Combined Constraints on First Generation Leptoquarks

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1 Introduction

Leptoquarks (LQs) are hypothetical beyond the Standard Model (BSM) particles that feature quark-lepton couplings. They have attracted particular attention in recent years, since they can explain the "flavor anomalies" deviations from SM predictions that hint at Lepton Flavor Universality Violation (LFUV):

- $B(D^{(*)} \to \rho \ell^-)$ with $\ell = e, \mu$,
- $b \to s \ell^+\ell^-$ transitions, $\ell = e, \mu$,

The contributions. In this way a finite result is obtained and the Wilson coefficients are constrained from Ref. [170], Refs. [177–179] and Refs. [179–182], respectively. Numerically, such couplings can be avoided (to all orders in perturbation theory).

3 Observables

Low Energy Precision Observables

- Cabibbo Angle Anomaly (CAA): deficit in 1\textsuperscript{st} row CKM unitarity, can be explained with 1\textsuperscript{st} generation LQs.
- Tree-level neutral current: constraints from parity violation experiments (DNP/AF and APF).
- $K^{0} \to e^{+}e^{-}$: $K \to e^{+}e^{-}$ and $K \to s \bar{s}$. $j_{T0} \to j_{T0}$ and $j_{T0} \to j_{T0}^{\ast}$ mixing: constraints on one-loop LQ contributions.

4 Phenomenological Analysis

Direct LHC Searches

- Pair production (PP): $\phi \to \phi \to \ell^{\pm}\ell^{\mp}$
- Single Resonant Production (SRP):
- Drell-Yan-like Signatures (DY):

5 Conclusions

- We performed a combined analysis of constraints on first generation LQs, including both low energy precision observables and direct searches.

References

1. Crivellin, Andreas, Dario Müller, and Luc Schnell. "Combined Constraints on First Generation Leptoquarks." ArXiv:2112.08823 (2021).
2. Abdesselam, A., et al. "Measurement of $R(D^{(*)})$ with a semileptonic tagging method." ArXiv:1904.04171 (2019).
3. Jegerlehner, F., et al. "Resonance masses in $B \to \ell^{+}\ell^{-}$ transitions and Global Fits." ArXiv:1710.00712 (2017).
4. Ali, B., et al. "Measurement of the positive mass anomalous magnetic moment of the muon." Physical Review Letters 121.14 (2018): 141801.
5. CERN-SPD-1: Andreas Vreken, Claudia Andrieux-Morin. "Global fit of muonic and hadronic tau decays." Physical Review Letters 125.7 (2020): 071802.
6. Ahn, Geonseok, et al. "Search for new non-resonant phenomena in high-mass dilepton final states with the ATLAS detector." Journal of High Energy Physics 2020,11 (2020): 1-41.
7. CMS Collaboration. "Search for new resonant and nonresonant new phenomena in high-mass dilepton final states at 13 TeV." ArXiv:1907.07815 (2021).