A gauged horizontal SU(2) symmetry and R_K

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Based on work with M. Reboud and O. Sumensari

Several references on horizontal symmetries for B anomalies

E.g.

[*Crivellin, D'Ambrosio, Heeck, PRD2015*]

[*Alonso, Cox, Han, Yanagida, PRD2017*]

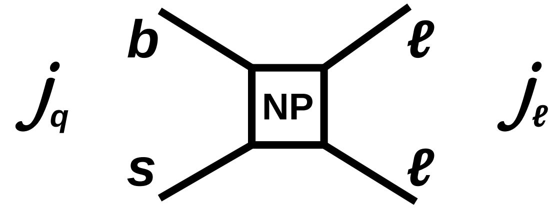
[*Cline, Martin Camalich, PRD2017*]

However, theory arguments quite distant from the one pursued here

$b \to s$ anomalies' basic challenge

- $R_K \approx 0.75$ ⇨

O(15-25%) effects in



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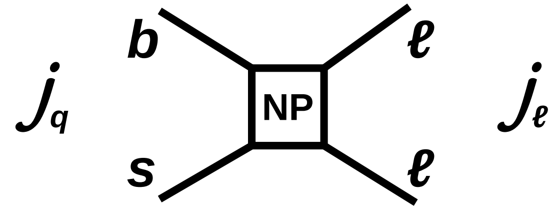
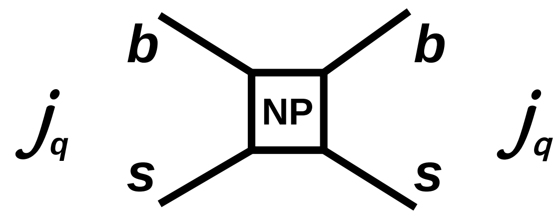


At the same time:

- $\Delta M_s \approx (\Delta M_s)_{SM}$ ⇨ *small corrections to*



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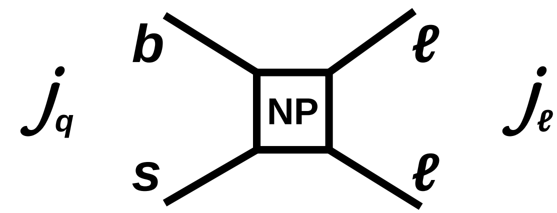

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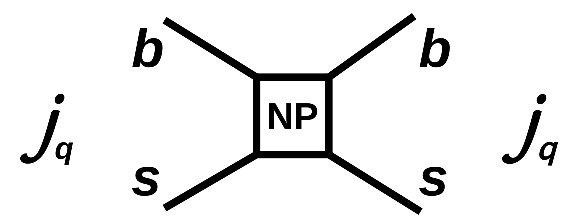
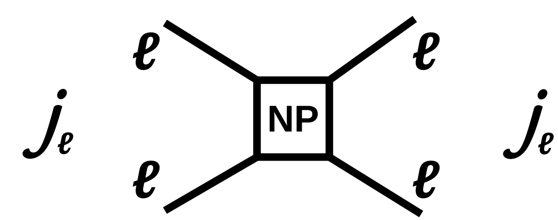


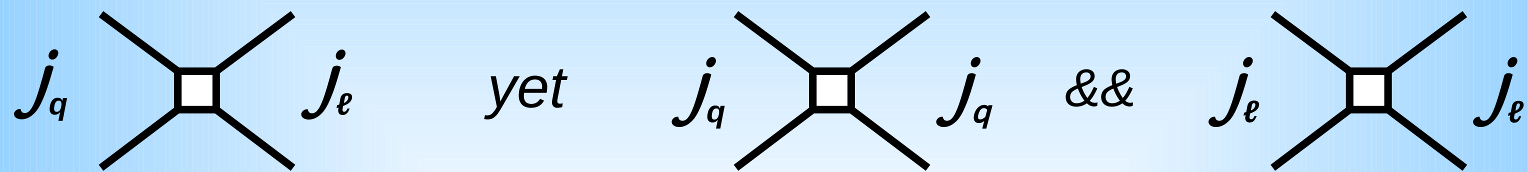
- $\ell \to \ell' + X$ $<$ *current limits* ⇨ *and small corrections to*



Z' - like NP

- *The challenge in short*

large enough *small enough*



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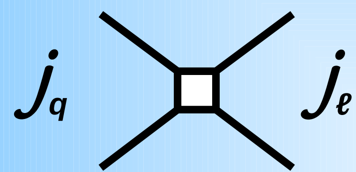

yet

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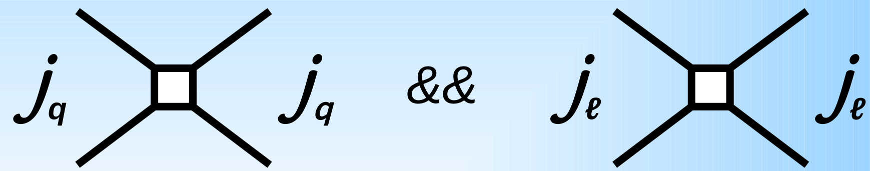
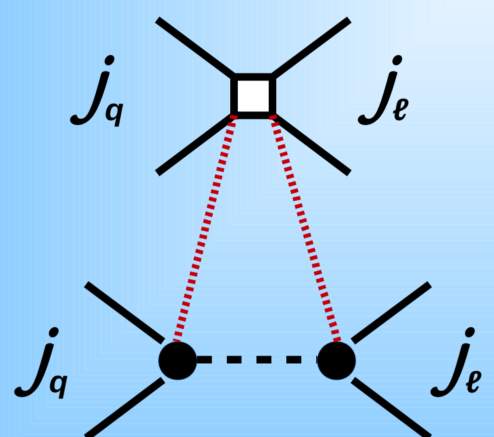


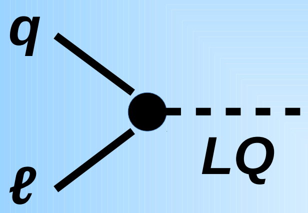
- *This is potentially a problem when*



i.e. when the semi-lep. 4-f structure arises from Z'-like NP

Leptoquark-like NP

Take



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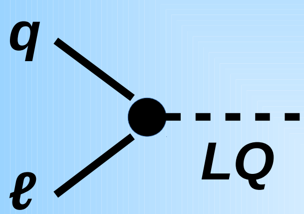
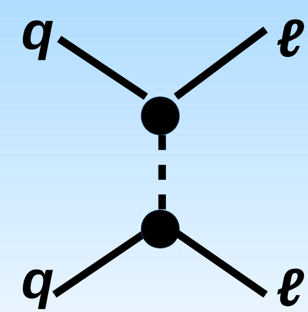


then j_q



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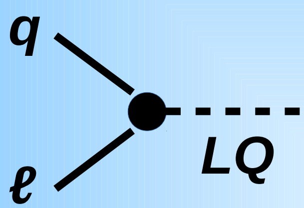

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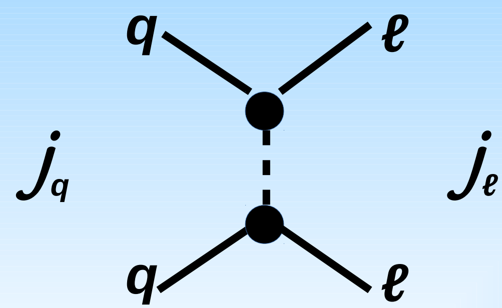

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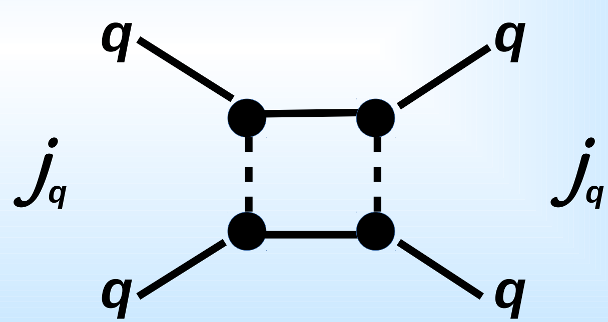

is loop-suppressed

(at least for "genuine" LQs [Dorsner et al., LQ review])

Can one accomplish

a mechanism for suppressing

flavour-changing $j_q \otimes j_q$ ***&&*** $j_\ell \otimes j_\ell$

within gauge extensions?

A gauged horizontal SU(2)

- *Place the two heavier generations of each fermion in a doublet* $\mathcal{F} \equiv \begin{pmatrix} f_2 \\ f_3 \end{pmatrix}$ *w/* $f = u_L, d_L, \ell_L, \nu_L,$ *or RH counterparts*

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- *Integrate out horizontal bosons*

$$\delta\mathcal{L}_{eff} = -\sum_{\mathfrak{F}, \mathfrak{F}', a} \frac{g_L^2}{2 M_{G_a}^2} \left(\bar{\mathfrak{F}}_L \, \gamma^\mu \tau^a \, \mathfrak{F}_L \right) \left(\bar{\mathfrak{F}}'_L \, \gamma^\mu \tau^a \, \mathfrak{F}'_L \right)$$

Basic argument

- *Doublets* $\mathfrak{F} \equiv \begin{pmatrix} f_2 \\ f_3 \end{pmatrix}$ *aren't yet in the mass basis.*

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- *How does* $\mathscr{L}_{\text{eff}}$ *change?*

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For the original argument (in unrelated context) see:
Cahn, Harari, NPB1980

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- *But processes like $K^0 - \bar{K}^0$ mixing and $\mu \to 3e$ very constraining*

  Is "small" small enough?

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- *Still exploring whether, with different* $U_{UL,DL}$ *assumptions, scenario 0 fulfils all main constraints:*

CKM	small $K^0 - \overline{K}^0$	small $D^0 - \overline{D}^0$	R_K as measured

Besides, several ways to generalize the idea

that will fulfil all constraints.

Examples:

(i) non-degenerate G_a *masses*

(ii) non-zero (but small) 1st – (2nd & 3rd) gen. mixing terms

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  - R_K *& Co.*
  - ΔM_s *ok, if somewhat < SM*
  - $B \to K \nu\bar{\nu}$ *shift small, due to underlying SU(2) sym.*
  - *Small shifts to* $\tau \to \ell \nu\nu$ *&* $D^0 \to \mu\mu$
  - *Small effects in di-muon tails* [Greljo, Marzocca, *EPJC2017*]

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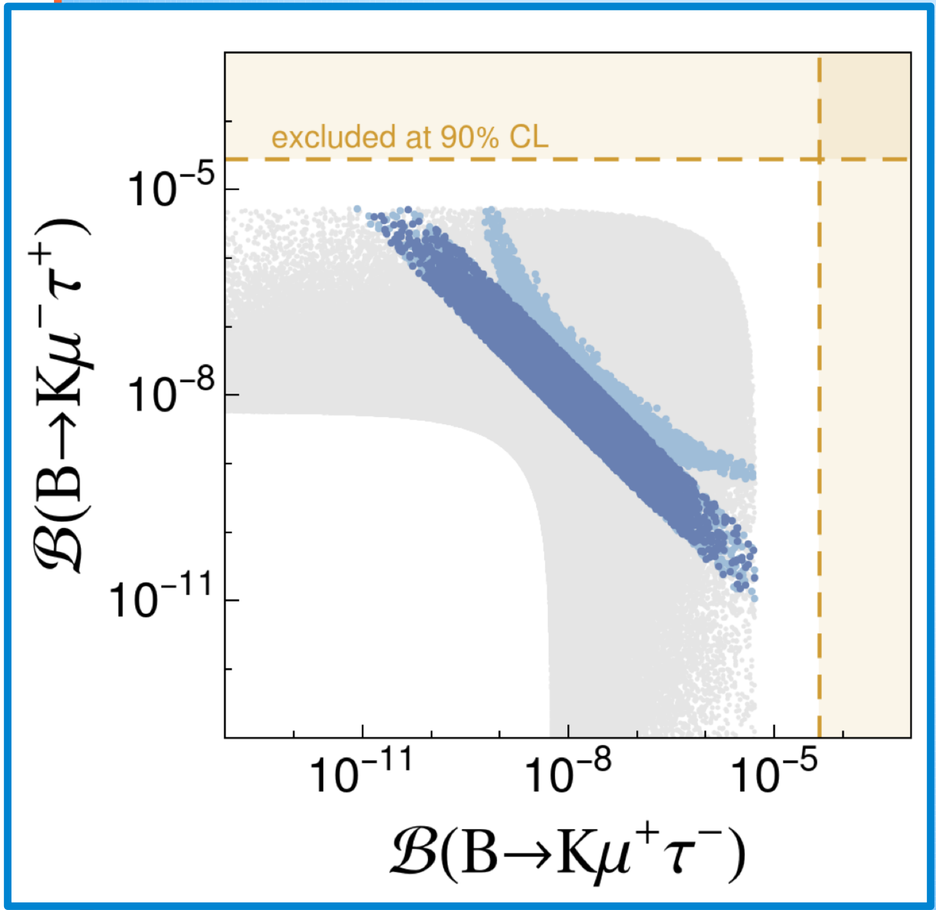

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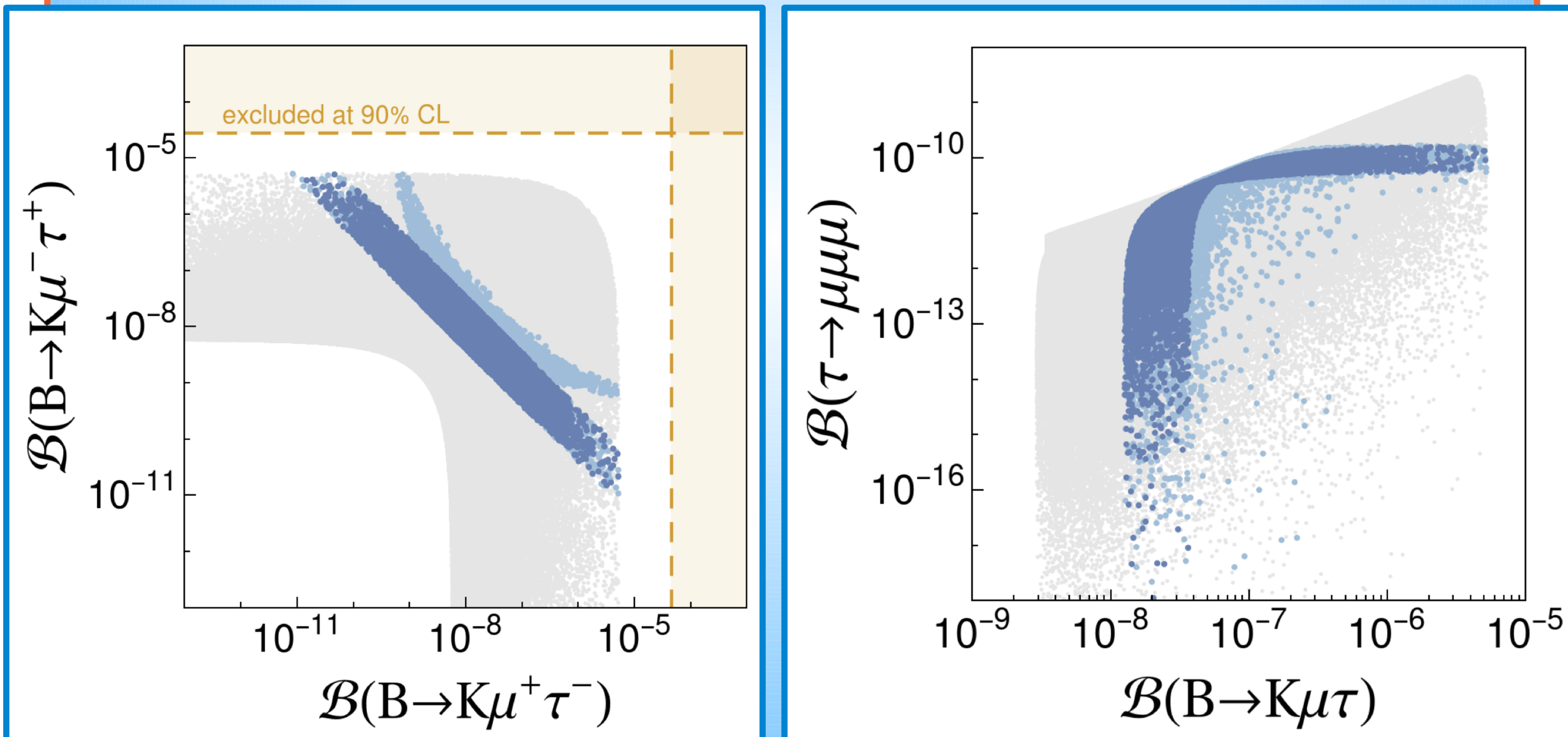

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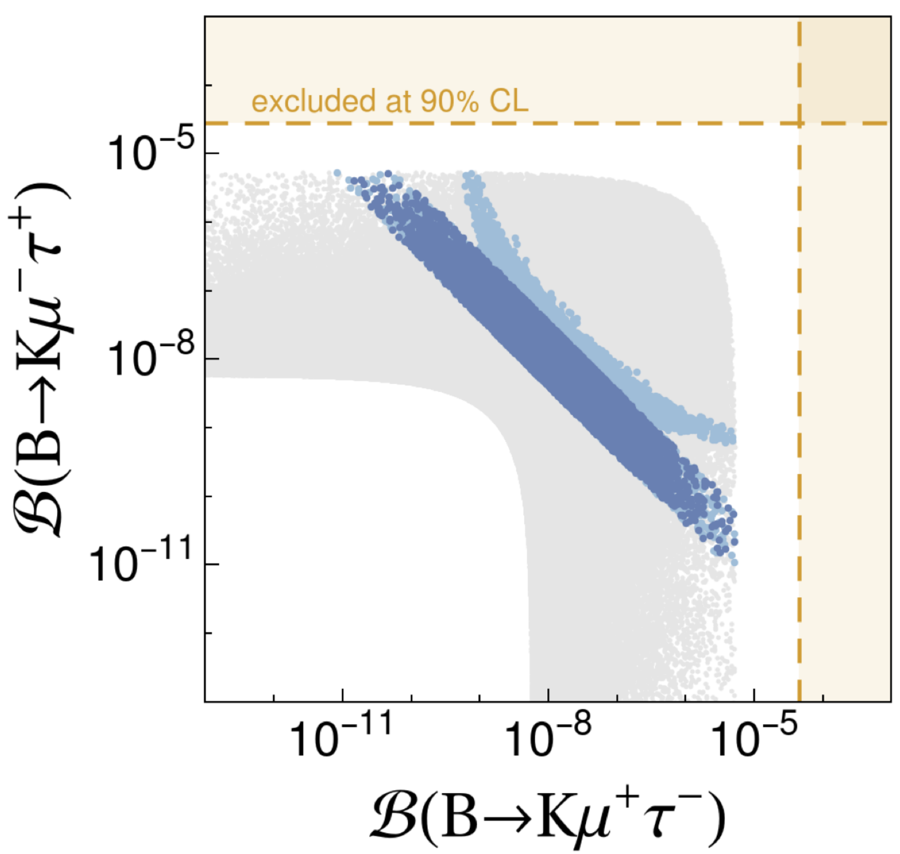

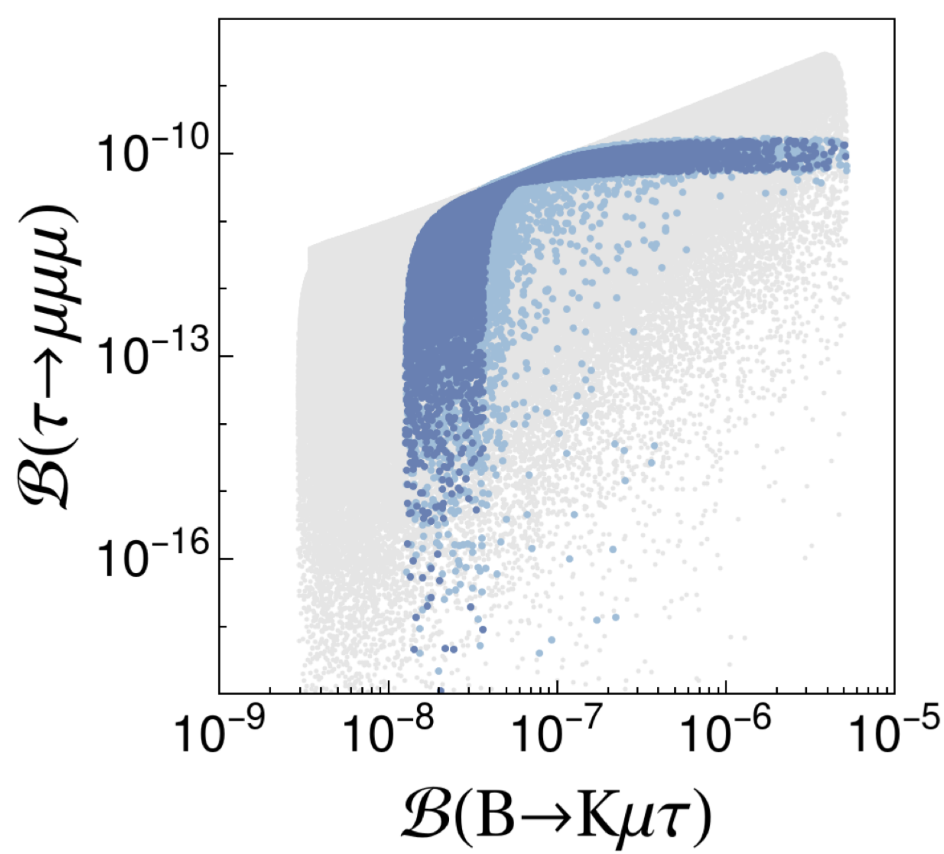

Note: $1.3\times10^{-8} \lesssim \mathcal{B}(B\to K\mu^+\tau^-) + \mathcal{B}(B\to K\mu^-\tau^+) \lesssim 5.2\times10^{-6}$

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  ↳ *A larger group would require extra matter*

  But maybe it would help solve extra problems?