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

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This dissertation is submitted for the degree of

Master of Science

Faculty of Science August 2017

APPROVAL SHEET

Title of the M.Sc. thesis

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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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August 2017

Acknowledgements

I would like to acknowledge **Prof. Dr. Tawfik Eldessouky** for his great support to my profile and for this thesis, his role is really like father. Also i will never forget my Supervisor **Asst. Prof. Esraa El-Khateeb** for her fruitful and helpful discussions and great support in all phases of this thesis. I've learned from here, along with science, sincerity in working, support rights and helping others unconditionally.

I hope that God accept **Prof. Dr. Mostafa Shalaby** in his heaven, he was a keen and loving scholar and was a reason for my love and passion for that kind of science.

Dr. Ahmed Ali Abdelalim for his great support in the analysis and pushing up my carrier profile with his deep and unique knowledge in that kind of work.

Dr. Mohamed Ahmed Abbas for his support in theoretical side and his fruitful discussion in the QFT and Lie-Algebra.

Dr. Amr Mohamed the team leader of CERN-CMS group in Egypt for giving me the full support and facility every thing to finalize this thesis from logistics support to group management and collaboration with others.

Dr. Hala Hosny, i would like to say not only because she represents the role of mother of the whole department, but she's also plays a real role for me either in that thesis or in my life in general.

My beloved wife **Asmaa Abd El-Baset** and beloved daughter **Fardia**, without them being in my life, i would not have completed the work of this thesis, thank you for being in my life.

Mono Z group, who did a great efforts for this thesis to be finalized especially **Nicholas Charles Smith** (University of Wisconsin (US)). **Andreas Albert** (RWTH Aachen University(Germany)), **Daniele Trocino** (Northeastern University, (US)) and **Bhawna Gomber** (University of Wisconsin (US)) for working with them and helping me to develop my experience and knowledge in CMS analysis in general and Dark Matter research work related to this thesis.

Finally i would like to say thank you for all my colleagues, in physics department - Ain shams University, mathematics department - Cairo University, for example but not limited to, **Waleed Abdallah, Mustafa Ashry, Ahmed ElSayed Moursy and Ali Gamal Elsayed** for their support, scientific discussions and the brotherhood between us.

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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