Crowded Field Photometry of Star Clusters M56 and NGC 6712
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Introduction

Globular star clusters are groups of \( \approx 10^5 \) stars bound together gravitationally. One primary way globular clusters are studied is through HR diagrams, which plot each star’s apparent brightness vs. color (a so-called color-magnitude diagram, or CMD), or luminosity vs. surface temperature. Stars begin on the main sequence, fusing hydrogen. Once all their hydrogen has been used up, they become red giants, and move to the red giant branch on the HR diagram. As technology has evolved, and the diagrams have become more precise, a horizontal splitting of the red giant branch has been observed. One group of stars appear redder than the other. This is caused by differences in chemical abundances. Stars with high light element abundances appear redder and less luminous due to their increased opacity. In order for some stars to have different chemical compositions, they must have formed at different times. One reason to create these HR diagrams is to detect this. However, it is very difficult to come up with the optimal procedure to make these graphs. Our group dedicated this summer to come up with the best procedure to create the HR diagrams.

Objectives

- Find the optimal procedure to create a well-subtracted image, using the program DAOPHOT
- Make the best color magnitude diagram (CMD) for clusters NGC 6712 and M56.
- Compare these CMDs to ones in other literature, in order to see how accurate they are.

Methods

The software package DAOPHOT measures star brightnesses by identifying stars via the shape of their light profiles and subtracting them from the image in an iterative way. This is necessary since it is a crowded field, and many stars are obscured by others. In order to create an accurate CMD, we must first create such a subtracted image using DAOPHOT. We took two different approaches to create this subtracted image.

Method 1:
Create a list of stars and subtract these from the original image.
From this subtracted image, create a new list of stars and add them to the previous list
Subtract these stars from the original image, creating a new subtracted image
Repeat this five times

The advantage of this procedure is that it was always re-fitting all the stars with each iteration. This means the photometry should always be improving.

Method 2:
Create a list of stars from the original image.
Perform aperture photometry on this list of stars
Subtract these stars from the image
Each time, a new list of stars will be found and subtracted from the image made during the previous iteration.

The remaining steps for making a CMD are the same for both methods. We ran two programs, DAOMATCH and DAOMASTER, to match up the stars in both filters. This allows us to have the B and the V magnitudes for each star. The final step was to make a graph that plotted the V magnitude on the y axis and the B-V magnitude difference on the x-axis.

Results

The resulting CMDs are below, along with their corresponding CMDs we identified in the literature. The magnitudes are instrumental, which means they are measured from some arbitrary zero point. In order to create CMDs that match the ones from literature, we would have to calibrate them.

Future Work

Our group was busy this summer, but there are many things left to be done. We were not able to take images with correct exposure times. The images that were taken were not sufficient enough to create well-defined CMDs – a much higher signal-to-noise ratio is needed to minimize the photometric uncertainties enough to identify any splitting on the RGB. Once we have done this, we will be able to achieve our original goal, which is to detect evidence of multiple stellar populations in these cluster.

Conclusion

Even though we did not achieve our original goal of finding multiple stellar populations in globular clusters, this summer can still be called a success. It is important for us to explore this process very closely, so we can iron out a streamlined way to analyze the data we receive from images. Becoming familiar with this process can transform our project into an ongoing one that we can do for many years. This process can also be important to other, non-related, projects.

References


