Giant Branch in M31 Globular Cluster

Studies of globular cluster systems can provide important insights on different fields in Astrophysics. Being the easiest identifiable members among the oldest stellar populations, they represent a unique tool to probe the formation and early evolution of galaxies. Being used as distance indicator, it is primordial to know to which extent globular cluster systems have the same properties from galaxy to galaxy.

Besides the Milky Way, M31 is the only galaxy within the Local Group to possess a large globular cluster population. Therefore, the study of these globular clusters, all located at the same distance, gives us a unique opportunity to expand our knowledge on the physical properties of globular clusters.

We have taken advantage of the high resolution capability of the CFHT HR-Camera to study the giant branch of a sample of globular clusters in M31. The whole sample has already been presented in a previous CFHT Bulletin (Racine and Harris [1]).

We present in this Scientific News the data of five globular clusters for which V and I frames have been obtained. The clusters we have chosen are shown in Table 3.

Metallicities have been taken from Huchra, Brodie, and Kent [2] (hereafter HBK). The coordinates 'R' and 'X' are respectively the distance from the center (in arcmin) and the distance from the minor axis (with positive 'X' eastward) of M31. With a scale of 0.13 "/px, a frame covers 4.5 arcmin square and a cluster covers typically 1-2 % of the frame. If we adopt a distance modulus of (m - M) = 24.3, the physical scale is 4.6"/kpc. The FWHM of the objects is in the range of 0.5-0.6" for V frames and 0.4-0.5" for I frames.

The first step of data reduction consisted in building median filter for each frame and subtracting it from the original frame. This procedure was very successful in removing the integrated light of the clusters produced by the non-resolved stars. We then performed stellar photometry on these new frames with DAOPHOT.

Figure 15 shows the combined CMD of G11, G319, and G323 for which giant branch lie approximately at the same location. In order to avoid a too large crowding or a too large field contamination, only

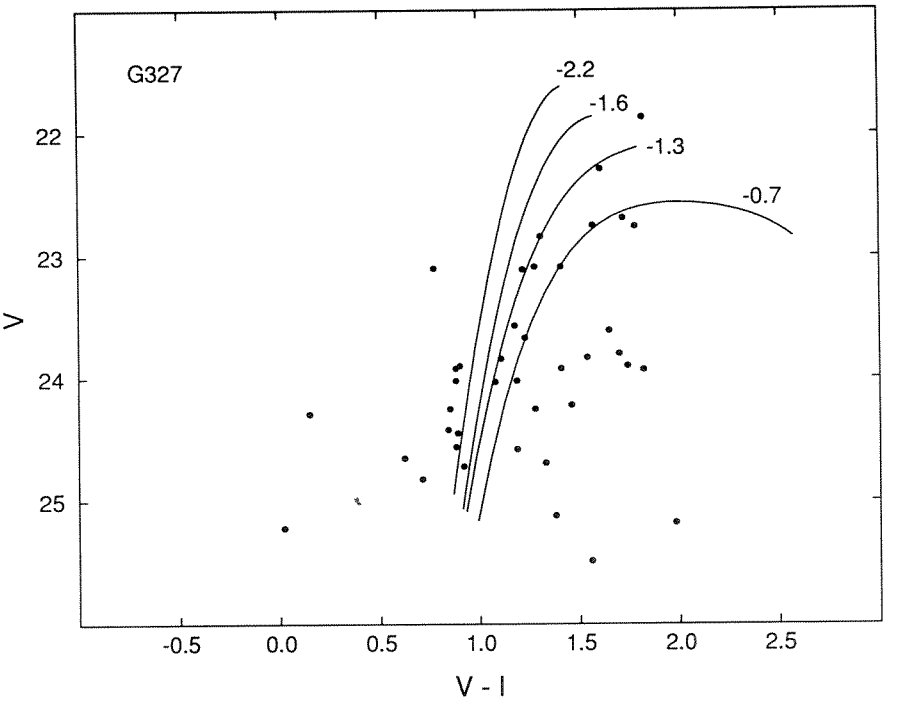

Figure 16: CMD of G327. Dereddening has been applied, using E(V - I) = 0.1. Fiducial giant branches of four galactic globular clusters are shown (from left to right: M15, M2, NGC 1851, and 47 Tuc) and their metallicity is indicated. We find [Fe/H] = -0.9 for this cluster.

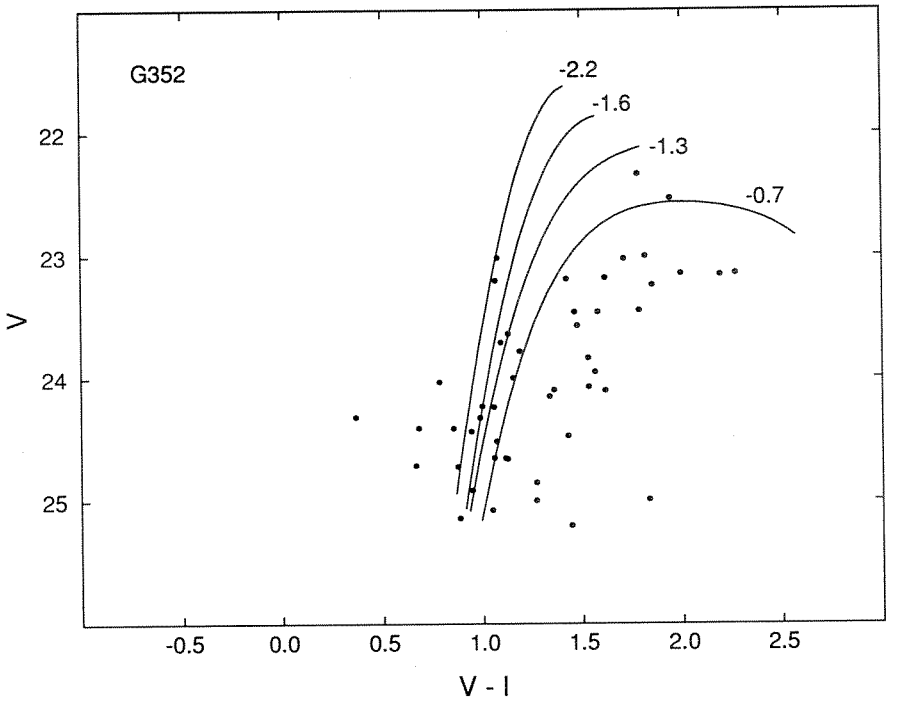

Figure 17: CMD of G352. Dereddening has been applied, using E(V - I) = 0.1. Fiducial giant branches of four galactic globular clusters are shown (from left to right: M15, M2, NGC 1851, and 47 Tuc) and their metallicity is indicated. We find [Fe/H] = -0.4 for this cluster.

Table 3

Cluster	Location in M31 R	X	[Fe/H]	Texp(sec) V	I
G11	75.7	-61.9	-1.89	10000	7500
G319	72.1	-20.8	-0.66	3500	3000
G323	53.8	0.36	-1.96	10000	7500
G327	99.7	0.15	-1.76	2000	3000
G352	87.1	0.15	-0.85	10000	6000

stellar objects located from 2" to 8" from the clusters center have been selected. Colors and magnitudes have been dereddened, using E(V - I) = 0.1. We also show the fiducial giant branches for M15 ([Fe/H] = -2.17) and 47 Tuc ([Fe/H] = -0.71) as computed by Da Costa and Armandruff [3]. We used a distance modulus of (m - M) = 24.3 to put the fiducial lines at M31 distance. We have computed the metallicities of the individual giant branches with the empirical relation used by Da Costa and Armandruff [3] and find [Fe/H] = -1.7, -1.7, and -2.0 respectively for G11, G319, and G323. Figures 16 and 17 show the CMDs of G327 and G352 respectively. The fiducial lines of M2 ([Fe/H] = -1.58) and NGC 1851 ([Fe/H] = -1.29) have been added to the M15 and 47 Tuc ones. We find [Fe/H] = -0.9 for G327 and -0.4 for G352.

Metallicities of G11, G323, and G352 are in good agreement with HBK determinations, based on spectroscopy of the clusters integrated light. However, we obtain a metallicity of 1 dex (in [Fe/H]) lower than HBK for G319 and 0.8 dex higher for G327. The cause of the discrepancy is still unknown. It is worth noting that both methods are very different and use different area of the clusters (we use the periphery, HBK use the center).

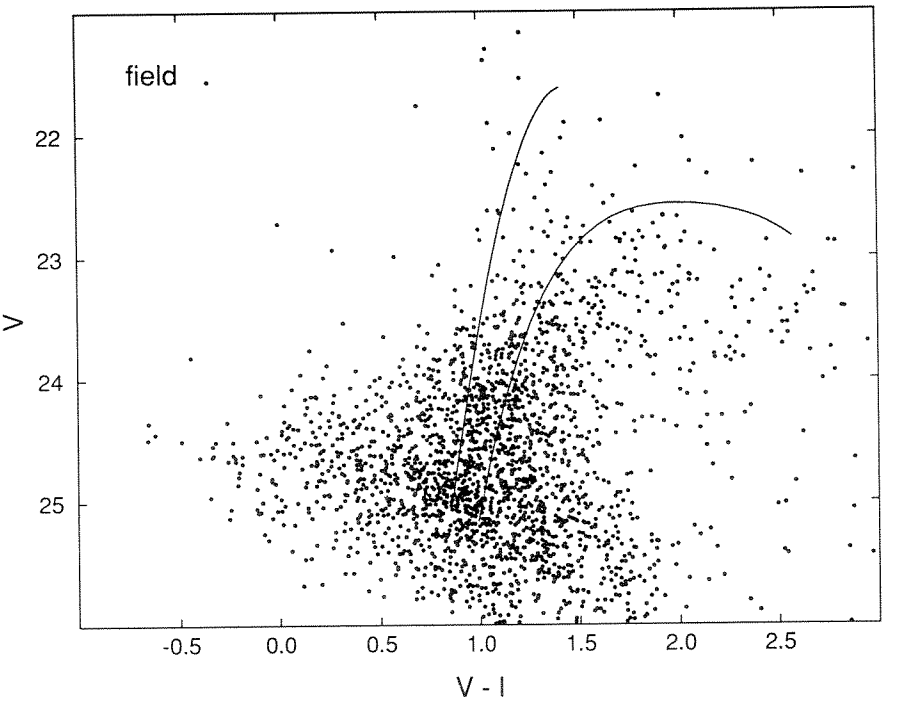

Figure 18: CMD of M31 field. Only stellar objects located at more than 13" from the clusters center have been considered. All the frames have been combined. Dereddening has been applied, using E(V - I) = 0.1. Fiducial giant branches of M15 (solid curve at the left) and 47 Tuc (solid curve at the right) are shown. Giants have a large range in metallicity. A large number of stars are redder than 47 Tuc ([Fe/H] = -0.71).

Contamination from the field is negligible (1 or 2 objects at the giant branch location). The horizontal branch was expected at V ~ 25 which is just too faint for our photometry. We estimate that a seeing of 0.3" would have been necessary to detect it.

Their metallicity has been estimated by interpolation between the fiducial lines used above. A large number of stars are more metal-rich than 47 Tuc and can not be properly calibrated. M31 globular clusters are slightly more metal-rich on average than those of our Galaxy, a well-known result. Metallicity of M31 halo stars spans a large range with a small peak around [Fe/H] = -1.0, slightly higher than the M31 globular clusters average. This result is in agreement with Pritchet and van den Bergh [4].

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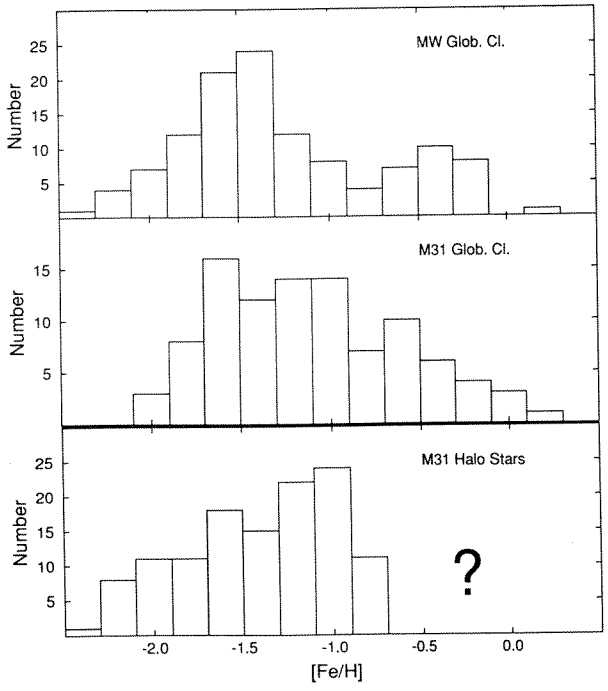

Figure 19: Metallicity distribution of Galactic globular clusters (upper panel), M31 globular clusters (middle panel), and M31 halo stars (lower panel). Globular clusters data for both galaxies come from Huchra, Brodie and Kent [1]. Only stellar objects located at more than 13" from the center of the clusters and brighter than V = 23 have been selected. Their metallicity has been interpolated from the fiducial giant branches used before.

References

1. Racine, R., and Harris, W. 1991, CFHT Bulletin No. **24**, 17.
2. Huchra, J.P., Brodie, J.P., and Kent, S.M. 1992, Ap. J., **370**, 495.
3. Da Costa, G.S., and Armandroff, T.E. 1990, A. J., **100**, 162.
4. Pritchet, C., and van den Bergh, S. 1988 Ap. J., **331**, 135.