University of Victoria | Graduate Studies

Notice of the Final Oral Examination
for the Degree of Doctor of Philosophy

of

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MSc (University of Padova, 2007)
BSc (University of Trieste, 2012)

"Advancing Next Generation Adaptive Optics in Astronomy: From Lab to Sky"

Department of Physics and Astronomy

Friday, July 28, 2017
10:00 A.M.
David Turpin Building
Room A144

Supervisory Committee:
Dr. Kim Venn, Department of Physics and Astronomy, University of Victoria (Co-Supervisor)
Dr. David Andersen, Department of Physics and Astronomy, University of Victoria (Co-Supervisor)
Dr. Alan McConnachie, Department of Physics and Astronomy, UVic (Member)
Dr. Colin Bradley, Department of Mechanical Engineering, UVic (Outside Member)

External Examiner:
Dr. Bryan Miller, Astronomer, Gemini Observatory

Chair of Oral Examination:
Dr. Robin Hicks, Department of Chemistry, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies

Abstract

High resolution imaging of wide fields has been a prerogative of space telescopes for decades. Multi-conjugate adaptive optics (MCAO) is a key technology for the future of ground-based astronomy, especially as we approach the era of ELTs, where the large apertures will provide diffraction limits that will significantly surpass even the James Webb Space Telescope.

NFIRAOS will be the first light MCAO system for the Thirty Meter Telescope and to support its development I have worked on HeNOS, its test bench integrated in Victoria at NRC Herzberg. I have aligned the optics, tested the electronic hardware, calibrated the subsystems (cameras, deformable mirrors, light sources, etc.) and characterized the system parameters.

Development and support for future MCAO instruments also involves data analysis, a critical process in delivering the expected performance of any scientific instrument. To develop a strategy for optimal stellar photometry with MCAO, I have observed the Galactic globular cluster NGC 1851 with GeMS, the MCAO system on the 8-meter Gemini South telescope. From near-infrared images of this target in two bands, I have found the optimal parameters to employ in the profile-fitting photometry and calibration. As testimony to the precision of the results, I have obtained the deepest near-infrared photometry of a crowded field from the ground and used it to determine the age of the cluster with a method recently proposed that exploits the bend in the lower main sequence. The precise color-magnitude diagram also allows us to clearly observe the double subgiant branch for the first time from the ground, caused by the multiple stellar populations in the cluster.

As the only facility MCAO system, GeMS is an important instrument serves to illuminate the challenges of obtaining accurate photometry using such a system. By coupling the knowledge acquired from an instrument already on-sky with experiments in the lab on a prototype of a future system, I have addressed new challenges in photometry and astrometry, like the promising technique of point spread function reconstruction. This thesis informs the development of appropriate data processing techniques and observing strategies to ensure the ELTs deliver their full scientific promise over extended fields of view.