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Stellar and dynamical masses of brightest cluster galaxies

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Abstract. We investigate the stellar and dynamical mass profiles of 32 brightest cluster galaxies (BCGs, M_K = –25.7 to –27.8 mag) in massive clusters ($0.05 < z < 0.30$), and in particular the rising velocity dispersion profiles of 23 of these BCGs found in Loubser *et al.* (2018). We make comprehensive measurements of the Gauss-Hermite higher order velocity moments h_3 and h_4, and find positive central values for h_4 for all the BCGs. We model the stellar and dynamical mass profiles of 25 of the BCGs using the Multi-Gaussian Expansion (MGE) and Jeans Anisotropic Method (JAM) for an axisymmetric case, deriving the stellar mass-to-light ratio ($\Upsilon_{\star\mathrm{DYN}}$), and anisotropy ($\beta_z$). We further explicitly add a dark matter halo mass component (M_{DM} within r_{200}) which we constrain from weak lensing results. In this proceedings, we summarise the study and show an example of the results.

Keywords. galaxies: clusters: general, galaxies: elliptical and lenticular, cD, galaxies: kinematics and dynamics

1. Data and methods

We use spatially-resolved long-slit spectroscopy for 14 MENeaCS brightest cluster galaxies (BCGs), and 18 CCCP BCGs, taken on the Gemini North and South telescopes (see Loubser *et al.* 2018 for details), and r-band imaging from the Canada-France-Hawaii Telescope (CFHT/MegaCam). We make comprehensive measurements of the Gauss-Hermite higher-order velocity moments h_3 and h_4 for the entire sample of BCGs, and compare these measurements to those of other massive early-type galaxies, as well as to similar measurements for 23 brightest group galaxies (using HET long-slit spectra from the CLoGS sample, see Loubser *et al.* 2018).

From the images, we find three BCGs with multiple nuclei, and another four with prominent substructure which we exclude from our modelling. We then model the stellar and dynamical mass profiles of BCGs located in 25 massive clusters, using the Multi-Gaussian Expansion (MGE, Cappellari 2002) and Jeans Anisotropic Method (JAM, Cappellari 2008) for an axisymmetric case, deriving the stellar mass-to-light ratio ($\Upsilon_{\star\mathrm{DYN}}$), and anisotropy ($\beta_z$).

We model the BCGs using a mass model which incorporates the stellar mass distribution, a central mass concentration representing a supermassive black hole (derived using the central velocity dispersion and a $M_{\mathrm{BH}} - \sigma$ relation), and a dark matter halo (M_{DM} within r_{200} derived using the weak lensing results from Herbonnet *et al.* (in prep), and assuming a mass-concentration relation and an NFW profile). We define the best-fitting model to be the one with the combination of parameters, $\Upsilon_{\star\mathrm{DYN}}$ and β_z, that results in a predicted second moment of velocity (ν_{rms}) that most closely match the observed ν_{rms} (see the BCG in Abell 2261 in Figure 1). Our fits to the observed kinematics are

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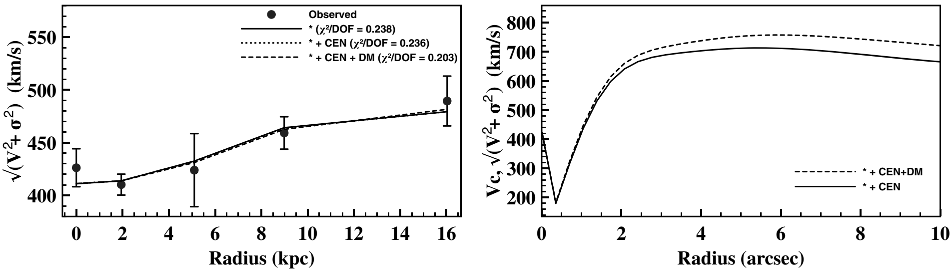

Figure 1. We find the best-fitting free parameters ($\Upsilon_{\star\mathrm{DYN}}$ and β_z) for three dynamical mass models: 1) a stellar mass component (*); 2) a stellar mass plus central mass component (* + CEN); 3) a stellar plus central mass plus dark matter mass component (* + CEN + DM). In the left panel we show the averaged second moment of velocity ($\sqrt{V^2+\sigma^2}$) profile for the BCG in Abell 2261 as an example, and in the right panel we illustrate the circular velocity curves for the total mass, and for the central and stellar mass only. For this example, we find the best-fitting $\Upsilon_{\star\mathrm{DYN}}$ and β_z (for the * + CEN + DM mass model) to be 3.36 and –0.28, respectively.

restricted to within <20 kpc from the galaxy centre, where the stellar mass is the dominant contributor. For all the BCGs, we assume an edge-on configuration (inclination $i = 90$ degrees).

2. Main results

We measure positive central values for h_4 for all the BCGs. Over the radial range (<20 kpc), we find that, the rising velocity dispersion profiles of many of the BCGs can be described by tangential anisotropy ($\beta_z < 0$), and that radial anisotropy ($\beta_z > 0$) describes the decreasing velocity dispersion profiles. For two BCGs, we find that a variable $\beta_z(r)$ (from radial anisotropy to isotropy) and/or a variable $\Upsilon_{\star\mathrm{DYN}}(r)$ is needed to fit the observed kinematic profiles, but from our stellar population analysis we conclude that a variable $\beta_z(r)$ is more likely. For BCGs with rising velocity dispersion profiles, we find a variable $\Upsilon_{\star\mathrm{POP}}(r)$ for a third of these cases from our stellar population analysis. These results suggest that the rising velocity dispersion profiles in BCGs can be the result of a variable $\Upsilon_{\star\mathrm{DYN}}$ in some cases, but more often it is the result of a tangential β_z. Our results encompass a range of velocity anisotropy (radial to tangential), and in cases with tangential anisotropy (typically associated with negative h_4), the positive measurements of h_4 must primarily result from gradients in the circular velocity profiles.

Two comprehensive papers from this study are in preparation (Loubser *et al.*) containing the full details of the: 1) dynamical and stellar mass models, stellar anisotropy and mass-to-light ratios; 2) combination of the dynamical and stellar population modelling to place constraints on the initial mass function (IMF).

References

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