SAMSUZZAMAN AFROZ

Quantitative Researcher | PhD Researcher in Physics | Statistical Modeling

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PROFILE SUMMARY

Quantitative researcher and Ph.D. candidate at TIFR with expertise in statistical inference, Bayesian modeling, and large-scale analysis of high-dimensional, noisy datasets. Strong background in Python-based numerical computation, probabilistic modeling, and algorithmic problem-solving, with experience building scalable inference and data analysis pipelines for complex datasets.

EDUCATION

Ph.D. in Physics

Tata Institute of Fundamental Research (TIFR), Mumbai

2022 – 2027 (Expected)

Research focus: Statistical, parametric and non-parametric modeling of large-scale, high-dimensional, noisy datasets using Bayesian inference.

M.Sc. & B.Sc. (Hons.) in Physics

Presidency University, Kolkata & Jamia Millia Islamia, New Delhi

2017 – 2022

TECHNICAL SKILLS

Python | NumPy | Pandas | Data Visualization | SciPy | Bayesian Inference | Statistical Modeling | Nested Sampling | Gaussian Processes | HPC / Parallel Computing | Git / Linux | LaTeX | C++ | Matlab | Mathematica

SELECTED TECHNICAL PROJECTS

- **Non-parametric Reconstruction Framework:** Built a **grid-based pipeline** for reconstructing astrophysical and cosmological parameters from noisy data; optimized performance using vectorization and scientific Python stack.
- **Bayesian Inference for GW Catalogs:** Developed hierarchical inference code integrating **gravitational-wave and large-scale structure data**.
- **Phase Space Classification Framework:** Designed a **fast, high-dimensional trajectory analysis** pipeline to extract physical parameters directly from observational data, enabling efficient classification of black hole formation scenarios without relying on traditional models.
- **High-Performance Computing Pipelines:** Performed large-scale simulations using MPI-based parallel sampling and cluster resources.
- **Cross-Correlation Signal Extraction:** Implemented **time-series cross-correlation** techniques to recover weak signals embedded in extremely noisy data, enabling reliable extraction of physical information from low signal to noise observations.
- **Cross-Modal Signal Integration:** Developed a **statistical framework to cross-correlate EM survey data with gravitational-wave event catalogs**, enabling joint inference of cosmological parameters through multi-dataset integration and noise-robust correlation analysis.

PROFESSIONAL ACTIVITIES

- Active member of the Nobel Prize-winning **LIGO–Virgo–KAGRA (LVK) Collaboration**, contributing to **large-scale statistical modeling**, **Bayesian inference**, and **data-analysis pipelines**.
- Delivered **invited and contributed talks** at multiple **national and international conferences and institutes**.
- Served on the **Local Organizing Committee** for **two national-level conferences** at TIFR, Mumbai.
- Participated in **advanced workshops and summer/winter schools** focused on **Bayesian inference**, **time-series analysis**, **numerical simulations**, and **large-scale statistical modeling**.

SELECTED PUBLICATIONS

- **Afroz, S.**, Navdha, & Mukherjee, S. (2025). *Are all Binary Black Holes Detected by LIGO–Virgo–KAGRA Following the Universal Time-Delay Distributions? Probably Not.* arXiv:2510.06352 [astro-ph.HE].
- **Afroz, S.** & Mukherjee, S. (2025). *The Non Parametric Reconstruction of Binary Black Hole Mass Evolution from GWTC-4.0 Gravitational Wave Catalog.* arXiv:2509.25356 [astro-ph.HE].
- **Afroz, S.** & Mukherjee, S. (2025). *Binary Black Hole Phase Space Discovers the Signature of Pair Instability Supernovae Mass Gap.* arXiv:2509.09123 [astro-ph.HE].
- **Afroz, S.** & Mukherjee, S. (2025). *Gravitational Wave Burst from Bremsstrahlung in Milky Way Can Discover Sub-Solar Dark Matter in Near Future.* arXiv:2507.22126 [astro-ph.CO].
- **Afroz, S.**, Mukherjee, S., & Tasinato, G. (2025). *Illuminating Dark Energy with Bright Standard Sirens from Future Detectors.* arXiv:2507.06340 [astro-ph.CO].
- **Afroz, S.** & Mukherjee, S. (2025). *The Phase Space of Low-Mass Binary Compact Objects from LVK Catalog: Hints on the Chances of Different Formation Scenarios.* arXiv:2505.22739 [astro-ph.HE].
- **Afroz, S.** & Mukherjee, S. (2025). *Hint towards Inconsistency between BAO and Supernovae Dataset: The Evidence of Redshift Evolving Dark Energy from DESI DR2 is Absent.* arXiv:2504.16868 [astro-ph.CO].
- **Afroz, S.** & Mukherjee, S. (2024). *Multi-messenger Cosmology: A Route to Accurate Inference of Dark Energy beyond CPL Parametrization from XG Detectors.* JCAP 03 (2025) 070, arXiv:2412.12285 [astro-ph.CO].
- **Afroz, S.** & Mukherjee, S. (2024). *Phase Space of Binary Black Holes from Gravitational Wave Observations to Unveil its Formation History.* Phys. Rev. D 112 (2025) 2, 023531, arXiv:2411.07304 [astro-ph.HE].
- **Afroz, S.** & Mukherjee, S. (2024). *Prospect of Precision Cosmology and Testing General Relativity using Binary Black Holes–Galaxies Cross-correlation.* Mon. Not. R. Astron. Soc. 534 (2024) 2, 1283–1298, arXiv:2407.09262 [astro-ph.CO].
- **Afroz, S.** & Mukherjee, S. (2024). *A Model-independent Precision Test of General Relativity using LISA Bright Standard Sirens.* JCAP 10 (2024) 100, arXiv:2406.08791 [astro-ph.CO].
- **Afroz, S.** & Mukherjee, S. (2023). *A Model-independent Precision Test of General Relativity using Bright Standard Sirens from Ongoing and Upcoming Detectors.* Mon. Not. R. Astron. Soc. 530 (2024) 4, 3812–3826, arXiv:2312.16292 [astro-ph.CO].
- **Full list available at:** inspirehep.net/authors/2741174