

## ABSTRACT

In the present thesis a search for new heavy fermions using LHC data collected in 2012 by the ATLAS experiment is presented. In particular, a search for pair and single production of vector-like quarks with electric charge  $2/3$  ( $T$ ) and  $-1/3$  ( $B$ ) decaying to a  $Z$  boson is discussed. For this search the analysis was divided in two channels, depending on the lepton multiplicity, and both channels were combined at the end for the final results. Since no evidence for signal was found, limits on the mass of the vector-like quarks were evaluated. The observed (expected) limit on the mass of an  $SU(2)$  singlet  $T$  quark is  $655\sim\text{GeV}$  ( $625\sim\text{GeV}$ ), while the observed (expected) limit on the mass of a  $T$  quark in a  $(T,B)$  doublet is  $735\sim\text{GeV}$  ( $720\sim\text{GeV}$ ). The observed (expected) limit on the mass of an  $SU(2)$  singlet  $B$  quark is  $685\sim\text{GeV}$  ( $670\sim\text{GeV}$ ), while the observed (expected) limit on the mass of a  $B$  quark in a  $(B,Y)$  doublet is  $755\sim\text{GeV}$  ( $755\sim\text{GeV}$ ).

The impact of a heavy gluon in the searches for pair production of vector-like quarks has also been studied. Even if kinematic differences were found at the parton level, these seem to be negligible after taking the detector simulation and event reconstruction effects into account. The ATLAS results obtained within the scope of the present thesis were recasted in a realistic scenario and it was found that the selection efficiencies for signal, as well as the final results, are not sensitive to the presence of a heavy gluon. Such conclusion allowed to reinterpret all the relevant ATLAS and CMS results by simply scaling the cross-section, obtaining limits on the mass of the heavy gluon.