Research Summary

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Pursuing my Master's in Physics from Savitribai Phule Pune University enabled me to be a part of the Inter-University Centre for Astronomy and Astrophysics (IUCAA), the hub for Astrophysics research in India, which allowed me to learn the necessary statistical tools and Bayesian techniques necessary for observational analysis.

To enhance the efficiency of the Quasar detection pipeline, I conducted my Master's thesis project under the guidance of Dr. Vaidehi Paliya at IUCAA. Utilizing Bayesian statistics and the Low Counts Image Reconstruction and Analysis (LIRA) algorithm, implemented in Python and essential CXC tools, I developed an advanced pipeline to detect extended emissions in high-redshift radio-loud Quasars using Chandra X-ray data. Incorporating MCMC analysis, the pipeline accurately identifies extended emissions by examining 2D Poisson deviations from the baseline model. Additionally, it generates higher-resolution data through LIRA to facilitate a more precise morphological analysis of the emissions.

Recently, I have been working with esteemed cosmologists of India, Dr. Saibal Ray, Dr. Anil Kumar Yadav, and Dr. Lokesh Kumar Sharma, to get collaborative exposure and learn to implement observational data to study cosmological models. In this project, we aimed to derive cosmological models to analyze the universe's expansion rate. My role was to develop a pipeline to calculate the cosmological parameters for the derived model using observational datasets. I used my knowledge of Bayesian statistics from my previous project to make the pipeline even more accurate. The results resonated with the current observational studies released by the Planck association, which confirmed the accuracy of the channel as well as the derivation of the model. It resulted in the preparation of multiple manuscripts. This experience helped me expand my data analysis and Bayesian analysis skills, which will benefit my research aspirations.

To further widen my computational skills and understand and search for the answer to the extended diffused emissions, such as radio halos and relics detected at the central region of AGNs and large-scale structures of the Galaxy Clusters (GCs), I am working with Dr. Viral Parekh, NRAO. This project involves the morphological analysis of the GCs center in the Radio and X-ray bands using NVSS, VLASS, and CXC data from the MGCLS clusters and MaDCoWS Catalogs, conducting a comprehensive analysis of the Radio Halos and relics. This analysis will help reveal the processes behind the unknown emissions observed and provide me with the new exposure necessary for my future research endeavors.

Amidst IUCAA, I comprehended Pulsar timing analysis under the supervision of Dr. Avinash Deshpande. In this mini-project, I observed how crucial mathematics, like the Fourier transform, can be used along with deconvolution and de-dispersion to calculate the rotation period of the pulsar.

I worked with Dr. Sanjeev Gupta for my bachelor's thesis to get interdisciplinary exposure. I devised computational methods to enhance solar cell efficiency by manipulating material properties like doping concentration and thickness. I extended theoretical efficiency by 5-8%, facilitating the presentation of the results at a National conference organized by the Gujarat Science Congress.

Apart from academics, I co-founded Astronomica: The Astronomy Club of St. Xavier's College Ahmedabad to initiate college astronomy discussions and organize outreach events, workshops, and talks for local schools and colleges. It provided me with unique exposure and cultivated leadership skills. I designed new teaching techniques like creating informative videos, simulations, models, and games to make outreach sessions engaging. A survey conducted by my team and me on implementing these teaching methodologies was even published at the International Astronomical Union conference and received acknowledgment from the Indian Association of Physics Teachers. Moreover, my involvement in extra-curricular activities like Swimming and cricket played a vital role in enhancing perseverance, teamwork, and time management skills.