Hyperion 2024–25: Astronomy Case Study Challenge

Participant: Aniket Kumar Choudhary
Indian Institute of Technology (IIT) Kanpur

Abstract

This report summarizes the methodology and preliminary findings of the Hyperion 2024–25 Astronomy Case Study Challenge, organized by the Astronomy Club at IIT Kanpur. The challenge involved analyzing astrophysical datasets and applying computational methods to derive meaningful scientific insights within a limited 48-hour time frame.

Methodology

1. **Data Ingestion**: Imported observational data (CSV/FITS formats) using Astropy and Pandas. 2. **Preprocessing**: Cleaned missing values, standardized units, and normalized columns. 3. **Exploratory Data Analysis**: Generated descriptive statistics, histograms, and scatter plots. 4. **Modeling**: Implemented astrophysical models (e.g., galactic rotation curves, GRB lightcurve fitting) using SciPy and custom likelihood functions. 5. **Validation**: Applied error estimation via chi-square minimization and curve fitting techniques. 6. **Visualization**: Produced plots to illustrate data trends and fitted models.

Results

The analysis produced parameter estimates consistent with expected astrophysical values. Lightcurve analysis identified key features, such as peak intensities and decay times. Rotation curve modeling highlighted contributions from baryonic and dark matter components. Figures and tables generated during the analysis phase are stored in the `results/` directory of the repository.

Discussion

The results demonstrate the effectiveness of combining computational methods with astrophysical theory to address open-ended scientific problems. While the models presented are simplified, they provide a foundation for more detailed research and refinement.

Conclusion

Participation in Hyperion fostered problem-solving skills under time constraints, enhanced proficiency in Python-based data analysis, and deepened understanding of astrophysical concepts. Future work could involve expanding the dataset, employing Bayesian inference methods, and refining the physical accuracy of models.