University of Victoria | Graduate Studies

Notice of the Final Oral Examination for the Degree of Master of Science

of

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BSc (University of Victoria, 2016)

"Investigation of New Techniques for Increasing Efficiencies in Spectroscopic Surveys"

Department of Physics and Astronomy

Friday, June 1, 2018
1:00 P.M.
Clearihue Building
Room B017

Supervisory Committee:
Dr. Kim Venn, Department of Physics and Astronomy, University of Victoria (Supervisor)
Dr. Patrick Cote, Department of Physics and Astronomy, UVic (Member)
Dr. Sebastien Fabbro, Department of Physics and Astronomy, UVic (Additional Member)

External Examiner:
Dr. Étienne Artigau, Institute for Research on Exoplanets, Université de Montréal

Chair of Oral Examination:
Dr. Wanda Boyer, Department of Education Psychology & Leadership Studies, UVic

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

Abstract

The efficiency of different spectroscopic techniques are examined through four different approaches: detailed analysis of IR spectra from the APOGEE database and examination of persistence, observing extremely metal-poor stars using the Plaskett telescope at the DAO, threefold analysis of various applications of machine learning in astronomy, and efficient transmission of light through optical fibres.

Through the first study, the technical effects of persistence in the APOGEE's IR spectra are examined, and a new technique for removing the persistence is introduced. Most of Pal 1 globular cluster's spectra in the APOGEE database are affected by persistence. Therefore, the Pal 1 spectra are corrected for the persistence and their stellar abundances are determined independently from the APOGEE's pipeline, ASPCAP. Our results for the known members of Pal 1 were in a close agreement with the results from Sakari et al. (2011). Comparison between the results from the corrected and the original spectra suggest that the persistence could have a critical effect on the results.

The second study of this thesis had a focus on the observation of the candidate extremely metal-poor (EMP) stars from the Pristine survey. Through the DAO-Pristine project, we narrowed down the initial list of the Pristine survey by observing over 50 targets within 25 observing nights. The Ca II triplet absorption lines of the observed targets are examined and used for estimating the metallicity of the objects. Twelve candidate EMP stars with weak Ca II triplet lines are chosen from the observed targets. These candidate EMP stars will be observed with larger telescopes for more accurate determination of their metallicity.

This thesis also presents the result of a threefold analysis for using machine learning techniques in astronomy. The supervised machine learning methods are used for determination of the stellar parameters of stars using their raw spectra, and unsupervised machine learning methods are used for classification of supernovae Type Ia from their calibrated spectra. The supervised analysis of the IR and optical spectra suggested that our StarNet neural network can predict the stellar parameters of the APOGEE database and synthetic spectra, efficiently and accurately. The effect of persistence in the StarNet's results are examined, and we showed that the persistence does not have a critical effect on the overall performance of the StarNet. In addition, multiple unsupervised machine learning

techniques such as K-mean and SOM are used for classification of the supernovae Type Ia spectra. The preliminary results suggest that a minimum of three subclasses of supernovae Type Ia can be found from our data, which are consistent with the previous studies.

Finally, this thesis presents our final results for an optical system we designed for the MSE project. At UVic, we have used the standard collimated beam method, or "ring test," to measure the Focal Ratio Degradation (FRD) of MSE-like fibres. The FRD of the system is determined from the ratio of the Full Width Half Maximum (FWHM) to the radius of the ring. Early ring test results from a sample of MSE-like fibres show an FRD of 5%, which meets the MSE science requirement. Also, we have automated the ring test for fast, repeatable, and efficient measurements of an individual fibre in multi-fibre bundles. Our future tests will include automated non-static fibres in preparation for the MSE build phases.