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Small-scale galaxy clustering in the EAGLE simulation

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ABSTRACT

We study present-day galaxy clustering in the EAGLE cosmological hydrodynamical simulation. EAGLE's galaxy formation parameters were calibrated to reproduce the redshift $z = 0.1$ galaxy stellar mass function, and the simulation also reproduces galaxy colours well. The simulation volume is too small to correctly sample large-scale fluctuations and we therefore concentrate on scales smaller than a few mega parsecs. We find very good agreement with observed clustering measurements from the Galaxy And Mass Assembly (GAMA) survey, when galaxies are binned by stellar mass, colour, or luminosity. However, low-mass red-galaxies are clustered too strongly, which is at least partly due to limited numerical resolution. Apart from this limitation, we conclude that EAGLE galaxies inhabit similar dark matter haloes as observed GAMA galaxies, and that the radial distribution of satellite galaxies as function of stellar mass and colour is similar to that observed as well.

Key words: galaxies: formation – galaxies: evolution – galaxies: haloes – galaxies: statistics – large-scale structure of Universe – cosmology: theory

1 INTRODUCTION

The spatial distribution of galaxies provides a powerful way to probe both cosmology and galaxy formation. Galaxy clustering measurements on scales where density fluctuations are only mildly non-linear, combined with other cosmological data sets such as CMB measurements, put impressively tight constraints on cosmological parameters (e.g. Hinshaw et al. 2013; Planck Collaboration et al. 2016). In addition, the detection of baryon acoustic oscillations in the clustering of galaxies (e.g. Cole et al. 2005; Eisenstein et al. 2005) opened up the way to quantify the nature of dark energy (e.g. Laureijs et al. 2011), and combined with redshift-space distortion measurements, test theories of gravity (e.g. Linder 2008).

From the perspective of galaxy formation, the clustering of galaxies inform us about the relation between galaxies and the underlying dark matter and can provide hints about the physical processes involved in galaxy assembly history. As galaxies reside within the dark matter haloes, their positions trace the underlying cosmic structure. While the formation and evolution of the dark matter haloes is governed exclusively by gravitational interaction, the assembly of the galaxies is governed by the more complex baryon physics that also affects the distribution of galaxies. Such 'galaxy bias' may impact as well cosmological inferences made from galaxy clustering measurements.

The main statistical tool used for characterising galaxy clustering is the two-point correlation function ξ(r), which measures the excess probability over random of finding pairs of galaxies at different separations r (Peebles 1980). Commonly, when analysing redshift surveys, the projected correlation function integrated along the line-of-sight is used, in order to eliminate in principle redshift-space distortions (Davis & Peebles 1983). Observations show that brighter, redder and more massive galaxies are more strongly clustered and related trends are also measured as a function of morphology and spectral type (e.g., Norberg et al. 2002a; Zehavi et al. 2002, 2005; Goto et al. 2003; Li et al. 2006; Coil et al. 2006; Croton et al. 2007; Zheng et al. 2007; Coil et al. 2008; Zehavi et al. 2011; Coupon et al. 2012; Guo et al. 2013; Farrow et al. 2015).

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