

# 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

<b>University of Illinois Urbana-Champaign</b> Ph.D. in Physics Advisor: Charles F. Gammie	Aug 2019 - May 2026 GPA: 3.96/4.0
<b>National Institute of Technology Karnataka, Surathkal</b> Bachelor of Technology in Mechanical Engineering	July 2014 - May 2018 GPA: 9.22/10.0

## RESEARCH EXPERIENCE

Graduate Research Assistant   <b>University of Illinois at Urbana-Champaign</b>	2020 - 2024; 2025 - Present
<i>Black hole accretion physics</i>	
<ul style="list-style-type: none"><li>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*).</li><li>Contributed toward the Event Horizon Telescope (EHT) theoretical analysis of the first Sgr A* results.</li><li>Developer and maintainer of GRMHD and general relativistic radiative transfer (GRRT) codes at <a href="#">AFD-Illinois</a>.</li><li>Studying potential observational signatures of well-motivated, alternate theories of gravity (dCS and EdGB).</li></ul>	
Guest Researcher   <b>Center for Computational Astrophysics, Flatiron Institute</b>	Aug 2023 - Oct 2023
<i>Particle-in-cell simulations</i>	
<ul style="list-style-type: none"><li>Investigating electron dynamics in collisionless, magnetically dominated flows (MADs) through PIC simulations of electron-ion plasmas.</li></ul>	
Research Scholar   <b>Tata Institute of Fundamental Research (TIFR), Mumbai</b>	2018 - 2019
<i>Helioseismology</i>	
<ul style="list-style-type: none"><li>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.</li></ul>	
Visiting Undergraduate Researcher   <b>TIFR, Mumbai</b>	May 2017 - July 2017
<i>Quantum fields in curved space</i>	
<ul style="list-style-type: none"><li>Calculated the non-relativistic limit of the Einstein-Dirac and the Einstein-Cartan-Dirac equations using a WKB-like series expansion.</li></ul>	

## GRANTS, AWARDS, AND SERVICE

### Computational Grants

<b>Co-Investigator</b> (PI: C. F. Gammie) <i>ACCESS Maximize “Event Horizon Telescope and Black Hole Astrophysics”</i> ~ 72k GPU hours, ~ 680k CPU core-hours	Oct 2024 - Mar 2026
<b>Co-Investigator</b> (PI: B. S. Prather) <i>DOE INCITE “Horizon-scale Variability Modeling for the EHT”</i> ~ 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

**Codes:** KHARMA (developer), `iham3d` (developer), `iham2d_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, <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

### 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"

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## PUBLICATIONS

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\$ 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'í-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