University of Florida
Astronomy 4300 Spring 2008
"Galactic Astronomy"
MWF 1:55 – 2:45pm
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The Properties of the Hyades Open Cluster

This lab involves an investigation of the Hyades open cluster located in the constellation of Taurus. As part of this exercise, you will determine the distance, age, and spatial distribution of stars in the Hyades. Keep in mind that you must propagate all observational errors through your calculations. Hand in your lab writeup, any programming code you wrote, and all plots with the relevant annotations.

1. Download the file of Hyades data obtained by the Hipparcos satellite from the course web page. The columns of this file are the star number assigned by Hipparcos, the parallax in milli-arcseconds, the parallax error in milli-arcseconds, right ascension in hours, minutes, seconds, the declination in degrees, minutes, seconds, the apparent V magnitude, the error in the V magnitude, the B–V color index, and finally the error in B–V.

2. Convert the RA and Dec to decimal degrees. Calculate the mean, standard deviation, and standard error of the mean of the RA and Dec. What is the significance of these numbers?

3. Make a plot of the distribution of Hyades stars on the sky (i.e. Dec as a function of RA) making sure to plot RA in decimal hours. Are your mean RA and Dec calculated in Question #2 consistent with the appearance of this diagram?

Due February 11th in class

4. Make plots of the V errors as a function of the V magnitude. Describe the behavior of this diagram and discuss the reasons for its appearance.

5. Now plot the V, B–V color-magnitude diagram (CMD) of the Hyades including the V error bars. What are the principal sequences apparent in this diagram? What do you think is the main reason why stars deviate from these sequences?

6. Calculate the distance to each star using the parallax. Include a calculation of the error in distance resulting from an error in the parallax. Assume that the effects of interstellar extinction on starlight are negligible. Why is this a good assumption?

7. Compute the mean distance, its standard deviation, and standard error.

Due March 3rd in class

8. Adopt twice the standard deviation (2σ) as the line-of-sight size of the Hyades. Differentiate the equation of photometric parallax ($m - M = -5 + 5 \log d$) with respect to the distance. Plot Δm as a function of distance assuming Δd represents the 2σ line-of-sight size of the Hyades. At the mean distance of the Hyades, what does this plot predict for the expected magnitude spread seen in the Hyades CMD plotted in #6? Is this value qualitatively consistent with that displayed in the CMD?

9. Use the distance to calculate the absolute V magnitude of each star. Remember to propagate the errors in distance and the apparent V magnitude to get the resultant error in M_v.

10. Using the apparent and absolute magnitude of each star, compute the mean apparent distance modulus and its standard error. Do the same for the intrinsic distance modulus.

11. Plot the H-R Diagram with $(B-V)_o$ on the abscissa and M_v on the ordinate. Include the error bars in M_v. How has the appearance of this diagram changed compared with the CMD constructed in Question #6?

Due March 21st in class

12. Download the theoretical isochrones of z=0.019 and z=0.03. These come in separate files for each age and are composed of two columns - column 1 is M_B and column 2 is M_v. Overplot the isochrones for each metallicity on the Hyades H-R Diagram. Comment on which metallicity isochrones provide the best fit to the unevolved main sequence.

13. Estimate the age of the Hyades based on the isochrone comparisons and be sure to provide an error in the age as well. Justify your answer for the age and its error.

14. (Extra Credit) For each hyades star, calculate its distance from the center of the cluster in RA and Dec in units of degrees using the equations of spherical trigonometry. Use the small angle formula to convert these to a physical distance in parsecs. Also calculate the line of sight distance of each star from the center of the cluster. Make a 3-D plot of the spatial distribution of Hyades stars assigning the RA in parsecs to the X-axis, the Dec in parsecs to the Y-axis, and the line of sight distance in parsecs to the Z-axis. You are free to select any azimuth that will showcase the structure of the cluster.

Due April 23rd in class