Saqlain Afroz

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About

BS-MS Physics graduate from IISER Kolkata, worked at the intersection of gravitational wave physics, machine learning, and quantum computing. My research focuses on fast parameter estimation, signal classification, and quantum simulations of black holes. Interested in general relativity, gravitational wave astrophysics, machine learning, quantum computation, and multi-messenger astronomy. Seeking a doctoral position at a reputable research organization to further pursue these interests and contribute to cutting-edge developments in fundamental physics.

Education

Indian Institute of Science Education and Research Kolkata *December 2020 – May 2025*

BS-MS Dual Degree in Physical Sciences

- **Some Relevant Coursework:** Introductory Astrophysics, General Theory of Relativity and Cosmology, Fluid and Magnetohydrodynamics, Statistics and Probability, Computational Astrophysics, Topology, Computer Science

Inter-University Center for Astronomy and Astrophysics, Pune *August 2024 – April 2025*

*Master's Thesis (**Supervisor:** Dr. Apratim Ganguly)*

- Developed a deep learning pipeline leveraging **normalizing flows** for rapid parameter estimation of gravitationally lensed gravitational waves, considering real noise, offering a significant speed-up over traditional Bayesian inference methods like bilby.
- Designed and trained **Convolutional Neural Networks** and **Vision Transformers** for classifying gravitational wave signals into distinct physical categories — lensed, precessing, eccentric, and unlensed — with high accuracy.

Research Experiences

Quasi-Normal Mode Computation of Black Holes via Physics-Informed Neural Networks

February 2025 - Ongoing

Guide: Prof. Ajit Kembhavi, Dr. Ninan Sajeeth Philip, Dr. Dawood Kothawala

- Developed a Physics-Informed Neural Network (PINN) framework to compute quasi-normal modes of black holes in alternative theories of gravity.
- Used Pytorch, a deep learning Python library, and its auto-differentiation feature to solve differential equations related to the computation of QNMs.
- Contributing to a multi-institutional research effort aimed at evaluating the capabilities of PINNs in addressing complex differential equations.

Numerical Relativity

August 2024 – December 2024

Advisor: Prof. Rajesh Kumble Nayak

- Studied the $3+1$ ADM decomposition of Einstein's field equations for numerical evolution of spacetime metrics.

Classification of Blazars using ANNs

April 2024 – Ongoing

Advisor: Prof. Raj Prince

- Developed an Artificial Neural Network (ANN) that learns to classify Blazars into BL Lac and FSRQ.
- Used the trained ANN model to classify BCUs.

Quantum Simulation of Hawking Radiation using VQE on IBM Quantum Computer

December 2022 – August 2023

Guide: Prof. Prasanta K. Panigrahi

- Designed and implemented a quantum simulation framework to study Hawking radiation using the Variational Quantum Eigensolver (VQE) algorithm.
- Leveraged Qiskit to model black hole-inspired Hamiltonians and simulate near-horizon quantum effects on IBM's superconducting quantum processors, by optimizing quantum circuits.

Natural Language Processing Project

August 2022 - January 2023

Guide: Prof. Kripabandhu Ghosh

- Developed machine learning model which can do segmentation on clauses from Law contracts and then do clause classification.

Skills

Programming Languages: Python, CUDA, Julia, Matlab, Arduino, C++, C, Linux, LaTeX, JavaScript, NextJS

High Performance Computing: HTCondor, SLURM, PBS, OpenMP, MPI

Deep Learning & Machine Learning: PyTorch, Tensorflow, normflows, nflows, CNNs, GNNs, RNNs, LSTMs, SVMs, Transformers, Autoencoders, Physics Informed Neural Network, Decision Trees, K-means, k-NN, Random Forests

Statistical Techniques: Bayesian Inference, Maximum Likelihood Estimation, Hypothesis Testing, Markov Chain Monte Carlo (MCMC), Regression Analysis, Time Series Analysis

Software Tools & Frameworks: Git, Matlab, Colab, Bilby, Dingo, Qiskit, NumPy, SciPy etc

Spoken Languages: English, Hindi, Assamese

Invited Talks & Presentations

Gravitational Wave Open Data Workshop, 2025

Appointed as an instructor to mentor and teach gravitational wave astronomy at the GW Open Data Workshop's Study Hub held at IISER Kolkata.

ML4HEP Workshop, 2025

Recognized for expertise in ML-HEP and invited to teach at a workshop hosted by IISER Kolkata in June 2025.

National Science Day Seminar, 2025

Presented a public lecture at IUCAA on National Science Day, reflecting on how modern physics—through General Relativity and Quantum Mechanics—challenges our everyday notions of reality.

Workshops and Conferences Attended

AI / ML Workshop at IUCAA, 2025 *Cert.*

LIGO Workshop, BITS Pilani and IUCAA, 2024 *Cert.*

NVIDIA AI Summit, Mumbai, 2024 *Cert.*

Classical and Quantum Gravity Conference, Cochin University, 2024 *Cert.*

GWOSC Workshop 5, 2022 *Cert.*

Quantum Information and Quantum Technology *Cert.*

Qiskit Global Summer School 2022 *Cert.*

Awards

UP Science Talent Search Examination Scholarship *Cert.*

A scholarship awarded by the State government for students highly talented in Basic Sciences.

NCC Special Trophy *Cert.*

Was awarded a special trophy from National Cadet Corps, of the Indian Armed Forces, for my excellent academic performance.

Robotics

Built a semi-autonomous robot using Arduino that can detect obstacles in its path and safely tackle them while walking on a specified track, using infrared sensors and ultrasonic sensors.

Publications

- **S. Afroz**; A. Ganguly "Novel Approach in Deep Learning Based Classification of Gravitational Waves" (Under preparation)
- **S. Afroz**; A. Ganguly "Deep Learning Based Parameter Estimation of Lensed Gravitational Waves" (Under preparation)

Extra-Curricular Activities

- **Chess:** Secured a top-10 position in chess tournaments at IISER Kolkata and IUCAA.
- **Leadership & Management:**
  - Served as **Secretary of IISER Kolkata Student's Mess** for two consecutive years, and held the position of **Office Bearer of the Institute's Gym**. And also managed the **official webpage of the Department of Physics, IISER Kolkata**.
  - **Literary Captain** at UP Sainik School.
- **Teaching:** Mentored students from high school to the undergraduate level in Maths, Physics, and Computer Science.