AST6215 Fall 2022 "Stars and the Galaxy"
Final Project
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Due **December 12th, 2022**

In this project, you will use data available from the Hubble Legacy Archive (HLA) to analyze a sample of Galactic globular clusters. In **Part I**, you will determine the GC distances using main sequence fitting. In **Part 2**, you will use theoretical isochrones from Dartmouth to determine their ages and determine an age-metallicity relation. Please hand in your project report along with tables, figures fully labeled and with figure captions, and any other relevant materials. **Neatness and organization count so please pay attention to detail. Label and caption your plots, add legends when needed, and use large enough fonts for label axes and ticks.**

Good luck!

Part 1: Globular Cluster MS Fitting and Distance Determination

1. Enter the HLA web site at http://hla.stsci.edu

2. Perform an advanced search for observations with the Wide Field Planetary Camera 2 (WFPC2) taken as part of program ID GO-10775. You only need to enter the program number in the web form.

3. Click on the "Inventory" tab so you can see a list of all of the observations. You will see entries for the following Milky Way globular clusters: NGC 104, NGC 362, NGC 3201, NGC 4833, NGC 5139, NGC 6121, NGC 6218, NGC 6254, NGC 6362, NGC 6397, NGC 6656, NGC 6752, NGC 6809, and NGC 6838.

4. Download the photometry available from the "PlotCat" link for clusters with "F606W/F814W" in the "Spectral_Element" column.

5. For each cluster, plot a color-magnitude diagram (CMD) with (f606w_TOTMAG) – (f814w_TOTMAG) on the abscissa and f606w_TOTMAG on the ordinate. Make sure to plot the vertical axis flipped with brighter magnitudes at the top of the axis. Scale the CMD so that you focus on the main sequence and that you use the same relative range of color and magnitude for all of the clusters.

6. Select one of the clusters as your standard reference cluster – choose the one that has the best determined and populated main sequence.

7. Assume all of the clusters have the same metallicity and reddening and determine the (vertical) magnitude shift required to match the lower (unevolved) main sequences of all of the other clusters to that of the reference cluster. Do this as quantitatively as you can. This represents an approximate distance modulus difference between these clusters in the F606W filter pass band, which is close to the ground-based Johnson V band. Determine an error value for each distance modulus difference using a method that is as quantitative as possible. If you are not able to measure a distance modulus difference for a given cluster, please comment on the reason(s) for this.

8. Go to the following web site and look-up the apparent distance modulus of your standard reference cluster in the V-band. http://physwww.mcmaster.ca/%7Eharris/mwgc.dat

9. Use this apparent distance modulus to compute the distance moduli of all of the other clusters in your dataset using the offsets determined in point 7 above.

10. Compare your apparent distance moduli for each cluster with those available at http://physwww.mcmaster.ca/%7Eharris/mwgc.dat. Make a plot illustrating this comparison. Calculate statistics of your choice to provide a quantitative comparison of the distance moduli. Comment on how well you did in your distance determinations.

11. Does the difference between your distance moduli and the actual values correlate with some other cluster parameter such as metallicity or reddening? Plot your distance moduli differences against the reddening for each cluster. What kind of overall behavior do you see? How do you interpret this behavior?

Part 2: Globular Cluster Isochrones Fitting and Age Determination

Go to the web site that has the Dartmouth Stellar Evolution Models http://stellar.dartmouth.edu/models/isolf_new.html.

1. Download the appropriate isochrones at different ages to produce a CMD fit to each of the globular clusters from Part I to determine their ages. Make sure to choose the appropriate [Fe/H] metallicity for each cluster from the literature or Simbad, as well as the colors from HST/WFPC2. You can choose the Helium abundance ratio to be Y=0.33 and [α/Fe]=+0.20. Make sure to construct the axes properly and to join the points with a line.
2. Present your determined ages for each cluster in a table, with the appropriate parameters for each. Comment on whether you are able to find an age-metallicity relation for Globular clusters.