INTERNATIONAL INSTITUTE OF INFORMATION TECHNOLOGY HYDERABAD

R&D SHOWCASE 2021
Technology, Social Impact

Precise limits on the charge-2/3 U1 vector leptoquark

[arXiv:2101.12069]

MOTIVATION

The semileptonic B-meson decays provides us with motivations to study the LHC data and put bounds on the R_D, R_{D^*} favoured parameter space in a charge 2/3 vector leptoquark (LQ), U1. We consider one large free coupling to accommodate the anomalies as they result in non-resonant $\tau\tau$ events at the LHC. We recast the latest $\tau\tau$ resonance search data to obtain exclusion limit on the LQ parameter space.

OBJECTIVE

- Recast the existing LHC search data in relevant channels with U1 model
- To put bounds on the parameter space (λ_i, M_{LQ}) We calculate the excluded region in the space for a range of mass of LQ masses

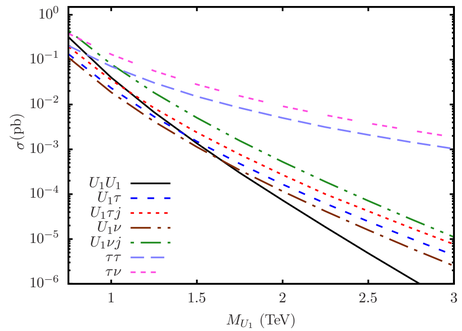

Figure 1: σ (Cross Section) vs. M_{U1} (LQ Mass) plot for all relevant processes

METHOD

- Implementing a model/lagrangian of the U1 vector LQ using FeynRules package for event generation.
- Two different scenarios are considered to study the couplings, λ^L_{23} and λ^L_{33} . Each scenario has only one of them as non-zero during event generation.
- MadGraph5 is used to generate the required events, parton showering and hadronization is done by Pythia6. Delphes3 simulates the detector environment.
- Events are tagged using ROOT software for $\tau\tau$ channel, binned in approrpriate total tranverse mass bins.
- We fit our model on the existing LHC search data of $\tau\tau$ then, perform a chi-square test in order to check the goodness of fit.

RESULTS, CONCLUSION

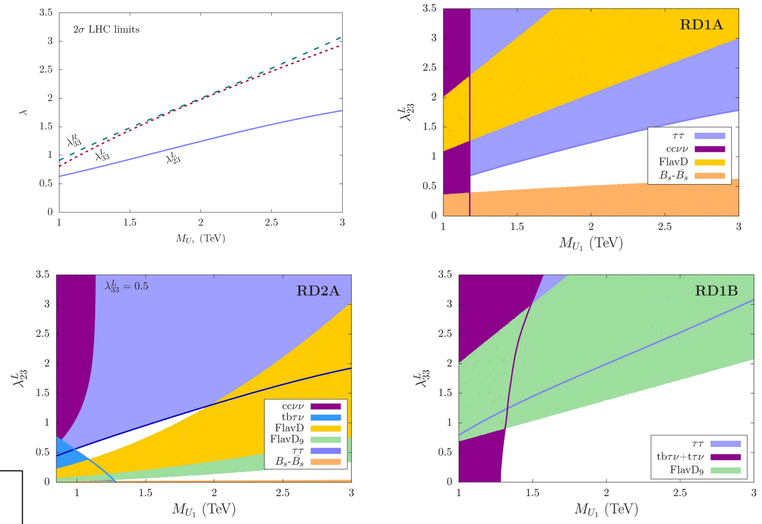

Figure 2 (clockwise): (a) LHC exclucion plots of all couplings, (b) LHC exclusion with RD* favorable regions for 23L, (c) LHC exclusion with RD* favorable regions for 33L, (d) combined scenario limits for carying 23L for 33L=0.5.

In minimal scenarios, almost all of the R_D, R_{D^*} favorable regions are excluded. Hence, tighter bounds are put on the parameter space from this study. However, combining the couplings do give us some allowed favorable regions.

U1 Model Lagrangian: $\mathcal{L}_{U1} \supset (Vx)^L_{ij}\bar{u}_i\gamma^\mu U^1_\mu \nu_j + x^L_{ij}\bar{d}_i\gamma^\mu U^1_\mu \ell_j + x^R_{ij}\bar{d}^i_R\gamma^\mu U^1_\mu \ell^j_R + \text{h.c.},$

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