The Determination of Open and Globular Clusters Age Using Isochrone and Horizontal Branch Morphology

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Abstract

This project explores methods for determining the age of open clusters M35, M37, M67 and globular clusters M3, M53. The Isochrone method was the most accurate method to study the age of open clusters, and the Horizontal Branch Morphology for the globular clusters.

Introduction

Star clusters are groups of hundreds of stars closely bound together. HR diagrams give information about the life cycle of stars within a cluster. This project explores methods for determining the age of open clusters M35, M37, M67 and globular clusters M3, M53. Isochrones model stars of the same age and metallicity which helps study the age of clusters. Horizontal Branch (HB) Morphology can be used to find the age of clusters using HB population models.

Methodology

Firstly, take photos of the star clusters with B and V filters using the 1-meter diameter telescope at the Thai National Observatory. Secondly, Aperture Photometry Tool is used to measure the apparent magnitude of each star and create HR diagrams. Thirdly, find the age of the clusters using the Isochrone method. Isochrone models are retrieved from MIST database [1]. Another method is the HB morphology method. The Horizontal Branch Ratio (HBR) is calculated and compared with HB population model.

Results and Discussion

Figure 1 : HR diagrams and Isochrones open clusters.

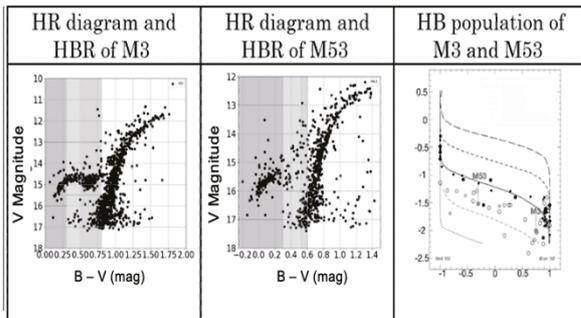Figure 2 : HR diagrams and HB population globular clusters.
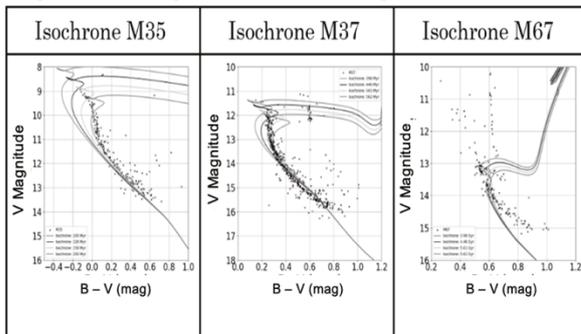
The HR diagrams, as well as the Isochrones for the open clusters are shown in Figure 1. It was found that clusters M37 and M67 show clear turnoff points. Whilst M35 doesn't show a clear turnoff point the age can still be determined from the Isochrone. Table 1 shows the age calculated from the Isochrone method for each open cluster.

Table 1 : Age of open clusters.

Cluster	Age (yrs)	Ref. Age (yrs)	Error %
M35	100-200 M	110-150 M	15.38%
M37	400-550 M	420-520 M	1.06%
M67	4-5.6 G	3.5-4 G	28.00%

The HR diagrams of the globular clusters are shown in Table 3. The HR Diagrams don't show clear turnoff points; therefore, Isochrones can't be used to determine the age. So, the HB morphology method is used to study the age of globular clusters, since the Horizontal Branch is clearly shown in the HR Diagrams. To study the HBR of clusters, blue, red and RR Lyrae type stars must be studied highlighted in Figure 2. Table 2 shows the age calculated from the HB morphology method.

Table 2 : Age of globular clusters.

Cluster	HBR	Age (Gyrs)	Ref. Age (Gyrs)	Error %
M3	-0.36	10.6	11.4	7.02%
M53	0.73	11	12.5	12.00%

Conclusion

From the study of HR diagrams of open clusters M35, M37, M67 and globular clusters M3, M53. It was found that the age of open clusters can be accurately calculated using the Isochrone method. Whilst for globular clusters, it was found that the HB Morphology method was the most accurate for studying the age of globular clusters.

Reference

[1]. Isochrone Models – MIST. Retrieved from https://waps.cfa.harvard.edu/MIST/index.html