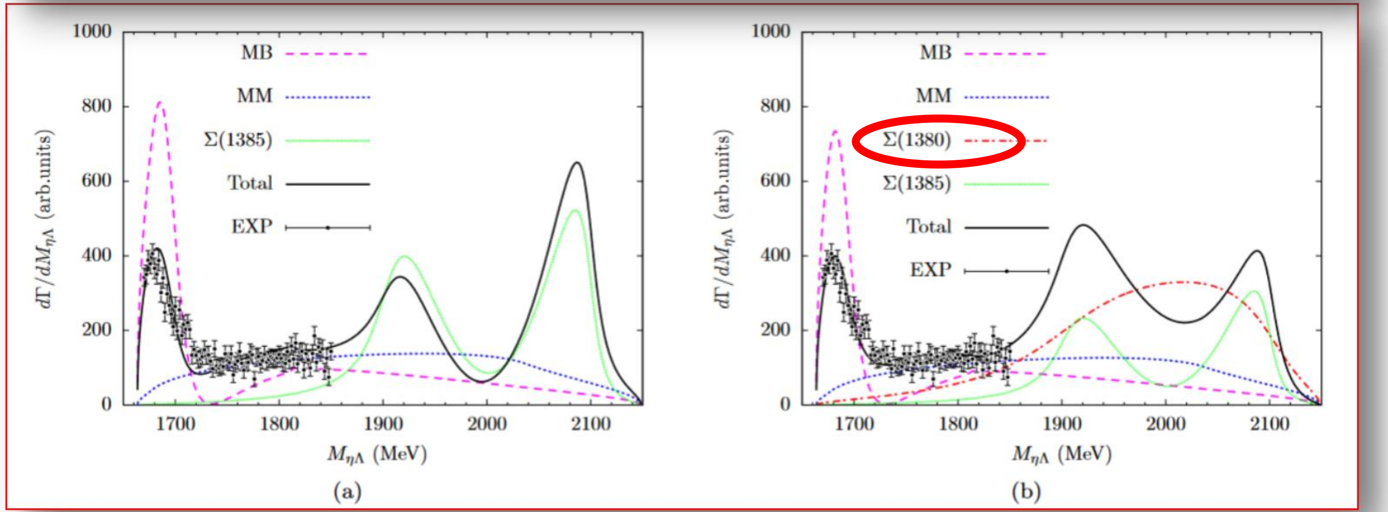


$\Sigma(1/2^-)$ in $\Lambda_c \to \eta\Lambda\pi$

□Intermediate of $\Sigma(1/2^-)$



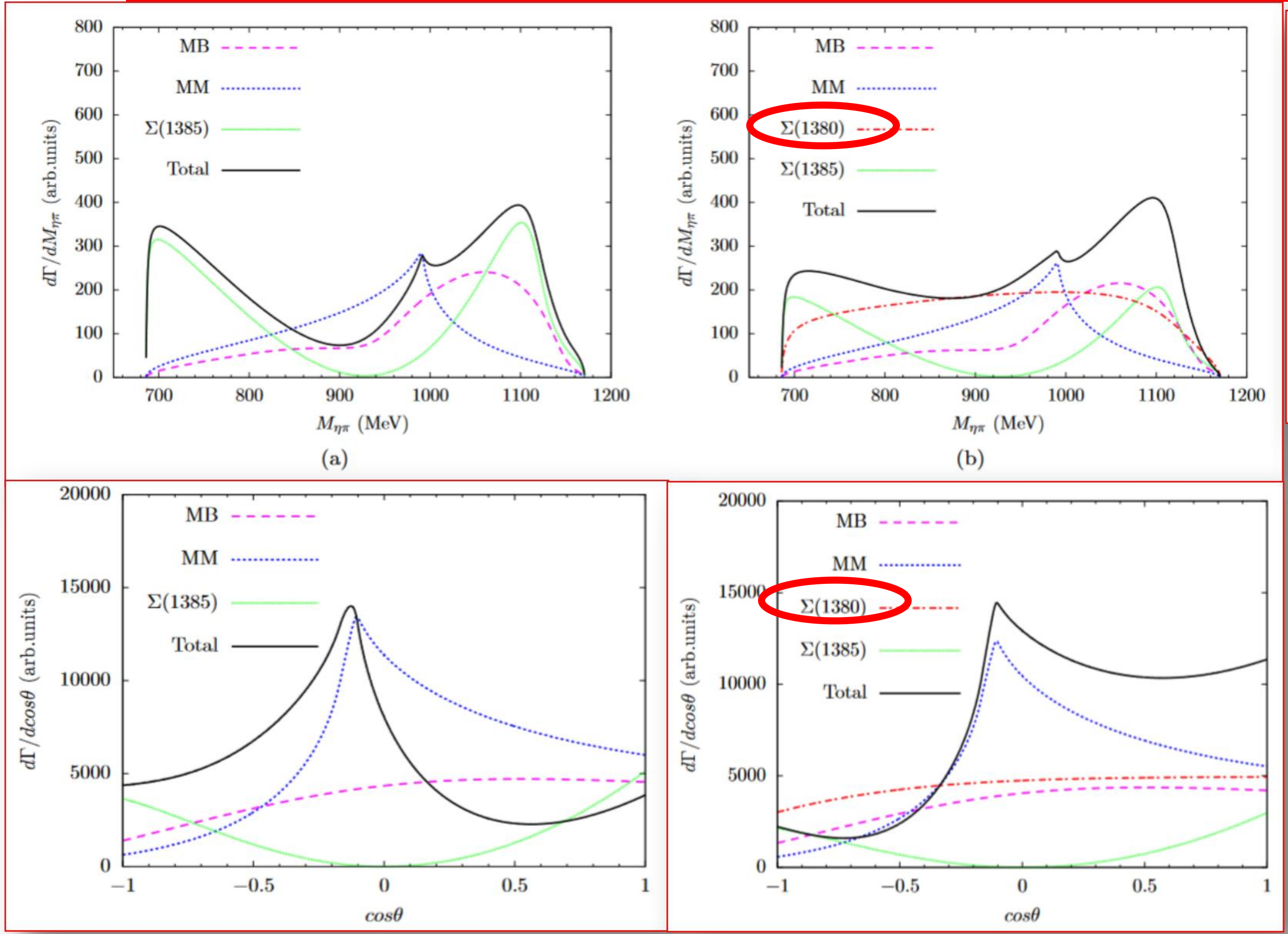


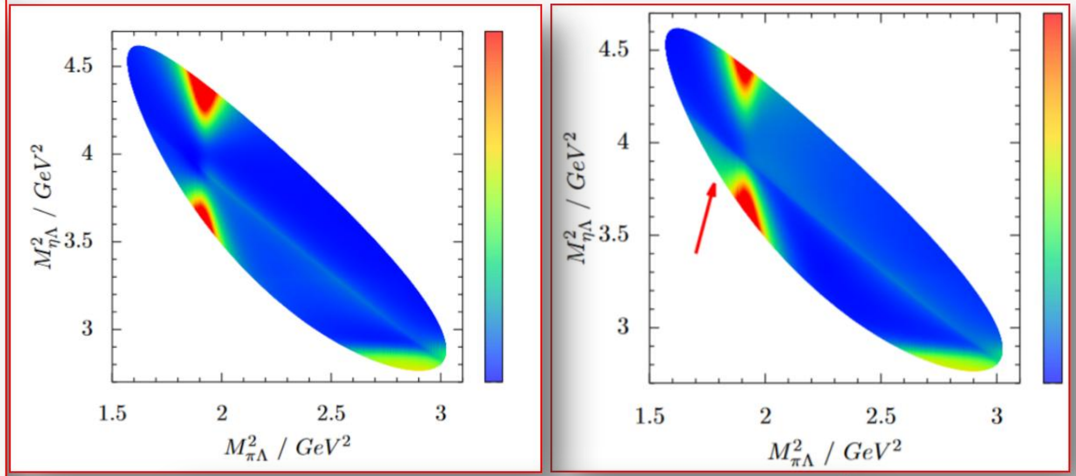


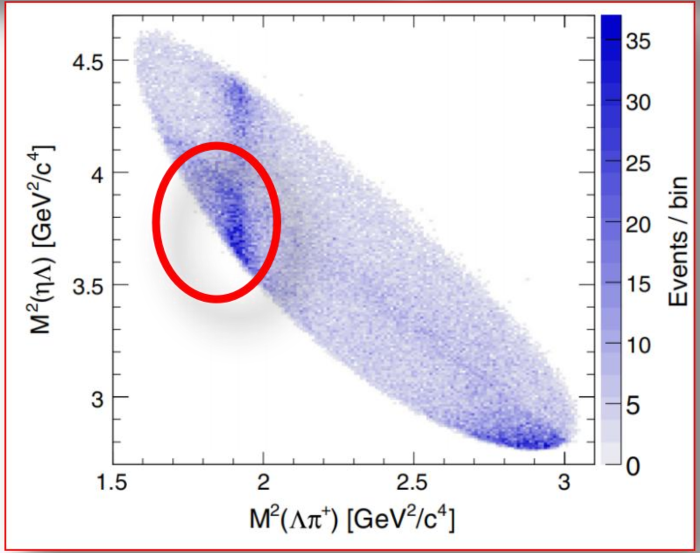
$$\mathcal{T}^{\Sigma(1/2^-)} = \frac{V^{\Sigma(1/2^-)} M_{\Sigma(1/2^-)} \Gamma_{\Sigma(1/2^-)}}{M^2_{\pi^+\Lambda} - M^2_{\Sigma(1/2^-)} + i M_{\Sigma(1/2^-)} \Gamma_{\Sigma(1/2^-)}},$$

Lyu, Zhang, GYWang, JJWu, JJXie, LSGeng, Phys.Rev.D 110 (2024) 5, 054020

The results with/without Σ(1380)



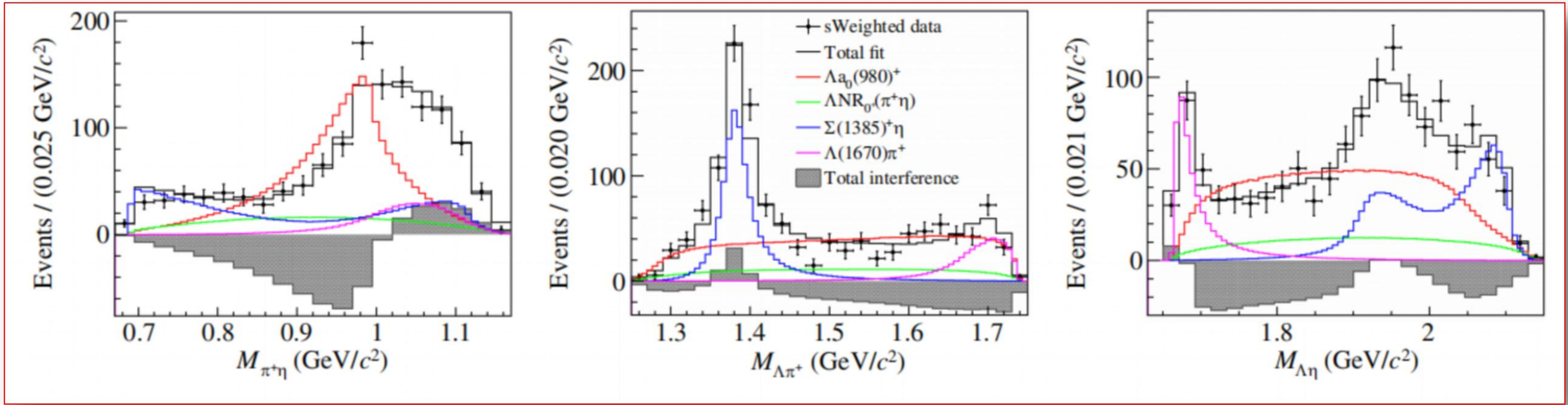




$M_{\pi\Lambda} \geq 1450$ MeV and $M_{\eta\Lambda} \geq 1760$ MeV.

Lyu, Zhang, GYWang, JJWu, JJXie, LSGeng, Phys.Rev.D 110 (2024) 5, 054020

BESIII results

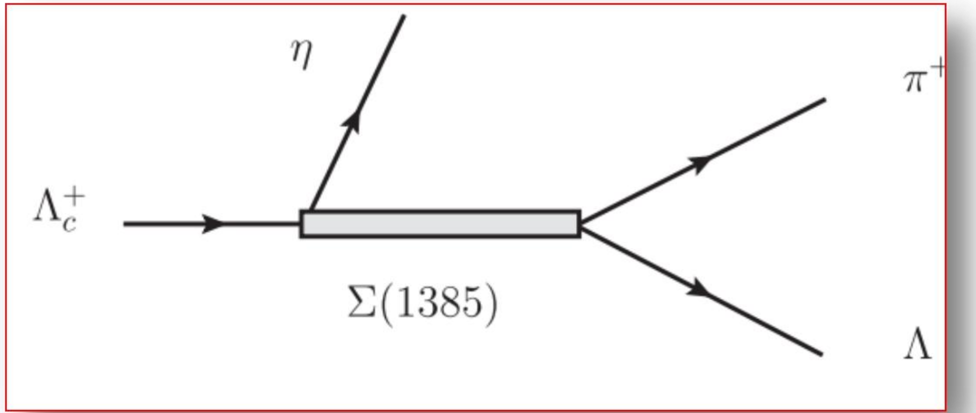


Process	Model A	Model B
$\Lambda a_0(980)^+$	$52.9 \pm 4.5(13.4\sigma)$	$50.6 \pm 8.0(11.1\sigma)$
$\Sigma(1385)^+\eta$	$36.6 \pm 2.6(15.8\sigma)$	$31.3 \pm 3.0(14.6\sigma)$
$\Lambda(1670)\pi^+$	$10.7 \pm 1.4(15.0\sigma)$	$9.0 \pm 1.6(11.9\sigma)$
$\Sigma(1380)^+\eta$	$15.5 \pm 4.4(6.1\sigma)$	$17.7 \pm 5.7(3.3\sigma)$
ΛNR_{0^+}	$\cdots$	$11.3 \pm 4.4(4.2\sigma)$

BESIII: PRL134, 021901 (2025)

Σ(1385)

Duan, Lyu, CWXiao, EW, JJXie, DYChen, Oset, PRD 111, 016004 (2025)



$$\left\langle \frac{3}{2}M \middle\| S^{\dagger}_{\nu} \middle\| \frac{1}{2}m \right\rangle = C\left(\frac{1}{2}, 1, \frac{3}{2}; m, \nu, M\right) \left\langle \frac{3}{2} \middle| S^{\dagger} \middle| \frac{1}{2} \right\rangle,$$

$$\begin{aligned} t_{\Sigma(1385)} &= \alpha \langle m' | S_i \vec{P}^*_{\pi^+ i} | M \rangle \langle M | S^{\dagger}_j \vec{P}^*_{\eta j} | m \rangle D \\ &= \alpha D \left\langle m' \middle| \frac{2}{3}\delta_{ij} - \frac{i}{3}\epsilon_{ijs}\sigma_s \middle| m \right\rangle \vec{P}^*_{\pi^+ i} \vec{P}^*_{\eta j} \\ &= \alpha D \left\langle m' \middle| \frac{2}{3} \vec{P}^*_{\pi^+} \cdot \vec{P}^*_{\eta} - \frac{i}{3}\epsilon_{ijs}\sigma_s \vec{P}^*_{\pi^+ i} \vec{P}^*_{\eta j} \middle| m \right\rangle, \end{aligned}$$

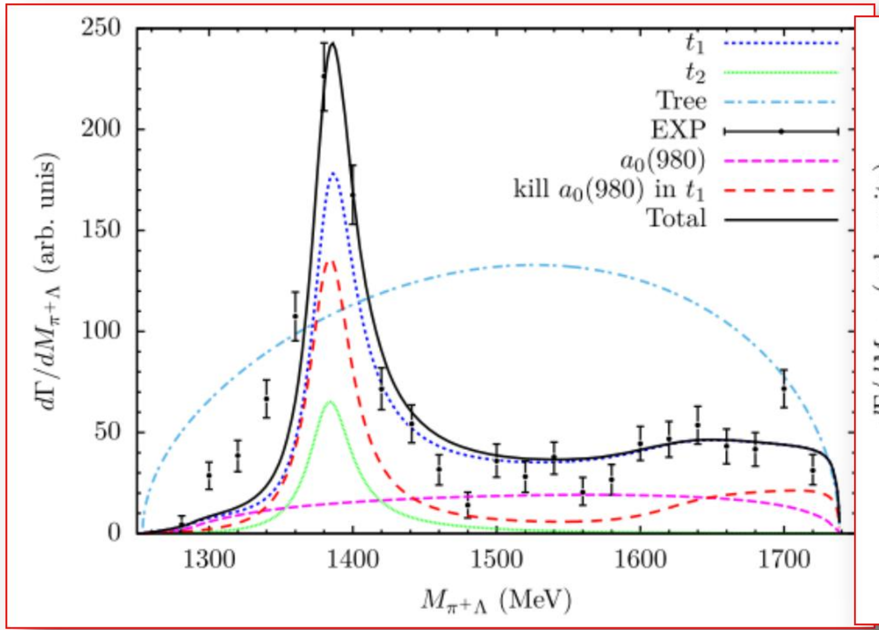
$$\begin{aligned} t_1 = A\Big\{ & h_{\pi^+\eta\Lambda} + h_{\pi^+\eta\Lambda} G_{\eta\Lambda}(M_{\rm inv}(\eta\Lambda)) t_{\eta\Lambda,\eta\Lambda}(M_{\rm inv}(\eta\Lambda)) \\ & + h_{\pi^+\eta\Lambda} G_{\pi^+\eta}(M_{\rm inv}(\pi^+\eta)) t_{\pi^+\eta,\pi^+\eta}(M_{\rm inv}(\pi^+\eta)) \\ & + h_{\pi^+\bar{K}N} G_{K^- p}(M_{\rm inv}(\eta\Lambda)) t_{K^- p,\eta\Lambda}(M_{\rm inv}(\eta\Lambda)) \\ & + h_{\pi^+\bar{K}N} G_{\bar{K}^0 n}(M_{\rm inv}(\eta\Lambda)) t_{\bar{K}^0 n,\eta\Lambda}(M_{\rm inv}(\eta\Lambda)) \\ & + \frac{\beta}{M_\Lambda}\frac{2}{3}\vec{P}^*_{\pi} \cdot \vec{P}^*_{\eta} D \Big\}, \end{aligned}$$

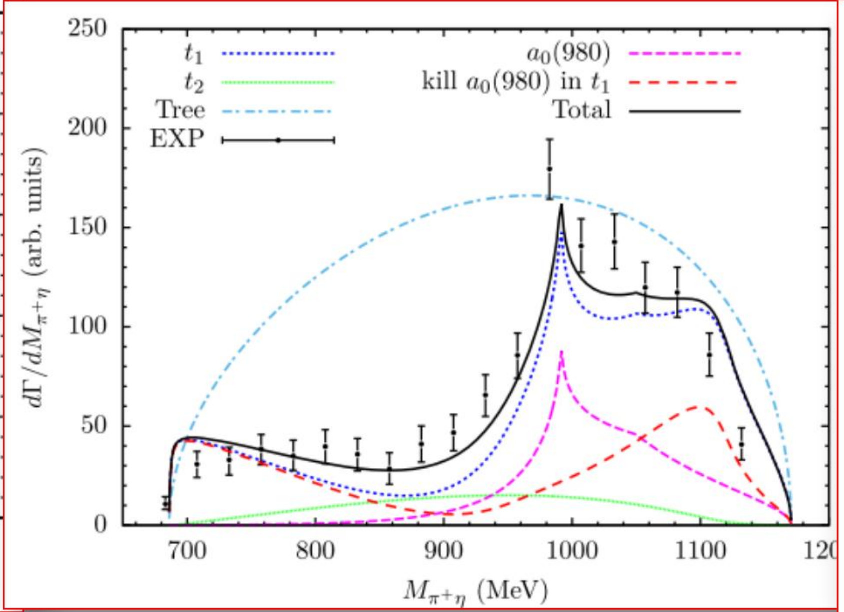
$$t_2 = -\frac{i}{3}\frac{A\beta}{M_\Lambda}\epsilon_{ijs}\sigma_s \vec{P}^*_{\pi i}\vec{P}^*_{\eta j} D,$$

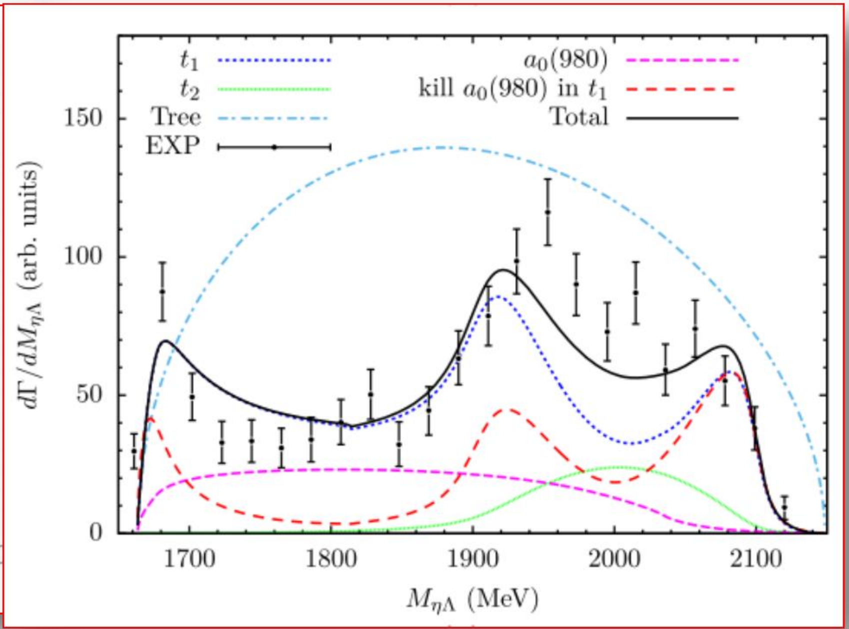
$$\overline{\sum}\sum |t|^2 = |t_1|^2 + \frac{1}{9}\left(\frac{A\beta}{M_\Lambda}\right)^2 |D|^2 \cdot \{\vec{P}^{*2}_{\pi} \cdot \vec{P}^{*2}_{\eta} - (\vec{P}^*_{\pi} \cdot \vec{P}^*_{\eta})^2\}.$$

Results

Duan, Lyu, CWXiao, EW, JJXie, DYChen, Oset, PRD 111, 016004 (2025)



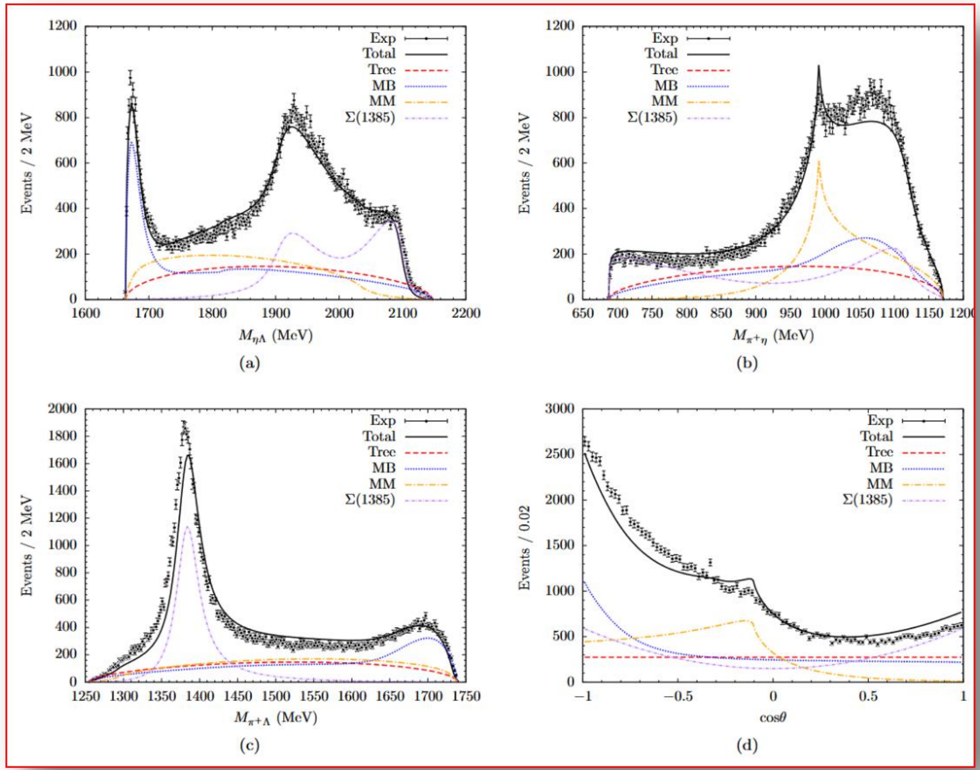




The $a_0(980)\Lambda$ decay mode appears automatically in our approach due to the $\eta\pi^+$ rescattering. It is clearly visible in the results and in the $\eta\pi^+$ mass distributions, but it has an integrated strength about one half of that obtained from the BESIII analysis, solving a puzzle of an apparent contradiction with the visual effects in the Dalitz plot.

BESIII MC data

Lyu, Liu, JJWu, DMLi, EW, 2606.04690



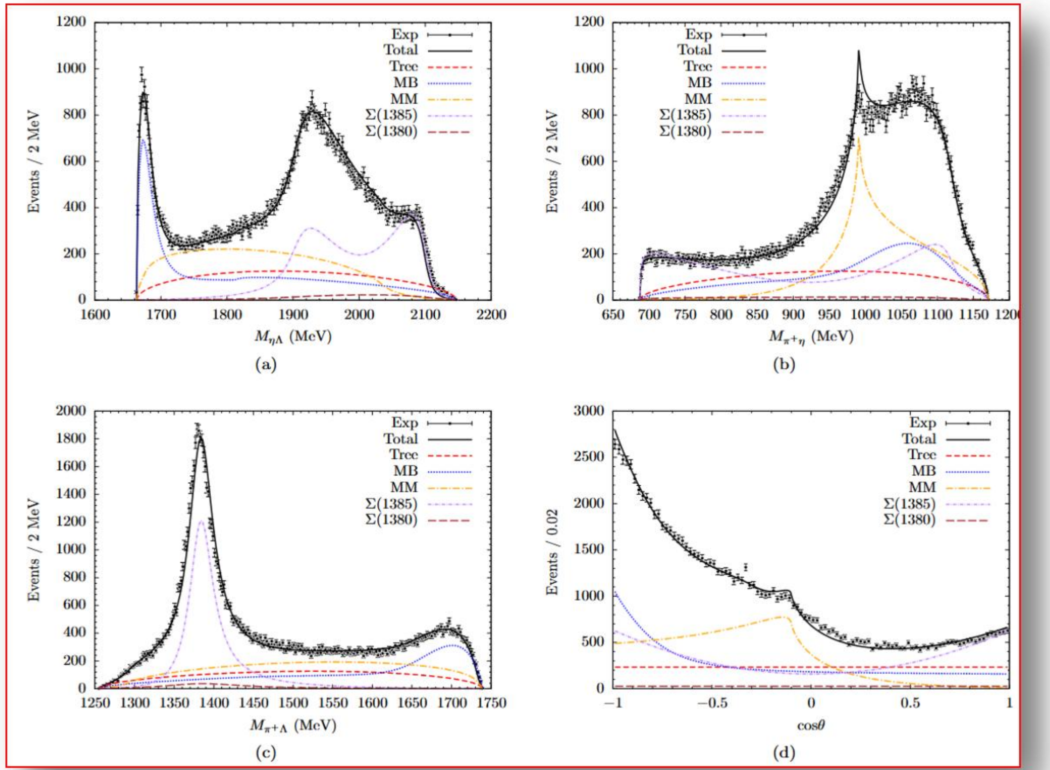
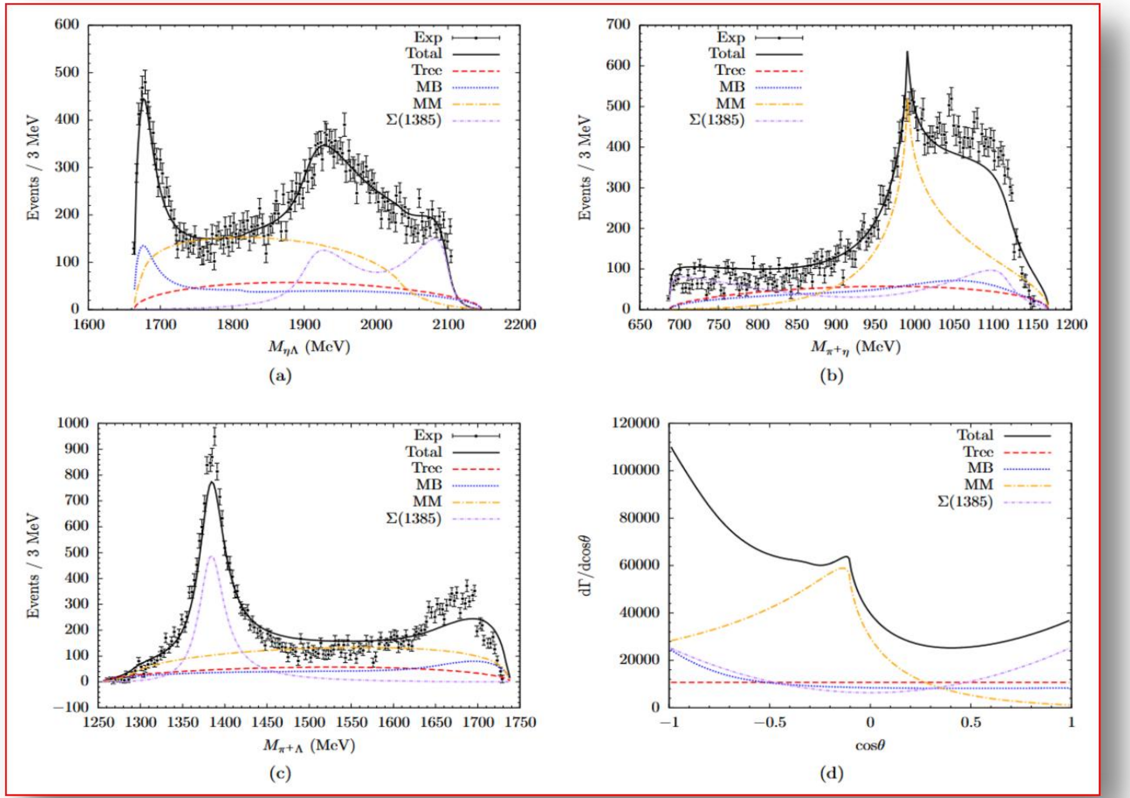


TABLE I. Free parameter values fitted to the MC sample with 829 data points.

	A	β	γ	ϕ	ϕ'	$V_{\Sigma(1380)}$	ϕ''	χ^2/d.o.f.
w/o $\Sigma(1380)$	1.52 MeV^{-1}	0.23	0.76	0.25π	1.42π	-	-	8.75
w $\Sigma(1380)$	1.41 MeV^{-1}	0.25	0.94	0.37π	1.40π	0.01	-0.45π	2.92

Belle data

Lyu, Liu, JJWu, DMLi, EW, 2606.04690



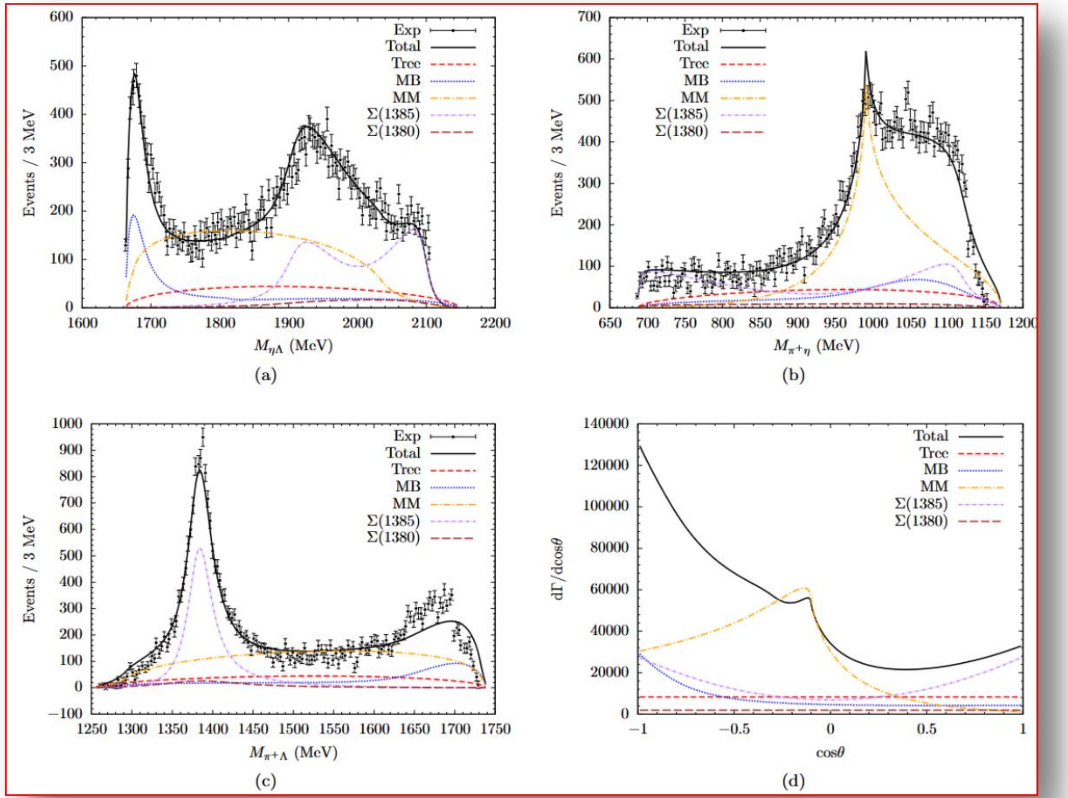
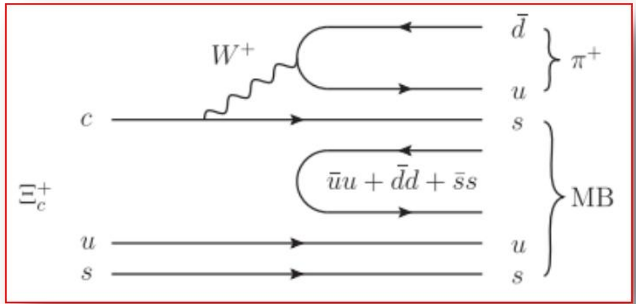


TABLE II. Free parameter values fitted to the Belle data sample.

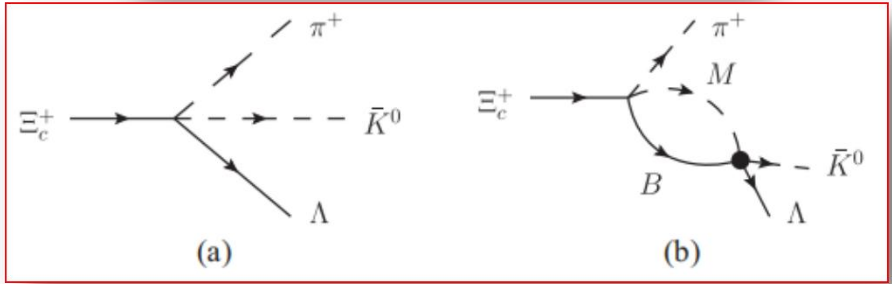
	A	β	γ	ϕ	ϕ'	$V_{\Sigma(1380)}$	ϕ''	χ^2/d.o.f.
w/o Σ(1380)	1.35	0.24	1.57	-0.05π	-1.05π	-	-	4.88
w Σ(1380)	1.18	0.28	1.77	0.05π	-0.98π	0.01	-0.62π	3.90

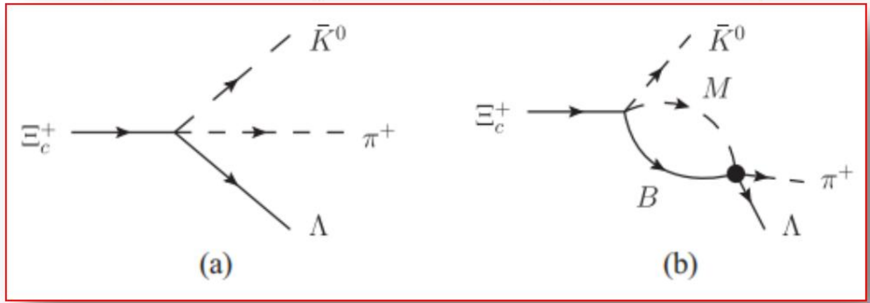
$\Xi_c \to \Lambda \bar{K}^0 \pi^+$

Li, Lyu, GYWang, LKLi, WCYan, EW, PRD 111, 054011 (2025)



$$\Xi_c^+ \Rightarrow \frac{1}{\sqrt{2}}\pi^+ s(\bar{u}u + \bar{d}d + \bar{s}s)(su - us)$$
$$= \pi^+ \sum M_{3i} B_{i2}$$
$$= \pi^+ \left(|K^- \Sigma^+\rangle - \frac{1}{\sqrt{2}}|\bar{K}^0 \Sigma^0\rangle + \frac{1}{\sqrt{6}}|\bar{K}^0 \Lambda\rangle - \frac{1}{\sqrt{3}}|\eta \Xi^0\rangle \right),$$

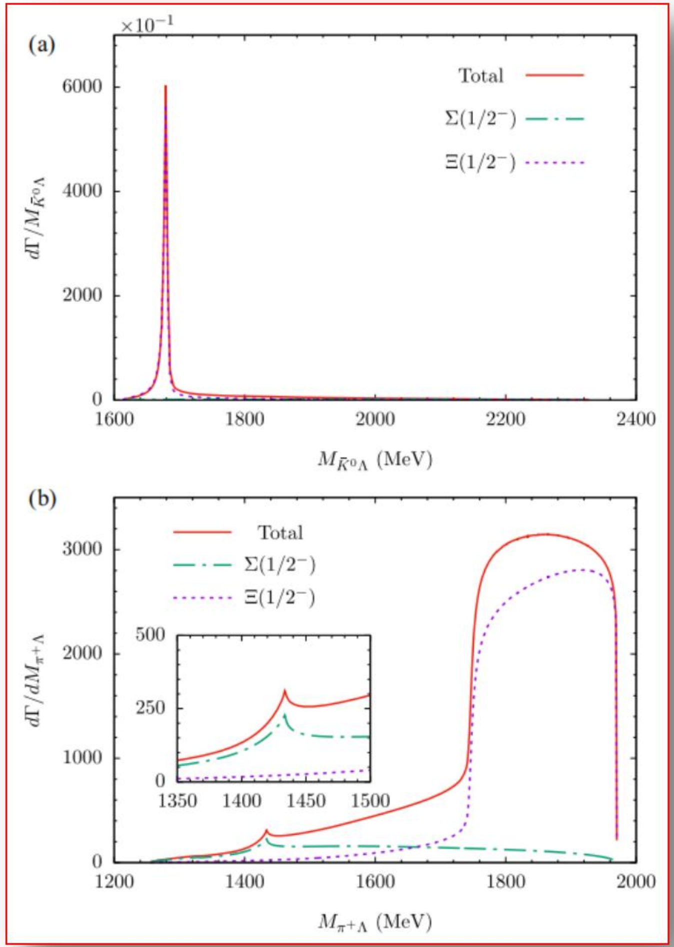




$$\mathcal{T}^{\Xi(1/2^-)} = CV_p \left[\frac{1}{\sqrt{6}} + G_{K^-\Sigma^+}(M_{\bar{K}^0\Lambda}) t_{K^-\Sigma^+ \to \bar{K}^0\Lambda}(M_{\bar{K}^0\Lambda}) - \frac{1}{\sqrt{2}} G_{\bar{K}^0\Sigma^0}(M_{\bar{K}^0\Lambda}) t_{\bar{K}^0\Sigma^0 \to \bar{K}^0\Lambda}(M_{\bar{K}^0\Lambda}) + \frac{1}{\sqrt{6}} G_{\bar{K}^0\Lambda}(M_{\bar{K}^0\Lambda}) t_{\bar{K}^0\Lambda \to \bar{K}^0\Lambda}(M_{\bar{K}^0\Lambda}) - \frac{1}{\sqrt{3}} G_{\eta\Xi^0}(M_{\bar{K}^0\Lambda}) t_{\eta\Xi^0 \to \bar{K}^0\Lambda}(M_{\bar{K}^0\Lambda}) \right],$$

$$\mathcal{T}^{\Sigma(1/2^-)} = V_p \left[\frac{1}{\sqrt{6}} + \frac{1}{\sqrt{2}} G_{\pi^0\Sigma^+}(M_{\pi^+\Lambda}) t_{\pi^0\Sigma^+ \to \pi^+\Lambda}(M_{\pi^+\Lambda}) - \frac{1}{\sqrt{2}} G_{\pi^+\Sigma^0}(M_{\pi^+\Lambda}) t_{\pi^+\Sigma^0 \to \pi^+\Lambda}(M_{\pi^+\Lambda}) + \frac{1}{\sqrt{6}} G_{\pi^+\Lambda}(M_{\pi^+\Lambda}) t_{\pi^+\Lambda \to \pi^+\Lambda}(M_{\pi^+\Lambda}) \right] + CV_p \left[-\frac{1}{\sqrt{2}} G_{\pi^+\Sigma^0}(M_{\pi^+\Lambda}) t_{\pi^+\Sigma^0 \to \pi^+\Lambda}(M_{\pi^+\Lambda}) + \frac{1}{\sqrt{6}} G_{\pi^+\Lambda}(M_{\pi^+\Lambda}) t_{\pi^+\Lambda \to \pi^+\Lambda}(M_{\pi^+\Lambda}) \right]. \quad (12)$$

Results



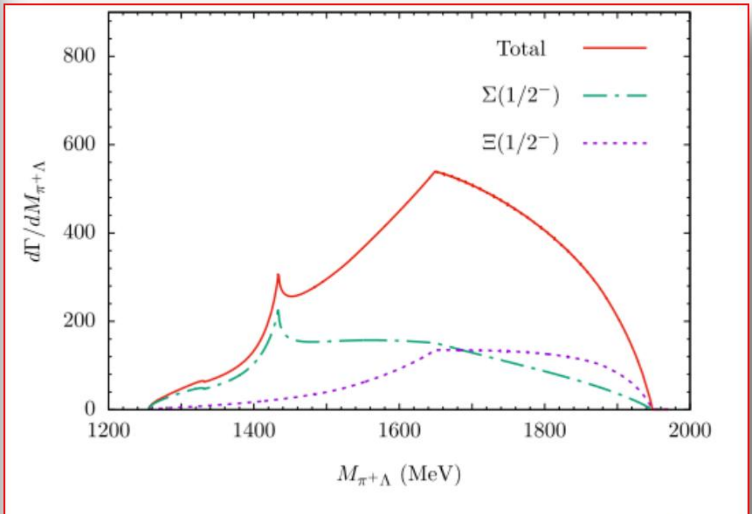
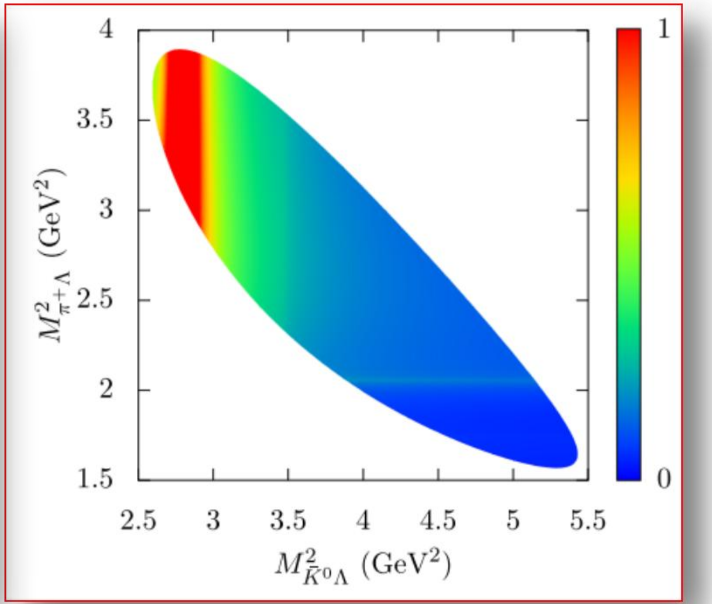
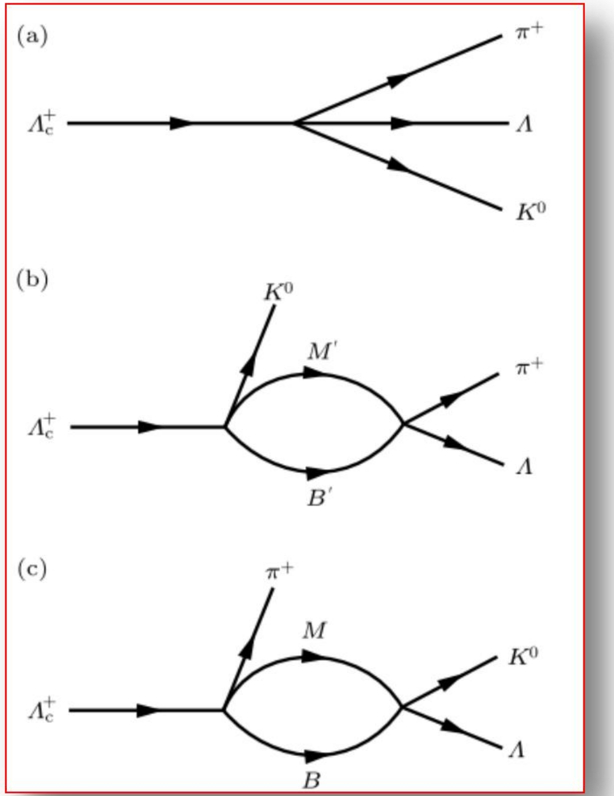


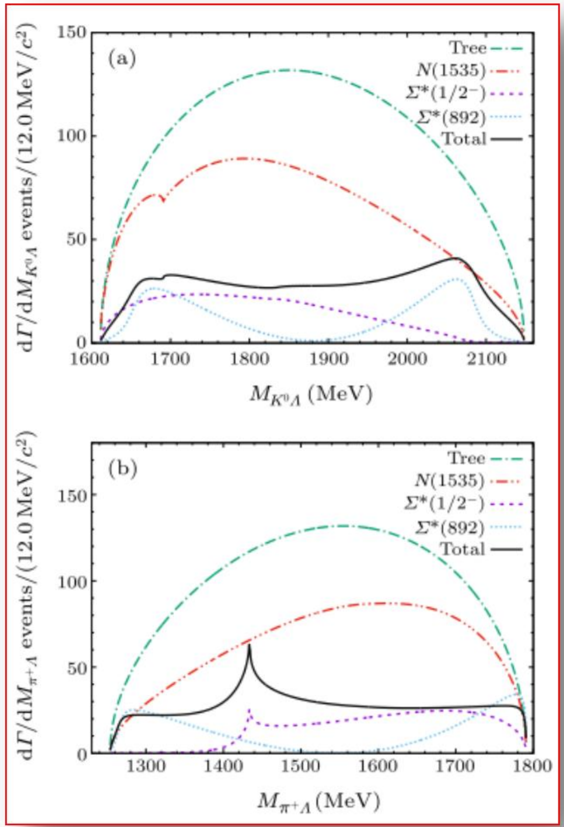
FIG. 9. Distribution of $\pi^+\Lambda$ invariant mass of the $\Xi_c^+ \to \Lambda\bar{K}^0\pi^+$ decay with the cuts of $M_{\bar{K}^0\Lambda} \geq 1750$ MeV.

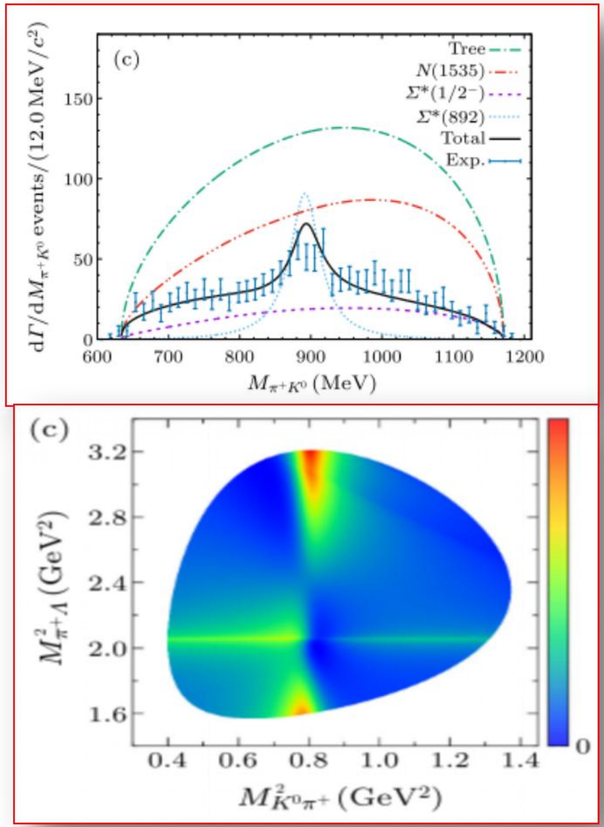


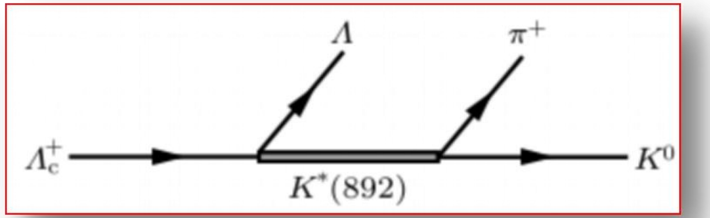
$\Lambda_c^+ \to \Lambda K^0 \pi^+$

Zhang, Lyu, GYWang, EW, Ma, CPL 43, 050203 (2026)







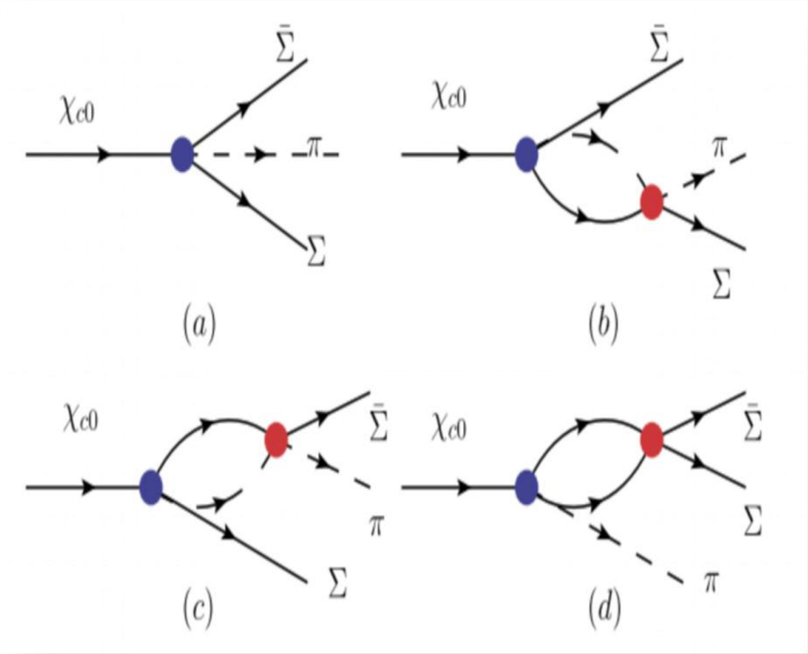


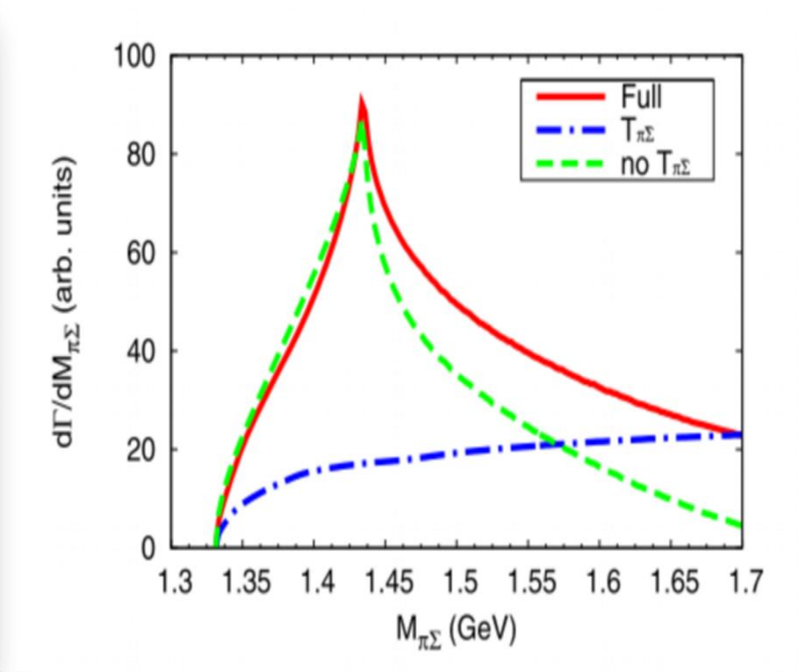
$$\mathcal{B}(\Lambda_c^+ \to \Lambda\pi^+ K^0) = (1.5 \pm 0.3) \times 10^{-3}$$

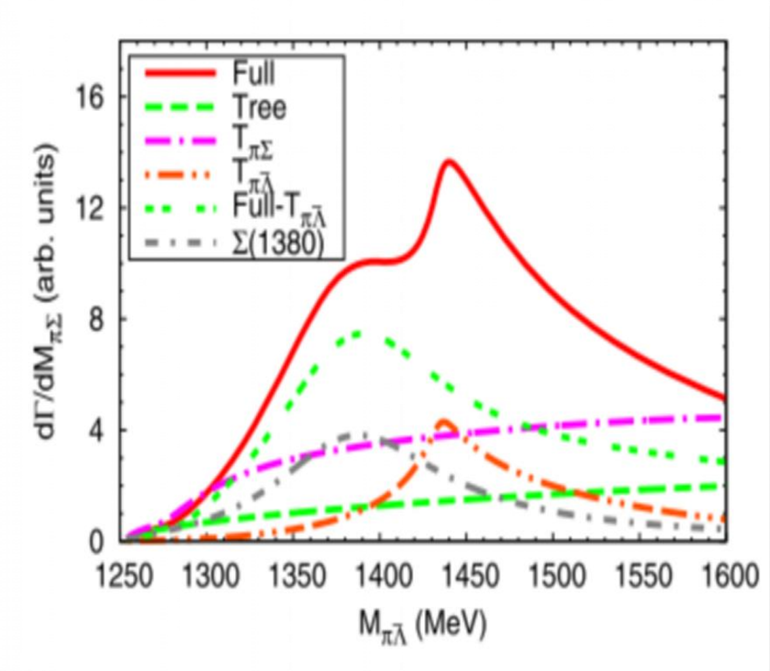
$$\mathcal{B}(\Lambda_c^+ \to \Lambda K_S^0 \pi^+) = (1.73 \pm 0.27 \pm 0.10) \times 10^{-3}$$

BESIII: PRD 109 (2024) 032003

Excited baryons in Charmonium decays







$\chi_{c0} \to \bar{\Sigma}\Sigma\pi$

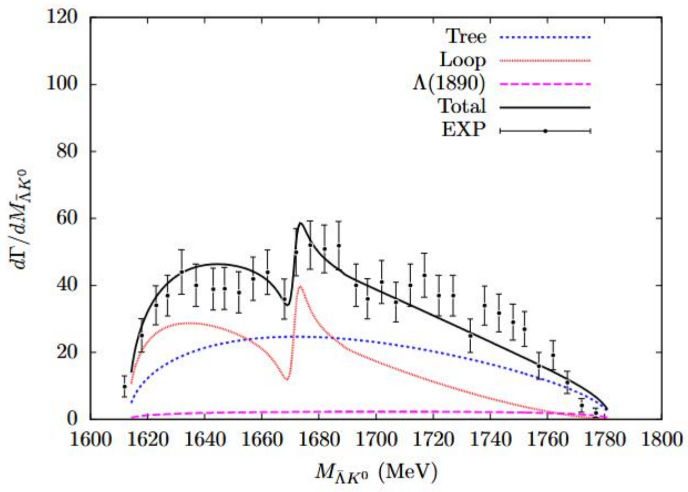
$\chi_{c0} \to \bar{\Lambda}\Sigma\pi$

PLB753(2016)526

PRD98(2018)114017

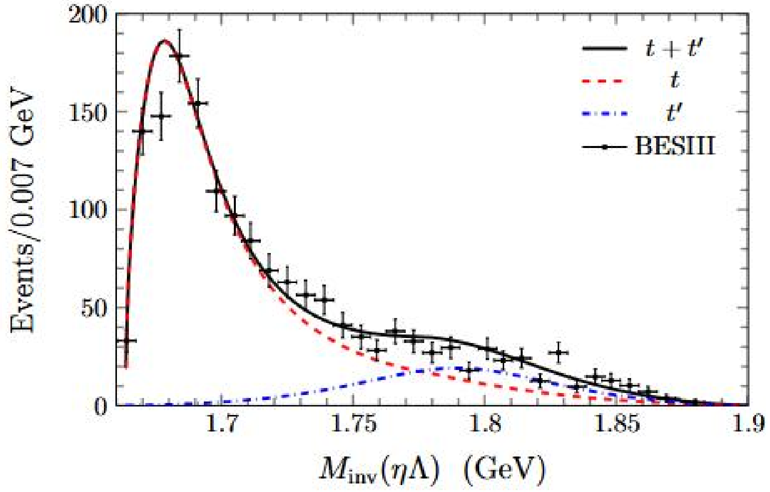
Excited hyperons in Charmonium decays

$\Xi(1690)$ **in** $J/\psi \to \Xi^0 \bar{\Lambda} K^0$



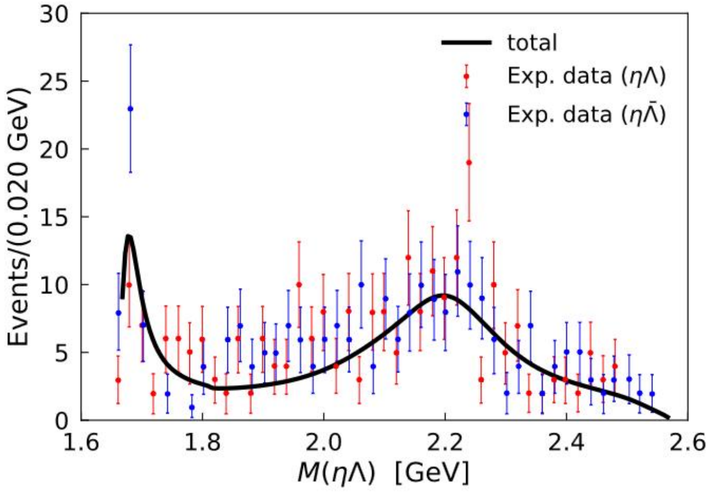
BESIII: PRD112(2025)112012
Lyu, Dai, Oset: 2603.16640

$J/\psi \to \Lambda \bar{\Sigma}^0 \eta$



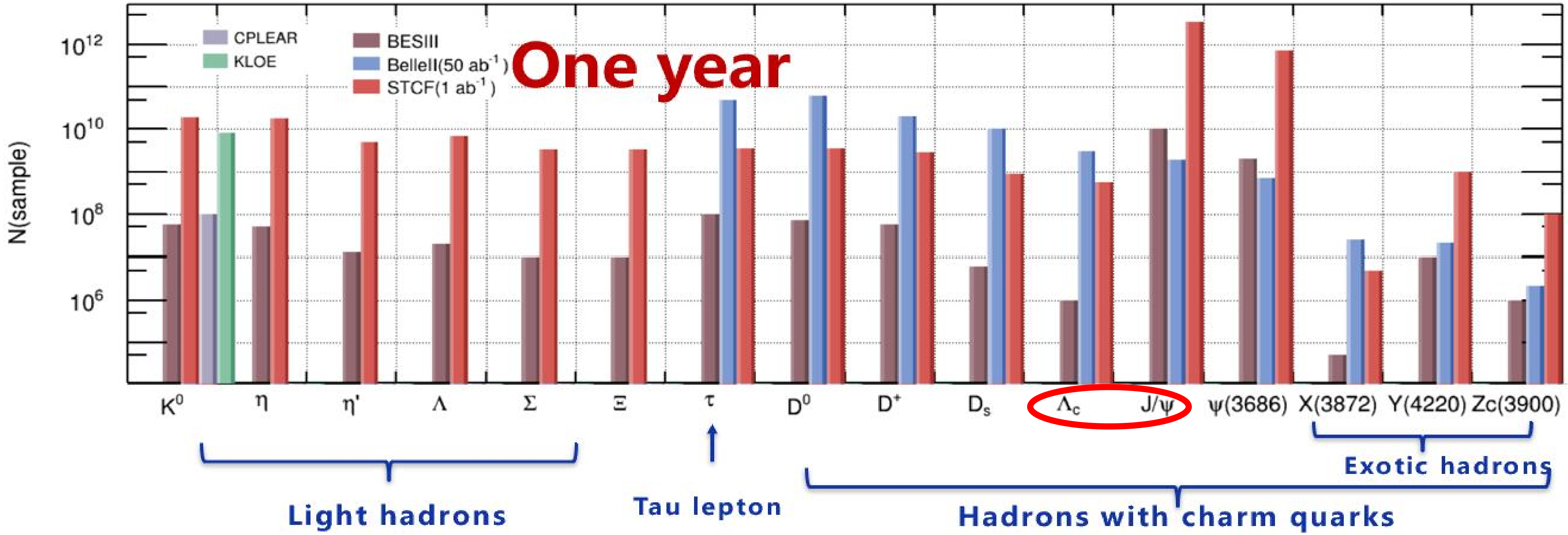
BESIII: 2601.07617
Dai, Lyu, Oset: 2602.09136

$\psi(3686) \to \Lambda \bar{\Lambda} \eta$



BESIII: PRD106(2022)072006
Ikeno, Oset: 2606.10578

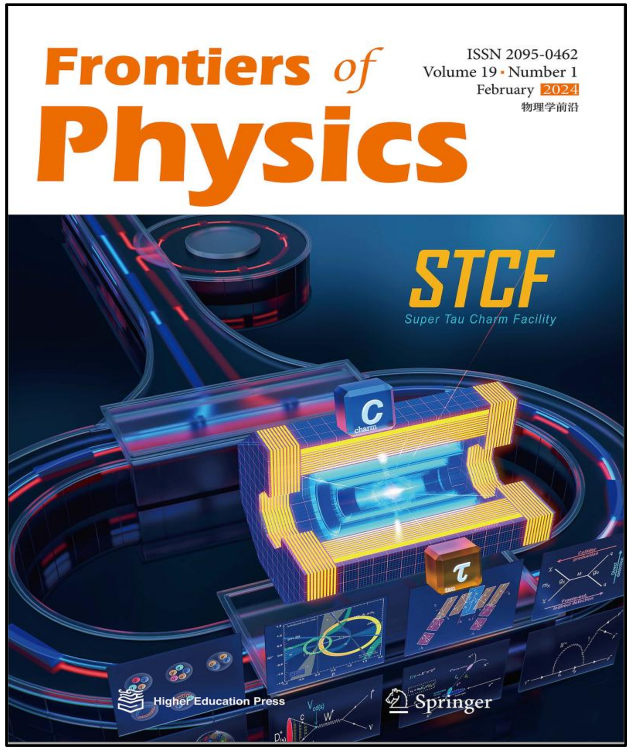
Excited hyperons in Charmonium decays



- About **1 ab^{-1}** integrated luminosity at STCF per year
- STCF shows superior **statistics and purity** compare to other experiments
- The **physics sensitivity** studies are based on, **but not limited to**, data samples of these size

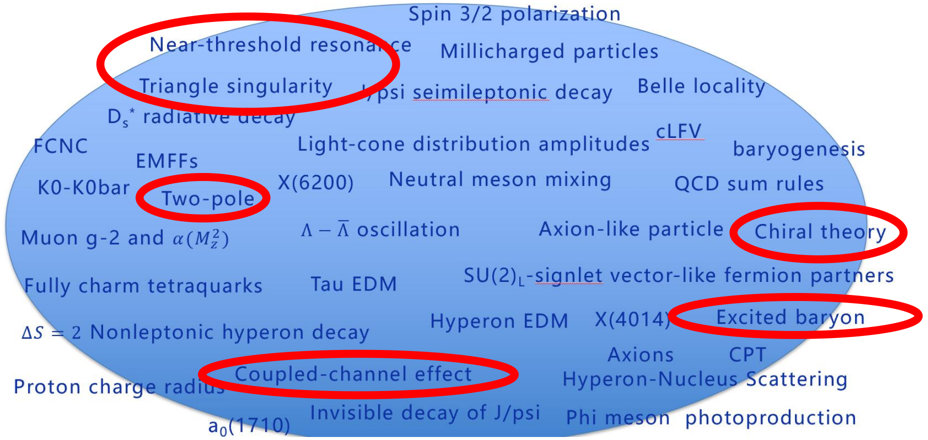
Excited baryons in STCF

M. Achasov, et al., STCF conceptual design report (Volume 1): Physics & detector, Front. Phys. 19(1), 14701 (2024)



Contents

Rich physics potential beyond the CDR content



Summary

- **The missing state $\Sigma(1/2^-)$ is crucial to undertand the baryon spectrum.**
- **We need more experimental measurements from STCF, BESIII and Belle II to learn about the excited hyperons.**

Thank you very much!