Sidhant Kumar Suar

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Education

MSc University College London   2024 - 2025
Astrophysics

Honours BSc University of Toronto   2019 - 2023
Physics and Astronomy Specialist, Mathematics Minor
Graduated with High Distinction

Research Interests

Planetary and Galactic Dynamics, Astrophysical Fluid Dynamics, and High-Energy Astrophysics.

Publications

Suar, S. K. & Millholland, S. C. "Planetary Obliquity Excitation Through Pre-Main Sequence Stellar Evolution", 2024, AAS Journals, *in review.*

Research Experience

Energetic events in astrophysical sources and neutrino emission
University College London   September 2024 - Present
Supervisor: Prof. Kinwah Wu

- Modeled the leptonic and hadronic spectral origin of the *Fermi* bubbles using `naima` and `aafragpy`.

- Currently building a lepto-hadronic model to explain the dynamics and evolution of galactic-scale bubbles and the AGN outflow events associated with them.

Excitation of planetary obliquities through star-planet interactions
Massachusetts Institute of Technology   November 2023 - November 2024
Supervisor: Prof. Sarah C. Millholland

- Used a spin-axis Hamiltonian to track the secular evolution of planetary obliquities (planet's spin-axis tilt) due to star-planet interactions.

- Found good agreement with N-Body integrations and added additional effects like protoplanetary disk potentials, tides, and planet-planet perturbations in the N-body integrator.

- Showed that close-in planets could be tipped permanently to large obliquities.

Dynamics of the atmospheres of ultra-hot Jupiters
Imperial College London   August 2023 - August 2024
Supervisor: Prof. James E Owen

- Used `Athena++` to show that an initially hydrostatic hot Jupiter atmosphere

would lead to noise on the order of actual wind speeds in a typical hot Jupiter atmosphere, thus potentially obscuring any interesting phenomena.

- Initialized a well-balanced hydrostatic isentropic hot Jupiter atmosphere using `Python` and implemented a well-balancing algorithm in `Athena++` to track the evolution of the initialized atmosphere due to day-night temperature variations and rotation of hot Jupiters.

- Showed that the dynamics of the well-balanced atmosphere led to no noise over time, therefore removing any potential issues while distinguishing between wind patterns and unwanted noise. Additionally, a Message Passing Interface (MPI) algorithm was implemented to run the simulations faster on larger computational domains.

Listening to gas giant planets

University of Toronto   May 2023 - August 2023
Supervisor: Dr. Janosz Dewberry

- Analytically derived a system of partial differential equations (PDEs) using Eulerian and Lagrangian perturbations applied to a simple planetary model for a non-rotating gas giant planet.

- Calculated the internal oscillation modes of the gas giant by numerically solving the system of PDEs using pseudo-spectral methods and compared them to the oscillation modes calculated for a rotating gas giant.

- Implemented a time-dependent perturbative force in `REBOUNDx` and then used power spectral densities (PSDs) to look at the difference in the accelerations of the satellite Juno due to the normal mode oscillations of Jupiter in the rotating and non-rotating planetary models.

Probing the formation and evolution of white dwarf debris disks

University of Toronto   July 2022 - April 2023
Supervisor: Prof. Yanqin Wu

- Implemented a keplerian white dwarf debris disk in `Athena++` based on different theoretical models with varying density profiles, initial eccentricities and semi-major axis, and time-dependent mass (dust+debris) injection rates.

- Wrote a code in `Python` to track the evolution of its orbital elements and other important physical parameters like angular momentum, energy, and mass over time, thus comparing its final state to the current observations.

Electronic states coupled to complex magnetic orders

University of Toronto   July 2022 - April 2023
Supervisor: Prof. Arun Paramekanti

- Used the Bogoliubov-de Gennes (BDG) Hamiltonian to numerically predict the presence of Majorana bound states (MBSs) in an s-type superconductor coupled to an anti-ferromagnetic skyrmion texture with a triangular lattice, thus reproducing results from current literature.

Characterization and performance testing of RFoF units for the CHORD telescope array

University of Toronto   May 2022 - July 2022

Supervisor: Prof. Keith Vanderlinde

- Tested and debugged the prototype units of radio frequency (RF) transmitters and receivers, thus measuring quantities like attenuation, gain compression, impedance, and signal-to-noise ratio (SNR) to show that optical fibers were more efficient at signal transmission when compared to their counterparts; the coaxial cables.

Awards and Honours

CITA Summer Undergraduate Research Fellowship

University of Toronto   APRIL 2023

Awarded for conducting summer research at the Canadian Institute for Theoretical Astrophysics (CITA).

Walter John Helm Scholarship in Astronomy and Astrophysics

University of Toronto   DECEMBER 2022

Awarded to the top third-year physics and astronomy undergraduate student.

Innis College Alumni Association Scholarship

University of Toronto   OCTOBER 2022

Awarded for high academic achievement during my undergraduate studies.

Natalia Krasnopolskaia Summer Undergraduate Research Fellowship

University of Toronto   MAY 2022

Awarded for conducting summer research under the Department of Physics.

Dean's List Scholar

University of Toronto   JUNE 2021 - JUNE 2023

Awarded for high academic achievement during my undergraduate studies.

University of Toronto Scholar

University of Toronto   OCTOBER 2019

Awarded to freshmen entering with high academic performance during their high school.

International Award for Young People (Bronze)

The Duke of Edinburgh's Award International Association   MARCH 2019

Awarded for community leadership during high school.

Posters and Presentations

Sidhant Kumar Suar, Dr. Janosz Dewberry, (August 2023). *Listening to gas giant planets.*
CITA Research Fair, University of Toronto

Sidhant Kumar Suar, Dr. Keith Vanderlinde, (October 2022). *Characterization and performance testing of RFoF units for the CHORD telescope array.*
Undergraduate Research Fair, University of Toronto

Conferences and Workshops

Canadian Astroparticle Physics Summer School (invited)

Queen's University   May 2022

- Selected to attend a summer school on astroparticle physics focused on the detection and phenomenology of probable dark matter candidates.

Outreach

AstroTours

University of Toronto   2022-2023

- Volunteered in this program to demonstrate upper-level astrophysics topics to high school students.

Volunteer Mentor

Center of Integrated and Sustainable Development   2019-Present

- Working towards women's empowerment, skill development, health, and hygiene. It has led to their economic growth and quality of life to ensure a sustainable ecosystem for rural entrepreneurship.

Volunteer Mentor

Kalinga Institute of Social Sciences   2017-Present

- Contributing to the underprivileged indigenous students' academic learning and mental health.

Programming Skills

Languages & Packages: Python, C++, Fortran, Athena++, aafragpy, naima, GYRE, REBOUND, REBOUNDx, TensorFlow, Keras, Wolfram Mathematica, HTML, CSS, LaTeX

Operating Systems: Windows, Linux (High-performance computing), macOS