

Suvinay Goyal

RESEARCHER IN EXPERIMENTAL AND OBSERVATIONAL COSMOLOGY

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Education

University of Illinois Urbana-Champaign

BS, DOUBLE MAJOR IN ASTROPHYSICS AND DATA SCIENCE

August 2022 - Current

- **GPA:** 4.0/4.0 ; **Minor:** Mathematics; James Scholars Honors Student ; Phi Beta Kappa Honors Society; Dean's List (Fall 2022-Spring 2025); On track to graduate with Highest Distinction in Astronomy and University Bronze Tablet Honors
- **Senior Thesis (In Progress):** Characterization of Terahertz absorbers using a Toptica Frequency Selectable Laser source and Kinetic Inductance Detector Arrays' optical response for the Terahertz Intensity Mapper
- **Specialized Coursework:** Graduate Physical Cosmology, Electronic Circuits, Graduate Nuclear Particle Astrophysics, Numerical Analysis, Machine Learning, Algorithms and Data Structures

Research Experience

Observational Cosmology & Particle Astrophysics Lab

(<https://jpf.web.engr.illinois.edu>)

UIUC

ADVISOR: PROF. JEFFREY P FILIPPINI

June 2023 - Present

- **Collaboration : SPIDER Balloon CMB Telescope** (Advised by: Jeffrey Filippini)

- Developed an astrometry package in Python to inspect the visibility of satellite constellations (Starlinks) during the SPIDER II flight. Used to look for satellite signals in SPIDER's flight by cross-correlation with CMB maps.

- **Collaboration: Terahertz Intensity Mapper (TIM) Balloon Telescope** (Advised by: Jeffrey Filippini, Joaquin Vieira)

- Actively assisting in the cryogenic cooldowns, lab readout and mechanical integration of TIM cryostat
- Engineered and calibrated a bolometer for checking infrared loading in cryogenic systems for TIM
- Developed a 0.5mm optical window by testing UHMWPE thicknesses for mechanical robustness
- Developed the usage of Toptica Terascan 1550, laser source for Terahertz characterization of absorbers and filters
- Developed a Terahertz reflective neutral density filter (attenuator) for characterizing the optical response of the LW KID detector module during first-light

- Optimizing for a Fabry Perot Terahertz Waveguide Spectrometer design using Ansys HFSS

Observational Cosmology Group (<https://cosmology.caltech.edu>)

Caltech

ADVISORS: PROF. JAMES J. BOCK, LATE DR. KENNY LAU

June 2025 - Aug 2025

- **Collaboration(s): BICEP, Tomographic Ionized Carbon Mapping Experiment (TIME)**

- Commissioned a 100 mK ADR (Adiabatic Demagnetization Refrigerator) testbed backed by a He-10 Sorption Fridge
- Installed and optimized design for the thermal connections in the cryostat with heatstraps for a 48-hour hold-time.
- Equipped the testbed with TDM (Time Division Multiplexing) readout, soldered cryogenic connections
- Tested the tin-coated copper readout cables on Kapton flex PCBs for TIME for lower resistances after superconducting transition, compared to the old cables. Helped inform a reliable manufacturing recipe for on-site deployment
- Presentation: Commissioning a 100 mK ADR Cryostat for CMB and Line-Intensity Mapping Applications

Exoplanet Technology Lab (<https://etlab.caltech.edu>)

Caltech

ADVISORS: PROF. DIMITRI MAWET, DR. NEMANJA JOVANOVIC, DR. YINZI XIN

June 2024 - Nov 2025

- **Collaboration: Photonic Lantern Nuller (PLN)**

- Developed post-processing algorithms for Angular Differential Imaging of Exoplanets directly imaged from a PLN
- Numerically characterized PLN's limitation of rotationally non-invariant 1D data for coronagraph algorithms
- Implemented a cost-function based optimization to localize planets from PLN data
- Final Presentation: Analysis of Angular-Differential Post-Processing Algorithms for Exoplanet Direct Detection with a PLN

- Awarded in-person observing time on the 200-inch Hale Telescope's DBSP for a Kepler-1788b transit at Palomar Observatory, gaining hands-on experience with the instrument and overnight observing; this was independent of my PLN project

Publications

SUBMITTED

Goyal, S., Xin, Y., Mawet, D., Jovanovic, N., Fitzgerald, M., *Analysis of Angular-Differential Post-Processing Algorithms for Exoplanet Direct Detection with a Photonic Lantern Nuller*, JATIS (Submitted Nov 29, 2025)

PUBLISHED

Xin, Y., et al. (incl. **Goyal, S.**). 2025. *Implicit Electric Field Conjugation with the Photonic Lantern Nuller*, JATIS 11(2), 025004
<https://arxiv.org/abs/2503.24292>

Presentations/Seminars

February 1, 2024. *Undergraduate Physics Seminar, UIUC, Spring 2024*

Title: Safeguarding the Early Universe. A one-hour seminar on the research project, Probing Starlinks, its applications in observational astronomy, the SPIDER telescope, CMB polarization, and inflation.

April 25-26, 2024. *Undergraduate Research Symposium, UIUC, Spring 2024 ; Astrofest, UIUC, Spring 2024*

Poster: Investigating Starlink Interference in SPIDER's Field of View

March, 2025. *APS Global Physics Summit 2025*

Poster: Analysis of Angular-Differential Post-Processing Algorithms for Exoplanet Direct Detection with a PLN

April 24-25, 2025. *Undergraduate Research Symposium, UIUC, Spring 2025 ; Astrofest, UIUC, Spring 2025*

Poster: Developing an Ultra-Thin UHMWPE Window for the Terahertz Intensity Mapper

Technical Skills

	Python, C++, FORTRAN, SQL, Mathematica, LaTeX Linux/Unix, Docker, virtual environments, Git Machine Learning,
Programming/Computation	Workflow Automation, Data Management, Feature Engineering
Specialized Python Libraries	Astropy, CAMB, HCIPy, CLASS PyTorch, Pandas, Sklearn, Scipy, Tensorflow Qiskit
Experimental	Mechanical Design & Instrumentation, Optical & Cryogenic Testbeds, Vacuum Systems, Readout Electronics, Soldering, Data Acquisition & Preprocessing, Thermal Modeling, CAD (Solidworks) & Rapid Prototyping (3D Printing, Machining)

Relevant projects

Cosmological Matter Simulation using Zel'dovich Approximation

Instructor : Prof. Kirk Barrow

GRADUATE LEVEL ASTR 507 (PHYSICAL COSMOLOGY)

Fall 2024

- Used Planck 2018 results from the TT,TE,EE+lowE+lensing+BAO parameters to simulate matter evolution of the universe from $z=1100$ to $z=0$, through a 3D cosmic web and a quiver animation showing attractors and voids formation.

Stellar Evolution using FORTRAN-based MESA

Advisor : Prof. Brian Fields

HONORS RESEARCH PROJECT: STELLAR ASTROPHYSICS

Fall 2023

- Used Modules for Experiments in Stellar Astrophysics (MESA) to simulate the lifetimes of $1 M_{\odot}$ and $20 M_{\odot}$ stars from pre-MS to White Dwarf/Core Collapse stage, to verify results in Stellar evolution.

Outreach & Professional Development

LABESCAPE (PROF. PAUL KWIAT)

May 2023-Current

- Science based escape room venture based on about Quantum Entanglement and astrophysical calamities.

SOCIETY OF PHYSICS STUDENTS (SPS) (TREASURER (2024-2025), SOCIAL CHAIR (2023-2024))

August 2023-Current

- Organized outreach ventures, reviewed projects' proposals, and managed project-based funding for equipment.

PHYSICS STUDENTS ADVISORY BOARD (PHYSAB) (EXECUTIVE BOARD)

August 2022- Present

- Student-based advisory board for advising on reforms in the department, like undergraduate research, course offerings, etc.

Teaching Experience

Astronomy **UG TA**, Stellar Astrophysics (2 Sem), Computing in Astronomy : Grading Assignments and Exams

CS **UG TA**, Data Structures for Data Science (Python), Data Structures (C++): Office Hours, Assisting Lab Sections, Developing Coding and Objective Assignments on Prarielearn, Developing Exam Questions

Statistics **UG TA**, Data Science Exploration (2 sem): Grading Assignments, Exams; Office hours, Assisting Lab Sections

Astronomy **Observatory Assistant**, Assists students in observing assignments by operating Dobsonians and the Dome Telescope

Awards, Fellowships, & Grants

2024 **Get Experience Scholarship**, College of Liberal Arts and Sciences, UIUC

2025 **Summer Undergraduate Research Fellowship**, California Institute of Technology

2024 **Summer Undergraduate Research Fellowship**, California Institute of Technology

2024 **Conference Travel Grant**, Illinois Office of Undergraduate Research UIUC