THE ROLE OF GALAXY ENVIRONMENT IN THE FORMATION OF MULTIPLE STELLAR POPULATIONS IN GLOBULAR CLUSTERS

INTRODUCTION

- Globular clusters have long been considered to be single stellar populations.
- In the last few decades, research has shown that they are infact multiple populations , with the secondary population enhanced in light elements with respect to the primordial population.
- To determine whether the galaxy environment plays a role in their formation, we analysed two Large Magellanic Cloud clusters (NGC 1898 and NGC 1786).
- Both clusters are older than 10 Gyr, similar to the ones found in Milkyway galaxy. This is crucial to determine the possible role of galaxy environment in the formation of multiple stellar populations.
- Since Red Giant Branch (RGB) is sensitive to light element variations, we use RGB width in a specific filter combination to compare the globular clusters in Milkyway and Magellanic Clouds.

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DETERMINATION OF RGB WIDTH

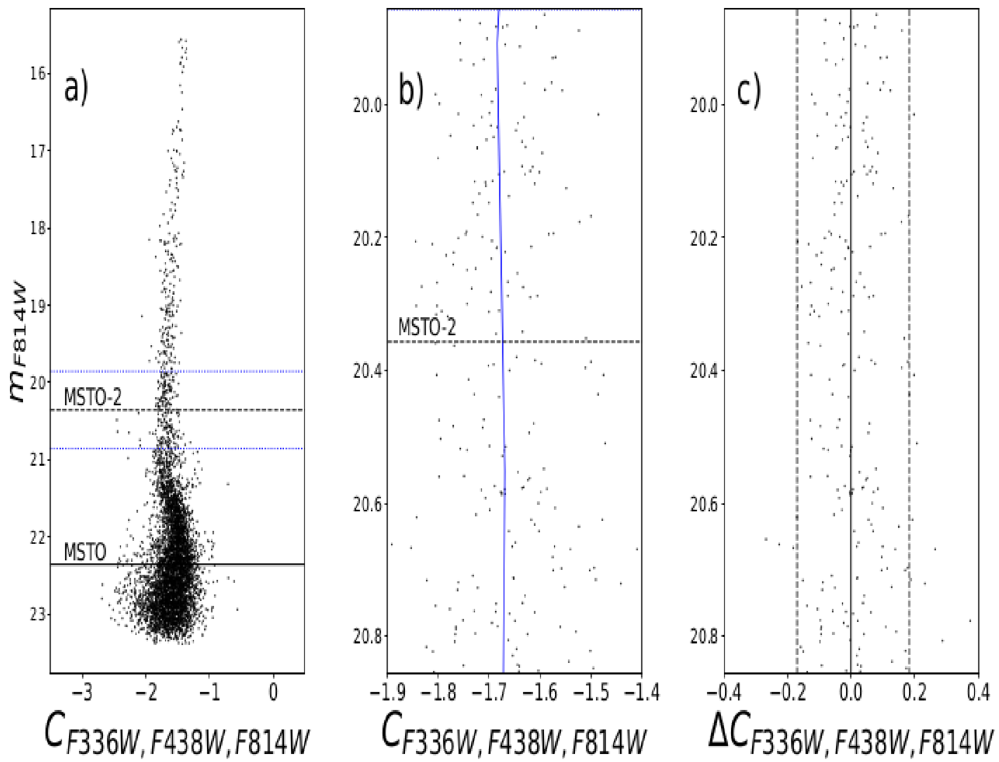

Figure 1: Pseudocolour-Magnitude Diagram of the globular cluster NGC 1898. (a) The RGB interval is defined by dashed blue lines. The Main Sequence Turn Off (MSTO) point is also indicated. (b) Fiducial line through the RGB interval. (c) The interval defined by dashed blacked lines is the observed RGB width.

- We use DOLPHOT photometry pipeline to run PSF photometry on the HST archival images of the two LMC clusters.
- In the $C_{F336W,F438,F814W}$ vs m_{F814W} pseudo -CMD, Main Sequence Turn Off point (MSTO) is determined using naive estimator method.[1]
- MSTO - 2 mag is chosen as the reference magnitude.
- A symmetric one-mag interval around the reference magnitude is chosen as the RGB interval. (Panel (a), Fig.1)
- The colour of each star is subtracted from the fiducial line through the stars in that interval at the same magnitude. (Panel (b), Fig.1)
- The difference between the 4th percentile and the 96th percentile of the resulting distribution is taken as the RGB width. . (Panel (c), Fig.1)
- The associated error is determined by bootstrapping method while the photometric error is subtracted using Artificial Stars test to get the intrinsic RGB width.

1. $C_{F336W,F438W,F814W} = (m_{F336W} – m_{F438W}) – (m_{F438W} – m_{F814W})$*, where* m_x *is the magnitude in filter ‘x’.*

EFFECT OF MASS ON RGB WIDTH

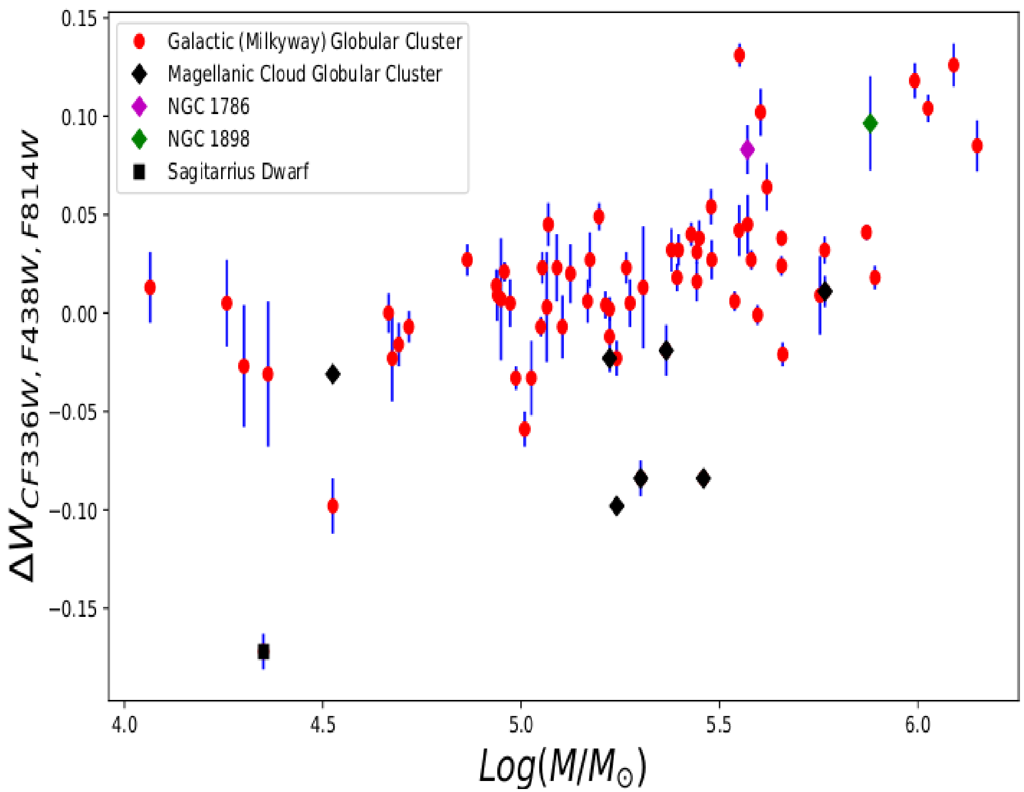

Figure 2: Distribution of metallicity-subtracted RGB width ($\Delta W_{CF336W,F438W,F814W}$) as a function of cluster mass for globular clusters in different galaxies. The error bars represent the uncertainty of RGB width for each cluster.

- Spearman's Correlation Test revealed that there is a significant and strongly monotonic correlation of metallicity with intrinsic RGB width.
- The effect of metallicity was subtracted to get the metallicity-subtracted RGB width ($\Delta W_{F336W,F438W,F814W}$) .
- Spearman's Correlation Test revealed that there was a significant correlation between $\Delta W_{F336W,F438W,F814W}$ and mass and parameters that are dependent on mass, e.g., escape velocity.
- Plotting $\Delta W_{F336W,F438W,F814W}$ vs total cluster mass, we find that the two clusters follow the same general trend as Milkyway clusters while other Magellanic Cloud clusters lie systematically below the Milkyway clusters (Fig 2.)

CONCLUSION

- Two LMC globular clusters, namely NGC 1898 and NGC 1786, were analysed and compared with the ones in the Milkyway.
- Based on the results of the two correlations, it is shown that both metallicity and mass are required to account for the variance of RGB width.
- The two clusters seemed to follow the same general trend as the Milkyway clusters of the same age range when metallicity-subtracted RGB width is plotted against cluster mass.
- This indicates that galaxy environment might not play a role in the formation of multiple stellar populations.
- More clusters in the Magellanic Clouds have to be analysed in order to affirm this conclusion.

Reference: Lagioia E. P., Milone A. P., Marino A. F., Cordoni G., Tailo M.,2019, AJ, 158, 202