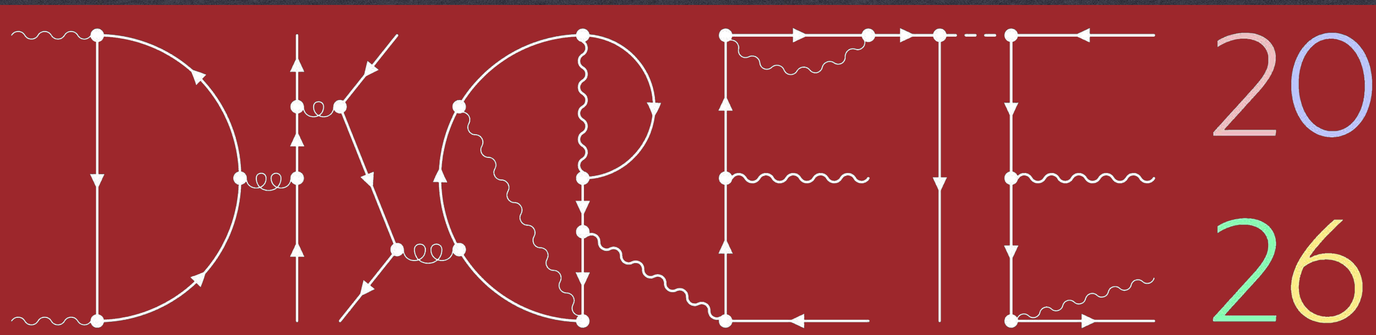


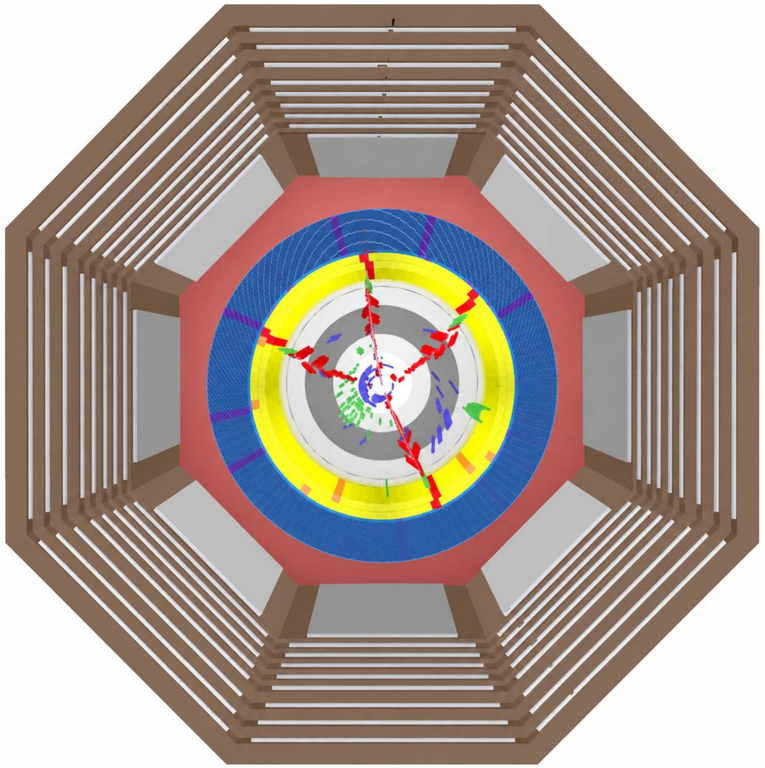
Nov 13 – 17, 2026
Faculty of Mathematics, Physics and Informatics, Comenius University Bratislava

RECENT RESULTS FROM THE BESIII EXPERIMENT

G. CIBINETTO (INFN FERRARA)
ON BEHALF OF THE BESIII COLLABORATION

Outline of the talk

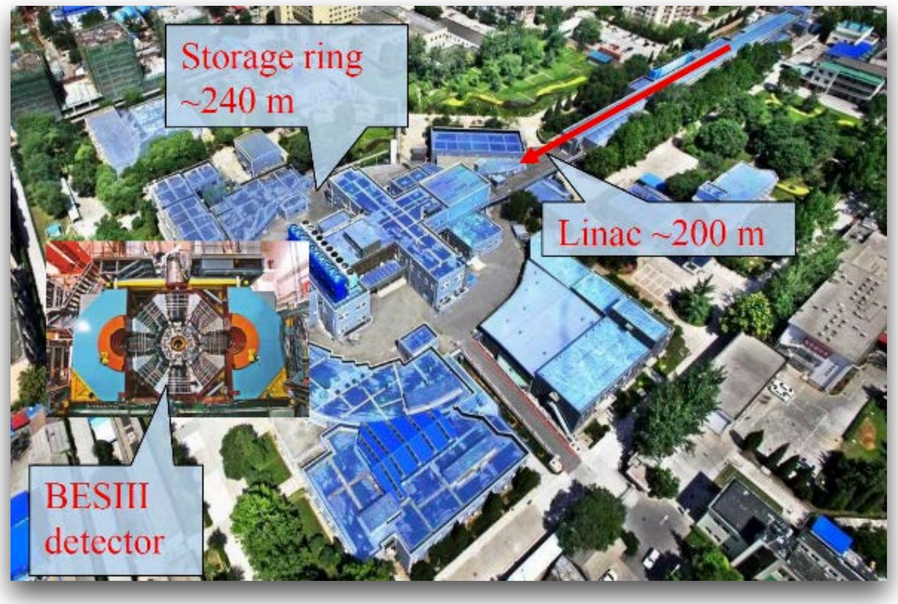
- The BESIII experiment, physics, and dataset
- The lightest pseudoscalar glueball candidate
- CPV in the neutral decays of Λ
- EDM search of the Λ Baryon
- Λ semileptonic decays
- Search for sub-GeV Dark Matter

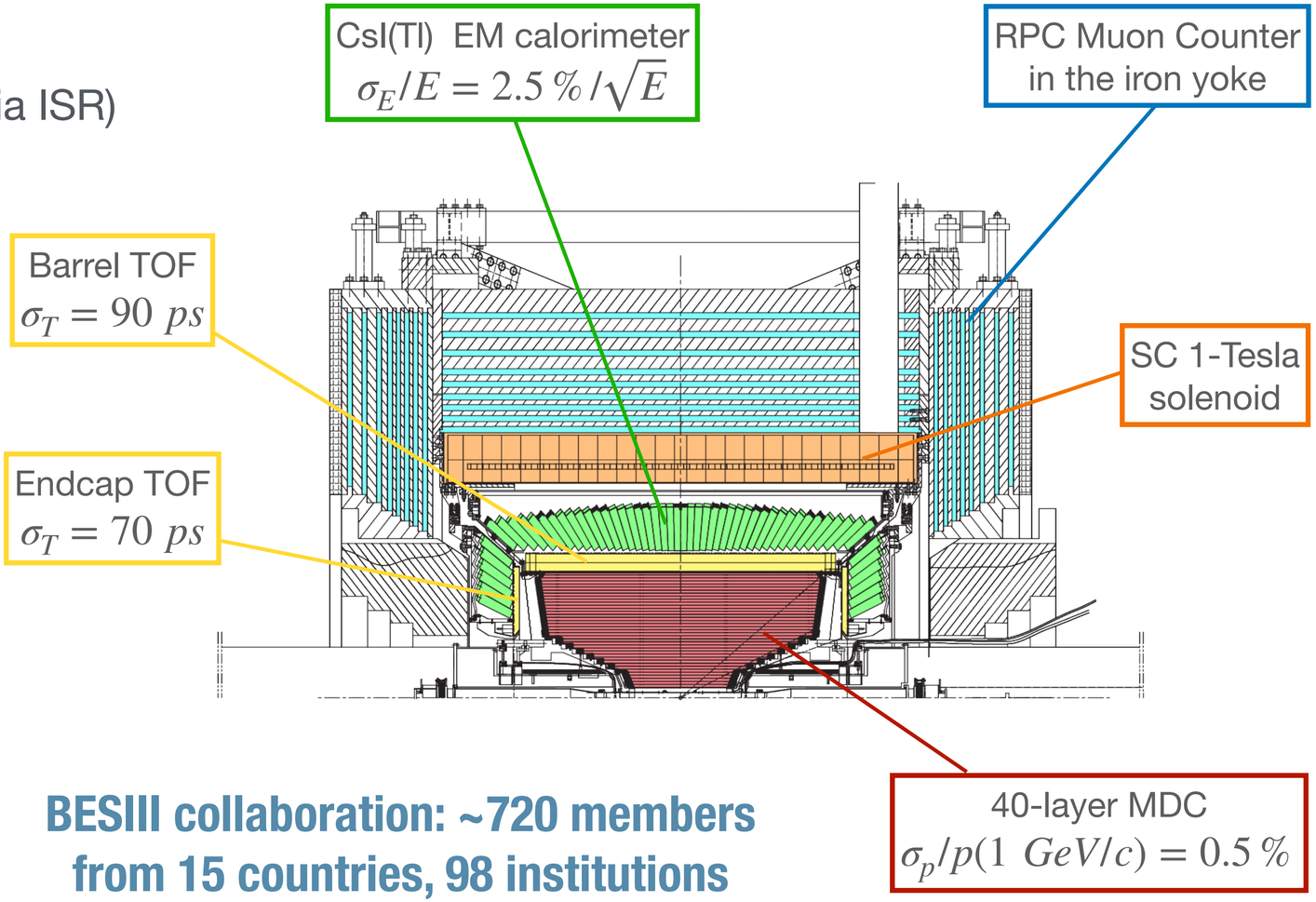


The BESIII experiment @ BEPCII

NIM A Volume 614 (345-399), Issue 3

- $E_{CM} = 1.84 - 4.95\ GeV$
- Region below 2 GeV directly accessible (via ISR)
- $\mathscr{L}_{peak} = 1.1 \times 10^{33}\ cm^{-2}s^{-1}$
- Beam energy spread $\sim 3 \times 10^{-5}$ at $m_{\tau\tau}$





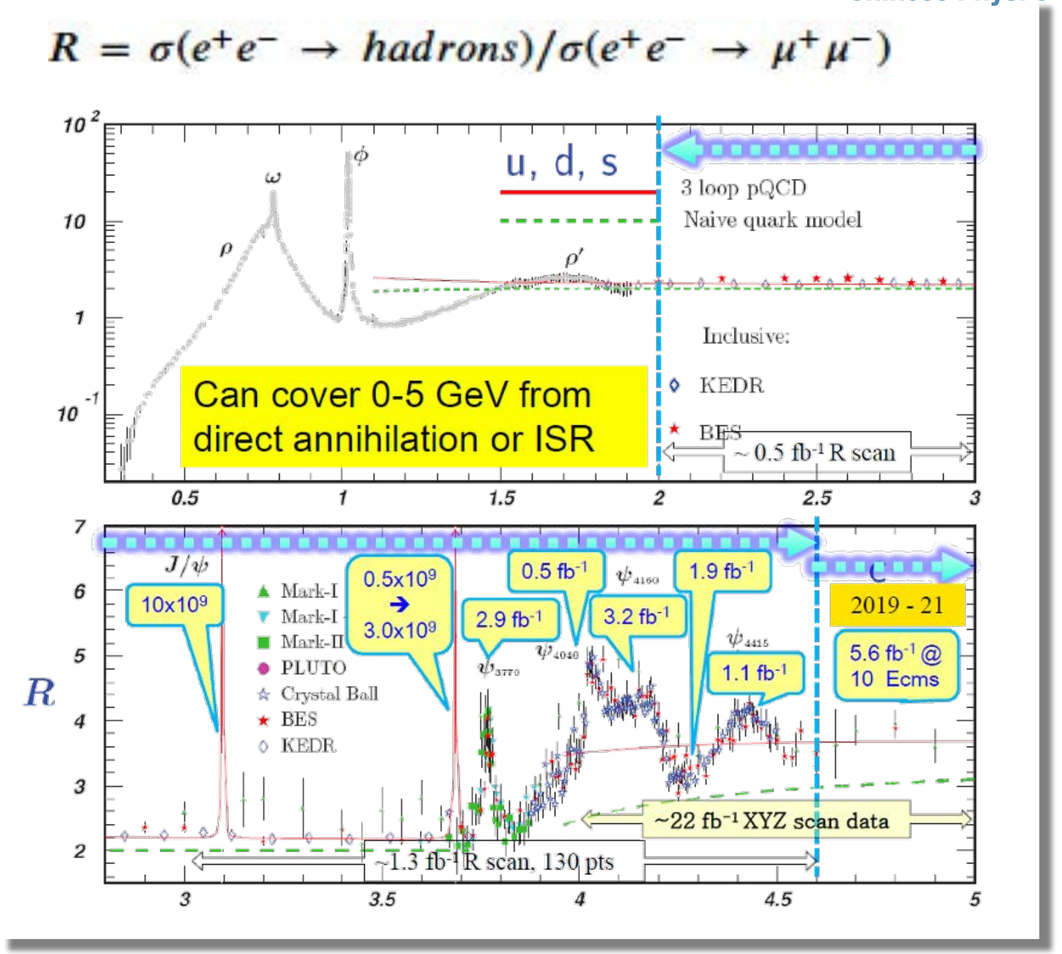
BESIII collaboration: ~720 members from 15 countries, 98 institutions

The BESIII experiment @ BEPCII

arXiv:0809.1869

Chinese Phys. C 44 040001

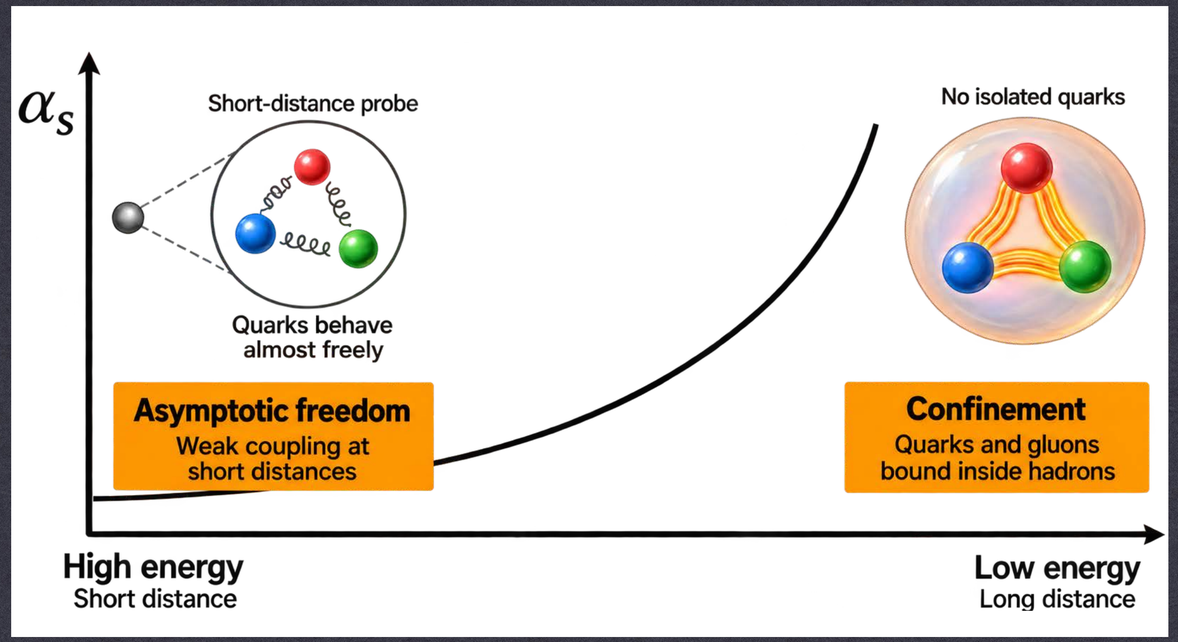
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- $\mathscr{L}_{peak} = 1.1 \times 10^{33}\ cm^{-2}s^{-1}$
- Beam energy spread $\sim 3 \times 10^{-5}$ at $m_{\tau\tau}$
- World's largest sample of
  - J/ψ **—> 10 billions**
  - $\psi(2S)$ —> 3 billions
  - $\psi(3770)$ —> 20 fb^{-1}
- About 22 fb^{-1} of data for Exotic Charmonium Spectroscopy



Spectroscopy & decays of light hadrons and charmonium, charm physics, precision measurements, tests of fundamental symmetry

LIGHTEST 0^{-+} GLUEBALL

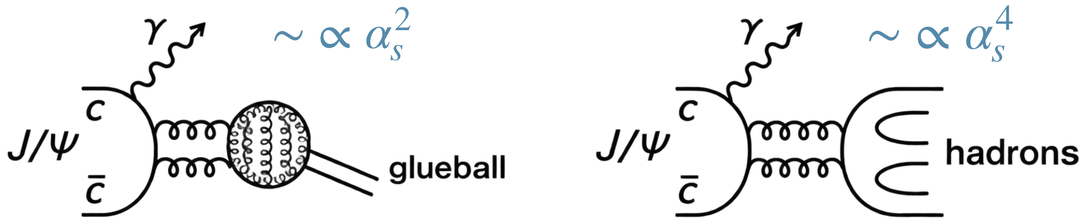
- QCD — SU(3) non-Abelian gauge theory
- At high energy
  - α_s running, widely confirmed experimentally
- At low energy
  - self-interaction of gluons
  - bound states of gluons: glueballs
  - Many candidates, not established yet



- Distinctive manifestation of gluon self-interactions
- Unique particle/matter made of pure force
- Direct proof of origin of mass from strong interaction

Glueball production and decays

- Gluon-rich environment for production
  - Glueball production rate in J/ψ radiative decays could be higher than that of normal hadrons
  - Spin-parity filter: C parity must be +, so J^{PC}=0^{-+}, 0^{++}, 1^{++}, 2^{++} , 2^{-+} …

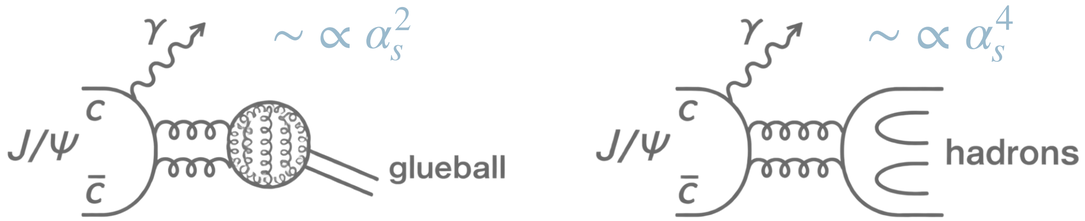


- Lattice QCD prediction for the lightest pseudoscalar glueball PRD 100 (2019) 054511
  - $M = 2395 \pm 14$ MeV
  - $B(J/\psi \to \gamma G_0^{-+}) = 2.31 \pm 0.80 \times 10^{-4}$
- Mixing mechanism between η_c and 0^{-+} glueball can significantly increase the production rate of the mixture 0^{-+} particle to $(2\sim20) \times 10^{-3}$ PLB 827 (2022) 136960 arXiv: 2605.01757

Clean environment in e^+e^- collision: very different from p-p collision

Glueball production and decays

- Gluon-rich environment for production
  - Glueball production rate in J/ψ radiative decays could be higher than that of normal hadrons
  - Spin-parity filter: C parity must be +, so J^{PC}=0^{-+}, 0^{++}, 1^{++}, 2^{++} , 2^{-+} …



- Glueball decays
  - Glueballs contain no quark flavor — flavor-singlet states
  - Similarities with η_c, decay through OZI-forbidden mechanisms
  - Suppressed radiative decays

- Lattice QCD prediction for the lightest pseudoscalar glueball

  PRD 100 (2019) 054511
  - $M = 2395 \pm 14$ MeV
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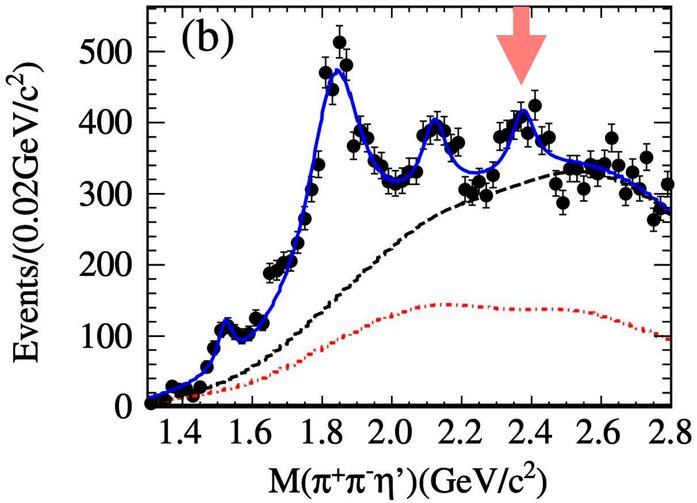
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  PLB 827 (2022) 136960 arXiv: 2605.01757

Clean environment in e^+e^- collision: very different from p-p collision

The X(2370) discovery

PRL106 (2011) 072002

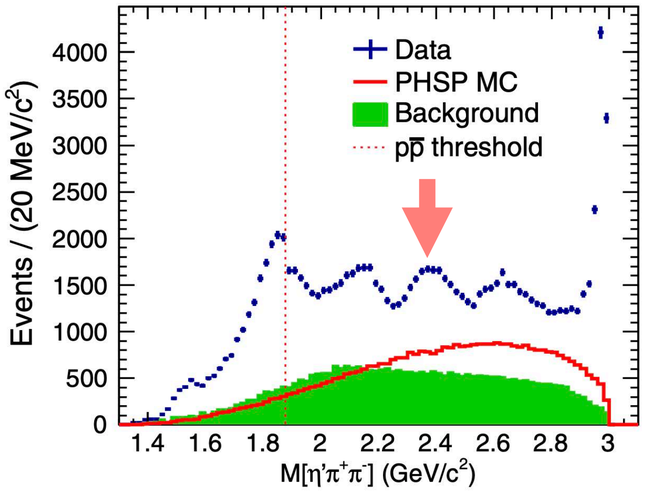


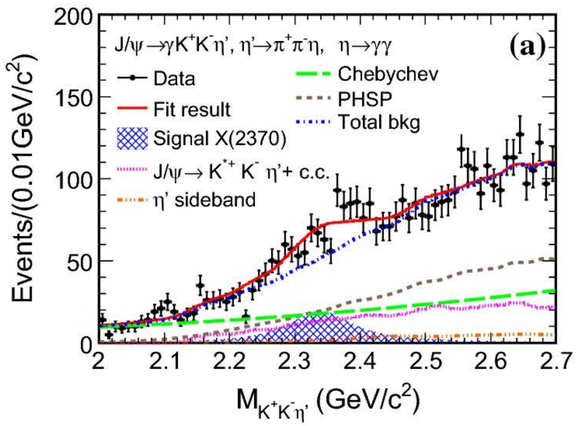
- Discovered by BESIII in $J/\psi \to \gamma\pi^+\pi^-\eta'$ in 2011

Resonance	$M(\mathrm{MeV}/c^2)$	$\Gamma(\mathrm{MeV}/c^2)$	N_{event}
$f_1(1510)$	1522.7 ± 5.0	48 ± 11	230 ± 37
$X(1835)$	1836.5 ± 3.0	190.1 ± 9.0	4265 ± 131
$X(2120)$	2122.4 ± 6.7	83 ± 16	647 ± 103
$X(2370)$	2376.3 ± 8.7	83 ± 17	565 ± 105

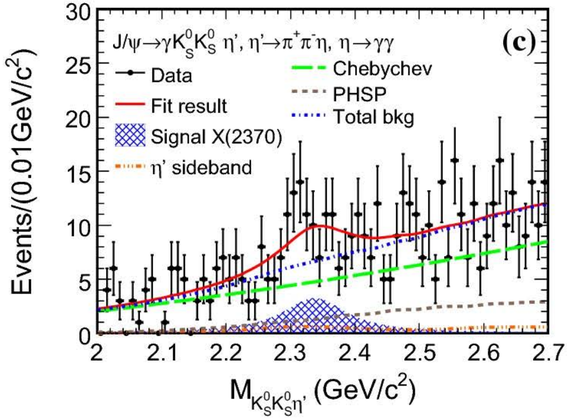
- Confirmed by BESIII in $J/\psi \to \gamma\pi^+\pi^-\eta'$, $\gamma KK\eta'$ (more data & new mode)

PRL 117 (2016) 042002

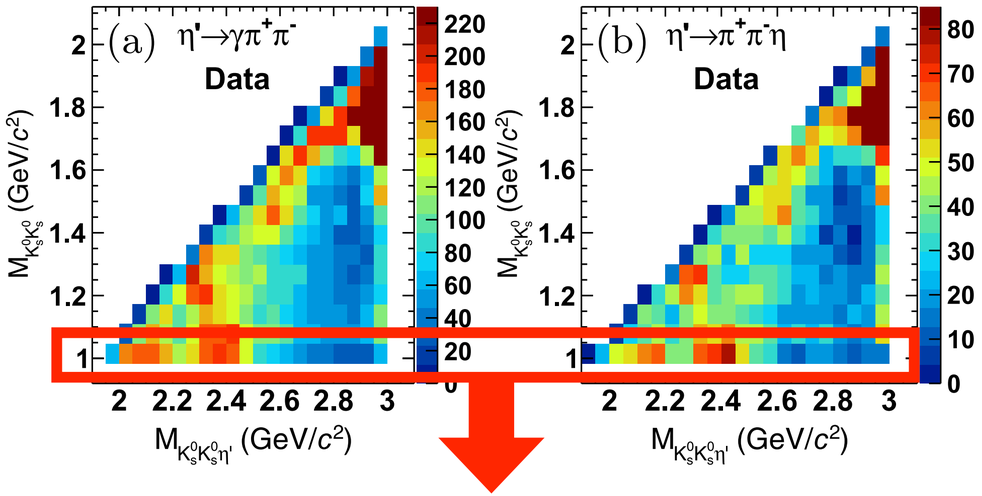


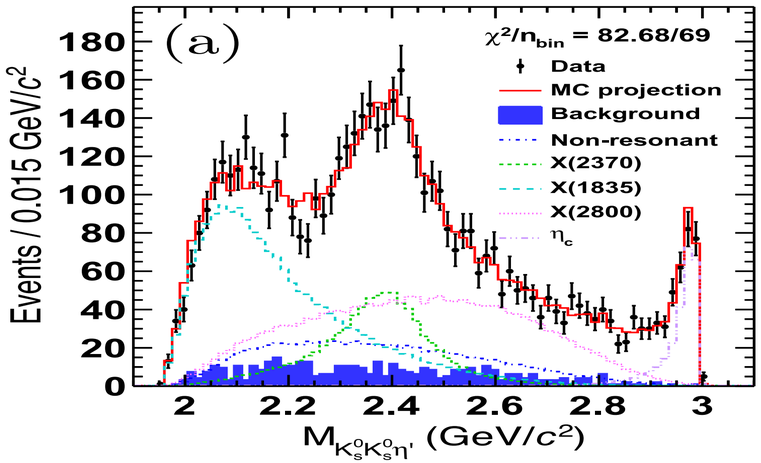


EPJC 80 (2020) 746



Other decay modes and narrow partial decay widths





- With the full BESIII dataset: 10 billion J/ψ

$J^{PC} = 0^{-+}$ with significance $> 9.8\,\sigma$ PRL 132 (2024) 181901

$B(J/\psi \to \gamma X(2370)) \times B(X(2370) \to f_0(980)\,\eta') \times B(f_0(980) \to K_S^0 K_S^0)$
$= 1.31 \pm 0.22\,{}^{+2.85}_{-0.84} \times 10^{-5}$

- Found also

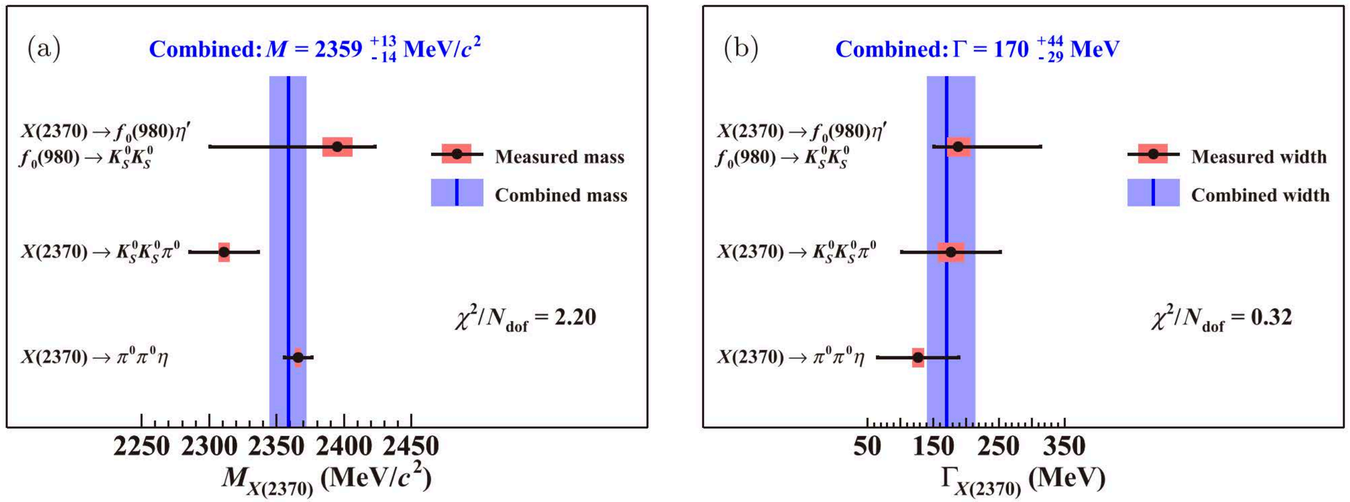
$$X(2370) \to K_S^0 K_S^0 \pi^0$$
$$X(2370) \to \pi^0\pi^0\eta$$
$$X(2370) \to a_0(980)\pi^0$$

Chinese Phys. C 50 101001

strong similarities with η_c decays

Combined results

Chinese Phys. C 50 101001



Combined result

$$M_{X(2370)} = 2359^{+13}_{-14}\ MeV/c^2$$

$$\Gamma_{X(2370)} = 170^{+44}_{-29}\ MeV$$

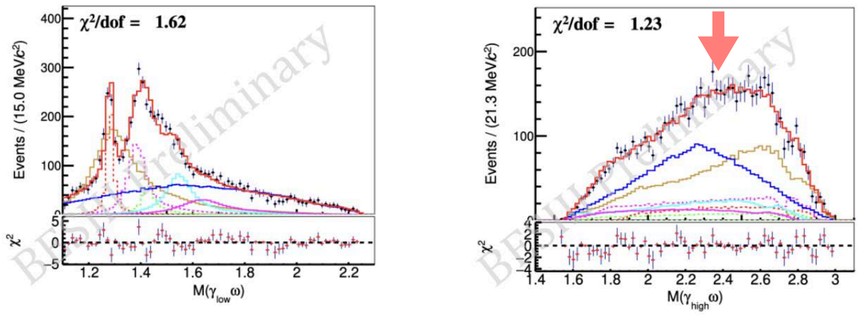
Decay channel	$\mathcal{B}$ $(\times 10^{-4})$
$J/\psi \to \gamma X(2370) \to \gamma K\bar{K}\pi$	$3.25 \pm 0.25^{+0.73}_{-0.75}$
$J/\psi \to \gamma X(2370) \to \gamma\pi\pi\eta$	$3.2 \pm 0.1^{+0.9}_{-1.0}$
$J/\psi \to \gamma X(2370) \to \gamma\pi\pi\eta'$	$1.94 \pm 0.04^{+0.33}_{-0.88}$
$J/\psi \to \gamma X(2370) \to \gamma K\bar{K}\eta'$	$0.39 \pm 0.05 \pm 0.10$

- The total sum from the left table is ~0.9 × 10^{-3}
  - Considering other unmeasured decay modes, it is reasonable to conclude

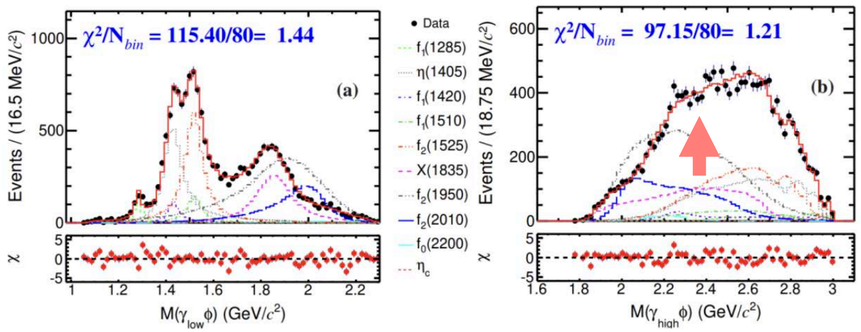
$$B(J/\psi \to \gamma X(2370)) > 1 \times 10^{-3}$$

Suppressions of X(2370) → $\gamma\omega$, $\gamma\phi$

$J/\psi \to \gamma\gamma\omega$



$J/\psi \to \gamma\gamma\phi$



PRD 111(2025) 052011

- $J/\psi \to \gamma\gamma\omega$, $\gamma\gamma\phi$ have been studied with amplitude analysis

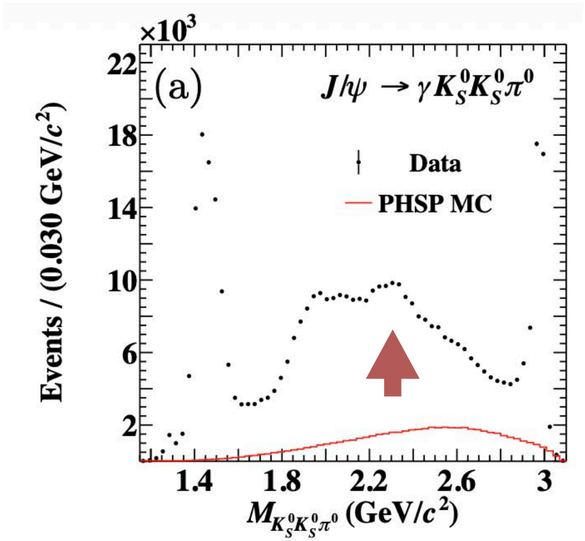
Resonance R	$J/\psi \to \gamma R \to \gamma\gamma\omega$ $(\times 10^{-6})$ [29]	$J/\psi \to \gamma R \to \gamma\gamma\phi$ $(\times 10^{-6})$ [30]
$\eta(1405)$	$3.54 \pm 0.20^{+0.65}_{-0.24}$	$3.57 \pm 0.18^{+0.59}_{-0.61}$
$X(1835)$	< 0.11	$3.37 \pm 0.19^{+0.78}_{-1.10}$
$X(2370)$	< 0.04	< 0.11

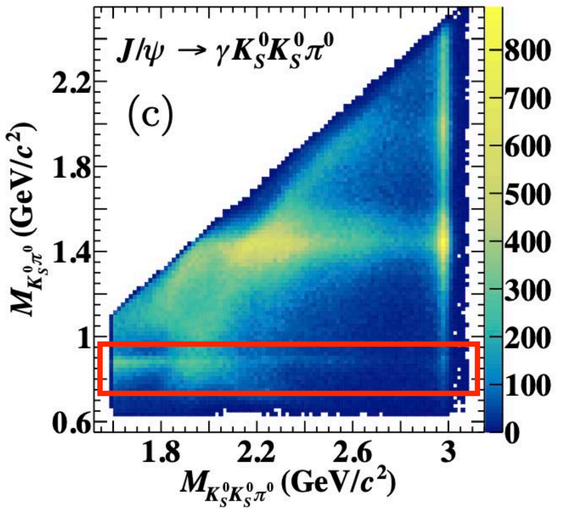
- With $B(J/\psi \to \gamma X(2370)) > 1 \times 10^{-3}$ → strong suppressions
- No evidence of **X(2370)**, consistent with the predictions for glueball
- $\eta_c \to \gamma\phi$ observed. The very first radiative decay mode of η_c
- X(1835) → γϕ suggests its assignment as the η′ excitation
- Observation of $f_2(1950)$ and $f_0(2200) \to \gamma\phi$ disfavored glueball interpretations

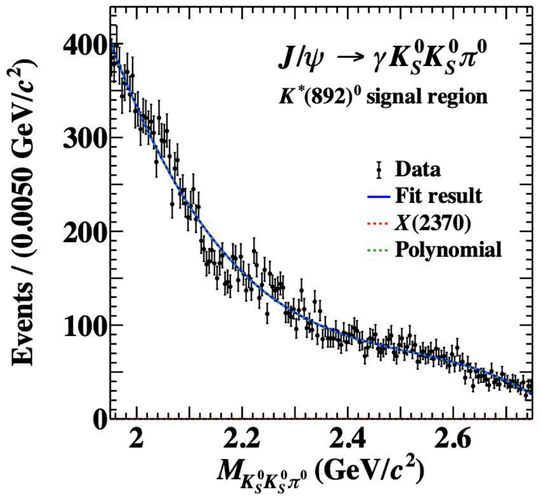
arXiv:2607.20366

Study of $X(2370) \to K^*(892)\bar{K} + c.c.$

- Forbidden by Generalized G-parity conservation







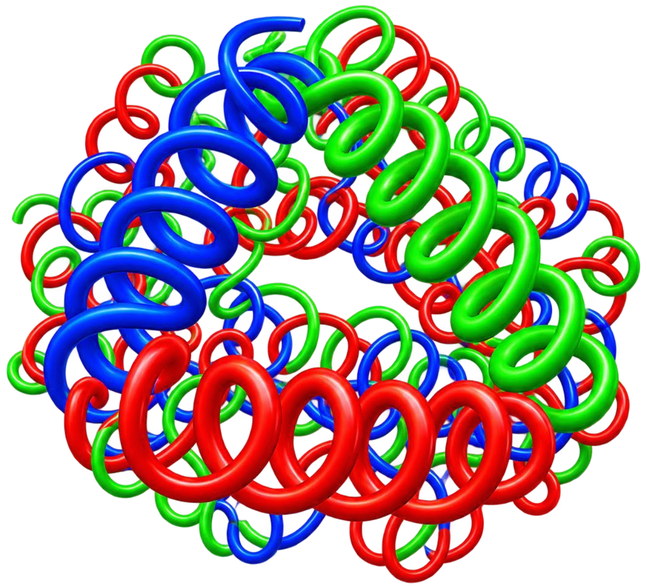
- $\mathcal{B}[J\psi \to \gamma X(2370)] \times \mathcal{B}[X(2370) \to K^*(892)^0 K_S^0 + \text{c.c.} \to K_S^0 K_S^0 \pi^0]$ $< 2.7 \times 10^{-6}$ @90% C.L.

$$\frac{\mathcal{B}[X(2370)\to K^*(892)^0 K_S^0 + \text{c.c.} \to K_S^0 K_S^0 \pi^0]}{\mathcal{B}[X(2370)\to K_S^0 K_S^0 \pi^0]} < 0.081 \text{ @90\% C.L.}$$

- The suppression of the X(2370) decay into K*(892) K supports that the X(2370) is a flavor-singlet

Summing up the X(2370)

- Properties of $X(2370)$
  - high production rate in J/ψ radiative decays
  - flavor-singlet state
  - decay pattern similarities to η_c
  - narrow partial decay widths
  - strong suppression of $\gamma\omega$, $\gamma\phi$ decays
- These observations are fully consistent with the expected signatures of a glueball
  - Other interpretations can hardly explain all of them simultaneously



- The lightest 0^{-+} glueball is needed for a natural and complete explanation of $X(2370)$ properties measured by BESIII

THE HYPERON LAB

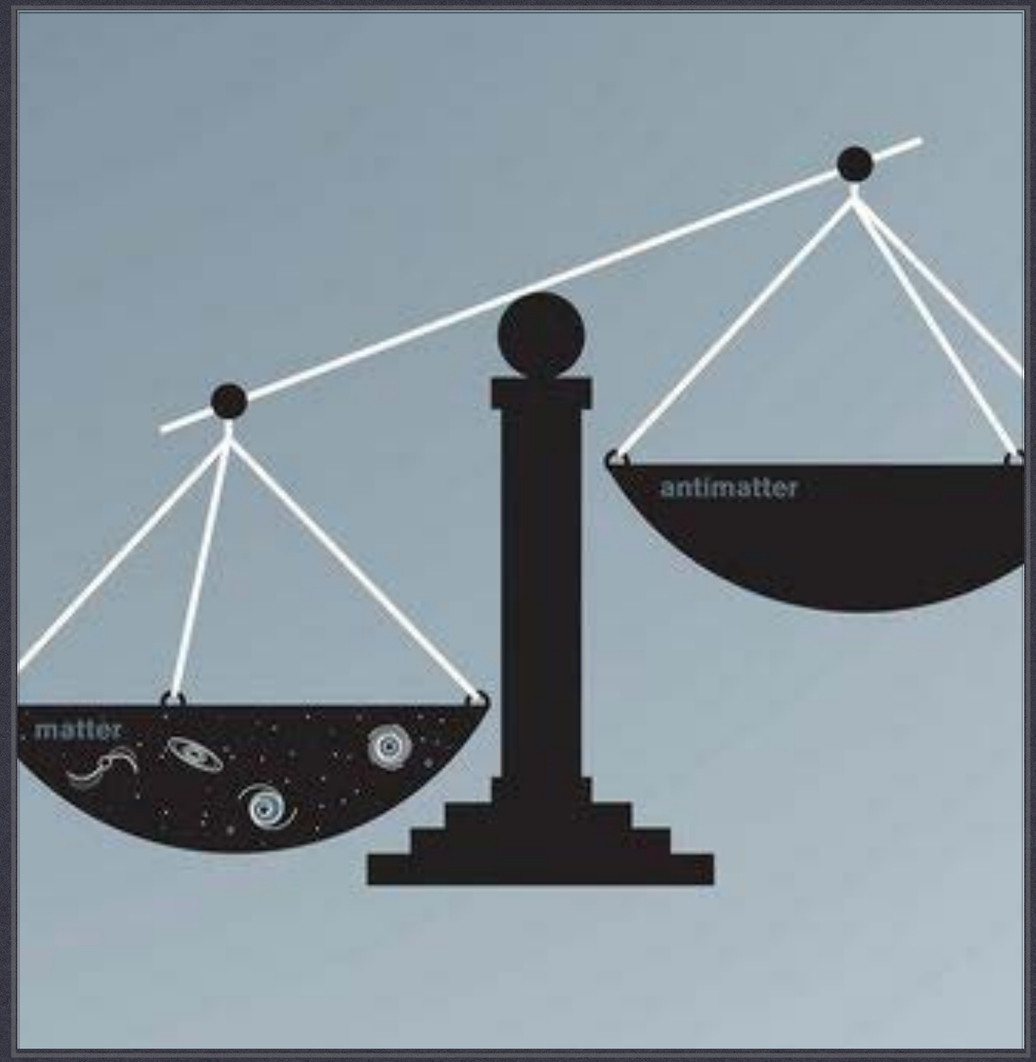
Unique combination of nature, experimental setup, and analysis tools

Matter-antimatter asymmetry demands new CP sources

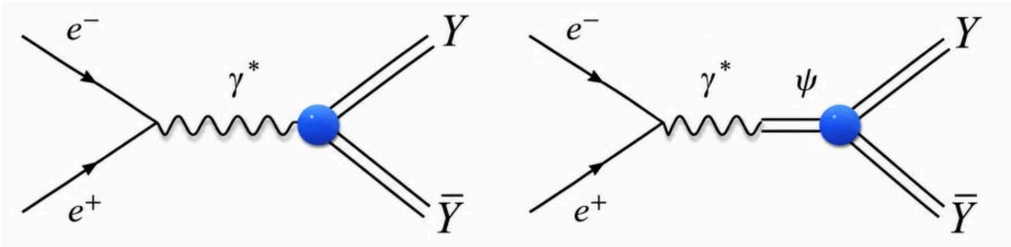
Sakharov conditions JETPLett. 5,24-27 (1967)

- Baryon-number violation
- C and CP violation
- Departure from thermal equilibrium

Known Standard Model CP violation is insufficient

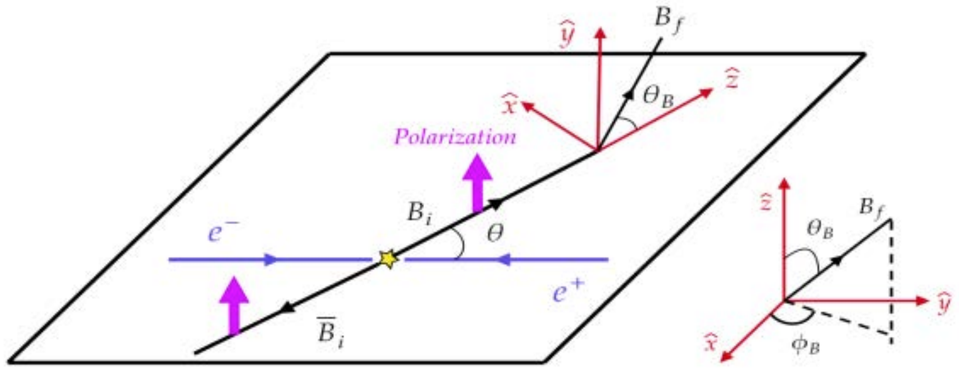


Hyperons production at BESIII



- Hyperons produced in charmonium decays can have polarization normal to the production plane, even when production conserves parity and CP

Polarization originates from interference between production amplitudes with a nonzero relative phase

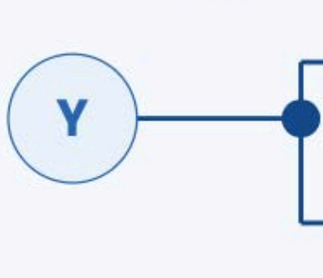


$$P_y(\cos\theta) = \frac{\sqrt{1-\alpha_\psi^2}\cos\theta\sin\theta}{1+\alpha_\psi \cos^2\theta}\sin(\Delta\Phi)$$

A non-zero $\boldsymbol{\Delta\Phi}$ represents the transverse polarization

$$\xi = (\theta_\Lambda, \theta_Y, \phi_Y, \theta_{\bar{Y}}, \phi_{\bar{Y}}) \qquad \omega = (\alpha_\psi, \Delta\Phi, \alpha_Y, \alpha_{\bar{Y}})$$

CP observables in hyperon decays



Bπ partial-wave decomposition

$$\mathcal{M} = S + P\sigma \cdot \hat{n}$$

$$\alpha = \frac{2Re(S*P)}{|S|^2+|P|^2}$$

$$\beta = \frac{2Im(S*P)}{|S|^2+|P|^2}$$

$$\gamma = \frac{|S|^2-|P|^2}{|S|^2+|P|^2}$$

$$\alpha^2+\beta^2+\gamma^2 = 1$$

S wave • L = 0 • parity violating

P wave • L = 1 • parity conserving

CP conservation: $\alpha_Y = -\bar{\alpha}_Y, \beta_Y = -\bar{\beta}_Y, \phi_Y = -\bar{\phi}_Y$

Two complex amplitudes: ϕ **weak phase,** δ **strong phase**

$$S = \Sigma^i S_i e^{i(\phi_i^S+\delta_i^S)}, \qquad P = \Sigma^i P_i e^{i(\phi_i^P+\delta_i^P)}$$

Under CP transformation:

$$\bar{S} = -\Sigma^i S_i e^{i(-\phi_i^S+\delta_i^S)}, \qquad \bar{P} = \Sigma^i P_i e^{i(-\phi_i^P+\delta_i^P)}$$

CPV observables

$$\Delta = \frac{\Gamma-\bar{\Gamma}}{\Gamma+\bar{\Gamma}}$$

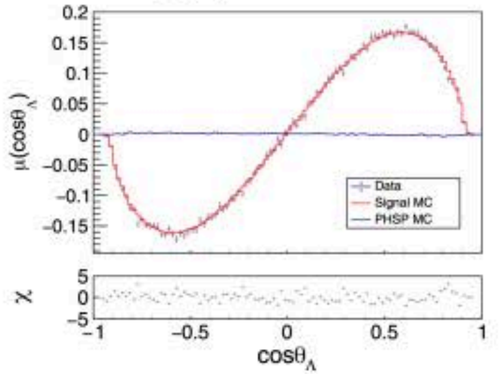
$$A = \frac{\Gamma\alpha+\bar{\Gamma}\bar{\alpha}}{\Gamma\alpha-\bar{\Gamma}\bar{\alpha}} \approx \frac{\alpha+\bar{\alpha}}{\alpha-\bar{\alpha}} + \Delta$$

$$B = \frac{\Gamma\beta+\bar{\Gamma}\bar{\beta}}{\Gamma\beta-\bar{\Gamma}\bar{\beta}} \approx \frac{\beta+\bar{\beta}}{\beta-\bar{\beta}} + \Delta$$

The daughter angular distribution analyzes the parent polarization and exposes the decay parameters

Spin-1/2 hyperons: a complete polarization map

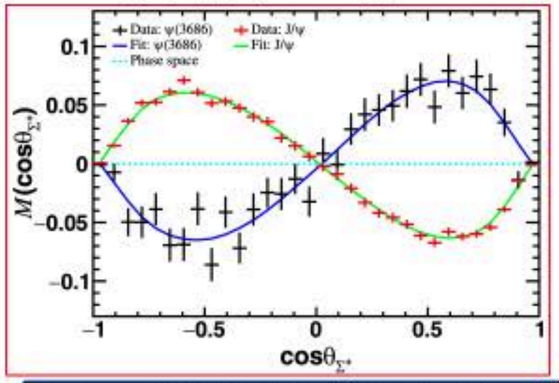
$J/\psi \to \Lambda\bar{\Lambda}$



$\Delta\Phi = (0.7521 \pm 0.0042 \pm 0.0066)$ rad

Phys. Rev. Lett. 129, 131801 (2022)

$J/\psi[\psi(3686)] \to \Sigma^+\bar{\Sigma}^-$

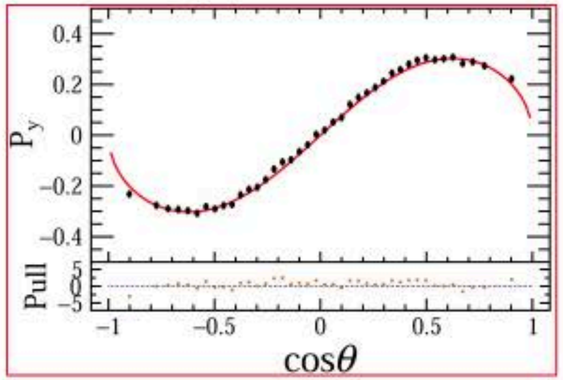


$\Delta\Phi_{J/\psi} = (-0.2744 \pm 0.0033 \pm 0.0010)$ rad

$\Delta\Phi_{\psi(2S)} = (0.427 \pm 0.022 \pm 0.003)$ rad

Phys. Rev. Lett. 135, 141804 (2025)

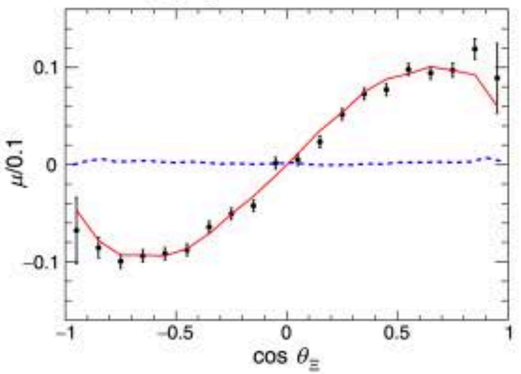
$J/\psi \to \Xi^-\bar{\Xi}^+$



$\Delta\Phi = (1.221 \pm 0.016 \pm 0.006)$ rad

Phys. Rev. Lett. 136, 201802 (2026)

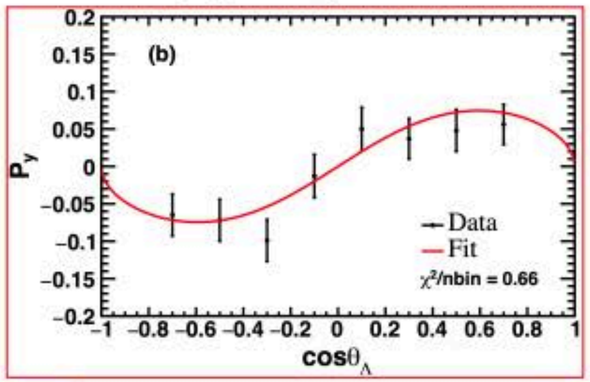
$J/\psi \to \Xi^0\bar{\Xi}^0$



$\Delta\Phi = (1.168 \pm 0.019 \pm 0.018)$ rad

Phys. Rev. D 108, L031106 (2023)

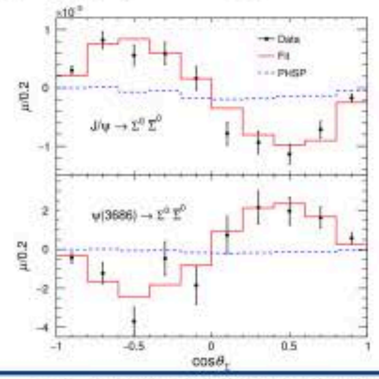
$\psi(3686) \to \Lambda\bar{\Lambda}$



$\Delta\Phi = (0.366 \pm 0.064 \pm 0.013)$ rad

arXiv:2509.15276

$J/\psi[\psi(3686)] \to \Sigma^0\bar{\Sigma}^0$

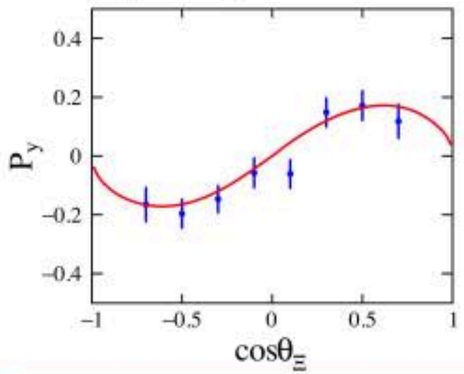


$\Delta\Phi_{J/\psi} = (-0.0828 \pm 0.0068 \pm 0.0033)$ rad

$\Delta\Phi_{\psi(2S)} = (0.512 \pm 0.085 \pm 0.034)$ rad

Phys. Rev. Lett. 133, 101902 (2024)

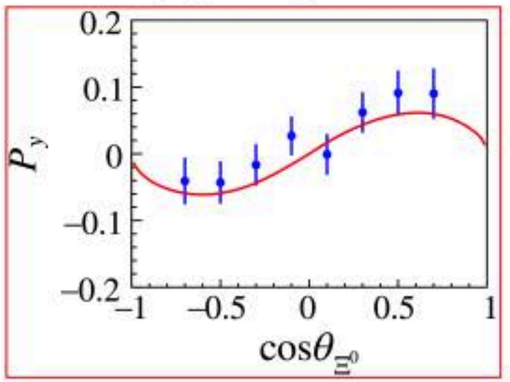
$\psi(3686) \to \Xi^-\bar{\Xi}^+$



$\Delta\Phi = (0.667 \pm 0.111 \pm 0.058)$ rad

Phys. Rev. D 106, L091101 (2022)

$\psi(3686) \to \Xi^0\bar{\Xi}^0$



$\Delta\Phi = (0.257 \pm 0.061 \pm 0.009)$ rad

Phys. Rev. D 113, L091501 (2026)

Phys. Rev. Lett. 136, 251802 (2026)

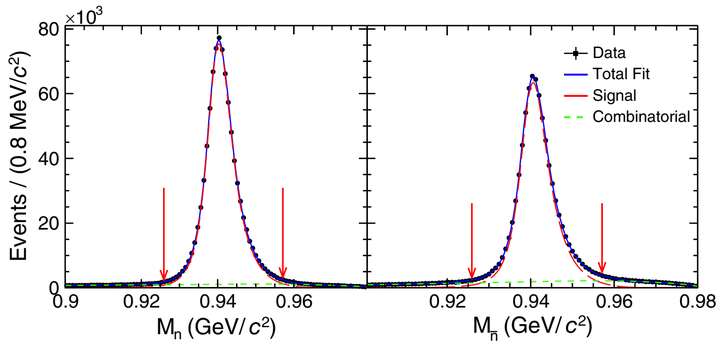
CP symmetry in neutral Λ decays

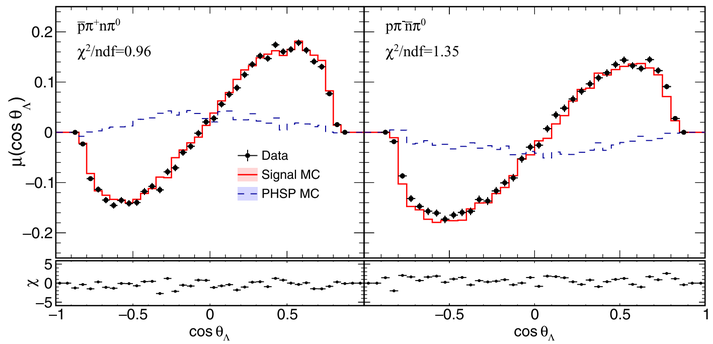
$J/\psi \to \Lambda\bar{\Lambda} \to (n\pi^0)(\bar{p}\pi^+) + c.c.$

- 10.087 billion J/ψ decays
- The neutron / antineutron is inferred from missing four-momentum
- A simultaneous five-angle fit uses transverse polarization and Λ–$\bar{\Lambda}$ spin correlations

$$\xi = (\theta_\Lambda, \theta_n, \phi_n, \theta_{\bar{p}}, \phi_{\bar{p}}) \qquad \omega = (\alpha_{J/\psi}, \Delta\Phi, \alpha_0, \alpha_+)$$

α_-	$0.756 \pm 0.008 \pm 0.003$
α_+	$-0.764 \pm 0.008 \pm 0.001$
α_0	$0.668 \pm 0.007 \pm 0.002$
$\bar{\alpha}_0$	$-0.677 \pm 0.007 \pm 0.003$





ΔΦ = 0.748 ± 0.006 ± 0.004 rad

A nonzero production phase generates transverse polarization

Phys. Rev. Lett. 136, 251802 (2026)

Neutral Λ CP test and the ΔI = 1/2 rule

$A^0_{CP} = (\alpha_0 + \bar{\alpha}_0) / (\alpha_0 - \bar{\alpha}_0)$ CP conservation: $\bar{\alpha}_0 = -\alpha_0$

$A^0_{\Lambda_{CP}} = -0.006 \pm 0.007 \pm 0.002$

Consistent with zero. Best neutral-Λ CP precision. Precision improves by ~30%

Neutral / charged decay-parameter ratios

Ratio	Measurement	Below unity
α_0 / α_-	$0.884 \pm 0.013 \pm 0.006$	8.1σ
$\bar{\alpha}_0 / \alpha_+$	$0.885 \pm 0.013 \pm 0.004$	8.5σ

Pure ΔI = 1/2 predicts unity (isospin limit)

The deviations establish ΔI = 3/2 contributions

Interpretation

SM estimates:
$|A_{\Lambda CP}| \lesssim 3 \times 10^{-5}$

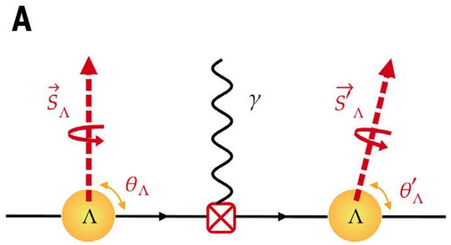
Current precision remains well above this scale

ΔI = 3/2 terms matter for reliable predictions

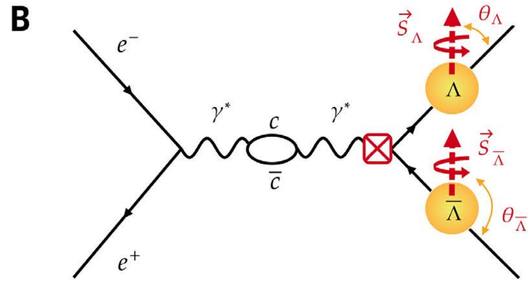
Science 393, 1027–1030 (2026)

Λ EDM and CP symmetry

- A permanent EDM violates P and T
- Assuming CPT invariance, an EDM also signals CP violation
- Hyperons probe CP-violating interactions involving strange quarks
- Their short lifetimes make conventional spin-precession measurements difficult



Spin precession in an external field



Entangled **ΛΛ** angular analysis

$$e^+e^- \rightarrow J/\psi \rightarrow \Lambda\bar{\Lambda} \rightarrow (p\pi^-)(\bar{p}\pi^+)$$

- The entangled pair provides correlated spin information, which the weak decays reveal through angular distributions
- Exploiting both polarization and spin correlations maximizes sensitivity to the EDM

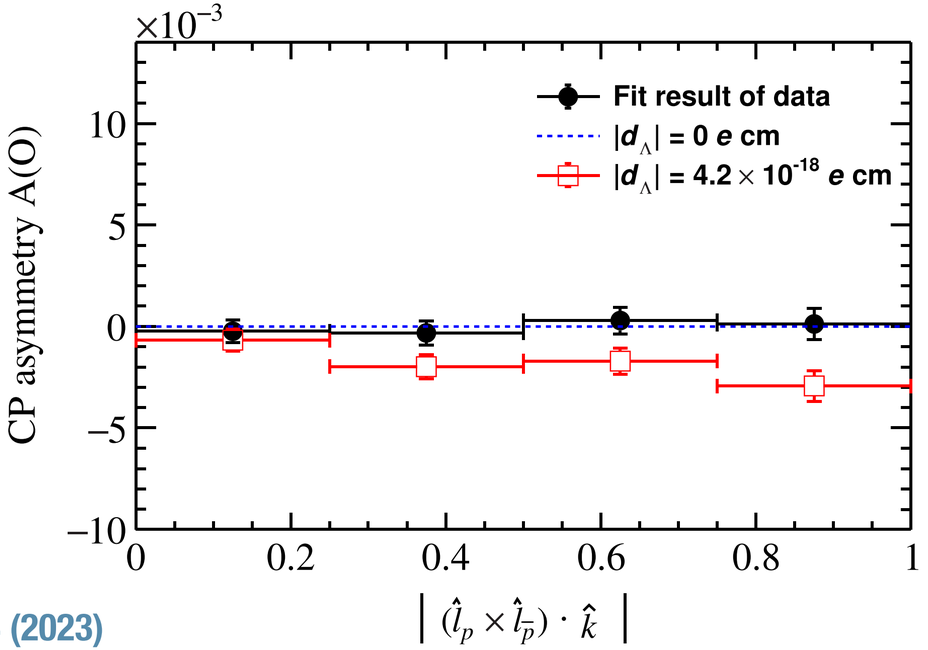
Science 393, 1027–1030 (2026)

EDM sensitivity from entangled $\Lambda\bar{\Lambda}$ pairs

$e^+e^- \rightarrow J/\psi \rightarrow \Lambda\bar{\Lambda} \rightarrow (p\pi^-)(\bar{p}\pi^+)$

~3M candidates - 99.9% purity from 10 billion J/ψ decays

- Parity and CP symmetry in ΛΛ pair production are characterized by the form factors F_A and H_T
- A blind five-angle likelihood fit extracts the complex CP-violating form factor H_T
- A CP-odd triple product sensitive to H_T Phys. Lett. B 839, 137834 (2023)



$O = (\hat{l}_p \times \hat{l}_{\bar{p}}) \cdot \hat{k}_\Lambda$

$$H_T = \frac{2e}{3m_{J/\psi}^2} g_V d_\Lambda$$

Data follow the null-EDM expectation; a non-zero EDM would generate a visible asymmetry

Measurement at $q^2 = m^2_{J/\psi}$. EDM conversion neglects q^2 dependence

Λ EDM result and sensitivity to strange-quark CPV

Science 393, 1027–1030 (2026)

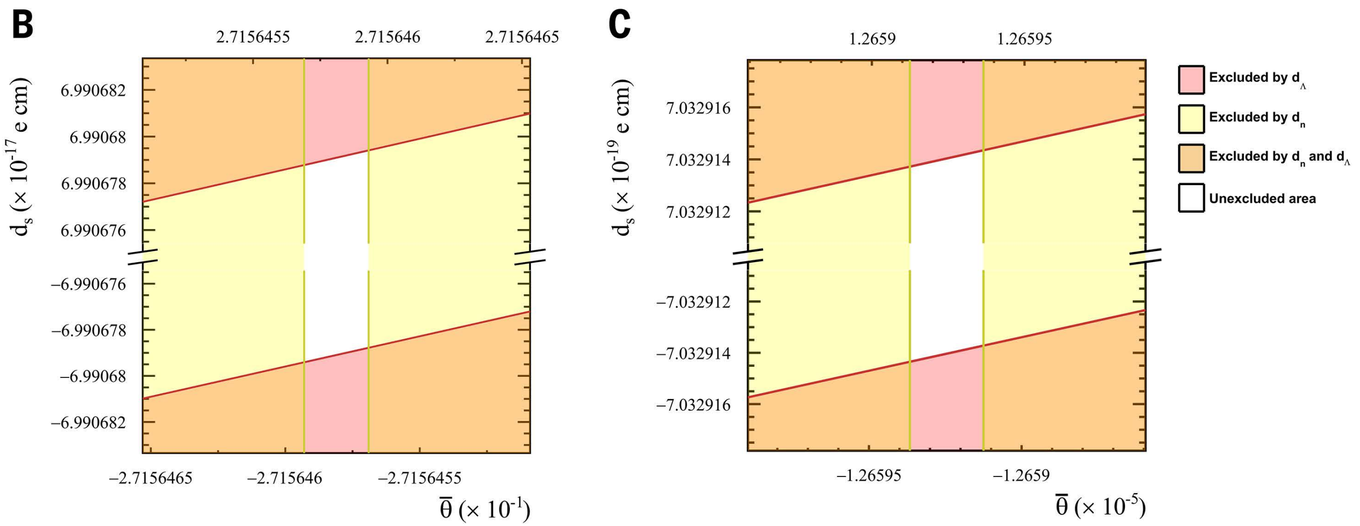
Component	Result [10^{-19} e cm]
Re(d_Λ)	–3.1 ± 3.2 ± 0.5
Im(d_Λ)	+2.9 ± 2.6 ± 0.6

No significant CP-violating signal

Previous quoted bound: 1.5×10^{-16} e cm (1981)

$|d_\Lambda| < 7.0 \times 10^{-19}$ e cm (95% CL)

- Complementary to neutron EDM searches. The Λ adds sensitivity to strange-quark CP-violating interactions
- Statistics dominate. Extensions to Ξ and Σ are possible



Λ semileptonic decay with entangled hyperons

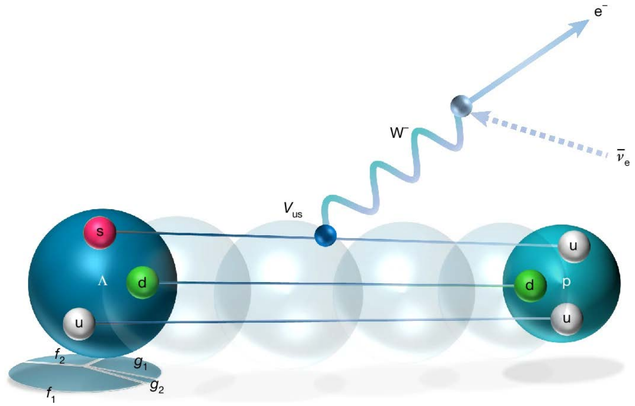
$J/\psi \to \Lambda\bar{\Lambda}$, $\Lambda \to p\, e^-\, \bar{\nu}_e$, $\bar{\Lambda} \to \bar{p}\, \pi^+$ (+ c.c.)

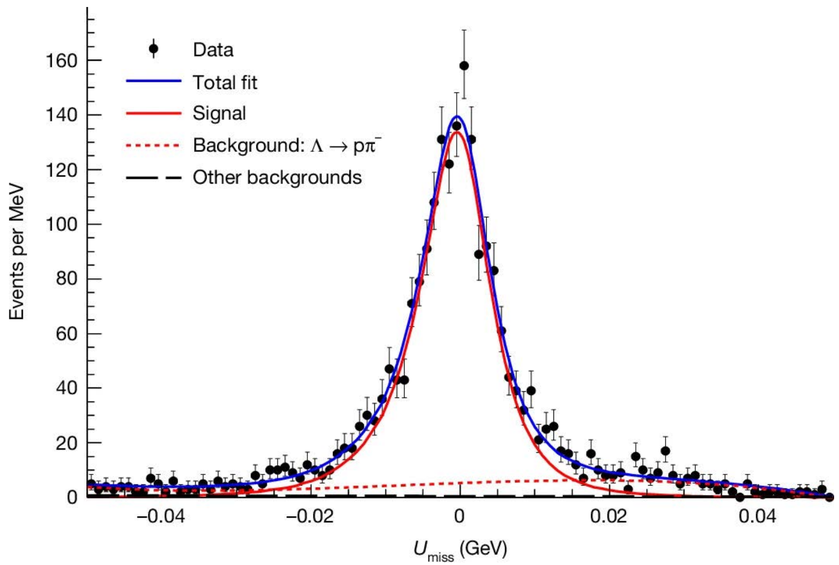
- 10.087×10^9 J/ψ events - 1854 ± 49 signal decays
- Double tag technique
- Hadronic tag fixes the recoil four-momentum and reconstructs the missing neutrino

$$\mathcal{B}(\Lambda \to pe^-\bar{\nu}_e) = \frac{N_{DT}}{\epsilon_{DT}} \frac{\epsilon_{ST}}{N_{ST}}$$

$$\mathcal{B}(\Lambda \to pe^-\bar{\nu}_e) = (8.16 \pm 0.22 \pm 0.15) \cdot 10^{-4}$$

$$\mathcal{B}(\Lambda \to pe^-\bar{\nu}_e) = (8.34 \pm 0.14) \cdot 10^{-4}$$ [PDG2024]





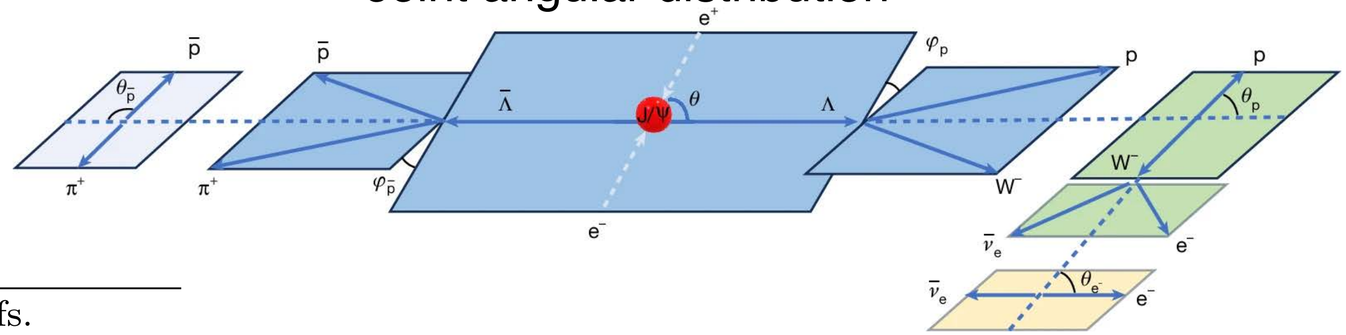
Nature 657, 92–97 (2026)

Form factors of the charged weak current

$$\mathcal{B}_{\mathrm{SL}} = \frac{\tau_\Lambda}{\hbar} K \left|V_{us}\right|^2 F(f_i, g_i)$$

Form factors: $f_1, f_2, f_3, g_1, g_2, g_3$

Joint angular distribution



	Observable	This work	Previous result	Refs.	
	g_{av}^-	$0.742^{+0.075}_{-0.057} \pm 0.009$	0.718 ± 0.015	[PDG2024]	$g_2 = 0$
	g_{av}^+	$-0.706^{+0.069}_{-0.073} \pm 0.014$	–		
	$\langle g_{av} \rangle$	$0.729^{+0.048}_{-0.047} \pm 0.007$	–		
	g_w^-	$0.93 \pm 0.51 \pm 0.17$	0.15 ± 0.30	[FNAL,1990]	
	g_w^+	$0.89 \pm 0.49 \pm 0.20$	–		
	$\langle g_w \rangle$	$0.89 \pm 0.35 \pm 0.14$	–		
g_1/f_1	$\langle g_{av} \rangle$	$0.706^{+0.089}_{-0.086}$	–		$g_2 \neq 0$
f_2/f_1	$\langle g_w \rangle$	$0.77^{+0.53}_{-0.49}$	–		
g_2/f_1	$\langle g_{av2} \rangle$	$-0.19^{+0.65}_{-0.63}$	–		

- First determination of g_2/f_1 in Λ semileptonic decay
- Consistent with zero, as expected in the exact SU(3) limit

$\langle g_i \rangle$ is measured for both $\Lambda \to p e^- \bar{\nu}_e$ and $\bar{\Lambda} \to \bar{p} e^+ \nu_e$, assuming $g_{av_i}^- = -g_{av_i}^+$, $g_w^- = g_w^+$

α_ψ, $\Delta\Phi$ and $\alpha_{\Lambda.\bar{\Lambda}}$ are fixed to [PRL129(2022)131801]

Nature 657, 92–97 (2026)

An independent determination of $|V_{us}|$

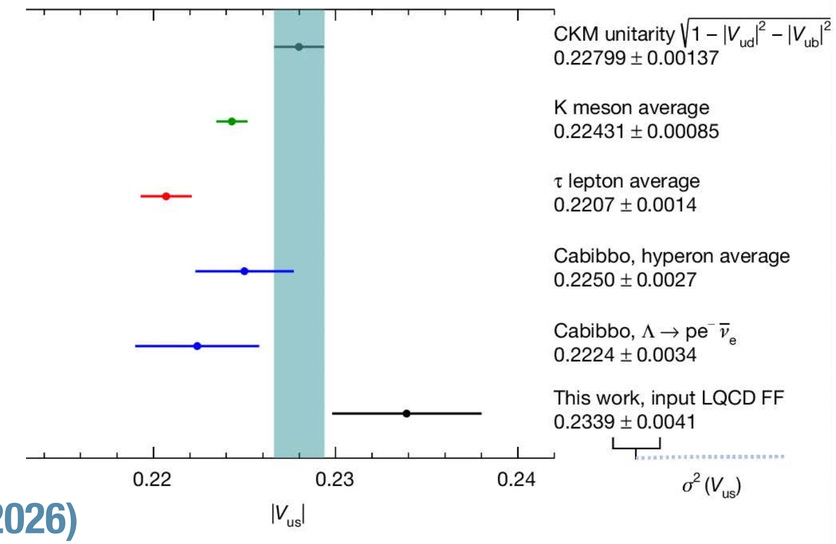
- Assume SU(3) is conserved, $f_1 = -\sqrt{3/2}$ [PRL92(2004)251803]

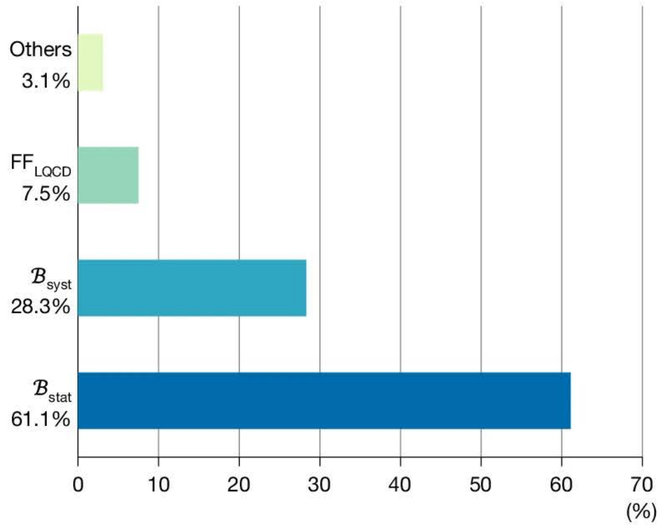
  $$|V_{us}|_{SU(3)} = 0.2194 \pm 0.0036_{BESIII-BF} \pm 0.0087_{BESIII-FF} \pm 0.0004_{\tau_\Lambda} \pm 0.0005_{RC}$$

- Using LQCD FF prediction [PRL135(2025)231901]

  $$|V_{us}|_{LQCD} = 0.2339 \pm 0.0038_{BESIII-BF} \pm 0.0004_{\tau_\Lambda} \pm 0.0006_{RC} \pm 0.0011_{LQCD}$$

compatible with CKM unitarity within 1.4σ

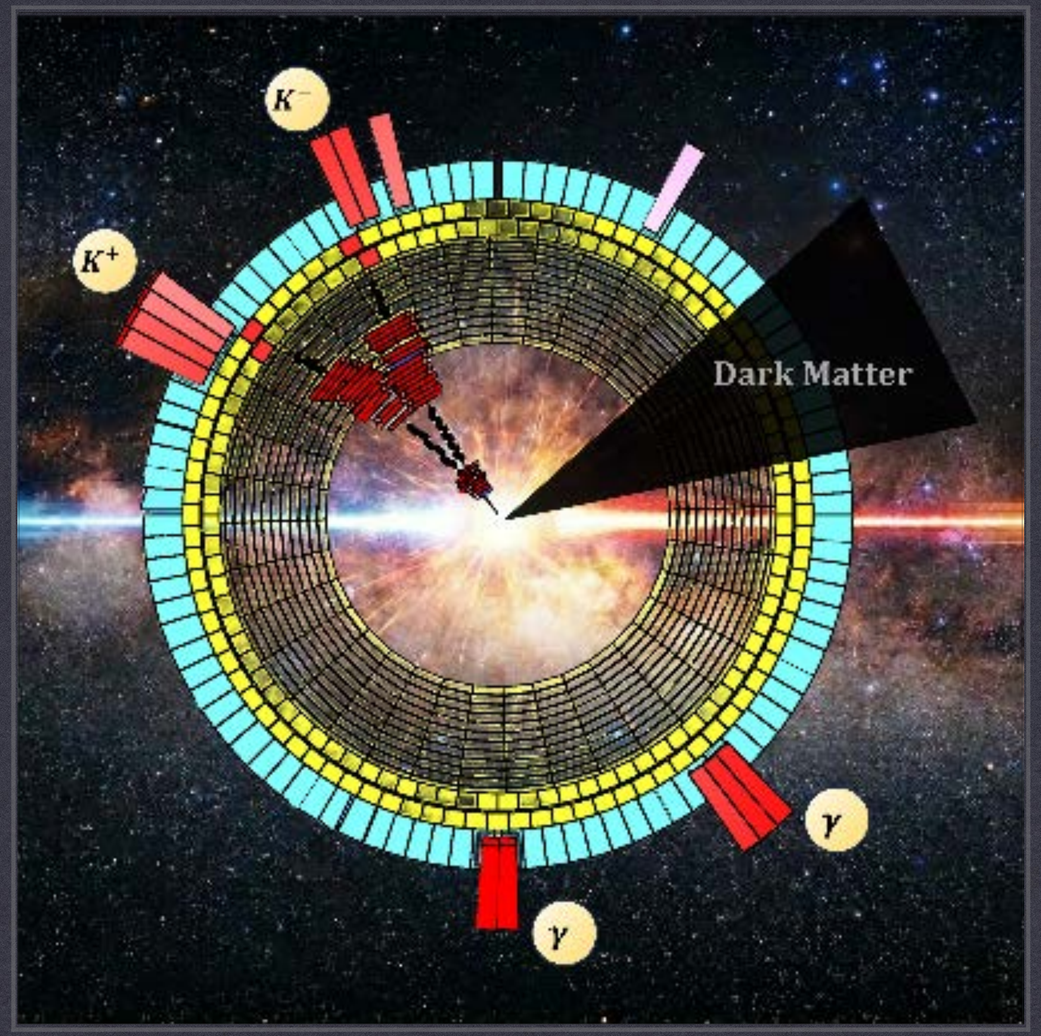




Nature 657, 92–97 (2026)

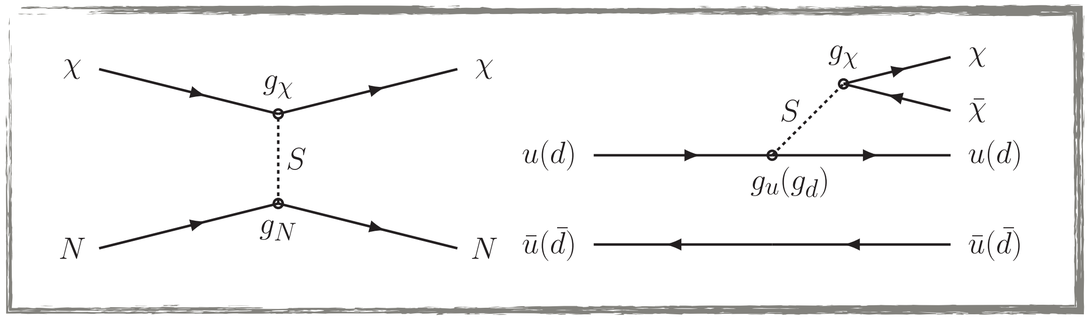
SUB-GEV DARK MATTER SEARCHES

- Dark matter (DM) is one of the strongest pieces of evidence for physics BSM
- Complementary searches across different energy scales are essential to reveal the particle nature of dark matter
- Many models predict light dark matter
  - Experimentally challenging for conventional direct-detection experiments
- Electron-positron colliders provide unique sensitivity

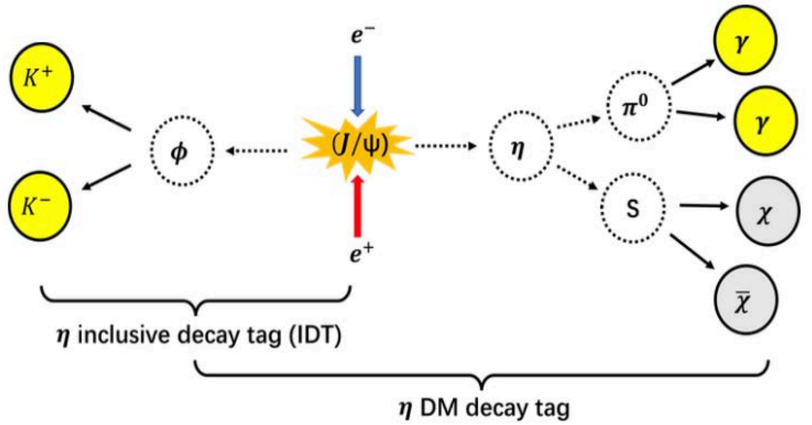


PRL 137 (2026) 031804

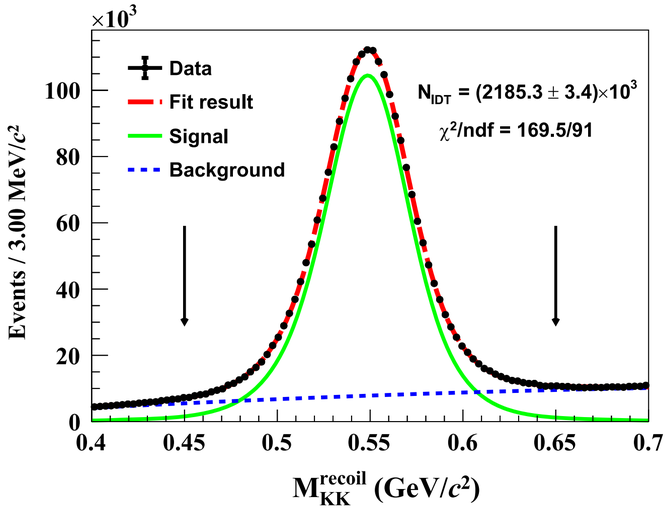
Search for $\eta \to \pi^0 + invisible$

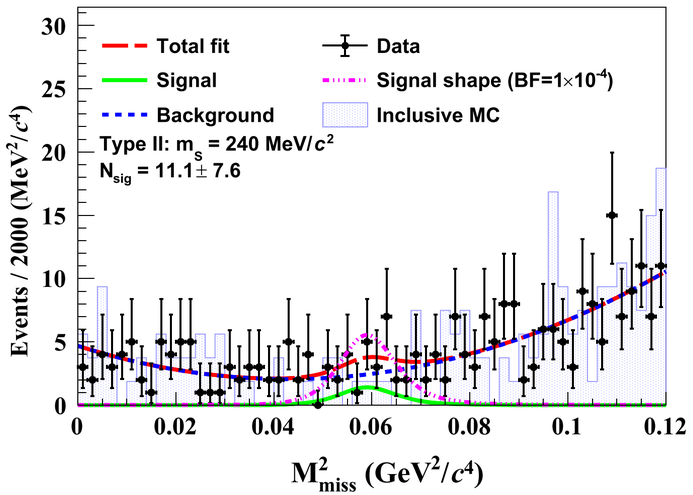


$J/\psi \to \phi\eta$, $\phi \to K^+K^-$, $\eta \to \pi^0 S$, $S \to \chi\bar{\chi}$



- ~2×10^6 η from $J/\psi \to \phi\eta \to K^+K^-\eta$ based on (10087 ± 44)×10^6 J/ψ
- On-shell $S \to \chi^-\chi$, m_S: ~0 to 400 MeV
- The K^+K^- recoil tags the η
- Reconstruct $\pi^0 \to \gamma\gamma$ and veto extra activity
- A narrow S would appear as a peak in the missing-mass-squared spectrum
- Maximum significance <2σ @ 240 MeV/c^2



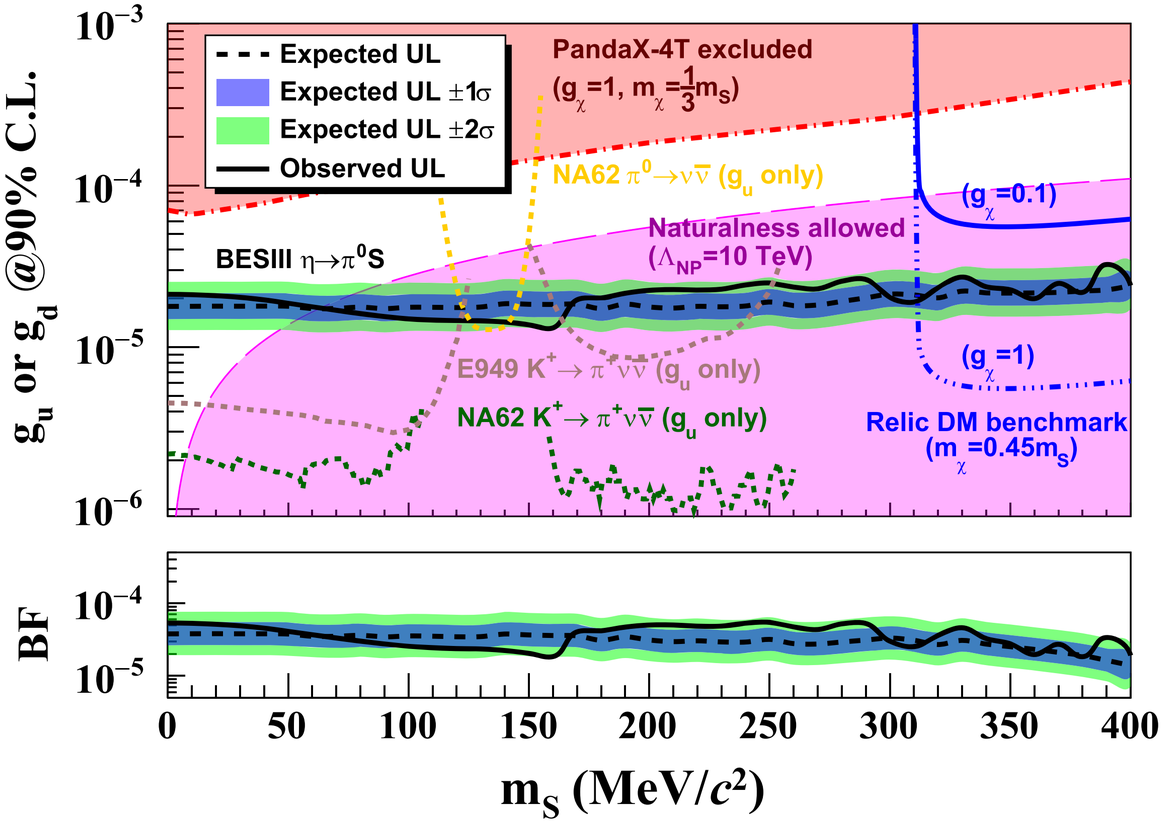


PRL 137 (2026) 031804

BF and Scalar-coupling limits

Flavor-specific model: $\mathcal{L} \supset -g_\chi S\bar{\chi}_L\chi_R - g_u S\bar{u}_L u_R + h.c.$, **effective coupling** $g_u \equiv \frac{c_S v}{\sqrt{2}\Lambda_{NP}}$

- Assuming $\mathcal{B}(S \to \text{invisible}) \simeq 1$
  - UL on $\mathcal{B}(\eta \to \pi^0 S)$ @90% C.L.: $(1.8\sim5.5)\times10^{-5}$
  - UL on g_u or g_d @ 90% C.L.: $(1.3\sim3.2)\times10^{-5}$
- Result complementary to direct detection from PandaX-4T [Phys. Rev. Lett. 131, 041001, 2023]
- Sensitive to both g_u and g_d ($K^+ \to \pi^+$ + invisible only sensitive to g_u)



PRL 137 (2026) 031804

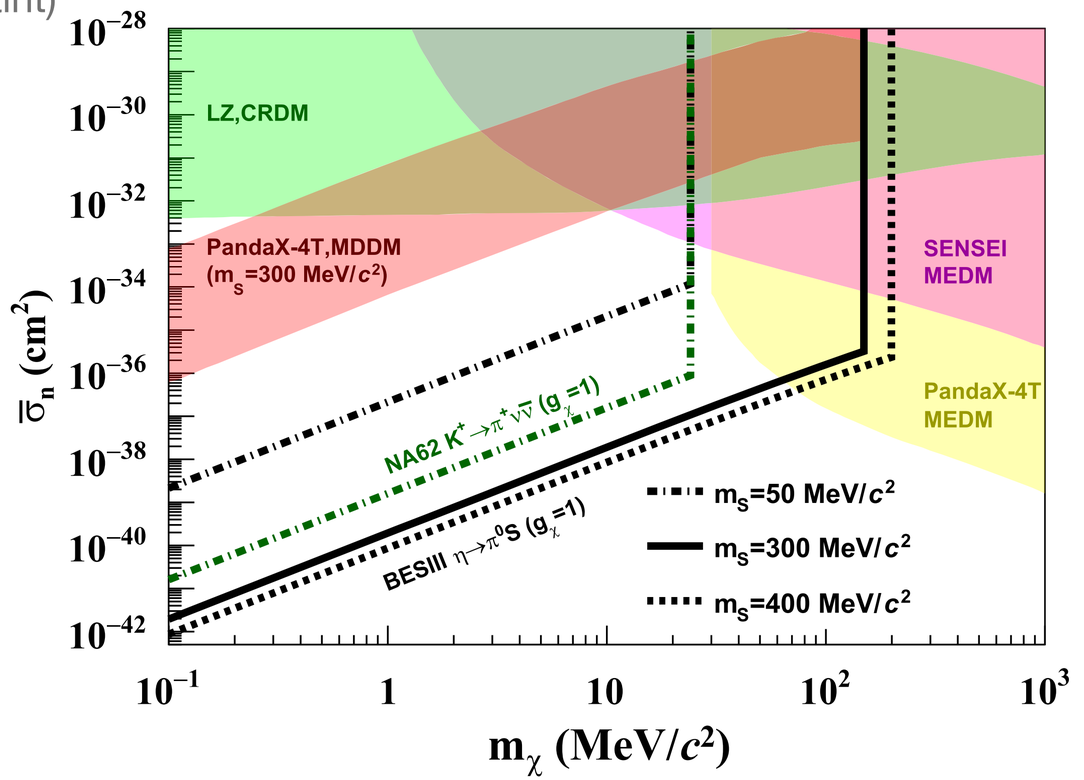
Connection to DM direct detection

Flavor-specific model: $\mathcal{L} \supset -g_\chi S\bar{\chi}_L\chi_R - g_u S\bar{u}_L u_R + h.c.$, **effective coupling** $g_u \equiv \frac{c_S v}{\sqrt{2}\Lambda_{NP}}$

- m_S = 300 MeV/c², $g_\chi = 1$, on-shell S (Model-dependent constraint)
- The constraint on the DM-nucleon cross section is improved by ~5 orders of magnitude

$$\bar{\sigma}_n = \frac{g_N^2 g_\chi^2 \mu_n^2}{\pi(q_0^2 + m_S^2)^2}$$

- Ongoing and Future
  - Off-shell S case in $\eta \to \pi^0\chi^-\chi$
  - Larger S mass in $\eta' \to \pi^0\chi^-\chi$
  - Pseudoscalar case in $\eta \to \pi^+\pi^-\chi^-\chi$
  - Vector case in $\pi^0/\eta \to \gamma\chi^-\chi$



Summary

A selection of recent BESIII results has been presented

- **Glueball spectroscopy:** the production and decay properties of $X(2370)$ support a substantial 0^{-+} glueball component
- **Hyperon CP violation:** the neutral-Λ asymmetry is consistent with zero; neutral/charged decay comparisons establish $\Delta I = 3/2$ contributions
- Λ **EDM:** no significant CP-violating signal, with $|d_\Lambda| < 7.0 \times 10^{-19}\ e\ \mathrm{cm}$ at 95% CL
- **Semileptonic decays:** polarization and entanglement enable form-factor measurements and a complementary determination, $|V_{us}|_{\mathrm{LQCD}} = 0.2339 \pm 0.0041$
- **Dark-sector searches:** no signal in $\eta \to \pi^0 + \mathrm{invisible}$; branching-fraction limits reach $(1.8 - 5.5) \times 10^{-5}$ at 90% CL

Outlook

- **Clarify the nature of $X(2370)$:** measure additional decay modes and perform coupled-channel amplitude analyses
- **Advance hyperon symmetry tests:** improve CP sensitivity and extend the EDM programme to other hyperons
- **Strengthen baryon determinations of $|V_{us}|$:** combine larger semileptonic samples with improved lattice-QCD inputs
- **Broaden dark-sector searches:** explore off-shell mediators, alternative interactions and higher masses through η' decays
- **Exploit a common experimental strength:** large, clean datasets and quantum-correlated particle pairs provide complementary probes of strong dynamics and new physics

THANKS FOR YOUR ATTENTION