



Astronomy Club, IITK

Summer Projects 2021



Computational Astrophysics

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Instructions: Follow the steps given in the Hon'ble Computational Astrophysics Repository to learn how to query cluster data from the coveted Gaia database. Also, read the details given below to understand the problem statement.

You will be working on the Pleiades star cluster, popularly known as the Seven Sisters. You can read more about the star cluster and its attributes.



Image credit: Steve Paukin captured this image in his back yard in Winslow, Arizona on November 3, 2019.

1 Absolute Magnitude and Distance

Absolute magnitude (M) is a measure of the luminosity of a celestial object, on an inverse logarithmic astronomical magnitude scale. Calculate the Absolute magnitude of the stars in your cluster.

$$m - M = 5 \log(d) - 5 \quad (1)$$

Note that $d = 1/\omega$, where d is distance measured in parsecs and ω is parallax measured in arcseconds. Our data column, `plx`, is parallax measured in milliarcseconds, so $\omega = \text{plx} / 1000$ and $d = 1000/\text{plx}$.

Make a density plot of the distances to the stars in your cluster using **Seaborn**. Exclude the outliers that maybe present in your data and then find the mean distance to your cluster.

2 Luminosity and Temperature

Calculate the Luminosity of stars in your cluster using `M`. Compare the luminosity that you have derived with the actual luminosity of the stars using `lum_val`. Do the same for effective Temperature and Radius of the stars in your cluster and compare with actual values of temperature (`teff_val`) and radius (`radius_val`).

$$M = 4.77 - 2.5 \log(L/L_o) \quad (2)$$

$$T_K = 5601 / (\text{color} + 9.4)^{2/3} \quad (3)$$

$$\frac{R}{R_\odot} = \frac{\sqrt{L/L_\odot}}{(T_K/T_\odot)^2} \quad (4)$$

Color is represented by `bp_rp`. Don't forget to drop Null values in your data which could lead to possible errors.

3 Position in the Night Sky

Define brightness of the stars to be difference of `max(gmag)` and `gmag`. Plot the position of the stars in your cluster using Right Ascension and Declination coordinates setting size of a star equal to its brightness.

4 Hertzsprung-Russell Diagram

Make the Absolute magnitude versus color plot to get the HR Diagram for the given cluster. We will then calculate the turnoff mass of the stars to determine the age of the cluster. Turnoff point in a HR diagram is the point from which the stars start deviating from the main sequence locus. It marks the age of the stars just about to escape the main sequence phase and thus this age is used to designate cluster age. We encourage you to find how to estimate the age once you have the turnoff point.