Novel EFT connections between K and B physics and their tests

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Snowmass LoI in collaboration with:

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4. $b \to c\,\tau\nu$ / $b \to c\,\ell\nu$ *ratios*
   Challenge: stats + syst

tree processes

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- *Can suitable K-physics measurements offer insights on such expectations?*

LUV / LFV
in Kaon decays

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- *It turns out that B-physics machines can offer complementary info on these decays w.r.t. Kaon machines, because of*
  - *the large amounts of Kaons produced*
  - *the excellent decay-reconstruction capabilities (e.g. for K_S)*

Why correlated effects

- *The new physics for B decays can usually be described by*

$$\mathcal{L}_{\text{eff}} \supset \frac{C^{(a)}_{ijkl}}{\Lambda^2}\,\mathcal{O}^{(a)}_{ijkl}$$

two-quark { i, j }
two-lepton { k, l }
operators

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In many motivated scenarios, the λ's entering B decays and those entering K decays are highly correlated

Example 1

- *LHCb may well improve existing limits on* $K_L \to \mu e$ *and* $K^+ \to \pi^+ \mu e$

[Borsato *et al.*, *1808.02006*][Alves Jr. *et al.*, *1808.03477*]

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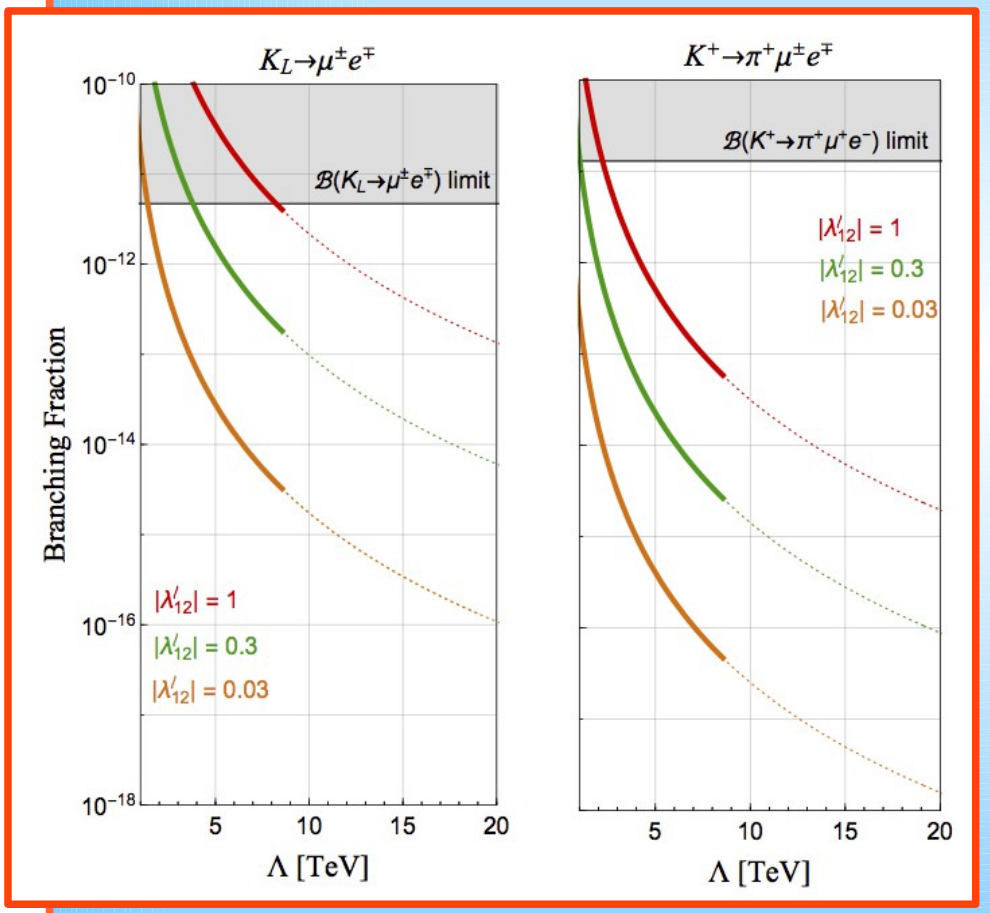

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- *(V–A)* $\times$ *(V–A), SU(2)*$_L$*-invariant* $qq\ell\ell$ Hamiltonian adopted in [Buttazzo *et al.*, *1706.07808*] to explain *B* anomalies

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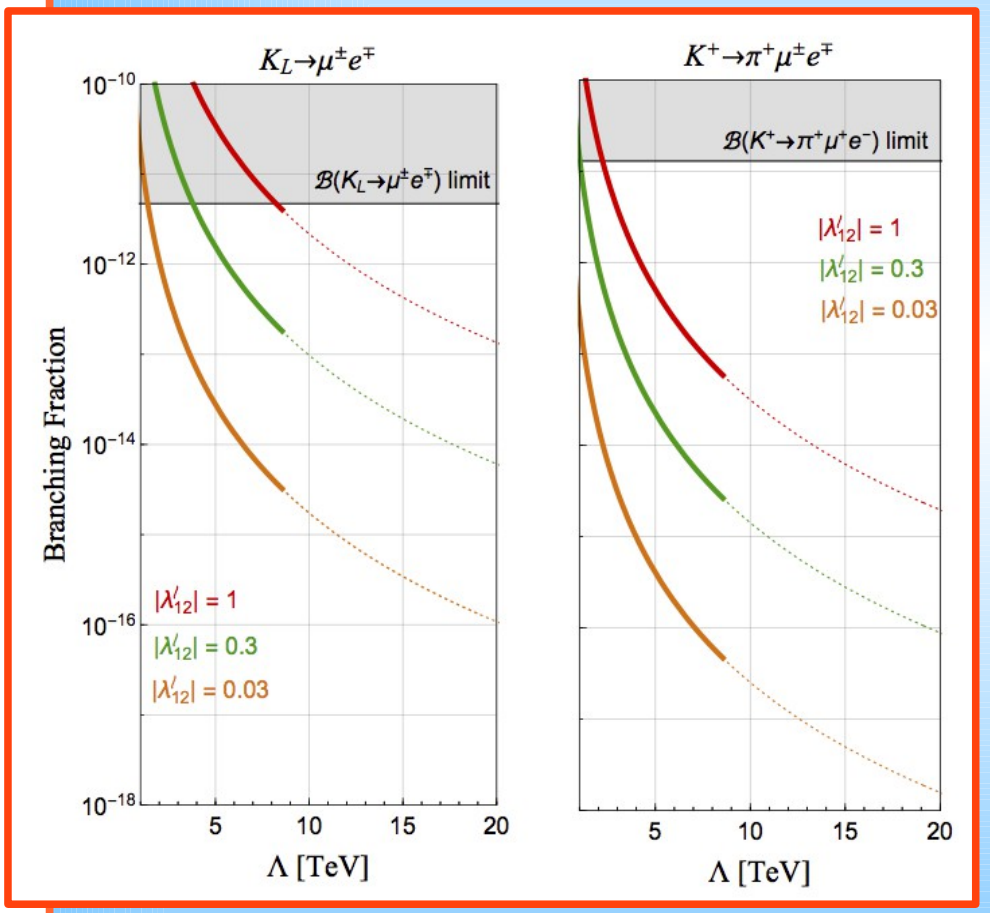

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- *(V–A)* $\times$ *(V–A),* $SU(2)_L$*-invariant* $qq\ell\ell$ Hamiltonian adopted in [Buttazzo *et al.*, *1706.07808*] to explain *B* anomalies
- *CKM-like ansatz for the* $\lambda^{(q)}$ *coupling*
- *Agnostic on the* $\lambda^{(\ell)}$ *coupling*

Example 2

- *Assuming a general, $SU(2)_L$-invariant $qq\ell\ell$ Hamiltonian the effects in $R_{K(*)}$ are generally correlated with those in $b \to s \nu\bar{\nu}$*

[Buras *et al.*, *1409.4557*]

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- *Assuming also that flavor couplings are ruled by MFV results in much wider correlations between effects in*

$B \to h_s \nu\bar{\nu}$ (h_s= K, K*, X_s) $\Leftrightarrow$ $K \to \pi \nu\bar{\nu}$

[Descotes-G *et al.*, *2005.03734*]

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that distinguishes the 1st & 2nd from the 3rd one

[Barbieri *et al.*, *1105.2296, 1512.01560*][Blankenburg *et al.*, *1204.0688*]

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- $K \to \pi \nu\bar{\nu}$ *are the only Kaon decays with 3rd-gen. leptons*
  Use of the above sym gives rise to a beautiful triple correlation

[Bordone *et al.*, *1705.10729*]

$$\frac{\Delta\mathcal{B}(K^+ \to \pi^+ \nu\bar{\nu})}{\Delta\mathcal{B}(B \to K^{(*)}\nu\bar{\nu})} \approx \frac{2}{3} \times \frac{\theta_q}{\cos\phi_q} \times \frac{1 - 12\,[R_{D^{(*)}} - 1]\theta_q^2 f_q}{1 - 15[R_{D^{(*)}} - 1]\,\frac{\theta_q f_q}{\cos\phi_q}}$$

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- *Interestingly, these probes are accessible not only at dedicated Kaon machines but also at B physics ones*