COMPUTATIONAL ASTROPHYSICS

Using computational methods to process and analyse astronomical data and draw graphical results.

MENTORS

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MENTEES

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LIBRARIES

Numpy, Pandas, Astropy, Scipy, Matplotlib, Astroquery and knowing their applications and implemented these to solve astronomical problems.

THEORY INVOLVED

Data handling, plotting data in graphs, scientific computation, curve fitting, cross-matching, astronomical data processing, image handling (FITS handling), querying astronomical data from different archives, and implementing them in case studies.

CASE STUDY: PLEIADES CLUSTER

Calculating the absolute magnitude, verifying values of calculated and observed data for temperature, luminosity and radius of stars in the Pleiades star cluster, plotting the Hertzsprung-Russell (HR) diagram and determining the cluster age.

APPROACH TO THE PROJECT

The course of the project can be broadly divided into 2 phases.

- **The initial introduction to python language, learning NumPy, Pandas, Matplotlib, Scipy, Astropy and applying the concepts to analyse astronomical data.**
  - Usage of NumPy allowed us faster computation than python lists. Pandas is used for data handling, and Matplotlib helps us to visualise the data in 2D graphs.
  - Scipy is used in scientific computation, like finding roots of equations, curve fitting, solving differential equations, Fourier transformation and other elements. Astropy allowed us to get easy access to the core elements of astronomy, and
- **FITS image handling:** Using Astropy.io.fits to open the file, and lastly using matplotlib to view the image with different colour scales and stretches and to make histograms, this module includes a demonstration of simple image stacking and processing.

FOURIER TRANSFORM, BINARY STARS AND CEPHEID VARIABLES

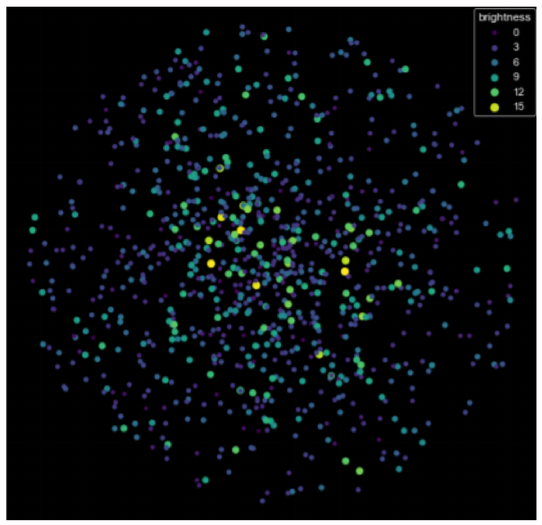
1. **In mathematics, a Fourier transform (FT) is a mathematical transform that decomposes functions depending on space or time into functions depending on spatial or temporal frequency.**
2. **X-ray binaries are a class of binary stars that are luminous in X-rays. We plotted a Mollweide projection of the given data seperating HMXBs and LMXBs.**
3. **A Cepheid variable is a type of star that pulsates radially, varying in both diameter and temperature and producing changes in brightness with a well-defined stable period and amplitude.**

CONCLUSION

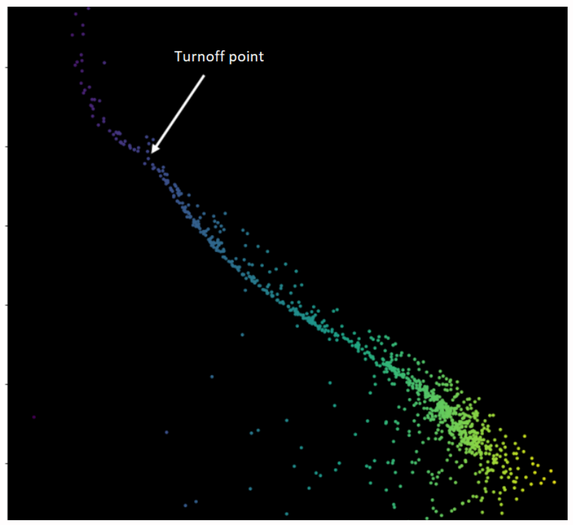
We wind up this project with lots of takeaways. Apart from getting to know the basic tools that an astrophysicist must have, we used Python, Git, Jupyter and Anaconda to convert raw data to more understandable forms. We ended by using all that we learnt on the Pleiades star cluster and found out its age, luminosity, temperature patterns and have been enriched in our understanding of astrophysics.

GRAPHICAL METHODS

Plotting over a thousand points on a graph to determine the age of the Pleiades star cluster, which we estimated to be 84 million years.



Position of stars



HR diagram for Pleiades

Age ~84 million years