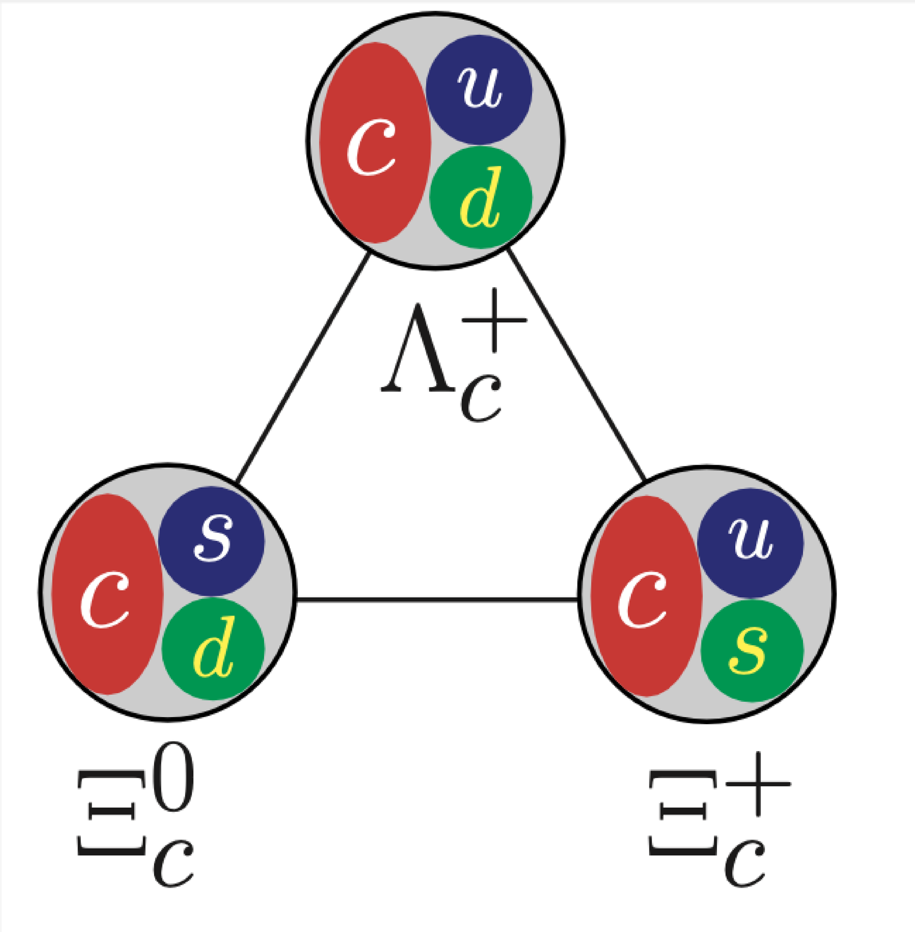
A global analysis for determined and undetermined hadronic two body weak decays of anti-triplet charmed baryons

Zhi-Peng XIng, Xiao-Gang He, **Fei Huang**, Chang Yang
School of Physics and Astronomy, Shanghai Jiao Tong University

arXiv: **2305.14854**
TOPAC2023, Jun. 2-4, 2023, Shanghai, China

Introduction



A large amount of data on hadronic two body weak decays of anti-triplet charmed baryons $T_{c\bar{3}}$ to an octet baryon T_8 and an octet or singlet pseudoscalar meson P, $T_{c\bar{3}} \to T_8 P$, have been measured. The SU(3) flavor symmetry has been applied to study these decays to obtain insights about weak interactions for charm physics. However not all such decays needed to determine the SU(3) irreducible amplitudes have been measured forbidding a complete global analysis. Previously, it has been shown that data from measured decays can be used to do a global fit to determine all except one parity violating and one parity conserving amplitudes of the relevant SU(3) irreducible amplitudes causing 8 hadronic two body weak decay channels involving Ξ_c^0 to η or η' transitions undetermined. In this work using newly measured decay modes by BESIII and Belle in 2022, we carry out a global analysis and parameterize the unknown amplitudes to provide the ranges for the branching ratios of the 8 undetermined decays.

SU(3) invariant amplitudes

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

References

References

[1] M. Ablikim *et al.* [BESIII], Phys. Rev. D. **106** (2022) no.7, 072002

[2] M. Ablikim *et al.* [BESIII], Phys. Rev. D **106**, no.11, L111101 (2022)

[3] L. K. Li *et al.* [Belle], Sci. Bull. **68**, 583-592 (2023) doi:10.1016/j.scib.2023.02.017

[4] S. X. Li *et al.* [Belle], Phys. Rev. D **107**, 032003 (2023)

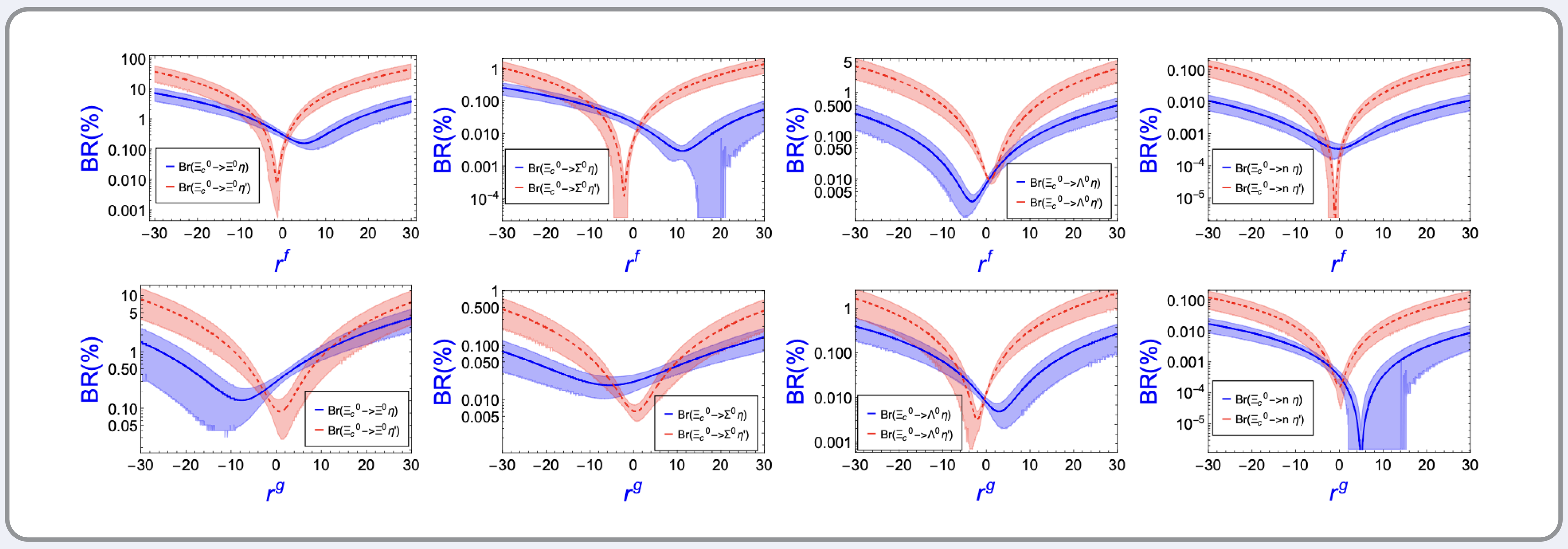
SU(3) symmetry for charmed baryon semileptonic decays

a significant amount of experimental data has been updated, and some previously unmeasured decay channels are now available experimentally which are shown in Table

Channel	Lastest measurement in 2022(%)
$\Lambda_c^+ \to pK_S^0$	–
$\Lambda_c^+ \to p\eta$	–
$\Lambda_c^+ \to p\eta'$	$0.0562^{+0.0246}_{-0.0204} \pm 0.0026$[30]
	$0.0473 \pm 0.0082 \pm 0.0046 \pm 0.0024$[34]
$\Lambda_c^+ \to \Lambda\pi^+$	$1.31 \pm 0.08 \pm 0.05$[33]
$\Lambda_c^+ \to \Sigma^0\pi^+$	$1.22 \pm 0.08 \pm 0.07$[33]
$\Lambda_c^+ \to \Sigma^+\pi^0$	–
$\Lambda_c^+ \to \Xi^0 K^+$	–
$\Lambda_c^+ \to \Lambda^0 K^+$	$0.0621 \pm 0.0044 \pm 0.0026 \pm 0.0034$[31]
	$0.0657 \pm 0.0017 \pm 0.0011 \pm 0.0035$[35]
$\Lambda_c^+ \to \Sigma^+\eta$	$0.416 \pm 0.075 \pm 0.021 \pm 0.033$[36]
$\Lambda_c^+ \to \Sigma^+\eta'$	$0.314 \pm 0.035 \pm 0.011 \pm 0.025$[36]
$\Lambda_c^+ \to \Sigma^0 K^+$	$0.047 \pm 0.009 \pm 0.001 \pm 0.003$[32]
	$0.0358 \pm 0.0019 \pm 0.0006 \pm 0.0019$[35]
$\Lambda_c^+ \to n\pi^+$	$0.066 \pm 0.012 \pm 0.004$[33]
$\Lambda_c^+ \to \Sigma^+ K_s^0$	$0.048 \pm 0.014 \pm 0.002 \pm 0.003$[32]

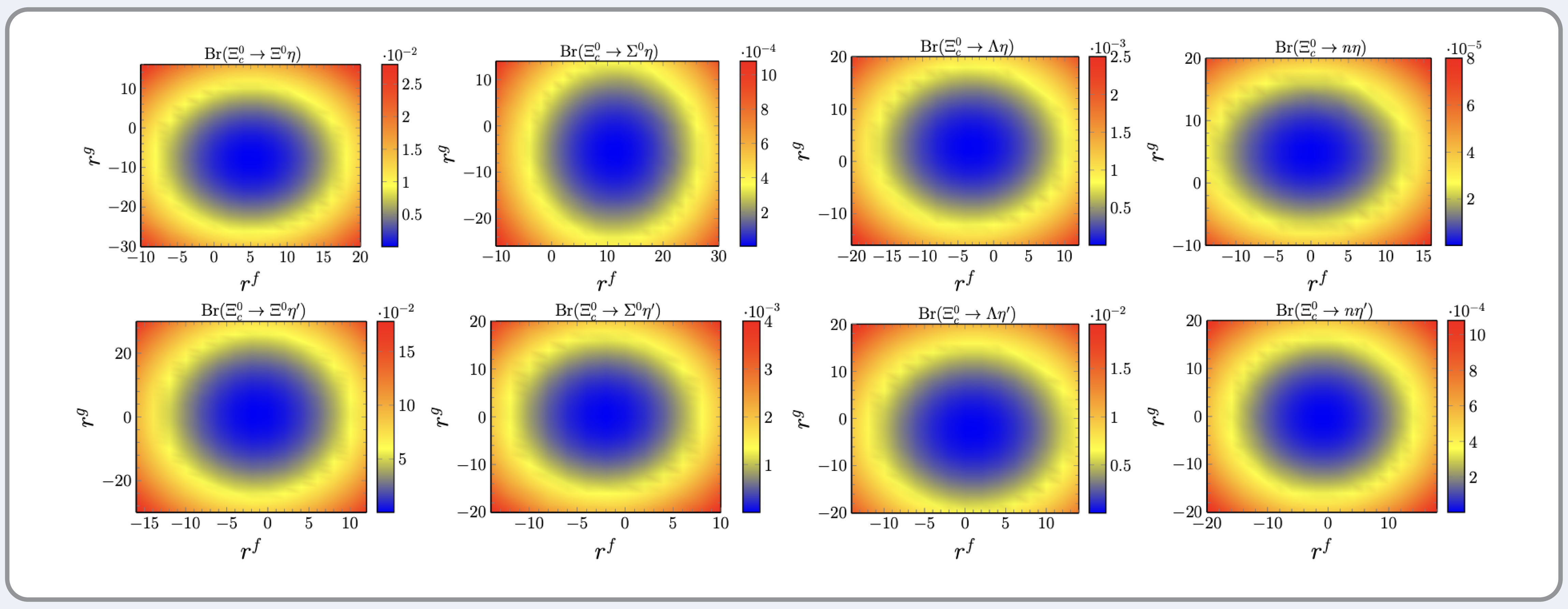
Channel	Lastest measurement in 2022
$\alpha(\Lambda_c^+ \to pK_S^0)$	–
$\alpha(\Lambda_c^+ \to \Lambda\pi^+)$	$-0.755 \pm 0.005 \pm 0.003$[35]
$\alpha(\Lambda_c^+ \to \Sigma^0\pi^+)$	$-0.463 \pm 0.016 \pm 0.008$[35]
$\alpha(\Lambda_c^+ \to \Sigma^+\pi^0)$	$-0.48 \pm 0.02 \pm 0.02$[36]
$\alpha(\Xi_c^0 \to \Xi^-\pi^+)$	–
$\alpha(\Lambda_c^+ \to \Sigma^0 K^+)$	$-0.54 \pm 0.18 \pm 0.09$[35]
$\alpha(\Lambda_c^+ \to \Lambda K^+)$	$-0.585 \pm 0.049 \pm 0.018$[35]
$\alpha(\Lambda_c^+ \to \Sigma^+\eta)$	$-0.99 \pm 0.03 \pm 0.05$[36]
$\alpha(\Lambda_c^+ \to \Sigma^+\eta')$	$-0.46 \pm 0.06 \pm 0.03$[36]

Data analysis



The branching ratios which depend on the r^f (first line) and r^g (second line) for the 8 undetermined decays: $\Xi_c^0 \to \Xi^0\eta^{(\prime)}, \Xi_c^0 \to \Sigma^0\eta^{(\prime)}, \Xi_c^0 \to \Lambda^0\eta^{(\prime)}, \Xi_c^0 \to n\eta^{(\prime)}$. In these figures, we set another parameter $r^{f(g)} = 0$.

Data analysis and prediction



The branching ratios of the 8 undetermined decays: $\Xi_c^0 \to \Xi^0\eta^{(\prime)}, \Xi_c^0 \to \Sigma^0\eta^{(\prime)}, \Xi_c^0 \to \Lambda^0\eta^{(\prime)}, \Xi_c^0 \to n\eta^{(\prime)}$ on the $r^f - r^g$ plane.

Prediction:

$$
\begin{aligned}
\mathcal{B}(\Xi_c^0 \to \Xi^0\eta) \quad &\sim \quad [0.193, 0.446]\%, \quad \mathcal{B}(\Xi_c^0 \to \Xi^0\eta') \geq 0.002\%, \\
\mathcal{B}(\Xi_c^0 \to \Sigma^0\eta) \quad &\sim \quad [0.0118, 0.0333]\%, \quad \mathcal{B}(\Xi_c^0 \to \Sigma^0\eta') \geq 9 \times 10^{-7}, \\
\mathcal{B}(\Xi_c^0 \to \Lambda^0\eta) \quad &\sim \quad [0.0039, 0.0139]\%, \quad \mathcal{B}(\Xi_c^0 \to \Lambda^0\eta') \geq 4.8 \times 10^{-6}, \\
\mathcal{B}(\Xi_c^0 \to n\,\eta) \quad &\sim \quad [0.00009, 0.00066]\%, \quad \mathcal{B}(\Xi_c^0 \to \Lambda^0\eta') \geq 6.0 \times 10^{-8}.
\end{aligned} \tag{1}
$$

Conclusions

- **We can obtain 16 SU(3) irreducible amplitudes with $\chi^2/d.o.f$ of 1.21 indicating a very reasonable fit**
- **We can provide rough predictions or lower limits on the branching ratios of $\Xi_c^0 \to \Xi^0\eta^{(\prime)}, \Xi_c^0 \to \Sigma^0\eta^{(\prime)}, \Xi_c^0 \to \Lambda^0\eta^{(\prime)}, \Xi_c^0 \to n\eta^{(\prime)}$ before the measurement in experimental facilities.**