WASHINGTON PHOTOMETRY OF THE FORNAX AND SCULPTOR DWARF SPHEROIDAL GALAXIES

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Abstract

Using Washington broad band photometry, we determined abundances of $(−1.5 ± 0.3)\text{\,dex}$ for the Fornax dSph galaxy, and $(−1.6 ± 0.3)\text{\,dex}$ for Sculptor. Globular cluster \#3 of Fornax is clearly more metal poor with $[\text{Fe}/\text{h}] \simeq −2.3\text{\,dex}$. In Fornax, we find evidence for a younger population.

1 Introduction

Many investigators have found that the giant branches of dwarf spheroidal (dSph) galaxies are broader in metallicity-sensitive colour indices than are the giant branches of globular clusters. Thus the origins of dwarf spheroidal galaxies are more heterogeneous than are globular clusters.

We have used the Washington broad band system to explore these matters because it is more sensitive to metallicity than other photometric systems. We computed theoretical isochrones from tracks of the Geneva group (e.g., Schaller et al. 1992). For the more metal-poor stars we used theoretical isochrones from Bergbusch and VandenBerg (1992), though these seem slightly too blue. These theoretical isochrones were then transformed by 3D interpolation in our grids of Washington colours computed from Kurucz flux tables. No transformation of the colours was necessary as demonstrated in calibration against stars of known atmospheric parameters and established colours.

2 Ages and evidence for a more recent origin

Dwarf spheroidal galaxies may have formed in tidal interactions between galaxies (e.g., Mirabel et al. 1992). Using our own Washington isochrones (Figs 1a and 2a), we confirm that the ages of these two dSphs are significantly younger than that of our Galaxy. For Sculptor, we find an age of $13\text{\,Gyr}$ and for the dominant population of Fornax $10\text{\,Gyr}$. All ages are uncertain at the $± 2\text{\,Gyr}$ level. No age spread can be resolved.

In addition, the field we observed in Fornax contains globular cluster \#3, which has a similar age to that of Fornax, while the galaxy itself contains a small population of younger stars.
FIG. 1A. The 250 stars with the smallest errors in Fornax. The filled triangles are stars with [Fe/H] < -1.8, and are mostly in GC #3. The isochrones bracket the age and metallicity found from a more complete CMD.

FIG. 1B. The same stars from Fornax plotted with isoabundance curves derived from our calibrated isochrones. The curves proceed upwards from higher to lower abundance.
Fig. 2A. The 250 stars with the smallest photometric errors in Sculptor. Evidence of a secondary, more metal poor population is apparent in both the CMD and the TCD below (triangles). The isochrones bracket the age and abundance found from a more complete CMD.

Fig. 2B. The same stars from the Sculptor CMD above plotted with the same isoabundance curves in Fig. 1b. Again, a bimodal metallicity distribution can be seen.
3 Abundances

Both galaxies show a broad range of metallicities. The Fornax galaxy has a mean metallicity of $-1.5$ dex with a spread of $\pm 0.3$ dex (Fig. 1b), while the older galaxy Sculptor has a mean metallicity of $-1.6$ dex with a similar range (Fig. 2b).

We compute a metallicity distribution function (MDF) by binning the 250 stars with the smallest photometric errors in each galaxy. We compute the metallicity of each star in the $(C - M), (M - T_2)$ two-colour diagram by performing Hermite interpolation among the isometallicity relations derived from the isochrones. We consider only those stars whose photometric errors propagate to abundance errors less than or equal to the abundance separation between their bounding isochrones.

4 Results

The Fornax metallicity distribution function (MDF) is broad and unimodal for the dominant population. Using our theoretical metallicity calibration, the Sculptor MDF has structure that is most consistent with a bimodal distribution with mean metallicities of $-1.5$ dex for the dominant population and $-2.0$ dex for a second, sparser, equally old population. However, using the empirical calibration of Geisler et al. (1991) the bimodality does not show up as significant. Though our photometric errors are low and the theoretical calibration sound, in view of this conflict we plan spectroscopic observations to check this result.

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References