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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 SM fields up to dimension six. We show that, while the renormalizable LQ-lepton-quark interaction Lagrangian can address the persistent hints for new physics in B-decays and the 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 sub-eV Majorana neutrino masses, mediation of neutrinoless double- β decay and novel LQ collider signals. For the latter, we focus on 3rd 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 leptons signals at the LHC. For example, with $M_{\phi_3} \sim 1$ TeV and a new physics scale of $\Lambda \sim 5$ TeV, we expect about 5000 positively charged $\tau^+\tau^+$ events via $pp \rightarrow \phi_3\phi_3 \rightarrow \tau^+\tau^+ + 2 \cdot j_b$ ($j_b = b$ -jet) at the 13 TeV LHC with an integrated luminosity of 300 fb^{-1} . We also consider the same-sign charged lepton signals in the LQ EFT framework at higher energy hadron colliders such as a 27 TeV HE-LHC and a 100 TeV FCC-hh.

Primary authors: Dr SONI, Amarjit (Brookhaven National Laboratory (BNL)); Mr COHEN, Jonathan (Technion); Prof. WUDKA, Jose (University of California at Riverside (UCR)); BAR-SHALOM, Shaouly (Physics Department Technion, Israel)

Presenter: BAR-SHALOM, Shaouly (Physics Department Technion, Israel)

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