Nick Tusay

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Research Focus:

Radio technosignature search methods, observations and data analysis.
Exoplanet transmission spectroscopy with JWST and ground-based optical observatories.

Education:

Ph.D. in Astronomy & Astrophysics and Astrobiology — August 2025
Thesis: A Lonely Astrobiologist (in progress)
Penn State University, State College, PA

M.S. in Astronomy & Astrophysics — May 2023
Penn State University, State College, PA

B.S. in Physics — May 2020
The College of New Jersey, Ewing, NJ

B.S. in Mechanical Engineering — May 2004
Rutgers University, New Brunswick, NJ

Research Experience:

Doctoral Research at Penn State University Advisor: Dr. Jason Wright
Mid-IR Spectroscopy of K2-22b with JWST August 2022 - present

- Science PI for JWST GO program 3315, MIRI LRS transmission spectroscopy of K2-22b
- Led and submitted successful JWST cycle 2 proposal. Awarded $261,526 for 18 hrs of science time
- Simulated JWST MIRI data using PandExo and built a linear regression code in Python to fit a suite of geophysical composition models
- Extended model retrieval simulations to optical wavelengths, and submitted successful proposals for simultaneous optical observations to LCO, WIYN, and CHEOPS
- Coordinated simultaneous optical observations at LCO, WIYN, APO, the 88" telescope at UH, and CHEOPS
- Reduced JWST MIRI LRS data from MAST using the Eureka! pipeline
- Fit transit models to the lightcurve and extracted a transmission spectrum from model depths in each channel
- Constructed geophysical models of mineralogical compounds based on mie scattering theory
- PI of 3 Cycle 4 proposals following up on K2-22b and 2 additional disintegrating planet candidates

Doctoral Research at Penn State University Advisor: Dr. Jason Wright
SETI during PPOs in TRAPPIST-1 with ATA August 2022 - December 2024

- Used `turboSETI` to identify narrowband signals in the high frequency resolution filterbank data products from observations of TRAPPIST-1 at the Allen Telescope Array
- Built a python based pipeline to filter and plot the detected signals by leveraging beamforming to discriminate obvious sources of radio frequency interference
- Tested my algorithm by applying `setigen` to perform injection recovery of simulated signals
- Modified and employed the julia code `NbodyGradient` to determine planet-planet occultation events that may have occurred during our observations
- Plotted and examined the dynamic spectrum of thousands of candidate signals
- Wrote and published paper in the Astronomical Journal as first and corresponding author.

Doctoral Research at Penn State University Advisor: Dr. Jason Wright
SETI at the Solar Gravitational Lens Focal Region August 2020 - August 2022

- Assisted in carrying out observations at Green Bank Telescope
- Managed data transfer to and storage on the Penn State high performance computing cluster
- Used `turboSETI` to analyze the high frequency resolution filterbank data products
- Plotted and examined the dynamic spectrum of thousands of candidate signals
- Co-first-authored the paper, being chiefly responsible for writing the analysis and results sections

Undergraduate Research at The College of New Jersey Advisor: Dr. Lauranne Lanz
Investigating Galactic Evolution by Measuring AGN Feedback Fall 2019 - Spring 2020

- Learned and utilized CIAO software to count X-ray photons in the central region of NGC1266
- Used Python to model X-ray spectra and map the temperature profile of the AGN outflow

REU at Notre Dame University Advisor: Dr. Justin Crepp

Improving Adaptive Optics Wavefront Instrumentation May 2019 - August 2019

- Used Solidworks to render a model of our optical system
- Assisted in the assembly and alignment of multiple optical setups in an optics lab
- Helped install and use a Shack-Hartmann Wave Front Sensor in our optical setup
- Developed GUI software for the mechanical components of our system using Matlab App Designer
- Coordinated with nanofabrication engineers to produce and measure microscopic etchings to test our optical system

Undergraduate Research at The College of New Jersey Advisor: Dr. Paul Wiita

High Resolution 3D Relativistic AGN Jet Simulations Fall 2018 - Spring 2019

- Used `Athena` and `Athena`++ code on TCNJ's computing cluster to run higher resolution simulations than previously done of AGN jets with various jet speeds and densities
- Constructed 2D and 3D images from the simulation outputs using ParaView software and compared against lower resolution runs
- Modified the `Athena`++ code to include relativistic effects in the equations of state

Undergraduate Research at The College of New Jersey Advisor: Dr. Nathan Magee

Investigating Ice Crystal Morphology in Cirrus Clouds May 2018 - August 2018

- Modified payloads and launched weather balloons to collect ice crystals in cirrus clouds
- Analyzed weather forecasts to select optimal launch and collection times and locations
- Grew ice crystals in the lab on various substrates at various pressures, temperatures and humidity levels to simulate ice crystal formation in cirrus clouds
- Used an ellipsometer to obtain polarization data on grown crystals in the lab
- Worked in the machine shop to synthesize mechanical components for the lab and our payloads
- Operated the scanning electron microscope to obtain images of captured and lab-grown crystals

Teaching and Mentorship Experience:

High School Physics Teacher

Hopewell Valley Central High School, Pennington, NJ September 2010 - June 2011

- Taught three sections of regular physics and one section of AP physics C
- Attended night classes while teaching to obtain alternate route public school certification in NJ

The Pennington School, Pennington, NJ September 2005 - June 2007

- Taught all three levels of physics: regular, honors and AP
- Acquired a Commercial Driver's License (CDL) to help transport students
- Lived on campus and assisted boarding students: monitoring, transporting, tutoring, etc.

Awards and Grants:

- 2025 ExoExplorer through NASA's Exoplanet Exploration Program
- Visiting Graduate Student Fellowship at IPAC (2025)
- JWST Cycle 2 GO Program 3315, Awarded $261,526 for 18 hrs of science time (2023)
- National Science Foundation Graduate Research Fellowship Program (NSF GRFP) Awardee (2020)
- Distinguished Graduate Fellowship at Penn State University (2020)

Skills:

- Proficient Languages: Python, Julia
- Familiar Languages: Fortran, R, C++, Matlab
- Software: turboSETI, NbeamAnalysis, Eureka, AstroImageJ
- Telescopes Observing Experience: GBT, ATA, WIYN, LCO, CHEOPS, JWST
- Other Skills: Linux, Bash, Github, Excel, LaTeX, High Performance Computing, Large data volume management (∼TBs)

Publications:

[1] Nick Tusay et al. "A Radio Technosignature Search of TRAPPIST-1 with the Allen Telescope Array". In: *arXiv e-prints*, arXiv:2409.08313 (Sept. 2024), arXiv:2409.08313. DOI: `10.48550/arXiv.2409.08313`. arXiv: `2409.08313 [astro-ph.EP]`.

[2] Nick Tusay and Macy J. Huston et al. "A Search for Radio Technosignatures at the Solar Gravitational Lens Targeting Alpha Centauri". In: *The Astronomical Journal* 164.3, 116 (Sept. 2022), p. 116. DOI: 10.3847/1538-3881/ac8358. arXiv: 2206.14807 [astro-ph.IM].

[3] Nathan Magee et al. "Captured cirrus ice particles in high definition". In: *Atmospheric Chemistry & Physics* 21.9 (May 2021), pp. 7171–7185. DOI: 10.5194/acp-21-7171-2021.

[4] Justin R. Crepp et al. "Measuring phase errors in the presence of scintillation". In: *Optics Express* 28.25 (Dec. 2020), p. 37721. DOI: 10.1364/OE.408825. arXiv: 2012.12695 [astro-ph.IM].

Conference Organizing and Committee Assignments:

- The Second Assembly of the Order of the Octopus, August 2024
  - Organizing Committee member (LOC & SOC)
- PSETI Symposium at PSU, June 2023
  - Co-chair of the Local Organizing Committee (LOC)
  - Science Organizing Committee (SOC) member
- The First PSETI Symposium at Penn State University, June 2022
  - Local Organizing Committee (LOC) member
- The First Assembly of the Order of the Octopus (virtual), August 2020
  - Organizing Committee member
- Climate and Diversity Committee, September 2020 - Present
  - Contributed in the planning and execution of activities designed to improve the climate and diversity of the Astronomy and Astrophysics department, such as Astro+ Reseach Showcase, Career Seminar Series, Department Beautification Project, Undergraduate Town Hall
- Graduate Program Committee, September 2021 - September 2023
  - Represented graduate student voices in discussions on improving the graduate program.
  - Actively worked with graduate students and faculty to design a better qualifying exam.
- Graduate Student Office Manager, September 2022 - September 2024
  - Managed the graduate student desk assignments and redistribution of office space with the yearly departure of newly graduated students and first-year arrivals

Conference and Workshop Presentations:

- The Second Assembly of the Order of the Octopus, August 2024
  - Oral presentation on TRAPPIST-1 PPOs with ATA project
- Escape from Exoplanets Workshop at Imperial College in London, UK, June 2024
  - Oral presentation on preliminary JWST results for the K2-22b project
- Exoplanets V in Leiden, Netherlands, June 2024
  - Poster presentation on preliminary JWST results for the K2-22b project
- American Astronomical Society (AAS) Summer Meeting 244 in Madison, WI, June 2024
  - Oral presentation on preliminary JWST results for the K2-22b project
- AbSciCon in Providence, Rhode Island, May 2024
- Extreme Solar Systems V in Christchurch, New Zealand, March 2024
  - Poster presentation on K2-22b with JWST project
- American Astronomical Society (AAS) Winter Meeting 243 in New Orleans, LA, January 2023
  - Oral presentation on TRAPPIST-1 PPOs with ATA project
- URSI GASS in Sapporo, Japan, August 2023
  - Oral Presentation to promote the PSETI Center
- PSETI Symposium at PSU, June 2023
  - Oral presentation on ongoing analysis of TRAPPIST-1 observations at ATA
- AbGradCon in San Diego, CA, May 2023
  - Poster presentation of the published SGL project
  - Proposal Writing Retreat (workshop before AbGradCon) on Catalina Island, CA
- SETI Workshop at Allen Telescope Array (ATA), April 2023
  - Oral presentation on SETI pipeline progress at ATA
- American Astronomical Society (AAS) Winter Meeting 241 in Seattle, WA, Jan 2023
  - Oral presentation on published SGL project

- The First PSETI Symposium at Penn State University, June 2022
  - Oral presentation on the submitted SGL project
- The First Assembly of the Order of the Octopus (virtual), August 2020
  - Oral presentation on commensal radio SETI
- American Astronomical Society (AAS) Winter Meeting 235 in Honolulu, HI, January 2020
  - Poster presentation on undergraduate AGN outflow research
- American Astronomical Society (AAS) Summer Meeting 234 in St. Louis, MO, June 2019
  - Poster presentation on undergraduate AGN jet simulation research