

Announcing the Final Examination of Kathleen McIntyre for the degree of Doctor of Philosophy in Physics.

Date: November 6, 2025

Time: 1:00 pm

Room: NSC 112

Dissertation Title: Investigations and Simulations: A Data-Driven Approach to Exoplanet Characterization

Abstract:

High-precision infrared photometry is fundamental to the field of exoplanet science, enabling direct measurements of planetary thermal emission, atmospheric composition, and energy redistribution. The stability and sensitivity achieved by instruments aboard the Spitzer Space Telescope provides a catalog of hundreds of transiting exoplanets with measurements of flux variations to the level of tens of parts per million. This legacy contextualizes and complements recent and upcoming high-resolution spectroscopic observations.

In this work I apply multiple analysis techniques to all available Spitzer observations of three hot Jupiters to determine how much we can still learn from archival data and what best practices should be applied to future observations. In Chapter 2, I resolve differences in the methodology of conflicting published results for HAT-P-13b, re-analyze the secondary eclipse light curves of HAT-P-13b and HAT-P-16b with updated techniques, determine their orbital properties, and perform atmospheric retrievals. In Chapter 3, I perform a comprehensive assessment of the current capabilities of photometric data analysis techniques using one of the highest signal-to-noise ratio and most frequently observed exoplanets, HD 209458 b. This chapter analyses 34 secondary eclipses of HD 209458 b observed across six Spitzer wavelength channels spanning 3.6 micron – 24 micron and retrieves atmospheric information using the resulting broadband spectra. In Chapter 4, I examine the 14 Spitzer primary transits of HD 209458 b, also spanning 3.6 micron – 24 micron and model their light curves. Finally, combining the parameters derived from my Spitzer light curves with recent findings from the James Webb Space Telescope, I explore several atmospheric scenarios for HD 209458 b.

Outline of Studies:

Major: Physics - Planetary Sciences Track

Education Career:

M. S. University of North Dakota, 2019

B. S. University of Florida, 2011

B. A. University of Florida 2011

Committee in Charge:

Dr. Joseph Harrington (chair)

Dr. Adrienne Dove

Dr. Stephen Eikenberry

Dr. Ramses Ramirez

Dr. Drake Deming (External Committee Member)

Approved for distribution by Joseph Harrington, Committee Chair, on October 22nd, 2025.

The public is welcome to attend.