中国科学院理论物理研究所
Institute of Theoretical Physics, Chinese Academy of Sciences
全国第十六届重味物理和CP破坏研讨会(HFCPV-2018)

# Hidden Gauged U(1) For Both RK and RD Anomalies

**Jiang-Hao Yu (于江浩)**

中国科学院理论物理研究所

Kaori Fuyuto, Hao-Lin Li, J.-H. Yu, PRD 97 (2018) 115003

**October 26, 2018**

# Outline

1. **Why B anomalies are interesting?**
2. **Simplified Model Classification**
3. **Hidden Gauged U(1) Model**
4. **Conclusion**

# New Physics in Flavor Physics

## Effective field theory framework

(Assuming no light new field …)

$m_{\rm NP}$

$$\mathcal{L} = \mathcal{L}^{\rm eff}_{\rm Gravity} + \underbrace{\mathcal{L}_{\rm QCD} + \mathcal{L}_{\rm QED} + \mathcal{L}_{\rm EW}}_{\mathcal{L}_{SM}} + \mathcal{L}^{NP}_{\rm heavy}$$

New Physics Model

$v \sim m_t$

$$\mathcal{L}_{SMEFT} = \mathcal{L}_{SM} + \frac{C_i^{(5)}}{\Lambda_{NP}} Q_i^{(5)} + \frac{C_i^{(6)}}{\Lambda_{NP}^2} Q_i^{(6)} + \cdots$$

$SU(2)_L \times U(1)_Y$ invariant

$m_b$

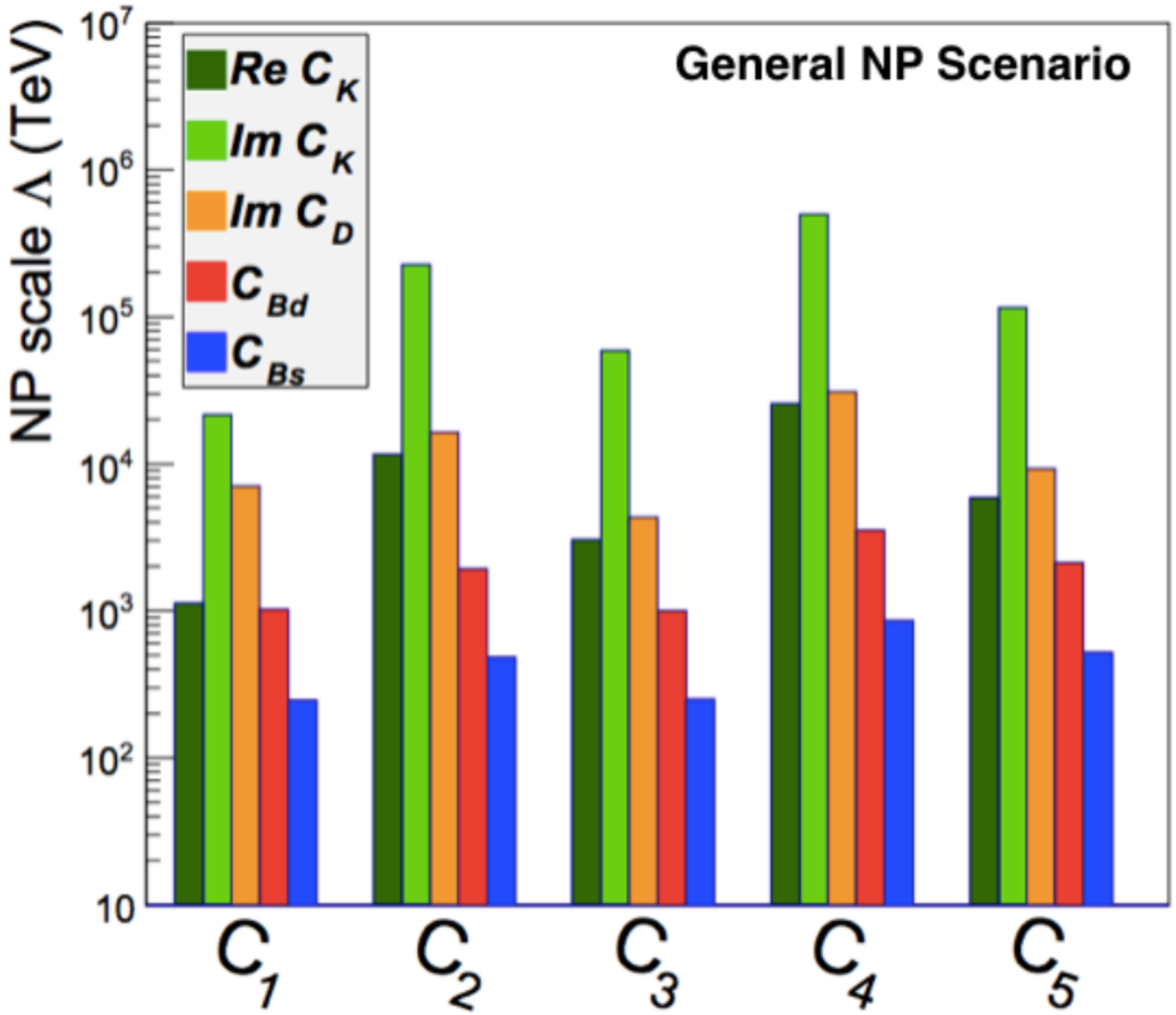
$$\mathcal{L}_W = \mathcal{L}_{\rm QCD} + \mathcal{L}_{\rm QED} + \frac{4G_F}{\sqrt{2}} \sum_i C_i(\mu)\, \mathcal{O}_i(\mu)$$

$$\mathcal{O}_1 = (\bar{c}\gamma_\mu P_L b)(\bar{s}\gamma^\mu P_L c)$$

$$\mathcal{O}_2 = (\bar{c}\gamma_\mu P_L T^a b)(\bar{s}\gamma^\mu P_L T^a c)$$

# Scale of New Physics

**Scale of new physics in flavor physics is usually quite high**

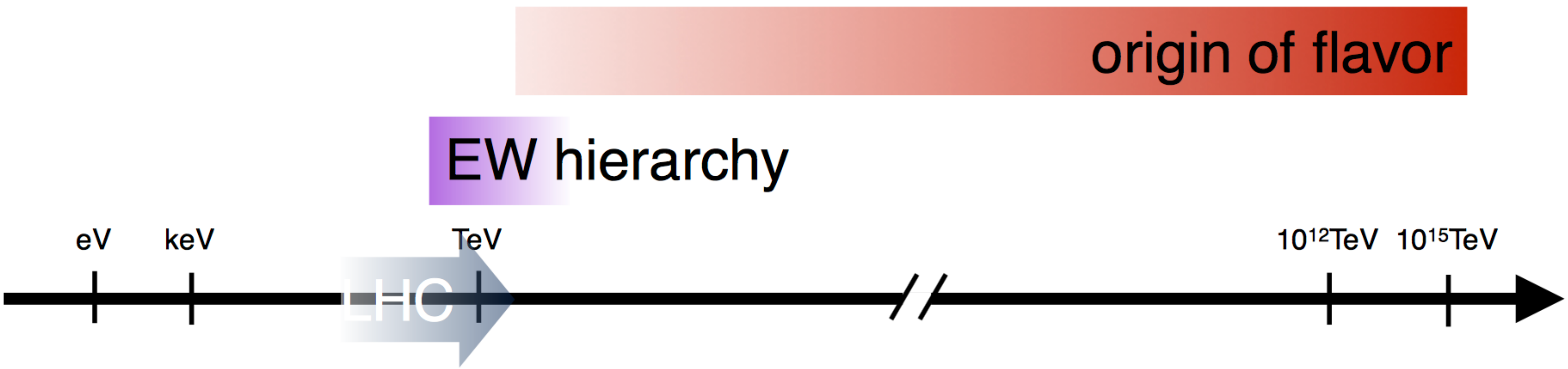



UTfit, 1710.09644

$$\mathcal{H}_{\rm eff} \simeq \sum_i \frac{C_i(\mu)}{\Lambda_i} \mathcal{O}_i(\mu)$$

# Scale of New Physics

## My personal view with bias




Concentrate on the Higgs hierarchy problem

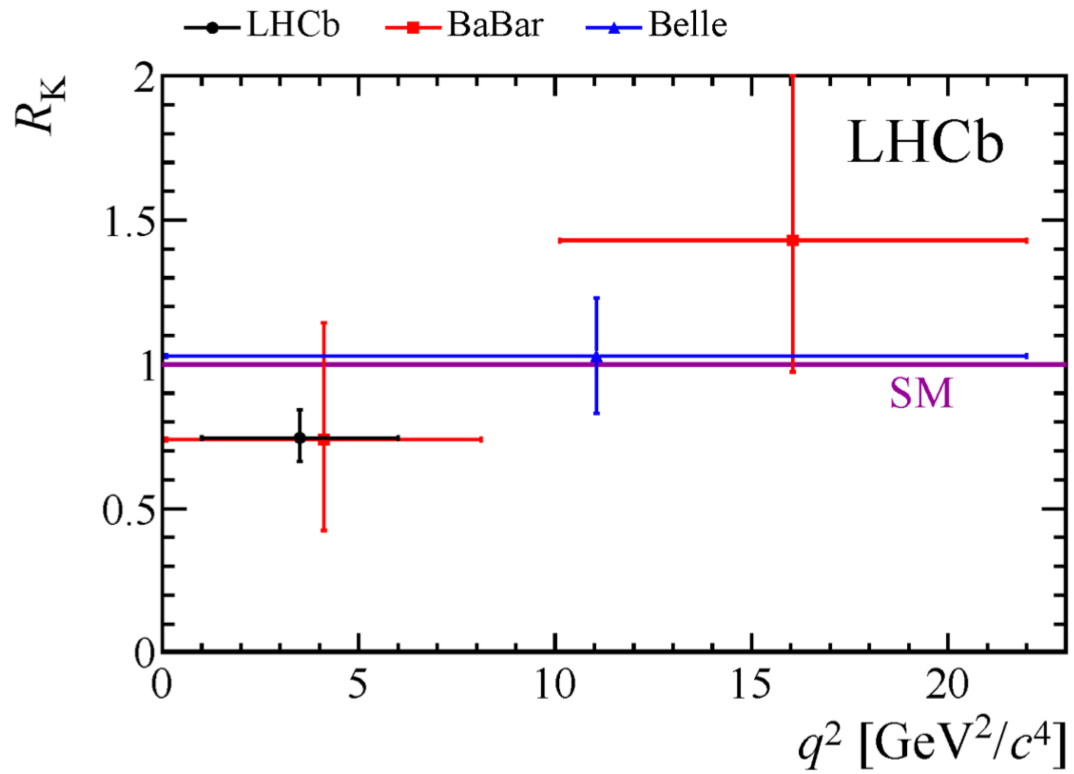
Postpone (*ignore*) the flavor problem

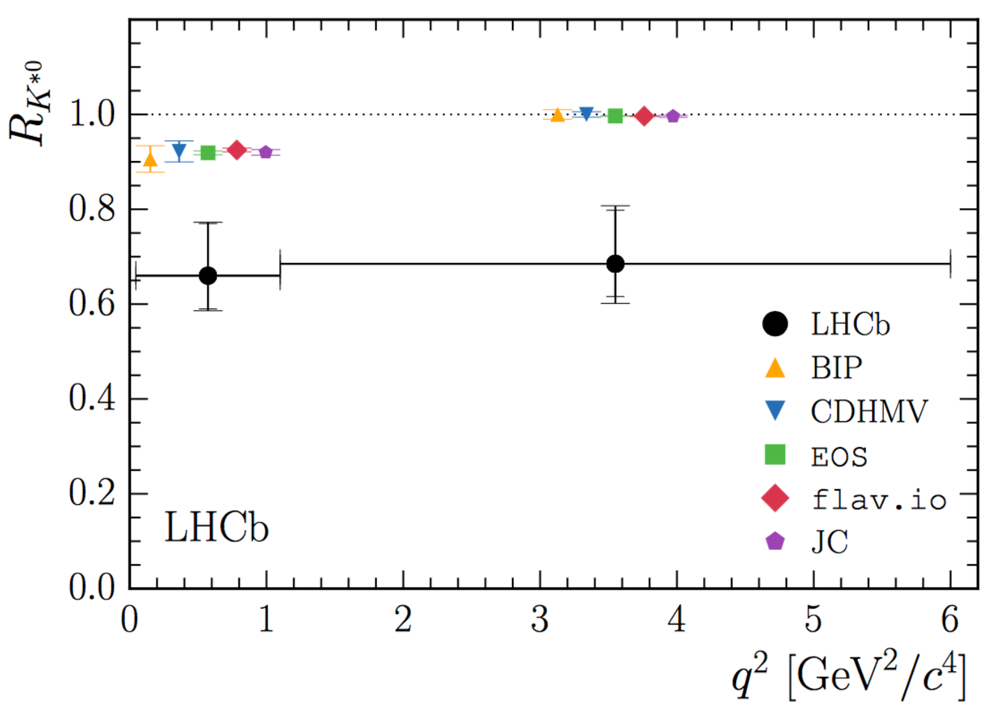
→ *The "MFV paradigm"*

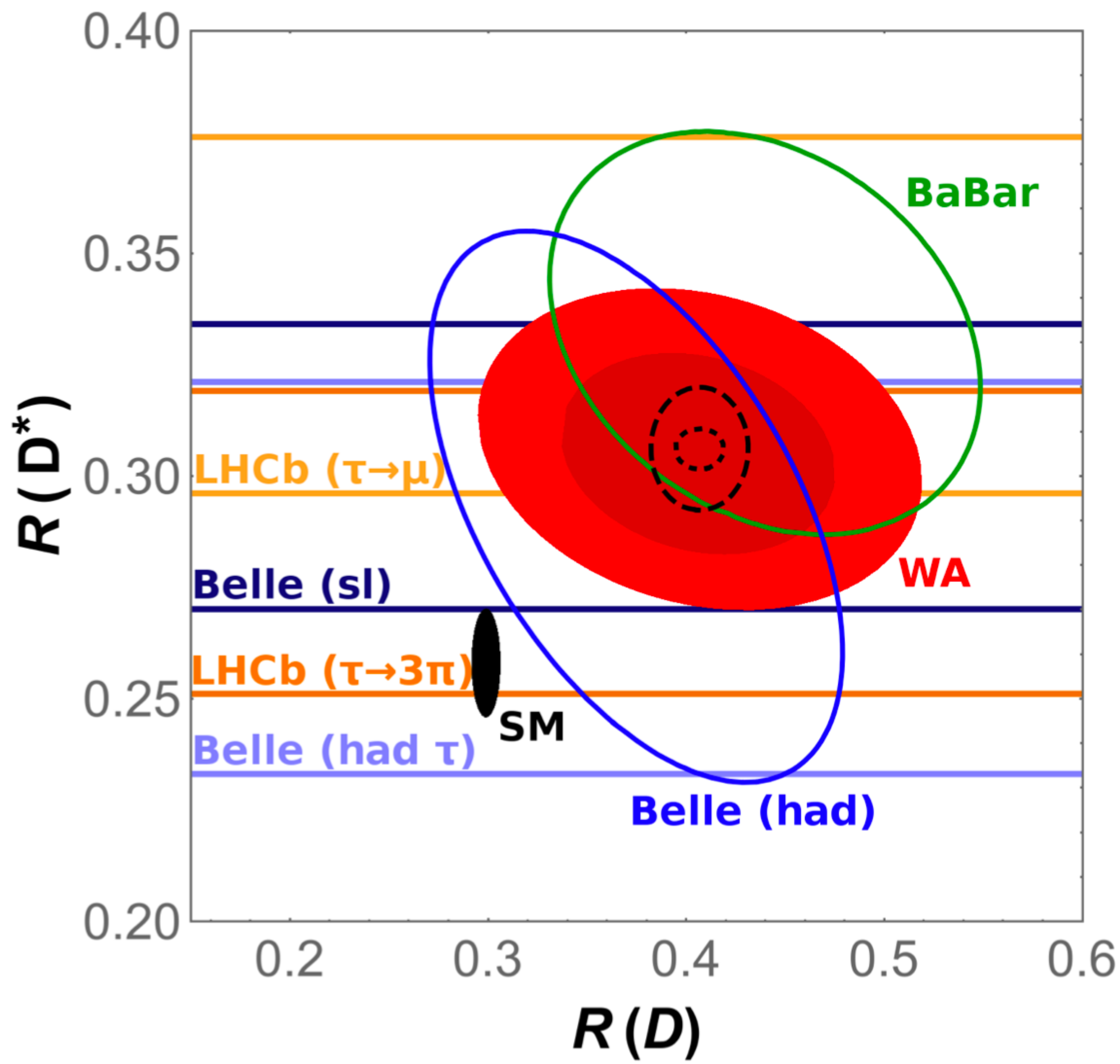
SM Yukawa remains the only source of flavor breaking

# B Anomalies

## Until B anomalies (if it is new physics) ....



# New Physics around TeV Scale?!

**New source of flavor breaking? Yes, but in lepton sector!**

**Lepton flavor universality is violated. (LUV)**

Lepton flavor violation (LFV) is not necessary
($\mu \to e\gamma$ is strongly constrained)

lepton number violation is not relevant

**Estimate scale of B-anomalies processes**

$$\mathcal{L}_{\rm eff}^{b\to s\ell\ell} = -V_{tb}V_{ts}^{*}\frac{\alpha_{\rm em}}{4\pi v^2}\sum C_i^{bs\ell\ell}\mathcal{O}_i^{bs\ell\ell} + \text{h.c.}$$

$$\Lambda = \frac{4\pi v}{e}\frac{1}{\sqrt{2|V_{tb}V_{ts}^{*}|}} \sim 35 \text{ TeV}$$

NP d.o.f accessible at LHC if their couplings to $bs$ and/or $\mu\mu$ is suppressed

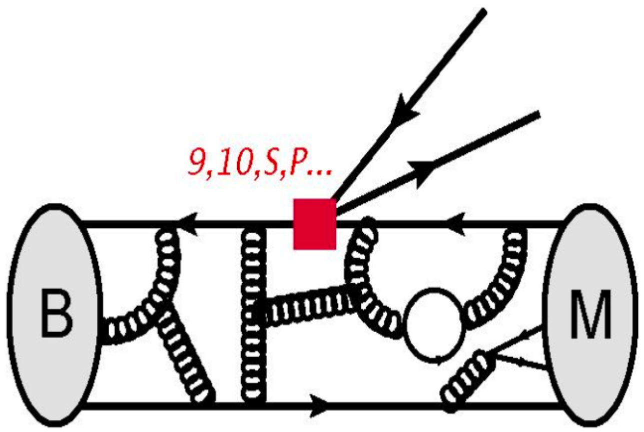
Or loop-level induced coupling $\to \Lambda = \frac{35\ \text{TeV}}{4\pi} = 2.8$ TeV

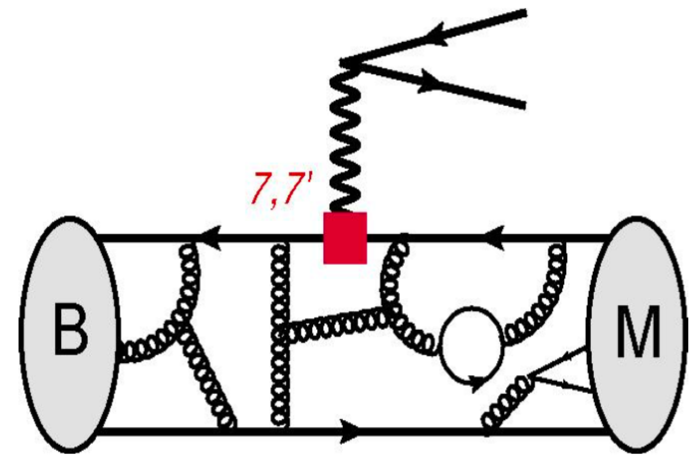
$$\mathcal{L}_{\rm eff}^{b\to c\,\ell\,\nu} = -\frac{2G_F V_{cb}}{\sqrt{2}}\sum C_i^{cb\ell\nu}\mathcal{O}_i^{cb\ell\nu} + \text{h.c.}$$

$$\Lambda^{\rm NP} \sim 1/(\sqrt{2}G_F|V_{cb}|0.10)^{1/2} \sim 3.9\,\text{TeV}$$

**New Physics is at TeV scale, LHC accessible!**

# RK: Low Energy EFT



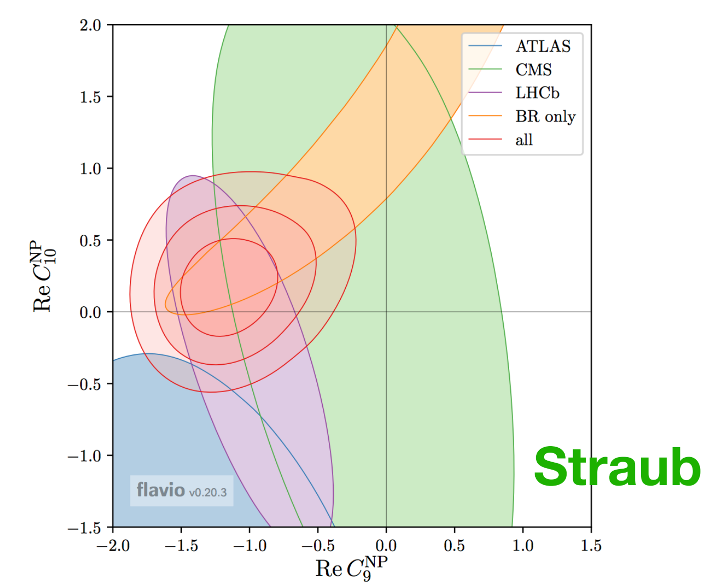

$$O_7^{(\prime)} = \frac{m_b}{e}(\bar{s}\sigma_{\mu\nu}P_{R(L)}b)F^{\mu\nu} \qquad O_9^{(\prime)\ell} = (\bar{s}\gamma_\mu P_{L(R)}b)(\bar{\ell}\gamma^\mu\ell) \qquad O_{10}^{(\prime)\ell} = (\bar{s}\gamma_\mu P_{L(R)}b)(\bar{\ell}\gamma^\mu\gamma_5\ell)$$

$$O_S^{(\prime)\ell} = (\bar{s}\gamma_\mu P_{L(R)}b)(\bar{\ell}\ell) \qquad O_P^{(\prime)\ell} = (\bar{s}\gamma_\mu P_{L(R)}b)(\bar{\ell}\gamma_5\ell)$$

$$O_T^{(\prime)\ell} = (\bar{s}\sigma_{\mu\nu}P_{L(R)}b)(\bar{\ell}\sigma^{\mu\nu}P_{L(R)}\ell)$$

violate hypercharge and thus do not arise at dimension 6 in SMEFT

| Decay | $C_7^{(\prime)}$ | $C_9^{(\prime)}$ | $C_{10}^{(\prime)}$ | $C_{S,P}^{(\prime)}$ |
|---|---|---|---|---|
| $B \to X_s\gamma$ | X | | | |
| $B \to K^*\gamma$ | X | | | |
| $B \to X_s\ell^+\ell^-$ | X | X | X | |
| $B \to K^{(*)}\ell^+\ell^-$ | X | X | X | |
| $B_s \to \mu^+\mu^-$ | | | X | X |




Global fit favors $C_9$ and/or $C_{10}$

# RK: Match to SM EFT

## Match to SM EFT (necessary step if linking to UV)

$$O_{lq}^{(1)} = (\bar{l}_i \gamma_\mu l_j)(\bar{q}_k \gamma^\mu q_l)$$
$$O_{lq}^{(3)} = (\bar{l}_i \gamma_\mu \tau^I l_j)(\bar{q}_k \gamma^\mu \tau^I q_l)$$
$$O_{qe} = (\bar{q}_i \gamma_\mu q_j)(\bar{e}_k \gamma^\mu e_l)$$

$$C_{ql}^{(1)} \to C_9^\mu = -C_{10}^\mu$$
$$C_{ql}^{(3)} \to C_9^\mu = -C_{10}^\mu$$
$$C_{qe} \to C_9^\mu = C_{10}^\mu$$

## Simplified Model Classification:

| Spin | Rep. | Name | $C_{lq}^{(1)}$ | $C_{lq}^{(3)}$ | $C_{qe}$ |
|---|---|---|---|---|---|
| 1 | $(1,1)_0$ | $Z'$ | × | | × |
| 1 | $(1,3)_0$ | $V'$ | | × | |
| 0 | $(\bar{3},1)_{\frac{1}{3}}$ | $S_1$ | × | × | |
| 0 | $(\bar{3},3)_{\frac{1}{3}}$ | $S_3$ | × | × | |
| 1 | $(3,1)_{\frac{2}{3}}$ | $U_1$ | × | × | |
| 1 | $(\bar{3},3)_{\frac{2}{3}}$ | $U_3$ | × | × | |

Many papers ….

# RD: EFT and Simplified Model

$$\mathcal{H}_{\rm eff} = \frac{4G_F}{\sqrt{2}} V_{cb} \left( O_{V_L} + \sum_i C_i O_i + \text{h.c.} \right)$$

$$O_{V_L} = (\bar{c}_L \gamma^\mu b_L)(\bar{\ell}_L \gamma_\mu \nu_{\tau L}) \qquad O_{S_R} = (\bar{c}_L b_R)(\bar{\ell}_R \nu_{\tau L})$$

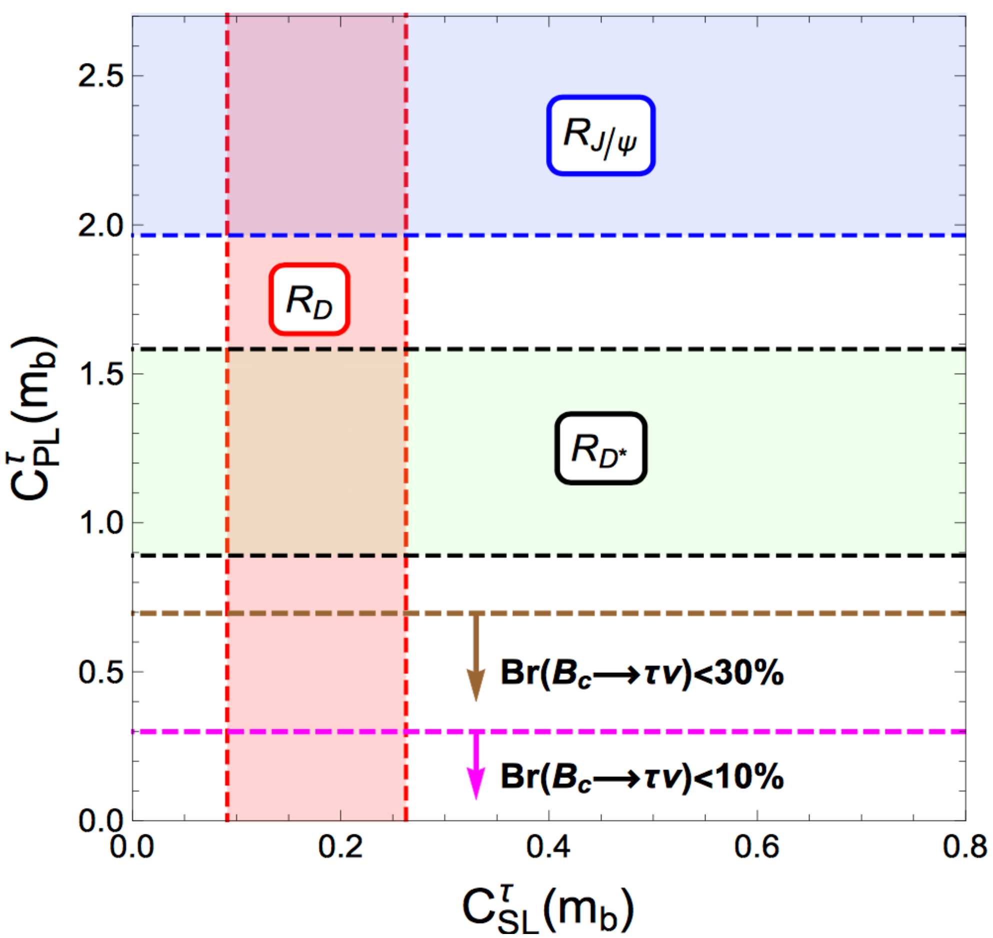
$$O_{V_R} = (\bar{c}_R \gamma^\mu b_R)(\bar{\ell}_L \gamma_\mu \nu_{\tau L}) \qquad O_{S_L} = (\bar{c}_R b_L)(\bar{\ell}_R \nu_{\tau L})$$

$$O_T = (\bar{c}_R \sigma^{\mu\nu} b_L)(\bar{\ell}_R \sigma_{\mu\nu} \nu_{\tau L})$$

## Simplified Model Classification:

| Spin | Rep. | Name | $C_{V_L}$ | $C_{S_R}$ | $C_{S_L}$ | $C_T$ |
|---|---|---|---|---|---|---|
| 0 | $(1,2)_{\frac{1}{2}}$ | $H^\pm$ | | × | × | |
| 1 | $(1,3)_0$ | $W'$ | × | | | |
| 0 | $(\bar{3},1)_{\frac{1}{3}}$ | $S_1$ | × | | × | × |
| 0 | $(\bar{3},3)_{\frac{1}{3}}$ | $S_3$ | × | | | |
| 0 | $(\bar{3},2)_{\frac{7}{6}}$ | $R_2$ | | | × | × |
| 1 | $(\bar{3},1)_{\frac{2}{3}}$ | $U_1$ | × | × | | |
| 1 | $(\bar{3},3)_{\frac{2}{3}}$ | $U_3$ | × | | | |
| 1 | $(\bar{3},2)_{\frac{5}{6}}$ | $V_2$ | | × | | |

1805.03209




$\mathcal{O}^\tau_{\rm SL}$ contributes to $R_D$ only, the operator $\mathcal{O}^\tau_{\rm PL}$ contributes only to $R_{D^*}$

the operator $\mathcal{O}^\tau_{\rm PL}$ directly contributes to the decay $B_c \to \tau\nu$

# Explain Both RK and RD

**$b \to s\mu^+\mu^-$**

- $[C_{lq}^{(1)}]^{2223} \to C_9 = -C_{10}$
- $[C_{lq}^{(3)}]^{2223} \to C_9 = -C_{10}$
- $[C_{qe}]^{2322} \to C_9 = C_{10}$

**$b \to c\tau\nu$**

- $[C_{lq}^{(3)}]^{33i3} \to C_{V_L}$
- $[C_{ledq}]^{333i*} \to C_{S_R}$
- $[C_{lequ}^{(1)}]^{333i} \to C_{S_L}$
- $[C_{lequ}^{(3)}]^{333i} \to C_T$

$b \to s\nu\nu$

$C_L^{\nu\nu} \propto [C_{lq}^{(1)}]_{3323} - [C_{lq}^{(3)}]_{3323}$

## Simplified Model Classification:

| Spin | Rep. | Name | $C_{qe}$ | $C_{lq}^{(1)}$ | $C_{lq}^{(3)}$ | $C_{ledq}$ | $C_{lequ}^{(1)}$ | $C_{lequ}^{(3)}$ | |
|---|---|---|---|---|---|---|---|---|---|
| 0 | $(1,2)_{\frac{1}{2}}$ | $H'$ | | | | × | × | | |
| 1 | $(1,1)_0$ | $Z'$ | × | × | | | | | |
| 1 | $(1,3)_0$ | $V'$ | | | × | | | | |
| 0 | $(\bar{3},1)_{\frac{1}{3}}$ | $S_1$ | | × | × | | × | × | |
| ~~0~~ | ~~$(\bar{3},3)_{\frac{1}{3}}$~~ | ~~$S_3$~~ | | ~~×~~ | ~~×~~ | | | | $b \to s\nu\nu$ |
| ~~0~~ | ~~$(\bar{3},2)_{\frac{7}{6}}$~~ | ~~$R_2$~~ | ~~×~~ | | | | ~~×~~ | ~~×~~ | $C_9^\mu = C_{10}^\mu$ |
| 1 | $(\bar{3},1)_{\frac{2}{3}}$ | $U_1$ | | × | × | × | | | |
| ~~1~~ | ~~$(\bar{3},3)_{\frac{2}{3}}$~~ | ~~$U_3$~~ | | ~~×~~ | ~~×~~ | | | | $b \to s\nu\nu$ |
| ~~1~~ | ~~$(\bar{3},2)_{\frac{5}{6}}$~~ | ~~$V_2$~~ | ~~×~~ | | | ~~×~~ | | | $C_9^\mu = C_{10}^\mu$ |

# Simplified Model

## Three options to explain both Anomalies

*Partial lists of references ….*
*(There are also other options)*

### Leptoquark (UV: Pati-Salam)

| Spin | Rep. | Name |
|---|---|---|
| 0 | $(3,1)_{\frac{1}{3}}$ | $S_1$ |
| 1 | $(\bar{3},1)_{\frac{2}{3}}$ | $U_1$ |

*Bauer, Neubert,* PRL 116 (2016) 141802

*Barbieri, Isidori, Pattori, Senia,* EPJC 76 (2016) 67

### G221 model

*Hsieh, Schmitz, J.-H.Yu, Yuan,* PRD 82 (2010) 035011

| Spin | Rep. | Name |
|---|---|---|
| 1 | $(1,3)_0$ | $V'$ |

Hao-Lin Li, J.-H. Yu, *Work in progress*

*Boucenna, Celis, Fuentes-Martin, Vicente, Virto,* PLB 760 (2016) 214

### Z’ + H’

*Kaori Fuyuto, Hao-Lin Li, J.-H. Yu,* PRD 97 (2018) 115003

| Spin | Rep. | Name |
|---|---|---|
| 0 | $(1,2)_{\frac{1}{2}}$ | $H'$ |
| 1 | $(1,1)_0$ | $Z'$ |

# Hidden Gauged U(1) Model

## Motivated from neutrino mass and dark matter

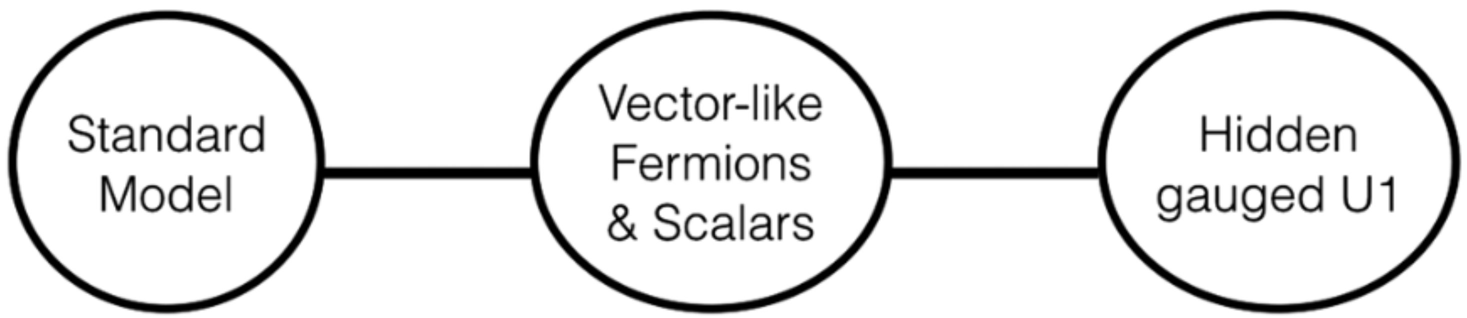
PHYSICAL REVIEW D **93**, 113007 (2016)

**Hidden gauged $U(1)$ model: Unifying scotogenic neutrino and flavor dark matter**

Jiang-Hao Yu*

## Explain RK and RD anomaly

Kaori Fuyuto, Hao-Lin Li, J.-H. Yu, PRD 97 (2018) 115003



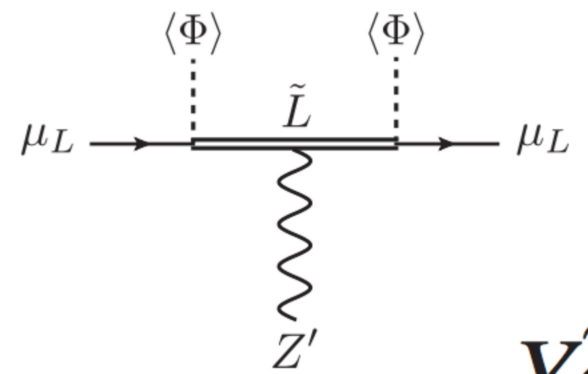

| | $SU(3)_C$ | $SU(2)_L$ | $U(1)_Y$ | $U(1)_H$ |
|---|---|---|---|---|
| $Q_{L,R} = (\tilde{U}_{L,R}\tilde{D}_{L,R})^T$ | **3** | **2** | $+\frac{1}{6}$ | $+1$ |
| $L_{L,R} = (\tilde{N}_{L,R}, \tilde{L}_{L,R})^T$ | **1** | **2** | $-\frac{1}{2}$ | $+1$ |
| $\Phi$ | **1** | **1** | 0 | $+1$ |
| $H'$ (optional) | **1** | **2** | $\frac{1}{2}$ | $+1$ |
| $\chi$ (optional) | **1** | **1** | 0 | $-1$ |

# Flavor Sector

## Lepton sector: new lepton only couples to 2nd generation

No lepton flavor violation

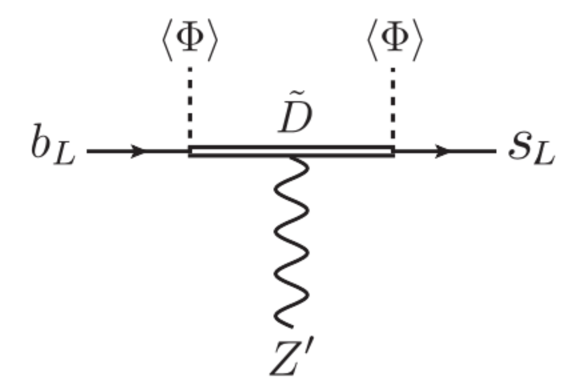
Violate lepton flavor universality




$Y_\mu^2$

## Quark sector: new quark couples to SM quark via MFV

Yukawa mixing similar to SM Yukawa



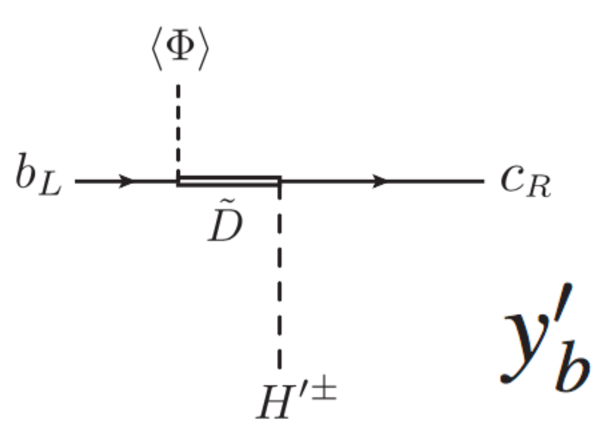

$Y_s Y_b$

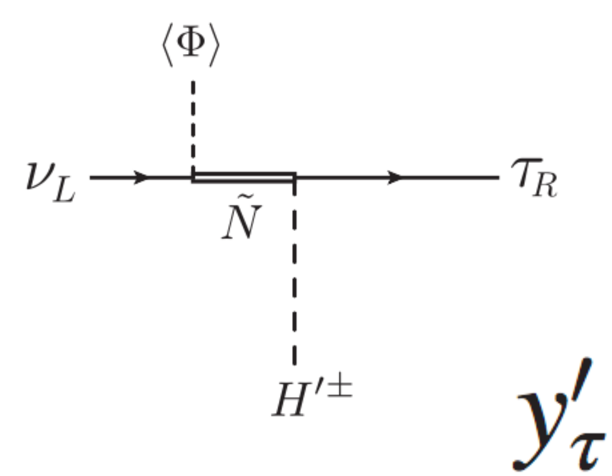
# Inert Doublet Yukawa

## Inert doublet

$$-\mathcal{L}'_{\text{Yukawa}} = \mathrm{y}'_{Q_L u_i} \overline{Q_L} \tilde{H}' u_R + \mathrm{y}'_{Q_L d_i} \overline{Q_L} H' d_R$$
$$+ \mathrm{y}'_{L_L e_i} \overline{L_L} H' e_R + \text{H.c.},$$

## Only couples to 3rd generation:

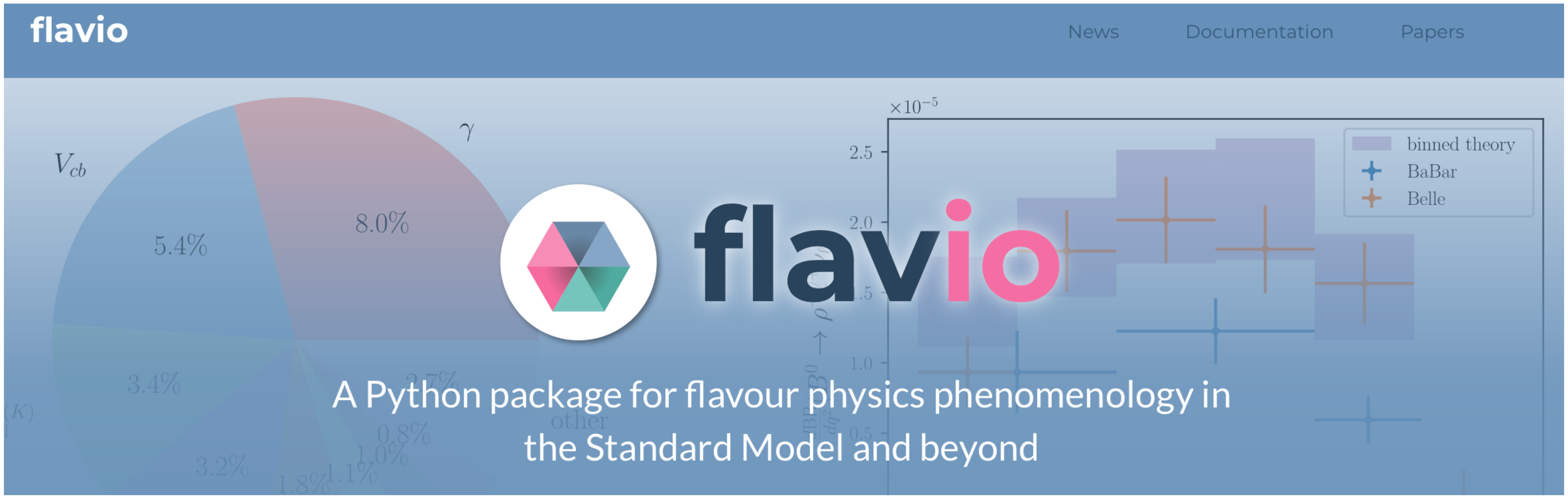


# Global Fit on RK

| Observable | $[q^2_{min}, q^2_{max}]$ [GeV$^2$] | Experiments |
|---|---|---|
| *Branching ratios* | | |
| $\frac{d}{dq^2}\mathrm{BR}(B \to X_s\mu\mu)$ | [1, 6], [14.2, 25] | *BABAR* [74] |
| $\frac{d}{dq^2}\mathrm{BR}(B^+ \to K^{*+}\mu\mu)$ | [0.0, 2.0], [2.0, 4.3] | CDF [75] |
| | [2, 4], [4, 6], [15,19] | LHCb [76] |
| $\frac{d}{dq^2}\mathrm{BR}(B^\pm \to K^\pm\mu\mu)$ | [0.0, 2.0], [2.0, 4.3] | CDF [75] |
| | [1.1, 2], [2, 3], [3, 4], [4, 5], [15, 22] | LHCb [76] |
| $\frac{d}{dq^2}\mathrm{BR}(B^0 \to K^{*0}\mu\mu)$ | [0.0, 2.0], [2.0, 4.3] | CDF [75] |
| | [1.1, 2.5], [2.5, 4], [4, 6], [15, 19] | LHCb [77] |
| | [1, 2], [2, 4.3] | CMS [78,79] |
| $\frac{d}{dq^2}\mathrm{BR}(B^0 \to K^0\mu\mu)$ | [0.0, 2.0], [2.0, 4.3] | CDF [75] |
| | [2.5, 4], [4, 6], [15, 22] | LHCb [76] |
| $\frac{d}{dq^2}\mathrm{BR}(B_s \to \phi\mu\mu)$ | [1, 6] | CDF [75] |
| | [1, 6], [15, 19] | LHCb [80] |
| $R_{K^*}$ | [0.045, 1.1], [1.1, 6.0] | LHCb [1] |
| $R_K$ | [1.0, 6.0] | LHCb [12] |
| $\mathrm{BR}(B_s \to \mu\mu)$, $\mathrm{BR}(B^0 \to \mu\mu)$ | ... | LHCb [81] |
| *Angular observables* | | |
| $\langle A_{FB}\rangle(B^0 \to K^{*0}\mu\mu)$ | [0.0, 2.0], [2.0, 4.3] | CDF [75] |
| | [1.1, 2.5], [2.5, 4], [4, 6], [15, 19] | LHCb [82] |
| | [1, 2], [2, 4.3], [4.3, 6] | CMS [78,79,83] |
| $\langle F_L\rangle(B^0 \to K^{*0}\mu\mu)$ | [0.0, 2.0], [2.0, 4.3] | CDF [75] |
| | [1.1, 2.5], [2.5, 4], [4, 6], [15, 19] | LHCb [82] |
| | [1, 2], [2, 4.3], [4.3, 6] | CMS [78,79,83] |
| | [0.04, 2.0], [2.0, 4.0], [4.0, 6.0] | ATLAS [84] |
| $\langle S_3\rangle(B^0 \to K^{*0}\mu\mu)$ | [1.1, 2.5], [2.5, 4], [4, 6], [15, 19] | LHCb [82] |
| | [1, 2], [2, 4.3], [4.3, 6] | CMS [78,79,83] |
| $\langle S_4\rangle(B^0 \to K^{*0}\mu\mu)$ | [1.1, 2.5], [2.5, 4], [4, 6], [15, 19] | LHCb [82] |
| | [1, 2], [2, 4.3], [4.3, 6] | CMS [78,79,83] |
| $\langle S_5\rangle(B^0 \to K^{*0}\mu\mu)$ | [1.1, 2.5], [2.5, 4], [4, 6], [15, 19] | LHCb [82] |
| | [1, 2], [2, 4.3], [4.3, 6] | CMS [78,79,83] |
| $\langle P_1\rangle(B^0 \to K^{*0}\mu\mu)$ | [0.04, 2.0], [2.0, 4.0], [4.0, 6.0] | ATLAS [84] |
| | [1.1, 2.5], [2.5, 4], [4, 6], [15, 19] | LHCb [82] |
| | [1, 2], [2, 4.3], [4.3, 6] | CMS [78,79,83] |
| $\langle P'_4\rangle(B^0 \to K^{*0}\mu\mu)$ | [0.04, 2.0], [2.0, 4.0], [4.0, 6.0] | ATLAS [84] |
| | [1.1, 2.5], [2.5, 4], [4, 6], [15, 19] | LHCb [82] |
| $\langle P'_5\rangle(B^0 \to K^{*0}\mu\mu)$ | [0.04, 2.0], [2.0, 4.0], [4.0, 6.0] | ATLAS [84] |
| | [1.1, 2.5], [2.5, 4], [4, 6], [15, 19] | LHCb [82] |
| | [1, 2], [2, 4.3], [4.3, 6] | CMS [78,79,83] |
| $\langle \bar{F}_L\rangle(B^0 \to K^{*0}\mu\mu)$ | [2, 5], [15, 19] | LHCb [82] |
| $\langle \bar{S}_3\rangle(B^0 \to K^{*0}\mu\mu)$ | [2, 5], [15, 19] | LHCb [82] |
| $\langle \bar{S}_4\rangle(B^0 \to K^{*0}\mu\mu)$ | [2, 5], [15, 19] | LHCb [82] |

# Global Fit on RK




D. Straub, Flavio 1810.08132

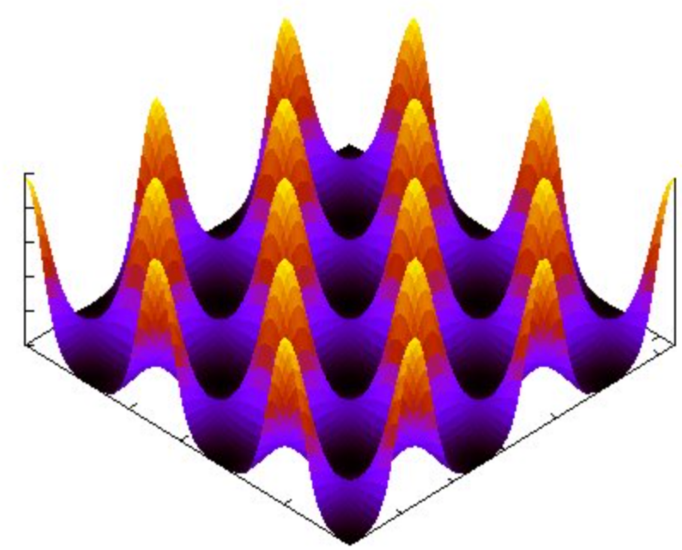
## Featured processes

- ✔ $B^0$, $B_s$, $K^0$, and $D^0$ mixing
- ✔ $B \to K^{(*)}\mu^+\mu^-$ and other exclusive rare $B$ decays
- ✔ Inclusive decays $B \to X_{s,d}\gamma$ and $B \to X_{s,d}l^+l^-$
- ✔ Lepton flavour violating $B$ decays
- ✔ $B \to D^{(*)}\tau\nu$ and other tree-level $B$ decays
- ✔ $K \to \ell\nu$, $K \to \pi\ell\nu$, and $K \to \pi\nu\bar{\nu}$ decays
- ✔ Lepton flavour violating $\tau$ and $\mu$ decays
- ✔ Neutron EDM

+

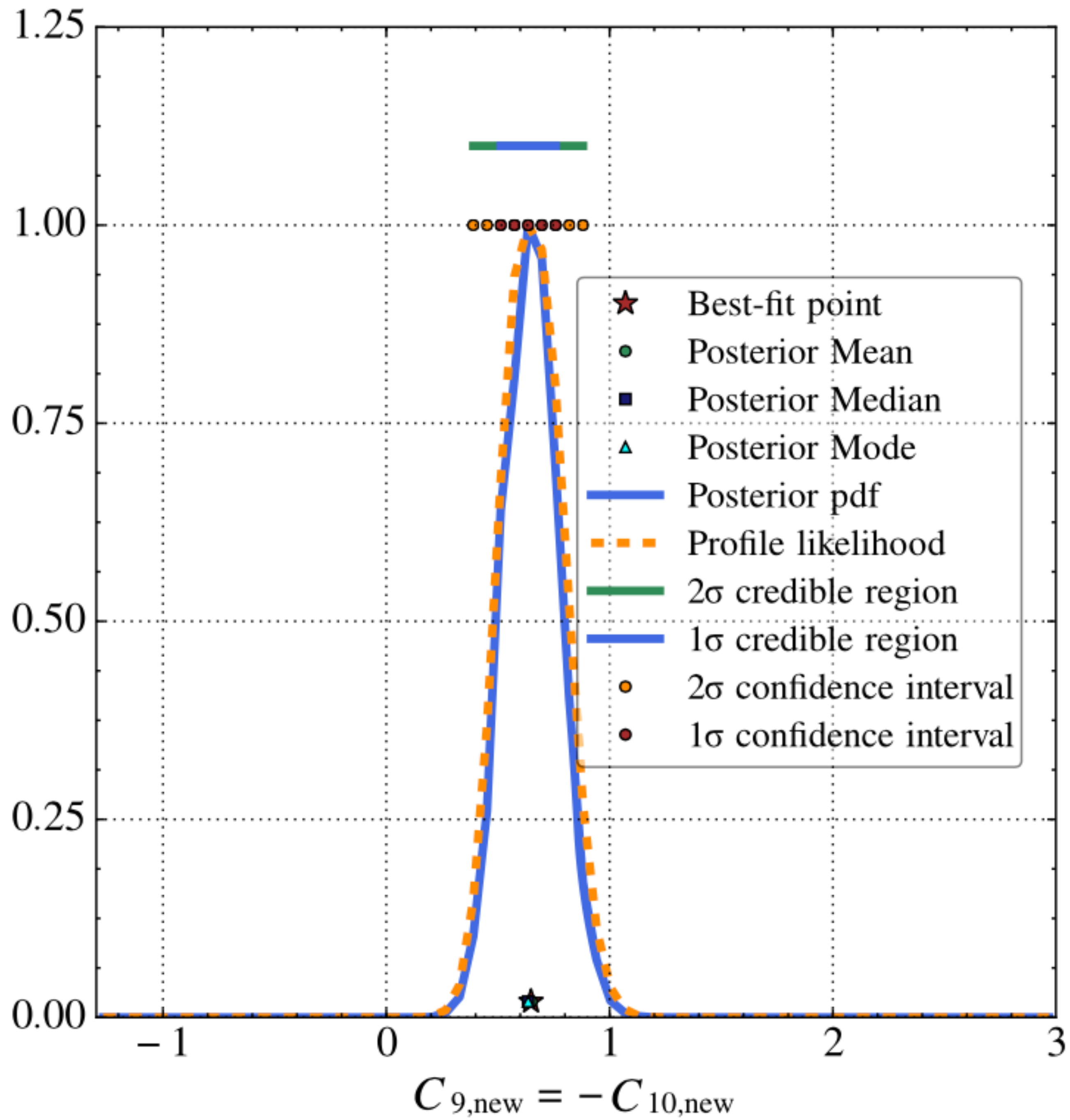
**MultiNest**

**Efficient and Robust Bayesian Inference**



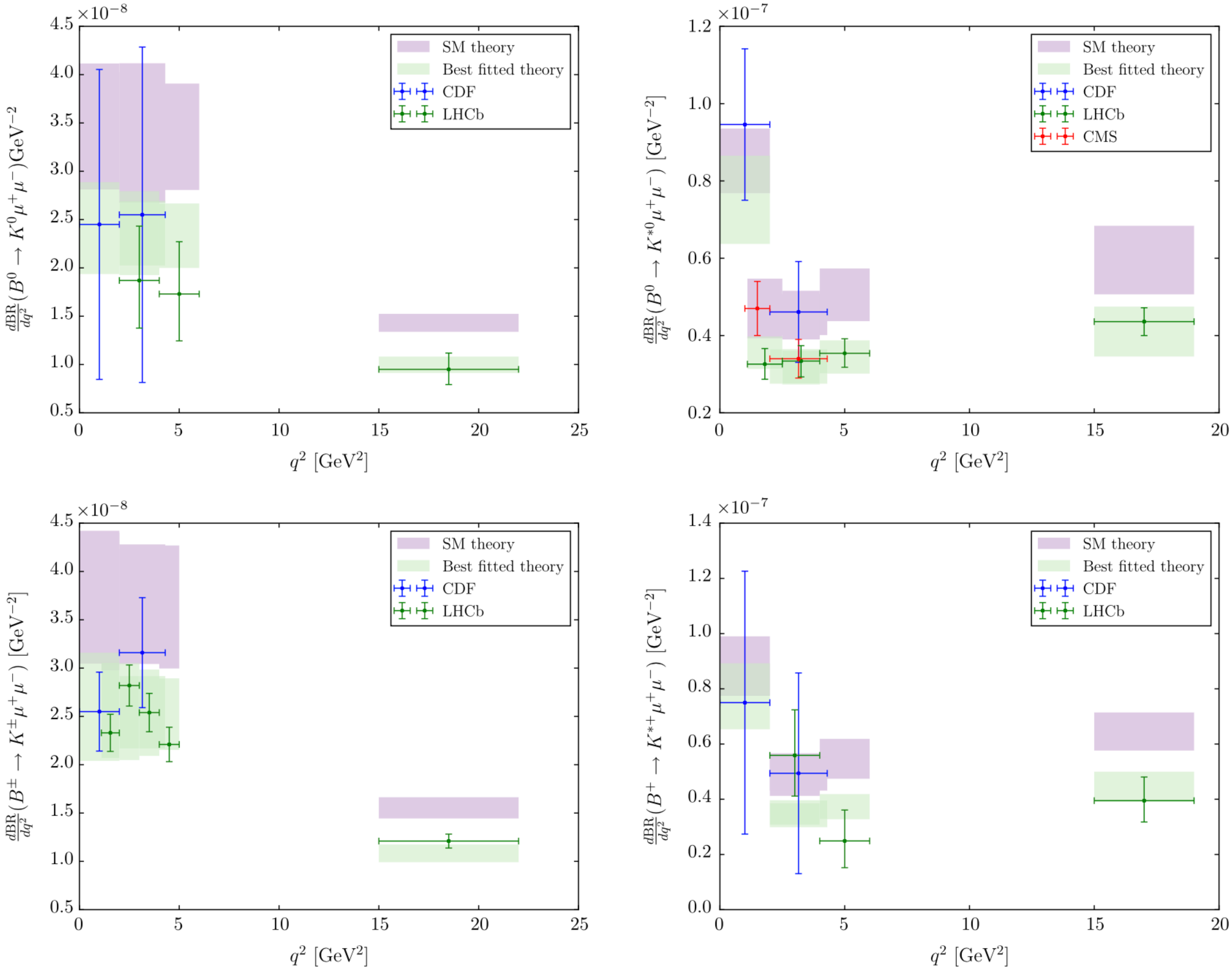
Markov Chain Monte Carlo

# Global Fit on RK

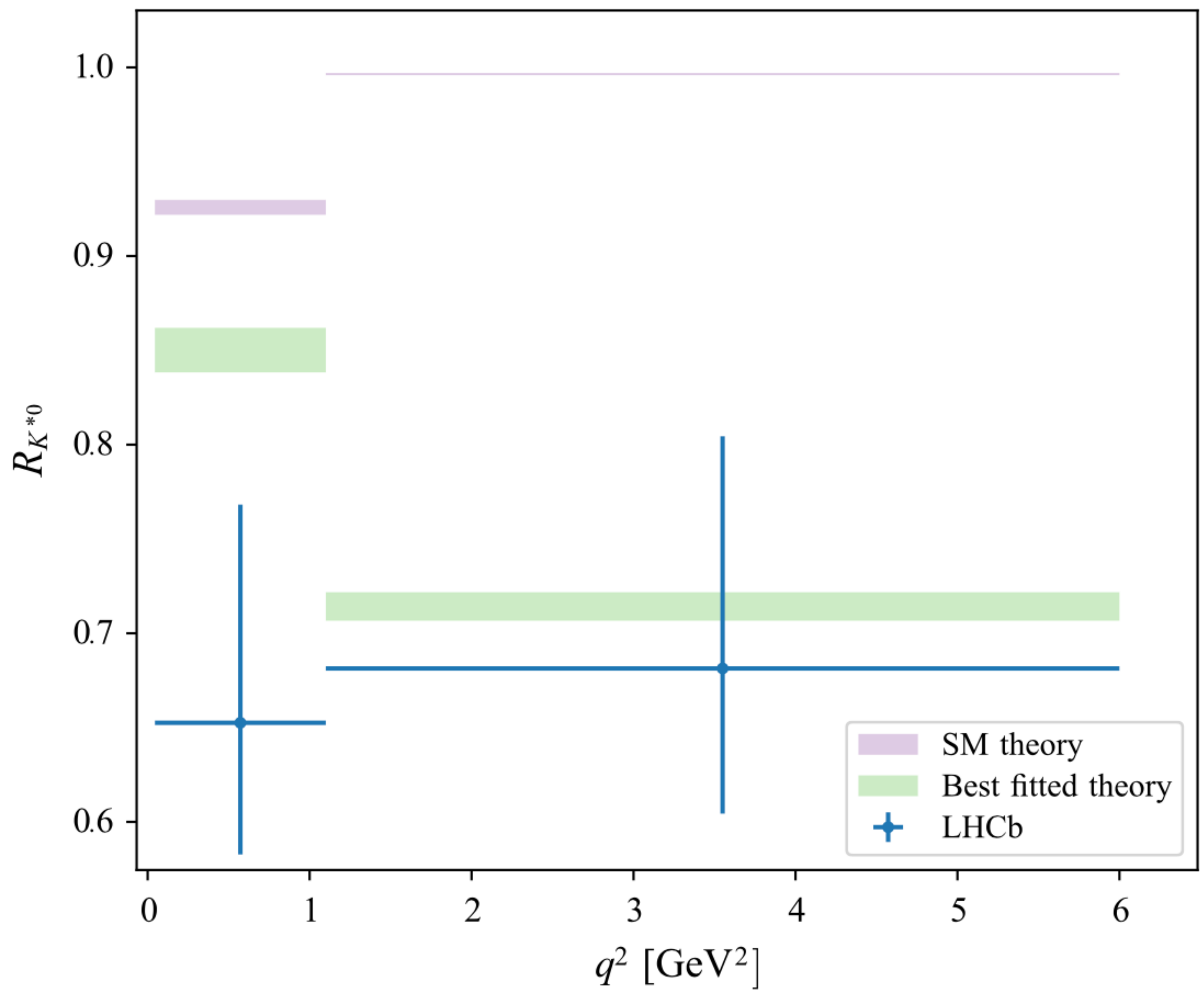



$$C_9 = -C_{10} = -\frac{1}{2m_{Z'}^2 C_{\rm SM}^{bs}} g_{sb}^L g_{\mu\mu}^L = -\frac{v_\Phi^2}{8C_{\rm SM}^{bs} m_Q^2 m_L^2} Y_s Y_b Y_\mu^2,$$

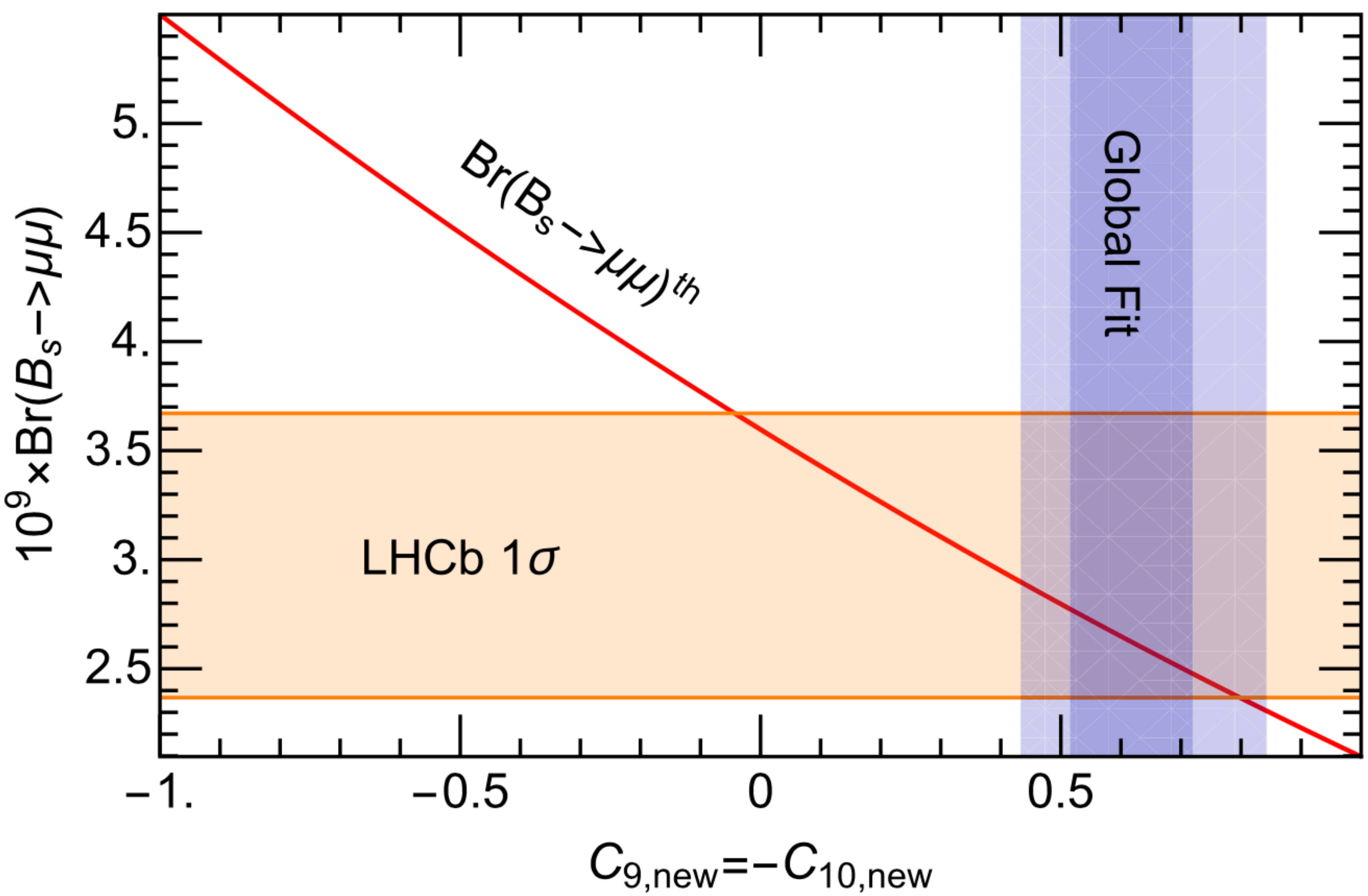
# Energy Distribution

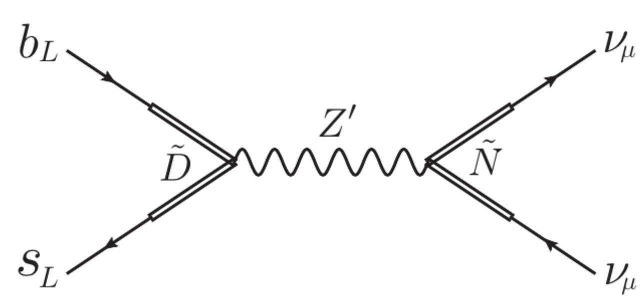


# Energy Distribution

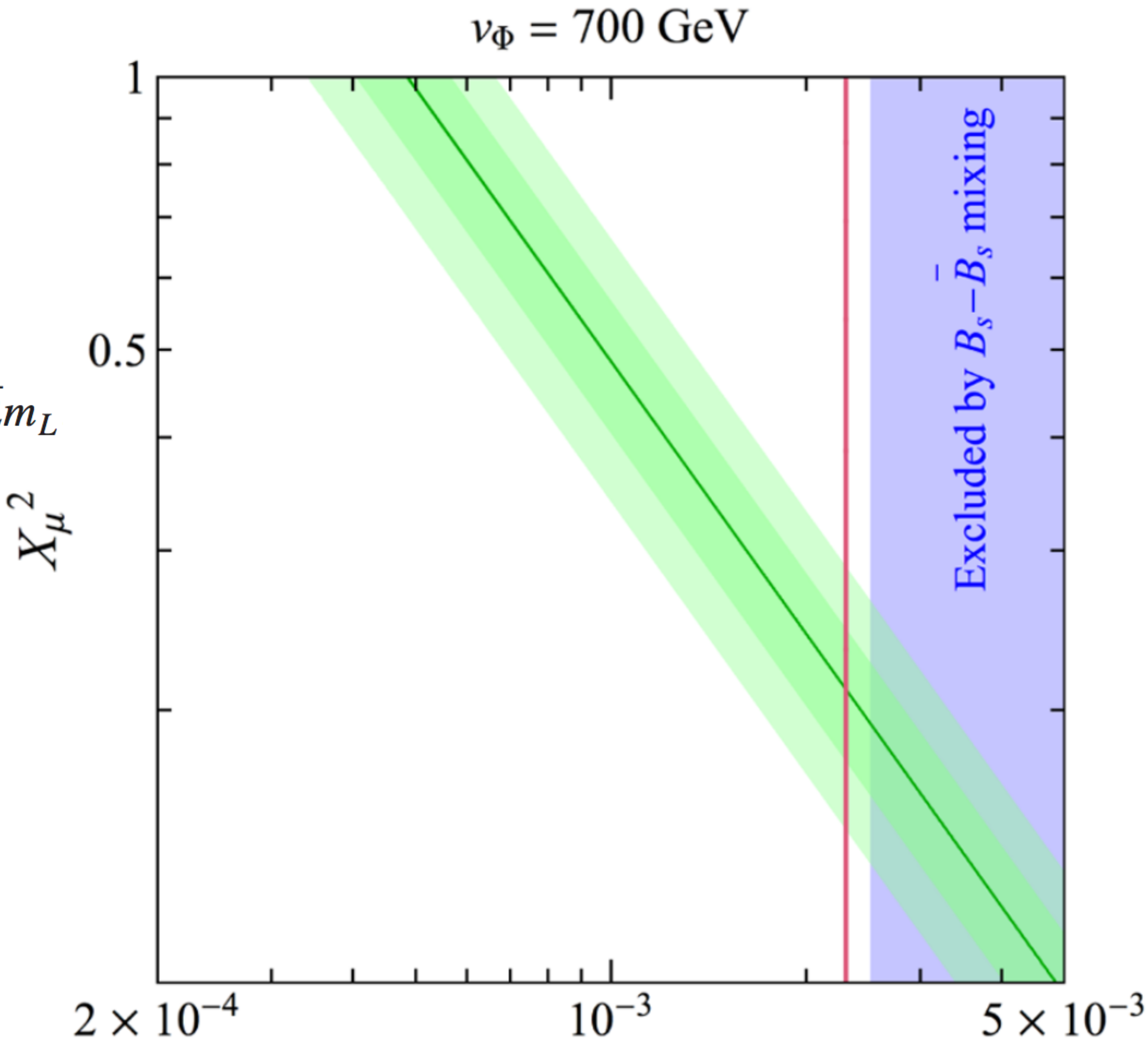


# Constraints



# Parameter Space and B-B Mixing

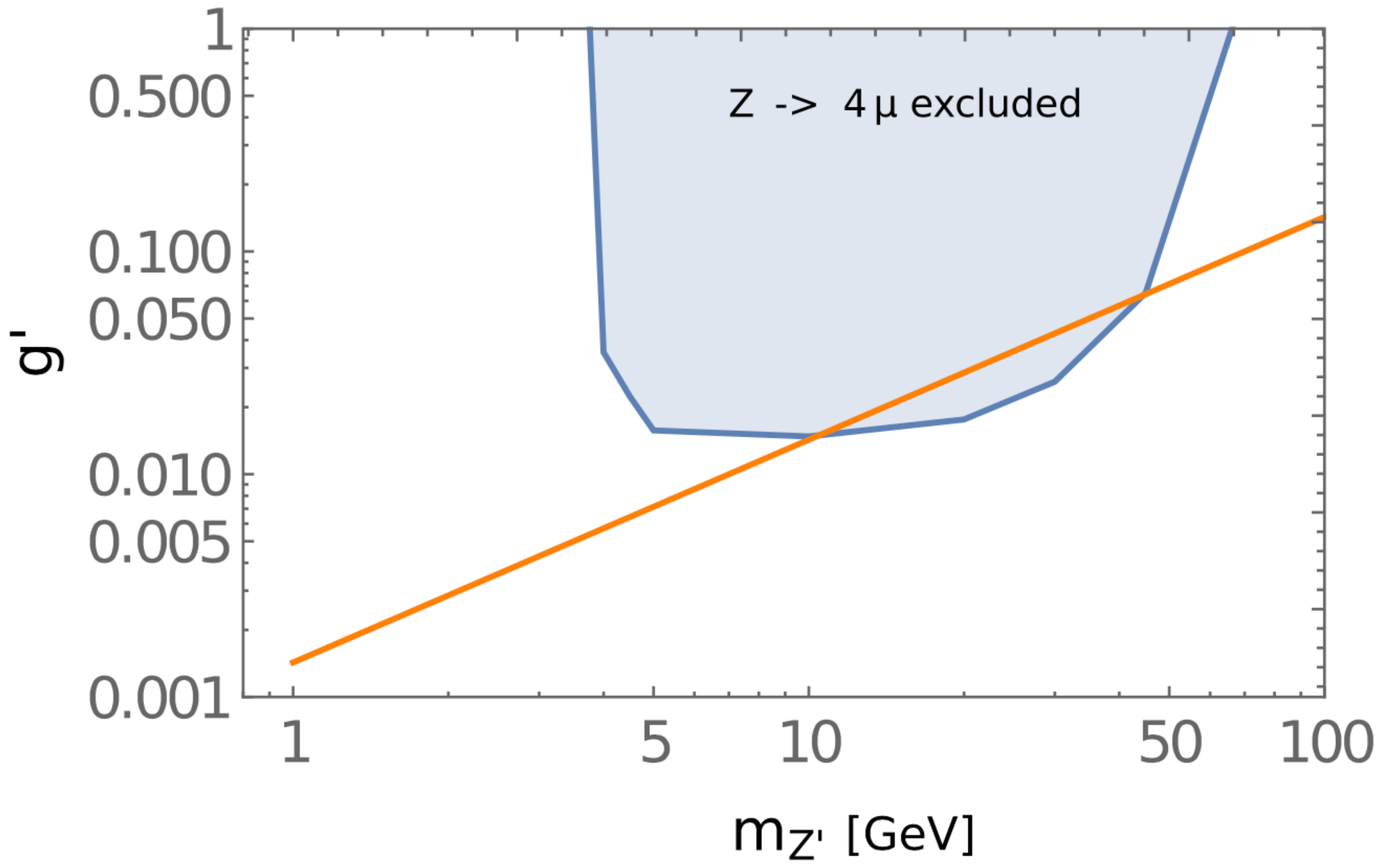



$X_\mu \equiv v_\Phi Y_\mu / \sqrt{2} m_L$

$X_q \equiv v_\Phi Y_q / \sqrt{2} m_Q$

# Constraints

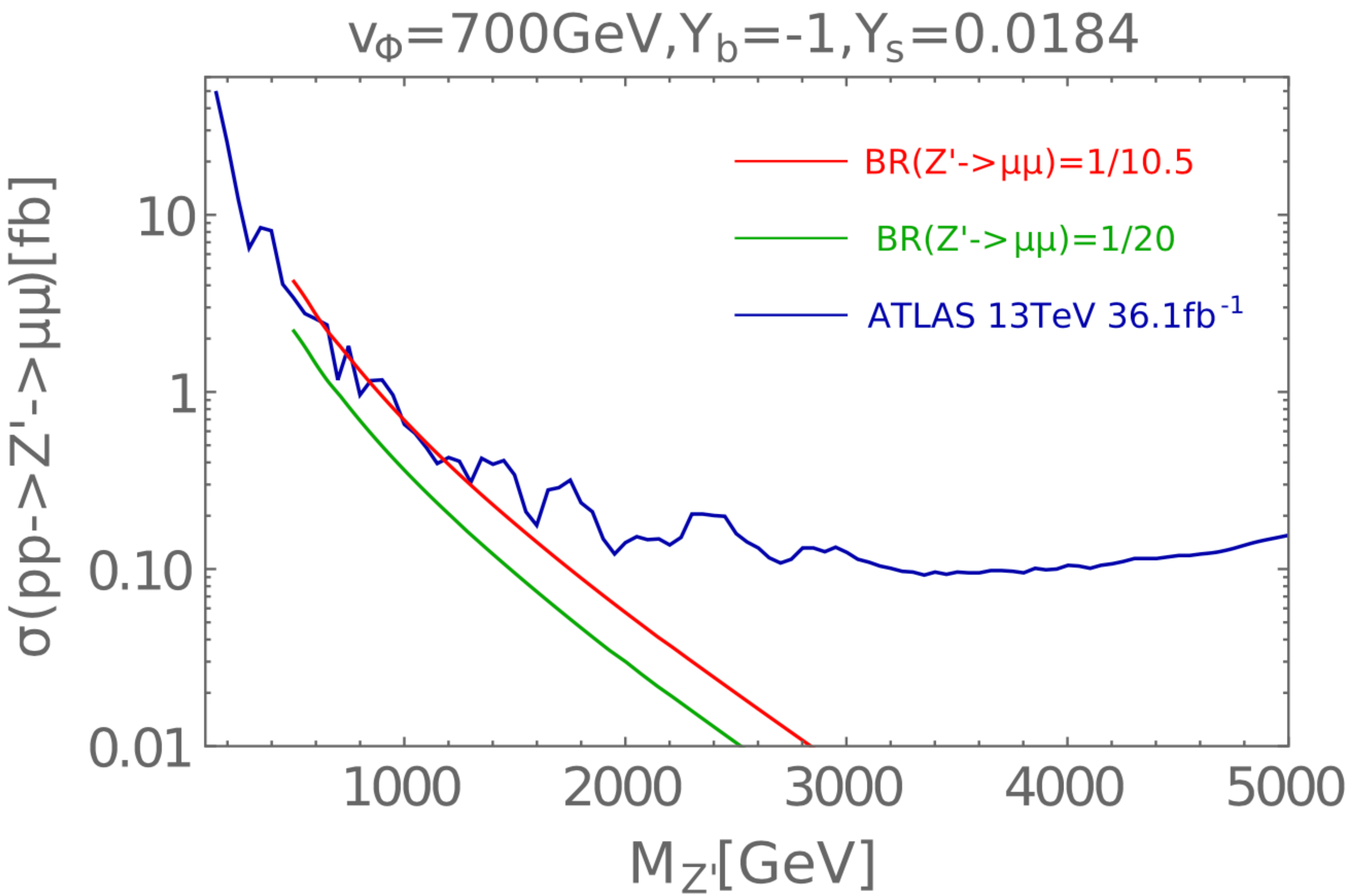
**Light hidden Z'**



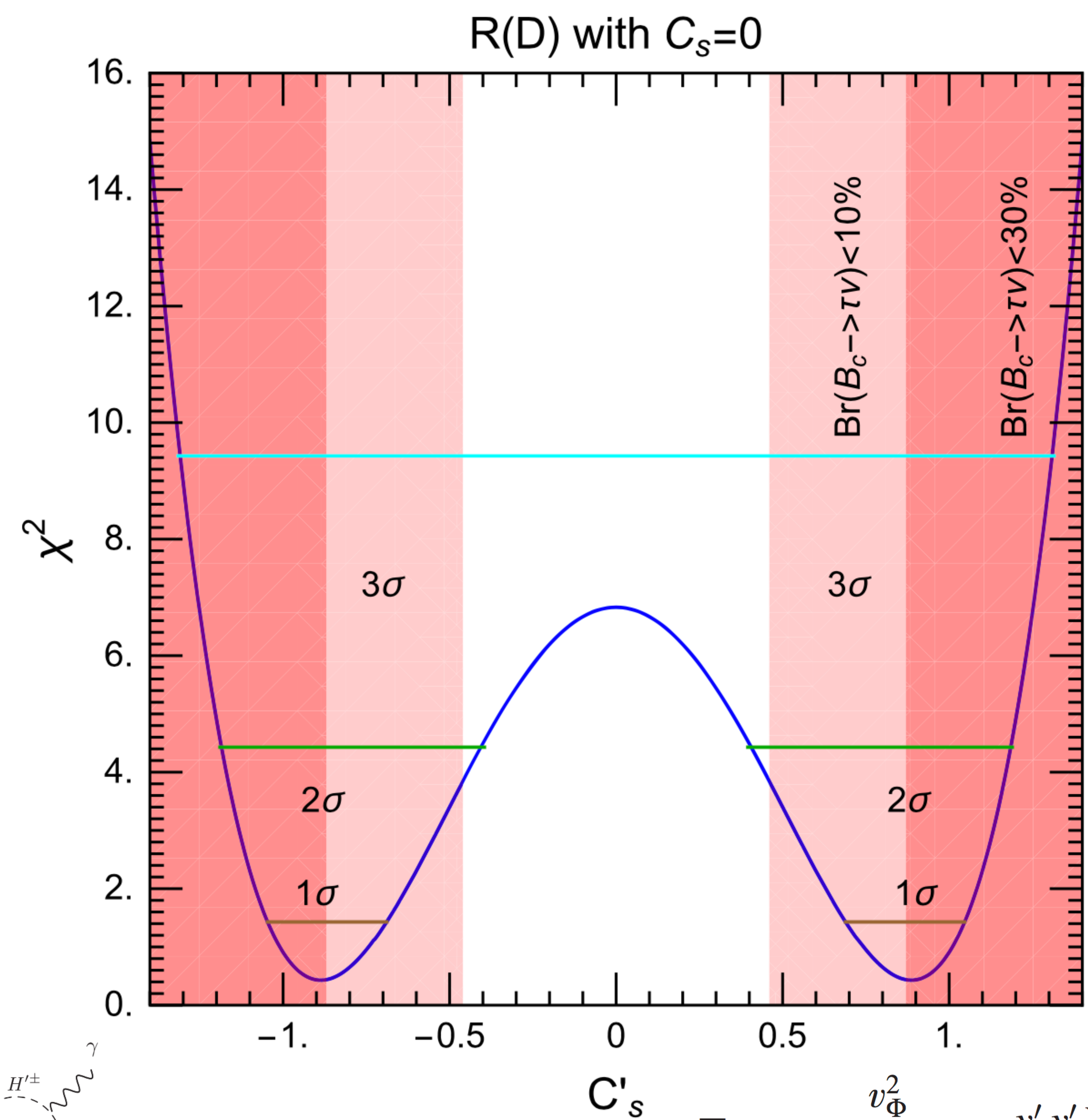

**Muon g-2?**

# Constraints

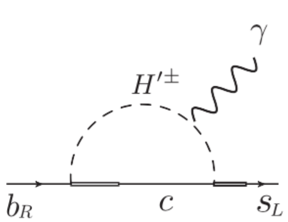
**Heavy hidden Z'**

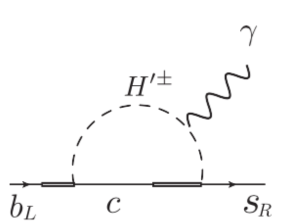


# Charged Higgs to Explain RD

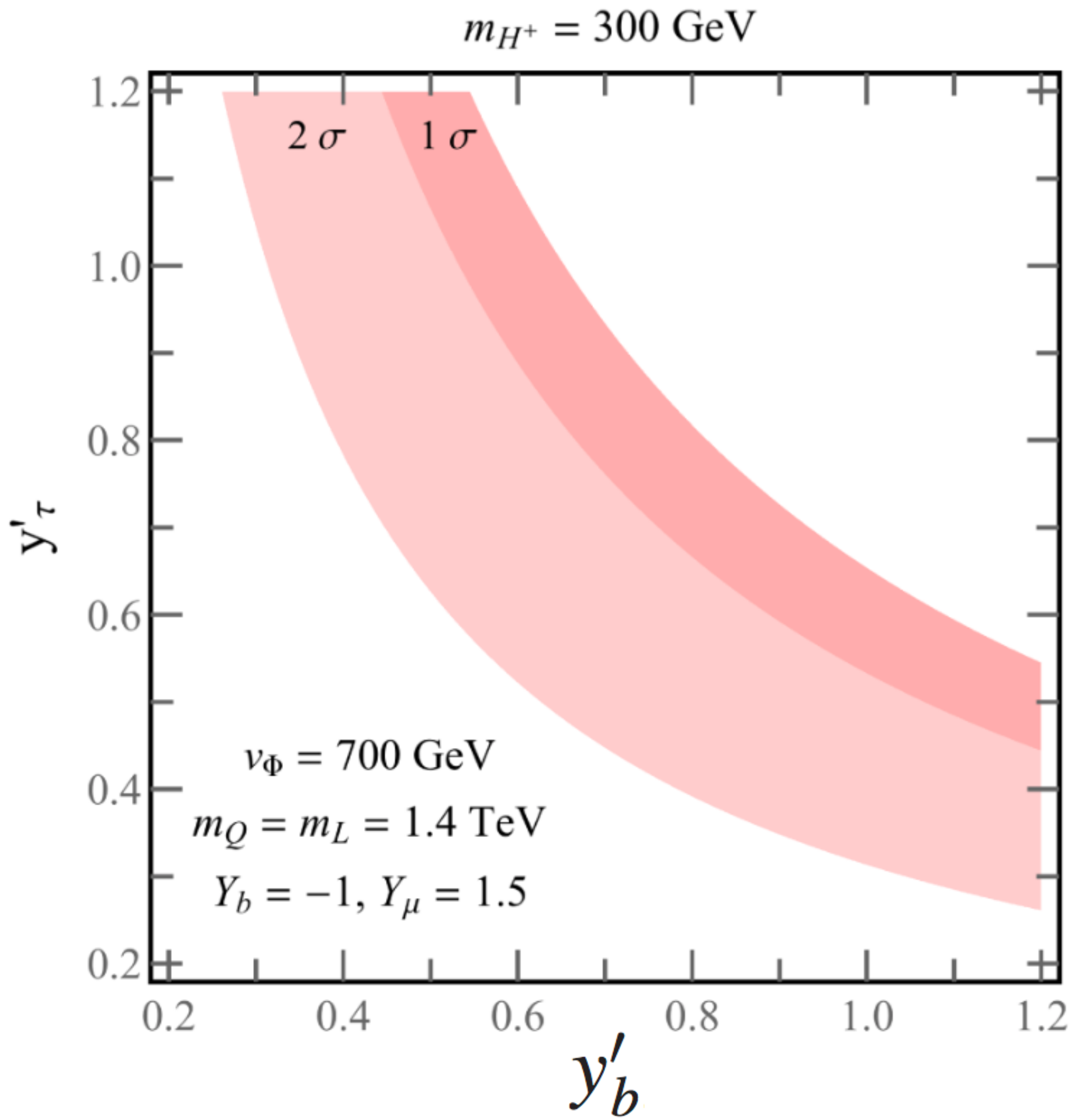



$$= -\frac{v_\Phi^2}{2C^{bc}_{\rm SM} m^2_{H'} m_Q m_L} y'_b y'_\tau Y_c Y_\mu$$



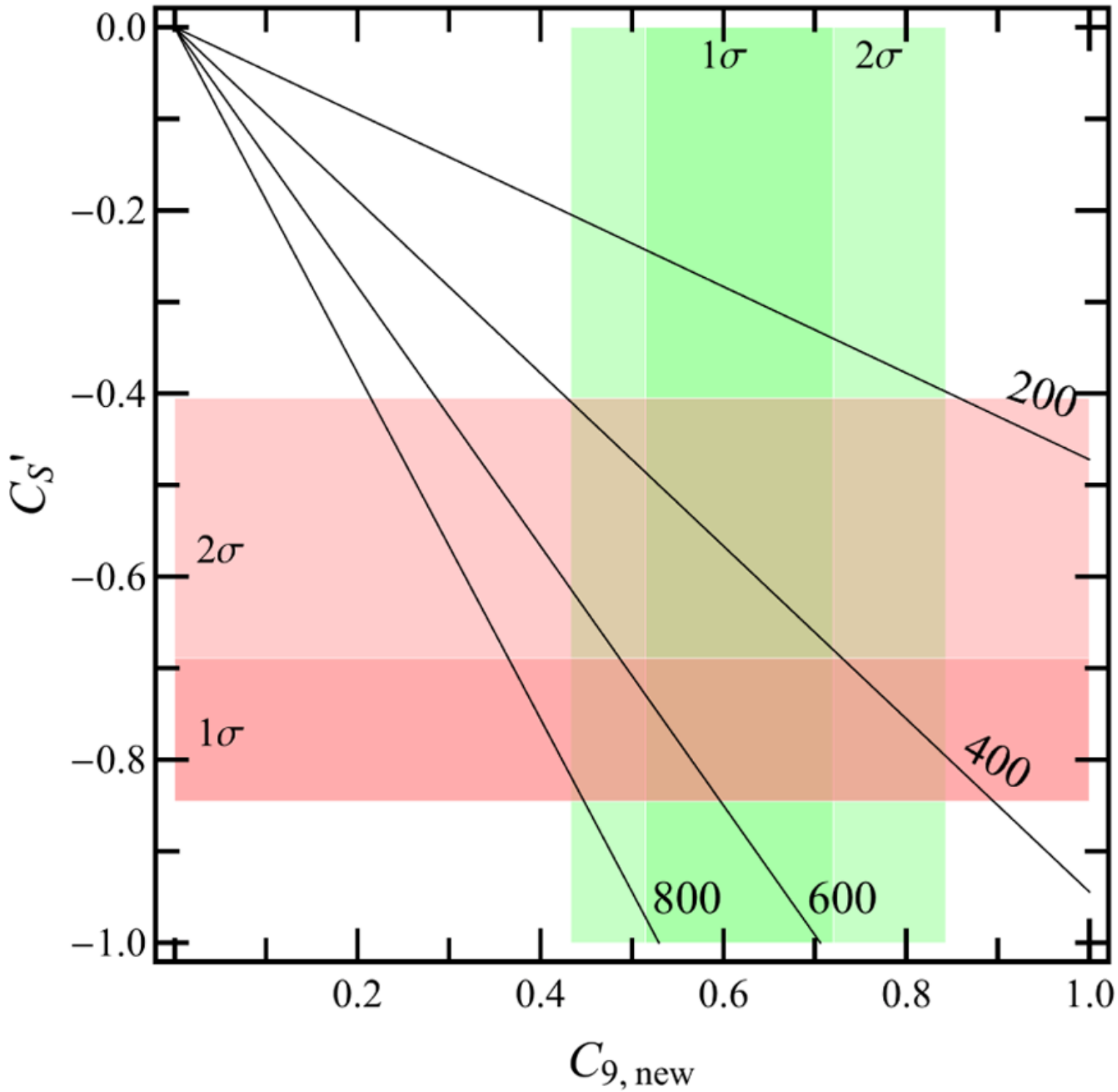



# Explain RD



$m_{H^+}$ = 300 GeV
2 σ
1 σ
1.2
1.0
0.8
0.6
0.4
0.2
$y'_\tau$
$v_\Phi$ = 700 GeV
$m_Q = m_L$ = 1.4 TeV
$Y_b = -1$, $Y_\mu = 1.5$
0.2
0.4
0.6
0.8
1.0
1.2
$y'_b$

# Combined Parameter Space



# Signatures

**WIMP Dark Matter Signature: indirect, direct, LHC searches**

$$\langle \sigma v \rangle_{\text{s-channel}}(\bar{\chi}\chi \to f\bar{f}) = \frac{g'^2 g^2_{Z'ff}}{2\pi} \frac{2m_\chi^2 + m_f^2}{4m_\chi^2 - m_{Z'}^2} \sqrt{1 - \frac{m_f^2}{m_\chi^2}},$$

$$\langle \sigma v \rangle_{\text{t-channel}}(\bar{\chi}\chi \to Z'Z') = \frac{g'^4}{4\pi} \frac{m_\chi^2}{(2m_\chi^2 - m_{Z'}^2)^2} \left(1 - \frac{m_{Z'}^2}{m_\chi^2}\right)^{3/2}$$

$$\Omega_{\text{DM}} h^2 = \frac{m_\chi n_\chi}{\rho_{\text{crit}}/h^2} = \frac{s_0 h^2}{\sqrt{\frac{\pi}{45}}\rho_{\text{crit}}} \frac{1}{M_{\text{pl}} \sqrt{g_{\text{eff}}} \mathcal{I}(x_f)}$$

$g' \sim 0.05$, the direct detection constraints

**Z-prime and charged Higgs searches at the LHC**

**For light Z-prime, muon g-2 signature?**

# Conclusion

- **B anomalies could be at TeV scale**
- **Classify all possible new particles**
- **Only few options to explain RK&RD**
- **Propose hidden gauged U(1) Model**

# Thanks very much!