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Phenomenology of TeV-scale scalar Leptoquarks in the EFT

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We examine new aspects of leptoquark (LQ) phenomenology using effective field theory (EFT). We construct a complete set of leading effective operators involving SU(2) singlets scalar LQ and the Standard Model (SM) fields up to dimension six. We show that, while the renormalizable LQ-lepton-quark interaction Lagrangian can address the persistent hints for physics beyond the SM in the B-decays and in the measured anomalous magnetic moment of the muon, the LQ higher dimensional effective operators may lead to new interesting effects associated with lepton number violation. These include the generation of one-loop and two-loops sub-eV Majorana neutrino masses, mediation of neutrinoless double-β decay and novel LQ collider signals. For the latter, we focus on third generation LQ (ϕ_3) in a framework with an approximate Z_3 generation symmetry and show that one class of the dimension five LQ operators may give rise to a striking asymmetric same-charge $\phi_3\phi_3$ pair-production signal, which leads to low background same-sign di-leptons signals at the LHC. For example, if the LQ mass is around 1 TeV and the new physics scale is $\Lambda \sim 5$ TeV, then we expect about 5000 positively charged $\tau^+\tau^+$ events via $pp \to \phi_3\phi_3 \to \tau^+\tau^+ + 2 \cdot j_b$ ($j_b = b$-jet), about 500 negatively charged $\tau^-\tau^-$ events with a signature $pp \to \phi_3\phi_3 \to \tau^-\tau^- + 4 \cdot j + 2 \cdot j_b$ ($j =$ light jet) and about 50 positively charged $\ell^+\ell^+$ events via $pp \to \ell^+\ell^+ + 2 \cdot j_b + MET$ ($\ell = e, \mu, \tau$), at the 13 TeV LHC with an integrated luminosity of 300 fb^{-1}. It is interesting to note that, in the LQ EFT framework, the expected same-sign lepton signals have a rate which is several times larger than the QCD LQ-mediated opposite-sign leptons signals, $gg, q\bar{q} \to \phi_3\phi_3^\star \to \ell^+\ell^- + X$.

In-person participation

No

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