Dynamical Evolution of Dense Stellar Systems
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GMOS Spectroscopy of Globular Clusters in Dwarf Elliptical Galaxies

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Abstract. We present a Gemini/GMOS program to measure spectroscopic metallicities and ages of globular clusters (GCs) and nuclei in dwarf elliptical galaxies in the Virgo and Fornax Clusters. Preliminary results indicate that the globular clusters are old and metal-poor, very similar to the GCs in the Milky Way halo. The nuclei tend to be more metal-rich than the globular clusters but more metal-poor and older, on average, than the stars in the bodies of the galaxies. The [α/Fe] ratio appears to be solar for the GCs, nuclei, and dEs, but the uncertainties do not exclude some globular clusters from being enhanced in alpha elements.

Keywords. galaxies: star clusters, galaxies: dwarf, galaxies: nuclei

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Dwarf elliptical (dE) galaxies are the dominant type of galaxy in galaxy clusters and they may be related to pre-galactic fragments in hierarchical formation scenarios. They also contain relatively large numbers of globular clusters (GCs; Miller & Lotz 2007). Photometry has shown that the GCs have $(V - I)$ colors similar to those of old, metal-poor Galactic clusters but that the mean color increases with galaxy luminosity (Lotz *et al.* 2004). The galaxies themselves have redder colors and the nuclei fall in between. However, from photometry alone it is not possible to distinguish the effects of age and metallicity on the colors.

Therefore, multi-object spectroscopy of the dE GC photometric candidates and nuclei were carried out with both GMOS instruments on the Gemini telescopes during four semesters between 2002A through 2004B. In all cases the B600 grating was used with 0.75 arcsec slits, giving a wavelength coverage from approximately 3500Å to 6500Å at $R \sim 1400$. Between one and three masks were observed for each galaxy depending on the number of candidates. The typical exposure time per mask is about five hours (some objects are observed in more than one mask) and the image quality varied between 0.7 and 0.85 arcsec. The data were reduced with the Gemini IRAF package with additional steps for handling bad pixel masks, relative quantum efficiency corrections between the three CCDs, and correcting the spectral shapes for slit losses due to the differences between the parallactic angles and the PAs of the slits. The spectra of many of the faint GCs have signal-to-noise too faint for line-strength analysis. Therefore, the spectra of all GC candidates for a given galaxy with radial velocities within about 200 km/sec of the velocity of the nucleus were combined to produce a "mean" GC spectrum. These mean spectra have $S/N \sim 30 - 40$ and are used for measuring line indices.

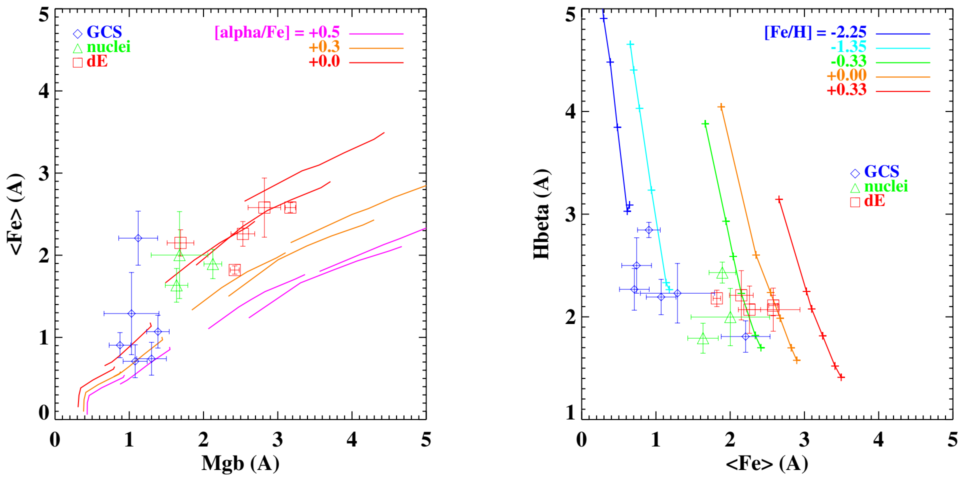

Figure 1. Line indices for GCs and nuclei from GMOS spectroscopy are compared with dE background light (Geha *et al.* 2003) and stellar evolutionary models (Thomas *et al.* 2003). The left plot shows ⟨Fe⟩ versus Mgb with models for different [α/Fe]. The right plot uses models with [α/Fe] = 0.0 and shows that the GCs are old and metal-poor while the dEs are more metal-rich and somewhat younger. The nuclei appear to have ages and metallicities between those of the GCs and dE field stars.

A preliminary comparison of the line indices of the GCs, nuclei, and background light in dEs is given in Fig. 1. Stellar evolutionary model of Thomas *et al.* (2003) are overplotted. For the nuclei and field stars [α/Fe] ≈ 0, indicating a star formation timescale longer than 1 Gyr. The uncertainties in the GC data make it difficult to determine [α/Fe]. It is consistent with the solar value but some GCs could be α enhanced. The right plot in Fig. 1 give models of different ages and metallicities in the $\langle \mathrm{Fe} \rangle - \mathrm{H}\beta$ diagram. In general the GCs are old and metal-poor, the nuclei are more metal-rich, and the galaxy field stars are even more metal-rich, $-0.5 \lesssim$ [Fe/H] $\lesssim 0$, and a few Gigayears younger. Thus, the color-trends are mostly a function of metallicity but there are also important age differences that the photometry can not discern. Future work includes a thorough analysis of the line indices and M/L estimates from the velocity dispersions.

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