Announcing the Final Examination of Michael Himes for the degree of Doctor of Philosophy in Physics

Date: June 30, 2022
Time: 12:00 p.m.
Room: PSB 160/161
Zoom: https://ucf.zoom.us/j/91538760478?pwd=a1o0SGNUcjZHUmJ5Vy9FNDdNY29TZz09
Dissertation title: Atmospheric Retrieval: Bayesian Methods, Machine Learning, and Application To Exoplanets

Abstract: Atmospheric retrieval is the inverse modeling method where atmospheric properties are constrained based on measured spectra. Due to the low signal-to-noise ratios of exoplanet observations, exoplanetary retrieval codes pair a radiative transfer (RT) simulator with a Bayesian statistical framework in order to characterize the distribution of atmospheric parameters that could explain the observations (the posterior distribution). This requires on the order of 10^6 RT model evaluations, which requires hours to days of compute time depending on model complexity. In this work, I investigate atmospheric retrieval methods and apply them to observations of hot Jupiters. Chapter 2 presents a set of RT and retrieval tests to validate the Bayesian Atmospheric Radiative Transfer (BART) retrieval code and applies BART to the emission spectrum of HD 189733 b. Chapter 3 investigates the dayside atmosphere of WASP-12b and resolves a tension in the literature over its composition. Chapter 4 introduces a machine learning direct retrieval framework which spawns virtual machines, generates spectra, trains neural networks, and performs atmospheric retrievals using trained neural networks. Chapter 5 builds on this and presents a machine learning indirect retrieval method, where the retrieval is performed using a neural network surrogate model for RT within a Bayesian framework, and compares it with BART. Chapter 6 utilizes the neural network surrogate modeling approach for thermochemical equilibrium chemistry models and compares it with other equilibrium estimation methods. Appendices address retrieval errors induced by choice of wavenumber gridding for opacity-sampling RT schemes, neural network model selection, the effects of data set size on neural network training, and the accuracy of Bayesian frameworks used for atmospheric retrieval.

Outline of Studies:
Major: Physics, Planetary Sciences Track

Educational Career:
B. S. UCF 2016

Committee in Charge:
Dr. Joseph Harrington (Chair)
Dr. Theodora Karalidi
Dr. Yanga Fernández
Dr. Atılım Güneş Baydin (External Committee Member)

Approved for distribution by Dr. Joseph Harrington, Committee Chair, on June 15, 2022.

The public is welcome to attend, either in person or remotely via Zoom.