BESIII粲强子物理研讨会

A Data-driven Approach to Charmed Baryon Weak Decays

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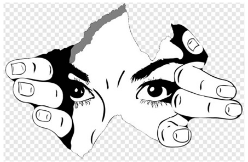
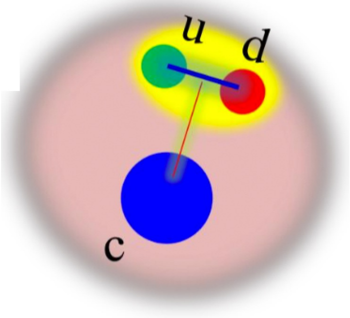
Outline

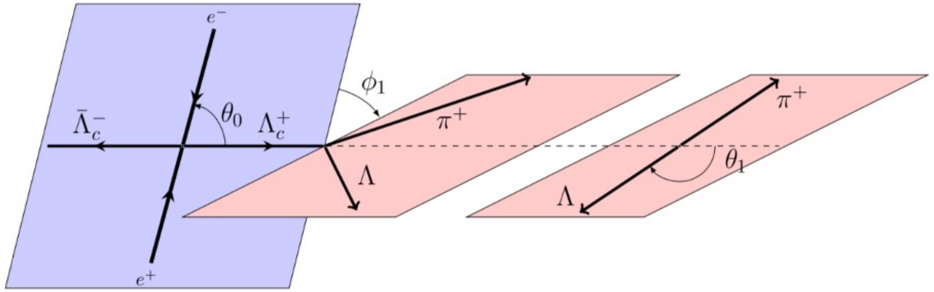
- Introduction
- Global fits based on SU(3)
- Global fits based on topological diagrams
- Summary

Huiling Zhong, FX, Qiaoyi Wen, Yu Gu, JHEP 02 (2023) 235,
& work to appear

Introduction

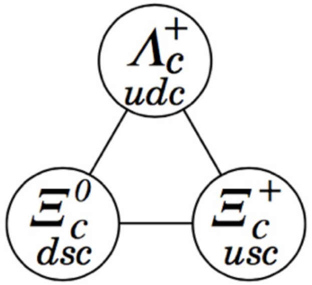






2286.46 ± 0.14 MeV

$(2.00 \pm 0.06) \times 10^{-13}$ s (S = 1.6)



$2470.87^{+0.28}_{-0.31}$ MeV

$(1.12^{+0.13}_{-0.10}) \times 10^{-13}$ s

2467.87 ± 0.30 MeV (S = 1.1)

$(4.42 \pm 0.26) \times 10^{-13}$ s (S = 1.3)

Branching Fractions

Decay Asymmetries (longitudinal, transvere)

	Channel	Channel
CF	$\Lambda_c^+ \to \Lambda^0\pi^+$	$\Xi_c^0 \to \Xi^0\pi^0$
	$\Lambda_c^+ \to \Sigma^0\pi^+$	$\Xi_c^0 \to \Xi^0\eta$
	$\Lambda_c^+ \to p\overline{K}^0$	$\Xi_c^0 \to \Xi^0\eta'$
	$\Lambda_c^+ \to \Sigma^+\pi^0$	$\Xi_c^0 \to \Xi^-\pi^+$
	$\Lambda_c^+ \to \Sigma^+\eta$	$\Omega_c^0 \to \Xi^0\overline{K}^0$
	$\Lambda_c^+ \to \Sigma^+\eta'$	
SCS	$\Lambda_c^+ \to \Lambda^0K^+$	$\Xi_c^0 \to \Xi^0K^0$
	$\Lambda_c^+ \to p\pi^0$	$\Xi_c^0 \to \Sigma^+\pi^-$
	$\Lambda_c^+ \to p\eta$	$\Xi_c^0 \to \Sigma^-\pi^+$
	$\Lambda_c^+ \to p\eta'$	$\Xi_c^0 \to \Xi^-K^+$
	$\Lambda_c^+ \to n\pi^+$	$\Omega_c^0 \to \Sigma^0\overline{K}^0$
	$\Lambda_c^+ \to \Sigma^0K^+$	$\Omega_c^0 \to \Sigma^+K^-$
	$\Lambda_c^+ \to \Sigma^+K^0$	$\Omega_c^0 \to \Lambda^0\overline{K}^0$
	$\Xi_c^+ \to \Lambda^0\pi^+$	$\Omega_c^0 \to \Xi^0\pi^0$
	$\Xi_c^+ \to p\overline{K}^0$	$\Omega_c^0 \to \Xi^-\pi^+$
	$\Xi_c^+ \to \Sigma^0\pi^+$	
	$\Xi_c^+ \to \Sigma^+\pi^0$	
DCS	$\Lambda_c^+ \to pK^0$	$\Omega_c^0 \to \Xi^0K^0$
	$\Lambda_c^+ \to nK^+$	$\Omega_c^0 \to \Lambda^0\eta$
	$\Xi_c^+ \to \Lambda^0K^+$	$\Omega_c^0 \to \Sigma^0\eta'$
	$\Xi_c^+ \to p\pi^0$	$\Omega_c^0 \to \Lambda^0\pi^0$
	$\Xi_c^+ \to p\eta$	$\Omega_c^0 \to \Sigma^0\pi^0$
	$\Xi_c^+ \to p\eta'$	$\Omega_c^0 \to \Sigma^+\pi^-$
	$\Xi_c^+ \to n\pi^+$	$\Omega_c^0 \to \Sigma^-\pi^+$
	$\Xi_c^+ \to \Sigma^0K^+$	$\Omega_c^0 \to \Xi^-K^+$

Experiemtal progress since 2022

- BESIII

$$\mathcal{B}(\Lambda_c^+ \to n\pi^+) = (6.6 \pm 1.2 \pm 0.4) \times 10^{-4},$$
$$\mathcal{B}(\Lambda_c^+ \to p\eta') = (5.62^{+2.46}_{-2.04} \pm 0.26) \times 10^{-4},$$
$$\mathcal{B}(\Lambda_c^+ \to \Lambda^0 K^+) = (6.21 \pm 0.44 \pm 0.26 \pm 0.34) \times 10^{-4},$$
$$\mathcal{B}(\Lambda_c^+ \to \Sigma^+ K_S^0) = (4.8 \pm 1.4 \pm 0.2 \pm 0.3) \times 10^{-4},$$
$$\mathcal{B}(\Lambda_c^+ \to \Sigma^0 K^+) = (4.7 \pm 0.9 \pm 0.1 \pm 0.3) \times 10^{-4}.$$

- Belle

$$\mathcal{B}(\Lambda_c^+ \to p\eta') = (4.73 \pm 0.82 \pm 0.47 \pm 0.24) \times 10^{-4},$$
$$\mathcal{B}(\Lambda_c^+ \to \Lambda^0 K^+) = (6.57 \pm 0.17 \pm 0.11 \pm 0.35) \times 10^{-4},$$
$$\mathcal{B}(\Lambda_c^+ \to \Sigma^0 K^+) = (3.58 \pm 0.19 \pm 0.06 \pm 0.19) \times 10^{-4},$$
$$\mathcal{B}(\Lambda_c^+ \to \Sigma^+ \eta) = (3.14 \pm 0.35 \pm 0.11 \pm 0.25) \times 10^{-3},$$
$$\mathcal{B}(\Lambda_c^+ \to \Sigma^+ \eta') = (4.16 \pm 0.75 \pm 0.21 \pm 0.33) \times 10^{-3},$$

$$\alpha(\Lambda_c^+ \to \Lambda^0 K^+) = -0.585 \pm 0.049 \pm 0.018,$$
$$\alpha(\Lambda_c^+ \to \Sigma^0 K^+) = -0.55 \pm 0.18 \pm 0.09,$$
$$\alpha(\Lambda_c^+ \to \Sigma^+ \eta) = -0.99 \pm 0.03 \pm 0.05,$$
$$\alpha(\Lambda_c^+ \to \Sigma^+ \eta') = -0.46 \pm 0.06 \pm 0.03.$$

	Channel	Channel
CF	$\Lambda_c^+ \to \Lambda^0 \pi^+$	$\Xi_c^0 \to \Xi^0 \pi^0$
	$\Lambda_c^+ \to \Sigma^0 \pi^+$	$\Xi_c^0 \to \Xi^0 \eta$
	$\Lambda_c^+ \to p \overline{K}^0$	$\Xi_c^0 \to \Xi^0 \eta'$
	$\Lambda_c^+ \to \Sigma^+ \pi^0$	$\Xi_c^0 \to \Xi^- \pi^+$
	$\Lambda_c^+ \to \Sigma^+ \eta$	$\Omega_c^0 \to \Xi^0 \overline{K}^0$
	$\Lambda_c^+ \to \Sigma^+ \eta'$	
SCS	$\Lambda_c^+ \to \Lambda^0 K^+$	$\Xi_c^0 \to \Xi^0 K^0$
	$\Lambda_c^+ \to p \pi^0$	$\Xi_c^0 \to \Sigma^+ \pi^-$
	$\Lambda_c^+ \to p \eta$	$\Xi_c^0 \to \Sigma^- \pi^+$
	$\Lambda_c^+ \to p \eta'$	$\Xi_c^0 \to \Xi^- K^+$
	$\Lambda_c^+ \to n \pi^+$	$\Omega_c^0 \to \Sigma^0 \overline{K}^0$
	$\Lambda_c^+ \to \Sigma^0 K^+$	$\Omega_c^0 \to \Sigma^+ K^-$
	$\Lambda_c^+ \to \Sigma^+ K^0$	$\Omega_c^0 \to \Lambda^0 \overline{K}^0$
	$\Xi_c^+ \to \Lambda^0 \pi^+$	$\Omega_c^0 \to \Xi^0 \pi^0$
	$\Xi_c^+ \to p \overline{K}^0$	$\Omega_c^0 \to \Xi^- \pi^+$
	$\Xi_c^+ \to \Sigma^0 \pi^+$	
	$\Xi_c^+ \to \Sigma^+ \pi^0$	
DCS	$\Lambda_c^+ \to p K^0$	$\Omega_c^0 \to \Xi^0 K^0$
	$\Lambda_c^+ \to n K^+$	$\Omega_c^0 \to \Lambda^0 \eta$
	$\Xi_c^+ \to \Lambda^0 K^+$	$\Omega_c^0 \to \Sigma^0 \eta'$
	$\Xi_c^+ \to p \pi^0$	$\Omega_c^0 \to \Lambda^0 \pi^0$
	$\Xi_c^+ \to p \eta$	$\Omega_c^0 \to \Sigma^0 \pi^0$
	$\Xi_c^+ \to p \eta'$	$\Omega_c^0 \to \Sigma^+ \pi^-$
	$\Xi_c^+ \to n \pi^+$	$\Omega_c^0 \to \Sigma^- \pi^+$
	$\Xi_c^+ \to \Sigma^0 K^+$	$\Omega_c^0 \to \Xi^- K^+$

Experimental results as inputs

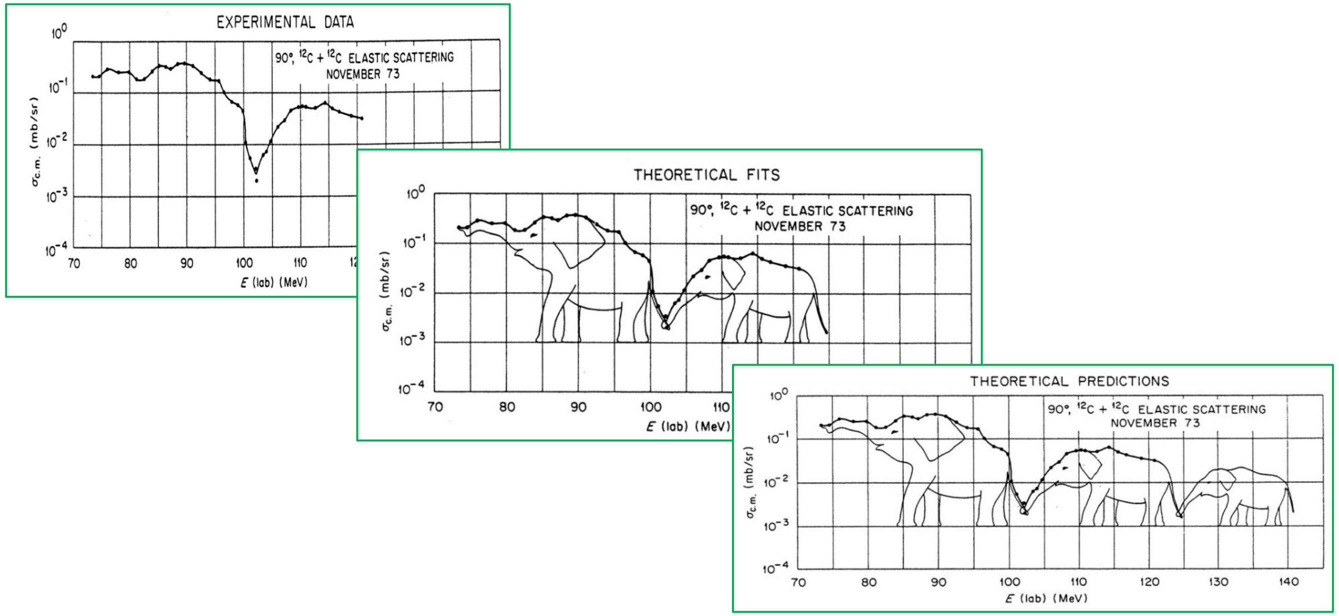
20 Branching ratios

Obs.	PDG	BESIII	Belle	Ave.
$10^2\mathcal{B}(\Lambda_c^+\to\Lambda^0\pi^+)$	1.30 ± 0.07	$1.24\pm0.08^*$ [3]		1.30 ± 0.07
$10^2\mathcal{B}(\Lambda_c^+\to\Sigma^0\pi^+)$	1.29 ± 0.07	$1.27\pm0.09^*$ [3]		1.29 ± 0.07
$10^2\mathcal{B}(\Lambda_c^+\to pK_S)$	1.59 ± 0.08	$1.52\pm0.09^*$ [3]		1.59 ± 0.08
$10^2\mathcal{B}(\Lambda_c^+\to\Sigma^+\pi^0)$	1.25 ± 0.10	$1.18\pm0.10^*$ [3]		1.25 ± 0.10
$10^2\mathcal{B}(\Lambda_c^+\to\Sigma^+\eta)$	0.44 ± 0.20 [2, 4]	$0.41\pm0.20^*$ [4]	0.314 ± 0.044 [5]	0.32 ± 0.04
$\frac{\mathcal{B}(\Lambda_c^+\to\Sigma^+\eta)}{\mathcal{B}(\Lambda_c^+\to\Sigma^+\pi^0)}$		0.35 ± 0.16 [4]		
$10^2\mathcal{B}(\Lambda_c^+\to\Sigma^+\eta')$	1.5 ± 0.6 [2, 4]	$1.34\pm0.56^*$ [4]	0.416 ± 0.085 [5]	0.44 ± 0.15 [1]
$\frac{\mathcal{B}(\Lambda_c^+\to\Sigma^+\eta')}{\mathcal{B}(\Lambda_c^+\to\Sigma^+\omega)}$		0.86 ± 0.34 [4]		
$10^2\mathcal{B}(\Lambda_c^+\to\Xi^0K^+)$	0.55 ± 0.07 [2, 6]	$0.590\pm0.094^*$ [6]		0.55 ± 0.07
$10^3\mathcal{B}(\Lambda_c^+\to p\eta)$	(Belle's data)	1.24 ± 0.30 [7]	1.42 ± 0.12 [8]	1.40 ± 0.11
$10^4\mathcal{B}(\Lambda_c^+\to p\eta')$		$5.62^{+2.46}_{-2.04}\pm0.26$ [9]	4.73 ± 0.97 [10]	4.85 ± 0.90
$10^4\mathcal{B}(\Lambda_c^+\to\Lambda^0K^+)$	6.1 ± 1.2 [11, 12]	6.21 ± 0.61 [13]	6.57 ± 0.40 [14]	6.44 ± 0.32
$\frac{\mathcal{B}(\Lambda_c^+\to\Lambda^0K^+)}{\mathcal{B}(\Lambda_c^+\to\Lambda^0\pi^+)}$			0.074 ± 0.016 [12]	
$10^4\mathcal{B}(\Lambda_c^+\to\Sigma^0K^+)$	5.2 ± 0.8 [11, 12]	4.7 ± 0.95 [15]	3.58 ± 0.28 [14]	3.82 ± 0.38 [2]
$\frac{\mathcal{B}(\Lambda_c^+\to\Sigma^0K^+)}{\mathcal{B}(\Lambda_c^+\to\Sigma^0\pi^+)}$			0.056 ± 0.016 [12]	
$10^4\mathcal{B}(\Lambda_c^+\to n\pi^+)$		6.6 ± 1.3 [16]		6.6 ± 1.3
$10^4\mathcal{B}(\Lambda_c^+\to\Sigma^+K_S)$		4.8 ± 1.4 [15]		4.8 ± 1.4
$10^4\mathcal{B}(\Lambda_c^+\to p\pi^0)$	(Belle's data)	<2.7 [7]	<0.80 [8]	<0.77
$10^2\mathcal{B}(\Xi_c^0\to\Xi^-\pi^+)$	1.43 ± 0.32 [2, 17]		$1.80\pm0.52^*$ [17]	1.43 ± 0.32
$10^3\mathcal{B}(\Xi_c^0\to\Xi^-K^+)$	0.39 ± 0.12 [2, 18]			0.39 ± 0.12
$10^2\frac{\mathcal{B}(\Xi_c^0\to\Xi^-K^+)}{\mathcal{B}(\Xi_c^0\to\Xi^-\pi^+)}$			2.75 ± 0.57 [18]	
$10^3\mathcal{B}(\Xi_c^0\to\Lambda^0K_S)$	3.2 ± 0.7 [2, 19, 20]			3.2 ± 0.7
$\frac{\mathcal{B}(\Xi_c^0\to\Lambda^0K_S^0)}{\mathcal{B}(\Xi_c^0\to\Xi^-\pi^+)}$			0.21 ± 0.03 [20]	
			0.229 ± 0.014[19]	
$10^3\mathcal{B}(\Xi_c^0\to\Sigma^0K_S)$	(Belle's data)		0.54 ± 0.16 [19]	0.54 ± 0.16
$10^3\mathcal{B}(\Xi_c^0\to\Sigma^+K^-)$	(Belle's data)		1.8 ± 0.4 [19]	1.8 ± 0.4
$10^2\mathcal{B}(\Xi_c^+\to\Xi^0\pi^+)$	1.6 ± 0.8 [17, 21]			1.6 ± 0.8
$\frac{\mathcal{B}(\Xi_c^+\to\Xi^0\pi^+)}{\mathcal{B}(\Xi_c^+\to\Xi^-2\pi^+)}$	0.55 ± 0.16 [21]			

9 decay asymmetries

$\alpha(\Lambda_c^+\to\Lambda^0\pi^+)$	-0.84 ± 0.09 [22–26]	$-0.80\pm0.11^*$ [22]	-0.755 ± 0.006 [14]	-0.76 ± 0.01
$\alpha(\Lambda_c^+\to\Sigma^0\pi^+)$	(BESIII's data)	-0.73 ± 0.18 [22]	-0.463 ± 0.018 [14]	-0.47 ± 0.03 [3]
$\alpha(\Lambda_c^+\to pK_S)$	(BESIII's data)	0.18 ± 0.45 [22]		0.18 ± 0.45
$\alpha(\Lambda_c^+\to\Sigma^+\pi^0)$	-0.55 ± 0.11 [22, 23]	$-0.57\pm0.12^*$ [22]	-0.48 ± 0.03 [5]	-0.49 ± 0.03
$\alpha(\Xi_c^0\to\Xi^-\pi^+)$	(Belle's data)		-0.64 ± 0.05 [27]	-0.64 ± 0.05
$\alpha(\Lambda_c^+\to\Sigma^+\eta)$			-0.99 ± 0.06 [5]	-0.99 ± 0.06
$\alpha(\Lambda_c^+\to\Sigma^+\eta')$			-0.46 ± 0.07 [5]	-0.46 ± 0.07
$\alpha(\Lambda_c^+\to\Lambda^0K^+)$			-0.585 ± 0.052 [14]	-0.585 ± 0.052
$\alpha(\Lambda_c^+\to\Sigma^0K^+)$			-0.55 ± 0.20 [14]	-0.55 ± 0.20

time to interpret data



Fits within SU(3) frame

- w/ or w/o Flavor symmetry
- w/ or w/o mixing effect

Flavor symmetry keeping

$$\mathcal{M} = \langle M \boldsymbol{B}_n | \mathcal{H}_{\rm eff} | \boldsymbol{B}_c \rangle = i \bar{u}_f (A - B\gamma_5) u_i$$

$$\mathcal{H}_{\rm eff} = \frac{G_F}{\sqrt{2}} V^*_{q_1 c} V_{u q_2} (c_+ \mathcal{O}_+ + c_- \mathcal{O}_-) + h.c.$$

$$(\boldsymbol{6}, \overline{\boldsymbol{15}})$$

$$\Gamma = \frac{p_c}{8\pi} \left(\frac{(m_i + m_f)^2 - m_P^2}{m_i^2} |A|^2 + \frac{(m_i - m_f)^2 - m_P^2}{m_i^2} |B|^2 \right)$$

$$\alpha = \frac{2\kappa {\rm Re}(A^* B)}{|A|^2 + \kappa^2 |B|^2}$$

$$\begin{aligned} A_0 = \; & a_0 H(6)_{ij} (\boldsymbol{B}'_c)^{ik} (\boldsymbol{B}_n)^j_k (M)^\ell_\ell + a_1 H(6)_{ij} (\boldsymbol{B}'_c)^{ik} (\boldsymbol{B}_n)^\ell_k (M)^j_\ell + a_2 H(6)_{ij} (\boldsymbol{B}'_c)^{ik} (M)^\ell_k (\boldsymbol{B}_n)^j_\ell \\ & + a_3 H(6)_{ij} (\boldsymbol{B}_n)^i_k (M)^j_\ell (\boldsymbol{B}'_c)^{k\ell} + a'_0 (\boldsymbol{B}_n)^i_j (M)^\ell_\ell H(\overline{15})^{jk}_i (\boldsymbol{B}_c)_k \\ & + a_4 H(\overline{15})^{\ell i}_k (\boldsymbol{B}_c)_j (M)^j_i (\boldsymbol{B}_n)^k_\ell + a_5 (\boldsymbol{B}_n)^i_j (M)^\ell_i H(\overline{15})^{jk}_\ell (\boldsymbol{B}_c)_k \\ & + a_6 (\boldsymbol{B}_n)^j_i (M)^m_\ell H(\overline{15})^{\ell i}_m (\boldsymbol{B}_c)_j + a_7 (\boldsymbol{B}_n)^\ell_i (M)^i_j H(\overline{15})^{jk}_\ell (\boldsymbol{B}_c)_k \end{aligned}$$

$$B_0 = A_0 \Big|_{a_i \to b_i},$$

M.J. Savage and R.P. Springer, *SU(3) Predictions for Charmed Baryon Decays*, *Phys. Rev. D* **42** (1990) 1527 [INSPIRE].

C.Q. Geng, C.-W. Liu and T.-H. Tsai, *Asymmetries of anti-triplet charmed baryon decays*, *Phys. Lett. B* **794** (2019) 19 [arXiv:1902.06189] [INSPIRE].

$$\boldsymbol{B}_c = \left(\Xi^0_c, -\Xi^+_c, \Lambda^+_c \right),$$

$$\boldsymbol{B}_n = \begin{pmatrix} \frac{1}{\sqrt{6}}\Lambda^0 + \frac{1}{\sqrt{2}}\Sigma^0 & \Sigma^+ & p \\ \Sigma^- & \frac{1}{\sqrt{6}}\Lambda^0 - \frac{1}{\sqrt{2}}\Sigma^0 & n \\ \Xi^- & \Xi^0 & -\sqrt{\frac{2}{3}}\Lambda^0 \end{pmatrix},$$

$$M = \begin{pmatrix} \frac{1}{\sqrt{2}}(\pi^0 + c_\phi \eta + s_\phi \eta') & \pi^+ & K^+ \\ \pi^- & \frac{1}{\sqrt{2}}(-\pi^0 + c_\phi \eta + s_\phi \eta') & K^0 \\ K^- & \overline{K}^0 & -s_\phi \eta + c_\phi \eta' \end{pmatrix}$$

$$\begin{aligned} \mathcal{M} = \; & a_{15} (T_{c\bar{3}})_i (H_{\overline{15}})^{\{ik\}}_j (\overline{T_8})^j_k P^l_l + b_{15} (T_{c\bar{3}})_i (H_{\overline{15}})^{\{ik\}}_j (\overline{T_8})^l_k P^j_l \\ & + c_{15} (T_{c\bar{3}})_i (H_{\overline{15}})^{\{ik\}}_j (\overline{T_8})^j_l P^l_k + d_{15} (T_{c\bar{3}})_i (H_{\overline{15}})^{\{jk\}}_l (\overline{T_8})^l_j P^i_k \\ & + e_{15} (T_{c\bar{3}})_i (H_{\overline{15}})^{\{jk\}}_l (\overline{T_8})^i_j P^l_k + a_6 (T_{c\bar{3}})^{[ik]} (H_{\overline{6}})_{\{ij\}} (\overline{T_8})^j_k P^l_l \\ & + b_6 (T_{c\bar{3}})^{[ik]} (H_{\overline{6}})_{\{ij\}} (\overline{T_8})^l_k P^j_l + c_6 (T_{c\bar{3}})^{[ik]} (H_{\overline{6}})_{\{ij\}} (\overline{T_8})^j_l P^l_k \\ & + d_6 (T_{c\bar{3}})^{[kl]} (H_{\overline{6}})_{\{ij\}} (\overline{T_8})^i_k P^j_l . \end{aligned}$$

$$H(\overline{15})^{ij}_k = \left(\begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \begin{pmatrix} 0 & s_c & 1 \\ s_c & 0 & 0 \\ 1 & 0 & 0 \end{pmatrix}, \begin{pmatrix} 0 & -s_c^2 & -s_c \\ -s_c^2 & 0 & 0 \\ -s_c & 0 & 0 \end{pmatrix} \right)$$

$$H(6)_{ij} = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 2 & -2s_c \\ 0 & -2s_c & 2s_c^2 \end{pmatrix}$$

F. Huang, Z.-P. Xing and X.-G. He, *A global analysis of charmless two body hadronic decays for anti-triplet charmed baryons*, *JHEP* **03** (2022) 143 [arXiv:2112.10556] [INSPIRE].

Flavor symmetry breaking

$$\gamma = \frac{m_s}{3\Lambda}\begin{pmatrix}1 & 0 & 0\\ 0 & 1 & 0\\ 0 & 0 & 1\end{pmatrix} + \frac{m_s}{3\Lambda}\begin{pmatrix}-1 & 0 & 0\\ 0 & -1 & 0\\ 0 & 0 & 2\end{pmatrix}$$

$(\mathbf{6}, \overline{\mathbf{15}})$

$$8 \otimes \overline{15} = \overline{42} \oplus 24^{(1)} \oplus \overline{15}^{(1)} \oplus \overline{15}^{(2)} \oplus \overline{15}^{(3)} \oplus 6^{(1)} \oplus \boxed{\bar{3}^{(1)}}$$

$$8 \otimes 6 = 24^{(2)} \oplus \overline{15}^{(4)} \oplus 6^{(2)} \oplus \boxed{\bar{3}^{(2)}}$$

$$\Delta\mathcal{L}_{QCD} = -m_s \bar{\psi}\lambda^8\psi$$

$$\mathcal{H} = (\bar{3} + 6 + \overline{15}) \times \left(1 + \epsilon 8 + \mathcal{O}(\epsilon^2)\right) \supset \bar{3} + 6 + \overline{15} + \epsilon\left(\bar{3}_i + 6_i + \overline{15}_1 + \overline{15}_2 + \overline{15}_3^1 + \overline{15}_3^2 + \overline{24}_3 + \overline{42}_3 + \cdots\right),$$

M.J. Savage, *SU(3) violations in the nonleptonic decay of charmed hadrons*, *Phys. Lett. B* **257** (1991) 414 [INSPIRE].

D. Pirtskhalava and P. Uttayarat, *CP Violation and Flavor SU(3) Breaking in D-meson Decays*, *Phys. Lett. B* **712** (2012) 81 [arXiv:1112.5451] [INSPIRE].

Assume symmetry breaking originates from $\bar{3}$

$$A' = u_1(\boldsymbol{B}_c)_i H(\bar{3})^i (\boldsymbol{B}_n)^j_k (M)^k_j + u_2(\boldsymbol{B}_c)_i H(\bar{3})^j (\boldsymbol{B}_n)^i_k (M)^k_j + u_3(\boldsymbol{B}_c)_i H(\bar{3})^j (\boldsymbol{B}_n)^k_j (M)^i_k$$

$$B' = A'\Big|_{u_i \to v_i}$$

$$H(\bar{3}) = (s_c, 0, 0)$$

C.Q. Geng, Y.K. Hsiao, C.-W. Liu and T.-H. Tsai, *SU(3) symmetry breaking in charmed baryon decays*, *Eur. Phys. J. C* **78** (2018) 593 [arXiv:1804.01666] [INSPIRE].

$\Xi_c - \Xi_c'$ mixing

$$R = 2\Gamma(\Xi_c^0 \to \Xi^- e^+ \nu_e)/3\Gamma(\Lambda_c^+ \to \Lambda e^+ \nu_e)$$

$$\mathcal{B}_{\rm Belle}(\Xi_c^0 \to \Xi^- e^+ \nu_e) = (1.31 \pm 0.04 \pm 0.07 \pm 0.38)\%\,,$$

$$\mathcal{B}_{\rm ALICE}(\Xi_c^0 \to \Xi^- e^+ \nu_e) = (2.43 \pm 0.25 \pm 0.35 \pm 0.72)\%\,,$$

$$\mathcal{B}_{\rm LQCD}(\Xi_c^0 \to \Xi^- e^+ \nu_e) = (2.38 \pm 0.44)\%$$

$$\mathcal{B}(\Lambda_c^+ \to \Lambda e^+ \nu_e) = (3.56 \pm 0.11 \pm 0.07)\%$$

$$R(\text{Belle}) = 0.33 \pm 0.10\,, \quad R(\text{ALICE}) = 0.60 \pm 0.21\,, \quad R(\text{LQCD}) = 0.59 \pm 0.11$$

$$R'_{av} = 0.46 \pm 0.07\,, \quad R_{av} = 0.59 \pm 0.10$$

$$R(SU(3)_F) = 1$$

$$|\theta_c| = 0.137(5)\pi$$

0.430398

$$|\Xi_c\rangle = \cos\theta_c|\Xi_c^{\bar{\mathbf{3}}}\rangle + \sin\theta_c|\Xi_c^{\mathbf{6}}\rangle$$

$$|\Xi_c'\rangle = \cos\theta_c|\Xi_c^{\mathbf{6}}\rangle - \sin\theta_c|\Xi_c^{\bar{\mathbf{3}}}\rangle$$

$$\theta = (1.200 \pm 0.090 \pm 0.020)^\circ$$

$$\theta = (1.220 \pm 0.130 \pm 0.010)^\circ$$

C.Q. Geng, X.-N. Jin, C.-W. Liu, PLB 833 (2023) 137736

H. Liu, L. Liu, P. Sun, J. Tan, W. Wang, Y. Yang, Q. Zhang, 2303.17863[hep-lat]

Amplitude relations

Channel	A	Channel	A
$\Lambda_c^+ \to \Lambda^0 \pi^+$	$\frac{\sqrt{6}}{6}(-2a_1 - 2a_2 - 2a_3 + a_5 - 2a_6 + a_7)$	$\Xi_c^+ \to \Xi^0 \pi^+$	$-2a_3 - a_4 - a_6$
$\Lambda_c^+ \to p\overline{K}^0$	$-2a_1 + a_5 + a_6$	$\Xi_c^0 \to \Lambda^0 \overline{K}^0$	$\frac{\sqrt{6}}{6}(-4a_1 + 2a_2 + 2a_3 - 2a_5 + a_6 + a_7)$
$\Lambda_c^+ \to \Sigma^0 \pi^+$	$\frac{\sqrt{2}}{2}(-2a_1 + 2a_2 + 2a_3 + a_5 - a_7)$	$\Xi_c^0 \to \Sigma^0 \overline{K}^0$	$\frac{\sqrt{2}}{2}(-2a_2 - 2a_3 + a_6 - a_7)$
$\Lambda_c^+ \to \Sigma^+ \pi^0$	$\frac{\sqrt{2}}{2}(2a_1 - 2a_2 - 2a_3 - a_5 + a_7)$	$\Xi_c^0 \to \Sigma^+ K^-$	$2a_2 + a_4 + a_7$
$\Lambda_c^+ \to \Sigma^+ \eta$	$\frac{\sqrt{2}}{6}c_\phi(-12a_0 - 6a_1 - 6a_2 + 6a_3 + 6a_0' + 3a_5 + 3a_7)$ $+s_\phi(2a_0 - a_0' - a_4)$	$\Xi_c^0 \to \Xi^0 \pi^0$	$\frac{\sqrt{2}}{2}(-2a_1 + 2a_3 + a_4 - a_5)$
$\Lambda_c^+ \to \Sigma^+ \eta'$	$\frac{\sqrt{2}}{6}s_\phi(-12a_0 - 6a_1 - 6a_2 + 6a_3 + 6a_0' + 3a_5 + 3a_7)$ $-c_\phi(2a_0 - a_0' - a_4)$	$\Xi_c^0 \to \Xi^0 \eta$	$\frac{\sqrt{2}}{6}c_\phi(12a_0 + 6a_1 - 6a_3 + 6a_0' + 3a_4 + 3a_5)$ $+\frac{1}{3}s_\phi(-6a_0 - 6a_2 - 3a_0' - 3a_7)$
$\Lambda_c^+ \to \Xi^0 K^+$	$-2a_2 + a_4 + a_7$	$\Xi_c^0 \to \Xi^0 \eta'$	$\frac{\sqrt{2}}{6}s_\phi(12a_0 + 6a_1 - 6a_3 + 6a_0' + 3a_4 + 3a_5)$ $-\frac{1}{3}c_\phi(-6a_0 - 6a_2 - 3a_0' - 3a_7)$
$\Xi_c^+ \to \Sigma^+ \overline{K}^0$	$2a_3 - a_4 - a_6$	$\Xi_c^0 \to \Xi^- \pi^+$	$2a_1 + a_5 + a_6$

$$A(\Lambda_c^+ \to \Sigma^0\pi^+) = -A(\Lambda_c^+ \to \Sigma^+\pi^0)$$
$$A(\Lambda_c^+ \to nK^+) = \sin^2\theta_c A(\Xi_c^+ \to \Xi^0\pi^+)$$
$$A(\Xi_c^+ \to n\pi^+) = \sin^2\theta_c A(\Lambda_c^+ \to \Xi^0 K^+)$$
$$A(\Xi_c^+ \to \Sigma^+ K^0) = \sin^2\theta_c A(\Lambda_c^+ \to p\overline{K}^0)$$
$$A(\Lambda_c^+ \to pK^0) = \sin^2\theta_c A(\Xi_c^+ \to \Sigma^+\overline{K}^0)$$
$$A(\Xi_c^0 \to \Sigma^- K^+) = -\sin^2\theta_c A(\Xi_c^0 \to \Xi^-\pi^+)$$
$$A(\Xi_c^0 \to p\pi^-) = -\sin^2\theta_c A(\Xi_c^0 \to \Sigma^+ K^-).$$

$$A(\Lambda_c^+ \to \Sigma^+ K^0) = A(\Xi_c^+ \to p\overline{K}^0)$$
$$A(\Lambda_c^+ \to n\pi^+) = A(\Xi_c^+ \to \Xi^0 K^+)$$
$$A(\Xi_c^0 \to n\overline{K}^0) = -A(\Xi_c^0 \to \Xi^0 K^0)$$
$$A(\Xi_c^0 \to p\pi^-) = \sin\theta_c A(\Xi_c^0 \to pK^-) = -\sin\theta_c A(\Xi_c^0 \to \Sigma^+\pi^-) = -\sin^2\theta_c A(\Xi_c^0 \to \Sigma^+ K^-)$$
$$A(\Xi_c^0 \to \Sigma^- K^+) = \sin\theta_c A(\Xi_c^0 \to \Xi^- K^+) = -\sin\theta_c A(\Xi_c^0 \to \Sigma^-\pi^+) = -\sin^2\theta_c A(\Xi_c^0 \to \Xi^-\pi^+)$$

broken by SU(3) breaking

Channel	$s_c^{-1}A$	Channel	$s_c^{-1}A$
$\Lambda_c^+ \to \Lambda^0 K^+$	$\frac{\sqrt{6}}{6}(2a_1 - 4a_2 + 2a_3 + 3a_4 - a_5 + 2a_6 + 2a_7$ $-2u_2 + u_3)$	$\Xi_c^+ \to \Xi^0 K^+$	$2a_2 + 2a_3 + a_6 - a_7 - u_2$
$\Lambda_c^+ \to p\pi^0$	$\frac{\sqrt{2}}{2}(2a_2 + 2a_3 - a_6 - a_7 + u_2)$	$\Xi_c^0 \to \Lambda^0 \pi^0$	$\frac{\sqrt{3}}{6}(-2a_1 - 2a_2 + 4a_3 + 3a_4 - a_5 - a_6 - a_7$ $+u_2 + u_3)$
$\Lambda_c^+ \to p\eta$	$\frac{\sqrt{2}}{2}c_\phi(4a_0 + 2a_2 - 2a_3 - 2a_0' + a_6 - a_7 + u_2)$ $+s_\phi(-2a_0 - 2a_1 + a_0' + a_4 + a_5 + a_6 - u_3)$	$\Xi_c^0 \to \Lambda^0 \eta$	$\frac{\sqrt{3}}{6}c_\phi(12a_0 + 2a_1 + 2a_2 - 4a_3 + 6a_0' + 3a_4 + a_5$ $+a_6 + a_7 + 2u_1 + u_2 + u_3)$ $+\frac{\sqrt{6}}{6}s_\phi(-6a_0 - 4a_1 - 4a_2 + 2a_3 - 3a_0' - 2a_5$ $+a_6 - 2a_7 + 2u_1)$
$\Lambda_c^+ \to p\eta'$	$\frac{\sqrt{2}}{2}s_\phi(4a_0 + 2a_2 - 2a_3 - 2a_0' + a_6 - a_7 + u_2)$ $-c_\phi(-2a_0 - 2a_1 + a_0' + a_4 + a_5 + a_6 - u_3)$	$\Xi_c^0 \to \Lambda^0 \eta'$	$\frac{\sqrt{3}}{6}s_\phi(12a_0 + 2a_1 + 2a_2 - 4a_3 + 6a_0' + 3a_4 + a_5$ $+a_6 + a_7 + 2u_1 + u_2 + u_3)$ $-\frac{\sqrt{6}}{6}c_\phi(-6a_0 - 4a_1 - 4a_2 + 2a_3 - 3a_0' - 2a_5$ $+a_6 - 2a_7 + 2u_1)$
$\Lambda_c^+ \to n\pi^+$	$2a_2 + 2a_3 + a_6 - a_7 + u_2$	$\Xi_c^0 \to pK^-$	$-2a_2 - a_4 - a_7 + u_1 + u_3$
$\Lambda_c^+ \to \Sigma^0 K^+$	$\frac{\sqrt{2}}{2}(2a_1 - 2a_3 - a_4 - a_5 + u_3)$	$\Xi_c^0 \to n\overline{K}^0$	$2a_1 - 2a_2 - 2a_3 + a_5 - a_7 + u_1$
$\Lambda_c^+ \to \Sigma^+ K^0$	$2a_1 - 2a_3 + a_4 - a_5 + u_3$	$\Xi_c^0 \to \Sigma^0 \pi^0$	$\frac{1}{2}(2a_1 + 2a_2 - a_4 + a_5 - a_6 + a_7$ $+2u_1 + u_2 + u_3)$
$\Xi_c^+ \to \Lambda^0 \pi^+$	$\frac{\sqrt{6}}{6}(2a_1 + 2a_2 - 4a_3 - 3a_4 - a_5 - a_6 - a_7$ $-u_2 - u_3)$	$\Xi_c^0 \to \Sigma^0 \eta$	$\frac{1}{2}c_\phi(-4a_0 - 2a_1 - 2a_2 - 2a_0' - a_4 - a_5$ $+a_6 - a_7 + u_2 + u_3)$ $+\frac{\sqrt{2}}{2}s_\phi(2a_0 - 2a_3 + a_0' + a_6)$
$\Xi_c^+ \to p\overline{K}^0$	$2a_1 - 2a_3 + a_4 - a_5 - u_3$	$\Xi_c^0 \to \Sigma^0 \eta'$	$\frac{1}{2}s_\phi(-4a_0 - 2a_1 - 2a_2 - 2a_0' - a_4 - a_5$ $+a_6 - a_7 + u_2 + u_3)$ $-\frac{\sqrt{2}}{2}c_\phi(2a_0 - 2a_3 + a_0' + a_6)$
$\Xi_c^+ \to \Sigma^0 \pi^+$	$\frac{\sqrt{2}}{2}(2a_1 - 2a_2 + a_4 - a_5 + a_6 + a_7 + u_2 - u_3)$	$\Xi_c^0 \to \Xi^0 K^0$	$-2a_1 + 2a_2 + 2a_3 - a_5 + a_7 + u_1$
$\Xi_c^+ \to \Sigma^+ \pi^0$	$\frac{\sqrt{2}}{2}(-2a_1 + 2a_2 + a_4 + a_5 + a_6 - a_7 - u_2 + u_3)$	$\Xi_c^0 \to \Sigma^+ \pi^-$	$2a_2 + a_4 + a_7 + u_1 + u_3$
$\Xi_c^+ \to \Sigma^+ \eta$	$\frac{\sqrt{2}}{2}c_\phi(4a_0 + 2a_1 + 2a_2 - 2a_0' - a_4 - a_5$ $-a_6 - a_7 - u_2 - u_3)$ $+s_\phi(-2a_0 + 2a_3 + a_0' - a_6)$	$\Xi_c^0 \to \Sigma^- \pi^+$	$2a_1 + a_5 + a_6 + u_1 + u_2$
$\Xi_c^+ \to \Sigma^+ \eta'$	$\frac{\sqrt{2}}{2}s_\phi(4a_0 + 2a_1 + 2a_2 - 2a_0' - a_4 - a_5$ $-a_6 - a_7 - u_2 - u_3)$ $-c_\phi(-2a_0 + 2a_3 + a_0' - a_6)$	$\Xi_c^0 \to \Xi^- K^+$	$-2a_1 - a_5 - a_6 + u_1 + u_2$

Coefficients from fit

SU(3) breaking

Exact SU(3)

(Fit 1)				(Fit 1')			
Coefficient	Value	Coefficient	Value	Coefficient	Value	Coefficient	Value
a_0	-0.46 ± 1.26	b_0	-0.78 ± 3.10	a_0	-0.20 ± 1.08	b_0	-0.75 ± 2.41
a_1	$-3.10^{+0.40}_{-0.48}$	b_1	$8.03^{+0.34}_{-0.48}$	a_1	$-3.95^{+0.15}_{-0.13}$	b_1	$3.40^{+0.85}_{-0.75}$
a_2	$1.28^{+0.15}_{-0.23}$	b_2	$2.14^{+1.42}_{-1.10}$	a_2	$0.98^{+0.19}_{-0.17}$	b_2	$4.17^{+0.30}_{-0.39}$
a_3	$1.44^{+0.30}_{-0.37}$	b_3	$0.67^{+0.66}_{-0.67}$	a_3	-1.61 ± 0.12	b_3	$1.75^{+1.12}_{-0.88}$
a'_0	1.69 ± 2.51	b'_0	1.83 ± 6.21	a'_0	1.16 ± 2.16	b'_0	1.75 ± 4.82
a_4	$-0.03^{+0.38}_{-0.39}$	b_4	$-2.26^{+1.21}_{-1.42}$	a_4	-0.13 ± 0.25	b_4	$-0.55^{+1.01}_{-1.12}$
a_5	$2.11^{+0.39}_{-0.36}$	b_5	$-2.09^{+0.60}_{-0.58}$	a_5	$1.03^{+0.30}_{-0.27}$	b_5	$-8.62^{+0.57}_{-0.55}$
a_6	$-3.13^{+0.77}_{-0.59}$	b_6	$-5.19^{+1.12}_{-0.66}$	a_6	$1.32^{+0.14}_{-0.17}$	b_6	$8.79^{+1.38}_{-1.59}$
a_7	$-0.35^{+0.36}_{-0.44}$	b_7	$-5.47^{+2.87}_{-2.11}$	a_7	$-1.12^{+0.33}_{-0.29}$	b_7	$0.23^{+1.07}_{-1.10}$
u_1	$-9.83^{+12.55}_{-1.94}$	v_1	30.48 ± 77.93				
u_2	$-2.74^{+0.93}_{-0.77}$	v_2	$-14.11^{+3.77}_{-3.44}$				
u_3	$2.92^{+0.69}_{-0.74}$	v_3	$4.78^{+2.31}_{-2.26}$				

(Fit 2)				(Fit 2')			
Coefficient	Value	Coefficient	Value	Coefficient	Value	Coefficient	Value
a_0	-0.47 ± 1.23	b_0	-0.04 ± 3.18	a_0	1.09 ± 1.09	b_0	2.45 ± 2.25
a_1	$-4.58^{+0.73}_{-1.34}$	b_1	$8.08^{+1.74}_{-1.02}$	a_1	$-5.05^{+0.73}_{-1.31}$	b_1	$3.40^{+1.63}_{-0.98}$
a_2	$0.34^{+0.47}_{-0.63}$	b_2	$0.45^{+1.24}_{-1.35}$	a_2	$0.47^{+0.42}_{-0.53}$	b_2	$5.39^{+1.44}_{-0.76}$
a_3	$-2.14^{+0.40}_{-0.33}$	b_3	$0.03^{+0.85}_{-0.68}$	a_3	$-1.55^{+0.14}_{-0.16}$	b_3	$-0.53^{+0.98}_{-0.82}$
a'_0	1.71 ± 2.47	b'_0	3.64 ± 6.36	a'_0	1.17 ± 2.19	b'_0	1.68 ± 2.45
a_4	$0.15^{+0.39}_{-0.45}$	b_4	$-3.88^{+1.59}_{-1.36}$	a_4	$-0.41^{+0.38}_{-0.30}$	b_4	$-1.68^{+1.69}_{-1.31}$
a_5	$0.35^{+1.16}_{-2.65}$	b_5	$0.09^{+3.23}_{-1.46}$	a_5	$-1.01^{+1.38}_{-2.61}$	b_5	$-6.28^{+3.11}_{-1.69}$
a_6	$-1.94^{+0.52}_{-0.75}$	b_6	$-3.09^{+1.42}_{-1.53}$	a_6	$1.48^{+0.14}_{-0.17}$	b_6	$1.23^{+1.49}_{-2.12}$
a_7	$-2.79^{+0.89}_{-1.26}$	b_7	$-8.09^{+2.09}_{-2.49}$	a_7	$-1.87^{+0.64}_{-1.01}$	b_7	$3.75^{+3.38}_{-2.65}$
u_1	$0.07^{+4.27}_{-26.14}$	v_1	26.62 ± 218.96	θ	$0.89^{+0.24}_{-0.29}$		
u_2	$-2.52^{+0.90}_{-0.87}$	v_2	$-15.45^{+3.92}_{-2.75}$				
u_3	$3.37^{+0.65}_{-0.69}$	v_3	$4.80^{+2.20}_{-1.86}$				
θ	$0.12^{+0.29}_{-0.28}$						

Identical mixing

$(6.88^{+16.62}_{-16.04})^\circ$

$|\theta_c| = 0.137(5)\pi$ 25° 0.430398

C.Q. Geng, X.-N. Jin, C.-W. Liu, PLB 833 (2023) 137736

$\theta = (1.200 \pm 0.090 \pm 0.020)^\circ$

$\theta = (1.220 \pm 0.130 \pm 0.010)^\circ$

H. Liu, L. Liu, P. Sun, J. Tan, W. Wang, Y. Yang, Q. Zhang, 2303.17863[hep-lat]

(Fit 3)				(Fit 3')			
Coefficient	Value	Coefficient	Value	Coefficient	Value	Coefficient	Value
a_0	-4.09 ± 1.15	b_0	-1.46 ± 3.24	a_0	-0.20 ± 1.09	b_0	-0.71 ± 2.45
a_1	$-7.86^{+2.42}_{-0.27}$	b_1	$6.60^{+0.78}_{-3.12}$	a_1	$-5.39^{+0.82}_{-2.11}$	b_1	$3.72^{+2.62}_{-1.14}$
a_2	$0.09^{+2.42}_{-0.26}$	b_2	$8.74^{+0.78}_{-2.28}$	a_2	$0.35^{+0.44}_{-0.75}$	b_2	$5.70^{+2.36}_{-0.88}$
a_3	$-2.09^{+0.17}_{-0.19}$	b_3	$-1.04^{+1.67}_{-1.21}$	a_3	$-1.55^{+0.14}_{-0.16}$	b_3	$-0.50^{+0.99}_{-0.82}$
a'_0	-5.50 ± 2.30	b'_0	0.25 ± 6.48	a'_0	1.17 ± 2.17	b'_0	1.67 ± 4.89
a_4	$0.22^{+0.43}_{-0.40}$	b_4	$-3.69^{+1.76}_{-2.17}$	a_4	$-0.43^{+0.37}_{-0.28}$	b_4	$-1.84^{+1.70}_{-1.21}$
a_5	$-6.53^{+4.83}_{-0.54}$	b_5	$0.24^{+1.22}_{-5.80}$	a_5	$-1.67^{+1.59}_{-4.21}$	b_5	$-5.52^{+5.03}_{-1.93}$
a_6	$1.59^{+0.13}_{-0.16}$	b_6	$11.40^{+1.61}_{-2.22}$	a_6	$1.49^{+0.14}_{-0.16}$	b_6	$11.27^{+1.41}_{-1.98}$
a_7	$-3.52^{+1.76}_{-0.50}$	b_7	$9.43^{+1.77}_{-5.10}$	a_7	$-2.08^{+0.70}_{-1.48}$	b_7	$4.55^{+5.00}_{-2.77}$
u_1	-32.61 ± 34.68	v_1	-19.78 ± 108.09	θ_1	$0.97^{+0.26}_{-0.25}$		
u_2	$0.90^{+0.85}_{-0.78}$	v_2	$-1.99^{+1.72}_{-1.99}$	θ_2	$0.01^{+3.84}_{-0.00}$		
u_3	$2.82^{+0.79}_{-0.81}$	v_3	$5.43^{+1.42}_{-1.54}$				
θ_1	1.23 ± 0.27	70°					
θ_2	$0.01^{+6.28}_{-0.01}$						

different mixings

Predictions from fit

Channel	Fit 1	Fit 1'	Fit 2	Fit 2'	Fit 3	Fit 3'	Expt.
(χ^2_{min}/d.o.f.	2.37	2.34	2.16	2.24	2.12	2.29)	
$10^2\mathcal{B}(\Lambda_c^+ \to \Lambda\pi^+)$	$1.28^{+0.13}_{-0.12}$	1.28 ± 0.08	$1.29^{+0.13}_{-0.18}$	$1.28^{+0.18}_{-0.14}$	$1.30^{+0.14}_{-0.24}$	$1.28^{+0.31}_{-0.16}$	1.30 ± 0.07
$10^2\mathcal{B}(\Lambda_c^+ \to \Sigma^0\pi^+)$	$1.29^{+0.09}_{-0.12}$	$1.31^{+0.06}_{-0.05}$	$1.28^{+0.11}_{-0.25}$	$1.30^{+0.12}_{-0.19}$	$1.28^{+0.38}_{-0.10}$	$1.30^{+0.16}_{-0.30}$	1.29 ± 0.07
$10^2\mathcal{B}(\Lambda_c^+ \to pK_S)$	1.57 ± 0.14	1.58 ± 0.09	$1.61^{+0.18}_{-0.25}$	$1.58^{+0.15}_{-0.25}$	$1.65^{+0.78}_{-0.18}$	$1.59^{+0.16}_{-0.36}$	1.59 ± 0.08
$10^2\mathcal{B}(\Lambda_c^+ \to \Sigma^+\pi^0)$	$1.29^{+0.09}_{-0.12}$	$1.31^{+0.06}_{-0.05}$	$1.28^{+0.11}_{-0.25}$	$1.31^{+0.12}_{-0.19}$	$1.28^{+0.38}_{-0.11}$	$1.30^{+0.16}_{-0.30}$	1.25 ± 0.10
$10^2\mathcal{B}(\Lambda_c^+ \to \Sigma^+\eta)$	0.43 ± 0.11	0.38 ± 0.11	$0.30^{+0.14}_{-0.12}$	$0.37^{+0.15}_{-0.14}$	0.25 ± 0.18	$0.36^{+0.19}_{-0.18}$	0.320 ± 0.120 [4, 10]
$10^2\mathcal{B}(\Lambda_c^+ \to \Sigma^+\eta')$	$0.41^{+0.12}_{-0.13}$	0.20 ± 0.06	$0.42^{+0.13}_{-0.14}$	0.20 ± 0.06	$0.40^{+0.14}_{-0.12}$	$0.20^{+0.06}_{-0.08}$	0.437 ± 0.151 [4, 10]
$10^2\mathcal{B}(\Lambda_c^+ \to \Xi^0K^+)$	0.51 ± 0.08	$0.38^{+0.31}_{-0.32}$	$0.53^{+0.09}_{-0.11}$	$0.38^{+0.07}_{-0.09}$	$0.52^{+0.17}_{-0.09}$	$0.38^{+0.09}_{-0.13}$	0.55 ± 0.07
$10^3\mathcal{B}(\Lambda_c^+ \to p\eta)$	$1.50^{+0.18}_{-0.16}$	$1.37^{+1.20}_{-1.13}$	$1.42^{+0.22}_{-0.18}$	$1.42^{+0.17}_{-0.19}$	$1.30^{+0.26}_{-0.12}$	$1.42^{+0.19}_{-0.24}$	1.42 ± 0.12
$10^4\mathcal{B}(\Lambda_c^+ \to p\eta')$	4.99 ± 0.87	$5.33^{+0.84}_{-0.85}$	$5.01^{+0.85}_{-1.15}$	$5.34^{+0.90}_{-1.10}$	$4.95^{+1.33}_{-1.08}$	$5.35^{+0.97}_{-1.47}$	4.849 ± 0.903 [14, 15]
$10^4\mathcal{B}(\Lambda_c^+ \to \Lambda K^+)$	$6.47^{+0.58}_{-0.61}$	$6.68^{+0.36}_{-0.35}$	$6.52^{+0.68}_{-0.98}$	$6.67^{+0.59}_{-0.82}$	$6.58^{+1.35}_{-0.49}$	$6.68^{+0.72}_{-1.20}$	6.462 ± 0.334 [11, 12]
$10^4\mathcal{B}(\Lambda_c^+ \to \Sigma^0K^+)$	$3.63^{+0.37}_{-0.40}$	$3.59^{+0.24}_{-0.22}$	$3.70^{+0.54}_{-0.39}$	$3.58^{+0.51}_{-0.58}$	$3.69^{+0.63}_{-1.10}$	$3.58^{+0.79}_{-0.87}$	3.670 ± 0.297 [12, 13]
$10^4\mathcal{B}(\Lambda_c^+ \to n\pi^+)$	$6.51^{+1.42}_{-1.22}$	$8.16^{+0.78}_{-0.66}$	$6.82^{+1.43}_{-1.28}$	$8.19^{+1.55}_{-0.98}$	$7.04^{+1.89}_{-2.01}$	$8.20^{+2.64}_{-1.00}$	6.6 ± 1.3 [16]
$10^4\mathcal{B}(\Lambda_c^+ \to \Sigma^+K_S)$	$2.57^{+0.72}_{-0.75}$	$3.61^{+0.65}_{-0.61}$	$1.82^{+0.85}_{-0.64}$	$3.74^{+0.79}_{-0.89}$	$1.86^{+1.05}_{-1.01}$	$3.72^{+0.93}_{-1.20}$	4.8 ± 1.4 [13]
$10^4\mathcal{B}(\Lambda_c^+ \to p\pi^0)$	$0.12^{+0.30}_{-0.26}$	0.17 ± 0.10	0.30 ± 0.53	$0.62^{+0.60}_{-0.62}$	$0.87^{+0.85}_{-0.81}$	$0.66^{+0.71}_{-0.63}$	< 0.80 [17]
$10^2\mathcal{B}(\Xi_c^0 \to \Xi^-\pi^+)$	$1.53^{+0.37}_{-0.40}$	$0.92^{+0.20}_{-0.18}$	$1.62^{+0.56}_{-0.84}$	$1.07^{+0.45}_{-0.69}$	$1.43^{+1.74}_{-2.09}$	$1.11^{+0.59}_{-1.09}$	1.43 ± 0.32
$10^3\mathcal{B}(\Xi_c^0 \to \Xi^-K^+)$	$0.38^{+0.54}_{-0.81}$	$0.40^{+0.09}_{-0.08}$	$0.38^{+0.15}_{-2.03}$	$0.47^{+0.20}_{-0.31}$	$0.38^{+0.66}_{-0.52}$	$0.49^{+0.26}_{-0.49}$	0.38 ± 0.12
$10^3\mathcal{B}(\Xi_c^0 \to \Lambda K_S)$	$3.14^{+0.86}_{-0.78}$	$4.28^{+0.58}_{-0.55}$	$2.96^{+1.22}_{-1.35}$	$3.53^{+1.39}_{-1.98}$	$3.37^{+4.20}_{-4.96}$	$3.36^{+0.18}_{-0.30}$	3.34 ± 0.67
$10^3\mathcal{B}(\Xi_c^0 \to \Sigma^0K_S)$	$0.69^{+0.40}_{-0.37}$	$0.79^{+0.26}_{-0.24}$	$0.60^{+0.38}_{-0.46}$	$0.72^{+0.43}_{-0.58}$	$0.69^{+1.00}_{-0.98}$	$0.69^{+0.48}_{-0.66}$	0.69 ± 0.24
$10^3\mathcal{B}(\Xi_c^0 \to \Sigma^+K^-)$	$1.85^{+0.67}_{-0.63}$	$1.73^{+0.41}_{-0.48}$	$1.89^{+0.76}_{-0.85}$	$1.80^{+0.96}_{-0.95}$	$1.81^{+2.38}_{-2.37}$	$1.81^{+1.43}_{-1.02}$	1.8 ± 0.4
$10^2\mathcal{B}(\Xi_c^+ \to \Xi^0\pi^+)$	$3.08^{+0.50}_{-0.49}$	$0.82^{+0.12}_{-0.10}$	$1.52^{+0.93}_{-0.94}$	$0.32^{+0.19}_{-0.24}$	$0.66^{+0.23}_{-0.25}$	$0.82^{+0.11}_{-0.13}$	1.6 ± 0.8

Predictions from fit

Channel ($\chi^2_{\rm min}$/d.o.f.	Fit 1 2.37	Fit 1' 2.34	Fit 2 2.16	Fit 2' 2.24	Fit 3 2.12	Fit 3' 2.29)	Expt.
$\alpha(\Lambda_c^+ \to \Lambda\pi^+)$	$-0.76^{+0.04}_{-0.02}$	-0.76 ± 0.01	$-0.76^{+0.04}_{-0.03}$	-0.75 ± 0.06	$-0.75^{+0.10}_{-0.05}$	$-0.75^{+0.08}_{-0.10}$	-0.755 ± 0.006 [4, 12]
$\alpha(\Lambda_c^+ \to \Sigma^0\pi^+)$	$-0.47^{+0.06}_{-0.04}$	$-0.47^{+0.04}_{-0.02}$	$-0.47^{+0.09}_{-0.08}$	$-0.48^{+0.12}_{-0.06}$	$-0.47^{+0.13}_{-0.23}$	$-0.48^{+0.23}_{-0.07}$	-0.466 ± 0.026 [4, 12]
$\alpha(\Lambda_c^+ \to pK_S)$	$-0.86^{+0.17}_{-0.13}$	-0.48 ± 0.19	-1.00 ± 0.002	$-0.14^{+0.35}_{-0.29}$	$-0.11^{+0.20}_{-0.53}$	$-0.13^{+0.47}_{-0.29}$	0.18 ± 0.45
$\alpha(\Lambda_c^+ \to \Sigma^+\pi^0)$	$-0.48^{+0.07}_{-0.04}$	$-0.48^{+0.04}_{-0.02}$	$-0.47^{+0.09}_{-0.08}$	$-0.48^{+0.12}_{-0.06}$	$-0.47^{+0.13}_{-0.23}$	$-0.48^{+0.23}_{-0.07}$	-0.485 ± 0.029 [4, 10]
$\alpha(\Xi_c^0 \to \Xi^-\pi^+)$	$-0.65^{+0.08}_{-0.07}$	-0.66 ± 0.06	$-0.65^{+0.16}_{-0.17}$	$-0.64^{+0.16}_{-0.20}$	$-0.64^{+0.21}_{-0.20}$	$-0.64^{+0.25}_{-0.31}$	-0.64 ± 0.05
$\alpha(\Lambda_c^+ \to \Sigma^+\eta)$	$-0.96^{+0.07}_{-0.08}$	-0.96 ± 0.05	$-0.97^{+0.09}_{-0.10}$	$-1.00^{+0.05}_{-0.04}$	$-0.96^{+0.14}_{-0.11}$	$-0.99^{+0.08}_{-0.07}$	-0.99 ± 0.06 [10]
$\alpha(\Lambda_c^+ \to \Sigma^+\eta')$	-0.46 ± 0.08	-0.45 ± 0.07	$-0.45^{+0.09}_{-0.08}$	$-0.46^{+0.12}_{-0.10}$	$-0.46^{+0.08}_{-0.12}$	$-0.46^{+0.18}_{-0.11}$	-0.46 ± 0.07 [10]
$\alpha(\Lambda_c^+ \to \Lambda K^+)$	$-0.58^{+0.11}_{-0.08}$	-0.55 ± 0.06	$-0.58^{+0.09}_{-0.10}$	$-0.55^{+0.13}_{-0.11}$	$-0.57^{+0.08}_{-0.14}$	$-0.55^{+0.19}_{-0.10}$	-0.585 ± 0.052 [12]
$\alpha(\Lambda_c^+ \to \Sigma^0 K^+)$	$-0.65^{+0.19}_{-0.21}$	$-0.98^{+0.02}_{-0.01}$	$-0.53^{+0.21}_{-0.27}$	-0.98 ± 0.03	$-0.63^{+0.26}_{-0.19}$	$-0.98^{+0.05}_{-0.04}$	-0.55 ± 0.20 [12]
$\alpha(\Lambda_c^+ \to \Xi^0 K^+)$	0.99 ± 0.05	0.90 ± 0.04	$1.00^{+0.03}_{-0.04}$	$0.91^{+0.09}_{-0.07}$	$0.97^{+0.07}_{-0.06}$	$0.91^{+0.13}_{-0.10}$	

- better with symmetry breaking terms in all schemes
- decay asymmetry for $\Lambda_c^+ \to pK_s$ in all schemes prefers to be negative

Comparison

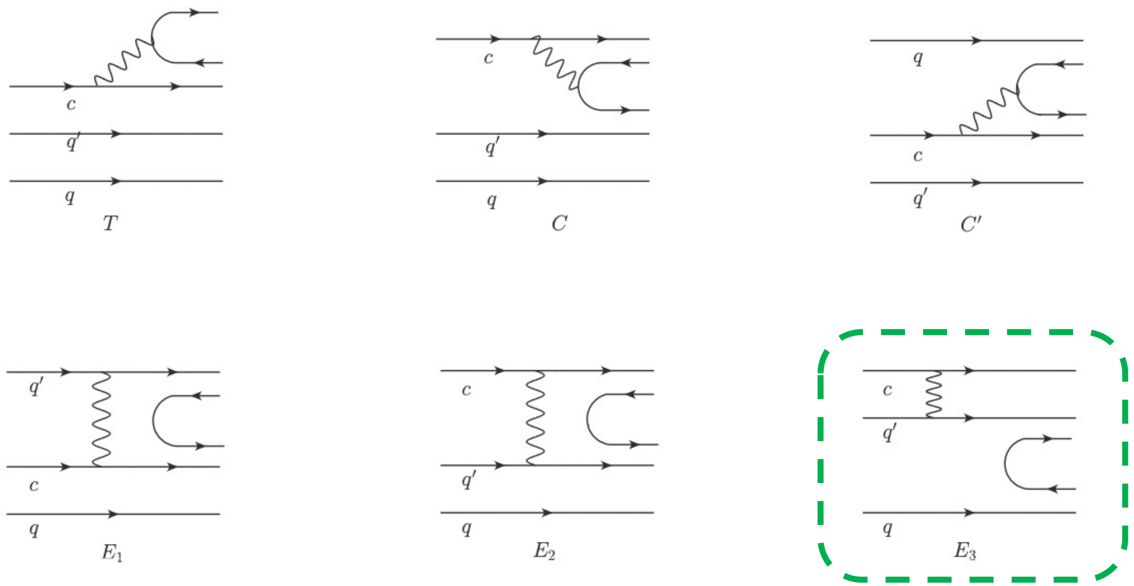
channel	Fit-III	Fit-III'	GLT [18]	HXH [19]	ZWHY [20]	ZXMC [13, 37]	Expt.
$10^2\mathcal{B}(\Lambda_c^+ \to \Lambda^0\pi^+)$	$1.30^{+0.12}_{-0.14}$	$1.27^{+0.08}_{-0.09}$	1.30 ± 0.07	1.307 ± 0.069	1.32 ± 0.34	1.30	1.30 ± 0.07
$10^2\mathcal{B}(\Lambda_c^+ \to pK_S)$	1.65 ± 0.11	1.59 ± 0.10	1.57 ± 0.08	1.587 ± 0.077	1.57 ± 0.05	1.06	1.59 ± 0.08
$10^2\mathcal{B}(\Lambda_c^+ \to \Sigma^0\pi^+)$	1.27 ± 0.09	1.30 ± 0.06	1.27 ± 0.06	1.272 ± 0.056	1.3 ± 0.32	2.24	1.29 ± 0.07
$10^2\mathcal{B}(\Lambda_c^+ \to \Sigma^+\pi^0)$	1.27 ± 0.09	1.30 ± 0.06	1.27 ± 0.06	1.283 ± 0.057	1.23 ± 0.17	2.24	1.25 ± 0.10
$10^2\mathcal{B}(\Lambda_c^+ \to \Sigma^+\eta)$	$0.30^{+0.06}_{-0.07}$	0.31 ± 0.05	0.32 ± 0.13	0.45 ± 0.19	0.47 ± 0.22	0.74	0.44 ± 0.20
							0.314 ± 0.044 [7]
$10^2\mathcal{B}(\Lambda_c^+ \to \Sigma^+\eta')$	0.39 ± 0.08	0.24 ± 0.05	1.44 ± 0.56	1.5 ± 0.60	0.93 ± 0.28	-	1.50 ± 0.60
							0.416 ± 0.085 [7]
$10^2\mathcal{B}(\Lambda_c^+ \to \Xi^0K^+)$	$0.50^{+0.06}_{-0.09}$	0.38 ± 0.03	0.56 ± 0.09	0.548 ± 0.068	0.59 ± 0.17	0.73	0.55 ± 0.07
$10^3\mathcal{B}(\Lambda_c^+ \to p\eta)$	1.27 ± 0.11	$1.36^{+0.11}_{-0.12}$	1.15 ± 0.27	1.27 ± 0.24	1.14 ± 0.35	1.28	1.42 ± 0.12
$10^4\mathcal{B}(\Lambda_c^+ \to p\eta')$	$4.65^{+0.79}_{-0.77}$	$5.93^{+0.73}_{-0.71}$	24.5 ± 14.6	27 ± 38	7.1 ± 1.4	-	4.73 ± 0.97 [5]
							$5.62^{+2.46}_{-2.04} \pm 0.26$ [2]
$10^4\mathcal{B}(\Lambda_c^+ \to \Lambda^0K^+)$	$6.54^{+0.42}_{-0.49}$	$6.62^{+0.23}_{-0.22}$	6.5 ± 1.0	6.4 ± 1.0	5.9 ± 1.7	10.7	6.21 ± 0.61 [3]
							6.57 ± 0.40 [6]
$10^4\mathcal{B}(\Lambda_c^+ \to \Sigma^0K^+)$	$3.71^{+0.39}_{-0.36}$	$3.56^{+0.68}_{-0.69}$	5.4 ± 0.7	5.04 ± 0.56	5.5 ± 1.6	7.2	4.7 ± 0.95 [4]
							3.58 ± 0.28 [6]
$10^4\mathcal{B}(\Lambda_c^+ \to n\pi^+)$	$6.47^{+1.33}_{-1.55}$	$8.15^{+0.69}_{-0.67}$	8.5 ± 2.0	3.5 ± 1.1	7.7 ± 2.0	-	6.6 ± 1.3 [1]
$10^4\mathcal{B}(\Lambda_c^+ \to \Sigma^+K_S)$	$1.99^{+0.49}_{-0.46}$	$3.11^{+0.35}_{-0.34}$	5.45 ± 0.75	1.03 ± 0.42	9.55 ± 2.4	7.2	4.8 ± 1.4 [4]
$10^4\mathcal{B}(\Lambda_c^+ \to p\pi^0)$	$0.51^{+0.59}_{-0.61}$	0.16 ± 0.09	1.2 ± 1.2	44.5 ± 8.5	$0.8^{+0.9}_{-0.8}$	1.26	< 0.80 [35]
$10^2\mathcal{B}(\Xi_c^0 \to \Xi^-\pi^+)$	$2.43^{+0.60}_{-0.64}$	$0.70^{+0.25}_{-0.22}$	2.21 ± 0.14	1.21 ± 0.21	1.93 ± 0.28	6.47	1.43 ± 0.32
$10^3\mathcal{B}(\Xi_c^0 \to \Xi^-K^+)$	$0.60^{+1.03}_{-0.67}$	$0.31^{+0.11}_{-0.09}$	0.98 ± 0.06	0.47 ± 0.083	0.56 ± 0.08	3.90	0.38 ± 0.12
$10^3\mathcal{B}(\Xi_c^0 \to \Lambda^0K_S)$	$3.34^{+0.97}_{-0.98}$	$3.79^{+0.66}_{-0.61}$	5.25 ± 0.3	3.34 ± 0.65	4.16 ± 2.51	6.65	3.34 ± 0.67
$10^3\mathcal{B}(\Xi_c^0 \to \Sigma^0K_S)$	$0.74^{+0.25}_{-0.30}$	$0.73^{+0.25}_{-0.25}$	0.4 ± 0.4	0.69 ± 0.24	3.96 ± 0.25	0.2	0.69 ± 0.24
$10^3\mathcal{B}(\Xi_c^0 \to \Sigma^+K^-)$	$1.86^{+0.45}_{-0.71}$	$1.74^{+0.41}_{-0.51}$	5.9 ± 1.1	2.21 ± 0.68	22.0 ± 5.7	4.6	1.8 ± 0.4
$10^2\mathcal{B}(\Xi_c^+ \to \Xi^0\pi^+)$	$0.55^{+0.19}_{-0.20}$	0.81 ± 0.11	0.38 ± 0.20	0.54 ± 0.18	0.93 ± 0.36	1.72	1.6 ± 0.8

Fit within topological diagrams

Working frame

$$\Gamma = \frac{p_c}{8\pi}\left(\frac{(m_i+m_f)^2-m_P^2}{m_i^2}|A|^2+\frac{(m_i-m_f)^2-m_P^2}{m_i^2}|B|^2\right),$$

$$\alpha = \frac{2\kappa\mathrm{Re}(A^*B)}{|A|^2+\kappa^2|B|^2},\beta = \frac{2\kappa\mathrm{Im}(A^*B)}{|A|^2+\kappa^2|B|^2},\gamma = \frac{|A|^2-\kappa^2|B|^2}{|A|^2+\kappa^2|B|^2},$$



22 parameters

$$A_T, A_C e^{i\delta_{A_C}}, A_{C'} e^{i\delta_{A_{C'}}}, A_{E_1} e^{i\delta_{A_{E_1}}}, A_{E_2} e^{i\delta_{A_{E_2}}}, A_{E_3} e^{i\delta_{A_{E_3}}},$$
$$B_T, B_C e^{i\delta_{B_C}}, B_{C'} e^{i\delta_{B_{C'}}}, B_{E_1} e^{i\delta_{B_{E_1}}}, B_{E_2} e^{i\delta_{B_{E_2}}}, B_{E_3} e^{i\delta_{B_{E_3}}}.$$

w/ or w/o $\Lambda^0-\Sigma^0$ mixing

Channel	Contributions	Channel	Contributions	Channel	Contributions
$\Lambda_c^+\to\Lambda^0\pi^+$	T, C', E_1, E_3	$\Lambda_c^+\to\Xi^0K^+$	E_1, E_3	$\Xi_c^0\to\Xi^0\pi^0$	C', E_1
$\Lambda_c^+\to\Sigma^0\pi^+$	T, C', E_1, E_3	$\Xi_c^+\to\Sigma^+\overline{K}^0$	C, C'	$\Xi_c^0\to\Xi^0\eta$	C', E_1, E_2, E_3
$\Lambda_c^+\to p\overline{K}^0$	C, E_2	$\Xi_c^+\to\Xi^0\pi^+$	T, C'	$\Xi_c^0\to\Xi^0\eta'$	C', E_1, E_2, E_3
$\Lambda_c^+\to\Sigma^+\pi^0$	C', E_1, E_3	$\Xi_c^0\to\Lambda^0\overline{K}^0$	C, C', E_2, E_3	$\Xi_c^0\to\Xi^-\pi^+$	T, E_1
$\Lambda_c^+\to\Sigma^+\eta$	C', E_1, E_2, E_3	$\Xi_c^0\to\Sigma^0\overline{K}^0$	C, C', E_2, E_3	$\Omega_c^0\to\Xi^0\overline{K}^0$	C, C'
$\Lambda_c^+\to\Sigma^+\eta'$	C', E_1, E_2, E_3	$\Xi_c^0\to\Sigma^+K^-$	E_2, E_3		
$\Lambda_c^+\to\Lambda^0K^+$	T, C', E_1, E_3	$\Xi_c^+\to\Sigma^+\eta$	C, C', E_1, E_2, E_3	$\Xi_c^0\to\Xi^0K^0$	C', E_2, E_3
$\Lambda_c^+\to p\pi^0$	C, C', E_1, E_2, E_3	$\Xi_c^+\to\Sigma^+\eta'$	C, C', E_1, E_2, E_3	$\Xi_c^0\to\Sigma^+\pi^-$	E_2, E_3
$\Lambda_c^+\to p\eta$	C, C', E_1, E_2, E_3	$\Xi_c^+\to\Xi^0K^+$	T, C', E_1, E_3	$\Xi_c^0\to\Sigma^-\pi^+$	T, E_1
$\Lambda_c^+\to p\eta'$	C, C', E_1, E_2, E_3	$\Xi_c^0\to\Lambda^0\pi^0$	C, C', E_1, E_2, E_3	$\Xi_c^0\to\Xi^-K^+$	T, E_1
$\Lambda_c^+\to n\pi^+$	T, C', E_1, E_3	$\Xi_c^0\to\Lambda^0\eta$	C, C', E_1, E_2, E_3	$\Omega_c^0\to\Sigma^0\overline{K}^0$	C', E_2, E_3
$\Lambda_c^+\to\Sigma^0K^+$	T, C', E_1, E_3	$\Xi_c^0\to\Lambda^0\eta'$	C, C', E_1, E_2, E_3	$\Omega_c^0\to\Sigma^+K^-$	E_2, E_3
$\Lambda_c^+\to\Sigma^+K^0$	C', E_2	$\Xi_c^0\to pK^-$	E_2, E_3	$\Omega_c^0\to\Lambda^0\overline{K}^0$	C', E_2, E_3
$\Xi_c^+\to\Lambda^0\pi^+$	T, C', E_1, E_3	$\Xi_c^0\to n\overline{K}^0$	C', E_2, E_3	$\Omega_c^0\to\Xi^0\pi^0$	C, E_1
$\Xi_c^+\to p\overline{K}^0$	C', E_2	$\Xi_c^0\to\Sigma^0\pi^0$	C, C', E_1, E_2, E_3	$\Omega_c^0\to\Xi^-\pi^+$	T, E_1
$\Xi_c^+\to\Sigma^0\pi^+$	T, C', E_1, E_3	$\Xi_c^0\to\Sigma^0\eta$	C, C', E_1, E_2, E_3		
$\Xi_c^+\to\Sigma^+\pi^0$	C, E_1, E_3	$\Xi_c^0\to\Sigma^0\eta'$	C, C', E_1, E_2, E_3		

Fitted parameters

w/ mixing | **w/o mixing**

w/ E_3

FitI				FitI'			
Coefficient	Value	Coefficient	Value	Coefficient	Value	Coefficient	Value
A_T	-0.46 ± 1.57	B_T	23.32 ± 5.20	A_T	-0.27 ± 1.71	B_T	24.19 ± 5.07
A_C	5.84 ± 1.99	B_C	37.02 ± 3.94	A_C	5.70 ± 2.01	B_C	37.20 ± 3.85
$A_{C'}$	-4.42 ± 0.68	$B_{C'}$	-31.08 ± 2.52	$A_{C'}$	-4.31 ± 0.71	$B_{C'}$	-31.32 ± 2.58
A_{E_1}	-6.77 ± 1.72	B_{E_1}	-26.82 ± 4.52	A_{E_1}	-6.71 ± 1.74	B_{E_1}	-26.76 ± 4.90
A_{E_2}	-5.32 ± 0.96	B_{E_2}	-7.51 ± 4.15	A_{E_2}	-5.34 ± 0.95	B_{E_2}	-8.02 ± 4.34
A_{E_3}	1.64 ± 1.70	B_{E_3}	-9.87 ± 5.59	A_{E_3}	1.62 ± 1.69	B_{E_3}	-10.07 ± 6.12
δ_{A_C}	1.81 ± 0.44	δ_{B_C}	-0.53 ± 0.17	δ_{A_C}	1.76 ± 0.43	δ_{B_C}	-0.53 ± 0.17
$\delta_{A_{C'}}$	2.53 ± 0.16	$\delta_{B_{C'}}$	-0.28 ± 0.04	$\delta_{A_{C'}}$	2.51 ± 0.15	$\delta_{B_{C'}}$	-0.27 ± 0.04
$\delta_{A_{E_1}}$	1.84 ± 0.30	$\delta_{B_{E_1}}$	1.40 ± 0.30	$\delta_{A_{E_1}}$	1.80 ± 0.31	$\delta_{B_{E_1}}$	1.37 ± 0.30
$\delta_{A_{E_2}}$	1.38 ± 0.35	$\delta_{B_{E_2}}$	-4.99 ± 0.57	$\delta_{A_{E_2}}$	1.33 ± 0.32	$\delta_{B_{E_2}}$	-5.03 ± 0.51
$\delta_{A_{E_3}}$	1.90 ± 0.89	$\delta_{B_{E_3}}$	-2.19 ± 0.41	$\delta_{A_{E_3}}$	1.83 ± 0.97	$\delta_{B_{E_3}}$	-2.24 ± 0.39
θ	-			θ	-0.03 ± 0.02		

w/o E_3

FitII				FitII'			
Coefficient	Value	Coefficient	Value	Coefficient	Value	Coefficient	Value
A_T	-1.94 ± 0.68	B_T	22.58 ± 3.58	A_T	-2.08 ± 0.72	B_T	23.07 ± 3.61
A_C	6.09 ± 1.35	B_C	39.75 ± 2.98	A_C	5.95 ± 1.40	B_C	39.69 ± 2.95
$A_{C'}$	-4.58 ± 0.41	$B_{C'}$	-30.62 ± 1.68	$A_{C'}$	-4.52 ± 0.42	$B_{C'}$	-30.61 ± 1.69
A_{E_1}	-5.54 ± 0.33	B_{E_1}	-18.68 ± 1.10	A_{E_1}	-5.56 ± 0.34	B_{E_1}	-18.60 ± 1.08
A_{E_2}	-3.97 ± 0.44	B_{E_2}	-4.33 ± 2.34	A_{E_2}	-3.99 ± 0.44	B_{E_2}	-4.33 ± 2.32
A_{E_3}	-	B_{E_3}	-	A_{E_3}	-	B_{E_3}	-
δ_{A_C}	1.98 ± 0.27	δ_{B_C}	-0.38 ± 0.10	δ_{A_C}	1.97 ± 0.28	δ_{B_C}	-0.39 ± 0.10
$\delta_{A_{C'}}$	2.48 ± 0.10	$\delta_{B_{C'}}$	-0.27 ± 0.04	$\delta_{A_{C'}}$	2.48 ± 0.10	$\delta_{B_{C'}}$	-0.27 ± 0.04
$\delta_{A_{E_1}}$	1.78 ± 0.11	$\delta_{B_{E_1}}$	1.71 ± 0.15	$\delta_{A_{E_1}}$	1.79 ± 0.11	$\delta_{B_{E_1}}$	1.71 ± 0.15
$\delta_{A_{E_2}}$	1.39 ± 0.26	$\delta_{B_{E_2}}$	-5.32 ± 0.62	$\delta_{A_{E_2}}$	1.39 ± 0.26	$\delta_{B_{E_2}}$	-5.29 ± 0.62
$\delta_{A_{E_3}}$	-	$\delta_{B_{E_3}}$	-	$\delta_{A_{E_3}}$	-	$\delta_{B_{E_3}}$	-
θ	-			θ	1.61 ± 0.02		

P-wave amplitudes have large sizes compared with corresponding s-wave one

The uncertainty of E_3 is large

TDA predictions in various schemes

Better: w/o $\boldsymbol{E_3}$

Λ^0/Σ^0 involved decays do not work well;

To introduce a mixing seems not a prescription

negative α

Obs.	Fit I χ_i^2	Fit I Pred.	Fit I' χ_i^2	Fit I' Pred.	Fit II χ_i^2	Fit II Pred.	Fit II' χ_i^2	Fit II' Pred.	Expt.
$(\chi^2_{\rm min}/\text{d.o.f.}$		12.50		14.05		8.60		$8.78)$	
$10^2\mathcal{B}(\Lambda_c^+\to\Lambda^0\pi^+)$	0.00	$1.30^{+0.85}_{-0.67}$	0.84	$1.36^{+0.92}_{-0.73}$	0.02	$1.29^{+0.19}_{-0.16}$	0.41	$1.35^{+0.20}_{-0.18}$	1.30 ± 0.07
$10^2\mathcal{B}(\Lambda_c^+\to\Sigma^0\pi^+)$	0.12	$1.26^{+0.82}_{-0.65}$	2.51	$1.16^{+0.76}_{-0.61}$	0.21	$1.25^{+0.18}_{-0.16}$	0.03	$1.28^{+0.17}_{-0.15}$	1.29 ± 0.07
$10^2\mathcal{B}(\Lambda_c^+\to pK_S)$	0.03	$1.58^{+0.49}_{-0.40}$	0.03	$1.58^{+0.49}_{-0.40}$	0.05	$1.57^{+0.32}_{-0.29}$	0.01	$1.58^{+0.33}_{-0.29}$	1.59 ± 0.08
$10^2\mathcal{B}(\Lambda_c^+\to\Sigma^+\pi^0)$	0.01	$1.27^{+0.54}_{-0.47}$	0.01	$1.26^{+0.56}_{-0.47}$	0.44	$1.32^{+0.16}_{-0.15}$	0.22	1.30 ± 0.15	1.25 ± 0.10
$10^2\mathcal{B}(\Lambda_c^+\to\Sigma^+\eta)$	0.12	$0.33^{+0.26}_{-0.19}$	0.13	$0.33^{+0.26}_{-0.19}$	0.09	$0.33^{+0.09}_{-0.08}$	0.10	$0.33^{+0.09}_{-0.08}$	0.32 ± 0.04 [2, 4, 5]
$10^2\mathcal{B}(\Lambda_c^+\to\Sigma^+\eta')$	0.06	$0.40^{+0.14}_{-0.12}$	0.06	$0.40^{+0.14}_{-0.12}$	0.49	0.34 ± 0.04	0.37	$0.35^{+0.05}_{-0.04}$	0.44 ± 0.15 [2, 4, 5]
$10^2\mathcal{B}(\Lambda_c^+\to\Xi^0K^+)$	0.04	$0.54^{+0.40}_{-0.30}$	0.01	$0.54^{+0.41}_{-0.31}$	0.38	0.59 ± 0.05	0.02	0.54 ± 0.05	0.55 ± 0.07
$10^3\mathcal{B}(\Lambda_c^+\to p\eta)$	0.00	$1.40^{+0.59}_{-0.50}$	0.00	$1.41^{+0.59}_{-0.49}$	0.08	$1.37^{+0.32}_{-0.29}$	0.14	$1.36^{+0.33}_{-0.29}$	1.40 ± 0.11 [7, 8]
$10^4\mathcal{B}(\Lambda_c^+\to p\eta')$	0.40	$5.42^{+1.47}_{-1.32}$	0.42	$5.43^{+1.49}_{-1.35}$	0.53	$5.50^{+0.64}_{-0.57}$	0.79	$5.65^{+0.61}_{-0.57}$	4.85 ± 0.90 [9, 10]
$10^4\mathcal{B}(\Lambda_c^+\to\Lambda^0K^+)$	3.01	$5.89^{+3.52}_{-2.78}$	1.29	$6.08^{+3.93}_{-3.25}$	3.54	$5.84^{+0.95}_{-0.77}$	0.79	$6.16^{+0.98}_{-0.84}$	6.44 ± 0.32 [11–14]
$10^4\mathcal{B}(\Lambda_c^+\to\Sigma^0K^+)$	6.65	$4.80^{+2.95}_{-2.31}$	3.31	$4.51^{+2.90}_{-2.34}$	5.76	$4.73^{+0.77}_{-0.63}$	0.00	$3.80^{+0.70}_{-0.58}$	3.82 ± 0.38 [11, 12, 14, 15]
$10^4\mathcal{B}(\Lambda_c^+\to n\pi^+)$	0.29	$7.30^{+4.98}_{-3.95}$	0.21	$7.19^{+5.12}_{-3.98}$	0.25	$7.25^{+1.16}_{-0.95}$	0.43	$7.46^{+1.11}_{-0.96}$	6.6 ± 1.3 [16]
$10^4\mathcal{B}(\Lambda_c^+\to\Sigma^+K_S)$	0.64	$3.68^{+1.06}_{-0.91}$	0.67	$3.66^{+1.02}_{-0.88}$	1.70	$2.98^{+0.57}_{-0.56}$	1.65	$3.00^{+0.58}_{-0.52}$	4.8 ± 1.4 [15]
$10^4\mathcal{B}(\Lambda_c^+\to p\pi^0)$	0.17	$0.32^{+2.22}_{-1.31}$	0.18	$0.32^{+2.24}_{-1.33}$	2.32	$1.17^{+0.93}_{-0.72}$	1.62	$0.98^{+0.96}_{-0.69}$	<0.77 [7, 8]
$10^2\mathcal{B}(\Xi_c^0\to\Xi^-\pi^+)$	0.33	$1.61^{+0.61}_{-0.50}$	0.36	$1.62^{+0.62}_{-0.51}$	0.03	$1.38^{+0.26}_{-0.22}$	0.00	$1.44^{+0.27}_{-0.21}$	1.43 ± 0.32 [2, 17]
$10^3\mathcal{B}(\Xi_c^0\to\Xi^-K^+)$	1.81	$0.23^{+0.11}_{-0.09}$	1.51	$0.24^{+0.11}_{-0.10}$	1.69	0.23 ± 0.07	1.22	$0.26^{+0.08}_{-0.06}$	0.39 ± 0.12 [2, 18]
$10^3\mathcal{B}(\Xi_c^0\to\Lambda^0K_S)$	11.30	$0.85^{+2.03}_{-1.34}$	10.05	$0.98^{+2.33}_{-1.46}$	10.48	$0.93^{+0.89}_{-0.62}$	10.38	$0.94^{+1.00}_{-0.70}$	3.2 ± 0.7 [2, 19, 20]
$10^3\mathcal{B}(\Xi_c^0\to\Sigma^0K_S)$	1.16	$0.71^{+1.83}_{-1.20}$	1.32	$0.72^{+1.79}_{-1.15}$	2.46	$0.79^{+0.78}_{-0.54}$	2.28	$0.78^{+0.75}_{-0.53}$	0.54 ± 0.16 [19]
$10^3\mathcal{B}(\Xi_c^0\to\Sigma^+K^-)$	0.01	$1.83^{+2.24}_{-1.61}$	0.01	$1.83^{+2.35}_{-1.68}$	0.04	$1.88^{+0.47}_{-0.40}$	0.01	$1.83^{+0.47}_{-0.40}$	1.8 ± 0.4 [19]
$10^2\mathcal{B}(\Xi_c^+\to\Xi^0\pi^+)$	0.68	$0.94^{+0.55}_{-0.39}$	0.85	$0.86^{+0.59}_{-0.40}$	1.17	$0.73^{+0.26}_{-0.19}$	1.22	$0.72^{+0.25}_{-0.18}$	1.6 ± 0.8 [17, 21]
$\alpha(\Lambda_c^+\to\Lambda^0\pi^+)$	6.13	$-0.74^{+0.44}_{-0.29}$	6.16	$-0.74^{+0.48}_{-0.29}$	5.87	$-0.74^{+0.12}_{-0.09}$	7.86	$-0.73^{+0.12}_{-0.09}$	-0.76 ± 0.01 [2, 14]
$\alpha(\Lambda_c^+\to\Sigma^0\pi^+)$	53.57	$-0.69^{+0.42}_{-0.29}$	53.55	$-0.69^{+0.46}_{-0.30}$	53.86	$-0.69^{+0.12}_{-0.09}$	52.03	$-0.69^{+0.12}_{-0.09}$	-0.47 ± 0.03 [2, 14]
$\alpha(\Lambda_c^+\to pK_S)$	0.66	$-0.19^{+0.34}_{-0.30}$	0.64	$-0.18^{+0.32}_{-0.29}$	0.90	$-0.25^{+0.22}_{-0.20}$	0.99	$-0.27^{+0.23}_{-0.21}$	0.18 ± 0.45
$\alpha(\Lambda_c^+\to\Sigma^+\pi^0)$	0.00	$-0.49^{+0.35}_{-0.28}$	0.00	$-0.49^{+0.35}_{-0.28}$	0.30	$-0.51^{+0.10}_{-0.09}$	0.01	$-0.49^{+0.10}_{-0.09}$	-0.49 ± 0.03 [2, 5]
$\alpha(\Xi_c^0\to\Xi^-\pi^+)$	0.00	$-0.64^{+0.34}_{-0.26}$	0.00	$-0.64^{+0.34}_{-0.27}$	0.36	-0.61 ± 0.14	0.02	$-0.63^{+0.15}_{-0.14}$	-0.64 ± 0.05
$\alpha(\Lambda_c^+\to\Sigma^+\eta)$	0.12	$-0.97^{+0.37}_{-0.17}$	0.15	$-0.97^{+0.37}_{-0.17}$	0.54	$-0.95^{+0.10}_{-0.05}$	0.34	$-0.95^{+0.10}_{-0.05}$	-0.99 ± 0.06 [5]
$\alpha(\Lambda_c^+\to\Sigma^+\eta')$	0.01	$-0.47^{+0.19}_{-0.18}$	0.00	$-0.46^{+0.20}_{-0.19}$	0.25	-0.42 ± 0.09	0.19	$-0.43^{+0.09}_{-0.09}$	-0.46 ± 0.07 [5]
$\alpha(\Lambda_c^+\to\Lambda^0K^+)$	0.05	$-0.57^{+0.44}_{-0.31}$	0.02	$-0.58^{+0.44}_{-0.32}$	0.73	$-0.54^{+0.13}_{-0.11}$	4.38	$-0.69^{+0.14}_{-0.12}$	-0.585 ± 0.052 [14]
$\alpha(\Lambda_c^+\to\Sigma^0K^+)$	0.13	$-0.62^{+0.47}_{-0.31}$	0.05	$-0.59^{+0.47}_{-0.31}$	0.04	$-0.59^{+0.14}_{-0.11}$	0.25	$-0.45^{+0.15}_{-0.13}$	-0.55 ± 0.20 [14]
$\alpha(\Lambda_c^+\to\Xi^0K^+)$		$-0.94^{+0.38}_{-0.19}$		$-0.95^{+0.39}_{-0.19}$		$-0.91^{+0.08}_{-0.05}$		$-0.87^{+0.08}_{-0.05}$	

Predictions for more observables

	Fit I			
Channel	$\mathcal{B}$	α	β	γ
$\Lambda_c^+ \to \Lambda^0\pi^+$	$(1.30^{+0.85}_{-0.67})\times 10^{-2}$	$-0.73^{+0.44}_{-0.29}$	$-0.01^{+0.56}_{-0.57}$	$0.68^{+0.29}_{-0.43}$
$\Lambda_c^+ \to \Sigma^0\pi^+$	$(1.26^{+0.82}_{-0.65})\times 10^{-2}$	$-0.69^{+0.42}_{-0.29}$	-0.01 ± 0.54	$0.72^{+0.26}_{-0.41}$
$\Lambda_c^+ \to pK_S$	$(1.58^{+0.49}_{-0.40})\times 10^{-2}$	$-0.19^{+0.34}_{-0.30}$	0.24 ± 0.30	$-0.95^{+0.17}_{-0.08}$
$\Lambda_c^+ \to \Sigma^+\pi^0$	$(1.27^{+0.54}_{-0.47})\times 10^{-2}$	$-0.49^{+0.34}_{-0.29}$	$-0.04^{+0.35}_{-0.33}$	$-0.87^{+0.26}_{-0.14}$
$\Lambda_c^+ \to \Sigma^+\eta$	$(0.33^{+0.26}_{-0.19})\times 10^{-2}$	$-0.97^{+0.37}_{-0.17}$	$0.18^{+0.42}_{-0.46}$	$-0.16^{+0.54}_{-0.51}$
$\Lambda_c^+ \to \Sigma^+\eta'$	$(0.40^{+0.14}_{-0.12})\times 10^{-2}$	$-0.47^{+0.19}_{-0.18}$	$0.46^{+0.20}_{-0.22}$	$0.76^{+0.11}_{-0.17}$
$\Lambda_c^+ \to \Xi^0K^+$	$(0.54^{+0.40}_{-0.30})\times 10^{-2}$	$-0.94^{+0.37}_{-0.20}$	$-0.30^{+0.56}_{-0.47}$	$0.17^{+0.39}_{-0.52}$
$\Lambda_c^+ \to p\eta$	$(1.40^{+0.59}_{-0.50})\times 10^{-3}$	$0.01^{+0.39}_{-0.38}$	$-0.08^{+0.41}_{-0.36}$	$-1.00^{+0.19}_{-0.09}$
$\Lambda_c^+ \to p\eta'$	$(5.42^{+1.47}_{-1.32})\times 10^{-4}$	$-0.34^{+0.25}_{-0.24}$	$-0.94^{+0.06}_{-0.12}$	$0.05^{+0.26}_{-0.25}$
$\Lambda_c^+ \to \Lambda^0K^+$	$(5.89^{+3.52}_{-2.78})\times 10^{-4}$	$-0.57^{+0.45}_{-0.32}$	$0.23^{+0.49}_{-0.54}$	$-0.78^{+0.43}_{-0.25}$
$\Lambda_c^+ \to \Sigma^0K^+$	$(4.80^{+2.95}_{-2.31})\times 10^{-4}$	$-0.62^{+0.47}_{-0.31}$	$0.25^{+0.51}_{-0.58}$	$-0.74^{+0.46}_{-0.30}$
$\Lambda_c^+ \to n\pi^+$	$(7.30^{+4.98}_{-3.95})\times 10^{-4}$	$-0.83^{+0.48}_{-0.27}$	$-0.01^{+0.59}_{-0.63}$	$0.56^{+0.38}_{-0.48}$
$\Lambda_c^+ \to \Sigma^+K_S$	$(3.68^{+1.06}_{-0.91})\times 10^{-4}$	$-0.87^{+0.20}_{-0.11}$	$-0.00^{+0.26}_{-0.27}$	$-0.49^{+0.27}_{-0.24}$
$\Lambda_c^+ \to p\pi^0$	$(0.32^{+2.22}_{-1.31})\times 10^{-4}$	$-0.25^{+0.70}_{-0.65}$	$-0.30^{+0.71}_{-0.67}$	$0.92^{+0.70}_{-0.65}$
$\Xi_c^0 \to \Xi^-\pi^+$	$(1.61^{+0.61}_{-0.50})\times 10^{-2}$	$-0.64^{+0.34}_{-0.26}$	$-0.68^{+0.33}_{-0.23}$	$-0.36^{+0.32}_{-0.27}$
$\Xi_c^0 \to \Xi^-K^+$	$(0.23^{+0.11}_{-0.09})\times 10^{-3}$	$-0.14^{+0.48}_{-0.44}$	0.00 ± 0.00	$-0.99^{+0.19}_{-0.05}$
$\Xi_c^0 \to \Lambda^0K_S$	$(0.85^{+2.03}_{-1.34})\times 10^{-3}$	$-0.05^{+0.71}_{-0.62}$	$-0.44^{+0.75}_{-0.54}$	$-0.90^{+0.72}_{-0.55}$
$\Xi_c^0 \to \Sigma^0K_S$	$(0.71^{+1.83}_{-1.20})\times 10^{-3}$	$-0.05^{+0.72}_{-0.63}$	$-0.48^{+0.76}_{-0.54}$	$-0.88^{+0.70}_{-0.60}$
$\Xi_c^0 \to \Sigma^+K^-$	$(1.83^{+2.24}_{-1.61})\times 10^{-3}$	$-0.10^{+0.61}_{-0.59}$	$-0.55^{+0.66}_{-0.48}$	$0.83^{+0.34}_{-0.60}$
$\Xi_c^+ \to \Xi^0\pi^+$	$(0.94^{+0.55}_{-0.39})\times 10^{-2}$	$0.03^{+0.51}_{-0.42}$	$0.98^{+0.12}_{-0.24}$	$0.21^{+0.35}_{-0.44}$

Summary

- Two independent fitting methods are investigated to explore the features of charmed baryon weak decays.
- In flavor symmetry framework, the Ξ_c mixing effect with identical or different mixing angles is studied both in flavor symmetry keeping or breaking cases.
- The data prefer the symmetry breaking case.
- The identical mixing angle is fitted to be $6.88°$.
- In our TDA approach, the case without E_3 is more preferred.
- More observables, including transverse decay asymmetries, can be predicted in TDA.
- Decays involving Λ^0/Σ^0 can not be fitted well, requiring a further study.