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# Dynamical modelling of brightest cluster galaxies: Constraints on the IMF

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**Abstract.** We study the stellar and dynamical masses, as well as the stellar populations, of brightest cluster galaxies (BCGs) located in 32 massive clusters, and for a sub-sample of these use the results to place constraints on the Initial Mass Function (IMF). We measure the spatially-resolved stellar population properties of the BCGs, such as recent star formation episodes, and use it to predict their stellar mass-to-light ratios ($\Upsilon_{\star \rm POP}$). We find that ∼60 per cent of the BCGs have constant $\Upsilon_{\star \rm POP}$ over the radial range (<15 kpc). We also use the stellar and dynamical mass profiles to derive the stellar mass-to-light ratio from dynamics ($\Upsilon_{\star \rm DYN}$, see Loubser, these proceedings). We directly compare $\Upsilon_{\star \rm POP}$ with $\Upsilon_{\star \rm DYN}$, and find that for most BCGs, a Salpeter IMF is needed to explain their properties, but we also find a small subset of BCGs for which a Kroupa-like IMF is needed to explain their properties.

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

## 1. Data and methods

These results form part of a larger study in which we use the stellar and dynamical mass profiles, as well as the stellar population properties, of a large sample of 32 brightest cluster galaxies (BCGs), up to a redshift of $z \sim 0.3$, from the well characterised MENeaCS and CCCP cluster samples (spanning $M_K$ = –25.7 to –27.8 mag), with host cluster halo masses $M_{500}$ up to $1.7 \times 10^{14}$ $\rm M_\odot$ (accurately constrained from weak lensing results). The data are described in Loubser *et al.* (2018). In an accompanying proceeding (Loubser), we summarised the stellar and dynamical mass models of 25 of the BCGs obtained using the Multi-Gaussian Expansion (MGE, Cappellari 2002) technique and Jeans Anisotropic Method (JAM, Cappellari 2008) for an axisymmetric case, deriving the stellar mass-to-light ratio ($\Upsilon_{\star \rm DYN}$), and anisotropy ($\beta_z$). We approximate the dark matter mass ($M_{\rm DM}$) within the radius $r_{200}$ from weak lensing observations. Here, we use the spatially-resolved stellar population properties of the BCGs, and predict their stellar mass-to-light ratios ($\Upsilon_{\star \rm POP}$) assuming first a Salpeter, and then a Kroupa IMF. We follow the method discussed in Loubser *et al.* (2016) to identify BCGs with young stellar population components. We use the Vazdekis models based on the MILES library (Vazdekis *et al.* 2010). We determine $\Upsilon_{\star \rm POP}$ in the inner (0 to 5 kpc) and outer (5 to 15 kpc) apertures of the BCGs. We then directly compare the stellar mass-to-light ratios derived from the two independent methods ($\Upsilon_{\star \rm POP}$ with $\Upsilon_{\star \rm DYN}$) and use it to constrain the IMF (see Figure 1). For this figure, we exclude all the BCGs with young stellar population components, or age gradients between the inner and outer apertures, or significant substructure in their surface brightness profiles.

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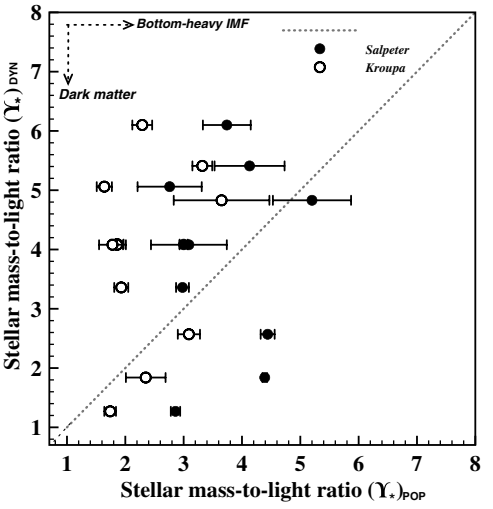


**Figure 1.** $\Upsilon_{\star \mathrm{POP}}$ vs $\Upsilon_{\star \mathrm{DYN}}$ for Salpeter and Kroupa IMFs. The data points show $\Upsilon_{\star \mathrm{DYN}}$ where a dark matter mass component was included in the dynamical models. We exclude the BCGs with young stellar components, age gradients, or substructure in their surface brightness profiles.

## 2. Main results

Combining these results with those in Loubser *et al.* (2016), we have detected prominent young (∼200 Myr) stellar populations in ∼22 per cent of the full BCG sample. We find that ∼60 per cent of the BCGs have constant $\Upsilon_{\star \mathrm{POP}}$ over this radial range (<15 kpc). From Figure 1 ($\Upsilon_{\star \mathrm{POP}}$ vs $\Upsilon_{\star \mathrm{DYN}}$), it follows that there is a small number of BCGs for which even the inclusion of a dark matter halo, and/or using a bottom-heavy IMF can not explain why they are below the 1-to-1 line, and that these BCGs are better described by a Kroupa IMF. This agrees both with the studies for the most massive early-type galaxies that find a 'heavy' IMF, like Salpeter or heavier as well as with the SNELLS galaxies which instead measured $\Upsilon_{\star}$ consistent with a Kroupa-like IMF (Smith *et al.* (2017)). We find substantial scatter in the IMF among the most massive galaxies, and neither a Salpeter or Kroupa IMF can be excluded for BCGs.

This proceedings follows from dynamical mass models presented in 'Stellar and dynamical mass models of BCGs' (these proceedings). 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 IMF.

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