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

of

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BSc (University of British Columbia, Okanagan, 2012)

“From Gas and Dust to Protostars: Addressing the Initial Stages of Star Formation Using Observations of Nearby Molecular Clouds”

Department of Physics and Astronomy

Friday, December 1, 2017
1:00 P.M.
Elliott Building
Room 161

Supervisory Committee:
Dr. Doug Johnstone, Department of Physics and Astronomy, University of Victoria (Co-Supervisor)
Dr. Falk Herwig, Department of Physics and Astronomy, UVic (Co-Supervisor)
Dr. Charles Curry, School of Earth and Ocean Sciences, UVic (Outside Member)

External Examiner:
Dr. Lee Hartmann, Department of Astronomy, University of Michigan

Chair of Oral Examination:
Dr. Olaf Niemann, Department of Geography, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies
Abstract

Though there has been a considerable amount of work investigating the early stages of low-mass star formation in recent years, the general theory is only broadly understood and several open questions remain. Specifically, the dominant physical mechanisms which connect large-scale molecular cloud structures, intermediate-scale filamentary gas flows, and small-scale collapsing prestellar envelopes in the interstellar medium are poorly constrained. Even for an individual forming protostar, the evolution of the mass accretion rate from the envelope onto the central object is debated with little observational evidence to help guide the theoretical framework. In addition, with the development of new technology such as the continuum imaging instrument in operation at the James Clerk Maxwell Telescope (JCMT), the Submillimetre Common User Bolometer Array 2 (SCUBA-2), the best practices for data reduction and image calibration for ground-based, submillimetre wavelength observations are still being investigated.

In this dissertation, I address facets of these open questions in five main projects with an overarching focus on the flow of material from the largest to the smallest scales in a molecular cloud. By performing synthetic observations of a numerical simulation of a turbulent molecular cloud, I investigate the nature of prestellar envelopes and find evidence of larger mass reservoirs that form filamentary structures and feed cluster formation. Then, after robustly investigating and suggesting improvements for ground-based, submillimetre data reduction techniques, I continue to probe the connection between larger and smaller scales by characterising structure fragmentation in the Southern Orion A Molecular Cloud from the perspective of 850 μm continuum data. Finally, I follow star forming material to even smaller scales by exploring the evolution of the mass accretion rate onto individual protostars. This examination has required designing and implementing unprecedented spatial alignment and flux calibration techniques at 850 μm. Using these newly calibrated images, I am able to identify several candidate sources that show evidence for submillimetre variability, suggesting changes in protostellar accretion rates over several year timescales.