



中国科学院大学
UNIVERSITY OF CHINESE ACADEMY OF SCIENCES

Probe hyperon electric dipole moments at e^+e^- colliders

bases on X.G.He, J.P. Ma, Bruce McKellar, PRD47(1993)1744

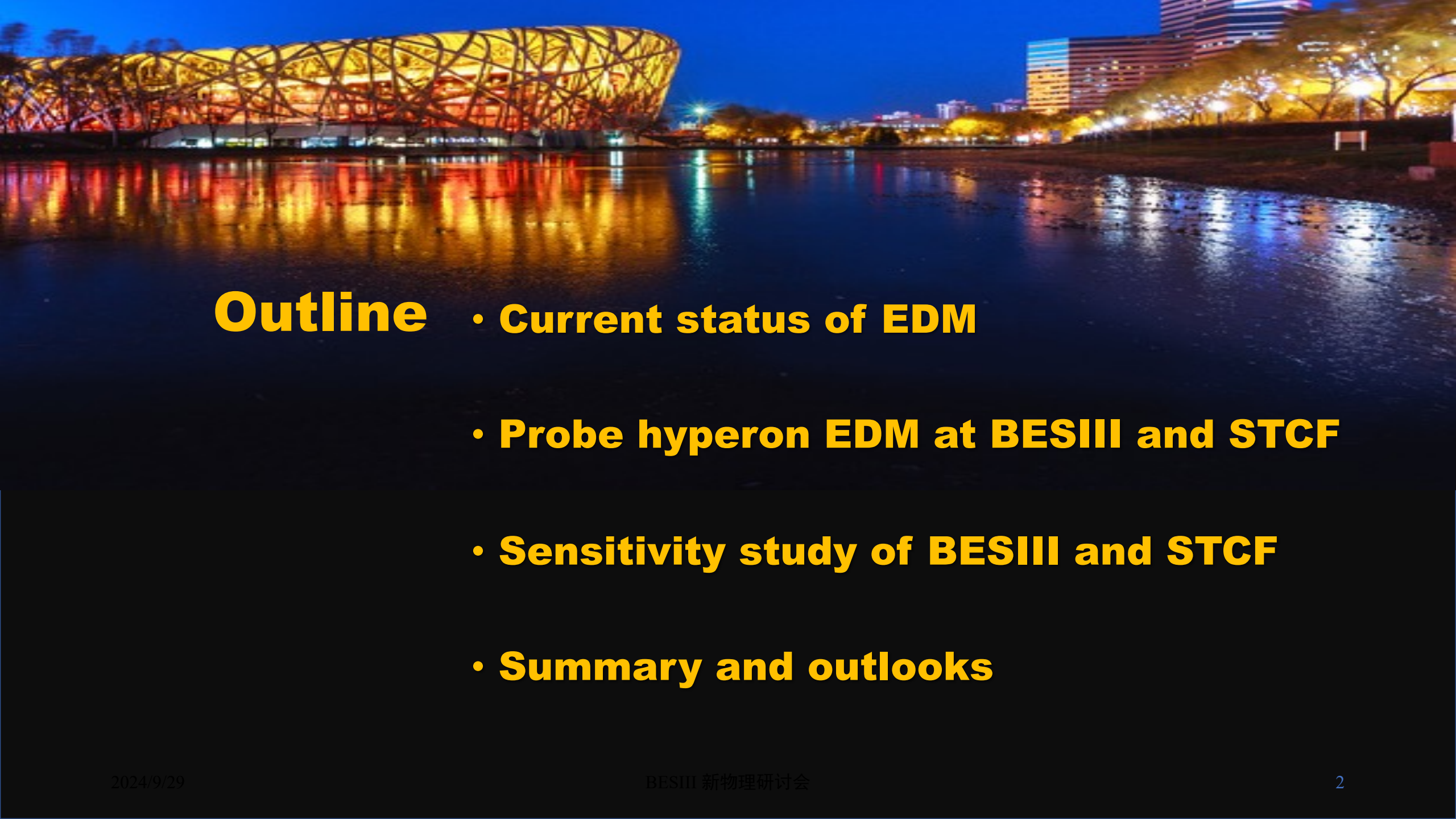
X.G.He, J.P. Ma, PLB 839(2023)137834

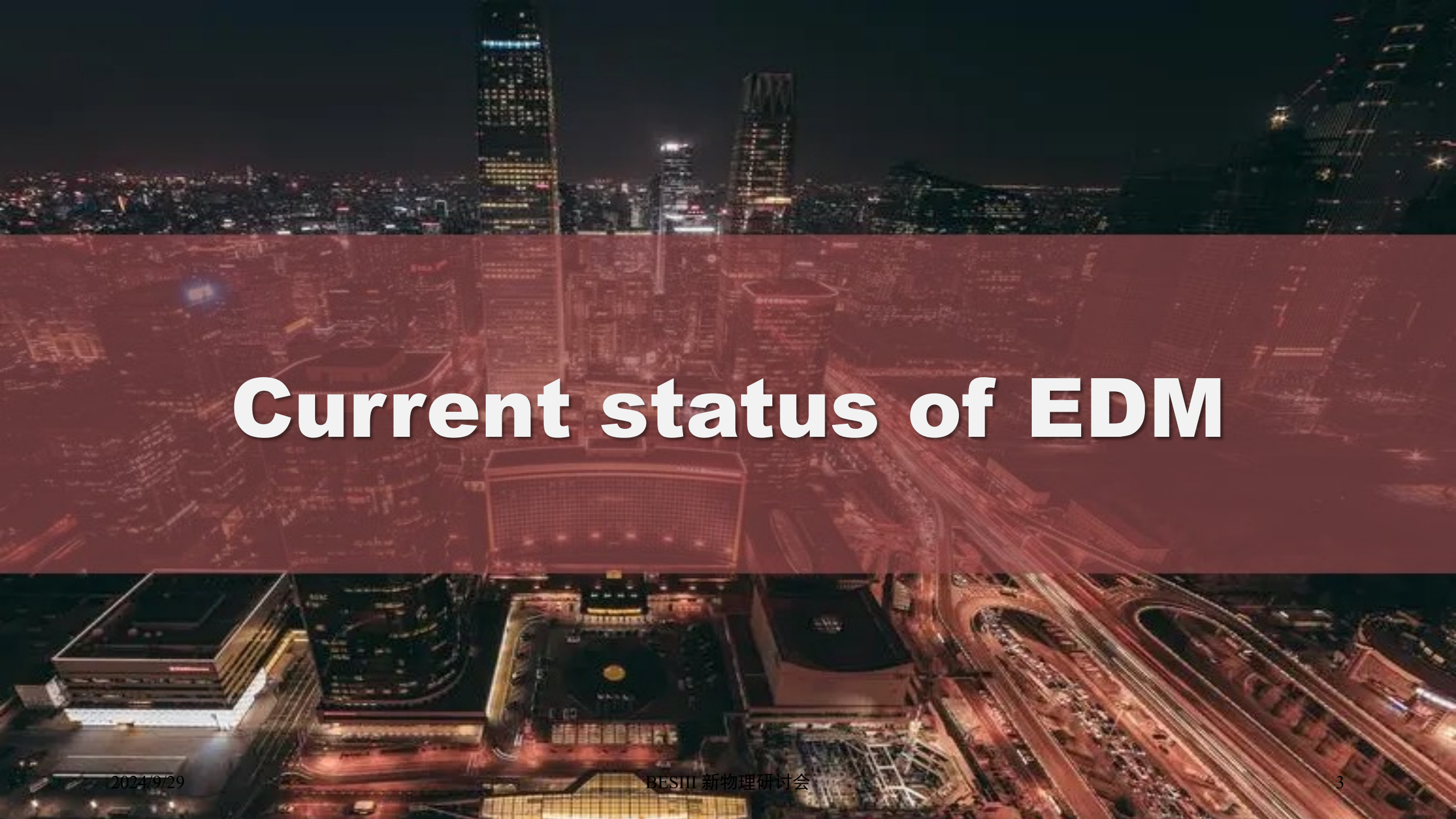
J. Fu, H.B. Li, J. Wang, F. Yu, and J. Zhang , PhysRevD.108.L091301

Workshop on New Physics Group 2024

张剑宇

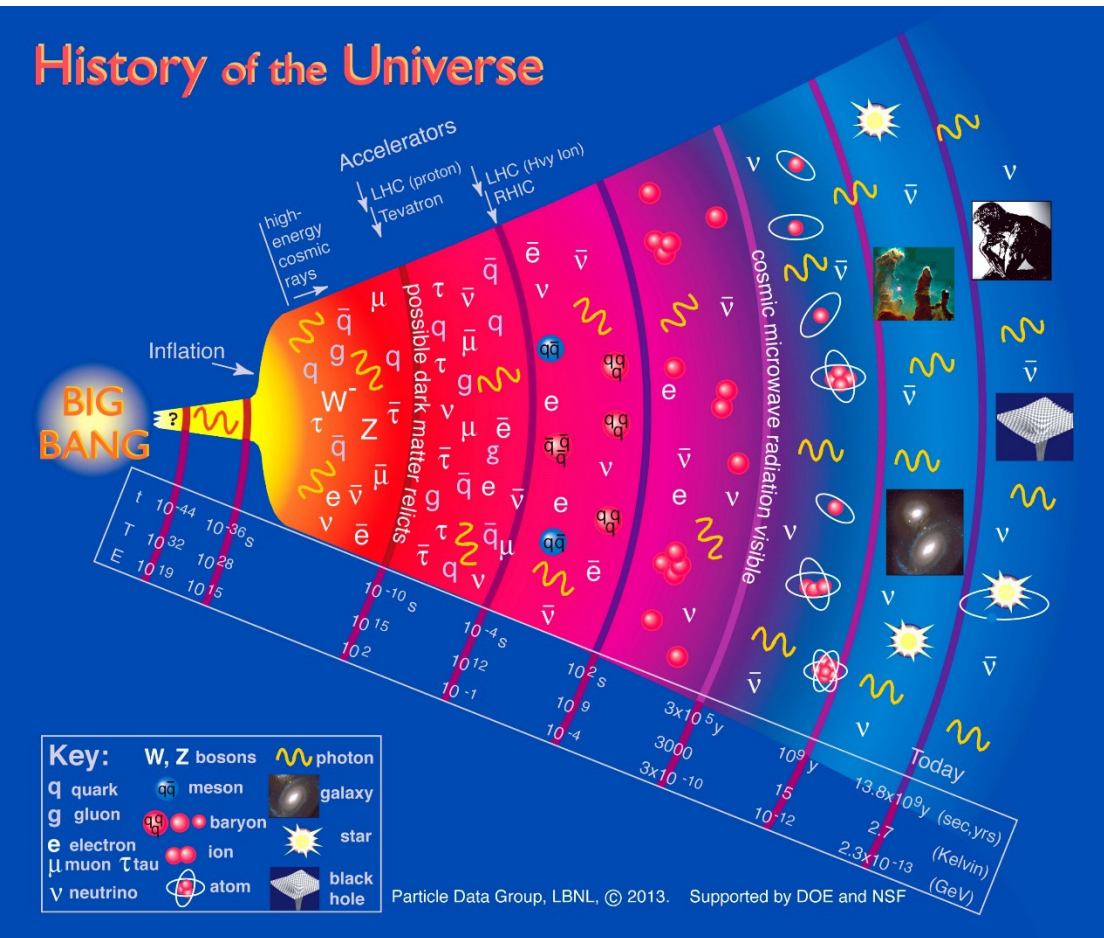
University of Chinese Academy of Sciences, Beijing, China

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- Outline**
- **Current status of EDM**
 - **Probe hyperon EDM at BESIII and STCF**
 - **Sensitivity study of BESIII and STCF**
 - **Summary and outlooks**

A nighttime aerial view of a city, likely Shanghai, with numerous illuminated skyscrapers and dense urban development. A semi-transparent red rectangular overlay covers the middle portion of the image, serving as a background for the title text.

Current status of EDM

Matter-antimatter asymmetry in the universe



- Big matter and anti-matter asymmetry founded in the universe!

WMAP+COBE(2012):

$$(n_B - n_{\bar{B}})/n_\gamma|_{CMB} = (6.08 \pm 0.09) \times 10^{-10}$$

- Sakharov three conditions require:

C and CP symmetry violation

Pisma Zh. Eksp. Teor. Fiz., 1967, 5: 32-35.



- CP violation has been founded at K, B, D meson system, but not enough to explain matter dominant universe.

Standard Model (SM) prediction:

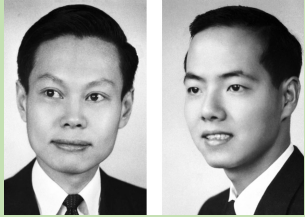
$$\hat{d}_{CP} = \frac{d_{CP}}{D^{12}} \sim 10^{-18} \ll 10^{-10}$$

W. Bernreuther
Lect. Notes Phys.591
(2002) 237-293

Exploring new physics is extremely important

A brief history of Parity and CP violation

Nobel Prize 1957



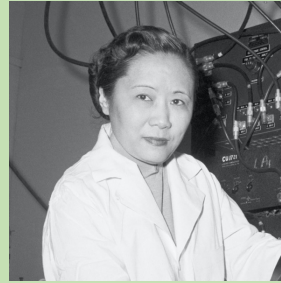
C. N. Yang T. D. Lee

$\theta - \tau$ puzzle [1]

First proposed Parity
violation in weak interaction



Confirmed by



Chien-Shiung Wu

1957

No CPV founded in
baryon sector!

K meson CP violation[2]

B meson CP violation [3,4]

D meson CP violation [5]

1964

James Watson
Cronin



Val Logsdon
Fitch

Nobel Prize 1980

2001



BESIII 新物理研讨会

2019



- [1] Phys. Rev. 104 (1956) 254-258
- [2] Phys. Rev. Lett., 1964, 13: 138-140
- [3] Phys. Rev. Lett., 2001, 87: 091801
- [4] Phys. Rev. Lett., 2001, 87: 091802
- [5] Phys. Rev. Lett., 2019, 122(21): 211803

CPV in Standard Model

CKM mechanism:

CPV from phase δ

$$V_{\text{CKM}} = \begin{pmatrix} c_{12}c_{13} & s_{12}c_{13} & s_{13}e^{-i\delta} \\ -s_{12}c_{23} - c_{12}s_{23}s_{13}e^{i\delta} & c_{12}c_{23} - s_{12}s_{23}s_{13}e^{i\delta} & s_{23}c_{13} \\ s_{12}s_{23} - c_{12}c_{23}s_{13}e^{i\delta} & -c_{12}s_{23} - s_{12}c_{23}s_{13}e^{i\delta} & c_{23}c_{13} \end{pmatrix} \begin{pmatrix} \blacksquare & \blacksquare & \blacksquare \\ \blacksquare & \blacksquare & \blacksquare \\ \blacksquare & \blacksquare & \blacksquare \end{pmatrix}$$



Dirac Medal
2010



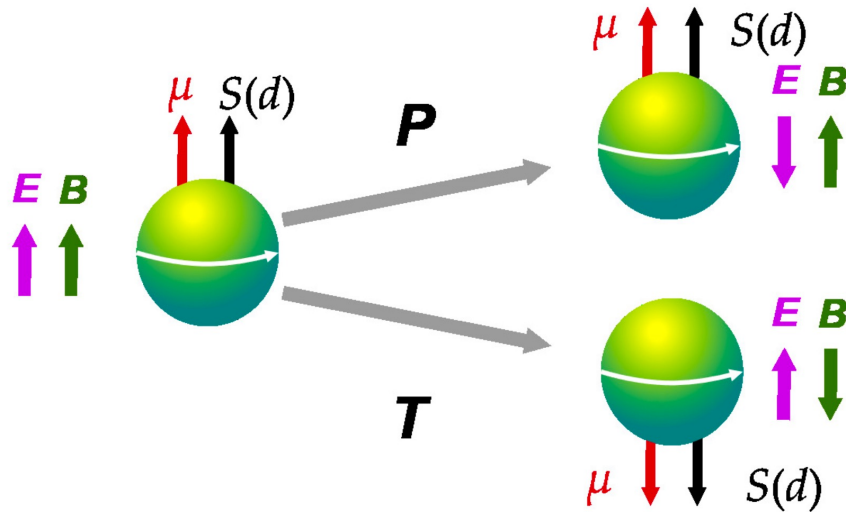
Nobel Prize
2008

Strong CP

- $\bar{\theta}$ term: $\mathcal{L}_{\bar{\theta}} = -\frac{\alpha_s}{16\pi^2} \bar{\theta} \text{Tr}(G^{\mu\nu} \tilde{G}_{\mu\nu})$
- Mainly through measuring the Electric Dipole Moment (EDM) of atomic nuclei, atoms, and molecular systems,
- The current most stringent constraints come from the EDM experiments of neutrons and ^{199}Hg :
 $\bar{\theta} < 10^{-10}$

Electric Dipole Moment

μ : magnetic dipole moment
 d : electric dipole moment
 S : particle spin



$$\mathcal{H} = -\mu \cdot \mathbf{B} - \delta \cdot \mathbf{E} \xrightarrow{P} \mathcal{H} = -\mu \cdot \mathbf{B} + \delta \cdot \mathbf{E}$$

$$\mathcal{H} = -\mu \cdot \mathbf{B} - \delta \cdot \mathbf{E} \xrightarrow{T} \mathcal{H} = -\mu \cdot \mathbf{B} + \delta \cdot \mathbf{E}$$

Non-zero EDM will violate P and T symmetry:
 T violation $\leftrightarrow$ CP violation, if CPT holds.

The contribution of the Standard Model to EDM is very small:

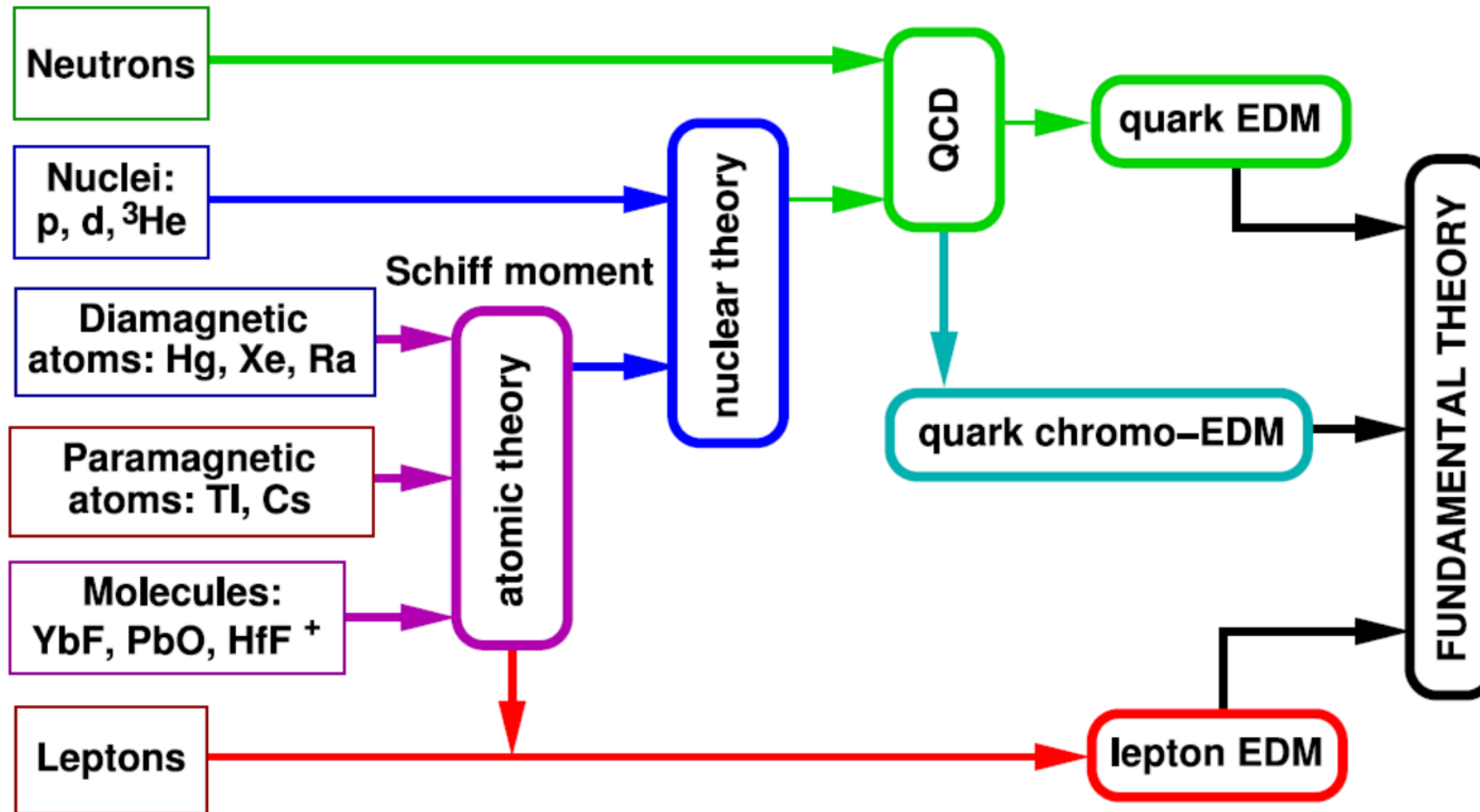
- CKM: highly suppressed by loop level (≥ 3) interaction
- QCD $\bar{\theta}$ term: main SM contributors to the EDM, $\bar{\theta} < 10^{-10}$
 - limited by neutron EDM:

$$d_n < 1.6 \times 10^{-26} \text{ ecm}$$

$$\mathcal{L}_{\text{CPV}} = \mathcal{L}_{\text{CKM}} + \mathcal{L}_{\bar{\theta}} + \mathcal{L}_{\text{BSM}}^{\text{eff}}$$

Very sensitive to BSM physics, large windows of opportunity for observing New Physics!

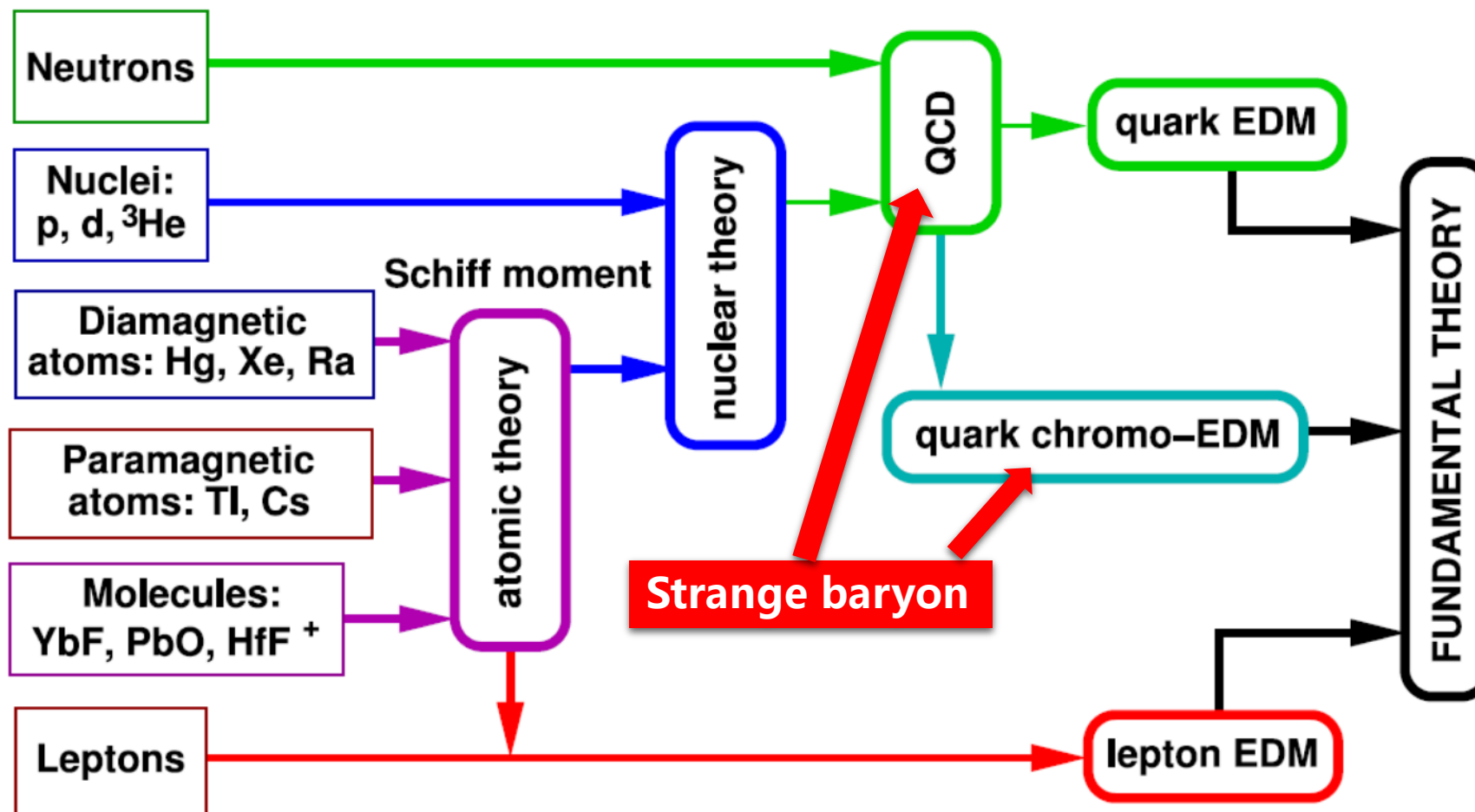
Map of EDM



C. R. Physique 13 168 (2012)

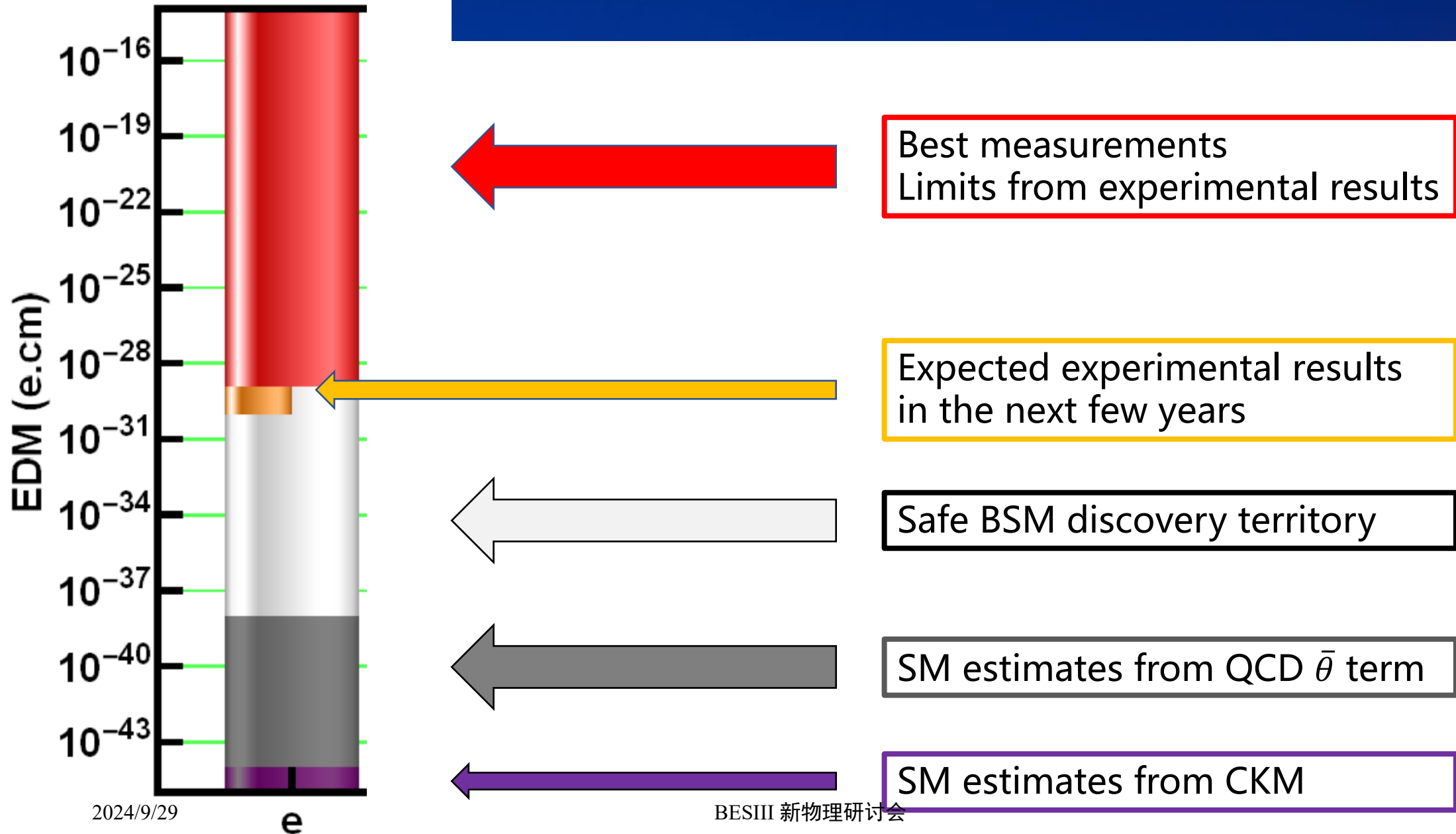
Map of EDM

The identification of the nature of the fundamental CP-violating mechanisms requires the study of EDMs in various systems



C. R. Physique 13 168 (2012)

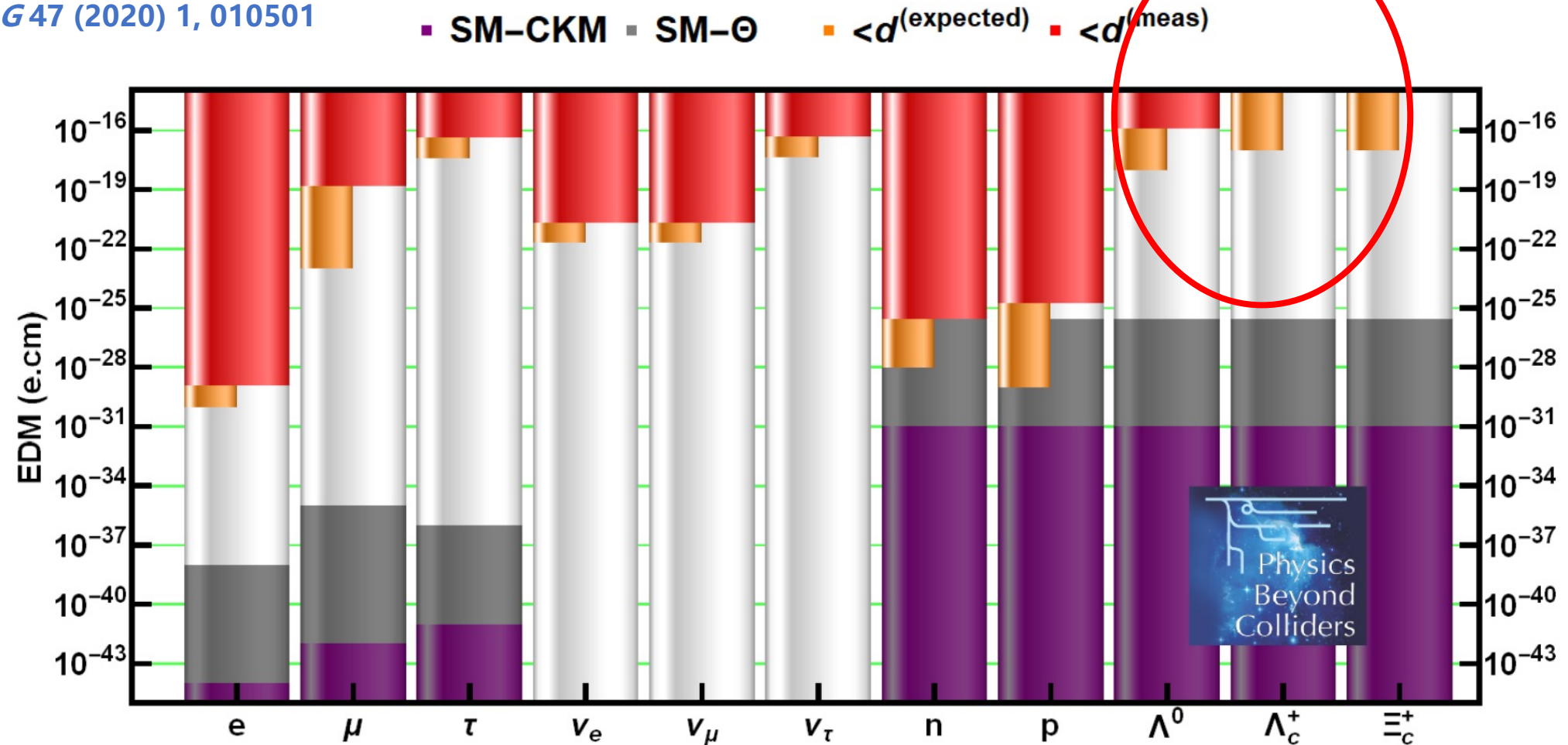
ILLUSTRATION of EDM STATUS



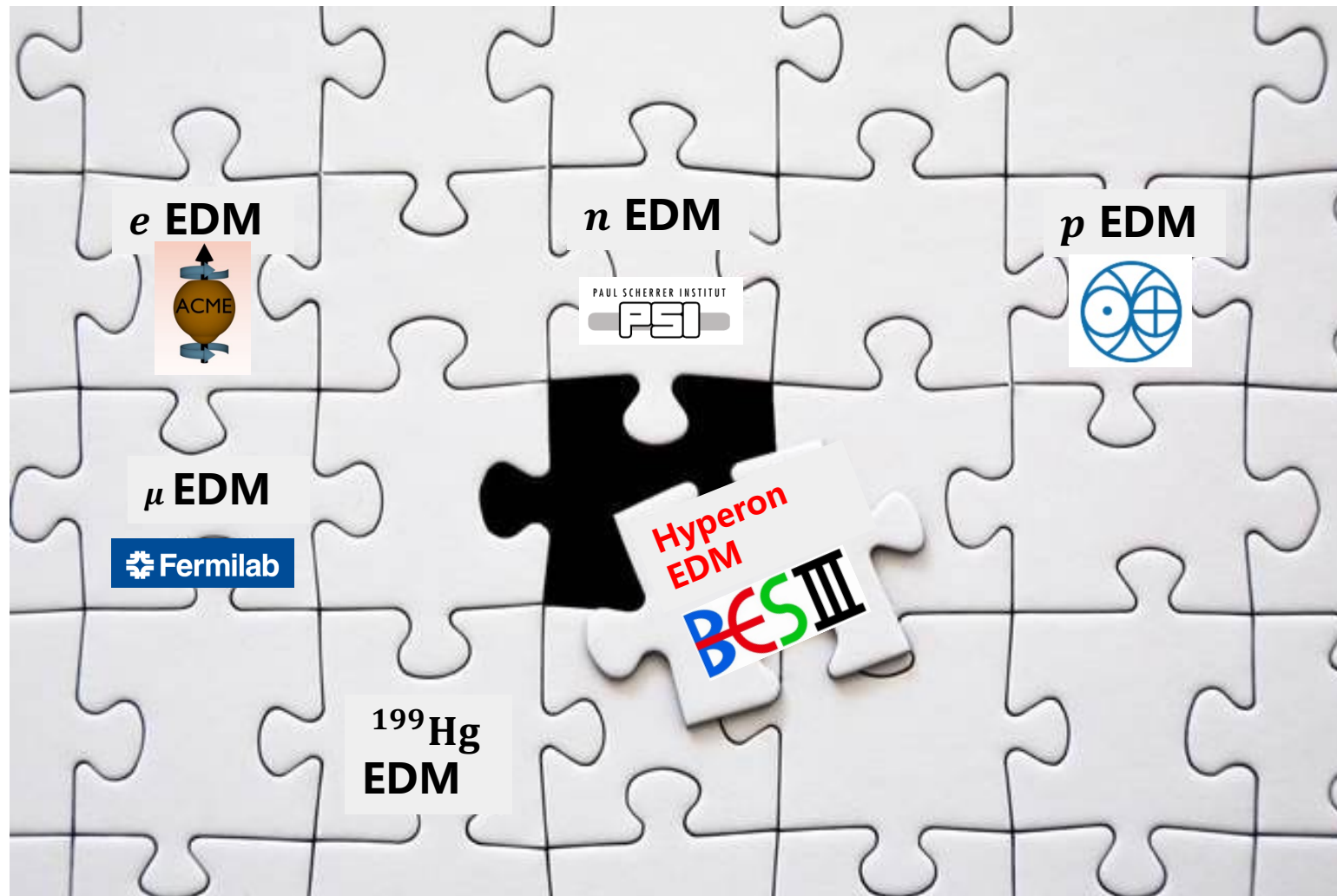
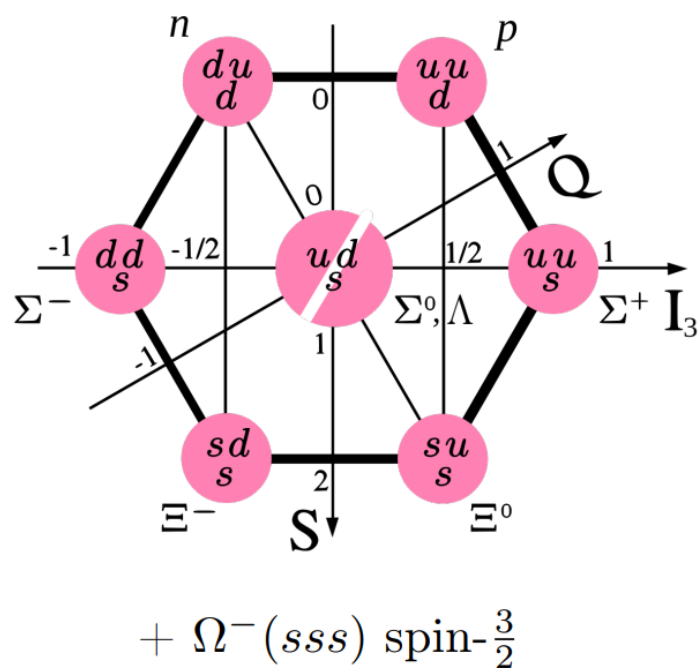
EDM Status

Only Λ hyperon has been measured with a large uncertainty!

J.Phys.G 47 (2020) 1, 010501



What can BESIII / STCF do for EDM?



What can BESIII / STCF do for EDM?

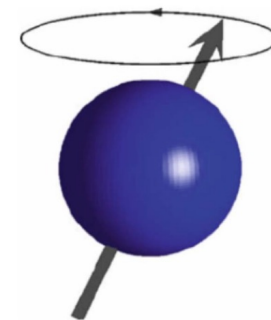
- Direct approach: spin precession 难以用来测量短寿命粒子的EDM

$$\frac{d\mathbf{s}}{dt} = \mathbf{s} \times \boldsymbol{\Omega}$$

$$\boldsymbol{\Omega} = \boldsymbol{\Omega}_{\text{MDM}} + \boldsymbol{\Omega}_{\text{EDM}} + \boldsymbol{\Omega}_{\text{TH}}$$

$$\boldsymbol{\Omega}_{\text{MDM}} = \frac{g\mu_B}{\hbar} \left(\mathbf{B} - \frac{\gamma}{\gamma+1} (\boldsymbol{\beta} \cdot \mathbf{B}) \boldsymbol{\beta} - \boldsymbol{\beta} \times \mathbf{E} \right)$$

$$\boldsymbol{\Omega}_{\text{EDM}} = \frac{d\mu_B}{\hbar} \left(\mathbf{E} - \frac{\gamma}{\gamma+1} (\boldsymbol{\beta} \cdot \mathbf{E}) \boldsymbol{\beta} - \boldsymbol{\beta} \times \mathbf{B} \right)$$



- Indirect approach: time-like dipole form factors ($q^2 \neq 0$)

$$L_{\text{dipole}} = i \frac{d_\Lambda}{2} \bar{\Lambda} \sigma_{\mu\nu} \gamma_5 \Lambda F^{\mu\nu}$$

$$L_{c-\Lambda} = -\frac{2}{3M^2} e d_\Lambda (p_1^\mu - p_2^\mu) \bar{c} \gamma_\mu c \bar{\Lambda} i \gamma_5 \Lambda$$

X.G.He, J.P. Ma, Bruce McKellar, Phys.Rev.D47(1993)1744
X.G.He, J.P. Ma, Phys.Lett.B 839(2023)137834

Prob hyperon EDM at BESIII and STCF

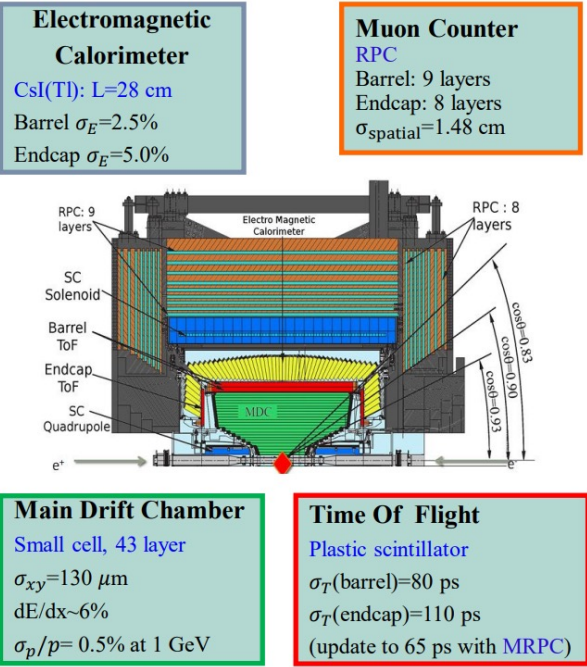


BESIII and STCF : a hyperon factory

- 10 billion J/ψ events collected at BESIII:
- Large Br. in J/ψ decay
 - Quantum entangled pair productions
 - High efficiency, background free

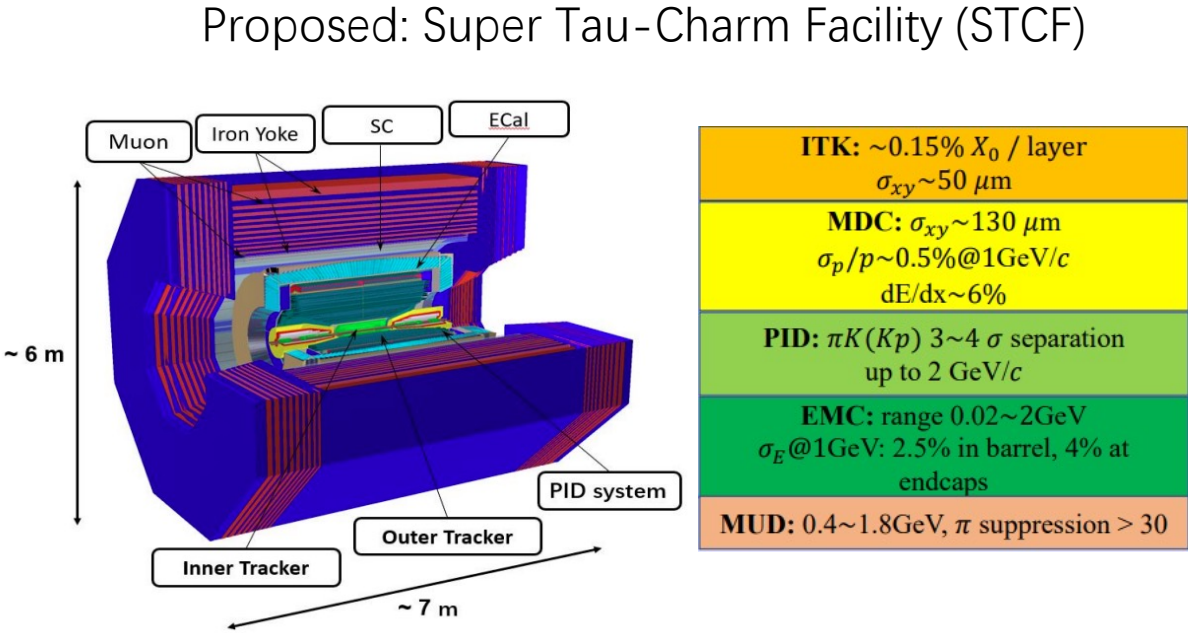
Decay	$\mathcal{B} (10^{-5})$	Events at BESIII
$J/\psi \rightarrow \Lambda \bar{\Lambda}$	189 ± 9	18.9×10^6
$J/\psi \rightarrow \Sigma^+ \bar{\Sigma}^-$	150 ± 24	15.0×10^6
$J/\psi \rightarrow \Xi \bar{\Xi}$	97 ± 8	9.7×10^6
$\psi(2S) \rightarrow \Sigma \bar{\Sigma}$	23.2 ± 1.2	116×10^3
$\psi(2S) \rightarrow \Omega \bar{\Omega}$	5.66 ± 0.30	28×10^3

Front. Phys. 12(5), 121301
(2017)
Phys. Rev. D 100, 114005 (2019)

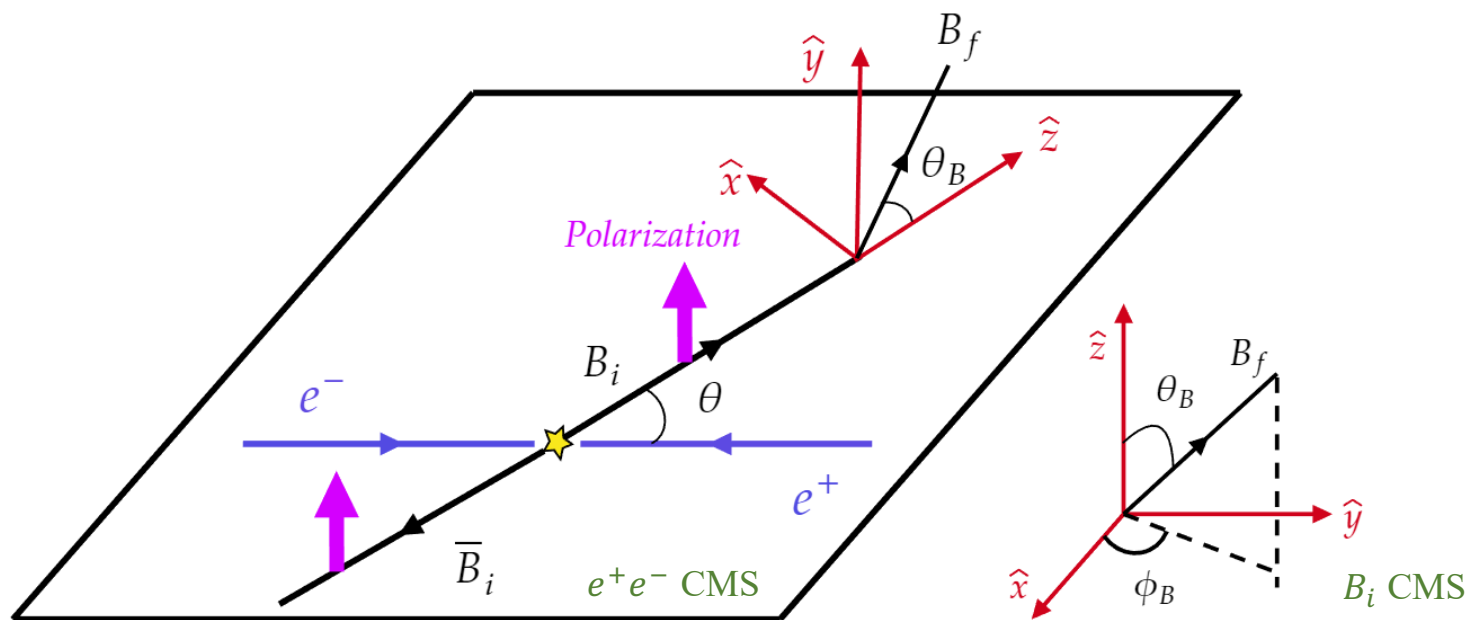


With 10 billion J/ψ collected at BESIII and $\sim 10^7$ entangled hyperon pairs can be studied.

At future, the STCF will collect 1 trillion J/ψ per year, and will provide $\sim 10^9$ hyperon pairs.



Polarized hyperon pairs produced in e^+e^- collisions



Two form factors are used to describe the production of hyperon pair: G_1, G_2 , which also known as $G_M = \frac{G_1}{e_g}$, $G_E = \frac{G_2}{e_g}$

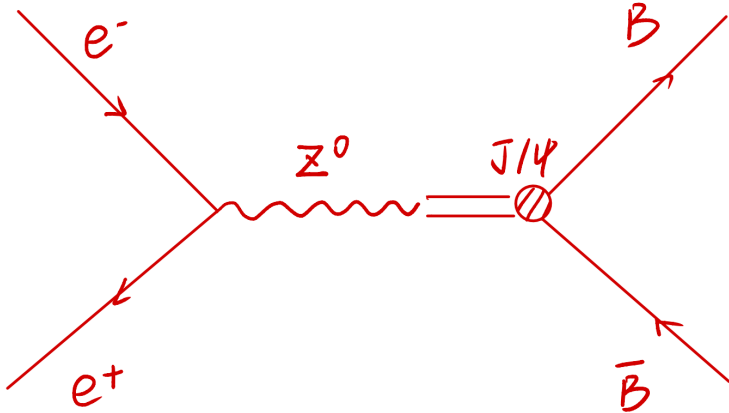
$$\alpha_\psi = \frac{s^2|G_1|^2 - 4m^2|G_2|^2}{s^2|G_1|^2 + 4m^2|G_2|^2}, \quad \frac{G_1}{G_2} = \left| \frac{G_1}{G_2} \right| e^{-i\Delta\Phi}$$

Polarization:

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

- Angular distribution of $\frac{d\Gamma}{d\Omega} \propto 1 + \alpha_\psi \cos^2 \theta$, $\alpha_\psi \in [-1.0, 1.0]$
- If $\Delta\Phi \neq 0$, the hyperon will have transverse polarization even e^+e^- beams are unpolarized.

Polarization of J/ψ



Considering Z^0 contribution:
 J/ψ has longitude polarization:
 denoted by P_L

No beam polarization:

$$P_L = \frac{\rho_{++} - \rho_{--}}{\rho_{++} + \rho_{--}}$$

$\rho_{mm'}$: J/ψ spin density matrix

$$P_L = \mathcal{A}_{LR}^0 = \frac{\sigma_R - \sigma_L}{\sigma_R + \sigma_L} = \frac{-\sin^2 \theta_W^{\text{eff}} + 3/8}{2 \sin^2 \theta_W^{\text{eff}} \cos^2 \theta_W^{\text{eff}}} \frac{M_{J/\psi}^2}{m_Z^2}$$

With beam polarization:

$$\xi = \frac{\sigma_R(1 + P_e)/2 - \sigma_L(1 - P_e)/2}{\sigma_R(1 + P_e)/2 + \sigma_L(1 - P_e)/2} = \frac{\mathcal{A}_{LR}^0 + P_e}{1 + P_e \mathcal{A}_{LR}^0} \approx P_e$$

Can be used for precise
 measurement beam
 polarization

Spin density matrix of hyperon-antihyperon

Polarization effects encoded in hyperon pair spin density matrix

$$R(\lambda_1, \lambda_2; \lambda'_1, \lambda'_2) \propto \sum_{m, m'} \rho_{m, m'} d_{m, \lambda_1 - \lambda_2}^{j=1}(\theta) d_{m', \lambda'_1 - \lambda'_2}^{j=1}(\theta) \\ \times \mathcal{M}_{\lambda_1, \lambda_2} \mathcal{M}_{\lambda'_1, \lambda'_2}^* \delta_{m, m'},$$

| Lorentz invariance introduces P and CP violation form factors in helicity amplitude

$$\mathcal{M}_{\lambda_1, \lambda_2} = \epsilon_\mu (\lambda_1 - \lambda_2) \bar{u}(\lambda_1, p_1) (F_V \gamma^\mu + \frac{i}{2M_\Lambda} \sigma^{\mu\nu} q_\nu H_\sigma \\ + \gamma^\mu \gamma^5 F_A + \sigma^{\mu\nu} \gamma^5 q_\nu H_T) v(\lambda_2, p_2).$$

X.G.He, J.P. Ma, Bruce McKellar,
Phys.Rev.D47(1993)1744

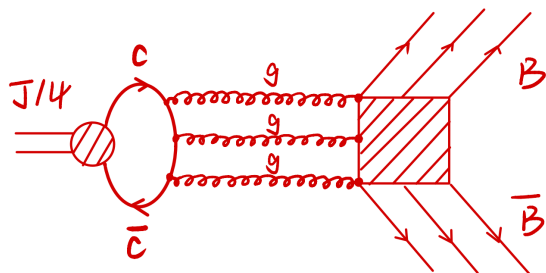
X.G.He, J.P. Ma,
Phys.Lett.B 839(2023)137834

Dynamics in $J/\psi \rightarrow B\bar{B}$

Detailed dynamics in J/ψ decay to hyperon pair, have been studied:

X.G.He, J.P. Ma, Phys.Lett.B 839(2023)137834

$$\mathcal{A} = \epsilon_\mu(\lambda) \bar{u}(\lambda_1) \left(\mathbf{F}_V \gamma^\mu + \frac{i}{2M_\Lambda} \sigma^{\mu\nu} q_\nu \mathbf{H}_\sigma + \gamma^\mu \gamma^5 \mathbf{F}_A + \sigma^{\mu\nu} \gamma^5 q_\nu \mathbf{H}_T \right) v(\lambda_2)$$



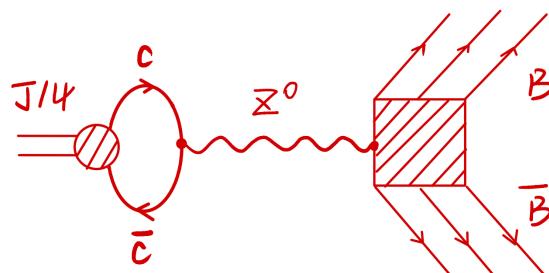
Dominant contribution

[arXiv:hep-ph/0412158](https://arxiv.org/abs/hep-ph/0412158)

Psionic form factor

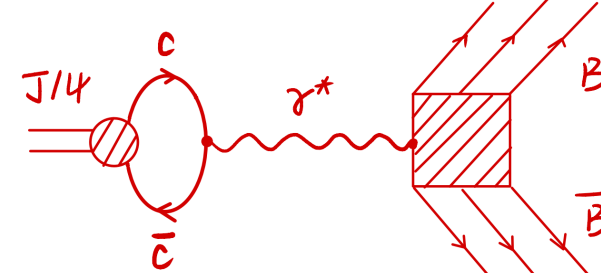
$\mathbf{F}_V$ and $\mathbf{H}_\sigma$

can also be represented
as $\mathbf{G}_1$ and $\mathbf{G}_2$



$\mathbf{F}_A$: P violation term

Complex form factor, $\mathbf{F}_A \neq 0$ indicate P violation



$\mathbf{H}_T$: CP violation term

$$\mathbf{H}_T(q^2) = \frac{2e}{3m_{J/\psi}^2} g_V d_B(q^2)$$

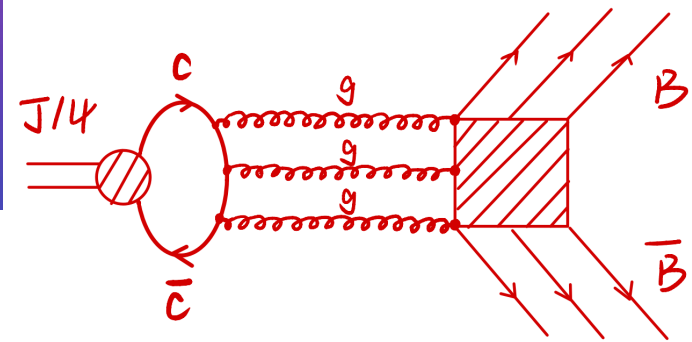
Assuming $d_B(q^2) \equiv d_B(0)$

$d_B(q^2)$: electric dipole form factor

$d_B(0)$: electric dipole moment

[Physics Letters B 551 \(2003\) 16–26](#)

Psionic form factors G_1, G_2



Psionic form factors

$$F_V = G_1 - \frac{4M^2}{Q^2}(G_1 - G_2)$$

$$H_\sigma = \frac{4M^2}{Q^2}(G_1 - G_2)$$

Hyperon polarization parameters

$$\alpha_{J/\psi} = \frac{s |G_1|^2 - 4m^2 |G_2|^2}{s |G_1|^2 + 4m^2 |G_2|^2}$$

$$\frac{G_1}{G_2} = \left| \frac{G_1}{G_2} \right| e^{-i\Delta\Phi}$$

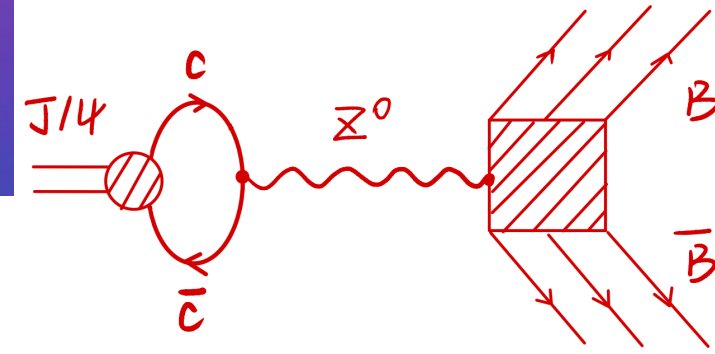
X.G.He, J.P. Ma, Bruce McKellar,
Phys.Rev.D47(1993)1744

X.G.He, J.P. Ma,
Phys.Lett.B 839(2023)137834

Göran Falldt, Andrzej Kupsc
Physics Letters B 772 (2017) 16–20

| G_1 can be extracted from the measurement of $\Gamma(J/\psi \rightarrow B\bar{B})$

P violation form factor F_A



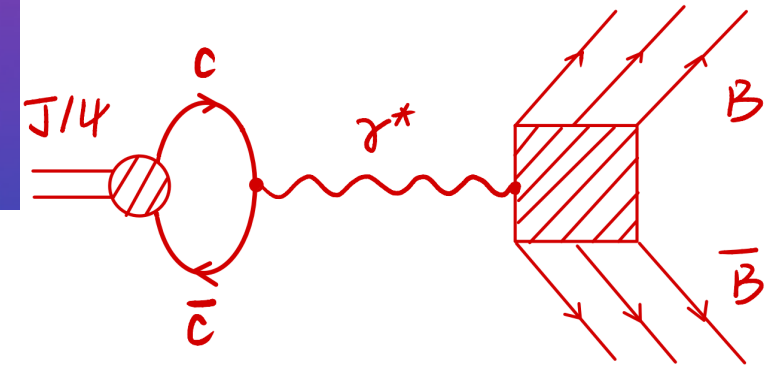
Primarily from Z-boson exchange between $c\bar{c}$ and light quark pairs

Related to weak mixing angle in SM

$$F_A \approx -\frac{1}{6} D g_V \frac{g^2}{4 \cos^2 \theta_W^{\text{eff}}} \frac{1 - 8 \sin^2 \theta_W^{\text{eff}} / 3}{m_Z^2} \approx -1.07 \times 10^{-6}$$

X.G.He, J.P. Ma,
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CP violation form factor H_T



Several CPV sources contributed to H_T

Take hyperon EDM as the major source for H_T

$$H_T = \frac{2e}{3M_{J/\psi}^2} g_V d_B \quad (q = M_{J/\psi})$$

Neglect q dependence, d_B for hyperon EDM

X.G.He, J.P. Ma, Bruce McKellar,
Phys.Rev.D47(1993)1744

X.G.He, J.P. Ma,
Phys.Lett.B 839(2023)137834

Full angular helicity amplitude of $e^+e^- \rightarrow J/\psi \rightarrow B\bar{B}$

J. Fu, H.B. Li, J. Wang, F. Yu, and J. Zhang,
PhysRevD.108.L091301

Angular formular based on helicity amplitude are developed:

$$R(\lambda_1, \lambda_2; \lambda'_1, \lambda'_2) \propto \sum_{m, m'} \rho_{m, m'} d_{m, \lambda_1 - \lambda_2}^{j=1}(\theta) d_{m', \lambda'_1 - \lambda'_2}^{j=1}(\theta) \mathcal{M}_{\lambda_1, \lambda_2} \mathcal{M}_{\lambda'_1, \lambda'_2}^* \delta_{m, m'}$$

Total angular distribution of J/ψ to spin-1/2 baryon pair:

➤ $J/\psi \rightarrow B\bar{B}, B = \Lambda^0, \Sigma^-, \Sigma^+$

$$\frac{d\sigma}{d\Omega_k d\Omega_p d\Omega_{\bar{p}}} = N \sum_{[\lambda]} R(\lambda_1, \lambda_2; \lambda'_1, \lambda'_2) D_{\lambda_1, \lambda_p}^{j=1/2}(\theta_1, \phi_1) D_{\lambda'_1, \lambda_p}^{*j=1/2}(\theta_1, \phi_1) |h_{\lambda_p}|^2 D_{\lambda_2, \lambda_{\bar{p}}}^{j=1/2}(\theta_2, \phi_2) D_{\lambda'_2, \lambda_{\bar{p}}}^{*j=1/2}(\theta_2, \phi_2) |h_{\lambda_{\bar{p}}}|^2$$

➤ $J/\psi \rightarrow B\bar{B}, B = \Xi^0, \Xi^-$

$$\frac{d\sigma}{d\Omega_k d\Omega_{\Lambda} d\Omega_{\bar{\Lambda}} d\Omega_p d\Omega_{\bar{p}}} = N \sum_{[\lambda]} R(\lambda_1, \lambda_2; \lambda'_1, \lambda'_2) D_{\lambda_1, \lambda_{\Lambda}}^{*j=1/2}(\theta_1, \phi_1) D_{\lambda'_1, \lambda'_{\Lambda}}^{j=1/2}(\theta_1, \phi_1) \mathcal{H}_{\lambda_{\Lambda}} \mathcal{H}_{\lambda'_{\Lambda}}^* D_{\lambda_2, \lambda_{\bar{\Lambda}}}^{*j=1/2}(\theta_2, \phi_2) \\ D_{\lambda'_2, \lambda'_{\bar{\Lambda}}}^{j=1/2}(\theta_2, \phi_2) \mathcal{H}_{\lambda_{\bar{\Lambda}}} \mathcal{H}_{\lambda'_{\bar{\Lambda}}}^* D_{\lambda_{\Lambda}, \lambda_p}^{*j=1/2}(\theta_3, \phi_3) D_{\lambda'_{\Lambda}, \lambda_p}^{j=1/2}(\theta_3, \phi_3) |h_{\lambda_p}|^2 D_{\lambda_{\bar{\Lambda}}, \lambda_{\bar{p}}}^{*j=1/2}(\theta_4, \phi_4) D_{\lambda'_{\bar{\Lambda}}, \lambda_{\bar{p}}}^{j=1/2}(\theta_4, \phi_4) |h_{\lambda_{\bar{p}}}|^2$$

The background image is a composite of two nighttime city scenes. The upper portion shows a skyline with several illuminated skyscrapers, including a very tall, slender one in the center. The lower portion shows a complex highway interchange with multiple overpasses and ramps, with light trails from vehicles creating a sense of motion. The text is overlaid on the upper portion of the image.

Sensitivity study of BESIII and STCF

Sensitivity study of BESIII and STCF

Sensitivity assessed from 500 pseudoexperiments generated and fitted by using a probability density function based on the full angular distribution

Expected yields, Form Factors and decay parameters are fixed to known values for generation: G_1 , $\alpha_{J/\psi}$, $\Delta\Phi$, F_A , H_T , α_B , $\alpha_{\bar{B}}$, ϕ_B and $\phi_{\bar{B}}$

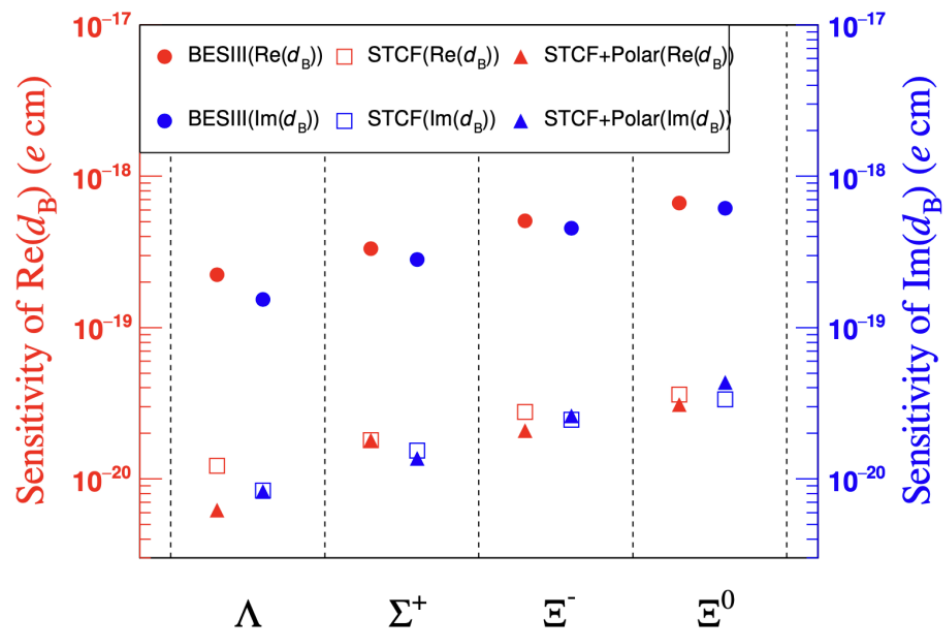
| $P_L \sim 10^{-4}$ (80%) for unpolarized (longitudinally polarized) electron beam

Decay Channel	$J/\psi \rightarrow \Lambda\bar{\Lambda}$	$J/\psi \rightarrow \Sigma^+\Sigma^-$	$J/\psi \rightarrow \Xi^-\Xi^+$	$J/\psi \rightarrow \Xi^0\Xi^0$
$B_{tag}/(\times 10^{-4})$ [29]	7.77	2.78	3.98	4.65
$\epsilon_{tag}/\%$ [22, 28, 30, 31]	40	25	15	7
$N_{tag}^{evt}/(\times 10^5)$ (BESIII)	31.3	7.0	6.0	3.3
$N_{tag}^{evt}/(\times 10^8)$ (STCF) [17]	10.6	2.4	2.0	1.1

Sensitivity of hyperon EDM measurements

reminder:
$$H_T = \frac{2e}{3M_{J/\psi}^2} g_V d_B$$

SM: $\sim 10^{-26}$ e cm



(a) Sensitivity of $\text{Re}(d_B)$ and $\text{Im}(d_B)$

BESIII: milestone for hyperon EDM measurement

Λ 10^{-19} e cm (FermiLab 10^{-16} e cm)

first achievement for Σ^+ , Ξ^- and Ξ^0 at level of 10^{-19} e cm

a litmus test for new physics

STCF: improved by 2 order of magnitude

Sensitivity of CP violation in hyperon decay

reminder:

$$A_{CP}^B = (\alpha_B + \bar{\alpha}_B)/(\alpha_B - \bar{\alpha}_B)$$

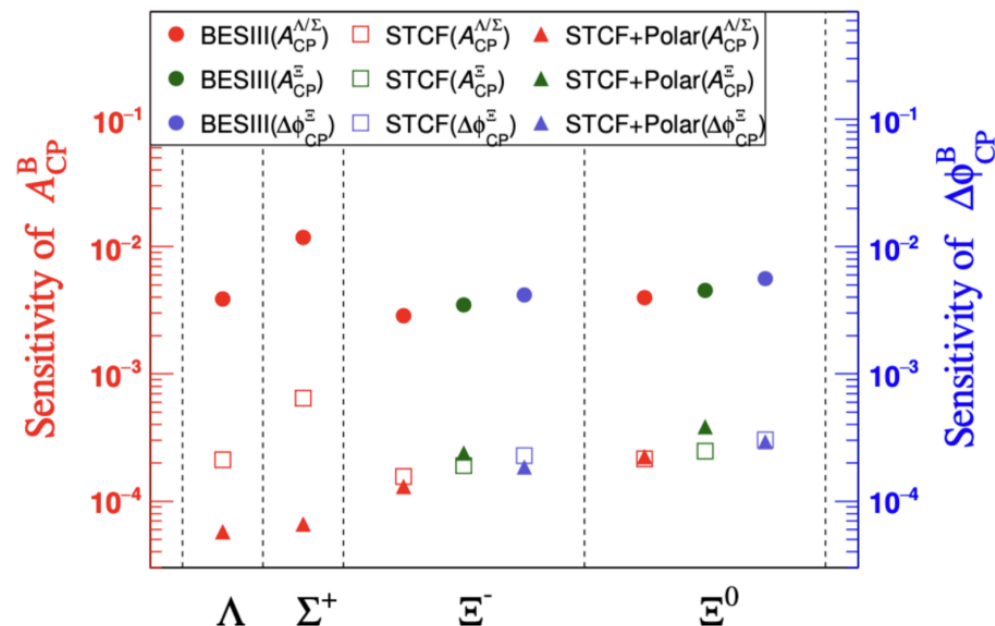
$$\Delta\phi_{CP}^B = (\phi_B + \bar{\phi}_B)/2$$

N.G.Deshpande et al, PLB326(1994)307

J.Tandean et al, PRD67(2003)056001

J.F.Donoghue et al, PRD34(1986)833

SM: $10^{-4} \sim 10^{-5}$



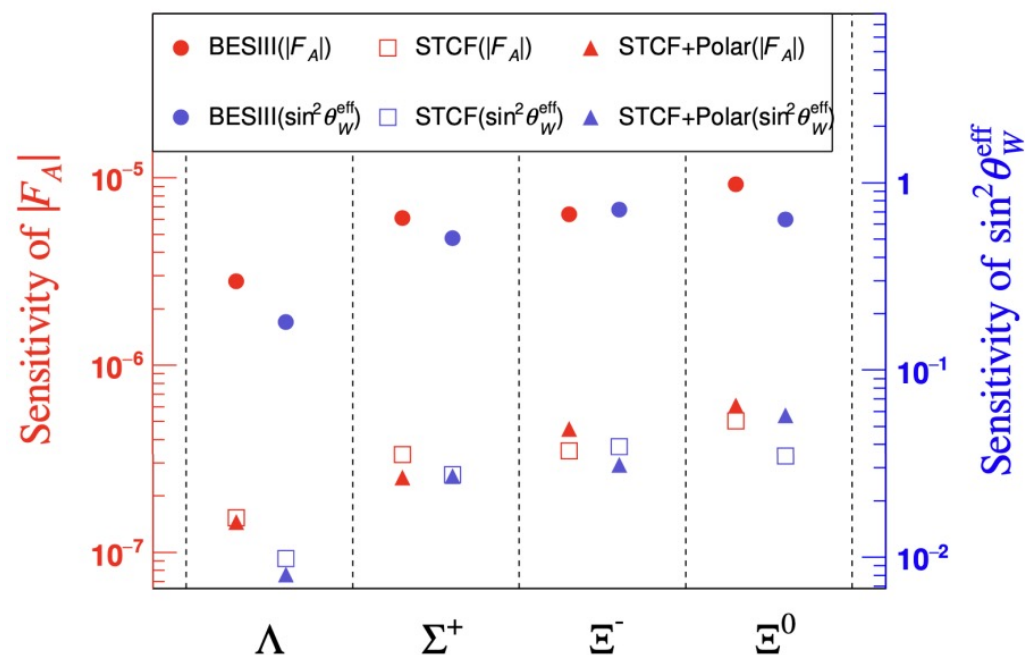
(b) Sensitivity of A_{CP}^B and $\Delta\phi_{CP}^B$

STCF:

SM prediction can be reached and further improved with a longitudinally polarized electron beam

Sensitivity of F_A and $\sin^2 \theta_W^{\text{eff}}$ measurements

reminder:
$$F_A \approx -\frac{1}{6} D g_V \frac{g^2}{4 \cos^2 \theta_W^{\text{eff}}} \frac{1 - 8 \sin^2 \theta_W^{\text{eff}}/3}{m_Z^2}$$



(c) Sensitivity of $|F_A|$ and $\sin^2 \theta_W^{\text{eff}}$

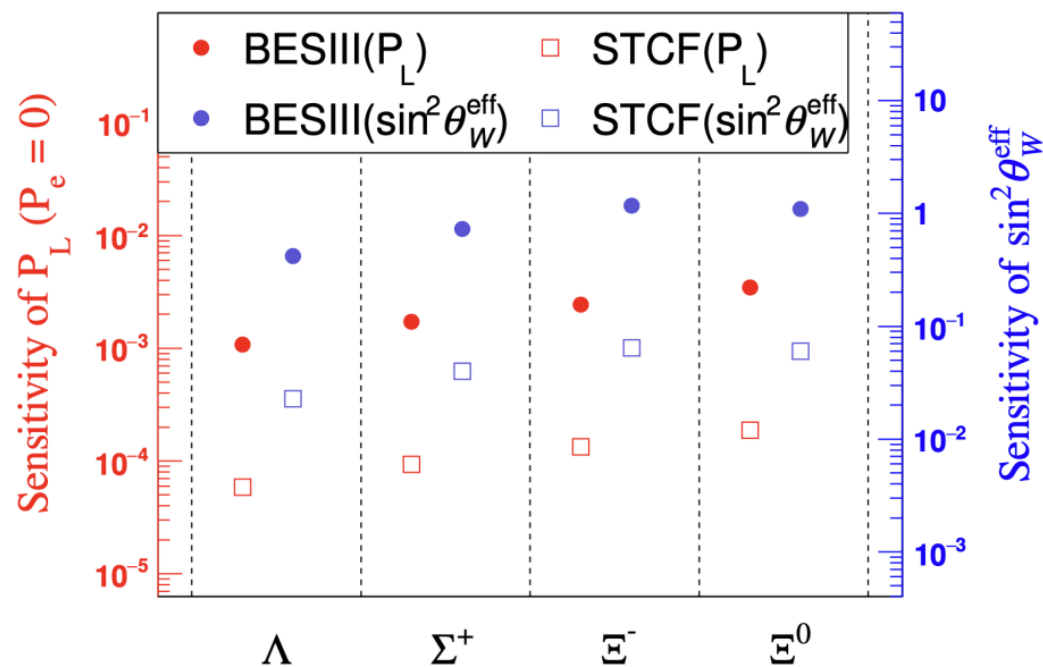
SM: $F_A \sim 10^{-6}$
 $\sin^2 \theta_W^{\text{eff}} \sim 0.235$

STCF:

Weak mixing angle at $Q = M_{J/\psi}$
 can be determined at the level
 of 8×10^{-3}

Sensitivity of P_L and $\sin^2 \theta_W^{\text{eff}}$ measurements

reminder: $P_L = \mathcal{A}_{LR}^0 = \frac{\sigma_R - \sigma_L}{\sigma_R + \sigma_L} = \frac{-\sin^2 \theta_W^{\text{eff}} + 3/8}{2 \sin^2 \theta_W^{\text{eff}} \cos^2 \theta_W^{\text{eff}}} \frac{M_{J/\psi}^2}{m_Z^2}$



(d) Sensitivity of P_L

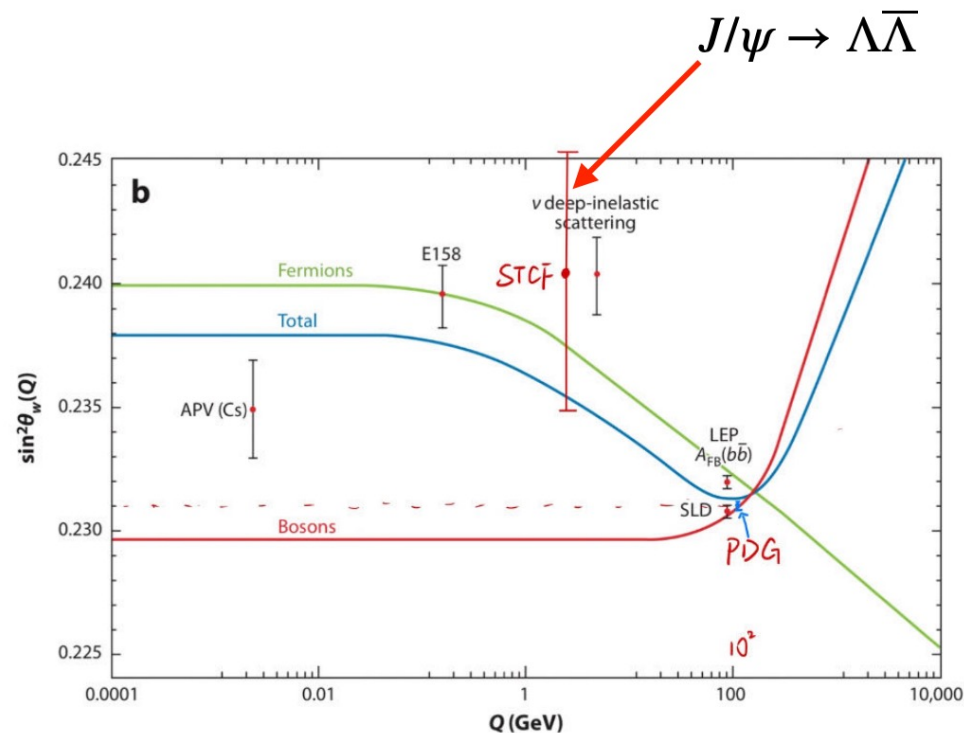
SM: $P_L \sim 10^{-4}$

$\sin^2 \theta_W^{\text{eff}} \sim 0.235$

STCF:

Weak mixing angle at $Q = M_{J/\psi}$
can be determined at the level
of 2×10^{-2}

Sensitivity of $\sin^2 \theta_W^{\text{eff}}$ by simultaneous fit



Weak mixing angle shared by F_A and P_L

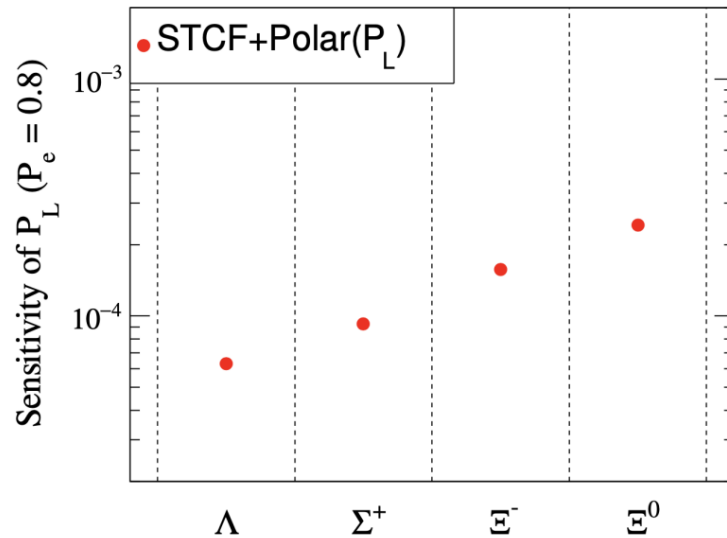
Sensitivity improved at the level 5×10^{-3}

Figure 1

(a) $\sin^2 \theta_W(\mu)_{\overline{\text{MS}}}$ (29) with an updated atomic parity violation (APV) result. (b) $\sin^2 \theta_W(Q^2)$, a one-loop calculation dominated by $\gamma - Z^0$ mixing (52). The red and green curves represent the boson and fermion contributions, respectively.

K.S.Kumar et al, Ann.Rev.Nucl.Part.Sci.
63 (2013) 237-267

Sensitivity of beam polarization measurements



Precisely measured beam polarization (10^{-5}) as input value for $\sin^2 \theta_W^{\text{eff}}$ measurement

A. Bondar et al, JHEP 03 (2020) 076

$$\mathcal{A}_{\text{LR}} \equiv \frac{\sigma_{\mathcal{P}_e} - \sigma_{-\mathcal{P}_e}}{\sigma_{\mathcal{P}_e} + \sigma_{-\mathcal{P}_e}} = \mathcal{A}_{\text{LR}}^0 \mathcal{P}_e$$

$$\sigma_{\mathcal{P}_e} = \frac{N_{\mathcal{P}_e}}{\mathcal{L}_{\mathcal{P}_e} \varepsilon_{\text{eff}}}$$

$$\sigma_{-\mathcal{P}_e} = \frac{N_{-\mathcal{P}_e}}{\mathcal{L}_{-\mathcal{P}_e} \varepsilon_{\text{eff}}}$$

analysis Bhabha scattering events

$$\mathcal{A}_{\text{LR}}^0 = \frac{\sigma_R - \sigma_L}{\sigma_R + \sigma_L} = \frac{-\sin^2 \theta_W^{\text{eff}} + 3/8}{2 \sin^2 \theta_W^{\text{eff}} \cos^2 \theta_W^{\text{eff}}} \frac{M_{J/\psi}^2}{m_Z^2}$$

Summary and Outlooks

- To measure EDM, we developed a set of helicity amplitude formulas describing the J/ψ decay to $\Lambda, \Sigma, \Xi, \Omega$ pairs
- Pseudo experiments are performed and the sensitivity of the hyperon EDM
 - The prospect sensitivity of Λ EDM at BESIII is 1000 times higher than the world's best measurement under the same statistical condition.
 - BESIII has the opportunity of first measurements of the EDM of Σ^+, Ξ^-, Ξ^0 hyperons , and the sensitivity are at the order of 10^{-19} (BESIII) and 10^{-20} (STCF).



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