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Possible connections to $R(D^{(*)})$
and the AMM of the muon

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Outline

• Introduction:
  New Physics and LFV
  - $b \rightarrow s \mu \mu$
  - $b \rightarrow c \tau \nu$
  - $a_\mu$

• Simultaneous explanations with LQs

• Conclusions
Hints for LFUV

Electron channels: SM like

- $\tau \to \mu \nu \nu$: 2σ
- $b \to s \mu \mu$: 5-6σ
- $h \to \tau \mu$: 2σ
- $a_\mu$: 3σ
- $R(D^{(*)})$: 4σ

Lepton Flavour Universality Violation (LFUV)

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$a_\mu$ explanations

- **MSSM** e.g. D. Stockinger, hep-ph/0609168
  - tan(β) enhanced slepton loops

- **Scalars** e.g. A. Broggio et al. arXiv:1409.3199
  - Light scalars with enhanced muon couplings
  - Very light with τμ couplings ($m_\tau$ enhancement)

- **Leptoquarks**
  - $m_\tau$ enhanced effects e.g. A. Djouadi et al. Z.Phys. C46 (1990)
  - M. Bauer, M. Neubert, 1511.01900

Chiral enhancement or very light particles
Scalar Leptoquarks in $a_\mu$

- Chirally enhanced effects via top-loops

E. Leskow, A.C., G. D'Ambrosio, D. Müller
arXiv:1612.06858

Z$\rightarrow$$\mu\mu$ at future colliders
$b \rightarrow s \mu \mu$ explanations

- **Z’**
  
  Talks of David Straub and Javier Fuentes-Martín

- **Leptoquarks**
  
  Talks of Ben Gripaios and Ivan Nisandzic

- **Loop effects**
  
  Talk of Yotam Soreq

Even high scale NP explanations possible
R(D) & R(D*) explanations

- Charged scalars
  - Problems with angular distributions and $B_c$ lifetime
    
    R. Alonso, B. Grinstein and J. Camalich, 1611.06676

- $W'$
  
  A. Greljo, G. Isidori and D. Marzocca, 1506.01705

- Talk of Mariano Quiros

- Leptoquark
  
  - Strong signals in $qq \rightarrow \tau\tau$ searches
    
    Faroughy et al. 1609.07138

Explanation difficult
R(D(\(\ast\))) and \(b\rightarrow s\tau\tau\) with Leptoquarks

- Large couplings to the 2\(^{\text{nd}}\) generation needed in order avoid collider bounds.
- Cancelation in \(b\rightarrow svv\) needed: \(C^{(1)}\equiv-C^{(3)}\)

R. Alonso, B. Grinstein and J. Camalich, 1505.05164
Leptoquarks?

- $h \rightarrow \tau \mu$
- $R(D^{(*)})$
- $b \rightarrow s \mu \mu$
- $Z'$ gauge boson

Higgses ( Scalars )

$\alpha_\mu$
R(D(\(\star\))), \(b \rightarrow s \mu\mu\) and \(a_\mu\) with Leptoquarks

- Scalar leptoquark singlet + triplet with \(Y=-2/3\)
- Cancelation in \(b \rightarrow s \nu\nu\) imposed

2 out of 3 can be explained
L$_\mu$ - L$_\tau$ model for $a_\mu$ and $h \to \tau \mu$ and $b \to s \mu \mu$

- L$_\mu$ - L$_\tau$ flavour symmetry
- Flavon mixes with the Higgs
- $\tau \to \mu \gamma$ is protected
- $a_\mu$ is not protected
- Effects in $h \to \mu \mu$

W. Altmannshofer, M. Carena, AC, 1604.08221
**L_{μ-τ} model for a_μ, h→τμ and b→sμμ**

α : mixing among CP even Higgses

\[ \Delta m^2 = m_a^2 - m_{φ}^2 \]

Can explain a_μ & h→μτ without violating τ→μγ bounds
Conclusions

• Intriguing hints for Lepton Flavour Universality violating New Physics
• Leptoquarks are a promising solution to the anomalies
• $L_\mu - L_\tau$ can explain the AMM of the muon, $b \to s \mu \mu$ and $h \to \tau \mu$

Exiting times in flavour physics are ahead of us!