DEBORAH J. GULLEDGE

gulledge.astro@gmail.com
Research Physicist, 15^{th} Space Surveillance Squadron
Secret: Active | TS/SCI: In Progress (Initiated 12 Oct 2022)
Click to access my: *Website* | *LinkedIn* | *ORCID* | *Google Scholar*

EDUCATION

Doctor of Philosophy in Astronomy — August 2018—November 2022
Dissertation: Expanding the Search for the Pulse of Jupiter — Advisor: Dr. Stuart Jefferies
Georgia State University (GSU), Atlanta, GA

Master of Science in Physics, Astronomy Concentration — August 2018—May 2020
Georgia State University (GSU), Atlanta, GA — Advisor: Dr. Stuart Jefferies

Bachelor of Science in Physics, Magna Cum Laude — August 2013—May 2018
Austin Peay State University (APSU), Clarksville, TN — Advisor: Dr. Allyn Smith

PROFESSIONAL EXPERIENCE

Research Physicist, DR-02 — January 2023—Present
Air Force Research Laboratory / 15^{th} Space Surveillance Squadron — *Duty Station: Kihei, HI*

- Leading organic research in unresolved imaging and satellite characterization to support the improvement and application of directed energy and electro-optics technologies for Space Domain Awareness (SDA) at the Maui Space Surveillance Complex (MSSC).
- Researching new techniques to collect, store, disseminate, and process Doppler spectroscopic / photometric / polarimetric data from ground-based electro-optical telescopes, along with improvment of existing observational and spectroscopic technologies to enable custody & material characterization of space-based assets, AI/ML object identification, low SNR regime data analysis, and closely-spaced objection detection techniques.
- Leading development and integration of hardware and software solutions for the enhancement, maintenance, and upgrades of MSSC research telescopes, sensors, facilities, and techniques.
- Providing technical management of a 14-member research team to define requirements and coordinate development and responsibilities to ensure successful delivery and integration of hardware and software to support new and on-going DOD missions. Managing and evaluating contractor, in-house, and outside laboratory programs, ensuring the technical accuracy of the proposed solutions.

National Science Foundation Research Fellow — August 2019—December 2022
Georgia State University — *Advisor: Dr. Stuart Jefferies*

- Design, development, build, and characterization of a novel instrument for Doppler imaging (the Planetary Multilevel Oscillations & Dynamics experiment, or PMODE, installed on the AEOS 3.6m telescope and the Long-duration Antarctic Night & Day Imaging Telescope, or LANDIT, a Raven-class telescope for seismic observations from the geographic South Pole) for the young field of planetary seismology to probe the internal structure and atmospheric dynamics of Jupiter.
- Led development of a robust and fully automated software package in MATLAB for reduction, calibration, time-domain analysis, and signal extraction from low-SNR regimes for large volumes of data from the PMODE instrument.
- Working in close collaboration with scientists at the USSF's MSSC site to realize and adapt the use of planetary seismology techniques for use in SDA and remote sensing; in particular, for fuel slosh measurements, maneuver detection, and rapid initial orbit determination.

Visiting Scientist November 2022
Max Planck Institute for Solar System Research (Gottingen, Germany) *Host: Dr. Patrick Gaulme*

· Analysis and comparison of the PMODE MOF-based Doppler imaging dataset with the JOVIAL Mach-Zehnder interferometric based Doppler imaging dataset. Presenting the 2020 PMODE seismic Doppler results to a global team spanning the United States, Germany, France, and Japan endeavoring to conduct similar measurement techniques.

Visiting Scientist November 2021, November 2022
New Mexico State University, Dept. of Astronomy *Host: Dr. Jason Jackiewicz*

· Intensive calibration and signal processing analysis of high-resolution time domain data to extract seismic signals from Jovian observations in both Doppler imaging (the 2020 PMODE campaign) and Mach-Zehnder interferometry (the JIVE/JOVIAL campaign).

Research Fellow June 2022—August 2022
Universities Space Research Association *Supervisors: Maj. Roman Tillman & Dr. Ryan Swindle*

· Integration of a holographic spatial light modulator for extended object scene generation (the CHAOS project) on the Adaptive Optics (AO) bench at the MSSC site. This object simulator enhances the capabilities of the site so that the sensor capabilities at the site can be leveraged without on-sky time to characterize incoherent, polychromatic wavefronts to emulate AEOS observations and provide feedback for optical alignment and corrections in real time, in addition to providing an avenue to generate large simulated datasets for AI/ML training.
· Managed 5-member technical team to lead this project to success and conducted optomechanical design, optical alignment, and development of a Python software package for GPU-based optimization routines, complex hologram generation & system control.
· Conceptualization and testing of a novel Imaging Shack-Hartmann Wavefront Sensor to significantly improve AO and image restoration capabilities at the MSSC site.

Visiting Scientist June 2021—October 2021
University of Hawai'i, Institute for Astronomy *Host: Dr. Stuart Jefferies*

· Developing novel software in MATLAB for enhancement and extraction of small planetary oscillation signals from an orders-of-magnitude larger background noise in the Fourier domain, focusing on significant improvement in reduction and analysis capabilities for the remote-sensing PMODE seismic dataset collected in Summer 2020.

Research Fellow June 2020—August 2020
Universities Space Research Association *Supervisor: Dr. Ryan Swindle*

· Development of Python software for image reconstruction from the AEOS 3.6m telescope's wavefront sensor. Python- and MATLAB-based M&S to evaluate theoretical performance between multiple wavefront sensing techniques (classic Shack-Hartmann, imaging Shack-Hartmann, and pyramid) for extended target correction.

Optical Engineering Graduate Intern June 2019—August 2019
NASA Jet Propulsion Laboratory *Mentors: Dr. Lewis Roberts & Dr. Neil Murphy*

· 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 at Table Mountain Observatory for NASA's Laser Communication Relay Demonstration Mission. Additionally, analyzed photometric data collected for Saturn ring seismology on the 120 inch Shane telescope at Lick Observatory.

Spectroscopic Data Analyst Intern June 2015—July 2018
Fermi National Accelerator Laboratory *Mentors: Dr. Allyn Smith & Dr. Douglas Tucker*

· Worked with an interdisciplinary, global team on absolute calibration for the Dark Energy Survey (DES) to better understand the nature of the dark energy that is accelerating the expansion of our Universe. Developed and implemented a wide array of astronomical software in both Python and IRAF to model and analyze large volumes of white dwarf spectroscopic data and strong gravitational lensing photometric data with high-performance computing clusters. This work enabled absolute calibration for the Dark Energy Survey (DES) to better understand the nature of dark energy.

Blue Waters Supercomputing Intern June 2014—May 2015
University of Illinois, Urbana-Champaign, IL *Mentor: Dr. Allyn Smith*

· Attended a highly-intensive two-week parallel and supercomputing workshop through Blue Waters Institute for Petascale Computing. Implemented learned skills during the academic year through the independent development of a fully-automated pipeline for the reduction and analysis of astronomical data from the 0.5m APSU telescope.

OBSERVING EXPERIENCE

Haleakalā Observatory July 2020—August 2020
AEOS 3.6m Telescope *Maui, HI, USA*

· 42 consecutive nights on the AEOS 3.6m telescope at Mount Haleakalā, Hawaii to collect polarimetric and velocimetry data to characterize the interior structure of Jupiter through radial displacement in the Jovian clouds using PMODE, a triple-channel Doppler imager and polarimeter. I assisted on concept, design, build, alignment, collecting observations, and data analysis for this experiment in its entirety.

Amundsen-Scott South Pole Station Cancelled due to Covid-19
LANDIT Winter-Over *South Pole, Antarctica*

· Selected as one of the two South Pole winter-overs for the LANDIT experiment, a novel 0.5m, dual-channel observatory, consisting of a Doppler imager and polarimeter for planetary seismology and satellite fuel slosh and maneuver observations, that I assisted in developing. I was chosen and cleared for deployment to the South Pole in the Austral winter of 2020. This observing run was cancelled due to COVID-19 complications and the instrumentation was modified to become PMODE.

Cerro Tololo Inter-American Observatory December 2017
0.9m and Blanco 4m Telescopes *Cerro Tololo, Chile*

· 5 nights consisting of a combination of photometric data collection for the DES Year 4 observing campaign using DECam on the 4m Blanco and white dwarf calibration work for the DES on Cerro Tololo's 0.9m telescope.

Kitt Peak National Observatory March 2014—June 2017
WIYN 3.5m and 0.9m Telescopes *Tucson, Arizona, USA*

· 16 cumulative nights at the Kitt Peak National Observatory (WIYN 3.5m using the Hydra spectrograph and 0.9m using the Half-Degree Imager) in AZ, USA. Collected and analyzed both spectroscopic and photometric data on white dwarf stars to support the Dark Energy Survey, in addition to photometric data to characterize the open cluster Dolidze-35.

Gemini Observatory October 2015
Gemini South 8.1m Telescope *Cerro Pachón, Chile*

· 5 nights at the Gemini Observatory, using the GMOS instrument on the Gemini South 8.1m telescope. Collected photometric and spectroscopic data to support the gravitational lensing subsection of the Dark Energy Survey.

ACCEPTED PROPOSALS AND GRANTS

- **"Taking the Pulse of the Gas Giants from Antarctica"**, Gulledge, Deborah J. (P.I.), NSF Graduate Research Fellowship Program, **$598,000**, Grant No. 1937956 (2019–2022)
- **"Electronic Music of the Planets: Organizing Dopplergrams and Polarimetry of Planetary Oscillations"**, Gulledge, Deborah J. (Co.I.), NASA Space Grants (2022)

SELECTED PUBLICATIONS AND PRESENTATIONS

Publications

To see my publication record on Google Scholar, *click here.*

- **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
(doi: 10.3389/fspas.2022.768452)
- **U.S. DoE Office of Scientific and Technical Information Report 2018**—Calibrating the Dark Energy Survey: The Role of DA White Dwarfs
(doi:10.2172/1477987)
- **SPIE 2018**—Dark energy survey operations: years 4 and 5
(doi:10.1117/12.2312113)
- **Astronomische Nachrichten 2017**—Discovery of a new quasar: SDSS J022155.26-064916.6
(doi:10.1002/asna.201713379)

Invited Talks and Colloquia

- "Expanding the Search for the Pulse of Jupiter", *Astronomy Seminar*, *Max Planck Institute for Solar System Research*, hosted by Dr. Patrick Gaulme, November 25, 2022
- "Limits on Excitation Mechanisms for Global Modes of Jupiter as seen by PMODE", *Astronomy Seminar*, *University of Kentucky*, hosted by Dr. Dirk Grupe, April 13, 2022
- "PMODE I: Design and Development of an Observatory for Characterizing Giant Planet Atmospheres and Interiors", *Astro Coffee & Journal Club*, *Michigan State University*, hosted by Brandon Barker, April 4, 2022
- "Limits on Excitation Mechanisms for Global Modes of Jupiter as seen by PMODE"
Keynote Presentation, Kentucky Area Astronomical Society Meeting, *Austin Peay State University*, hosted by Dr. J Allyn Smith, April 1, 2022
- "PMODE: the Planetary Multilevel Oscillations & Dynamics Experiment", *Lunchtime Colloquium*, *New Mexico State University*, hosted by Dr. Jason Jackiewicz, Nov 8, 2021
- "From APSU to the Stars—Taking the Pulse of the Gas Giants", *Governor's School for Computational Physics*, *Austin Peay State University*, hosted by Dr. B. Alex King III, June 15, 2021

Conference Talks

- **AGU 2021**—Limits on Excitation Mechanisms for Global Modes of Jupiter as seen by PMODE

Conference Posters

- **AAS 2023**—Updated Limits on Jovian Oscillations and Zonal Wind Measurements from PMODE
- **Juno Prime Mission Results Workshop 2022**—PMODE: The Planetary Multilevel Oscillations & Dynamics Experiment
- **AGU 2021**—Jovian Clouds, Hazes, and Zonal Winds as seen by PMODE
- **AAS 2020/2021**—Taking the Pulse of the Gas Giants from Antarctica

- **AAS 2018**—Modeling and Analysis of CTIO 1.5m White Dwarf Spectra
- **AAS 2017**—Spectroscopic Reductions of White Dwarf Stars to Support Dark Energy Survey Calibrations
- **AAS 2016**—Dolidze-35: Results for a Possible Open Cluster

AWARDS, MEMBERSHIPS, AND PROFESSIONAL AFFILIATIONS

AWARDS

Col. Bradford W. Parkinson Innovation Award Recipient (Space Delta 2 Level)	2023
Civillian Category III Quarterly Award Recipient (Branch Level)	2023
Giller Team Award Recipient (Division Level)	2023
Giller Team Award Recipient (Branch Level)	2023
NSF Graduate Research Fellowship Recipient	2019–2022
GSU Remote Sensing for Space Sciences Fellowship Recipient	2019
GSU Second Century Initiative Fellowship Recipient	2018
APSU Robert F. Sears Physics/Astronomy Award Recipient	2018
APSU Presidential Scholarship Recipient	2013–2017

MEMBERSHIPS

American Geophysical Union Member	2021–Present
Sigma Pi Sigma National Physics Honors Society	2016–Present
American Astronomical Society Member	2014–Present
Society of Physics Students Member	2015–2022

PROFESSIONAL AFFILIATIONS

JUNO Prime Mission Results Workshop, Caltech	2022
NASA Dragonfly Science Team Meeting Observer	2020

SKILLS AND CERTIFICATIONS

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

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

Astronomical Observations & Dedicated Software—10+ years of collecting remote sensing data including photometry, spectroscopy, Doppler imaging, and polarimetry techniques on a broad range of world-class telescopes. Experienced in developing novel software to perform photometric, spectral, and time-domain analysis of large datasets using Python, MATLAB, IRAF, PyRAF, and DS9.

Technical—Comfortable working with sensitive equipment and lasers in optics laboratories, fine alignment of optical equipment, build and assembly of telescopes and functional observatories from the ground-up. Significant experience performing data quality analysis in low S/N regimes and conducting time-domain analysis. Experience integrating multiple subsystems (optical, mechanical, thermal, and software) into a functional experiment, identifying and correcting unexpected issues, and significant experience documenting and communicating the integration process, including issues and resolutions.

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. 5 years of experience working closely with the DOD and Gov't contractors. Leadership of teams conducting research across multiple engineering disciplines (optical, mechanical, thermal, electrical). Creative & passionate about

incorporating scientific principles spanning multiple fields to enable novel solutions to current experiments. Experience defining, documenting, and communicating technical requirements to leadership. Experience handling and protecting classified data.

Safety Certifications—Trained in cyber-security, laser safety, ESD safety, and PPE safety for working in optical laboratories.

TEACHING EXPERIENCE

- **Georgia State University Lab Instructor** Fall 2018–Spring 2019
  Led a total of 5 introductory Solar System astronomy and Stellar astronomy lab sections.
- **Governor's School for Computational Physics Mentor** June 2015–June 2018
  Introduced 40 high school students each summer to the field of computational physics. Consisted of teaching introductions to computer programming, physics, and calculus, then teaching the students to combine these areas to model more difficult physical problems. Held tutoring sessions, assisted the students with computational projects and homework, and provided mentorship for future plans and college preparation.
- **APSU Physics SLA Instructor** Fall 2016
  Led a two hour Structured Learning Assistance physics workshop to improve academic success rates for struggling students in introductory physics.

STUDENTS SUPERVISED

- **Brady Smith (Undergraduate)** 2022
  Awarded NASA KY Space Grant to act as the prime research mentor to one student at the University of Kentucky. Funding was awarded for public data release of PMODE research products—these data will significantly contribute to the planetary science field. Mentorship and leadership includes guidance on programming with MATLAB and astronomical data manipulation techniques to prepare the dataset for hosting on NASA PDS.
- **Ashley Wheeler (Undergraduate)** 2021
  Training includes familiarization of basic astronomical software (DS9, Stellarium) and an introduction to programming with MATLAB and astronomical data reduction techniques.

PUBLIC OUTREACH

Invited Talks

- "A Day With Your Local Astrophysicist" for the 8^{th} grade class at Ethridge Elementary School, Ethridge TN, March 22, 2022
- "What 'Juno About Jupiter?" talk at Louisiana State University's Astronomy on Tap, November 12, 2020 *(Click Here for Recording—begins at 46:47)*
- "Seismology of the Gas Giants" talk at Charlie Elliot Astronomy, November 2, 2019

University Outreach

- Presentations of Science Public Outreach Team (SPOT) Resources to K-12 students 2019
- APSU Planetarium shows for local grade school students 2014–2018
- APSU physics demonstration shows for K–12 students 2014–2018

MEDIA

"APSU grad could be on first team ever to prove Jupiter has a solid core" (Fox 17 Nashville Television Interview)	2019–Click Here
"APSU Physics Grad joins 10 Month Expedition to the South Pole"	2019–Click Here
"GSU Next Gen Scholars Interview"	2019–Click Here
"APSU NSF GRFP Interview"	2019–Click Here
"Graduate Student Awarded NSF Fellowship"	2019–Click Here
"GSU Students Awarded Prestigious Internships"	2019–Click Here
"APSU physics student named *Scientist of the Week* at national lab"	2018–Click Here
"Physics senior explores passion for astronomy in Arizona, Chile"	2018–Click Here
"*Scientist of the Week* interview with Fermilab"	2018–Click Here

REFERENCES

Stuart M. Jefferies, Ph.D.
GSU Professor and Dissertation Advisor
Email: sjefferies@gsu.edu
Phone: (808) 250-7589

Ryan Swindle, Ph.D.
Odyssey Systems Research Engineer and USRA Independent Contract Supervisor
Email: ryanswindle@odysseyconsult.com
Phone: (501) 339-4150

Neil Murphy, Ph.D.
JPL Scientist, Astrophysics and Space Science Section, and Research Supervisor
Email: neil.murphy@jpl.nasa.gov
Phone: (931) 472-8242

Roman Tillman, Major, USSF
15 SPSS Research Flight Commander
Email: roman.tillman12@gmail.com
Phone: (850) 685-3758

J. Allyn Smith, Ph.D.
APSU Professor and Undergraduate Advisor
Email: smithj@apsu.edu
Phone: (931) 472-8242

Updated November 6th, 2023