Hyperon Physics at BESIII

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on Hadron Spectroscopy and Structure
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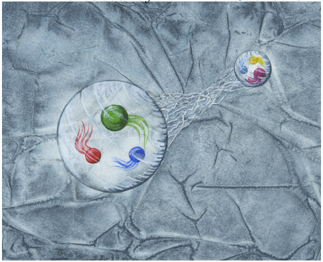
Introduction

- More than 50 years of the knowledge about CP violation (CPV)
  - Confirmed only in meson decays

created by Annika Rockström



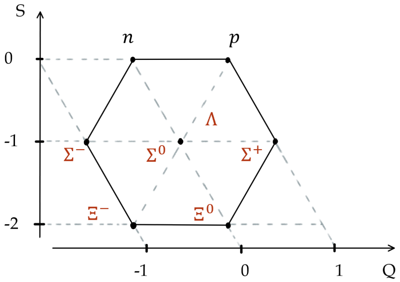
- SM CPV is not sufficient to explain observed matter-antimatter asymmetry
- Baryogenesis requires C and CP violation in the processes

  [PismaZh.Eksp.Teor.Fiz.5(1967)32]

- Systematical mapping with different hadronic systems and complementary methods are needed for understanding CPV in flavour sector

Ground-state strange baryons

- Spin-$\frac{1}{2}$ baryon octet
- Weak $\Delta S = 1$ transitions



created by Nora Salone

$+\ \Omega^-$ spin-$\frac{3}{2}$

Hyperon	Mass [GeV/c²]	Decay ($\mathcal{B}$)
$\Lambda(uds)$	1.116	$p\pi^-(64.1\%)$ $n\pi^0(35.9\%)$
$\Sigma^-(dds)$	1.197	$n\pi^-(99.8\%)$
$\Sigma^+(uus)$	1.189	$p\pi^0(51.6\%)$ $n\pi^+(48.3\%)$
$\Xi^0(uss)$	1.315	$\Lambda\pi^0(99.5\%)$
$\Xi^-(dss)$	1.322	$\Lambda\pi^-(99.9\%)$
$\Omega^-(sss)$	1.672	$\Lambda K^-(67.8\%)$ $\Xi^0\pi^-(23.6\%)$ $\Xi^-\pi^0(8.6\%)$

Decay amplitudes in hyperon decays

- P- and S-wave amplitudes:
  $\Lambda \to p\pi^-$, $\Xi^- \to \Lambda\pi^-$, $\Sigma \to N\pi$

$$\boxed{\mathcal{A} = S + P\vec{\sigma}\cdot\hat{\mathbf{n}}}$$

- $|\Delta I| = 1/2$
- Contribution of $|\Delta I| = 3/2$ is $\sim 10\%$

weak CP-odd phases

$$\boxed{\begin{array}{c} S = |S|exp(\xi_S)exp(i\delta_S) \\ P = |P|exp(\xi_P)exp(i\delta_P) \end{array}}$$

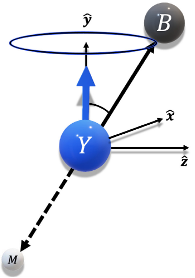
strong phases

- Two measurable parameters

$$\boldsymbol{\alpha} = \frac{2\mathrm{Re}(S{*}P)}{|S|^2+|P|^2} \qquad \beta = \frac{2\mathrm{Im}(S{*}P)}{|S|^2+|P|^2} = \sqrt{1-\alpha^2}\sin\boldsymbol{\phi}$$

Measurement of hyperon decay parameters

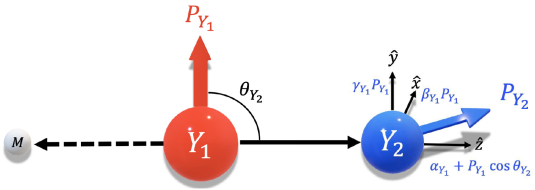
- Polarisation of hyperons experimentally accessible in weak parity violating decays



- Example:
  angular distribution of $Y \to BM$

$$\boxed{I(\cos\theta_B) \propto 1 + \alpha_B P_y \cos\theta_B}$$

- Angle ϕ accessible when daughter baryon polarisation measured
  - Example: $Y_1 \to Y_2(\to BM)M$



CP tests in hyperon decays

- If CP conserved: $\bar{\alpha} = -\alpha$, $\bar{\beta} = -\beta$, $\bar{\phi} = -\phi$
- Possible CP tests:

weak P-S phase difference

$$A_{CP} = \frac{\alpha+\bar{\alpha}}{\alpha-\bar{\alpha}} = -\sin\phi\tan(\xi_P - \xi_S)\frac{\sqrt{1-\alpha^2}}{\alpha}$$
$$\Phi_{CP} = \frac{\phi+\bar{\phi}}{2} = \cos\phi\tan(\xi_P - \xi_S)\frac{\alpha}{\sqrt{1-\alpha^2}}$$

- HyperCP measurement [PRL93(2004)262001]:
  $A^{\Lambda}_{CP} + A^{\Xi}_{CP} = (0.0 \pm 5.1_{\rm stat} \pm 4.4_{\rm syst}) \cdot 10^{-4}$

- SM predictions [PRD105(2022)116022]
  $-3 \cdot 10^{-5} \leq A_\Lambda \leq 3 \cdot 10^{-5}$
  $0.5 \cdot 10^{-5} \leq A_\Xi \leq 6 \cdot 10^{-5}$

Decay mode	$\xi_P - \xi_S$ [10^{-4}rad]
$\Lambda \to p\pi^-$	-0.2 ± 2.2
$\Xi^- \to \Lambda\pi^-$	-2.1 ± 1.7

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$$(\xi_P - \xi_S)_{BSM} = \frac{C'_B}{B_G}\left(\frac{\epsilon'}{\epsilon}\right)_{BSM} + \frac{C_B}{\kappa}\epsilon_{BSM}$$

[PRD69(2004)076008]

- SM predictions [PRD105(2022)116022]

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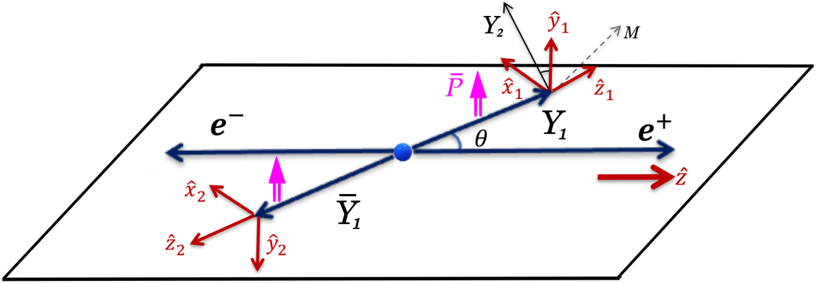
- BSM predictions [PRD105(2022)116022]

$|A_{\Lambda} + A_{\Xi}| \leq 11 \cdot 10^{-4}$

Decay	$\lvert\xi_P - \xi_S\rvert$
$\Lambda \to p\pi^-$	$\leq 5.3 \cdot 10^{-3}$
$\Xi^- \to \Lambda\pi^-$	$\leq 3.7 \cdot 10^{-3}$

Baryon polarisation in e^+e^- collisions



- Unpolarised e^+e^- beams $\Longrightarrow$ transverse polarisation (if $\Delta\Phi \neq 0$):

$$P_y(\cos\theta) = \frac{\sqrt{1-\alpha_\psi{}^2}\cos\theta\sin\theta}{1+\alpha_\psi\cos^2\theta}\sin(\Delta\Phi)$$

- Angular distribution:

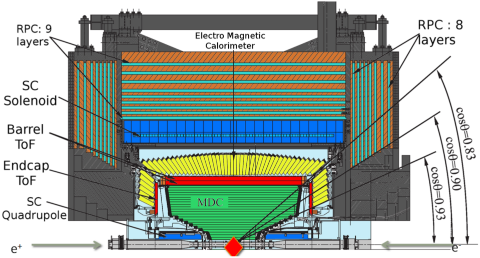
$$\frac{d\Gamma}{d\Omega} \propto 1 + \alpha_\psi\cos^2\theta \text{ with } \alpha_\psi \in [-1, 1]$$

BESIII @ BEPCII

[Nucl.Instrum.Meth.A598(2009)7]

- Beijing Electron-Positron Collider (BEPCII)
  - e^+e^- collider with 2.0 GeV$< E_{\text{CMS}} <$ 4.95 GeV
  - $\mathcal{L}_{\text{peak}} = 10^{33}\text{cm}^{-2}\text{s}^{-1}$
  - Data taking since 2009

- Beijing Spectrometer (BESIII)
  - Optimized for flavour physics
  - Covers 93% of the 4π solid angle
  - 1.0 T super-condacting solenoid
  - Momentum resolution: $\sigma(p)/p = 0.5\%$ at 1 GeV/c
  - Time resolution: 68 (65) ps in the barrel (end cap)



Resonance	Pair	$\mathcal{B}(\cdot 10^{-4})$	$\epsilon(\%)$	$\text{N}_{\text{obs}}(10^3)$	Reference
J/ψ	$\Lambda\bar{\Lambda}$	$19.43 \pm 0.03 \pm 0.33$	42.37 ± 0.14	441	[PRD95(2017)052003]
	$\Sigma^0\bar{\Sigma}^0$	$11.64 \pm 0.04 \pm 0.23$	17.83 ± 0.06	111	
	$\Xi^-\bar{\Xi}^+$	$10.40 \pm 0.06 \pm 0.74$	18.40 ± 0.04	43	[PRD93(2016)072003]
$\psi(2S)$	$\Lambda\bar{\Lambda}$	$3.97 \pm 0.02 \pm 0.12$	42.83 ± 0.34	31	[PRD95(2017)052003]
	$\Sigma^0\bar{\Sigma}^0$	$2.44 \pm 0.03 \pm 0.11$	14.79 ± 0.12	6.6	
	$\Xi^-\bar{\Xi}^+$	$2.78 \pm 0.05 \pm 0.14$	18.04 ± 0.04	5.3	[PRD93(2016)072003]
	$\Omega^-\bar{\Omega}^+$	$0.59 \pm 0.01 \pm 0.03$	17.1/18.9	4.1	[PRL126(2021)092002]

Formalism $e^+e^- \to J/\psi, \psi(2S) \to Y_1\bar{Y}_1$, $Y_1 \to Y_2 M$ + c.c.

[PRD99(2019)056008]

- Two spin-$\frac{1}{2}$ particle state:

$$\boxed{\rho_{1/2,\overline{1/2}} = \frac{1}{4}\sum_{\mu\bar{\nu}} C_{\mu\bar{\nu}}\sigma_{\mu}^{Y_1} \otimes \sigma_{\bar{\nu}}^{\bar{Y}_1}}$$

$\mathrm{Y_1}$ transverse polarisation

$$C_{\mu\bar{\nu}} = \begin{pmatrix} 1+\alpha_\psi\cos^2\theta & 0 & \boxed{\beta_\psi\sin\theta\cos\theta} & 0 \\ 0 & \sin^2\theta & 0 & \gamma_\psi\sin\theta\cos\theta \\ \boxed{-\beta_\psi\sin\theta\cos\theta} & 0 & \alpha_\psi\sin^2\theta & 0 \\ 0 & -\gamma_\psi\sin\theta\cos\theta & 0 & -\alpha_\psi-\cos^2\theta \end{pmatrix}$$

$\bar{\mathrm{Y}}_1$ transverse polarisation

Spin correlations

where $\beta_\psi = \sqrt{1-\alpha_\psi^2}\sin(\Delta\Phi)$ and $\gamma_\psi = \sqrt{1-\alpha_\psi^2}\cos(\Delta\Phi)$

- Decay can be presented via decay matrices:

$$\boxed{\sigma_{\mu}^{Y_1} \to \sum_{\mu'=0}^{3} a_{\mu\mu'}^{Y_1}(\alpha_{Y_1}, \phi_{Y_1}; \theta_{Y_2}, \varphi_{Y_2})\sigma_{\mu'}^{Y_2}}$$

- Full angular distribution:

$$\boxed{\mathcal{W}(\boldsymbol{\xi}, \boldsymbol{\omega}) = \mathrm{Tr}\rho_{Y_2\bar{Y}_2} = \sum_{\mu,\bar{\nu}=0}^{3} C_{\mu\bar{\nu}} a_{\mu 0}^{Y_1} a_{\bar{\nu}0}^{\bar{Y}_1}}$$

$e^+e^- \to J/\psi \to \Lambda\bar{\Lambda}$, $\Lambda \to p\pi^-$+c.c. (1)

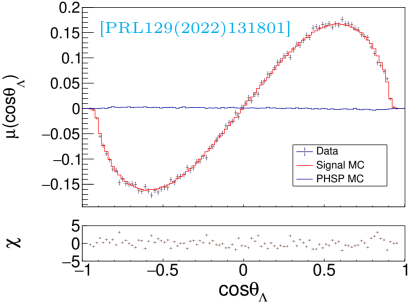
- Increasing data statistics have allowed for the significant result improvement:

  [1] [Nature Phys.15(2019)631] $\Longrightarrow$ [2] [PRL129(2022)131801]

	This work[2]	Previous work[1]
$N_{J/\psi}$	10^{10}	$1.31 \cdot 10^9$
N_{sig}	$3.2 \cdot 10^6$	$421 \cdot 10^3$
N_{bkg}	3801 ± 63	399 ± 20

- Angular dependence of the moment for the acceptance-corrected data:

$$\mu(\cos\theta_\Lambda) = \frac{\alpha_\Lambda - \bar{\alpha}_\Lambda}{2} \frac{1 + \alpha_\psi \cos^2\theta_\Lambda}{3 + \alpha_\psi} P_y(\cos\theta_\Lambda)$$



Parameters	This work[2]	Previous results[1]
$\boldsymbol{\alpha_\psi}$	$\mathbf{0.4748 \pm 0.0022 \pm 0.0024}$	$0.461 \pm 0.006 \pm 0.007$
$\boldsymbol{\Delta\Phi}$ [rad]	$\mathbf{0.7521 \pm 0.0042 \pm 0.0080}$	$0.740 \pm 0.010 \pm 0.009$
$\boldsymbol{\alpha_\Lambda}$	$\mathbf{0.7519 \pm 0.0036 \pm 0.0019}$	$0.750 \pm 0.009 \pm 0.004$
$\boldsymbol{\bar{\alpha}_\Lambda}$	$\mathbf{-0.7559 \pm 0.0036 \pm 0.0029}$	$-0.758 \pm 0.010 \pm 0.007$

$e^+e^- \to J/\psi \to \Lambda\bar{\Lambda},\ \Lambda \to p\pi^-$+c.c. (2)

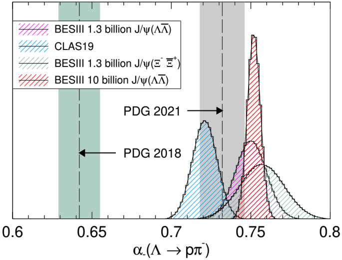
[arXiv:2204.11058 update]

$$A_{CP}^{\Lambda} = \frac{\alpha_\Lambda + \bar{\alpha}_\Lambda}{\alpha_\Lambda - \bar{\alpha}_\Lambda} = -0.0025 \pm 0.0046_{\text{stat}} \pm 0.0011_{\text{syst}}$$

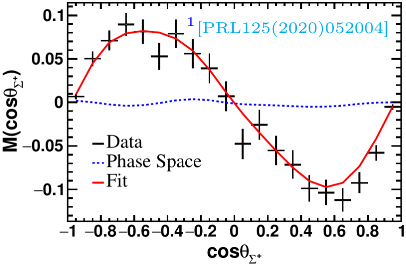
- BESIII: $A_{CP}^{\Lambda} = -0.006 \pm 0.012_{\text{stat}} \pm 0.007_{\text{syst}}$ [Nature Phys.15(2019)631]
- PS185: $A_{CP}^{\Lambda} = 0.013 \pm 0.021_{\text{tot}}$ [PRC54(1996)1877]

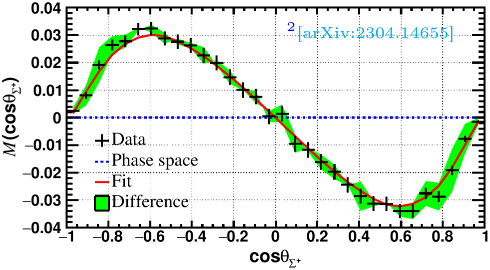
$$\langle \alpha_\Lambda \rangle = \frac{\alpha_\Lambda - \bar{\alpha}_\Lambda}{2} = 0.7542 \pm 0.0010_{\text{stat}} \pm 0.0020_{\text{syst}}$$

- BESIII: $\langle \alpha_\Lambda \rangle = 0.754 \pm 0.003_{\text{stat}} \pm 0.002_{\text{syst}}$ [Nature Phys.15(2019)631]
- CLAS: $\alpha_\Lambda = 0.721 \pm 0.006_{\text{stat}} \pm 0.005_{\text{syst}}$ [PRL123(2019)182301]



$e^+e^- \to J/\psi \to \Sigma^+\bar{\Sigma}^-$



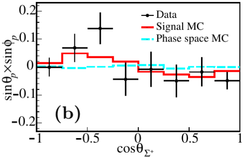


Parameters	$(p\pi^0)(\bar{p}\pi^0)$ [1]	$(p\pi^0)(\bar{n}\pi^-)$ + c.c. [2]
$N_{J/\psi}$	$1.31 \cdot 10^9$	10^{10}
N_{sig}	$87 \cdot 10^3$ with 5% bkg	$(3.1 + 7.5) \cdot 10^5$ with 2% bkg
$\boldsymbol{\alpha_\psi}$	$-0.508 \pm 0.006 \pm 0.004$	$\mathbf{-0.5156 \pm 0.0030 \pm 0.0061}$
$\boldsymbol{\Delta\Phi}$ [rad]	$-0.270 \pm 0.012 \pm 0.009$	$\mathbf{-0.2772 \pm 0.0044 \pm 0.0041}$
$\langle\boldsymbol{\alpha_0}\rangle$	$-0.994 \pm 0.004 \pm 0.002$	
$\langle\boldsymbol{\alpha_+}\rangle$		$0.0506 \pm 0.0026 \pm 0.0019$
$\boldsymbol{A^0_{CP}}$	$\mathbf{-0.004 \pm 0.037 \pm 0.010}$	$3.6 \cdot 10^{-6}$ (SM[3])
$\boldsymbol{A^+_{CP}}$	$3.9 \cdot 10^{-4}$ (SM[3])	$\mathbf{-0.080 \pm 0.052 \pm 0.028}$

[3] [PRD67(2003)056001]

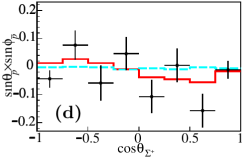
$e^+e^- \to J/\psi \to \Sigma^+\bar{\Sigma}^- \to (p\gamma)(\bar{p}\pi^0)$+c.c.

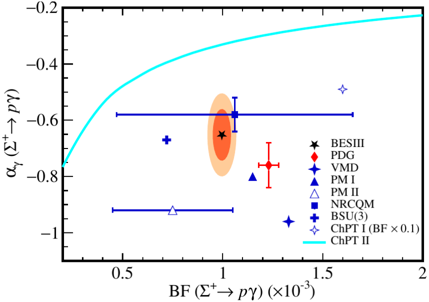
[arXiv:2302.13568]



$\longleftarrow \bar{\Sigma}^- \to \bar{p}\gamma$

$\Sigma^+ \to p\gamma \longrightarrow$





- Data sample of 10^{10} J/ψ events
- 1189 ± 38 and 1306 ± 39 events for $(p\gamma)(\bar{p}\pi^0)$ and $(p\pi^0)(\bar{p}\gamma)$, respectively

$$\mathcal{B} = (0.996 \pm 0.021 \pm 0.018) \cdot 10^{-3}$$
$$\langle \alpha_\gamma \rangle = -0.651 \pm 0.056 \pm 0.020$$

$$\Delta_{CP} = \frac{\mathcal{B} - \bar{\mathcal{B}}}{\mathcal{B} + \bar{\mathcal{B}}} = 0.006 \pm 0.011 \pm 0.004$$
$$A_{CP} = \frac{\bar{\alpha}_\gamma + \alpha_\gamma}{\bar{\alpha}_\gamma - \alpha_\gamma} = 0.095 \pm 0.087 \pm 0.018$$

Formalism sequential weak decays

[PRD99(2019)056008] [PRD100(2019)114005]

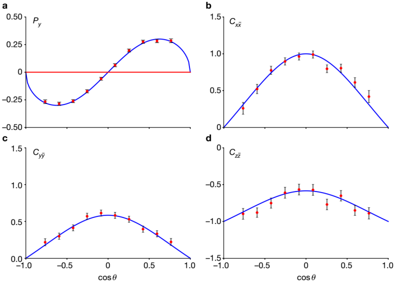
- Decays $B_1 \to B_2(\to B_3 + M_2) + M_1$: $\Xi^- \to \Lambda(\to p\pi^-)\pi^-$+c.c.
- Formalism exploits polarisation, entanglement and sequential decays

$$\mathcal{W}(\boldsymbol{\xi},\boldsymbol{\omega}) = \sum_{\mu,\bar{\nu}=0}^{3} \boxed{C_{\mu\bar{\nu}}} \sum_{\mu',\bar{\nu}'=0}^{3} \boxed{a^{B_1}_{\mu\mu'} a^{\bar{B}_1}_{\bar{\nu}\bar{\nu}'} a^{B_2}_{\mu'0} a^{\bar{B}_2}_{\bar{\nu}'0}}$$

- 9-dimensional phase space given by 9 helicity angles
- 8 free parameters determined by unbinned MLL method

$$\boldsymbol{\omega} = (\alpha_\psi, \Delta\Phi, \alpha_\Xi, \bar{\alpha}_\Xi, \phi_\Xi, \bar{\phi}_\Xi, \alpha_\Lambda, \bar{\alpha}_\Lambda)$$

not measured before



[Nature 606(2022)64]

- $e^+e^- \to J/\psi \to \Xi^-\bar{\Xi}^+$,
  $\Xi^- \to \Lambda(\to p\pi^-)\pi^-$+c.c.
- Data sample of $1.3 \cdot 10^9\, J/\psi$ events
- $73.2 \cdot 10^3$ events with $N_{\rm bkg} = 199 \pm 17$

$e^+e^- \to J/\psi \to \Xi^-\bar{\Xi}^+$, $\Xi^- \to \Lambda(\to p\pi^-)\pi^-$+c.c.

[Nature 606(2022)64]

- First measurement of Ξ^- polarisation
- First direct determination of all $\Xi^-\bar{\Xi}^+$ decay parameters
- Independent measurement of Λ decay parameters
  - Excellent agreement with previous BESIII results
- First measurement of weak phase difference

$(\xi_P - \xi_S)_{\rm SM} = (-2.1 \pm 1.7) \cdot 10^{-4}$ rad [PRD105(2022)116022]

- Two independent CP tests

Parameter	This work	Previous result	
α_ψ	$0.586 \pm 0.012 \pm 0.010$	$0.58 \pm 0.04 \pm 0.08$	[1]
$\Delta\Phi$	$1.213 \pm 0.046 \pm 0.016$ rad	–	
α_Ξ	$-0.376 \pm 0.007 \pm 0.003$	-0.401 ± 0.010	[2]
ϕ_Ξ	$0.011 \pm 0.019 \pm 0.009$ rad	-0.037 ± 0.014 rad	[2]
$\overline{\alpha}_\Xi$	$0.371 \pm 0.007 \pm 0.002$	–	
$\overline{\phi}_\Xi$	$-0.021 \pm 0.019 \pm 0.007$ rad	–	
α_Λ	$0.757 \pm 0.011 \pm 0.008$	$0.750 \pm 0.009 \pm 0.004$	[3]
$\overline{\alpha}_\Lambda$	$-0.763 \pm 0.011 \pm 0.007$	$-0.758 \pm 0.010 \pm 0.007$	[3]
$\xi_P - \xi_S$	$(1.2 \pm 3.4 \pm 0.8) \times 10^{-2}$ rad	–	
$\delta_P - \delta_S$	$(-4.0 \pm 3.3 \pm 1.7) \times 10^{-2}$ rad	$(10.2 \pm 3.9) \times 10^{-2}$ rad	[4]
$A^\Xi_{\rm CP}$	$(6.0 \pm 13.4 \pm 5.6) \times 10^{-3}$	–	
$\Delta\phi^\Xi_{\rm CP}$	$(-4.8 \pm 13.7 \pm 2.9) \times 10^{-3}$ rad	–	
$A^\Lambda_{\rm CP}$	$(-3.7 \pm 11.7 \pm 9.0) \times 10^{-3}$	$(-6 \pm 12 \pm 7) \times 10^{-3}$	[3]
$\langle\phi_\Xi\rangle$	$0.016 \pm 0.014 \pm 0.007$ rad		

[1] [PRD93(2016)072003] [2] [PTEP2020(2020)083C01] [3] [Nature Phys.15(2019)631] [4] [PRL93(2004)011802]

$e^+e^- \to J/\psi \to \Xi^0\bar{\Xi}^0$, $\Xi^0 \to \Lambda(\to p\pi^-)\pi^0$+c.c.

[arXiv:2305.09218]

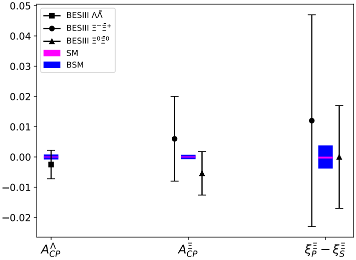
- Data sample of 10^{10} J/ψ events
- $3.3 \cdot 10^5$ events with 2% bkg
- First measurement of Ξ^0 polarisation
- Improved measurement:
  - All $\Xi^0\bar{\Xi}^0$ decay parameters
  - Weak phase difference
  - Two independent CP tests

Parameter	This work	Previous result	
$\alpha_{J/\psi}$	$0.514 \pm 0.006 \pm 0.015$	0.66 ± 0.06	[1]
$\Delta\Phi$(rad)	$1.168 \pm 0.019 \pm 0.018$	-	
α_{Ξ}	$-0.3750 \pm 0.0034 \pm 0.0016$	-0.358 ± 0.044	[2]
$\bar{\alpha}_{\Xi}$	$0.3790 \pm 0.0034 \pm 0.0021$	0.363 ± 0.043	[2]
ϕ_{Ξ}(rad)	$0.0051 \pm 0.0096 \pm 0.0018$	0.03 ± 0.12	[2]
$\bar{\phi}_{\Xi}$(rad)	$-0.0053 \pm 0.0097 \pm 0.0019$	-0.19 ± 0.13	[2]
α_{Λ}	$0.7551 \pm 0.0052 \pm 0.0023$	0.7519 ± 0.0043	[3]
$\bar{\alpha}_{\Lambda}$	$-0.7448 \pm 0.0052 \pm 0.0017$	-0.7559 ± 0.0047	[3]
$\xi_P - \xi_S$(rad)	$(0.0 \pm 1.7 \pm 0.2) \times 10^{-2}$	-	
$\delta_P - \delta_S$(rad)	$(-1.3 \pm 1.7 \pm 0.4) \times 10^{-2}$	-	
A_{CP}^{Ξ}	$(-5.4 \pm 6.5 \pm 3.1) \times 10^{-3}$	$(-0.7 \pm 8.5) \times 10^{-2}$	[2]
$\Delta\phi_{CP}^{\Xi}$(rad)	$(-0.1 \pm 6.9 \pm 0.9) \times 10^{-3}$	$(-7.9 \pm 8.3) \times 10^{-2}$	[2]
A_{CP}^{Λ}	$(6.9 \pm 5.8 \pm 1.8) \times 10^{-3}$	$(-2.5 \pm 4.8) \times 10^{-3}$	[3]
$\langle\alpha_{\Xi}\rangle$	$-0.3770 \pm 0.0024 \pm 0.0014$	-	
$\langle\phi_{\Xi}\rangle$(rad)	$0.0052 \pm 0.0069 \pm 0.0016$	-	
$\langle\alpha_{\Lambda}\rangle$	$0.7499 \pm 0.0029 \pm 0.0013$	0.7542 ± 0.0026	[3]

[1] [PLB770(2017)217] [2] [arXiv:2302.09767] [3] [PRL129(2022)131801]

Summary and Outlook

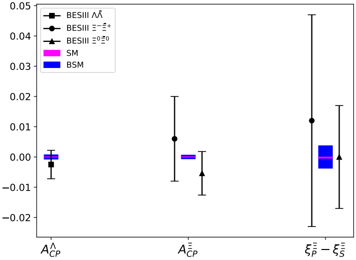
- BESIII has performed
  - Measurements of polarisation and spin correlations
    - $10^{10} J/\psi$ events: $\Lambda\bar{\Lambda}, \Xi^0\bar{\Xi}^0, \Sigma\bar{\Sigma}$
    - $1.3 \cdot 10^9 J/\psi$ events: $\Sigma\bar{\Sigma}, \Xi^-\bar{\Xi}^+$
    - $0.5 \cdot 10^9 \psi'$ events: $\Sigma\bar{\Sigma}, \Xi\bar{\Xi}$
  - Determination of hyperon and antihyperon decay parameters
  - CP tests comparing hyperon and antihyperon
    - Separation of strong and weak decay phases $\Longrightarrow$ more sensitive CP tests



- Future prospects
  - More interesting results are expected with recently collected 10^{10} J/ψ and $3 \cdot 10^9$ ψ' events
  - Good prospects for future Super J/ψ Factories [Snowmass2021] [PRD105(2022)116022]
    - Planning produce more than 10^{12} J/ψ events
    - Polarized electron beam
    - Statistical precision will be comparable to the SM predictions
    - Progress of STCF: Zhujun Fang's talk at Thursday

Summary and Outlook

- BESIII has performed
  - Measurements of polarisation and spin correlations
    - $10^{10}\, J/\psi$ events: $\Lambda\bar{\Lambda}, \Xi^0\bar{\Xi}^0, \Sigma\bar{\Sigma}$
    - $1.3 \cdot 10^9\, J/\psi$ events: $\Sigma\bar{\Sigma}, \Xi^-\bar{\Xi}^+$
    - $0.5 \cdot 10^9\, \psi'$ events: $\Sigma\bar{\Sigma}, \Xi\bar{\Xi}$
  - Determination of hyperon and antihyperon decay parameters
  - CP tests comparing hyperon and antihyperon
    - Separation of strong and weak decay phases $\Longrightarrow$ more sensitive CP tests



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Stay tuned and thank you for your attention!