Notice of the Final Oral Examination
for the Degree of Doctor of Philosophy
of
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BSc (University of Victoria, 2014)

“Search for Higgs boson decays to beyond-the-Standard-Model light bosons in four-lepton events with the ATLAS detector at the LHC”

Department of Physics and Astronomy

Friday, November 20, 2020
2:00 P.M.
Conducted Remotely

Supervisory Committee:
Dr. Michel Lefebvre, Department of Physics and Astronomy, University of Victoria (Supervisor)
Dr. Robert McPherson, Department of Physics and Astronomy, UVic (Member)
Dr. Ian Putnam, Department of Mathematics and Statistics, UVic (Outside Member)

External Examiner:
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Chair of Oral Examination:
Dr. G. Cornelis van Kooten, Department of Economics, UVic

Dr. Stephen Evans, Acting Dean, Faculty of Graduate Studies
Abstract

This thesis presents the search for the dark sector process $h \rightarrow Z_{d}Z_{d} \rightarrow 4\ell$ in events collected by the ATLAS detector at the Large Hadron Collider in 2015-2018. In this theorized process, the Standard Model Higgs boson ($h$) decays to four leptons ($4\ell$) via two intermediate Beyond-the-Standard-Model particles each called $Z_{d}$. This process arises from interactions of the Standard Model with a dark sector. A dark sector consists of one or more new particles that have limited or zero interaction with the Standard Model, such as the new vector boson $Z_{d}$ (dark photon). It could have a rich and interesting phenomenology like the visible sector (the Standard Model) and could naturally address many outstanding problems in particle physics. For example, it could contain a particle candidate for dark matter. In particular, Higgs decays to Beyond-the-Standard-Model particles are well-motivated theoretically and are not tightly constrained; current measurements of Standard Model Higgs properties permit the fraction of such decays to be as high as approximately 30%. The results of this search do not show evidence for the existence of the $h \rightarrow Z_{d}Z_{d} \rightarrow 4\ell$ process and are therefore interpreted in terms of upper limits on the branching ratio $\mathcal{B}(h \rightarrow Z_{d}Z_{d})$ and the effective Higgs mixing parameter $\kappa'$. 