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

of

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BSc (University of Victoria, 2014)

“Computational Cosmology as Seen Through a Telescope:
Observational Properties of Simulated Galaxies”

Department of Physics and Astronomy

Thursday, July 21, 2016
9:00 A.M.
David Turpin Building
Room A136

Supervisory Committee:
Dr. Luc Simard, Department of Physics and Astronomy, University of Victoria (Co-Supervisor)
Dr. Sara Ellison, Department of Physics and Astronomy, UVic (Co-Supervisor)

External Examiner:
Dr. Jennifer Lotz, Assistant Astronomer, Space Telescope Science Institute

Chair of Oral Examination:
Dr. Barbara Hawkins, Department of Biology, UVic

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

The current generation of cosmological hydrodynamical simulations offer new levels of fidelity in galaxy formation and evolution that can be benchmarked against observations. However, it is crucial that the comparison between the simulation products and observations is performed on level-ground. Using mock-observations of galaxies from hydrodynamical simulations with observational realism, an image-based comparison is enabled between the simulations and modern galaxy surveys that allow galaxy properties to be derived consistently. A new methodology is presented that provides an unprecedentedly comprehensive suite of observational realism to synthetic images of galaxies from simulations and performs detailed decomposition of their morphological structures. The crux of the methodology is that the same procedure for image-based surface-brightness decompositions of galaxy structures is employed for the simulations and observations -facilitating a fair and unbiased comparison of galaxy properties. The methodology is piloted on galaxies from the Illustris simulation and is designed to enable comparison with galaxies from the Sloan Digital Sky Survey (SDSS). The biases from observational realism on the decomposition results for the simulated galaxies are characterized in detail using several controlled experiments. Then, the decompositions are used in a comparison of the galaxy size-luminosity and bulge-to-total vs. total stellar mass relations. The comparisons show that galaxies from Illustris contain too many discs and too few bulges at low masses $\log M_*/M_\odot \lesssim 11$ relative to the SDSS. A comparison of the photometric and kinematic bulge-to-total is also enabled by the methodology. The comparison suggests that photometry tends to systematically under-estimate the bulge fractions relative to the kinematics- allowing no discernible connection to be made between photo-bulges and kinematic bulges. Several possibilities that may be driving the bulge deficit in Illustris' low-mass galaxies are discussed, though particle resolution is argued to be the main culprit. The methodology that is presented in this thesis has broad applications to comparisons between computational and observational galaxy astronomy and stands to provide a wealth of feedback between each community.