Curriculum Vitae

Anargha Mondal

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EDUCATION

Indian Institute of Science Education and Research Pune — Expected Graduation: August 2027
Bachelor of Science-Master of Science (BS-MS), **Physics Major** — **CGPA: 8.6/10**

RESEARCH EXPERIENCE

Semseter Project Student at IISER, Pune (under Dr. Arka Banerjee) — Pune, Maharashtra, India
August 2024 - Present

- Investigated whether **cross-correlations** between the 3D matter power spectrum and galaxy clusters with the Nearest Neighbor Cumulative Distribution Functions (**NNCDFs**) can impose stronger bounds on the total mass of the three neutrino mass eigenstates compared to the matter power spectrum.
- Developed codes to calculate the empirical tracer-field cross-correlation kNN CDF from *QUIJOTE* **N-body simulations** snapshots of the 3D matter power spectrum. Developed code based on the **Fisher formalism** for NNCDFs to compare with the marginalised errors given by the Fisher matrix cosntructed with the matter power spectrum.

Summer Intern at NAOJ, Mitaka (under Dr. Maria G. Dainotti) — Mitaka, Tokyo, Japan
May 2024 - August 2024

- Helped develop a new **joint catalogue** of Type Ia supernovae, focused on studying how the Hubble Constant evolves with redshift, possibly helping to mitigate the long-standing Hubble Constant tension.
- Helped compile this catalog from cutting-edge samples available: Pantheon Plus, Pantheon, DES, JLA and SH0ES.
- Performed an Markov Chain Monte Carlo (**MCMC**) analysis of the binned 'master' sample to determine the H_0 value for each redhsift bin, estimating it through the standard flat ΛCDM and the w_0w_aCDM models. These H_0 values are then fitted with a phenomenological function to study its evolution.
- Our results indicate a decreasing trend. Such a trend points out the possible existence of **evolutionary effects** with redshift for the SNe Ia astrophysical variables or intrinsic physics, possibly the ***f(R)* theory of gravity**, which could be responsible for this trend, or unveiled selection biases. The paper has been currently submitted for **review** at the *Journal of High Energy Astrophysics(JHEAP)*.

Summer Intern at TIFR, Mumbai (under Dr. Sudip Bhattacharyya) — Online
July 2023 - August 2023

- Tested how well our current **theoretical models of accretion disks** in **Black Hole Binaries** and **Low Mass X-Ray Binaries** fit actual observed data. This helped us test General Relativity in the strong field regime.
- Our methodology involved using data from the Large X-ray Photon Counter and Soft X-ray Telescope to run analyses using HEASoft.

CODING EXPERIENCE

Python

- Extensive experience in using `NumPy`, `SciPy`, and analysing `.fits` files with `AstroPy`. These packages were directly used in the cosmology and astrophysics projects undertaken. `NumPy` and `SciPy` especially played an overarching role in the codes to calculate the cross-correlations and Fisher information matrices for computational cosmological analyses.
- Extensively used visualization packages such as `Matplotlib` and `getdist`. The latter was used extensively to plot poterior distributions from the MCMC framework used in the joint catalogue project.

- Proficient with packages for running MCMC analysis, such as `cobaya` and `emcee`. Extensively used these in the joint catalogue project for parameter inference from binned samples of Type Ia supernovae.
- Extensively used the `Pylians` package to generate density fields, compute the power spectrum and read GADGET codes in QUIJOTE simulation snapshots for the NNCDFs project.
- Proficient in handling data on Python using `pandas` dataframes. This was heavily implemented when combining and extraction of bins for the combination of the Pantheon Plus, Pantheon, DES and JLA astrophysical samples of Type Ia supernovae.

Mathematica

- Helped develop a Mathematica routine to divide the SNe samples into redshift bins, and for the combination of several samples to present our joint sample, while seeding out known duplicates.
- Utilised the computational power of Mathematica for all the fittings of the phenomenological function, subsequent parameter estimation, plottings and likelihood function estimation for the bins in the joint catalogue project.

MATLAB

- Experienced in data analysis and visualization

SKILLS SUMMARY

- **Theoretical Training**: Gravitation, Cosmology, Quantum Field Theory, Mathematical Physics
- **Computer Skills**: Python, Mathematica, MATLAB, LaTeX, Bash, HEASoft, Git

PUBLICATIONS

- ***A New Master Supernovae Ia sample and the investigation of the H_0 tension***
  Dainotti, M.G., De Simone, B., **Mondal, A.**, et al (2025). (arxiv.2501.11772(Under review at JHEAP)

AWARDS & FELLOWSHIPS

- National Top 1% in National Graduate Physics Examination (NGPE) *February, 2023*
- Kishore Vaigyanik Protsahan Yojana (KVPY) Fellow *August, 2021*
- National Talent Search Examination (NTSE) Scholar *March, 2021*
- Indian Olympiad Qualifier in Mathematics (IOQM) Merit Awardee *January, 2021*
- Jagadish Bose National Talent Search Scholar *December, 2020*

TALKS & CONFERENCES

Talks

- **"Investigating the Hubble Tension with Type Ia Supernovae"** 13^{th} *November, 2024*
  Invited Talk, Science Club, Indian Institute of Science Education and Research, Pune, India.

- **"Investigating the Hubble Tension with Type Ia Supernovae"** 14^{th} *November, 2024*
  Contributed Talk, Lagrangians to Lasers , Indian Institute of Science Education and Research, Pune, India.

Conferences

- **Conference on Blazars and Restless AGN (COBRA)** $22^{nd} - 22^{nd}$ *July, 2024*
  Organised by Inter-Univrsity Centre for Astrophysics and Astronomy(IUCAA), Pune and Presidency University, Kolkata

NON-RESEARCH ACTIVITIES

- Coordinator, Helicase, the Science Magazine of IISER Pune
- 'Cosmic Forums' Team Member, Aakashganga, Astronomy Club of IISER Pune
- Regular speaker in the Lagrangians to Lasers and Cosmology Journal Clubs
- Physics Question-Making Team Member, Mimamsa
- Core Team Member, Math Club, IISER Pune