

Izaak's PhD defense

Report of Contributions

Contribution ID: 2

Type: **not specified**

Presentation: "A Search for Leptoquarks Coupling to ☒ Leptons and Bottom Quarks in Proton-Proton Collisions at the CMS Experiment"

Thursday, 23 February 2023 16:00 (30 minutes)

Despite the many remarkable successes of the Standard Model (SM) of particle physics, there are both theoretical and experimental reasons that imply the SM is not the final and most fundamental theory of nature. Some anomalies have emerged in measurements of semileptonic B hadron decays that could reveal the violation of lepton flavor universality. Models that propose a new particle called the leptoquark (LQ) are strongly motivated as a possible explanation, and could reveal the underlying connection between quarks and leptons and explain the observed flavor symmetries, as well as the hierarchical mass pattern.

This thesis presents a search for the single and pair production of LQs that decay exclusively to a τ lepton and a bottom quark, as well as a novel search for the exchange of an LQ by b quarks that produces a τ lepton pair. This is done by targeting the $\tau\tau$ decay channels, and creating several event categories based on the number of jets and heavy-flavored jets. The search uses a data set of pp collisions corresponding to an integrated luminosity of 138 fb^{-1} , collected at a center-of-mass energy of 13 TeV, and recorded with the CMS detector. Preliminary results are presented: Upper limits are set on the production cross section of third-generation scalar and vector LQs as a function of the LQ mass, and results are compared with theoretical predictions to obtain lower limits on the LQ mass. At 95% confidence level, third-generation LQs decaying to a τ lepton and a b quark with unit coupling are excluded for masses below 1.25 TeV for a scalar model, and below 1.53 (1.86) TeV for a vector model with nonminimal coupling $\kappa = 0$ (1). At $\lambda = 2.5$, the lower limits are 1.37 TeV for a scalar model, and 1.86 (1.96) TeV for a vector model with $\kappa = 0$ (1). Upper limits are also set on the coupling strength of such LQs as a function of their mass. Due to the inclusion of the nonresonant LQ exchange processes, this analysis is able to set constraints on LQs with masses up to 10 TeV, much higher than can be produced directly at the LHC. For a representative LQ mass of 2 TeV and a coupling strength of 2.5, an excess with a significance of 3.4 standard deviations above the standard model expectation is observed in the data. Consequently, the observed upper limits on the LQ production cross section are about three times larger than expected for this benchmark.

As hadronic decays of the τ lepton (τ_h) are an important part of this search, this thesis also presents the reconstruction and identification algorithms used in CMS, as well as the measurements of its performance and the corrections to simulated τ_h candidates that are needed to ensure good modeling of the data.

Presenter: NEUTELINGS, Izaak (University of Zurich (CH))

Session Classification: Colloquium (public)

Contribution ID: 3

Type: **not specified**

Q&A

Thursday, 23 February 2023 16:30 (15 minutes)

Session Classification: Colloquium (public)