Life in Low-density Environments – Field Galaxies from z=1.0 to the Present

Inger Jørgensen[1], Scott Fisher[2], Charity Woodrum[2], Teiler Kwan[2], Jacob Bieker[2]

[1]Gemini Observatory USA; [2]University of Oregon USA

Perseus z=0.018

IAU 2015: S319p.220

Coma z=0.024

Abstract: We present results on the stellar populations of bulge-dominated field galaxies at redshifts up to ≈1.0. The sample consists of non-cluster galaxies observed as part of the spectroscopic observations for the Gemini/HST Galaxy Cluster Project (GCP). Our preliminary results show that the bulge-dominated field galaxies contain younger stellar populations than cluster galaxies at similar redshifts. Future work will include photometry from Hubble Space Telescope and will be aimed at establishing the evolution of the sizes and the mass-to-light ratios for the field galaxies.
This poster is presented by the PI of the GCP on behalf of students at University of Oregon, C. Woodrum, T. Kwan and J. Bieker, who carried out the analysis as a student research project.

Sample selection and redshift distribution

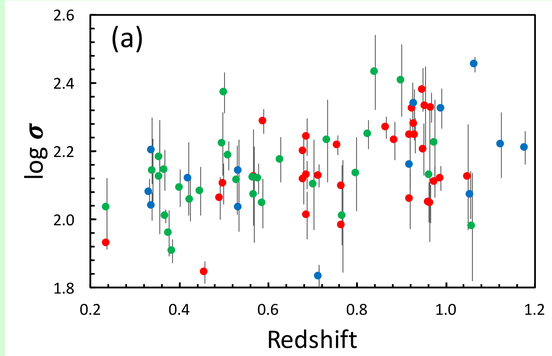

Fig 1: (a) Velocity dispersion versus redshift, illustrating the available data for the project. (b) Redshift distribution of the samples. *The results presented on this poster focus on the bulge-dominated galaxies without significant emission*. Galaxies with n_{ser}>1.5 as determined from profile fitting of HST imaging are considered bulge-dominated. Emission is evaluated from the presence of lines [OII], [OIII] and Hβ in emission.

Line indices versus velocity dispersion: From our analysis of the available absorption line measurements versus the velocity dispersion of the galaxies we find that the galaxies in the bulge-dominated sample contain young stellar populations consistent with a formation redshift of z_{form}=1.2-1.4 (Fig 2ab, Fig 3ab). As for the cluster galaxies the CN3883 index is stronger than expected for such young stellar populations (Fig 2c, Fig 3c). The weak Fe4383 indicates that the sample spans a range of abundance ratios [α/Fe] (Fig 2d).

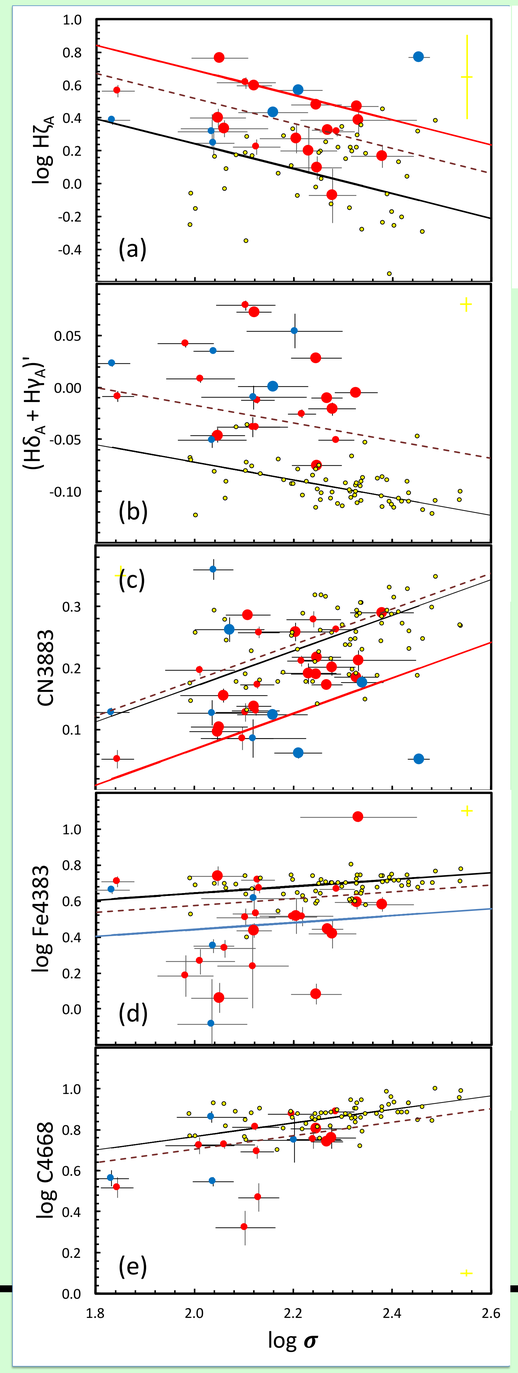

Fig 2: Absorption line indices versus velocity dispersions. The samples of bulge-dominated field galaxies are shown together with our z~0 cluster sample as well as representative relations for massive clusters, see legend (Jørgensen & Chiboucas 2013, Jørgensen et al. 2014).

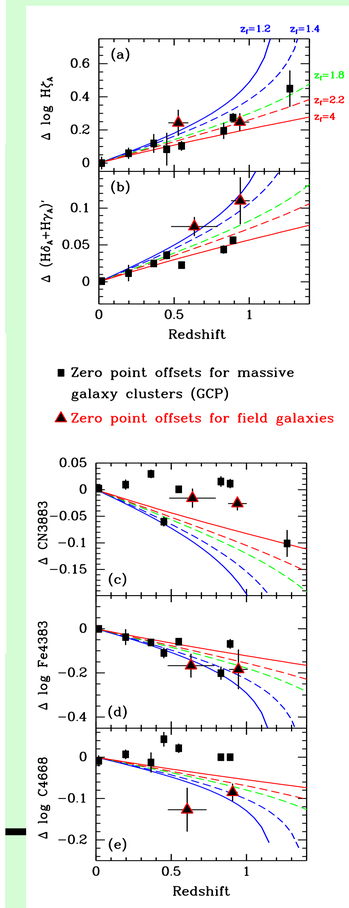

Fig 3: Zero point offsets of scaling relations relative to the z=0 cluster sample: Solid and dashed lines show passive evolution modes for z_{form} as labeled based on SSP models from Maraston & Strömbäck (2011) for $H\zeta_A$ and CN3883, and from Thomas et al. (2011) for the remainder of the indices. The results for massive clusters are from the GCP (Jørgensen & Chiboucas 2013, Jørgensen et al. 2014, 2015). *The bulge-dominated field galaxies are in general younger than cluster galaxies at similar redshifts (panels (a) and (b)). Our results indicate formation redshifts of z_{form}=1.2-1.4. However, as for the z<1 cluster galaxies, the CN3883 index is significantly stronger than expected based such recent star formation.*

Absorption line indices: Figure 4 shows the field galaxy data together with our low redshift cluster galaxy comparison sample. Each panel has Single Stellar Population (SSP) models over plotted. *These figures confirm that the field galaxies contain young stellar populations (1-5 Gyr, see panel a and b), and that the sample contains a range of abundance ratios [α/Fe] (see panel c).*

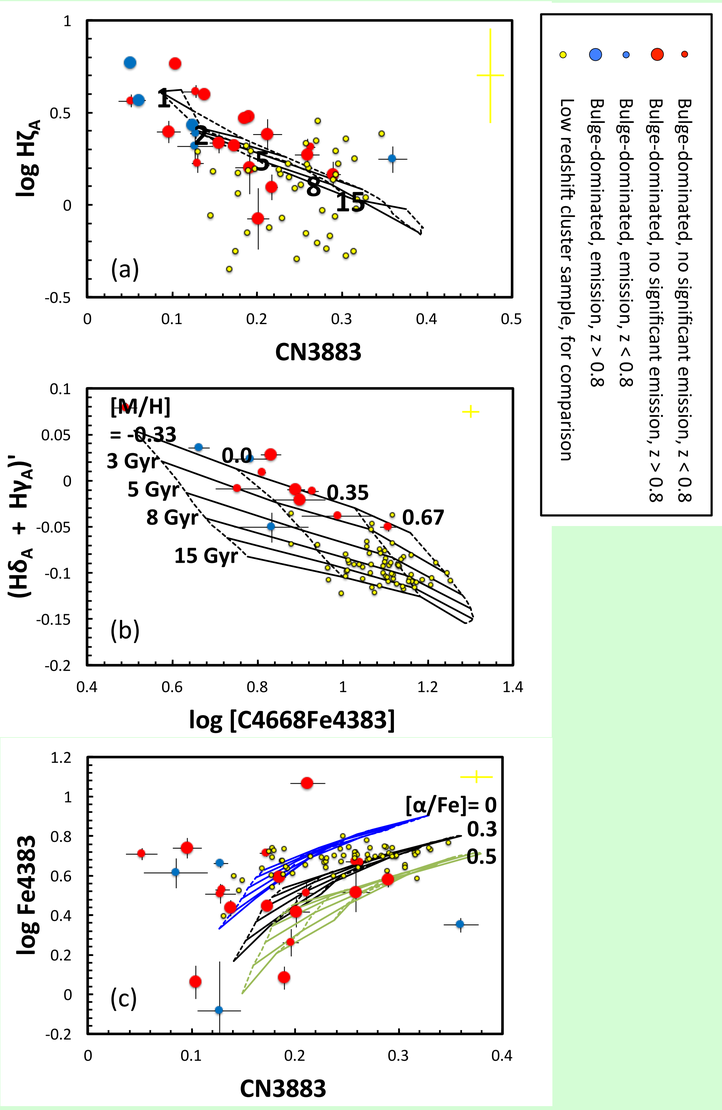

Fig 4: Absorption line indices. Single stellar population (SSP) models from Maraston & Strömbäck (2011) are over plotted on panel (a). Similar models from Thomas et al. (2011) are shown on panels (b) and (c). Maraston & Strömbäck (2011) provide models for solar abundance ratio [α/Fe]=0. The locations of ages 1, 2, 5, 8, and 15 Gyr for solar metallicity are labeled. The model grid on panel (b) is for [α/Fe]=0.3, labeled with ages and metallicities [M/H], while the three model grids on panel (c) show [α/Fe]= 0 (blue), 0.3 (black) and 0.5 (green). *The index-index plots confirm the presence of young stellar populations in the field galaxies (ages 1-5 Gyr, panels a and b) and shows rather large spread in abundance ratios [α/Fe] (panel c).*

Conclusions:

Based on spectroscopy of bulge-dominated field galaxies observed during execution of observations for the Gemini/HST Galaxy Cluster Project we find:

- The bulge-dominated field galaxies contain young stellar populations with ages of 1-5 Gyr.
- The Balmer lines indicate formation redshifts of z_{form}=1.2-1.4
- The galaxies are younger than cluster galaxies at similar redshifts.
- As for the z<1 cluster galaxies, the CN3883 index is stronger than expected in galaxies containing such young stellar populations.
- The galaxies contain a range of abundance ratios [α/Fe].

Future work:

HST imaging is available for the full sample of galaxies. We plan to use effective radii, surface brightnesses, luminosities and colors from these data to address the following questions:

- Do the galaxies evolve in size with redshift at a given dynamical mass?
- Do the changes in M/L ratios with redshift agree with the formation redshift found from the line indices?

We will also conduct a detailed comparison of our results with those published by other research groups.

Finally, we will include in the sample additional non-member galaxies observed as part of the Gemini/HST Galaxy Cluster Project.

References:
Jørgensen & Chiboucas, 2013, AJ, 145, 77
Jørgensen et al. 2014, AJ, 148, 117
Jørgensen et al. 2015, in prep, see also Poster S319p.159
Maraston & Strömbäck, 2011, MNRAS, 418, 2785
Thomas et al. 2011, MNRAS, 412, 2183

Acknowledgements: Based on observations obtained at the Gemini Observatory, which is operated by AURA under a cooperative agreement with the NSF on behalf of the Gemini partnership.