

# VEDANT DHURUV

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## RESEARCH INTERESTS

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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

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**University of Illinois Urbana-Champaign**

Aug 2019 - May 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

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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

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### Computational Grants

**Co-Investigator** (PI: C. F. Gammie)

*ACCESS Maximize “Event Horizon Telescope and Black Hole Astrophysics”*

Oct 2024 - Mar 2026

~ 72k GPU hours, ~ 680k CPU core-hours

**Co-Investigator** (PI: B. S. Prather)

*DOE INCITE “Horizon-scale Variability Modeling for the EHT”*

Jan 2024 - Dec 2024

~ 600k Frontier node-hours

## Awards

Selected for Doctoral Showcase track at SC25 (Supercomputing Conference), St. Louis	2025
Dissertation Completion Fellowship (one of 21 awardees across 51 departments)	2025 - 2026
Donald C. and F. Shirley Jones Fellowship (~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 <i>Excellent Teaching Assistant</i> 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-
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## COMPUTING/SOFTWARE EXPERIENCE

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**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

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### Invited Talks

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

### Contributed Talks

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

## MENTORING AND TEACHING EXPERIENCE

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### Undergraduate Students Mentored

T Thomas ( <i>WashU, St. Louis, MO, USA; currently at Univ. of Virgia, VA, USA</i> )	Aug 2024 - May 2025
Implementing Kerr-like metrics in alternate theories of gravity in the radiative transfer code <code>ipole</code> .	
Sam Mason ( <i>UIUC, IL, USA; currently at Epic Systems, Madison, WI, USA</i> )	May 2023 - Dec 2024
The importance of radiative cooling in numerical simulations of M87*	
Shreya Majumdar ( <i>UIUC, IL, USA; currently at Georgia Tech, Atlanta, GA, USA</i> )	May 2023 - Apr 2024

Testing modified theories of gravity in black hole accretion simulations

César Díaz Blanco (*UIUC, IL, USA; currently at Univ. of Tübingen, Germany*)

May 2021 - Mar 2023

Implemented and tested a passive electron heating scheme in the GPU-accelerated GRMHD code KHARMA

### 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”

## PUBLICATIONS

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ADS List: [NASA ADS](#) | Total Publications: 34 | Citations: 5101 | h-index: 24

### First Author, Significant Contributions

8. **Dhruv, V.**, Sironi, L., Tran, A., Davelaar, J. 2025, *in prep*  
PIC Simulations of a Magnetically Dominated Plasma in a Compressing Box: Characterization of Dominant Plasma Instabilities
7. **Dhruv, V.**, Prather, B., Chandra, M. et al. 2025, *ApJL*  
[Electromagnetic Observables of Weakly Collisional Black Hole Accretion](#)
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](#)

### Collaboration Papers

25. Dahale, R., Cho, I., Moriyama, K. et al. 2025, *A&A* [Origin of the ring ellipticity in the black hole images of M87\\*](#)
24. Goddi, C., Carlos, D. F., Crew, G. B. et al. 2025, *A&A* [First polarization study of the M87 jet and active galactic nuclei at submillimeter wavelengths with ALMA](#)
23. Röder, J., Wielgus, M., Lobanov, A. P. et al. 2025, *A&A* [A multifrequency study of sub-parsec jets with the Event Horizon Telescope](#)
22. Event Horizon Telescope Collaboration, Akiyama, K., Alberdi, A. et al. 2025, *A&A* [The persistent shadow of the supermassive black hole of M87: II. Model comparisons and theoretical interpretations](#)
21. Backzko, A., Kadler, M., Ros, E. et al. 2024, *A&A* [The putative center in NGC 1052](#)
20. Algaba, J. C., Balokovic, M., Chandra, S. et al. 2024, *A&A* [Broadband multi-wavelength properties of M87 during the 2018 EHT campaign including a very high energy flaring episode](#)
19. Raymond, A. W., Doeleman, S. S., Asada, K. et al. 2024, *AJ* [First Very Long Baseline Interferometry Detections at 870  \$\mu\text{m}\$](#)

18. Event Horizon Telescope Collaboration, Akiyama, K., Alberdi, A. et al. 2024, *ApJL* [First Sagittarius A\\* Event Horizon Telescope Results. VII. Polarization of the Ring](#)
17. Event Horizon Telescope Collaboration, Akiyama, K., Alberdi, A. et al. 2024, *ApJL* [First Sagittarius A\\* Event Horizon Telescope Results. VIII. Physical Interpretation of the Polarized Ring](#)
16. Paraschos, G. F., Kim, J.-Y., Wielgus, M. et al. 2024, *A&A* [Ordered magnetic fields around the 3C 84 central black hole](#)
15. Event Horizon Telescope Collaboration, Akiyama, K., Alberdi, A. et al. 2024, *A&A* [The persistent shadow of the supermassive black hole of M 87. I. Observations, calibration, imaging, and analysis](#)
14. Torne, P., Liu, K., Eatough, R. P. et al. 2023, *ApJ* [A Search for Pulsars around Sgr A\\* in the First Event Horizon Telescope Data Set](#)
13. Event Horizon Telescope Collaboration, Akiyama, K., Alberdi, A. et al. 2023, *ApJL* [First M87 Event Horizon Telescope Results. IX. Detection of Near-horizon Circular Polarization](#)
12. Roelofs, F., Johnson, M. D., Chael, A. et al. 2023, *ApJL* [Polarimetric Geometric Modeling for mm-VLBI Observations of Black Holes](#)
11. Prather, B. S., Dexter, J., Moscibrodzka, M. et al. 2023, *ApJ* [Comparison of Polarized Radiative Transfer Codes Used by the EHT Collaboration](#)
10. Jorstad, S., Wielgus, M., Lico, R. et al. 2023, *ApJ* [The Event Horizon Telescope Image of the Quasar NRAO 530](#)
9. Issaoun, S., Wielgus, M., Jorstad, S. et al. 2022, *ApJ* [Resolving the Inner Parsec of the Blazar J1924-2914 with the Event Horizon Telescope](#)
8. Event Horizon Telescope Collaboration, Akiyama, K., Alberdi, A. et al. 2022, *ApJL* [First Sagittarius A\\* Event Horizon Telescope Results. II. EHT and Multiwavelength Observations, Data Processing, and Calibration](#)
7. Wielgus, M., Marchili, N., Mart'ı-Vidal, I. et al. 2022, *ApJL* [Millimeter Light Curves of Sagittarius A\\* Observed during the 2017 Event Horizon Telescope Campaign](#)
6. Event Horizon Telescope Collaboration, Akiyama, K., Alberdi, A. et al. 2022, *ApJL* [First Sagittarius A\\* Event Horizon Telescope Results. IV. Variability, Morphology, and Black Hole Mass](#)
5. Event Horizon Telescope Collaboration, Akiyama, K., Alberdi, A. et al. 2022, *ApJL* [First Sagittarius A\\* Event Horizon Telescope Results. VI. Testing the Black Hole Metric](#)
4. Broderick, A. E., Gold, R., Georgiev, B. et al. 2022, *ApJL* [Characterizing and Mitigating Intraday Variability: Reconstructing Source Structure in Accreting Black Holes with mm-VLBI](#)
3. Event Horizon Telescope Collaboration, Akiyama, K., Alberdi, A. et al. 2022, *ApJL* [First Sagittarius A\\* Event Horizon Telescope Results. V. Testing Astrophysical Models of the Galactic Center Black Hole](#)
2. Event Horizon Telescope Collaboration, Akiyama, K., Alberdi, A. et al. 2022, *ApJL* [First Sagittarius A\\* Event Horizon Telescope Results. I. The Shadow of the Supermassive Black Hole in the Center of the Milky Way](#)
1. Georgiev, B., Pesce, D. W., Broderick, A. E. et al. 2022, *ApJL* [A Universal Power-law Prescription for Variability from Synthetic Images of Black Hole Accretion Flows](#)