FCC prospects for probing flavor anomalies and neutron dark decay

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(1) Pati-Salam gauge leptoquark for flavor anomalies at the FCC

(2) Scalar and vector mediators for neutron dark decay at the LHC and FCC

(1) Pati-Salam gauge leptoquark for flavor anomalies

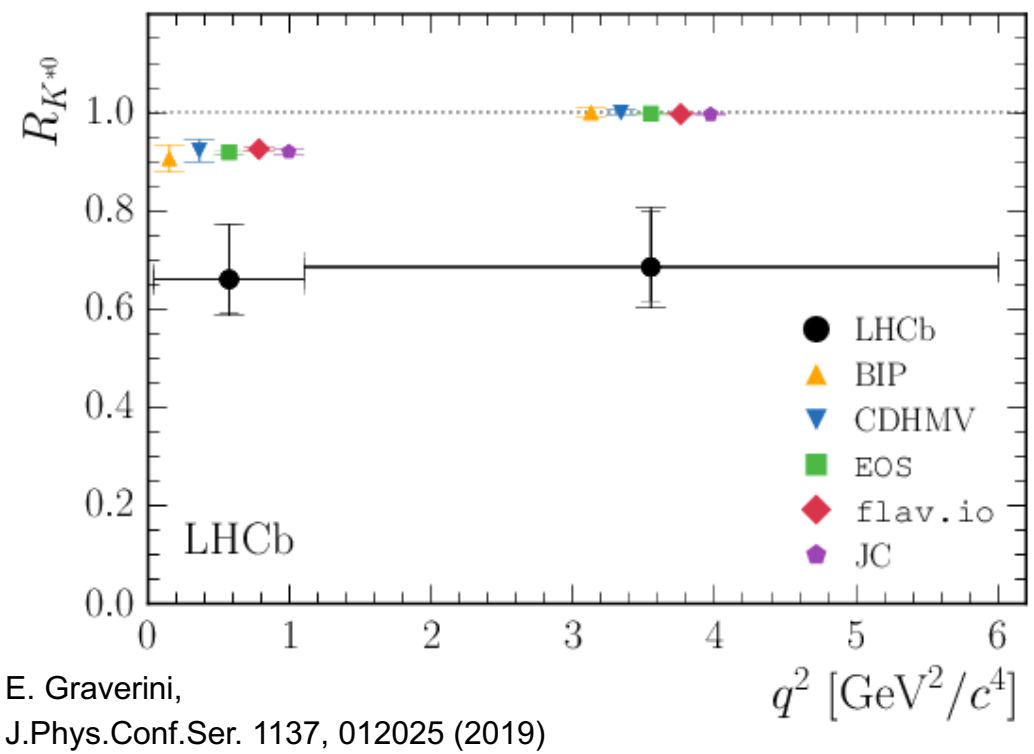
Flavor anomalies

$$R(K^{(*)}) = \frac{\mathrm{Br}\,[B \to K\mu^+\mu^-]}{\mathrm{Br}\,[B \to Ke^+e^-]}$$

Best fit provided by:

vector leptoquark

$$(3,1)_{\frac{2}{3}}$$



E. Graverini,
J.Phys.Conf.Ser. 1137, 012025 (2019)

- N. Assad, BF, B. Grinstein, *Baryon Number and Lepton Universality Violation in Leptoquark and Diquark Models*, PLB 777, 324 (2018)

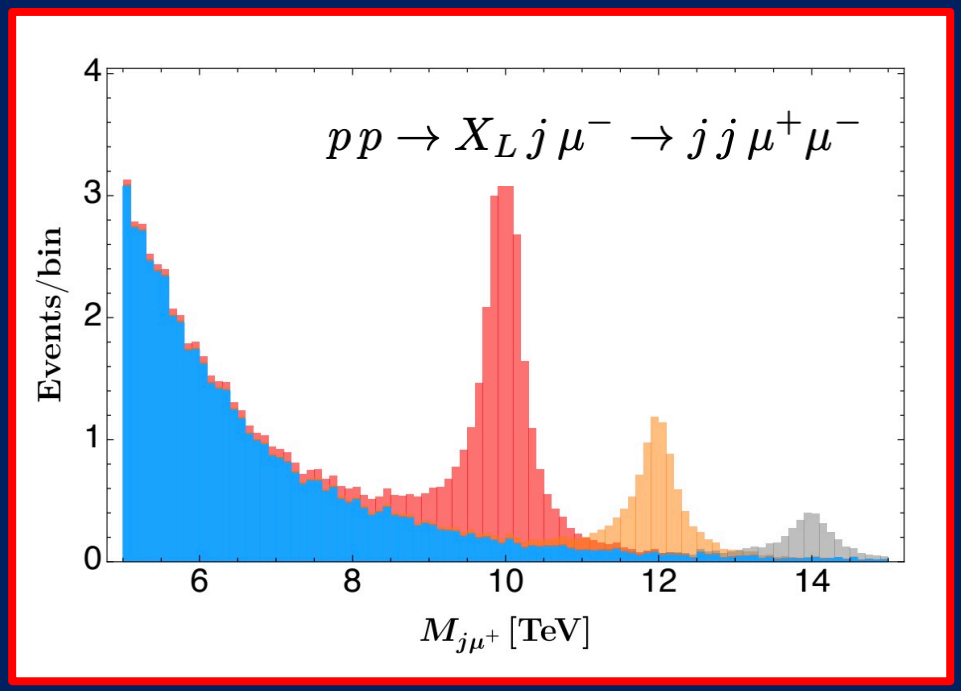
$$(3,1)_{\frac{2}{3}}$$ **from a Pati-Salam type theory**

(1) Pati-Salam gauge leptoquark for flavor anomalies

- BF, S.A. Gadam, B. Grinstein, *Left-Right SU(4) Vector Leptoquark Model for Flavor Anomalies*, PRD 99, 055025 (2019)

$$\mathrm{SU}(4)_L \times \mathrm{SU}(4)_R \times \mathrm{SU}(2)_L \times \mathrm{U}(1)'$$

$$M_{X_L} \gtrsim 10 \text{ TeV}$$



$$\mathcal{L}_v \supset \frac{g_L}{\sqrt{2}} X_{L\mu} \left[L^u_{ij} \left(\bar{u}^i \gamma^\mu P_L\, \nu^j\right) + L^d_{ij} \left(\bar{d}^i \gamma^\mu P_L\, e^j\right) \right]$$

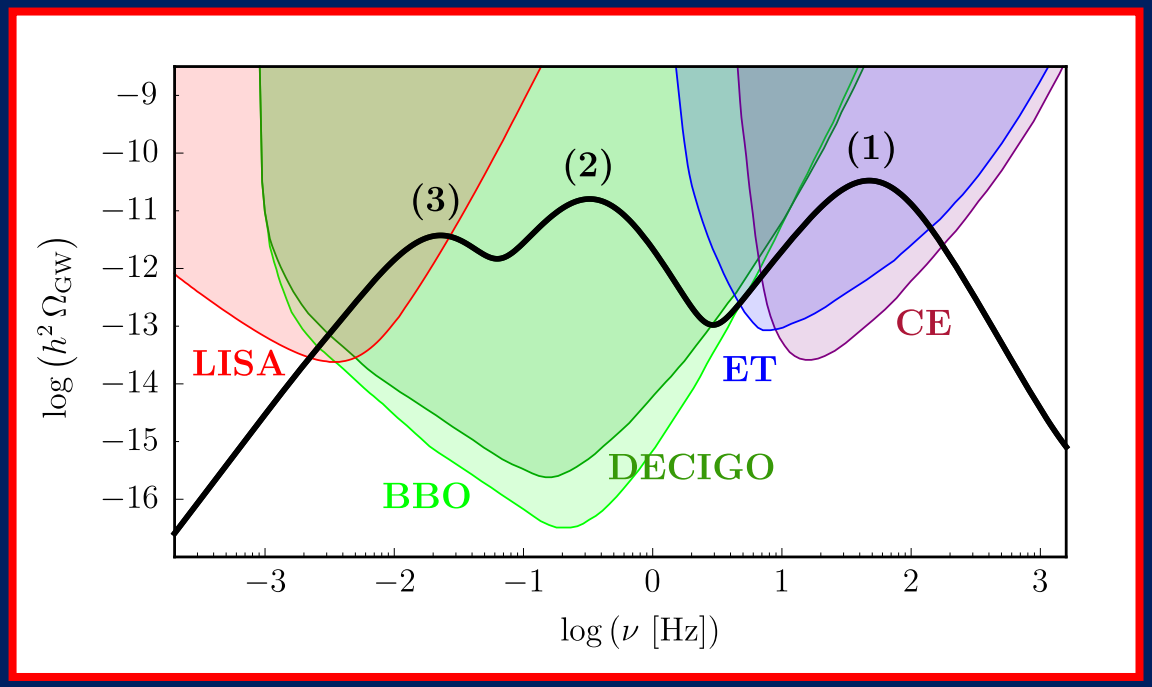
Required condition

$$\frac{M_{X_L}}{g_L \sqrt{\mathrm{Re}\left(L^d_{22} L^{d*}_{32} - L^d_{21} L^{d*}_{31}\right)}} \approx 23 \text{ TeV}$$

<u>Project 1</u>: Signatures of the Pati-Salam leptoquark at the FCC.

(1) Pati-Salam gauge leptoquark for flavor anomalies

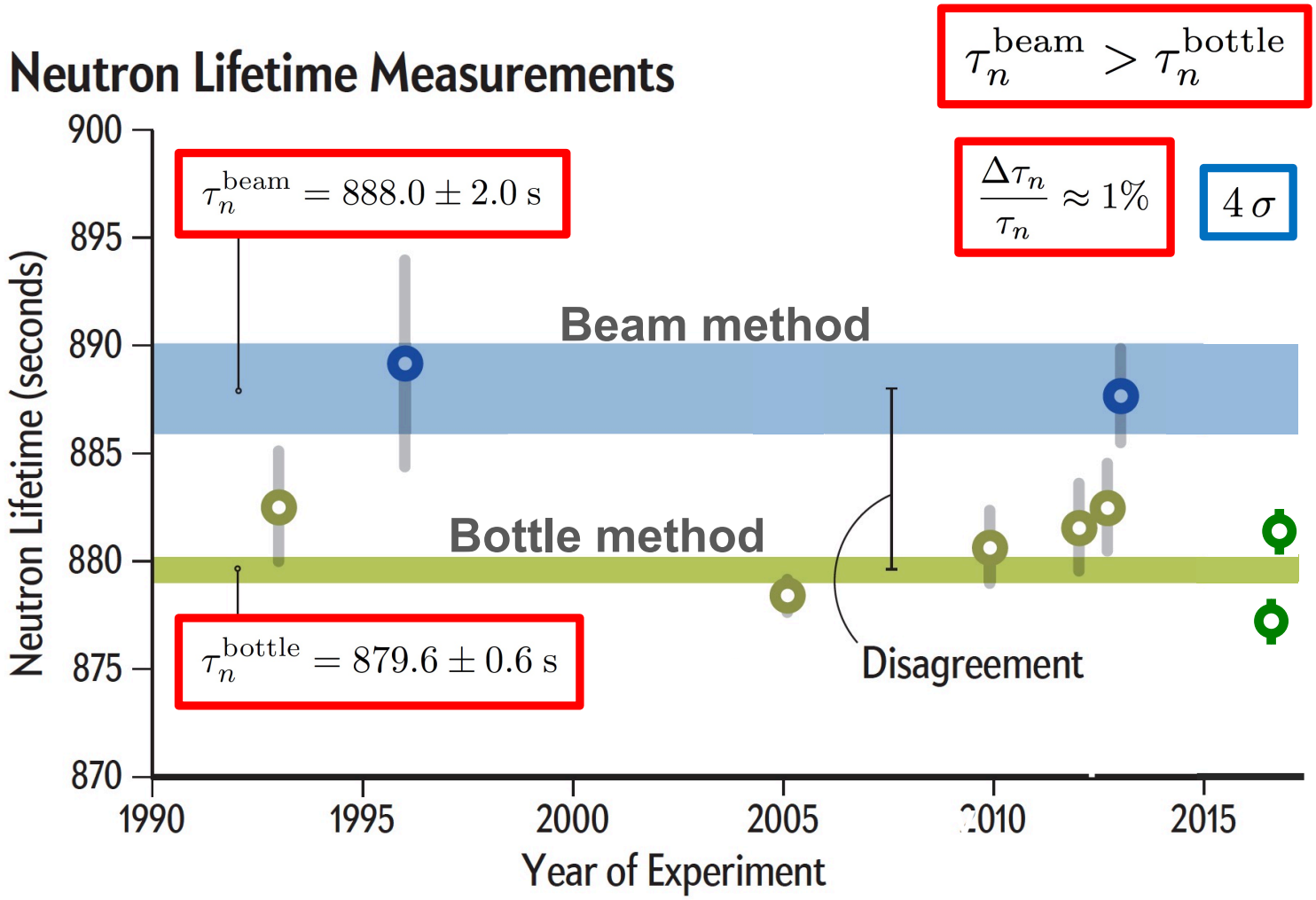
Gravitational wave signature $\mathrm{SU}(4)_L \times \mathrm{SU}(4)_R \times \mathrm{SU}(2)_L \times \mathrm{U}(1)'$



BF, *Gravitational Wave Signatures of Lepton Universality Violation*, arXiv:2006.08802 [hep-ph]

<u>Project 2</u>: Complementarity between LHCb, GW and FCC.

(2) Scalar and vector mediators for neutron dark decay



https://www.scientificamerican.com, modified

(2) Scalar and vector mediators for neutron dark decay

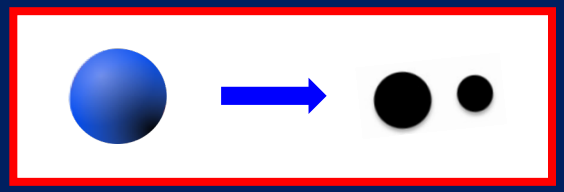
BF, B. Grinstein, ***Dark Matter Interpretation of the Neutron Decay Anomaly***, PRL 120, 191801 (2018)

$$\mathrm{Br}(n \to p + \text{anything}) \approx 99\%$$

$$\mathrm{Br}(n \to \text{anything} \neq p) \approx 1\%$$

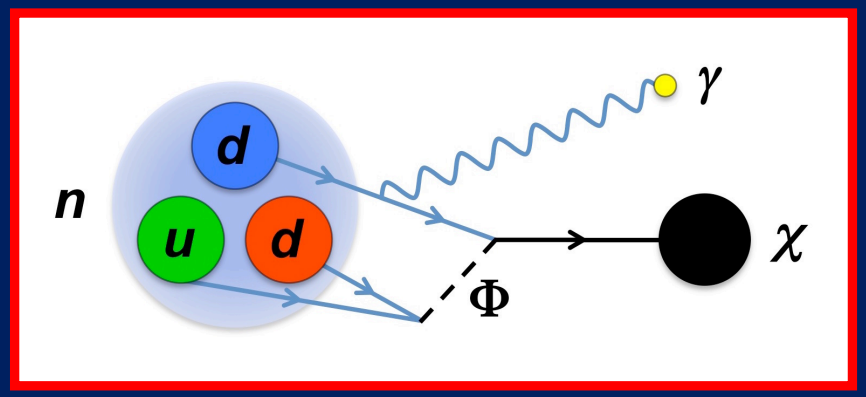
$$n \to \text{ dark particles}$$

$$n \to \text{ dark particle(s) } + \text{ SM particle(s)}$$



(2) Scalar and vector mediators for neutron dark decay

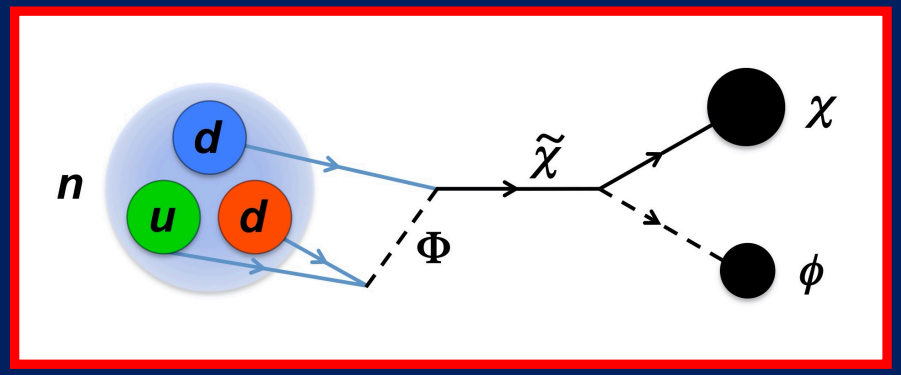
Model 1



$$\frac{M_\Phi}{\sqrt{|\lambda_q \lambda_\chi|}} \approx 200 \text{ TeV}$$

$$\mathcal{L}_1 = \left(\lambda_q \, \epsilon^{ijk} \, \overline{u^c_{Li}} \, d_{Rj} \Phi_k + \lambda_\chi \Phi^{*i} \bar{\chi} \, d_{Ri} + \text{h.c.}\right) - M_\Phi^2 |\Phi|^2 - m_\chi \, \bar{\chi} \, \chi$$

Model 2



$$\frac{M_\Phi}{\sqrt{|\lambda_q \lambda_{\tilde{\chi}} \lambda_\phi|}} \approx 300 \text{ TeV}$$

<u>Project 3</u>: LHC and FCC sensitivity to the colored state.

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