Three methods to search for the two $\Xi(1820)$ states

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Chiral Lagrangians for meson baryon interaction, Kbar N

The two states of the $\Lambda(1405)$

Equivalence to vector exchange in the hidden gauge approach

Interaction of pseudoscalars with the baryons of the Δ decuplet

The two $\Xi(1820)$ states

$\psi(3686)$ decay to $K^-\Lambda\bar{\Xi}^+$

The $\Omega_c \to \pi^+ (\pi^0, \eta)\, \pi\Xi^*$ **reactions**

$\psi(3686) \to \bar{\Xi}^+ \bar{K}^0 \Sigma^{*-}(\pi^-\Lambda)$ **decay**

Chiral Lagrangians for P B interaction

G. Ecker, Prog. Part. Nucl. Phys. 35 (1995) 1.
V. Bernard, N. Kaiser and U.G. Meissner, Int. J. Mod. Phys. E 4 (1995) 193.

$$\nabla_\mu B = \partial_\mu B + [\Gamma_\mu, B] ,$$
$$\Gamma_\mu = \tfrac{1}{2}(u^+ \partial_\mu u + u \partial_\mu u^+) ,$$
$$U = u^2 = \exp(i\sqrt{2}\Phi/f) ,$$
$$u_\mu = i u^+ \partial_\mu U u^+ .$$

$$L_1^{(B)} = \langle \bar{B} i \gamma^\mu \nabla_\mu B \rangle - M_B \langle \bar{B} B \rangle$$

$$\Phi = \begin{pmatrix} \frac{1}{\sqrt{2}}\pi^0 + \frac{1}{\sqrt{6}}\eta & \pi^+ & K^+ \\ \pi^- & -\frac{1}{\sqrt{2}}\pi^0 + \frac{1}{\sqrt{6}}\eta & K^0 \\ K^- & \bar{K}^0 & -\frac{2}{\sqrt{6}}\eta \end{pmatrix}$$

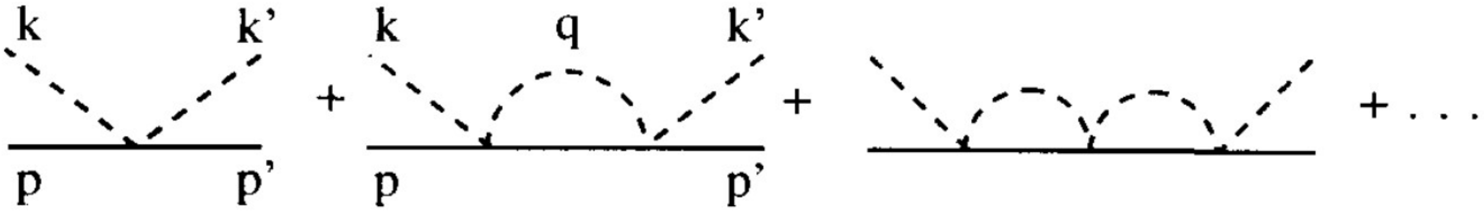
$$B = \begin{pmatrix} \frac{1}{\sqrt{2}}\Sigma^0 + \frac{1}{\sqrt{6}}\Lambda & \Sigma^+ & p \\ \Sigma^- & -\frac{1}{\sqrt{2}}\Sigma^0 + \frac{1}{\sqrt{6}}\Lambda & n \\ \Xi^- & \Xi^0 & -\frac{2}{\sqrt{6}}\Lambda \end{pmatrix}$$

$$L_1^{(B)} = \langle \bar{B} i \gamma^\mu \frac{1}{4f^2} [(\Phi \partial_\mu \Phi - \partial_\mu \Phi \Phi) B - B (\Phi \partial_\mu \Phi - \partial_\mu \Phi \Phi)] \rangle$$

$$V_{ij} = -C_{ij}\frac{1}{4f^2}\bar{u}(p')\gamma^{\mu}u(p)(k_{\mu}+k'_{\mu}) \qquad V_{ij} = -C_{ij}\frac{1}{4f^2}(k^0+k'^0)$$

C_{ij} coefficients of Eq. (7). $C_{ji} = C_{ij}$

	$K^- p$	$\bar{K}^0 n$	$\pi^0 \Lambda$	$\pi^0 \Sigma^0$	$\eta \Lambda$	$\eta \Sigma^0$	$\pi^+ \Sigma^-$	$\pi^- \Sigma^+$	$K^+ \Xi^-$	$K^0 \Xi^0$
$K^- p$	2	1	$\frac{\sqrt{3}}{2}$	$\frac{1}{2}$	$\frac{3}{2}$	$\frac{\sqrt{3}}{2}$	0	1	0	0
$\bar{K}^0 n$		2	$-\frac{\sqrt{3}}{2}$	$\frac{1}{2}$	$\frac{3}{2}$	$-\frac{\sqrt{3}}{2}$	1	0	0	0
$\pi^0 \Lambda$			0	0	0	0	0	0	$\frac{\sqrt{3}}{2}$	$-\frac{\sqrt{3}}{2}$
$\pi^0 \Sigma^0$				0	0	0	2	2	$\frac{1}{2}$	$\frac{1}{2}$
$\eta \Lambda$					0	0	0	0	$\frac{3}{2}$	$\frac{3}{2}$
$\eta \Sigma^0$						0	0	0	$\frac{\sqrt{3}}{2}$	$-\frac{\sqrt{3}}{2}$
$\pi^+ \Sigma^-$							2	0	1	0
$\pi^- \Sigma^+$								2	0	1
$K^+ \Xi^-$									2	1
$K^0 \Xi^0$										2



$$T = V + VGT \qquad\qquad T = [1 - VG]^{-1} V$$

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

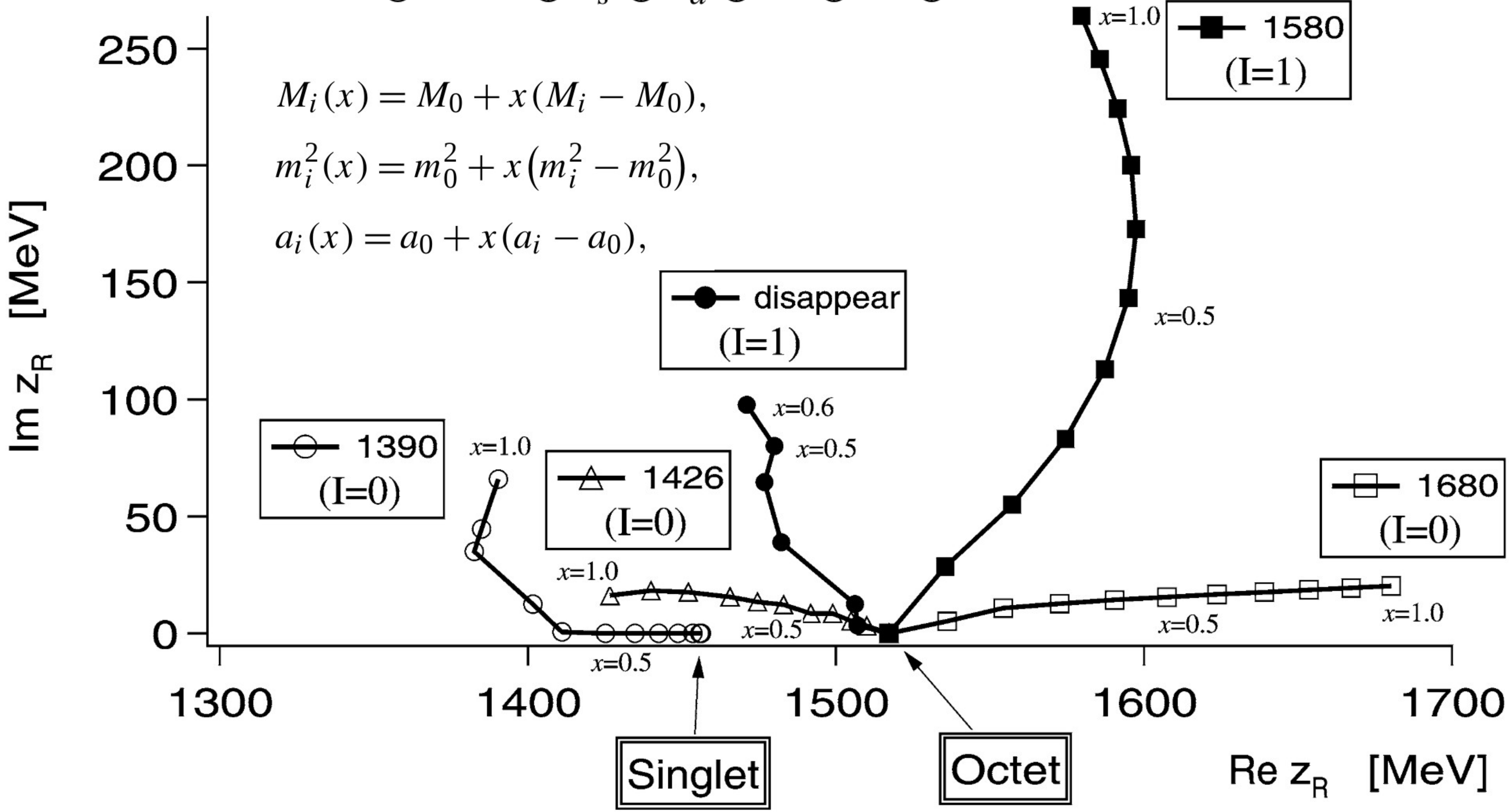
$$= \int \frac{d^3 q}{(2\pi)^3} \frac{1}{2\omega_l(q)} \frac{M_l}{E_l(\boldsymbol{q})} \frac{1}{p^0 + k^0 - \omega_l(\boldsymbol{q}) - E_l(\boldsymbol{q}) + i\epsilon},$$

$\boxed{\Lambda(1380)\ 1/2^-}$ $J^P = \frac{1}{2}^-$ Status: ∗∗

$\boxed{\Lambda(1405)\ 1/2^-}$ $I(J^P) = 0(\frac{1}{2}^-)$ Status: ∗∗∗∗

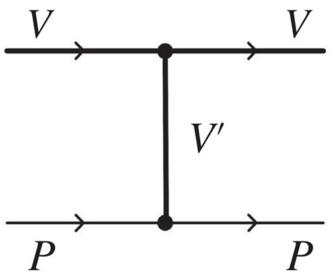
1429^{+8}_{-7}	[1] MAI	15	DPWA
1434 ± 2	[2] MAI	15	DPWA
1421^{+3}_{-2}	GUO	13	DPWA
1424^{+7}_{-23}	IKEDA	12	DPWA

$$8 \otimes 8 = 1 \oplus 8_s \oplus 8_a \oplus 10 \oplus \overline{10} \oplus 27$$



VP INTERACTION IN THE LOCAL HIDDEN GAUGE APPROACH

Bando et al Phys Rep. 164
U. G. Meissner, Phys. Rept. 161, 213 (1988)



$$\mathcal{L}_{VVV} = ig\langle (V_\mu \partial_\nu V^\mu - \partial_\nu V_\mu V^\mu) V^\nu \rangle$$

$$g = M_V/2f \;\; (M_V \approx 800 \text{ MeV}, \; f = 93 \text{ MeV})$$

$$\mathcal{L}_{VPP} = -ig\langle V^\mu [P, \partial_\mu P] \rangle$$

Neglecting the k/M$_V$

$$\varepsilon_1(\mathbf{k}) = (0, 1, 0, 0)$$
$$\varepsilon_2(\mathbf{k}) = (0, 0, 1, 0)$$
$$\varepsilon_3(\mathbf{k}) = (|\mathbf{k}|, 0, 0, \omega_{\mathbf{k}})/m_W$$

$$-it = -g(V^\mu \partial_\nu V_\mu - \partial_\nu V_\mu V^\mu)_{ij} V^\nu_{ji} \frac{i}{q^2 - M_V^2} V^{\nu'}_{lm} [P, \partial_{\nu'} P]_{ml}$$

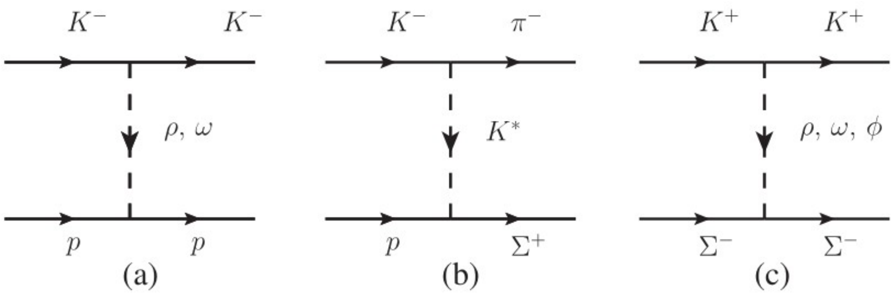
$$\sum_{pol} \epsilon^\nu_{ji} \epsilon^{\nu'}_{lm} = \left(-g^{\nu\nu'} + \frac{q^\nu q^{\nu'}}{M_V^2} \right) \delta_{jl} \delta_{im}$$

$$-it = -i\frac{g^2}{M_V^2} \langle (V^\mu \partial_\nu V_\mu - \partial_\nu V_\mu V^\mu)[P, \partial^\nu P] \rangle$$

$$\mathcal{L} = -\frac{1}{4f^2} \langle [V^\mu, \partial_\nu V^\mu][P, \partial^\nu P] \rangle$$

Chiral Lagrangian of M. C. Birse, Z. Phys. A 355, 231 (1996)

For pseudoscalar-baryon of the octet interaction



$$\mathcal{L}_{\mathrm{VPP}} = -ig\langle[\Phi, \partial_\mu \Phi]V^\mu\rangle$$

$$V_\mu = \begin{pmatrix} \frac{1}{\sqrt{2}}\rho^0 + \frac{1}{\sqrt{2}}\omega & \rho^+ & K^{*+} \\ \rho^- & -\frac{1}{\sqrt{2}}\rho^0 + \frac{1}{\sqrt{2}}\omega & K^{*0} \\ K^{*-} & \bar{K}^{*0} & \phi \end{pmatrix}_\mu ,$$

$$\mathcal{L}_{\mathrm{VBB}} = g(\langle \bar{B}\gamma_\mu [V^\mu, B]\rangle + \langle \bar{B}\gamma_\mu B\rangle\langle V^\mu\rangle)$$

Alternative way of calculation

$$\rho^0 = \frac{1}{\sqrt{2}}(u\bar{u} - d\bar{d}),$$

$$\omega = \frac{1}{\sqrt{2}}(u\bar{u} + d\bar{d}),$$

$$\phi = s\bar{s}.$$

$$\gamma^\mu \to \gamma^0$$ → 1, spin independent vertex

$$\langle p|g\rho^0|p\rangle \equiv \frac{1}{\sqrt{2}}\frac{1}{\sqrt{2}}\langle \phi_{\mathrm{MS}}\chi_{\mathrm{MS}} + \phi_{\mathrm{MA}}\chi_{\mathrm{MA}}|g\frac{1}{\sqrt{2}}(u\bar{u} - d\bar{d})| \times \phi_{\mathrm{MS}}\chi_{\mathrm{MS}} + \phi_{\mathrm{MA}}\chi_{\mathrm{MA}}\rangle, \quad (10)$$

This procedure can be used for the decuplet baryons and is particularly useful for baryons with charm or bottom.

E. Jenkins, A.V. Manohar, Phys. Lett. B 259 (1991) 353

E.E. Kolomeitsev, M.F.M. Lutz, Phys. Lett. B 585 (2004) 243,

S. Sakar, E. Oset and M.J.Vicente-Vacas, Nucl.Phys.A 750 (2005) 294-323,

$$10 \otimes 8 = 8 \oplus 10 \oplus 27 \oplus 35$$

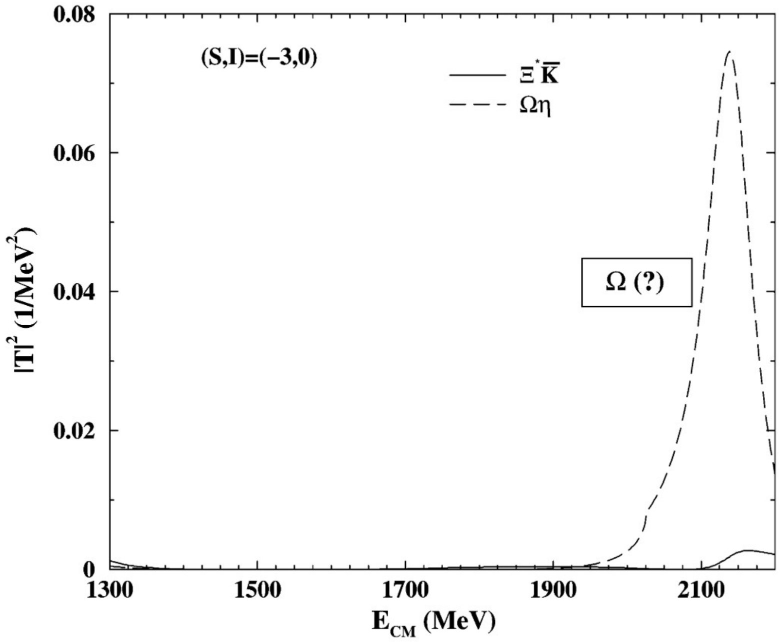
0^- 3/2^+ in s-wave → 3/2^- states

Many states of $3/2^-$ are dynamically generated from the interaction with coupled channels:

$N^*(1520)$ $\Delta(1700)$

$\Lambda(1520)$ $\Sigma(1670)$

$\Sigma(1940)$ $\Xi(1820)$



The Ω state around 2100 MeV has been confirmed recently, by Belle and called $\Omega(2012)$

J. Yelton et al. (Belle Collaboration), Phys. Rev. Lett. 121, 052003 (2018)

$$m_{\Omega^*}^{\exp} = 2012.4 \pm 0.92 \text{ MeV},$$
$$\Gamma_{\Omega^*}^{\exp} = 6.4^{+3.0}_{-2.6} \text{ MeV}.$$

In R. Pavao and E. Oset, Eur. Phys. J. C 78, 857 (2018)

$\bar{K}\Xi^*$, $\eta\Omega$ and $\bar{K}\Xi$ channels

$$V = \begin{array}{cc} \begin{array}{ccc} \bar{K}\Xi^* & \eta\Omega & \bar{K}\Xi \end{array} & \\ \begin{pmatrix} 0 & 3F & \alpha q^2 \\ 3F & 0 & \beta q^2 \\ \alpha q^2 & \beta q^2 & 0 \end{pmatrix} & \begin{array}{c} \bar{K}\Xi^* \\ \eta\Omega \\ \bar{K}\Xi \end{array} \end{array}$$

Final Belle results

$$\mathcal{R}^{\Xi\pi\bar{K}}_{\Xi\bar{K}} = 0.97 \pm 0.24 \pm 0.07$$

arXiv:2207.03090 [hep-ex]

and it was concluded that “this ratio is consistent with the molecular interpretation of the $\Omega(2012)$”

α (10^{-8} MeV^{-3})	β (10^{-8} MeV^{-3})	$q_{\max}$ (MeV)	(m_{Ω^*}, Γ_{Ω^*}) (MeV)	$\Gamma(\bar{K}\Xi)$ (MeV)	$\Gamma(\pi\bar{K}\Xi)$ (MeV)
5.0	0.1	735	(2012.19, 6.36)	3.35	3.01
4.0	1.5	735	(2012.4, 6.2)	3.22	2.98
3.0	3.0	735	(2012.36, 6.19)	3.25	2.94
2.0	4.5	735	(2012.26, 6.23)	3.34	2.89

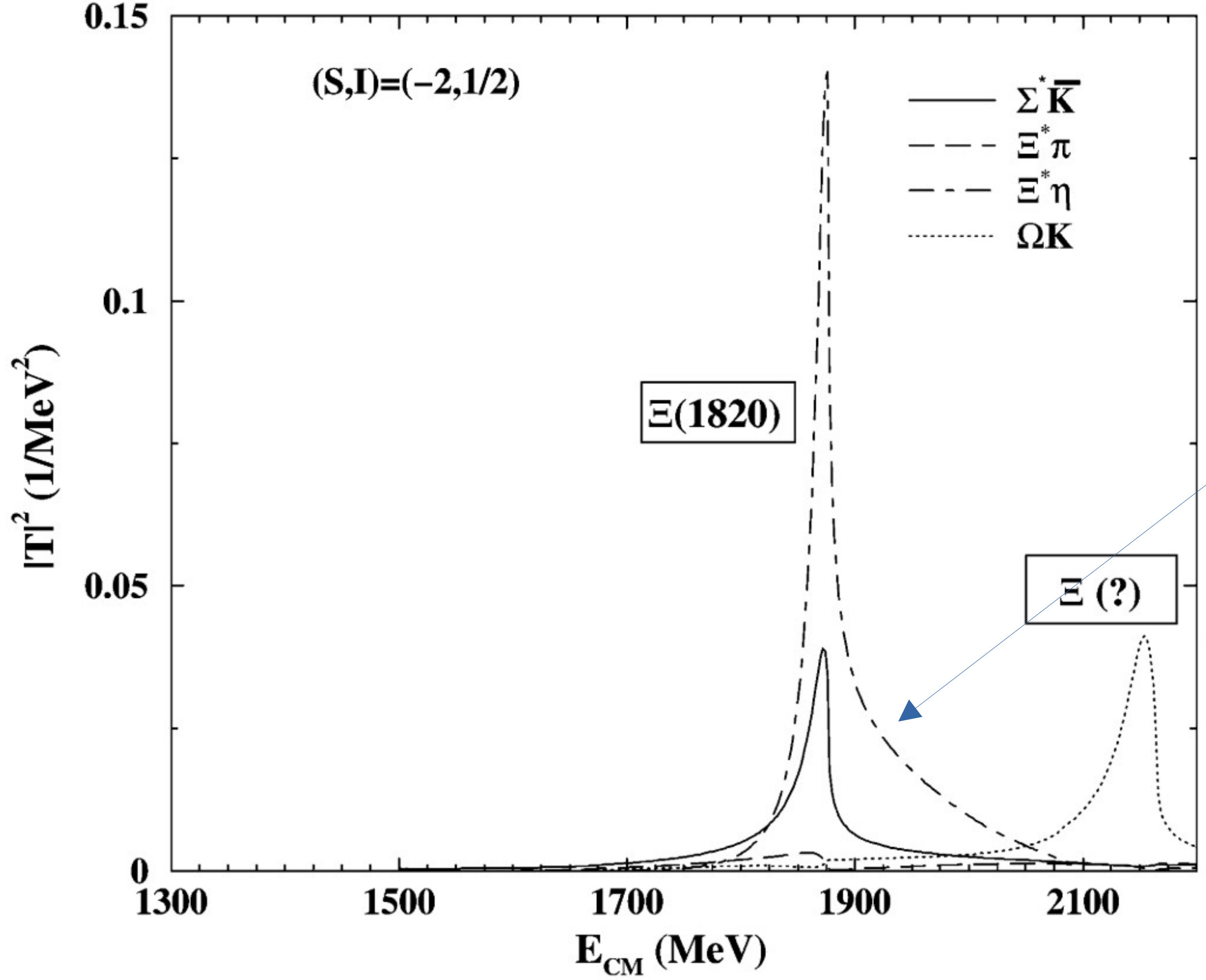
Related works with similar conclusions

[9] M. P. Valderrama, Phys. Rev. D 98, 054009 (2018).
[10] Y.-H. Lin and B.-S. Zou, Phys. Rev. D 98, 056013 (2018).
[11] R. Pavao and E. Oset, Eur. Phys. J. C 78, 857 (2018).
[12] Y. Huang, M.-Z. Liu, J.-X. Lu, J.-J. Xie, and L.-S. Geng, Phys. Rev. D 98, 076012 (2018).
[13] J.-X. Lu, C.-H. Zeng, E. Wang, J.-J. Xie, and L.-S. Geng, Eur. Phys. J. C 80, 361 (2020).
[14] N. Ikeno, G. Toledo, and E. Oset, Phys. Rev. D 101, 094016 (2020).
[15] X. Liu, H. Huang, J. Ping, and D. Chen, Phys. Rev. C 103, 025202 (2021).

[18] W.-L. Wang, F. Huang, Z.-Y. Zhang, Y.-W. Yu, and F. Liu, Commun. Theor. Phys. 48, 695 (2007).

[19] W. L. Wang, F. Huang, Z. Y. Zhang, and F. Liu, J. Phys. G 35, 085003 (2008).
[20] T. Gutsche and V. E. Lyubovitskij, J. Phys. G 48, 025001 (2020).

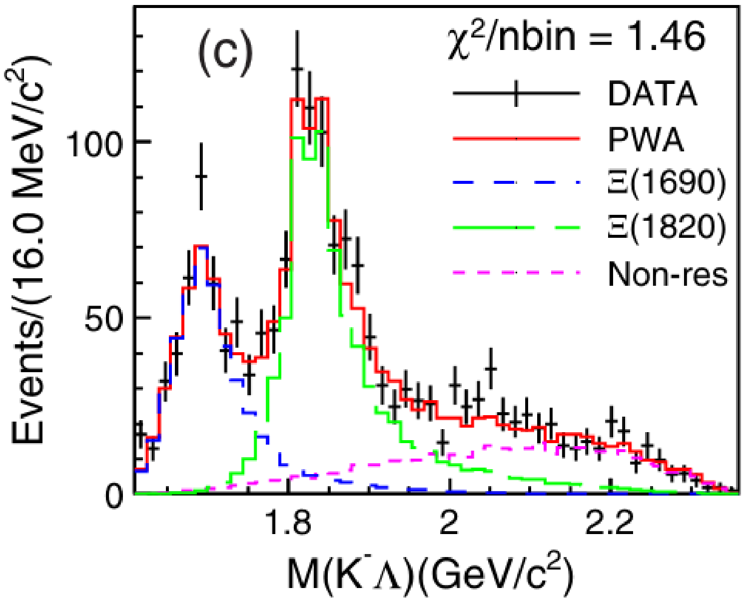
Ξ(1820)



Second state coupling to Ξ* η around 1900 MeV

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

M. Ablikim *et al.*[*]
(BESIII Collaboration)
PHYSICAL REVIEW D 109, 072008 (2024)



$$\Gamma_{\Xi(1820)} = 73^{+6}_{-5} \pm 9 \text{ MeV}.$$

This result is much bigger, and incompatible with that of the PDG [3] of

$$\Gamma^{\text{PDG}}_{\Xi(1820)} = 24^{+15}_{-10} \text{ MeV (PDG estimate)}; \quad 24 \pm 5 \text{ MeV (PDG average)}.$$

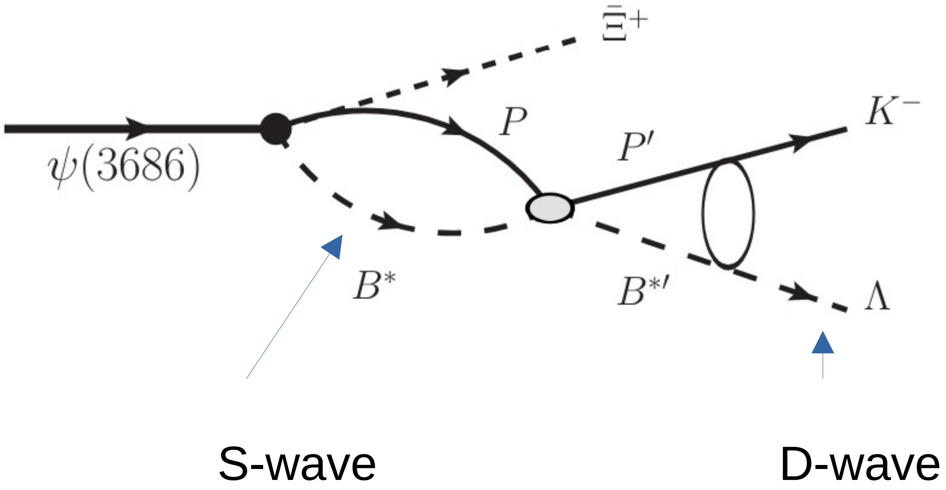
e-Print: 2309.03618 R.~Molina, W.~H.~Liang, C.~W.~Xiao, Z.~F.~Sun and E.~Oset,

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

$$T = [1 - VG]^{-1} V.$$

TABLE I. C_{ij} coefficients of Eq. (3).

C_{ij}	$\Sigma^* \bar{K}$	$\Xi^* \pi$	$\Xi^* \eta$	ΩK
$\Sigma^* \bar{K}$	2	1	3	0
$\Xi^* \pi$		2	0	$\frac{3}{\sqrt{2}}$
$\Xi^* \eta$			0	$\frac{3}{\sqrt{2}}$
ΩK				3



$$t = \sum_j A_j \, \vec{\epsilon}_\psi \cdot \vec{p}_\Xi \, G_j(PB^*) \, T_{ji} \, C_i \, \tilde{k}^2$$

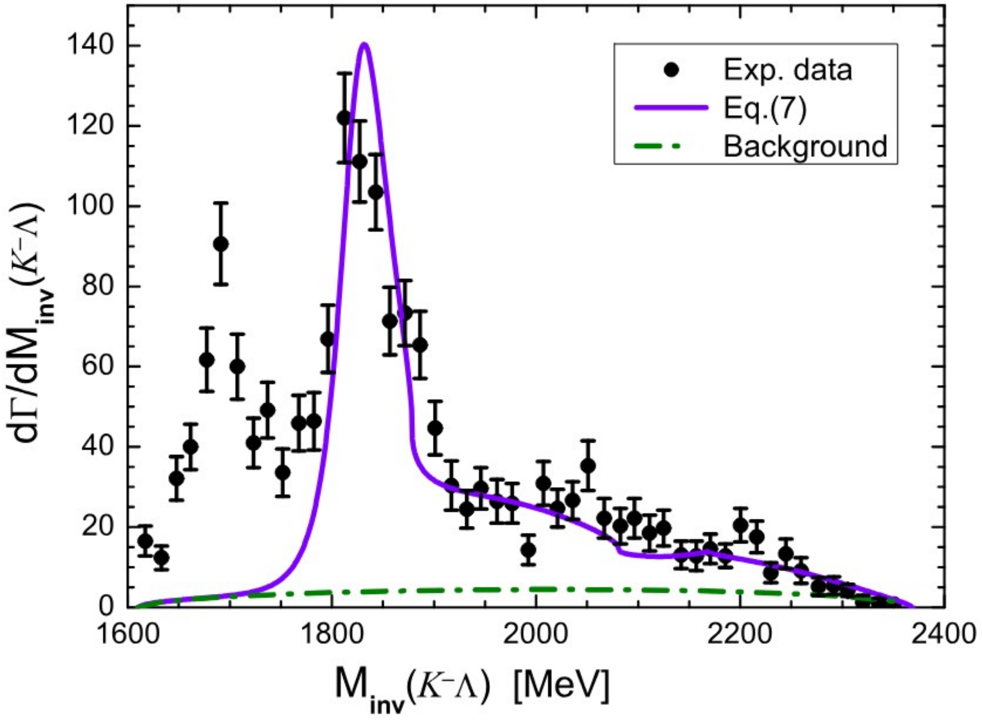
$$\sim \sum_{ij} D_{ij} \, \tilde{k}^2 \, \vec{\epsilon}_\psi \cdot \vec{p}_\Xi \, T_{ji},$$

$$\frac{d\Gamma}{dM_{\rm inv}(K^-\Lambda)} = \frac{1}{(2\pi)^3} \, \frac{1}{4M_\psi^2} \, p_\Xi \, \tilde{k} \, \bar{\sum} \sum |t|^2, \qquad = W \, p_\Xi^3 \, \tilde{k}^5 \sum_{ij} |D_{ij} \, T_{ji}|^2$$

Since the Ξ* η channel has the largest strength, we take just this amplitude

Add background following phase space $C \, p_\Xi \, \tilde{k}$

Fit parameters , W, q_{max}, C

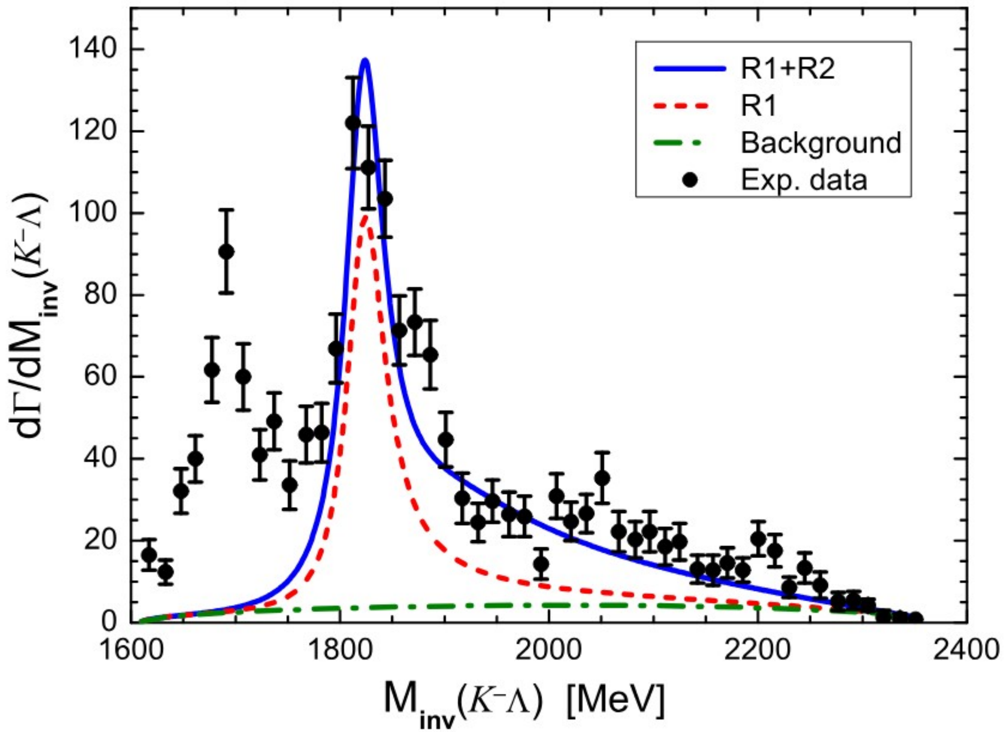


Poles	$\|g_i\|$	g_i	channels
$1824 - 31i$	3.22	$3.22 - 0.096i$	$\bar{K}\Sigma^*$
	1.71	$1.55 + 0.73i$	$\pi\Xi^*$
	2.61	$2.58 - 0.38i$	$\eta\Xi^*$
	1.62	$1.47 + 0.67i$	$K\Omega$
$1875 - 130i$	2.13	$0.29 + 2.11i$	$\bar{K}\Sigma^*$
	3.04	$-2.07 + 2.23i$	$\pi\Xi^*$
	2.20	$1.11 + 1.90i$	$\eta\Xi^*$
	3.03	$-1.77 + 2.45i$	$K\Omega$

$f=1.28f_\pi$, and q_{max} = 830 MeV.

t = $$\frac{A}{M_{\rm inv} - M_{R_1} + i\frac{\Gamma_1}{2}} + \frac{B}{M_{\rm inv} - M_{R_2} + i\frac{\Gamma_2}{2}}$$

with R_1, R_2 representing approximately the two resonances of Table II, with $M_{R_1} = 1822$ MeV, $\Gamma_1 = 45$ MeV, $M_{R_2} = 1870$ MeV, $\Gamma_2 = 200$ MeV. We adjust A and B and the background



A good reproduction of the data is obtained with the two poles of the Ξ(1820)

The $\Omega_c \to \pi^+ (\pi^0, \eta)\, \pi\Xi^*$ reactions and the two $\Xi(1820)$ states

W. H. Liang, R. Molina, E. O, e-Print: 2404.18882

$$\Omega_c \to \pi^+\, \Xi(1820) \to \pi^+ \pi^0\, \Xi^{*-}\ (\pi^- \Xi^{*0}),$$

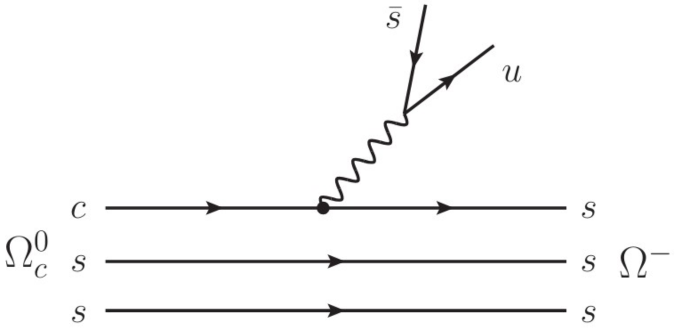
$$\Omega_c \to \pi^0\, \Xi(1820) \to \pi^0 \pi^+\, \Xi^{*-}\ (\pi^0 \Xi^{*0}),$$

$$\Omega_c \to \eta\, \Xi(1820) \to \eta\pi^+\, \Xi^{*-}\ (\pi^0 \Xi^{*0}).$$

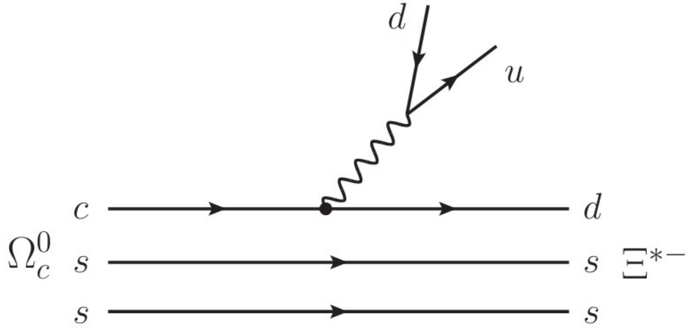
$\bar{K}^0\Sigma^{*-},\ K^-\Sigma^{*0},\ \pi^0\Xi^{*-},\ \eta\Xi^{*-},\ \pi^-\Xi^{*0},\ K^0\Omega^-,$ with charge Q = −1

$\bar{K}^0\Sigma^{*0},\ K^-\Sigma^{*+},\ \pi^+\Xi^{*-},\ \pi^0\Xi^{*0},\ \eta\Xi^{*0},\ K^+\Omega^-,$ with charge Q = 0

1/2^+



(a)



(b)

3/2^+

$$u\bar{s} \;\to\; \sum_i u\bar{q}_i q_i \bar{s} = P_{1i}\,P_{i3} = (P^2)_{13}$$
$$= \left(\frac{\pi^0}{\sqrt{2}} + \frac{\eta}{\sqrt{3}}\right) K^+ + \pi^+ K^0 - \frac{1}{\sqrt{3}} K^+ \eta.$$

$$u\bar{d} \;\to\; \sum_i u\bar{q}_i q_i \bar{d} = P_{1i}\,P_{i2} = (P^2)_{12}$$
$$= (\frac{\pi^0}{\sqrt{2}} + \frac{\eta}{\sqrt{3}})\pi^+ + \pi^+(-\frac{\pi^0}{\sqrt{2}} + \frac{\eta}{\sqrt{3}}) + K^+ \bar{K}^0.$$

$$P = \begin{pmatrix} \frac{\pi^0}{\sqrt{2}} + \frac{\eta}{\sqrt{3}} & \pi^+ & K^+ \\ \pi^- & -\frac{\pi^0}{\sqrt{2}} + \frac{\eta}{\sqrt{3}} & K^0 \\ K^- & \bar{K}^0 & -\frac{\eta}{\sqrt{3}} \end{pmatrix}$$

Upper vertex $\langle [P, \partial_\mu P]\, W^\mu\, T_- \rangle$

Lower vertex $\gamma^\mu (1 - \gamma_5)$

$$(p_1 - p_2)_\mu\, \gamma^\mu (1 - \gamma_5) \longrightarrow$$

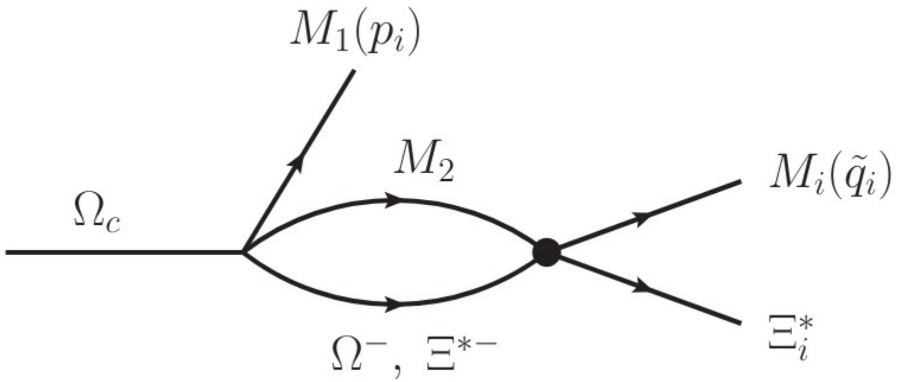
$$(p_1 - p_2)^i \gamma^i \gamma_5 \to \sigma^i (p_1 - p_2)^i$$

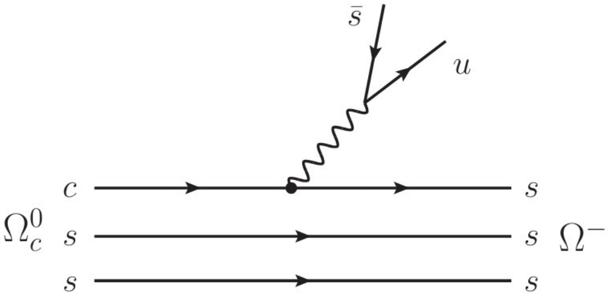
$$\begin{aligned}&\langle sss\,\chi_S|\ \vec{\sigma}\cdot(\vec{p}_1-\vec{p}_2)\bar{c}s\,|css\,\chi_{MS}\rangle\\ =\ &\langle\chi_S|\,\vec{\sigma}\cdot(\vec{p}_1-\vec{p}_2)\,|\chi_{MS}\rangle\,.\end{aligned}$$

$$\langle\frac{1}{\sqrt{3}}(dss+sds+ssd)\,\chi_S|\,\vec{\sigma}\cdot(\vec{p}_1-\vec{p}_2)\bar{c}d|css\,\chi_{MS}\rangle\ =\ \frac{1}{\sqrt{3}}\,\langle\chi_S|\,\vec{\sigma}\cdot(\vec{p}_1-\vec{p}_2)\,|\chi_{MS}\rangle\,,$$

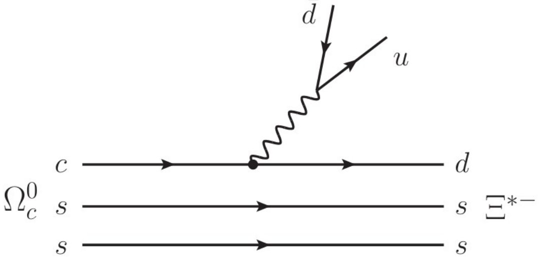
Macroscopic representation $\langle\Omega^-\,(\Xi^{*-}(1530))\big|\vec{S}^+\cdot(\vec{p}_1-\vec{p}_2)\big|\Omega_c^0\rangle$

$$\sum_M S_i\,|M\rangle\,\langle M|\,S_j^+=\frac{2}{3}\delta_{ij}-\frac{i}{3}\epsilon_{ijk}\,\sigma_k$$





(a)



(b)

1) $\Omega_c^0 \to \pi^+\pi^0\Xi^{*-}$

$$t_1 = C \, \langle \Omega^- | \vec{S}^+ \cdot \vec{p}_{\pi^+} | \Omega_c^0 \rangle \, t_1', \tag{12}$$
$$t_1' = G_{K^0\Omega^-}(M_{\rm inv}(\pi^0\Xi^{*-})) \cdot t_{K^0\Omega^-,\pi^0\Xi^{*-}}(M_{\rm inv}(\pi^0\Xi^{*-}));$$

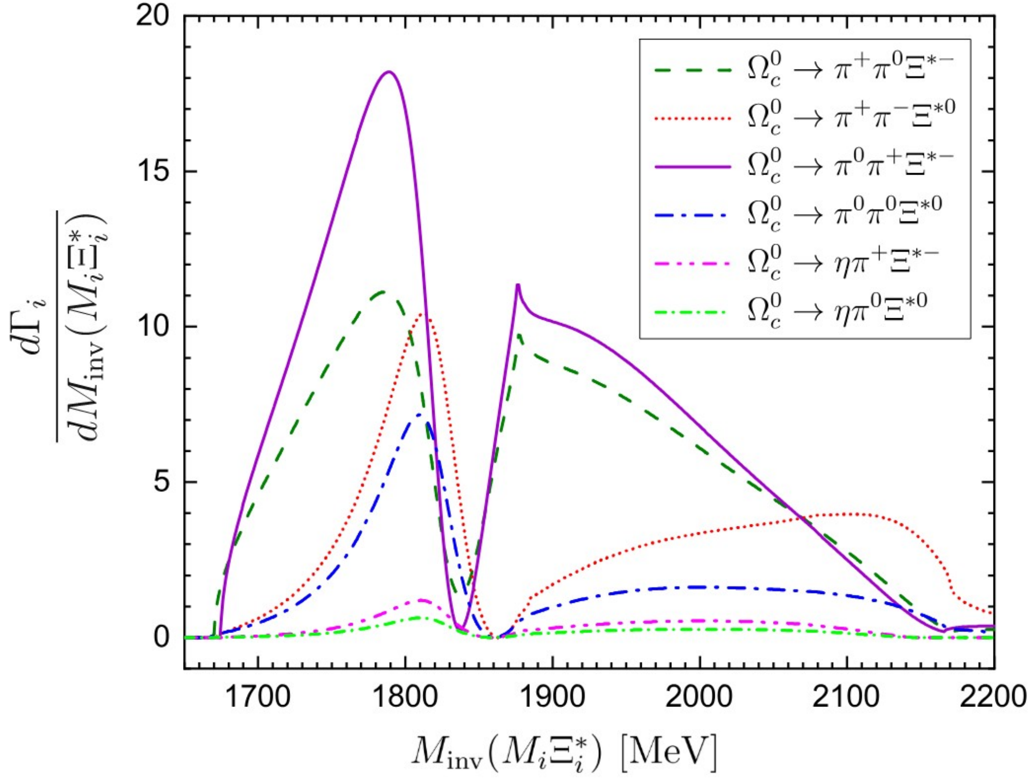
7) $\Omega_c^0 \to \pi^+\pi^0\Xi^{*-}$

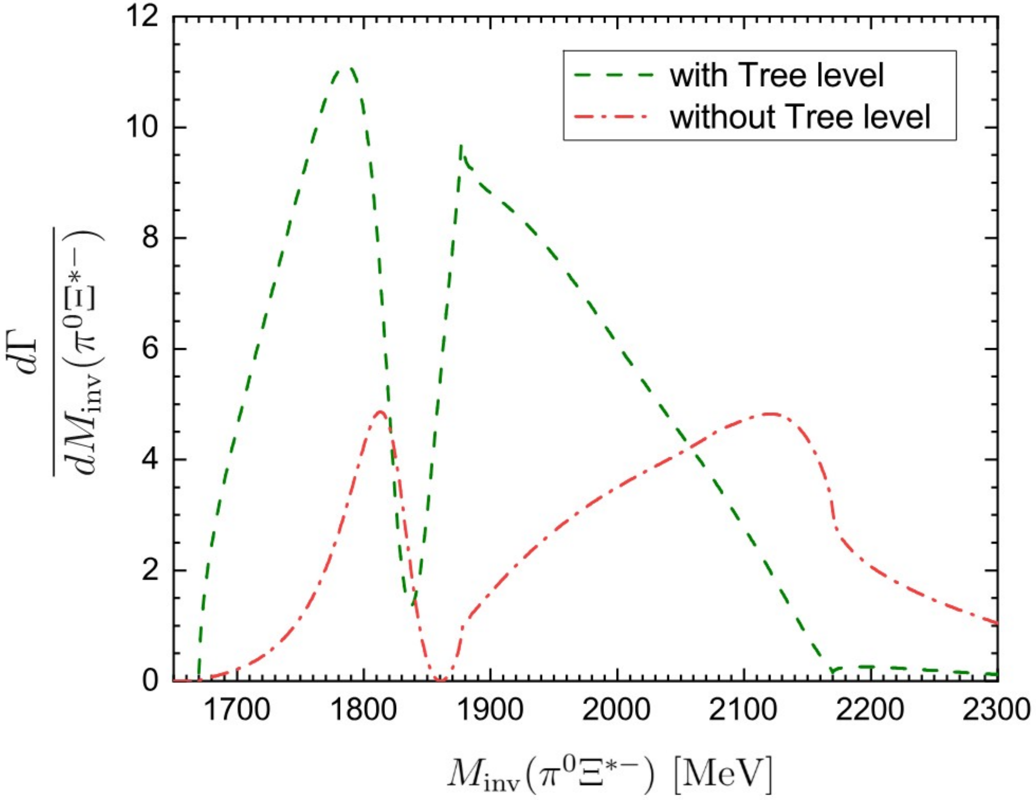
$$t_7 = C \, \langle \Xi^{*-} | \vec{S}^+ \cdot \vec{p}_{\pi^+} | \Omega_c^0 \rangle \, t_7',$$
$$t_7' = -\sqrt{\frac{2}{3}} \, [1 + G_{\pi^0\Xi^{*-}}(M_{\rm inv}(\pi^0\Xi^{*-}))$$
$$\cdot t_{\pi^0\Xi^{*-},\pi^0\Xi^{*-}}(M_{\rm inv}(\pi^0\Xi^{*-}))]$$

t_1 and t_7 have the same
Cabibbo factor $\cos\theta_c \sin\theta_c$
Single Cabibbo suppressed

…. for the other final channels

$$\frac{\mathrm{d}\Gamma_i}{\mathrm{d}M_{\mathrm{inv}}(M_i\Xi_i^*)} = \frac{1}{(2\pi)^3}\ \frac{1}{4M_{\Omega_c}^2}\ p_i\ \tilde{q}_i\ \overline{\sum}\sum |t_i|^2,\ (i = 1 \sim 6)$$



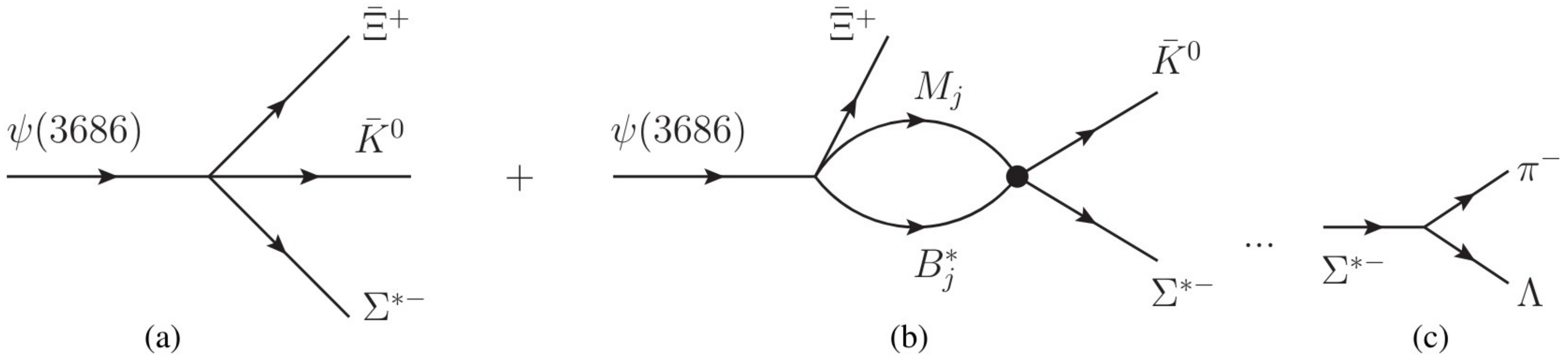


Searching for the two poles of the $\Xi(1820)$ in the $\psi(3686) \to \bar{\Xi}^+ \bar{K}^0 \Sigma^{*-}(\pi^- \Lambda)$ decay

Man Yu Duan, Jing Song, Wei Hong Liang, E. O. e-Print: 2405.03622

Same BESIII reaction but with a different final state Kbar Σ*

The choice of Kbar Σ* is motivated by the threshold around 1880 MeV, although we can have smaller energies because of the width of the Σ*. This kills the 1820 resonance and gives more chances to the one around 1875 MeV.



We use the fact that the ψ(3686) is ccbar and hence a SU(3) singlet.

$$\bar{\Xi}^+ M_j B^*_i,$$

These vertices can be calculated using S U(3) Clebsch Gordan coefficients of 8 ⊗10 → 8, choosing for the 8 ⊗10 the MB* states of the coupled channels, and for the final 8 multiplet the state Ξ. Phase convention $|K^-\rangle = -|\frac{1}{2}, -\frac{1}{2}\rangle$, $|\pi^+\rangle = -|1, 1\rangle$

TABLE I: W_j Clebsch-Gordan coefficients for the different coupled channels.

Channels	$\bar{K}^0\Sigma^{*-}$	$K^-\Sigma^{*0}$	$\pi^0\Xi^{*-}$	$\eta\Xi^{*-}$	$\pi^-\Xi^{*0}$	$K^0\Omega^-$
W_j	$-\sqrt{\frac{2}{15}}$	$-\sqrt{\frac{1}{15}}$	$\sqrt{\frac{1}{15}}$	$-\sqrt{\frac{1}{5}}$	$-\sqrt{\frac{2}{15}}$	$\sqrt{\frac{2}{5}}$

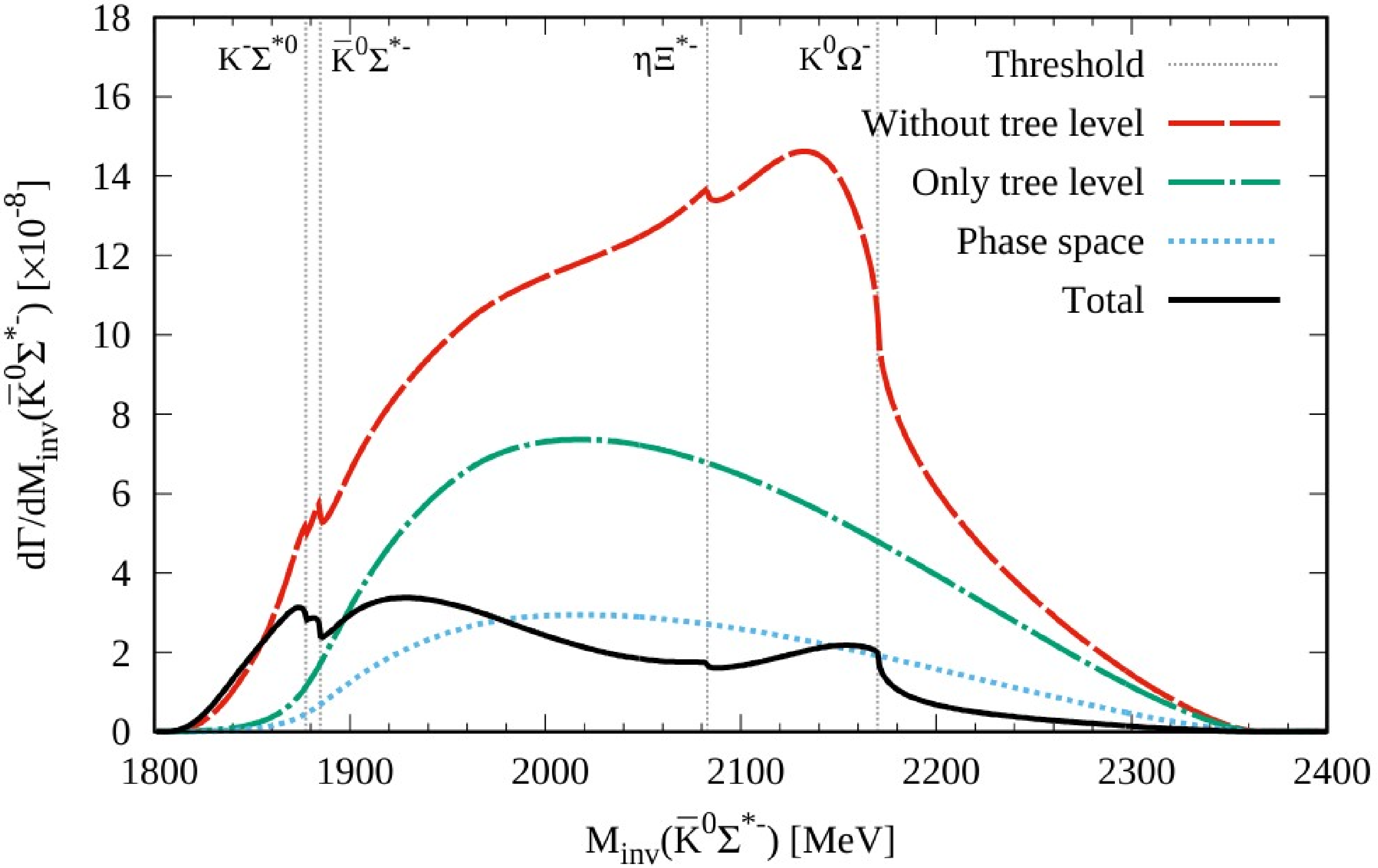
$$t = C\,\langle B^* \,|\, (\vec{S}^+ \times \vec{p}_{\bar{\Xi}^+}) \cdot \vec{\epsilon} \,|\, \Xi^- \rangle\, t' \qquad\qquad t' = W_{\bar{K}^0\Sigma^{*-}} + \sum_j W_j\, G_j\, t_{j,\bar{K}^0\Sigma^{*-}}$$

$$\frac{d\Gamma}{dM_{\rm inv}(\bar{K}^0\Sigma^{*-})} = \frac{1}{(2\pi)^3}\,\frac{1}{4M_\psi^2}\, p_{\bar{\Xi}^+}\, \tilde{p}_{\bar{K}^0} \bar{\sum} \sum |t|^2 2M_{\bar{\Xi}^+}\, 2M_{\Sigma^{*-}}\,,$$

$$\begin{aligned}\frac{d\Gamma}{dM_{\rm inv}(\bar{K}^0\Sigma^{*-})} &= \frac{1}{(2\pi)^3}\,\frac{1}{4M_\psi^2}\, p_{\bar{\Xi}^+}\, \tilde{p}_{\bar{K}^0} |t'|^2\, \frac{C'}{M_\psi^2}\, p_{\bar{\Xi}^+}^2 \\ &= \frac{1}{(2\pi)^3}\,\frac{C'}{4M_\psi^4}\, p_{\bar{\Xi}^+}^3\, \tilde{p}_{\bar{K}^0} |t'|^2\,,\end{aligned}$$

$$\frac{d\Gamma}{dM_{\rm inv}(\bar{K}^0\Sigma^{*-})dM_{\rm inv}(\Sigma^{*-})} = -\frac{1}{\pi}{\rm Im}\frac{\frac{\Gamma_{\pi^-\Lambda}}{\Gamma_{\Sigma^{*-}}}}{M_{\rm inv}(\Sigma^{*-}) - M_{\Sigma^{*-}} + i\frac{\Gamma_{\Sigma^{*-}}(M_{\rm inv}(\Sigma^{*-}))}{2}} \cdot \frac{1}{(2\pi)^3}\,\frac{C'}{4M_\psi^4}\, p_{\bar{\Xi}^+}^3\, \tilde{p}_{\bar{K}^0} |t'|^2$$

$$\Gamma_{\Sigma^{*-}}\left(M_{\rm inv}(\Sigma^{*-})\right) = \Gamma_{\rm on}\,\frac{M_{\Sigma^{*-}}}{M_{\rm inv}(\Sigma^{*-})}\left(\frac{\tilde{p}_\pi}{\tilde{p}_{\pi,{\rm on}}}\right)^3$$



The lower resonance is suppressed due to phase space and the upper one shows up clearly

Note also striking difference from phase space

Back to

The $\Omega_c \to \pi^+ (\pi^0, \eta) \pi \Xi^*$ reactions and the two $\Xi(1820)$ states

$$\Omega_c^0 \to \pi^+ \Xi(1820) \to \pi^+ \bar{K}^0 \Sigma^{*-} (K^- \Sigma^{*0}),$$

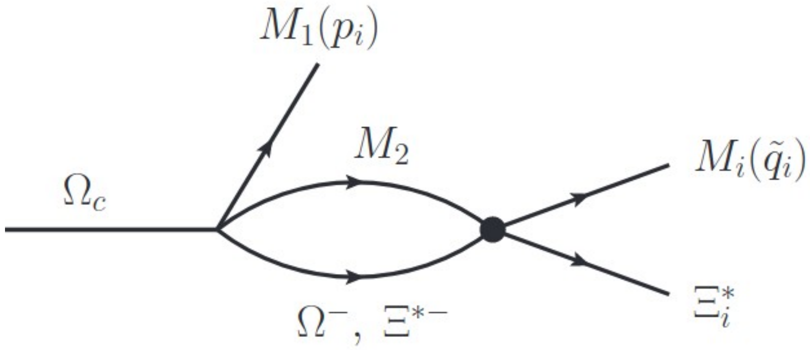
But this time with

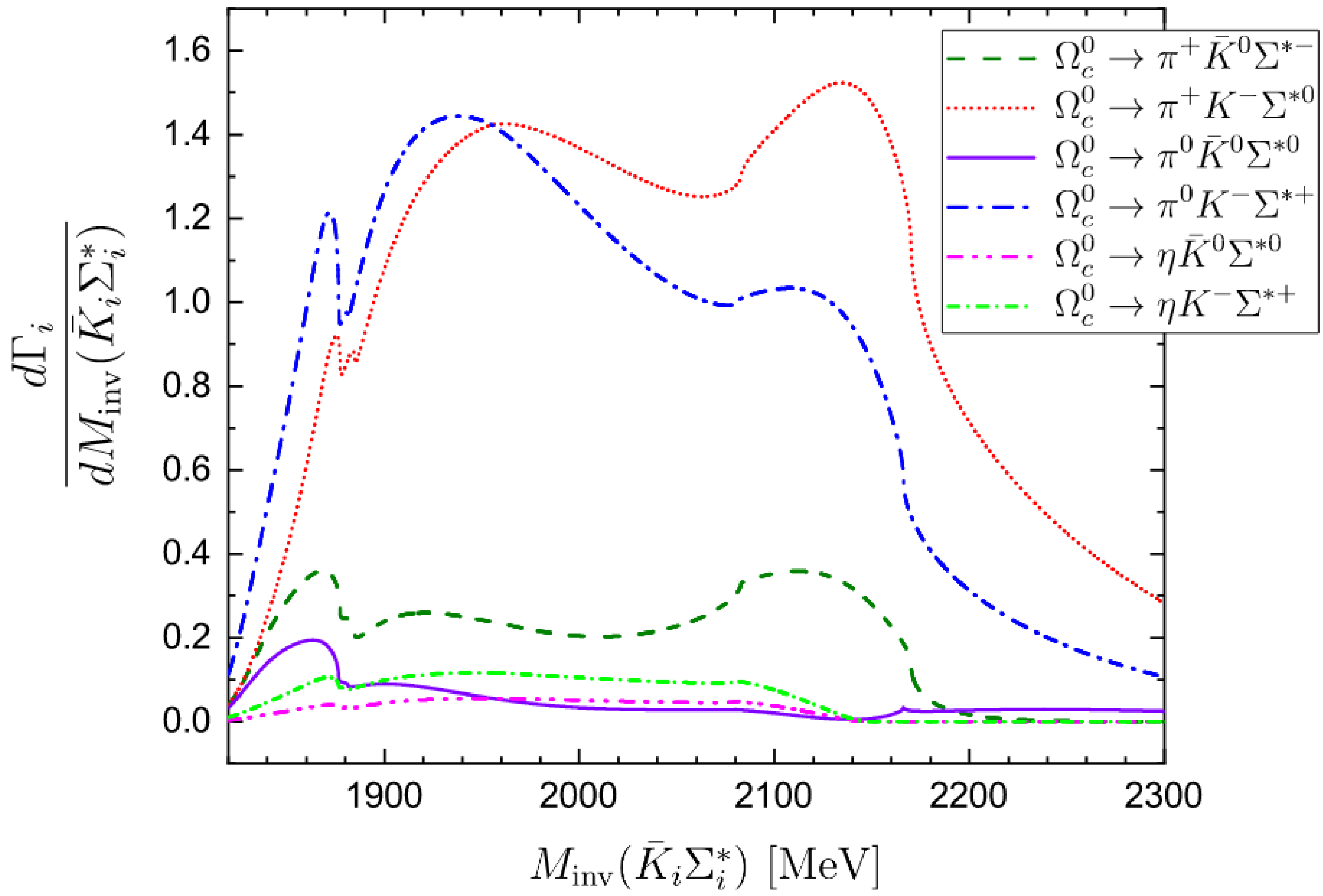
$$\Omega_c^0 \to \pi^0 \Xi(1820) \to \pi^0 \bar{K}^0 \Sigma^{*0} (K^- \Sigma^{*+}),$$

$$\Omega_c^0 \to \eta \Xi(1820) \to \eta \bar{K}^0 \Sigma^{*0} (K^- \Sigma^{*+}).$$

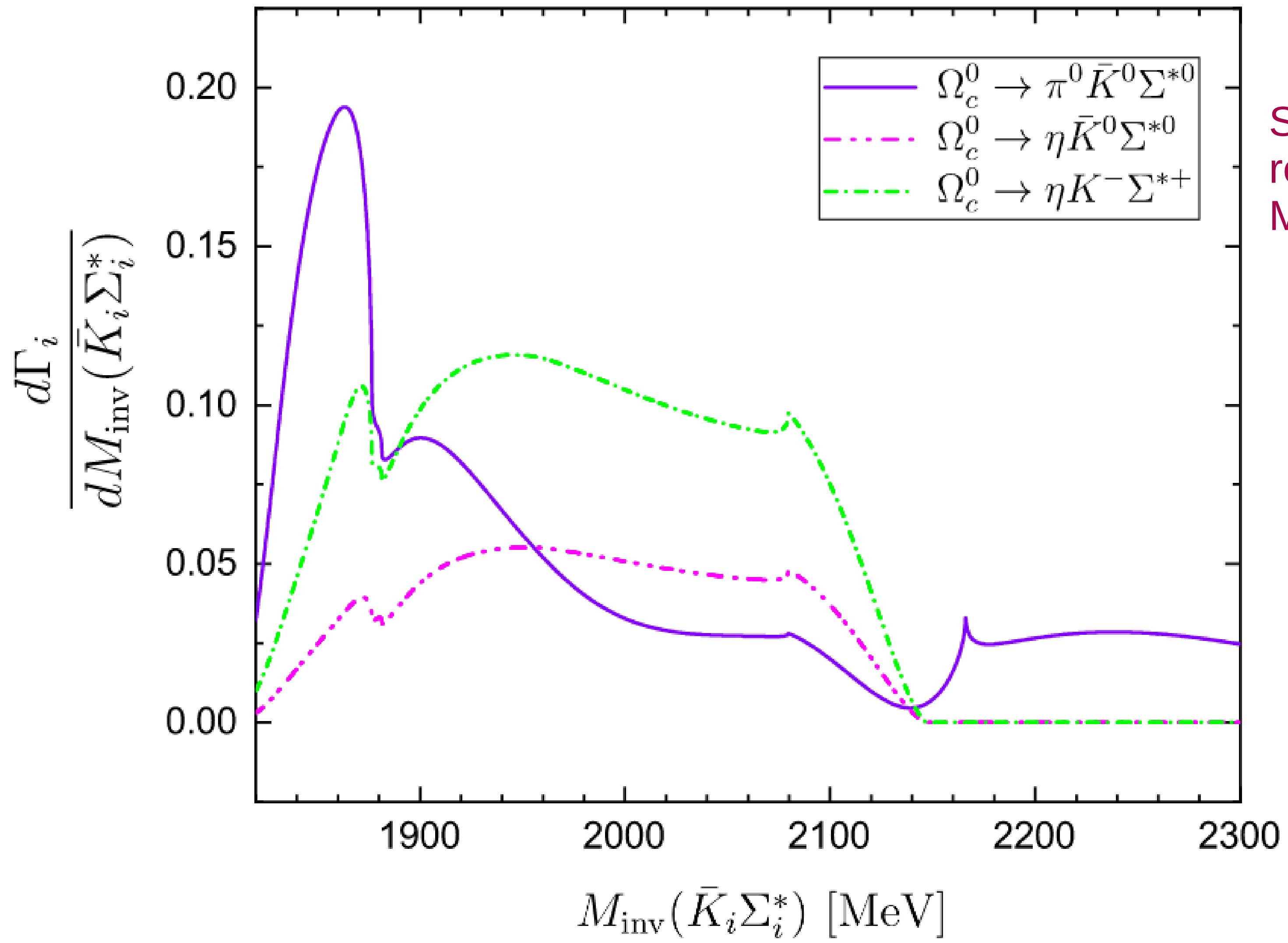
The reduced phase space for Kbar Σ* production can suppress the contribution of the low energy Ξ state and show better the higher state.

Also, there is no tree level contribution now.





$\frac{d\Gamma_i}{dM_{\rm inv}(\bar{K}_i\Sigma_i^*)}$
$M_{\rm inv}(\bar{K}_i\Sigma_i^*)$ [MeV]
$\Omega_c^0 \to \pi^+\bar{K}^0\Sigma^{*-}$
$\Omega_c^0 \to \pi^+K^-\Sigma^{*0}$
$\Omega_c^0 \to \pi^0\bar{K}^0\Sigma^{*0}$
$\Omega_c^0 \to \pi^0K^-\Sigma^{*+}$
$\Omega_c^0 \to \eta\bar{K}^0\Sigma^{*0}$
$\Omega_c^0 \to \eta K^-\Sigma^{*+}$
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1900
2000
2100
2200
2300



See interference of Ξ(1875) resonance with the Ξ at 2100 MeV

Conclusions

The interaction of pseudoscalar mesons with 3/2^+ baryons leads to two Ξ* states around 1820 MeV.

The BESIII experiment, with an apparent large width of the Ξ(1820) can be interpreted in terms of these two resonances.

We suggest the $\Omega_c \to \pi^+ \, (\pi^0, \, \eta) \, \pi \Xi^*$ reactions where the two resonances interfere giving rise to a minimum in the mass distribution

We suggest the $\psi(3686) \to \bar{\Xi}^+ \bar{K}^0 \Sigma^{*-} (\pi^- \Lambda)$ reaction, where the lower state is suppressed and the higher mass one shows up clearly

The $\Omega_c \to \pi^+ \, (\pi^0, \, \eta) \, \bar{K} \Sigma^*$ reactions have similar features and provide information on both states.