

A panoramic view of the Lanzhou University campus, showing various buildings, greenery, and a cityscape in the background under a blue sky with light clouds. The university's motto is visible in the top right corner.

自强不息 獨樹一幟

WELCOME TO LANZHOU UNIVERSITY

Prediction of CPV in b -baryon decays

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Phys.Rev.Lett.134(2025)221801

Chin.Phys.C 48(2024)101002

arXiv:2602.03661

第八届全国重味物理与量子色动力学研讨会@2026·重庆

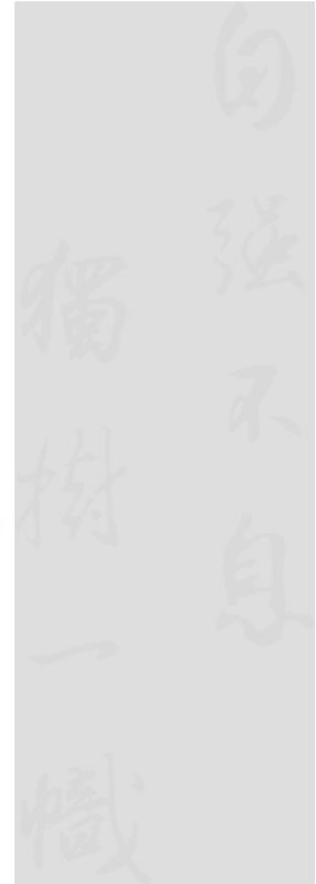


Introduction

CPV in two-body decay

CPV in multi-body decay

Summary and outlook



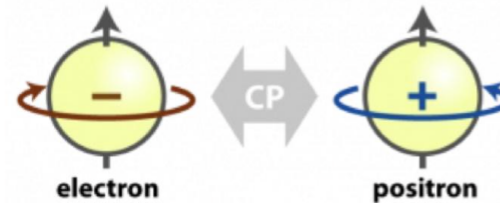
CP violation

➤ Matter-antimatter asymmetry in the Universe

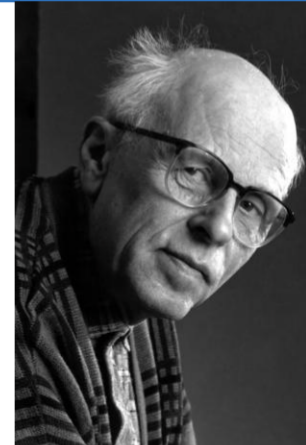
[Science 109 (2005) 5731]

➤ Three conditions for Matter-antimatter asymmetry:

- Interaction to violate baryon number;
- **C and CP violation;**
- Deviate thermal equilibrium

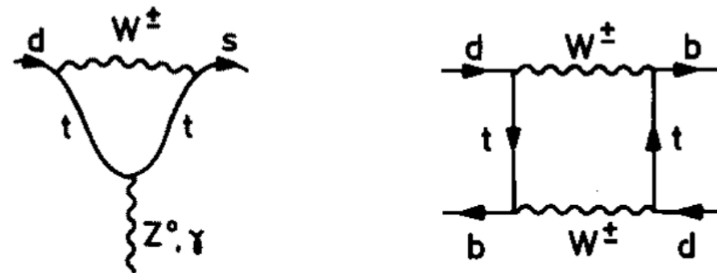


CP: 电荷共轭+宇称变换

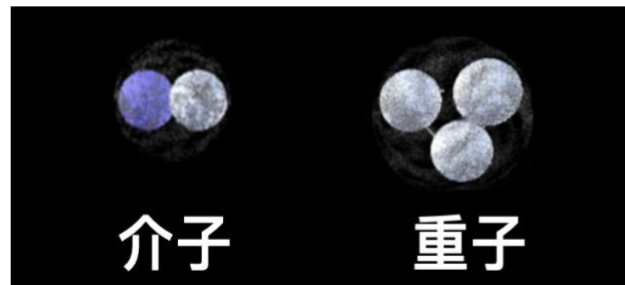


[Sakharov JETP Lett.(1967)]

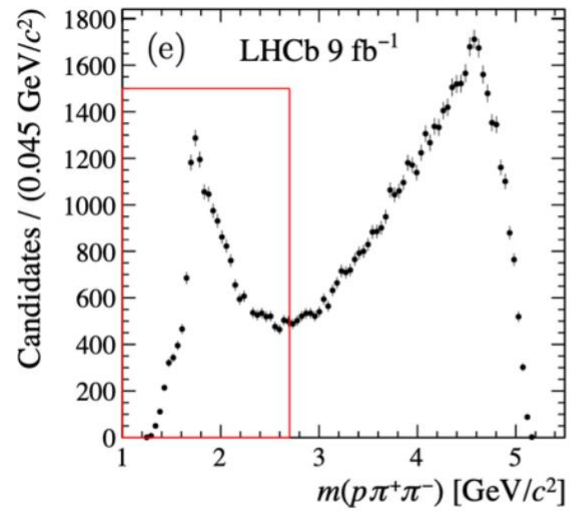
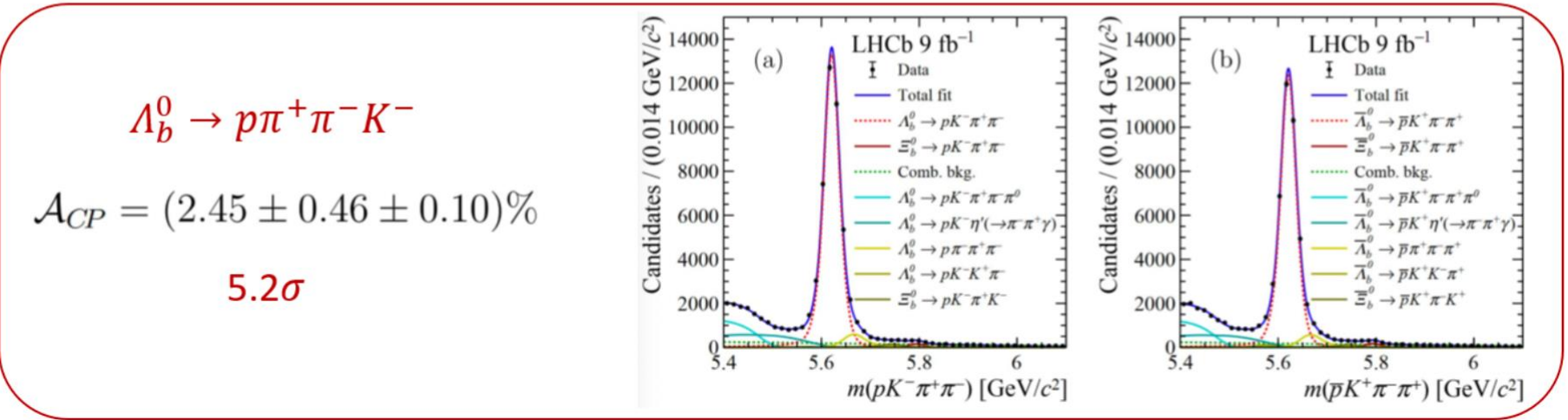
➤ Moreover, CPV relates to parameters in SM, is helpful to search NP indirectly.



➤ Baryon CPV is more crucial, as visible matter in Universe is made of baryons.



➤ LHCb实验组首次发现重子衰变CP破坏



[LHCb Nature(2025)]

Decay topology	Mass region (GeV/c ²)	\mathcal{A}_{CP}
$\Lambda_b^0 \rightarrow R(pK^-)R(\pi^+\pi^-)$	$m_{pK^-} < 2.2$	$(5.3 \pm 1.3 \pm 0.2)\%$
	$m_{\pi^+\pi^-} < 1.1$	
$\Lambda_b^0 \rightarrow R(p\pi^-)R(K^-\pi^+)$	$m_{p\pi^-} < 1.7$	$(2.7 \pm 0.8 \pm 0.1)\%$
	$0.8 < m_{\pi^+K^-} < 1.0$ or $1.1 < m_{\pi^+K^-} < 1.6$	
$\Lambda_b^0 \rightarrow R(p\pi^+\pi^-)K^-$	$m_{p\pi^+\pi^-} < 2.7$	$(5.4 \pm 0.9 \pm 0.1)\%$
$\Lambda_b^0 \rightarrow R(K^-\pi^+\pi^-)p$	$m_{K^-\pi^+\pi^-} < 2.0$	$(2.0 \pm 1.2 \pm 0.3)\%$

6.0σ

➤ 实验发现之前

- 理论上最关键的科学问题：什么样的观测量和衰变道是寻找重子CP破坏的最佳选择？

➤ 理论该做什么



观测量：研究新的CP破坏观测量，提高重子CP破坏发现的可能性

[Zhen-Hua Zhang, et.al.]
[J.P.Wang, Q.Qin, F.S.Yu]

动力学：发展末态重散射的动力学方法，预言重子CP破坏

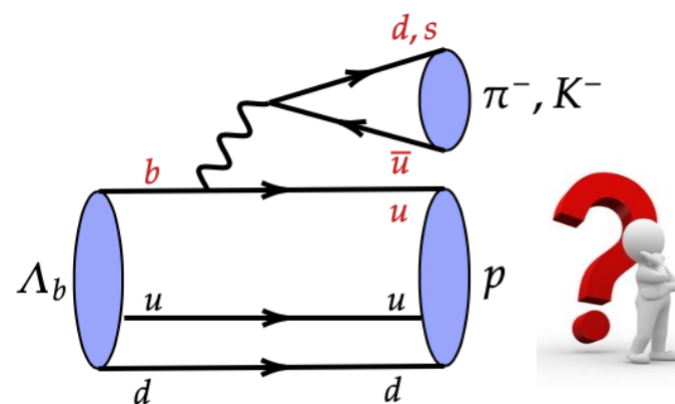
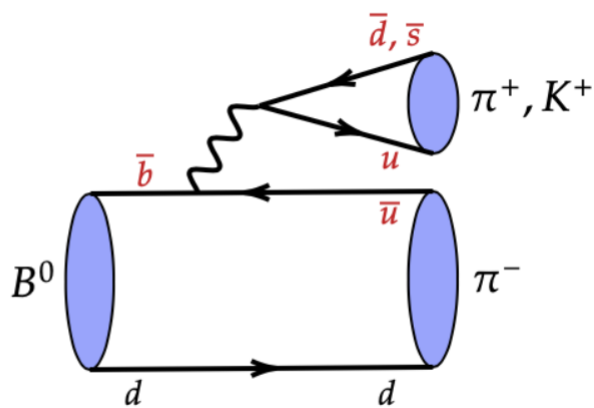
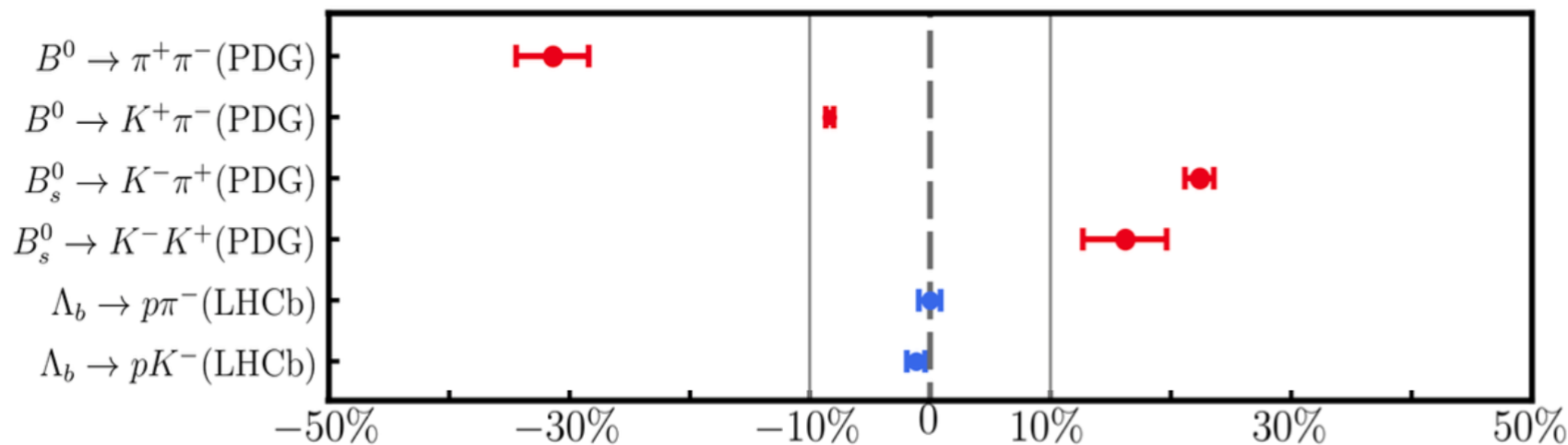
[HJJ, J.X.Yu, Y.Li, H.n.Li, J.P.Wang, Z.J.Xiao, F.S.Yu, PQCD(2025)]
[J.P.Wang, F.S.Yu, FSI(2024)]

Puzzle of b -baryon CPV

➤ Why baryon two-body CPV small?

$$A_{CP}(\Lambda_b \rightarrow p\pi^-) = (0.20 \pm 0.83 \pm 0.37)\% \quad \text{➤ LHCb, 2024}$$

$$A_{CP}(\Lambda_b \rightarrow pK^-) = (-1.14 \pm 0.67 \pm 0.36)\%$$



➤ Baryons have half-integer spin, and thus two partial wave amplitudes.

$$\mathcal{A}(\Lambda_b \rightarrow ph) = i\bar{u}_p(S + P\gamma_5)u_{\Lambda_b}$$

$$\begin{aligned} A_{CP}^{dir} &\equiv \frac{\Gamma(\Lambda_b \rightarrow ph^-) - \bar{\Gamma}(\bar{\Lambda}_b \rightarrow \bar{p}h^+)}{\Gamma(\Lambda_b \rightarrow ph^-) + \bar{\Gamma}(\bar{\Lambda}_b \rightarrow \bar{p}h^+)} \\ &= \frac{M_+^2(|S|^2 - |\bar{S}|^2) + M_-^2|P|^2 - |\bar{P}|^2}{M_+^2(|S|^2 + |\bar{S}|^2) + M_-^2|P|^2 + |\bar{P}|^2} \\ &= \frac{|S|^2}{|S|^2 + \frac{M_-^2(1+A_{CP}^S)}{M_+^2(1+A_{CP}^P)}|P|^2} A_{CP}^S + \frac{\frac{M_-^2}{M_+^2}|P|^2}{\frac{1+A_{CP}^P}{1+A_{CP}^S}|S|^2 + \frac{M_-^2}{M_+^2}|P|^2} A_{CP}^P \\ &\approx \frac{|S|^2}{|S|^2 + |P|^2} A_{CP}^S + \frac{|P|^2}{|S|^2 + |P|^2} A_{CP}^P \end{aligned}$$

$$\begin{aligned} A_{CP}^S &\equiv \frac{|S|^2 - |\bar{S}|^2}{|S|^2 + |\bar{S}|^2} = \frac{-2r_S \sin\Delta\phi \sin\Delta\delta_S}{1 + r_S^2 + 2r_S \cos\Delta\phi \cos\Delta\delta_S}, \\ A_{CP}^P &\equiv \frac{|P|^2 - |\bar{P}|^2}{|P|^2 + |\bar{P}|^2} = \frac{-2r_P \sin\Delta\phi \sin\Delta\delta_P}{1 + r_P^2 + 2r_P \cos\Delta\phi \cos\Delta\delta_P} \end{aligned}$$

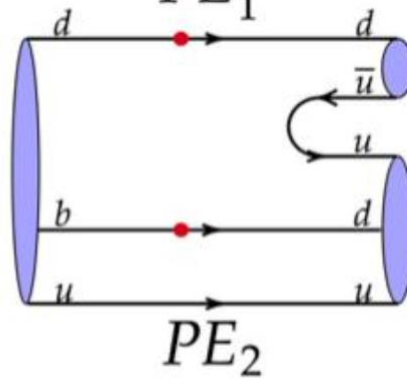
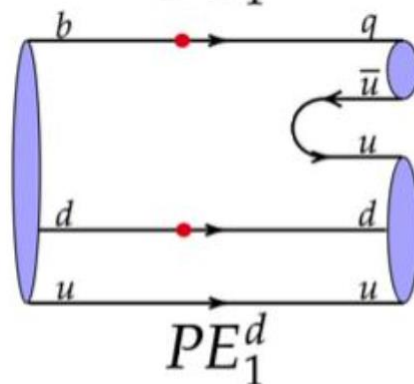
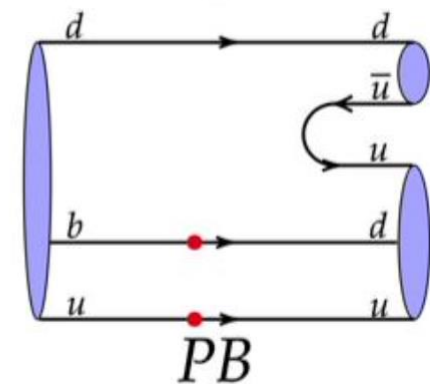
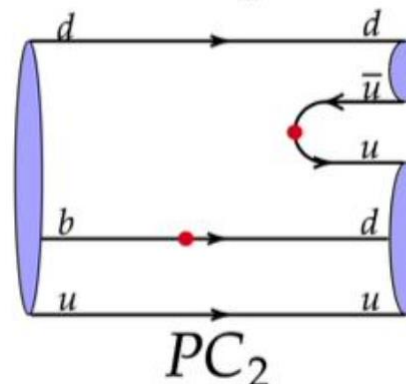
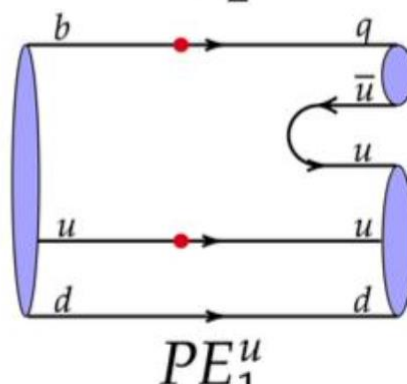
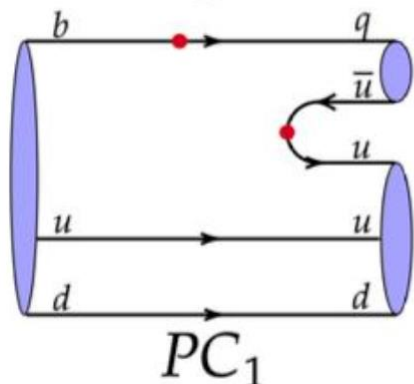
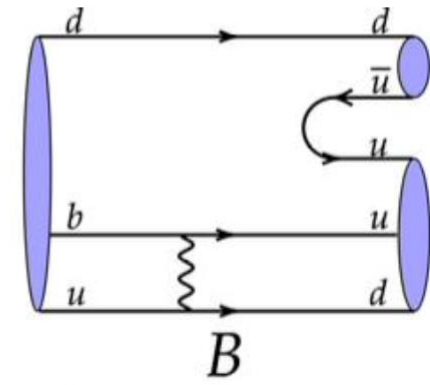
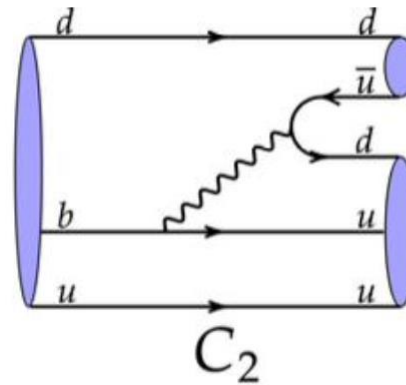
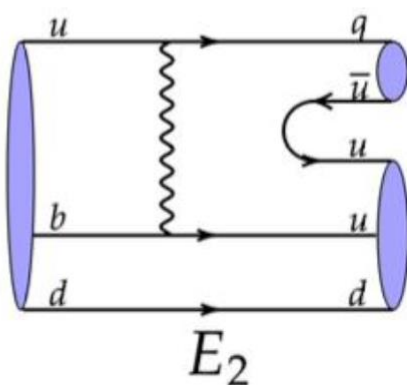
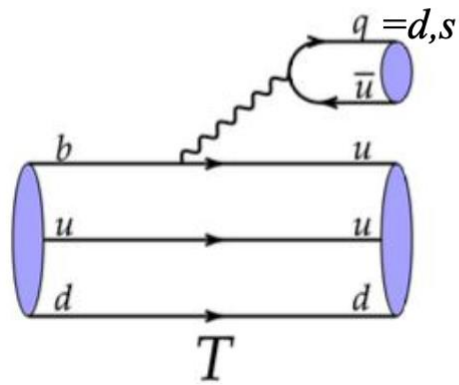
弱相位 强相位

$\Delta\delta_S = \delta_P^S - \delta_T^S$
 $\Delta\delta_P = \delta_P^P - \delta_T^P$

partial-wave CPVs



Topological diagrams



$$\frac{|C_2|}{|T|} \sim \frac{|E_2|}{|T|} \sim \frac{|B|}{|T|} \sim \mathcal{O}\left(\frac{\Lambda_{\text{QCD}}}{m_b}\right)$$

[A.Leibovich, Z.Ligeti, I.Stewart, M.Wise, Phys.Lett.B (2024)]

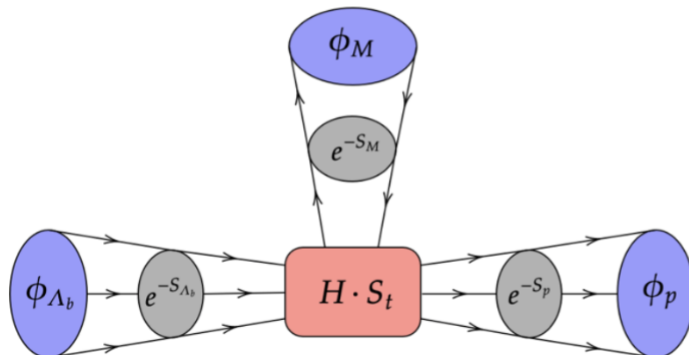
- Strong phases need to be determined by QCD calculations
- Based on k_T factorization, PQCD approach has successfully predicted B meson CPV

$C_{\pi\pi}(B \rightarrow \pi^+\pi^-)\%$	$A_{CP}(B \rightarrow K^+\pi^-)\%$
~ -40 [Lü,Ukai,Yang,2000]	~ -18 [Keum,Li,Sanda,2000]
$-30 \pm 25 \pm 4$ [BaBar,2002]	$-19 \pm 10 \pm 3$ [BaBar,2001]
$-12.8^{+3.48}_{-3.29}$ [Chai,Cheng,Ju,Yan, Lü,Xiao,2022]	$-5.43^{+2.25}_{-2.34}$ [Chai,Cheng,Ju,Yan, Lü,Xiao,2022]
-31.4 ± 3 [PDG]	-8.31 ± 0.31 [PDG]

- Amplitudes are expressed as convolution of hard kernels and LCDAs

$$\begin{aligned}
 \mathcal{M} &= \langle pM | H_{eff} | \Lambda_b \rangle && \text{[Sterman,Hsiang-nan Li,1995~2000]} \\
 &\sim \int [d^4k_p][d^4k_M][d^4k_{\Lambda_b}] \Psi_p([k_p], \mu) \Psi_M([k_M], \mu) \Psi_{\Lambda_b}([k_{\Lambda_b}], \mu) \cdot C_i(\mu) H([k_p], [k_M], [k_{\Lambda_b}], \mu) \\
 &\sim \int_0^1 [dx_p][dx_M][dx_{\Lambda_b}] \int [d^2k_p^T][d^2k_M^T][d^2k_{\Lambda_b}^T] \phi_p([x_p], \mu) \phi_M([x_M], \mu) \phi_{\Lambda_b}([x_{\Lambda_b}], \mu) \\
 &\quad \cdot C_i(\mu) H([x_p, k_p^T], [x_M, k_M^T], [x_{\Lambda_b}, k_{\Lambda_b}^T], \mu)
 \end{aligned}$$

- Free of end-point singularity



Results of $\Lambda_b \rightarrow p\pi^-$

TABLE V. Invariant amplitudes of the $\Lambda_b \rightarrow p\pi^-$ decay classified by topologies without the CKM matrix elements. in unit of 10^{-9}

$\Lambda_b \rightarrow p\pi^-$	$ S $	$\delta^S(^{\circ})$	Real(S)	Imag(S)	$ P $	$\delta^P(^{\circ})$	Real(P)	Imag(P)
T^f	707.17	0.00	707.17	0.00	1004.44	0.00	1004.44	0.00
T^{nf}	51.72	-96.64	-5.98	-51.38	267.72	-97.92	-36.90	-265.17
$T^f + T^{nf}$	703.07	-4.19	701.19	-51.38	1003.22	-15.33	967.54	-265.17
C_2	29.37	154.96	-26.61	12.43	41.51	179.80	-41.51	0.14
E_2	66.94	-145.26	-55.01	-38.14	72.58	119.94	-36.23	62.89
B	10.40	112.64	-4.00	9.60	23.65	-122.56	-12.73	-19.93
Tree	619.26	-6.26	615.57	-67.49	904.75	-14.21	877.08	-222.06
PC_1^f	58.44	0.00	58.44	0.00	2.90	0.00	2.90	0.00
PC_1^{nf}	1.24	-115.38	-0.53	-1.12	11.16	-95.25	-1.02	-11.11
$PC_1^f + PC_1^{nf}$	57.91	-1.11	57.90	-1.12	11.27	-80.38	1.88	-11.11
PC_2	13.36	-116.10	-5.88	-12.00	14.93	71.96	4.62	14.20
PE_1^u	9.48	-87.62	0.39	-9.47	8.83	114.44	-3.65	8.04
PB	1.36	-51.30	0.85	-1.06	1.55	-159.86	-1.46	-0.53
$PE_1^d + PE_2$	3.87	-98.18	-0.55	-3.83	1.41	-12.55	1.37	-0.31
Penguin	59.45	-27.54	52.71	-27.49	10.65	74.93	2.77	10.28

S波的强相位

P波的强相位

➤ Baryons have half-integer spin, and thus two partial wave amplitudes.

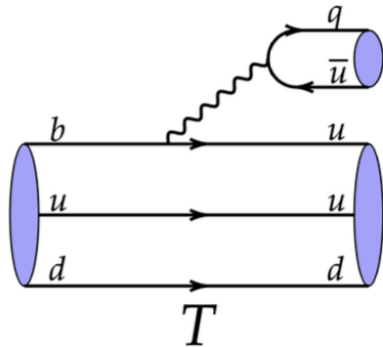
$$\mathcal{A}(\Lambda_b \rightarrow ph) = i\bar{u}_p(S + P\gamma_5)u_{\Lambda_b}$$

$$S \text{ wave } S = \lambda_{\mathcal{T}}|S_{\mathcal{T}}|e^{i\delta_{\mathcal{T}}^S} + \lambda_{\mathcal{P}}|S_{\mathcal{P}}|e^{i\delta_{\mathcal{P}}^S}$$

$$P \text{ wave } P = \lambda_{\mathcal{T}}|P_{\mathcal{T}}|e^{i\delta_{\mathcal{T}}^P} + \lambda_{\mathcal{P}}|P_{\mathcal{P}}|e^{i\delta_{\mathcal{P}}^P}$$

Tree

Penguin

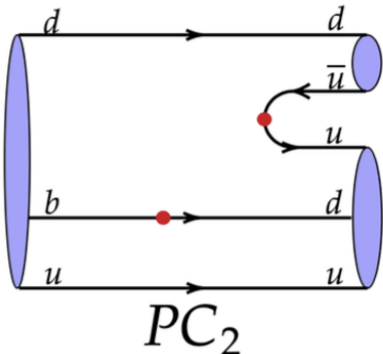


$$\sim q^\mu \bar{u}_p \gamma_\mu (1 - \gamma_5) u_{\Lambda_b} \sim \bar{u}_p (1 + \gamma_5) u_{\Lambda_b}$$

$$\Delta\delta_{S\text{-wave}} = \delta_{PC_2}^{S\text{-wave}} - \delta_T^{S\text{-wave}}$$

$$\Delta\delta_{P\text{-wave}} = \delta_{PC_2}^{P\text{-wave}} - \delta_T^{P\text{-wave}}$$

different by π



$$\sim \bar{u}_p (1 + \gamma_5) (\gamma_5 \not{p}_\pi) (\not{p}_{\Lambda_b} \gamma_5) \not{p}_p (1 - \gamma_5) u_{\Lambda_b} \sim \bar{u}_p (1 - \gamma_5) u_{\Lambda_b}$$

Observables of $\Lambda_b \rightarrow p\pi^-, pK^-$

$$A_{CP}^{dir} \approx \frac{|S|^2}{|S|^2 + |P|^2} A_{CP}^S + \frac{|P|^2}{|S|^2 + |P|^2} A_{CP}^P$$

$$A_{CP}^S \equiv \frac{|S|^2 - |\bar{S}|^2}{|S|^2 + |\bar{S}|^2} = \frac{-2r_S \sin\Delta\phi \sin\Delta\delta_S}{1 + r_S^2 + 2r_S \cos\Delta\phi \cos\Delta\delta_S}$$

$$A_{CP}^P \equiv \frac{|P|^2 - |\bar{P}|^2}{|P|^2 + |\bar{P}|^2} = \frac{-2r_P \sin\Delta\phi \sin\Delta\delta_P}{1 + r_P^2 + 2r_P \cos\Delta\phi \cos\Delta\delta_P}$$

分波CPV符号相反，相互抵消

$Br(\times 10^{-6})$							
$\Lambda_b \rightarrow p\pi^-$	$3.34_{-1.30}^{+2.53+1.33+0.10+0.47}$						
$\Lambda_b \rightarrow pK^-$	$2.83_{-1.05}^{+2.17+1.17+0.49+2.19}$						
A_{CP}^{dir}		$A_{CP}^S(\kappa_S)$			$A_{CP}^P(\kappa_P)$		
$\Lambda_b \rightarrow p\pi^-$	$0.05_{-0.02}^{+0.00+0.00+0.00+0.02}$	$0.17_{-0.04}^{+0.01+0.01+0.03+0.04}$ (49%)	$-0.06_{-0.02}^{+0.01+0.03+0.02+0.00}$ (51%)				
$\Lambda_b \rightarrow pK^-$	$-0.06_{-0.01}^{+0.01+0.01+0.02+0.00}$	$-0.05_{-0.02}^{+0.02+0.02+0.04+0.00}$ (94%)	$-0.21_{-0.15}^{+0.07+0.23+0.29+0.04}$ (6%)				

	A_{CP}^{dir}	$A_{CP}^{S^T\text{-wave}}(\kappa_{S^T})$	$A_{CP}^{(D+S^L)\text{-wave}}(\kappa_{D+S^L})$	$A_{CP}^{P_1\text{-wave}}(\kappa_{P_1})$	$A_{CP}^{P_2\text{-wave}}(\kappa_{P_2})$	A_{CP}^J
$\Lambda_b \rightarrow p\rho^-$	$0.03_{-0.05}^{+0.03}$	$0.01_{-0.04}^{+0.01}$ (7%)	$0.02_{-0.03}^{+0.07}$ (44%)	$0.03_{-0.12}^{+0.04}$ (45%)	$0.17_{-0.06}^{+0.04}$ (4%)	$-0.01_{-0.01}^{+0.01}$
$\Lambda_b \rightarrow pK^{*-}$	$-0.05_{-0.16}^{+0.10}$	$-0.15_{-0.06}^{+0.12}$ (6%)	$0.27_{-0.27}^{+0.09}$ (33%)	$-0.23_{-0.18}^{+0.10}$ (55%)	$-0.14_{-0.10}^{+0.02}$ (6%)	$0.02_{-0.05}^{+0.04}$

	A_{CP}^{dir}	$A_{CP}^{S^T\text{-wave}}(\kappa_{S^T})$	$A_{CP}^{(D+S^L)\text{-wave}}(\kappa_{D+S^L})$	$A_{CP}^{P_1\text{-wave}}(\kappa_{P_1})$	$A_{CP}^{P_2\text{-wave}}(\kappa_{P_2})$	A_{CP}^{UD}
$\Lambda_b \rightarrow pa_1^-(1260)$	$-0.01_{-0.03}^{+0.04}$	$-0.22_{-0.10}^{+0.10}$ (6%)	$-0.11_{-0.07}^{+0.03}$ (46%)	$0.18_{-0.06}^{+0.11}$ (40%)	$-0.24_{-0.13}^{+0.07}$ (8%)	$-0.24_{-0.13}^{+0.08}$
$\Lambda_b \rightarrow pK_1^-(1270) (\theta_K = 30^\circ)$	$0.09_{-0.05}^{+0.08}$	$0.34_{-0.06}^{+0.02}$ (8%)	$-0.11_{-0.12}^{+0.03}$ (42%)	$0.19_{-0.15}^{+0.17}$ (42%)	$0.33_{-0.05}^{+0.04}$ (8%)	$0.26_{-0.10}^{+0.04}$
$\Lambda_b \rightarrow pK_1^-(1270) (\theta_K = 60^\circ)$	$0.07_{-0.06}^{+0.05}$	$0.46_{-0.09}^{+0.02}$ (9%)	$0.06_{-0.08}^{+0.11}$ (37%)	$-0.07_{-0.10}^{+0.09}$ (45%)	$0.46_{-0.07}^{+0.06}$ (9%)	$0.40_{-0.09}^{+0.04}$

► 为什么研究多体衰变CP破坏

- **实验优势**: 统计量高, 可以尝试更多观测量

$$Br[\Lambda_b^0 \rightarrow p\pi^+\pi^-\pi^-] = (2.08 \pm 0.21) \times 10^{-5}$$

$$Br[\Lambda_b^0 \rightarrow pK^-\pi^+\pi^-] = (5 \pm 0.5) \times 10^{-5}$$

$$Br[\Lambda_b^0 \rightarrow pK^-K^+\pi^-] = (4 \pm 0.6) \times 10^{-6}$$

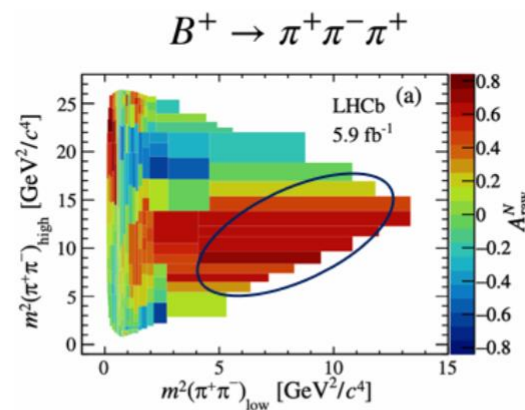
$$Br[\Lambda_b^0 \rightarrow pK^+K^-K^-] = (1.25 \pm 0.13) \times 10^{-5}$$

Decay mode	Signal yields	
	X_b^0	\bar{X}_b^0
$\Lambda_b^0 \rightarrow p\pi^-\pi^+\pi^-$	2335 ± 56	2264 ± 55
$\Lambda_b^0 \rightarrow pK^-\pi^+\pi^-$	6807 ± 92	6232 ± 89
$\Lambda_b^0 \rightarrow pK^-K^+\pi^-$	555 ± 38	630 ± 38
$\Lambda_b^0 \rightarrow pK^-K^+K^-$	2312 ± 54	2248 ± 54

- 多体衰变可能有**很大的局域CP破坏**

$$A_{CP}(B^\pm \rightarrow \pi^\pm\pi^+\pi^-) = +0.080 \pm 0.004$$

[LHCb, [Phys.Rev.D 108 \(2023\)](#)]



- **理论缺乏研究**: 中间共振态多, 理论不确定性变大

➤ 理论困难

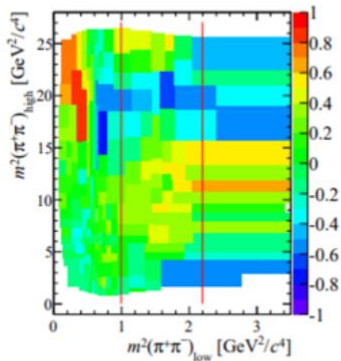
- 多体衰变 $\Lambda_b^0 \rightarrow (p\pi^0)h^-, (p\pi^+\pi^-)h^- (h=\pi, K)$ 中存在大量共振态

$N(1650)$	$1/2^-$	****
$N(1675)$	$5/2^-$	****
$N(1680)$	$5/2^+$	****
$N(1700)$	$3/2^-$	***
$N(1710)$	$1/2^+$	****
$N(1720)$	$3/2^+$	****

$N(1700)$ BREIT-WIGNER MASS	1650 to 1800 (≈ 1720) MeV
$N(1700)$ BREIT-WIGNER WIDTH	100 to 300 (≈ 200) MeV
$N(1710)$ BREIT-WIGNER MASS	1680 to 1740 (≈ 1710) MeV
$N(1710)$ BREIT-WIGNER WIDTH	80 to 200 (≈ 140) MeV
$N(1720)$ BREIT-WIGNER MASS	1680 to 1750 (≈ 1720) MeV
$N(1720)$ BREIT-WIGNER WIDTH	150 to 400 (≈ 250) MeV

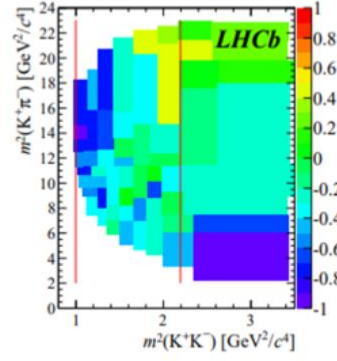
- $p\pi, p\pi\pi$ 系统共振态太多，彼此靠近!
- 难以确定主导贡献来源，理论无法预言!

► B介子三体衰变的启发



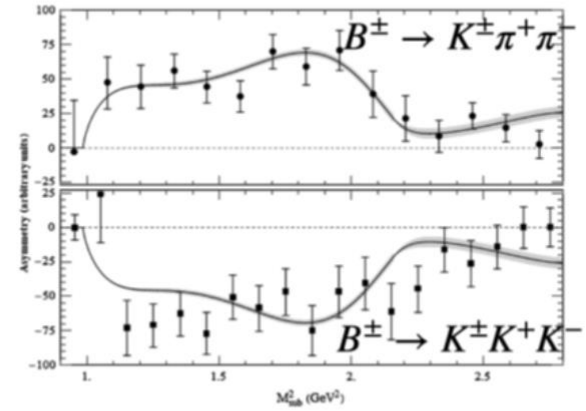
$B^+ \rightarrow \pi^+ \pi^+ \pi^-$

$$\pi^+ \pi^- \leftrightarrow K^+ K^-$$



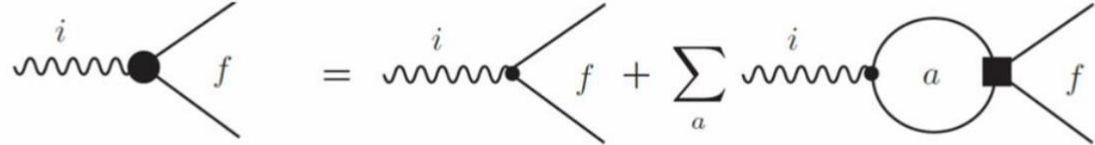
$B^+ \rightarrow K^+ \pi^+ K^-$

实验理论符合



$$\begin{pmatrix} A(B^- \rightarrow \pi^+ \pi^- P^-) \\ A(B^- \rightarrow K^+ K^- P^-) \end{pmatrix}_{\text{FSI}}^{\text{S-wave}} = S^{1/2} \begin{pmatrix} A(B^- \rightarrow \pi^+ \pi^- P^-) \\ A(B^- \rightarrow K^+ K^- P^-) \end{pmatrix}_{\text{S-wave}}$$


$$\langle f | \mathcal{H}_W | i \rangle = \sum_a \langle f | a \rangle \langle a | \mathcal{H}_W | i \rangle$$



➤ $N\pi$ 散射

- N^* 共振态来源于 $N\pi$ 散射分波振幅
- $N\pi$ 散射分波振幅有实验数据

<https://gwdac.phys.gwu.edu>



— Data Analysis Center —
Institute for Nuclear Studies
THE GEORGE WASHINGTON UNIVERSITY
WASHINGTON, DC

INS DAC Home
INS DAC [SAID]
INS Home
Pi-N Newsletters
Obituary R.A. Arndt

Partial-Wave Analyses at GW
[See Implications]
Pion-Nucleon
Pi-Pi-N
Kaon(+)-Nucleon
Nucleon-Nucleon
Pion Photoproduction
Pion Electroproduction
Kaon Photoproduction
Eta Photoproduction
Eta-Prime Photoproduction
Pion-Deuteron (elastic)
Pion-Deuteron to Proton+Proton

INS DAC Services [SAID Program]

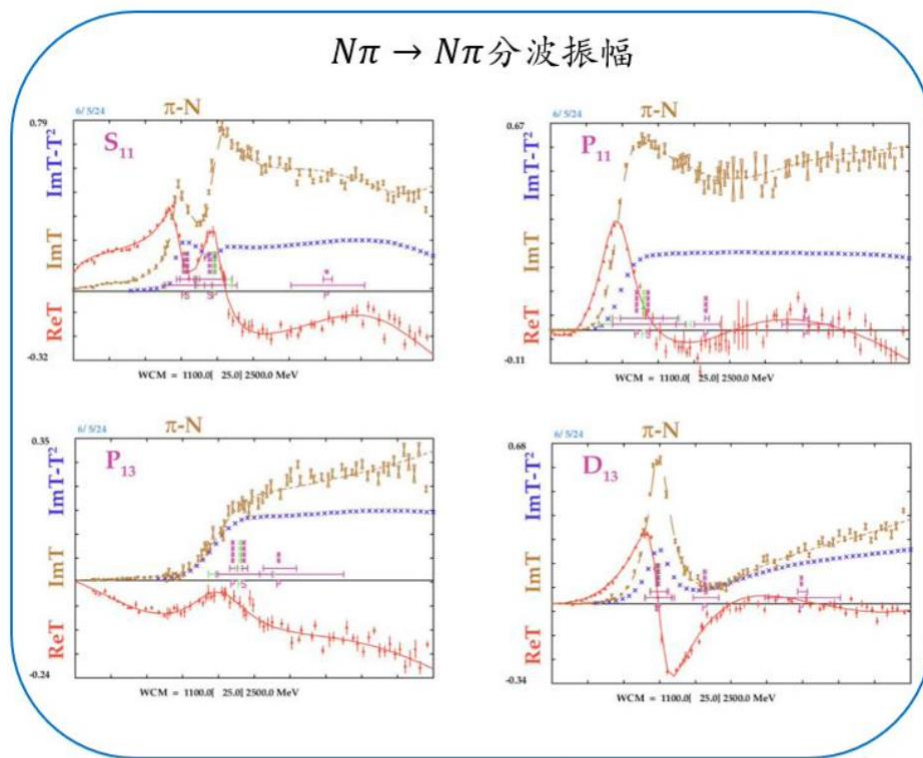
- The SAID Partial-Wave Analysis Facility is based
- New features are being added and will first appear always welcome.

Instructions for Using the Partial-Wave Analyses

The programs accessible with the left-hand side navigation t available through the SAID program. Contact a member of c If you enter choices which are unphysical, you may still get garbage out' rule). Please report unexpected garbage-out to t

Note: These programs use HTML forms to run the SAID co setup first. The output is an (edited) echo of an interactive se SSH version. If the default example fails to clarify the speci mail message).

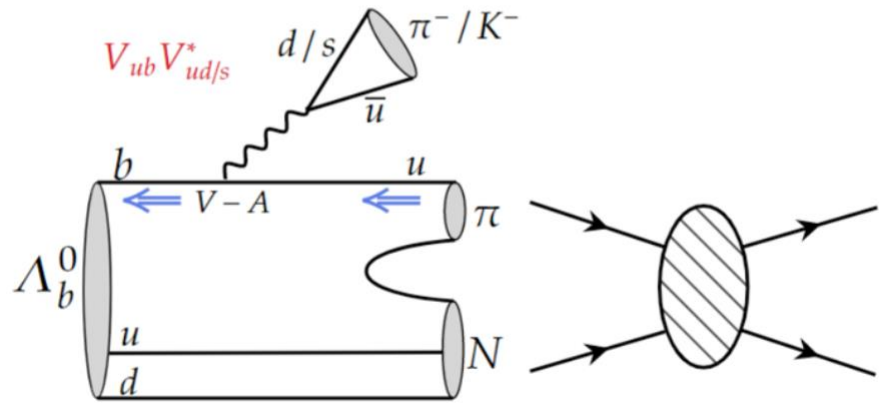
All programs expect energies in MeV units. All of the soluti Some are unstable beyond their upper energy limits. Extrapa **Increments:** The programs will not allow an arbitrary numb



- 散射分波振幅有明显的虚部，提供强相位！
- 避免处理共振态，采用实验数据，**model-independent!**

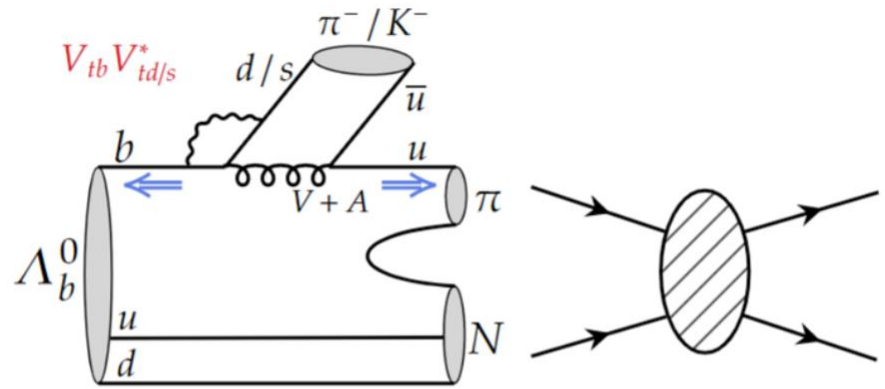
数据驱动

多体衰变CP破坏机制



$$O_1^u = (\bar{u}_\alpha b_\alpha)_{V-A} (\bar{q}_\beta u_\beta)_{V-A},$$

$$O_2^u = (\bar{u}_\alpha b_\beta)_{V-A} (\bar{q}_\beta u_\alpha)_{V-A},$$



$$O_5 = (\bar{q}_\alpha b_\alpha)_{V-A} \sum_{q'} (\bar{q}'_\beta q'_\beta)_{V+A},$$

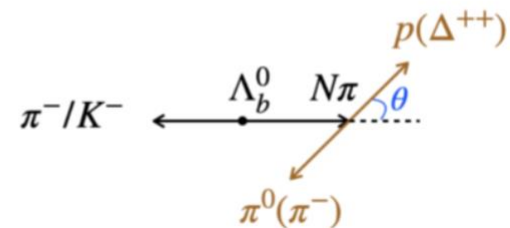
$$O_6 = (\bar{q}_\beta b_\alpha)_{V-A} \sum_{q'} (\bar{q}'_\alpha q'_\beta)_{V+A},$$

手征不同 → 分波不同 → 树振幅和企鹅振幅有不同的重散射贡献

弱相位CKM机制 强相位 $N\pi \rightarrow N\pi, N\pi\pi$

[J.P.Wang, F.S.Yu, Chin.Phys.C 48 (2024)]

➤ 多体衰变CP破坏数值结果：总CP破坏

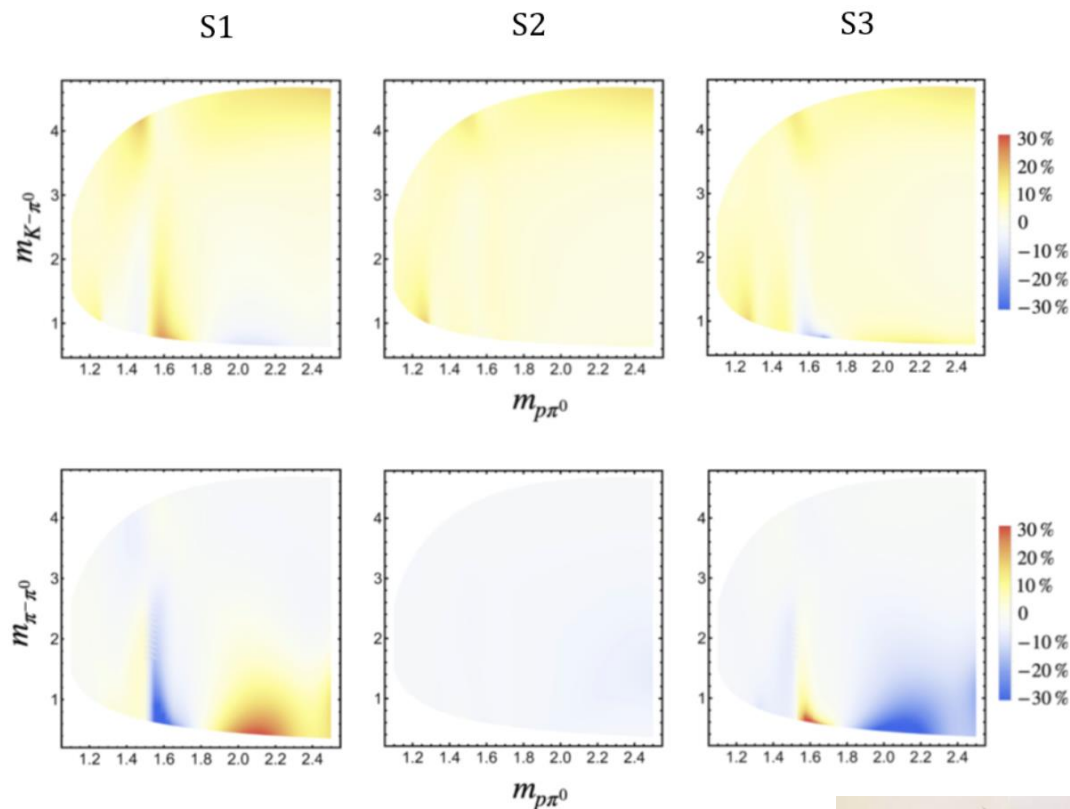


decay processes		Scenarios	global CPV	CPV of $\cos \theta < 0$	CPV of $\cos \theta > 0$
$N\pi \rightarrow \Delta^{++}\pi^-$ $m_{N\pi} \in [1.3, 1.9]\text{GeV}$	$\Lambda_b^0 \rightarrow (\Delta^{++}\pi^-)K^-$ $\rightarrow (p\pi^+\pi^-)K^-$	S1	5.9%	8.0%	3.6%
		S2	5.8%	6.3%	5.3%
		S3	5.6%	4.3%	7.0%
	$\Lambda_b^0 \rightarrow (\Delta^{++}\pi^-)\pi^-$	S1	-4.1%	-5.4%	-2.4%
		S2	-3.9%	-3.9%	-3.9%
		S3	-3.6%	-2.3%	-5.3%
$N\pi \rightarrow p\pi^0$ $m_{N\pi} \in [1.1, 2.5]\text{GeV}$	$\Lambda_b^0 \rightarrow (p\pi^0)K^-$	S1	5.8%	8.2%	2.7%
		S2	5.8%	8.0%	3.0%
		S3	5.8%	7.8%	3.3%
	$\Lambda_b^0 \rightarrow (p\pi^0)\pi^-$	S1	-3.9%	-3.9%	-3.7%
		S2	-3.9%	-3.8%	-4.3%
		S3	-3.8%	-3.6%	-4.8%

➤ 更多预言: Dalitz分布

(S1: $f_1 = 1.1, g_1 = 0.9$, S2: $f_1 = g_1 = 1.0$, S3: $f_1 = 0.9, g_1 = 1.1$)

$\Lambda_b^0 \rightarrow (p\pi^0)K^-$
 $N\pi \rightarrow p\pi^0$
 $m_{N\pi} \in [1.1, 2.5]\text{GeV}$



- Dalitz分布包含了所有信息, 将来实验进一步验证!
- 发现很大的局域CP破坏 (20%到30%), 和B介子CP破坏在相同量级

Jian-Peng Wang, Fu-Sheng Yu, CPC(2024)



Baryon CPV is a new horizon of heavy flavor physics.

We do first full QCD analysis of b -baryon two-body decays in PQCD

We propose a new CPV mechanism from $N\pi$ scatterings