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

of

ROSEMARY PIKE

BSc (Massachusetts Institute of Technology, 2007)

“On the Population of the 5:1 Neptune Resonance”

Department of Physics and Astronomy

Monday, July 18, 2016
2:00 P.M.
David Turpin Building
Room A144

Supervisory Committee:
Dr. JJ Kavelaars, Department of Physics and Astronomy, University of Victoria (Co-Supervisor)
Dr. Kim Venn, Department of Physics and Astronomy, UVic (Co-Supervisor)
Dr. Colin Goldblatt, School of Earth and Ocean Sciences, UVic (Outside Member)

External Examiner:
Dr. Martin Duncan, Physics and Astronomy, Queen’s University

Chair of Oral Examination:
Dr. Charlotte Loppie, School of Public Health & Social Policy, UVic

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

The recent discovery of objects near the 5:1 Neptune resonance prompts the study of the size, structure, and surface properties of this population to determine if these parameters are consistent with a `Nice model' type evolution of the outer Solar System. Previous TNO discovery surveys have primarily targeted the ecliptic plane, where discovery of high inclination objects such as the 5:1 resonators is unlikely, and theoretical work on the evolution of the outer Solar System has focused on structure in and around the main Kuiper belt and largely ignored the distant resonant TNOs. I tracked these objects for several semesters, measured their positions accurately, and determined precise orbits. Integrating these orbits forward in time revealed that three objects were 5:1 resonators, and one object was not resonant but may have been resonant in the past. I constrained the structure of the 5:1 resonance population based on the three detections and determined that the minimum population in this resonance was much larger than expected, \( 1900^{+3300}_{-1400} \) with \( H_g < 8 \). I compared this large population with the orbital distribution of TNOs resulting from a Nice model evolution and determined that the population in the real 5:1 resonance is \( \sim 20–100 \) times larger than the model predicts. However, the structure of the 5:1 resonance in this model was consistent with the orbital distribution I determined based on the detections. The orbital distribution of the scattering population in the Nice model is consistent with other models and survey results, leading to the conclusion that the 5:1 resonance cannot be a steady state transient population produced via resonance sticking from the scattering objects. To test the origin of the 5:1 resonators, I measured the objects’ surface colors in multiple wavelength ranges and compared their surface reactance to TNOs from a large color survey, CoLiSSOS. The 5:1 resonators have a consistent selection criteria to the TNOs from the CoLiSSOS survey, so these samples have known selection biases and can be usefully compared to each other. The surfaces of the three 5:1 resonators showed three different spectral reactance shapes, indicating that these three objects do not share a common formation location. The surface properties and orbital distribution of current 5:1 resonators are consistent with the remnant of a large captured population, partially resupplied by the scattering objects.