Vaishnav V. Rao

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Education

2023-Present **University of Michigan, Ann Arbor, MI**.
- Pre-Candidate, Astronomy & Astrophysics PhD
  GPA: 4.0/4.0

2019–2023 **Indian Institute of Technology Bombay, Mumbai, India**.
- **Major:** Bachelor of Technology in Physics with Honours
  GPA: 9.51/10
- **Minor:** Mathematics
  GPA: 9.5/10

Research Publications

V. V. Rao, P. Kharb, et al. (2023). **AGN Feedback Through Multiple Jet Cycles in the Seyfert Galaxy NGC 2639**. *Monthly Notices of the Royal Astronomy Society.* 524,1615 10.1093/mnras/stad1901.

K. Gozman, E. Bell, I. Jang, J.M Arias, J. Bailin, R. de Jong, R. D'Souza, O. Gnedin, A. Monachesi, P. Price, **V. V. Rao**, A. Smericna. **Exploring the Diversity of Ultra-Faint Dwarf Satellites in the M81 Group**. *Astrophysical Journal Letters (submitted).*

Research Experience

May'24-Present **Resolving Stars Formed in M82's Outflow**, *(paper in prep).*
Guide: Prof. Eric Bell | Dept. of Astronomy, University of Michigan
- Analyzed **Hubble Space Telescope** photometry of the M82 galaxy to characterize, for the very first time, star formation triggered within a starburst driven outflow
- Used the color magnitude diagram (CMD) fitting software **MATCH** to deduce star formation histories and discovered signs of an episodic outflow
- Using star formation age gradients, constrained the proper motion of the galaxy

Aug'23-Present **Search for Ultra Faint Dwarf Galaxies in the M81 Galaxy Group**.
Guide: Prof. Eric Bell | Dept. of Astronomy, University of Michigan
- Improved star-galaxy separation in **Subaru Hyper Suprime-Cam** photometry of the M81 group of galaxies using realistic morphological selections and **machine learning (ML) classifiers** to aid the search for ultra-faint dwarf **(UFD) satellites** in the stellar halo
- Searched for clustering of old, metal-poor red giant branch stars using **kernel density estimators** and ML-based clustering algorithms to identify candidate UFDs

May'22-Jul'22 **Episodic activity in NGC 2639**.
Guide: Dr. Preeti Kharb | National Centre for Radio Astrophysics(NCRA-TIFR), India
- Reduced the data of the **Giant Metrewave Radio Telescope** (GMRT) and the **Jansky Very Large Array** (JVLA) using the radio data reduction software CASA, to image the multiple radio jets of the Seyfert galaxy NGC 2639, originating from multiple minor mergers.
- Performed **synchrotron spectral ageing** of the radio lobes to estimate the timescale of minor mergers using the BRATS software and corroborated the results with theoretical estimates.
- Analysed the GALEX Near-UV and Far-UV images and CO molecular gas distribution data from the CARMA-EDGE survey to trace star formation and found clear signs of quenched star formation due to **AGN negative feedback** from the multiple jet episodes.

Aug'22-Jun'23 **Beyond Standard Model explanations for Black Hole Mass Gap**.
Guide: Prof. Vikram Rentala | Dept. of Physics | Indian Institute of Technology, Bombay(IITB)

- Motivated by the detection of intermediate mass black holes by LIGO, worked on modifying the CO-reaction rate at astrophysical energies by incorporating a new **oxygen nucleus resonance** at low energies through the **R-Matrix** formalism to explain black holes within the classical mass gap.
- Investigated **dark matter capture** and **modified gravity** effects as viable mechanisms for increasing or decreasing final black hole mass.

Conferences

Finding Ultra Faint Dwarf Galaxies in M81's Stellar Halo, *Poster*.
Small Galaxies, Cosmic Questions-II, *Durham University, UK*
Dwarf Galaxies, Star Clusters, and Stellar Streams in the LSST Era, *University of Chicago, US*

Multiple Jets Driving AGN Feedback in the Seyfert NGC 2639?, *Poster*.
National Workshop on Galactic Inflows and Outflows on all Scales, *IUCAA, India*

Teaching and Mentorship

Fall 2024 & Winter 2024 **Graduate Student Instructor**, *Introduction to Astronomy & Astrophysics*.
Taught weekly labs to undergraduate astronomy majors to help them gain practical experience in spectroscopy, python, data analysis, and telescope observing amongst other astronomical techniques

Spring 2022 **Teaching Assistant**, *Quantum Physics & Applications*, IIT Bombay.
Handled a tutorial group of 42 undergraduates, presented problem solutions, revised concepts, solved doubts, conducted examinations, and graded exam papers.

May'21-Apr'22 **Department Academic Mentor**, *Student Mentorship Program*, IIT Bombay.
Assigned to 10 junior students to help them cope with any academic problems they may face in the Physics department or otherwise. Undertook initiatives beneficial to the department including course mentoring, organizing career sessions, and compiling academic records.

Key Courses

Astronomy	Galaxies*, Stellar Structure & Evolution, High Energy Astrophysics, GW Astronomy
Physics	Adv. General Relativity, Quantum Field Theory, Elementary Particle Physics, Nuclear Physics, Atomic & Molecular Physics, Data Analysis & Interpretation
Math	Differential Geometry, Numerical Analysis, General Topology, Complex Analysis
Misc.	Machine Learning, Scientific Writing*, Optics & Spectroscopy Lab, Electronics Lab

*Ongoing courses

Outreach Activities

Jun'20-May'21 **Convener, Kritika- The Astronomy Club**.
IIT Bombay

- Part of a team of **10**, responsible for organizing several **Institute-wide events** such as lectures, workshops, group discussions, projects, interactive online activities including quizzes and trivia, to foster enthusiasm in Astronomy and Astrophysics in the institute.
- Worked in amateur **Astrophotography** by processing images of galaxies, clusters, and nebulae, captured by the 0.7m **GROWTH-India** telescope situated at Hanle-Ladakh.
- Facilitated the Krittika Summer Projects by organizing and coordinating astronomy tasks among participants ranging from UG freshmen to PhDs
- Organised and moderated the **Techfest Astrophysics Workshop** for over **200 participants** covering theoretical and practical aspects of topics such as **Gamma-Ray Bursts, Gravitational Waves**, and **EM counterparts**.

Technical Skills

Languages	Python, C++, Fortran, Git, HTML
Softwares	MATCH, CASA, BRATS, MESA, Mathematica, DS9, Photoshop
Telescopes	Magellan (FourStar), HST, Subaru HSC, GMRT