VEDANT DHRUV

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RESEARCH INTERESTS

I am a theoretical and computational astrophysicist with broad interests in black hole and plasma physics. My research primarily focuses on improving models of black hole accretion, and is guided by observational data. I employ a range of computational techniques to study the influence of dissipative and microphysical plasma processes on the global dynamics of accretion flow.

PROFESSIONAL APPOINTMENTS

Graduate Research Assistant Aug 2020-
University of Illinois at Urbana-Champaign

Guest Researcher Aug 2023 - Oct 2023
Center for Computational Astrophysics, Flatiron Institute, New York, USA

Research Scholar May 2018 - April 2019
Tata Institute of Fundamental Research, Mumbai, India

Visiting Undergraduate Researcher May 2017 - July 2017
Tata Institute of Fundamental Research, Mumbai, India

EDUCATION

University of Illinois Urbana-Champaign Aug 2019 - Aug 2025 (Expected)
PhD 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

Black hole accretion physics
University of Illinois at Urbana-Champaign

Improving global models of collisionless plasmas by incorporating beyond-ideal effects.
Contributed toward the theoretical analysis of the first Sgr A* results by the Event Horizon Telescope.
Developer and maintainer of general relativistic magnetohydrodynamic (GRMHD) codes at AFD-Illinois.

CCA, Flatiron Institute
Conducted particle-in-cell (PIC) simulations of astrophysical plasmas motivated by EHT targets, and investigated the role of kinetic instabilities on ion and electron thermodynamics.

Alternate theories of gravity
University of Illinois at Urbana-Champaign

Studying potential observational signatures of well-motivated, alternate theories of gravity (dynamical Chern-Simons and Einstein dilaton Gauss-Bonnet) in event horizon-scale observations of black hole accretion using GRMHD simulations and radiative transfer techniques.

Tata Institute of Fundamental Research, Mumbai
Calculated the non-relativistic limit of the Einstein-Dirac and the Einstein-Cartan-Dirac equations using a WKB-like series expansion.

Helioseismology
Tata Institute of Fundamental Research, Mumbai

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.

GRANTS AND AWARDS

Computational Grants

Co-Investigator
ACCESS Maximize "Event Horizon Telescope and Black Hole Astrophysics" Oct 2024 - Sep 2025
$\sim 72k$ GPU hours, $\sim$ 680k CPU core-hours

Co-Investigator
DOE INCITE "Horizon-scale Variability Modeling for the EHT" Jan 2024 - Dec 2024
$\sim 600k$ Frontier node-hours

Awards

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

COMPUTING/SOFTWARE EXPERIENCE

Codes: KHARMA, `iharm3d` (current maintainer), `iharm2d_v4` (primary developer), `ipole`, TRISTAN-MP
HPC-related frameworks: Kokkos, Parthenon OpenMP, MPI, SLURM, PBS, TACC Launcher
Programming languages: C/C++, Python, Fortran, UNIX Shell Scripting
Supercomputers: Delta (NCSA), Rusty (Flatiron Institute), Ginsburg (Columbia University), Frontier, Summit, Andes (OLCF), Polaris (ALCF)
Numerical-analysis softwares: Mathematica, MATLAB

SCIENTIFIC TALKS

Invited Talks

Theoretical High Energy Astrophysics (THEA) Group Meeting Oct 2024
Columbia University, New York, USA
Numerical Series for Fluids and Plasmas Oct 2024
CCA Flatiron Institute, New York, USA
Astrophysics, Relativity, and Cosmology Seminar Apr 2024
University of Illinois at Urbana-Champaign, Illinois, USA
Quataert Group Meeting Oct 2023
Princeton University, New Jersey, USA
Astroplasma Meeting Oct 2023
CCA Flatiron Institute, New York, USA

Contributed Talks

Event Horizon Telescope Collaboration 2024 Winter Meeting — Dec 2024
Virtual

NCSA Student Research Conference — Apr 2023
NCSA, Illinois, USA

Event Horizon Telescope Meeting — Nov 2021
University of Arizona in Tuscon, Arizona, USA

International Conference on Mathematical Modelling and Scientific Computing — Jul 2018
IIT Indore, India

MENTORING AND TEACHING EXPERIENCE

Undergraduate Students Mentored

T Thomas (Washington University in St. Louis) — Aug 2024-
Implementing Kerr-like metrics in alternate theories of gravity in the radiative transfer code `ipole`.

Sam Mason (University of Illinois at Urbana-Champaign) — May 2023 -
The importance of radiative cooling in numerical simulations of M87*

Shreya Majumdar (University of Illinois at Urbana-Champaign) — May 2023 - Apr 2024
Testing modified theories of gravity in black hole accretion simulations

César Díaz Blanco (University of Illinois at Urbana-Champaign) — May 2021 - Mar 2023
Impleted 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

Discussion TA: PHYS 101: "College Physics: Mech & Heat"
Discussion TA: PHYS 214/213: "University Physics: Quantum/Thermal Physics"
Lab TA: PHYS 213: "University Physics: Thermal Physics"