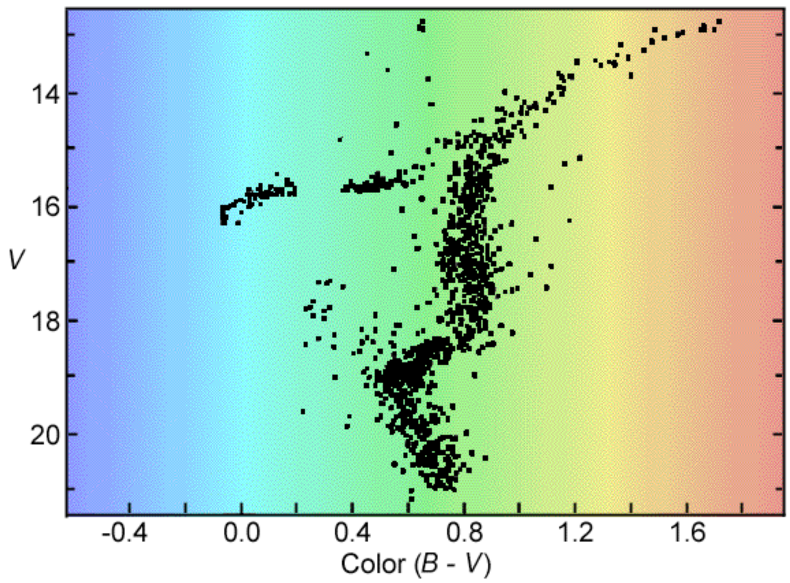
Color Magnitude Diagram of M80



Background:

A familiar staple of the study of stellar evolution is the Hertzsprung-Russell (H-R) Diagram, like the one above. Developed in the early 1900s, the original H-R diagram plotted stars' spectral type versus their absolute magnitude. Today, diagrams plot stars' B-V color index (observed magnitude in the B band minus magnitude in the V band) versus magnitude. For obvious reasons, this is also known as a color magnitude diagram. H-R diagrams can also be made by plotting effective temperature versus luminosity. These two forms of the H-R diagram are similar in that they can both be used to identify stars of different ages and match observations to theoretical stellar evolution models, however the transformation between the two is not trivial. Because it relies solely on observation, we will focus on the color magnitude diagram (CMD).

A CMD of a single cluster gives a snapshot of that cluster's evolution, with the key features distinguishing groups of different ages. A star's mass governs both its initial position on the CMD and it's evolution. Most stars fall along the very distinct main sequence, where they spend 90% of their lives. This stage is characterized the fusing of hydrogen into helium in the stellar core. More massive stars burn fuel faster, and so exhaust their inner supply of hydrogen before their less-massive neighbors. When this occurs, these stars "turn off" the main sequence, brighten and migrate redwards.

Red giants are characterized by helium burning in the core, surrounded by a hydrogen shell. This helium burns into carbon, which combines with helium to make oxygen. The increase of carbon and oxygen in the core causes the star's surface temperature to increase and its color to get bluer.

Eventually, the helium in the core is exhausted and a helium shell builds under the hydrogen shell. For less massive stars, the star then expands and cools and continues its evolution along the asymptotic giant branch. This parallels the original giant branch, though the star goes through it much faster. Over time, the star loses mass through stellar winds and violent pulsations. This gas builds up a shell called a circumstellar envelope, which can form a planetary nebula if the outer layers of the star get ejected. The remaining star cools to become a white dwarf. More massive stars often end as Type II supernovae, a violent explosion, rather than peacefully becoming white dwarfs.

Purpose:

In this lab, you will plot a CMD of M80 and label all stages of stellar evolution that you see (main sequence, subgiant, red giant, horizontal branch, etc).

Things you will need to get:

DAOphot catalogs for HST project ID 11233, visit 6 (Hubble Legacy Archive)

Hints:

Opening HLA catalogs in Microsoft Excel

1. Download the catalog from the HLA
2. Save a copy as a text file
    a. Save as – *nameofyourchoosing*.txt (NOT .cat or .dat or anything else)
3. Open the text file in Excel
    a. If it doesn't show up, make sure that you are seeing all files, not just .xls files
4. Select **Delimited**
5. Change the "start import row" to the first row of data
6. **Next**
7. Select **Space** as your delimiter
8. Make sure that "Treat consecutive delimiters as one" is checked
9. Click **Next**
10. Click **Finish**
11. Copy column heads over from your original text file
12. Delete any columns you don't need