VEDANT DHRUV

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RESEARCH INTERESTS

I am a theoretical and computational astrophysicist with broad interests in black hole and plasma physics. I use a multi-scale approach, employing both general relativistic magnetohydrodynamics (GRMHD) and particle-in-cell (PIC) simulations to bridge the gap between kinetic plasma processes and the large-scale dynamics of accretion flows. My work is driven by the need for robust models that can be tested against astronomical observations.

EDUCATION

University of Illinois Urbana-Champaign	Aug 2019 - Jun 2026
Ph.D. in Physics	GPA: 3.96/4.0
Advisor: Charles F. Gammie	

National Institute of Technology Karnataka, Surathkal	July 2014 - May 2018
Bachelor of Technology in Mechanical Engineering	GPA: 9.22/10.0

RESEARCH EXPERIENCE

Graduate Research Assistant | **University of Illinois at Urbana-Champaign**   2020 - 2024; 2025 - Present

Black hole accretion physics

- Implemented a relativistic, weakly collisional plasma model in a performance-portable GPU GRMHD code. Produced the first horizon-scale images and spectra of Sagittarius A* (Sgr A*).
- Contributed toward the Event Horizon Telescope (EHT) theoretical analysis of the first Sgr A* results.
- Developer and maintainer of GRMHD and general relativistic radiative transfer (GRRT) codes at AFD-Illinois.
- Studying potential observational signatures of well-motivated, alternate theories of gravity (dCS and EdGB).

Guest Researcher | **Center for Computational Astrophysics, Flatiron Institute**   Aug 2023 - Oct 2023

Particle-in-cell simulations

- Investigating electron dynamics in collisionless, magnetically dominated flows (MADs) through PIC simulations of electron-ion plasmas.

Research Scholar | **Tata Institute of Fundamental Research (TIFR), Mumbai**   2018 - 2019

Helioseismology

- Validated a helioseismic inversion algorithm to recover solar sub-surface flow profile of supergranular flows from surface measurements of synthetic travel times for various separable and a non-separable flow model with realization noise.

Visiting Undergraduate Researcher | **TIFR, Mumbai**   May 2017 - July 2017

Quantum fields in curved space

- Calculated the non-relativistic limit of the Einstein-Dirac and the Einstein-Cartan-Dirac equations using a WKB-like series expansion.

GRANTS, AWARDS, AND SERVICE

Computational Grants

Co-Investigator (PI: C. F. Gammie)
ACCESS Maximize "Event Horizon Telescope and Black Hole Astrophysics"   Oct 2024 - Mar 2026
$\sim 72k$ GPU hours, $\sim 680k$ CPU core-hours

Co-Investigator (PI: B. S. Prather)
DOE INCITE "Horizon-scale Variability Modeling for the EHT"   Jan 2024 - Dec 2024
$\sim 600k$ Frontier node-hours

Awards

Dissertation Completion Fellowship	2025 - 2026
Donald C. and F. Shirley Jones Fellowship ($\sim$1 student in the department every year)	2025
Selected for ALCF ATPESC HPC Workshop	2023
ICASU-NCSA Graduate Student Fellowship, UIUC	2022 - 2023
Recognized as *Excellent Teaching Assistant* for all TA appointments, UIUC	2019 - 2020
Visiting Students' Research Programme (VSRP), TIFR Mumbai	2017
Nominated for the OPJEMS Scholarship (top 5% in the department)	2017

Peer review

Astrophysical Journal (ApJ), Astronomy & Astrophysics (A&A)	2025-

COMPUTING/SOFTWARE EXPERIENCE

Codes: KHARMA (developer), `iharm3d` (developer), `iharm2d_v4` (primary developer), `ipole`(developer), TRISTAN-MP

HPC-related frameworks: Kokkos, Parthenon OpenMP, MPI, SLURM, PBS, TACC Launcher

Programming languages: C/C++, Python, Fortran, UNIX Shell Scripting

Numerical-analysis softwares: Mathematica, MATLAB

Other tools: HTML, CSS, PHP, Globus, LaTeX, Git, VS Code, Linux

Supercomputers: Delta (NCSA), Rusty (Flatiron Institute), Ginsburg (Columbia University), Frontier, Summit, Andes (OLCF), Polaris (ALCF)

SCIENTIFIC TALKS

Invited Talks

Astrophysics Seminar, **Bar-Ilan University, Ramat Gan, Israel**	Mar 2025
Theoretical High Energy Astrophysics (THEA) Group Meeting, **Columbia University, NY, USA**	Oct 2024
Numerical Series for Fluids and Plasmas, **CCA Flatiron Institute, New York, USA**	Oct 2024
Astrophysics, Relativity, and Cosmology Seminar, **UIUC, IL, USA**	Apr 2024
Eliot Quataert's Group Meeting, **Princeton University, NJ, USA**	Oct 2023
Astroplasma Meeting, **CCA Flatiron Institute, NY, USA**	Oct 2023

Contributed Talks

Frontiers of Relativistic Plasma Physics in Astrophysics and Laboratory Experiments, **KITP, UC Santa Barbara, CA, USA** (link)	Aug 2025
Event Horizon Telescope Collaboration 2024 Winter Meeting, **Virtual**	Dec 2024
NCSA Student Research Conference, **NCSA, IL, USA**	Apr 2023
Event Horizon Telescope Meeting, **University of Arizona, Tuscon, AZ, USA**	Nov 2021
International Conference on Mathematical Modelling and Scientific Computing, **IIT Indore, India**	Jul 2018

MENTORING AND TEACHING EXPERIENCE

Undergraduate Students Mentored

T Thomas (*WashU, St. Louis, MO, USA; currently at Univ. of Virgia, VA, USA*) Implementing Kerr-like metrics in alternate theories of gravity in the radiative transfer code `ipole`.	Aug 2024 - May 2025
Sam Mason (*UIUC, IL, USA; currently at Epic Systems, Madison, WI, USA*) The importance of radiative cooling in numerical simulations of M87*	May 2023 - Dec 2024
Shreya Majumdar (*UIUC, IL, USA; currently at Georgia Tech, Atlanta, GA, USA*) Testing modified theories of gravity in black hole accretion simulations	May 2023 - Apr 2024
César Díaz Blanco (*UIUC, IL, USA; currently at Univ. of Tübingen), Germany* Impleted and tested a passive electron heating scheme in the GPU-accelerated GRMHD code KHARMA	May 2021 - Mar 2023

Graduate Teaching Assistant

University of Illinois Urbana-Champaign	Aug 2019 - Jul 2020; Jan - May 2025

Discussion TA: PHYS 225: "Relativity & Math Applications"
Discussion TA: PHYS 101: "College Physics: Mech & Heat"
Discussion TA: PHYS 214/213: "University Physics: Quantum/Thermal Physics"

SELECTED PUBLICATIONS

Full list: NASA ADS | Total Publications: 32 | Citations: 4748 | h-index: 23

7. **Dhruv, V.**, Prather, B., Chandra, M. et al. 2025, *submitted to ApJL*

6. **Dhruv, V.**, Prather, B., Wong, G. N., & Gammie, C. F. 2025, *ApJS*
   A Survey of General Relativistic Magnetohydrodynamic Models for Black Hole Accretion Systems

5. Conroy, N. S., Bauböck, M., **Dhruv, V.**, et al. 2023, *ApJ*
   Rotation in Event Horizon Telescope Movies

4. Event Horizon Telescope Collaboration et al. 2022, *ApJL*
   First Sagittarius A* Event Horizon Telescope Results. V. Testing Astrophysical Models of the Galactic Center Black Hole

3. Wong, G. N., Prather, B., **Dhruv, V.** et al. 2022, *ApJS*
   PATOKA: Simulating Electromagnetic Observables of Black Hole Accretion

2. **Dhruv, V.**, Bhattacharya, J., & Hanasoge, S. M. 2019, *ApJ*
   Validating Time–Distance Helioseismic Inversions for Nonseparable Subsurface Profiles of an Average Supergranule

1. Khanapurkar, S., Pradhan, A., **Dhruv, V.**, et al. 2018, *PRD*
   Nonrelativistic limit of Einstein-Cartan-Dirac equations