Milind Sarkar

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Education

Indian Institute of Science Education and Research Mohali (IISERM) *[2022 - 2027]*
Bachelor and Master of Science (BS-MS) | *Department of Physics* |
Major in **Physics** | Minor in **Astronomy** |

Research Interests

Computational Astrophysics, Galactic Dynamics and Evolution, Galaxy Morphology, Gamma Ray Bursts, Statistical Astronomy, Machine Learning & Data Science

Publications

- M.G. Dainotti, S. Bhardwaj *et al.* incl. M. Sarkar ; **GRB Redshift Classifier to Follow-up High-Redshift GRBs Using Supervised Machine Learning** [arXiv:2408.08763] ; *Accepted at Astrophysical Journal Supplements(ApJS)*
- A. Narendra, M.G. Dainotti, M. Sarkar *et al.*; **GRB Redshift Estimation using Machine Learning and the Associated Web-App** [arXiv:2410.13985] ; *Accepted at Astronomy and Astrophysics(A&A)*
- M. Sarkar, M.G. Dainotti, A. Narendra *et al.*; **Redshift Classification of High-Redshift Optical GRBs Using Supervised Machine Learning** ; *Manuscript in Progress for submission to Journal of High Energy Astrophysics(JHEAP)*
- M. Sarkar, A. Ghosh *et al.*; **Multi-Wavelength Structural Parameter Analysis for 8 Million Galaxies in the Hyper Suprime-Cam Wide Survey Using Machine Learning** ; *Manuscript in Progress for submission to the Astrophysical Journal(ApJ)*

Conferences

- M. Sarkar, A. Ghosh; **Multi-Wavelength Structural Parameter Analysis for 8 Million Galaxies in the Hyper Suprime-Cam Wide Survey** Poster Presentation at ASI 2025 [Abstract, Poster]
- M. Sarkar, A. Ghosh; **Multi-Wavelength Structural Parameter Analysis for 8 Million Galaxies in the Hyper Suprime-Cam Wide Survey** Poster Presentation at APS Global Physics Summit 2025

Research Experience

Undergraduate Research Assistant *[May 2024 - Present]*
DiRAC Institute, University of Washington, Seattle | *Dr. Aritra Ghosh* |

- Utilized **GaMPEN** to estimate morphological parameters and uncertainties for approximately 8 million galaxies across multiple bands in the Hyper Suprime-Cam Wide survey
- Estimated Bayesian Posteriors for a galaxy's bulge-to-total light ratio (L_B/L_T), effective radius (R_e), and flux (F).
- Initial training on galfitted galaxies followed by transfer learning with less than 1% real data.
- Predicted posteriors deviate by less than $\approx 5\%$ compared to traditional light profile fitting, which underestimates uncertainties by up to $\approx 60\%$.

Undergraduate Research Assistant *[Dec 2023 - Present]*
National Astronomical Observatory of Japan | *Prof. Maria Giovanna Dainotti* |

1. **GRB Redshift Estimation using Machine Learning**
   - Increased the known LGRB redshift sample by 20% using machine learning.
   - Estimated redshifts for 276 LGRBs, more than **doubling** the largest existing sample.
   - Developed the first open source web app for redshift estimation, enabling easy user access.
2. **Redshift Classification of X-Ray GRBs using Machine Learning**
   - Improved high-z GRB classification using an ensemble ML model on 251 GRBs from Swift Observatory.

- Increased sensitivity by 9% and 11% over Random Forest, achieving 87% and 89% accuracy for $z_t = 3.0$ and $z_t = 3.5$ with balanced sampling.
- This refined classification enables more efficient high-z GRB follow-ups, aiding early Universe studies.

3. **Redshift Classification of Optical GRBs using Machine Learning**

- Used ensemble ML to classify GRBs into high-z and low-z groups based on optical data from Swift.
- Combined prompt emission and plateau phase features to enhance accuracy across redshift thresholds ($z_t = 2.0, 2.5, 3.0$).
- Achieved best performance at $z_t = 3.0$, improving high-z GRB follow-up studies.

Undergraduate Research Assistant *[Jan 2024 - Present]*
Institute for Advanced Study & Princeton University | Dr. Uddipan Banik |

- Surveyed literature on N-body simulations and Galactic Dynamics; developed a Python script to generate initial conditions (ICs) for galaxy evolution.
- Reviewed N-body simulations and developed a Python script for galaxy initial conditions.
- Extended the IC generator to analyze density profiles; ran Gadget2 simulations for 10 Gyr with 10^5–10^6 particles.
- Simulated static and growing black holes, analyzing density spikes and stability.
- Exploring neutrino signals to probe inner halo density and dark matter properties.

Summer Research Student *[June 2023 - Aug 2023]*
Department of Physics, IISER Mohali | Prof. Jasjeet Singh Bagla |

- Studied a key paper, transitioning its principles to a computational framework for replication.
- Analyzed GAIA DR-3 data to determine gravitational wave properties and fit optimal trend lines.
- Estimated gravitational wave strain from hypothetical binary black hole systems.
- Modeled strain-frequency distributions near the Milky Way's center, assessing data completeness and binary system contributions.

Awards And Accolades

- Awarded the Best Poster Award at the annual meeting of Astronomical Society of India (ASI) 2025, standing out as the sole undergraduate among predominantly PhD presenters. *[2025]*
- Awarded the **Merit cum Means Scholarship** for at IISER Mohali. *[2024]*
- Ranked in the **top 1** percentile in the JEE-Mains Examination, out of over **1 million** candidates *[2022]*
- Awarded the **Chief Minister's Academic Excellence Award** for exemplery performance in ICSE. *[2019]*
- Awarded the **Dr B.R. Ambedkar Medha Puraskar** for exemplery academic performance in ICSE. *[2019]*

Technical Skills

Software	Gadget-2, Nemo-GyrFalcon, Galfit
Tools and Web Dev	Git, GitHub, LaTeX, HTML, CSS
Languages	Python, R, Java
Libraries	Pynbody, Galsim, Astropy, sklearn, fitsio, PyTorch, Tensorflow, SciPy, NumPy, Pandas, Matplotlib, Xarray, etc.
HPC and Linux	Proficient in Linux-based environments, SLURM job scheduling, and high-performance computing (HPC) cluster usage

Key Courses Undertaken

Physics	Classical Mechanics, Quantum Mechanics, Electrodynamics, Mathematical Methods, Statistical Mechanics †, Advanced Quantum Mechanics †, Newtonian Mechanics, Electricity & Magnetism, Thermodynamics and Statistical Physics, & Waves & Optics
Astronomy	Astronomy & Astrophysics
Mathematics and CS	Linear Algebra & Group Theory, Probability & Statistics, Real Analysis, Differential Geometry, Introduction to Programming, & Climate Data Analysis
Online	Data-Driven Astronomy, Machine Learning, Neural Networks & Deep Learning

†*to be completed by April 2025*

Extra-Curricular Activities

- **Technical**
  - Served as the outreach volunteer of the physics club at IISER Mohali *Phi@I* and was responsible for increasing the presence of *Phi@I* on academic Twitter in the academic year - 22-23 .
- **Sports**
  - Won the Gold Medal at the Inter Hostel Table Tennis Tournament in 2023

Volunteer Experiences

Educational Outreach *[Aug 2023 - Jan 2024]*

National Service Scheme | IISER Mohali

Mentored underprivileged students in English and Mathematics. This included solving students' doubts and addressing other concerns.

References

Dr. Aritra Ghosh
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University of Washington, Seattle
Email: aritrag@uw.edu

Dr. Maria Giovanna Dainotti
Division of Science
National Astronomical Observatory of Japan
Email: maria.dainotti@nao.ac.jp

Prof. Jasjeet Singh Bagla
Department of Physical Sciences
IISER Mohali, India
Email: jasjeet@iisermohali.ac.in

Dr. Uddipan Banik
Department of Astrophysical Sciences
Princeton University, New Jersey
Email: uddipan.banik@princeton.edu