DEBORAH J. GULLEDGE

Research Physicist, 15^{th} Space Surveillance Squadron
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Over five years of experience in fundamental and applied research, focusing on instrument development, contemporary observations of Jupiter and spatially-resolved time-domain data analysis techniques for giant planet seismology with the goal of inferring formation mechanisms for protoplanetary systems.

EDUCATION

Doctor of Philosophy in Astronomy (Nov 2022) — Georgia State University, Atlanta, GA
Dissertation: Expanding the Search for the Pulse of Jupiter — *Advisor: Dr. Stuart Jefferies*
Master of Science in Physics (May 2020) — Georgia State University, Atlanta, GA
Bachelor of Science in Physics (May 2018) — Austin Peay State University, Clarksville, TN

EXPERIENCE

Research Physicist, DR-02 — January 2023—Present
Air Force Research Laboratory / 15^{th} Space Surveillance Squadron

- Technical SME in Astronomy for a DoD science & technology development program executing $10M in SDA R&D. Providing risk reduction & technology options for transition partners in Space Systems Command, U.S. Space Command, & other agencies.
- Leading organic research in bench-level photometric, spectroscopic, and polarimetric instrument development. Leading Doppler imaging experiment on both 1m and 3.6m telescopes, using Jupiter as an analog for man-made satellites. Python and MATLAB based M&S of expected instrument performance & astrophysical phenomena (e.g., giant planet differential rotation, atmospheric dynamics, and internal global oscillations) to support technologies for SDA at the Maui Space Surveillance Complex.

National Science Foundation Graduate Research Fellow — August 2018—December 2022
Georgia State University

- Design, development, build, and characterization of a novel instrument for Doppler imaging (the Planetary Multilevel Oscillations & Dynamics Experiment, or PMODE) to probe the internal structure of Jupiter through the search for internal global oscillations, with the intent to differentiate between disk instability and core accretion as the most likely model for planetary formation.
- Collected 24 nights of Doppler imagery through PMODE on the AEOS 3.6m telescope. Led development of a robust and fully automated software package in MATLAB for reduction, calibration, and high-fidelity time-domain analysis for large volumes of Jovian Doppler and polarimetric data. Developed MATLAB & Python radiation transport simulation of global modes through the Jovian atmosphere to simulate expected polarization results, and comparison of reduced data with these simulated results.

Visiting Scientist — November 2022
Max Planck Institute for Solar System Research (Gottingen, Germany)

- Analysis and comparison of the PMODE Doppler observations, along with the JIVE/JOVIAL global team's Mach-Zehnder interferometric observations to infer implications from both experiments regarding the amplitude and frequency of Jovian global modes, the implication of results for the deep interior structure of Jupiter, and the overall implication of results for giant planet formation.

Juno Prime Mission Results Workshop Member — June 2022
California Institute of Technology

- Invited participant for the Caltech-hosted workshop to analyze the results of Juno's prime mission as they relate to Jupiter's atmosphere, interior, and origin. Active member in discussions regarding the nature and origin of Jupiter's dynamic gravity, comparison of accretion and evolution models with

current interior models, and led the discussion on the necessity of Doppler imagery to unambiguously probe the deep interior of the Gas Giant planets.

Research Fellow June 2020—August 2022
Universities Space Research Association / AFRL

· Optomechanical design and integration of a holographic spatial light modulator on the 3.6m AEOS telescope for accurate and robust simulation of giant planet exhibiting global atmospheric oscillatory behavior for propagation through the same optical system and data analysis pipeline as the PMODE data to validate extraction of Doppler signals from low SNR data. Development of a Python software package for GPU-based optimization routines, complex hologram generation, and system control.

Optical Engineering Graduate Intern June 2019—August 2019
NASA Jet Propulsion Laboratory

· Installed and aligned electro-optical hardware, characterized camera and system performance, and developed software in MATLAB to remotely operate the California ground station adaptive optics system for NASA's Laser Communication Relay Demonstration Mission.

Spectroscopic Data Analyst Intern June 2015—July 2018
Fermi National Accelerator Laboratory

· Developed and implemented a wide array of astronomical software in both Python and IRAF to model and analyze large volumes of spectroscopic data with high-performance computing clusters alongside an international team. This work enabled absolute calibration for the Dark Energy Survey (DES).

SKILLS

Computer Languages—Proficient in Python, MATLAB, Fortran, Julia, bash, familiar with C/C++.

General Software & Tools—Comfortable using Windows, MacOS, Ubuntu, LaTeX, Vim, Microsoft Office Suite. Some experience with Zemax Optics Studio, Solidworks, PyTorch, and Tensorflow.

Remote Sensing Techniques—10+ years of collecting remote sensing data (photometry, spectroscopy, Doppler, and polarimetry) on a range of world-class telescopes, from the 8.1m Gemini telescope in Chile, to the 3.6m AEOS telescope in Hawai'i. Experience developing novel software to perform photometric, spectral, and time-domain analysis of large datasets using Python, MATLAB, & IRAF.

Technical—Comfortable working with sensitive equipment and lasers in optics laboratories, fine alignment of optical equipment, and assembly of functional observatories from the ground-up. Significant experience performing data quality analysis in low S/N regimes and conducting time-domain analysis.

Personal—Excellent oral & written communication skills, rapid adaptability to new environments & projects, self-motivated, strong problem-solving skills. Interest in understanding emerging technologies & combining scientific endeavours with national defense capability to enable novel solutions to current challenges. Technical leadership of teams conducting research across multiple engineering disciplines (optical, mechanical, thermal, electrical).

SELECTED PRESENTATIONS AND PUBLICATIONS

Advanced Maui Optical and Space Surveillance Technologies (AMOS) 2022—ARES: a versatile benchtop testbed for evaluating techniques for imaging through atmospheric turbulence
Frontiers in Astronomy 2022—PMODE I: Design and Development of an Observatory for Characterizing Giant Planet Atmospheres and Interiors
AGU 2021—Jovian Clouds, Hazes, and Zonal Winds as seen by PMODE
AGU 2021—Limits on Excitation Mechanisms for Global Modes of Jupiter as seen by PMODE
AAS 2020/2021—Taking the Pulse of the Gas Giants from Antarctica
U.S. DoE Office of Scientific and Technical Information Report 2018—Calibrating the Dark Energy Survey: The Role of DA White Dwarfs
SPIE 2018—Dark energy survey operations: years 4 and 5