

Search for Dark Matter Produced in Association with Neutral Gauge Boson at the LHC



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DEDICATED TO THE MEMORY OF MY BELOVED PARENTS WHO HAD BEEN THE
GREATEST SOURCE OF INSPIRATION OF ALL MY WORK AND WHO HAVE LEFT
ME FOR THEIR HEAVENLY ABODE ...

Declaration

I hereby declare that except where specific reference is made to the work of others, the contents of this dissertation are original and have not been submitted in whole or in part for consideration for any other degree or qualification in this, or any other university. This dissertation is my own work and contains nothing which is the outcome of work done in collaboration with others, except as specified in the text and Acknowledgements.

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Abstract

The Standard Model of Particle Physics is the most successive theory that describes the basic structure of matter and interactions between the fundamental particles. Standard Model of particle Physics does not contain any good Dark Matter candidate, and there is no detectable interaction except the gravitational one between the DM and SM particles. .

First analysis in this thesis is searching for dark matter in events with a Z boson and missing transverse momentum in proton-proton collisions at a center of mass energy of 13 TeV using events containing two charged leptons (electrons or muons), consistent with the decay of a Z boson, and large missing transverse momentum. This study is based on data collected with the CMS detector in 2015, corresponding to an integrated luminosity of 2.3 fb^{-1} of pp collisions at the LHC at a center-of-mass energy of 13 TeV. No excess over the standard model expectation is observed. The results are interpreted in terms of a simplified model of DM production for both vector and axial vector couplings between a mediator and DM particles. Additionally, effective field theories of DM and unparticle production are used to interpret the data.

This Analysis is published as a paper in JHEP [DOI:10.1007/JHEP03(2017)061].

A second analysis performed in the thesis is a search for new physics in events with a Z boson produced in association with large missing transverse momentum with the CMS experiment at the LHC. This search is interpreted in a simplified model with a spin-1 dark matter mediator and in a model with a standard model Higgs-like scalar particle, each produced in association with the Z boson and decaying invisibly. The search is done using 2016 data sample of proton-proton collisions at a center-of-mass energy of 13 TeV corresponding to an integrated luminosity of 12.9 fb^{-1} . No excess over the standard model expectation is observed. The results are interpreted in terms of a simplified model of DM production for both vector and axial vector couplings between a mediator and DM particles. Additionally, a model with a standard model Higgs-like scalar particle, each produced in association with the Z boson and decaying invisibly are used to interpret the data.

This Analysis is published as Physics Analysis Summary (PAS) *EXO* – 016 – 038 on CERN data base.

The last analysis performed on the full 2016 data-set with 35.9 fb^{-1} . The results of this

search are interpreted in terms of a simplified model of dark matter production with spin-0 or spin-1 mediators and a standard model Higgs boson decaying invisibly and produced in association with the Z boson, as well as unparticle model. For all models, no significant deviation from the background expectation is found, and limits are set with respect to relevant model parameters.

This analysis is published as a Physics Analysis Summary (PAS) *EXO – 016 – 052* on CERN data base, and a paper ready for submission.

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