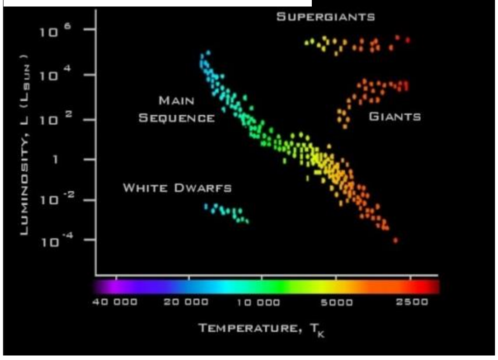
Report

Introduction to Hertzsprung-Russell Diagrams

Hertzsprung-Russell Diagrams first appeared in 1911 when Dutch astronomer Enjar Hertzsprung explored the correlation between the absolute magnitude of stars against their colour, i.e the luminosity and the temperature. Later on in 1913 Henry Norris Russell who was an American astronomer used spectral class and absolute magnitude. From this knowledge regarding the relationship between temperature and luminosity of a star was gleaned, as they appeared to fall into specific groups rather than being random as was originally thought.[1] The diagram that is used now has luminosity (Lsun) plotted against Temperature (Kelvin).

Figure 1: example of a HR diagram.



In figure 1 (The Hertzsprung-Russell Diagram) main sequence stars that are a higher temperature and are more blue than red have a higher luminosity this means that they are younger and larger were as cooler and more red stars tend to have a smaller luminosity this causes an almost diagonal line going straight from the lowest temperature to the highest luminosity. Giants and Supergiant's are cooler but have the luminosity comparable to a main sequence star at 20,000 Kelvin even though they are only around 3000- 5000 Kelvin and finally white dwarfs have an extremely low luminosity similar to a main sequence star are 3000 Kelvin but they are as hot as 20,000 Kelvin so they are pretty much opposite to Giants and Supergiants.

Target and Dataset

Our aim was to determine the types of stars that make up globular clusters by measuring their brightness and hence use this to plot a colour magnitude diagram from which we could use to identify the colours of the stars that the globular cluster is composed of by comparing it to a Hertzsprung-Russell diagram. We were given six images of the three globular clusters: M5, M10 and M92. We had two images of each, one through a V filter and one through a B filter.

Method

As part of our research project we went onto LT image and opened up two images of the same globular cluster, one taken a V filter and one with a B filter. The V filter only allows light of wavelength 551nm to pass through it and the B filter only allows light of 445nm to pass through[2]. As a result we can determine the types of stars that are present in the globular clusters that we were analysing. Each star emits light of different frequency, depending on their brightness; using this information it is possible to determine the colour of the stars.

Then we used the brightness tool to calculate the luminosity of a star in the B filter and the same star in the V filter, and we measured this in counts. We repeated this for around 20 other stars in the

[1] http://www.atnf.csiro.au/outreach/education/senior/astrophysics/stellarevolution_hrintro.html

[2] https://en.wikipedia.org/wiki/Photometric_system

globular cluster and then again for the images of the other two globular clusters we were given. After we had recorded it in counts we converted the brightness into magnitude using the equation M = -2.5logF. Once we had the luminosity of the stars in both filters in magnitude we subtracted the magnitude of each star in filter V from the magnitude of the star in filter B to get an estimate for the temperature of the star.

We then plotted a colour magnitude graphs from the data with temperature (B-V) on the X-axis and the magnitude of V on the Y-axis. Once we had done this we realised that there was a problem with the data as we had collected as the range of data that had a much larger magnitude than expected. In order to resolve this we considered what may have gone wrong and realised that we had included stars which were outside the globular cluster rather than only using stars within it. After we had removed these stars the graph looked as we expected it to.

Results

Globular cluster M5

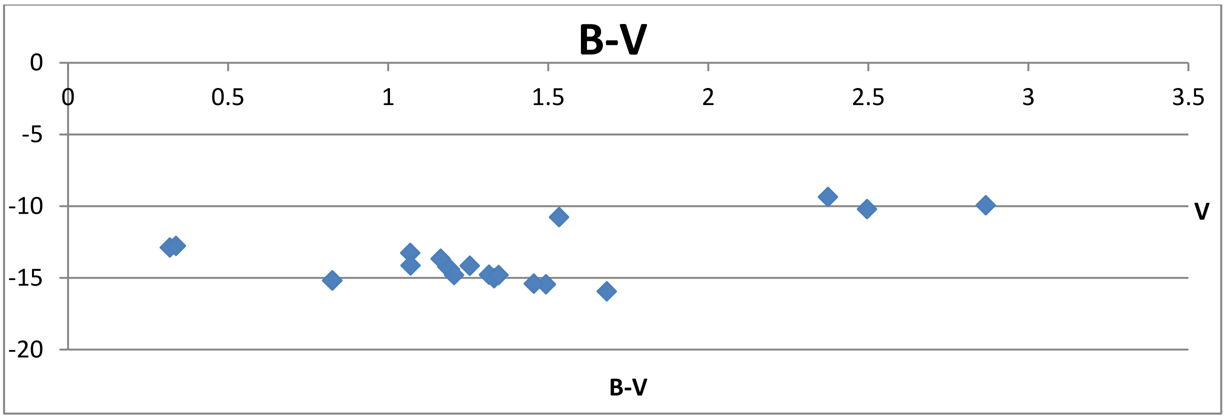


Figure 2: Magnitude-Colour Graph of M5

Globular cluster M10

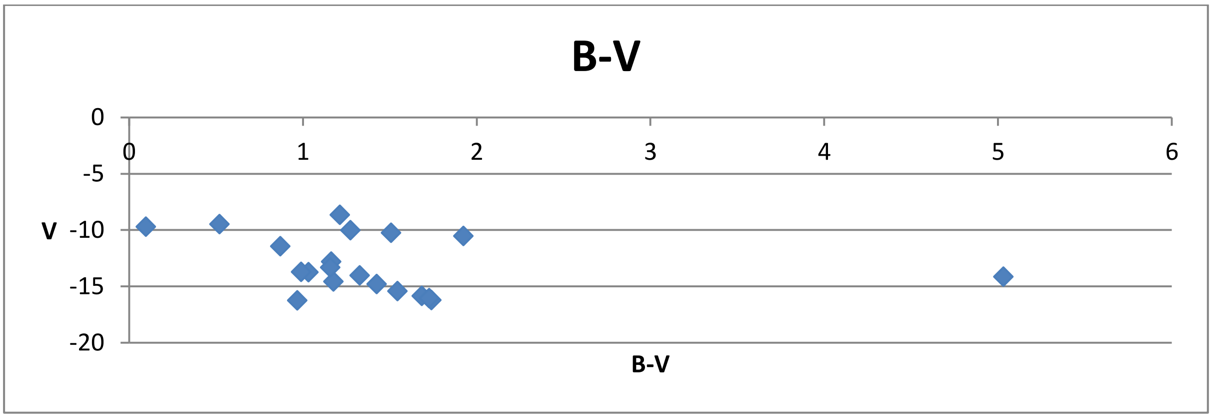


Figure 3: Magnitude-Colour Graph of M10

Globular cluster M92

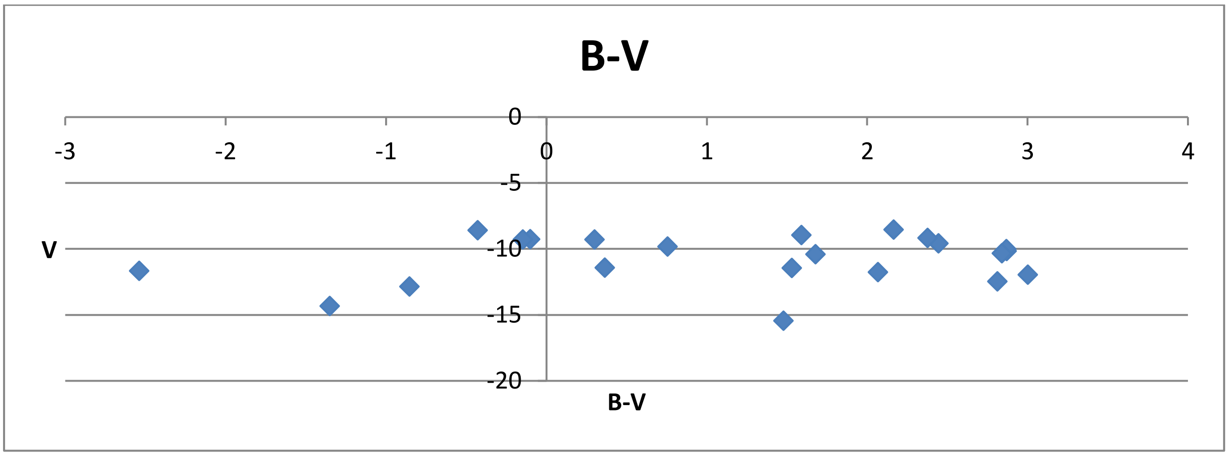


Figure 4: Magnitude-Colour Graph of M92

Absolute magnitude of the nearest stars to us

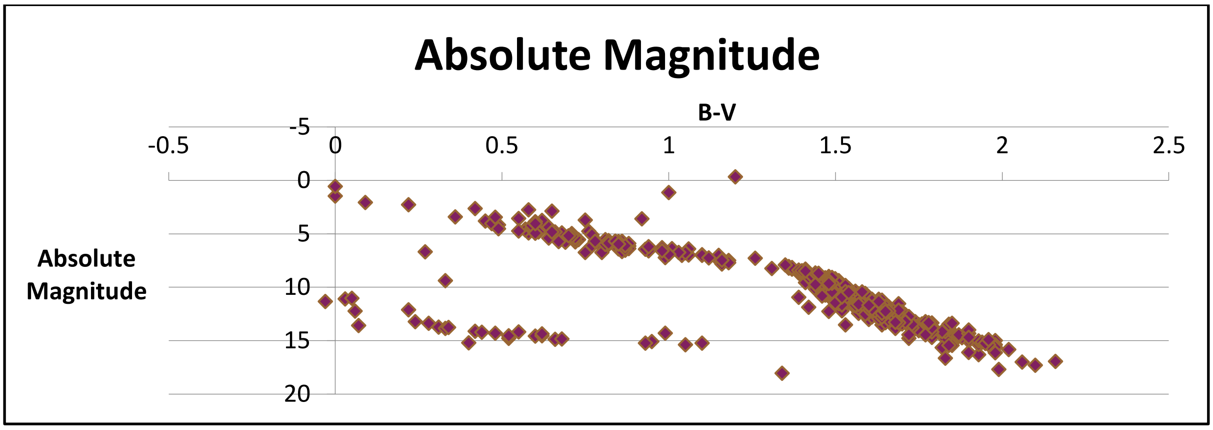


Figure 5: Absolute Magnitude- Temperature Graph of the stars closest to us.

Apparent Magnitude of the nearest stars to us

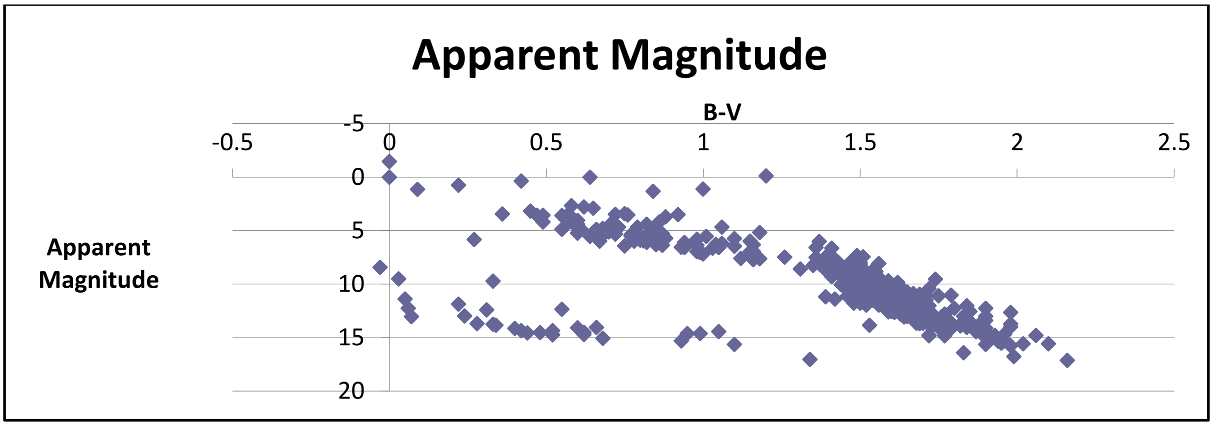


Figure 6: Apparent Magnitude- Temperature Graph of the stars closest to us.

The absolute magnitude is the magnitude of celestial object as it would have been seen at a standard distance of 10 parsecs[3] whereas the apparent magnitude is the magnitude of a celestial object as seen from earth[4]. There is less scatter in the absolute magnitude because all the stars are assumed to be of the same distance away because they are relatively close to one another.

From the data we have collected we can see that the stars we measured are red giants, white dwarfs and main sequence stars. We can infer that they are red giants because they have a low temperature however they are still have a large magnitude due to their large surface area. We can infer that some are white dwarfs because they have a high temperature but a low magnitude due to their small surface area. Finally we know there are main sequence stars because there is a continuous distinct band on the graph.

Conclusions

Globular Clusters

In conclusion from the graph of the globular cluster M10 we can clearly see that the stars in the cluster are within the main sequence meaning that they are currently in the same stage of their lifespan. From the graph of globular cluster M5 we can see the majority of the stars have a magnitude of between -1.5 and -1 suggesting that they are of the same age and origin however quite a few of the stars have different magnitudes suggesting that we need to collect more data in order see a clear pattern. Finally the graph of the globular cluster M92 shows no clear pattern as all the stars have very different magnitudes; therefore no conclusion can be drawn from these results, suggesting that we should review our method.

Apparent and absolute magnitude of some stars in the Milky Way

From the graphs we can infer that the most of the stars are in the main sequence and a small majority of the stars are either white dwarfs or red giants suggesting that the main sequence is the longest part of a stars lifespan. Overall we found that globular clusters contain stars of similar age and that most of the stars are in the main sequence thus proving that they all follow a similar life span.

Improvements

One of the ways in which our research could have been improved would have been through making a note of stars we measured the brightness of; consequently there would have been no chance that we measured the same star multiple times.

Also we could have taken brightness measurements of more stars in the globular cluster therefore the graphs we plotted would be easier to interpret as there would be more points so the pattern would be more distinguishable, also plotting more points makes it easier to identify anomalous results, however we were unable to do this due to time constraints.

The data we collected was not as accurate as we had hoped due to the interference by the brightness of stars near the star we were measuring the brightness of. This could have been resolved

[3] https://en.wikipedia.org/wiki/Absolute_magnitude
[4] https://en.wikipedia.org/wiki/Apparent_magnitude

by zooming in as much as possible on the star and ensuring that we only chose stars that weren't surrounded by any other stars. Finally we could have repeated the experiment multiple times and worked out an average to make the data we collected as reliable as possible.

References

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