Stellar Populations - Planning for the Next Decade
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Stellar populations in brightest cluster galaxies

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Abstract. We present the results of an investigation of a large sample of brightest cluster galaxies (BCGs), their kinematic and stellar population properties and the relationships between these and the properties of the host clusters. We have obtained high signal-to-noise, long-slit spectra of 49 BCGs in the nearby Universe with the Gemini and WHT telescopes. From this, we have measured the radial velocity and velocity dispersion profiles, and used the Lick system of absorption indices to derive Single Stellar Population (SSP)-equivalent ages, metallicities and α-abundance ratios. The results were systematically compared with those of large samples of ordinary elliptical galaxies in the same mass range. In addition, the derived properties were tested for possible correlations with the internal properties of the galaxies (mass, rotation and luminosity) and the properties of the host clusters (density, mass, distance to X-ray peak and cooling flows). We address the following questions: how the kinematic and stellar population properties differ from those of ordinary giant elliptical galaxies; and whether these properties are more influenced by the internal parameters of the BCGs or the properties of the clusters.

Keywords. galaxies: formation, galaxies: elliptical and lenticular, cD, galaxies: stellar content

1. Introduction

We have presented the largest optical, spatially-resolved, spectroscopic sample of BCGs to date (Loubser *et al.* 2008; 2009). The sample contains high signal-to-noise ratio, long-slit data for 49 BCGs in the nearby Universe, allowing possible connections between the kinematical, dynamical and stellar population properties to be studied. Here, we will summarise the main results of the study thus far, and highlight future prospects.

2. Results

Clear rotation curves were found for a number of galaxies for which major axis spectra were obtained, and in particular, two galaxies were found to have rotational velocities exceeding 100 km s^{-1}. The large rotation is unexpected in the light of numerical simulations, which predict that the bombardment of small satellites without gas is very effective at heating the disc and creating a spheroid supported by velocity anisotropies. However, in general the BCG data are consistent with the known trend for very massive elliptical galaxies to be supported by velocity anisotropy, because of the large central velocity dispersions.

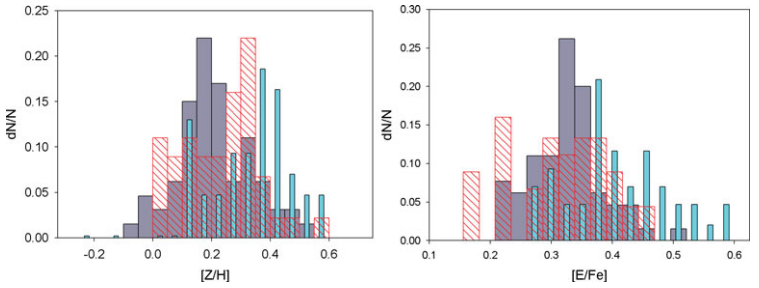

Figure 1. Distributions of the derived SSP-equivalent parameters (metallicity [Z/H] and α-abundance [E/Fe]) for the BCGs (narrow), compared with those for ordinary ellipticals (Thomas *et al.* 2005 – solid thick; Sánchez-Blázquez *et al.* 2006 – shaded thick), over the same mass range.

At least 31 per cent of the BCGs show very clear velocity substructure, which could be due to a merger event or because the galaxy is triaxial and supports different orbital types in the core and the main body. Despite the undeniably special nature of BCGs due to their extreme morphological properties and locations, the kinematic properties investigated in this study (rotation and incidence of velocity substructure) seem normal when compared with their ordinary giant elliptical counterparts. However, there are exceptions: 1) we found that the BCGs lie above the Faber–Jackson relation, which is naturally explained if the galaxies formed through dissipationless mergers of elliptical galaxies on radial orbits; and 2) we found rising velocity dispersion profiles for a small number of BCGs, which are generally not found in ordinary ellipticals, and might imply a rising mass-to-light ratio.

The derived SSP-equivalent ages of these massive galaxies are generally old, as expected, although we do detect possible signatures of small, recent star formation episodes in a quarter of the sample. There are also differences – albeit small – between the stellar populations in BCGs and ordinary elliptical galaxies over the same mass range. The BCGs show higher metallicity and α-enhancement values (Figure 1). The former possibly indicates more efficient star formation, and the latter is most commonly interpreted as a consequence of shorter formation time-scales in BCGs, though other interpretations are possible including differences in the initial mass function, differences in the binary fractions, or selective winds. The SSP-equivalent parameters show very little dependence on the mass or brightness of the galaxies, or the mass or density of the host clusters.

3. Future Work

Stellar population gradients can be used as chemodynamical signatures of the different formation processes at work in galaxy formation, as gas dissipation and mergers will leave different radial signatures. Such gradients and their relationships to galaxy structural parameters, therefore, provides strong constraints on galaxy formation and will be investigated in a future paper in the series.

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