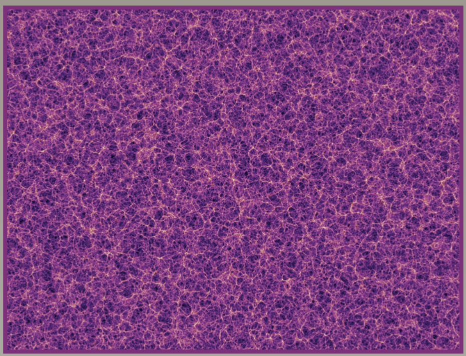
Cosmological constraints from models of galaxy clustering

Geraint Harker† & Shaun Cole

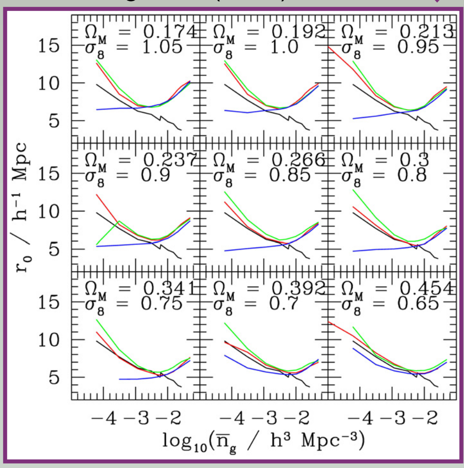
Institute for Computational Cosmology, University of Durham

Abstract

Given a dark matter distribution, the halo occupation distribution (HOD) provides a complete description of galaxy clustering. The form of the HOD is a basic prediction of galaxy formation models. We self-consistently combine semi-analytic models with *N*-body simulations and examine the resulting predictions for galaxy clustering. Comparing these clustering results with surveys constrains cosmological parameters and constrains the physics that goes into the semi-analytic models. The constraints on, for example, the matter density and power spectrum normalization are independent of CMB data, and we are able to achieve statistical errors of around 10% on $\sigma_8\Omega_M^{-2}$ (cf. ~20% for WMAP). We also use our catalogues to test the underlying assumptions of the HOD models which we use to understand the clustering results.

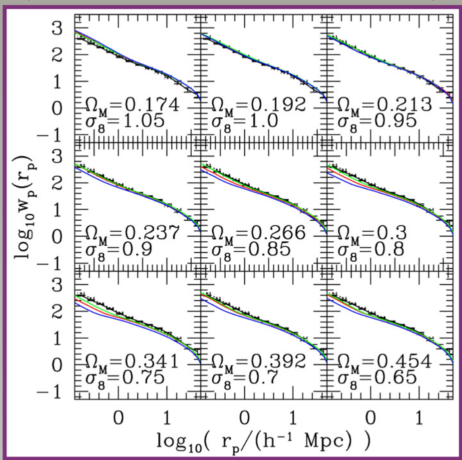


N-body simulations give the full nonlinear distribution of dark matter, in particular the structure and distribution of dark matter haloes. We use a suite of simulations with 512^3 particles run with a version of GADGET2 (Springel, Yoshida & White 2001, Springel 2005). The cosmologies are chosen to lie on the degeneracy between Ω_M and σ_8 from studies of cluster number counts. We aim to break this degeneracy. Grids are centred on $(\Omega_M,\sigma_8)=(0.3,0.8)$ ('Grid 1') or on $(\Omega_M,\sigma_8)=(0.3,0.9)$ ('Grid 2'). We rescale simulations as in Zheng et al. (2002).



The clustering length, r_0, as a function of galaxy sample space density (SDSS result from Zehavi et al. (2005) in black). Matching the data at a range of space densities imposes severe constraints on the models.

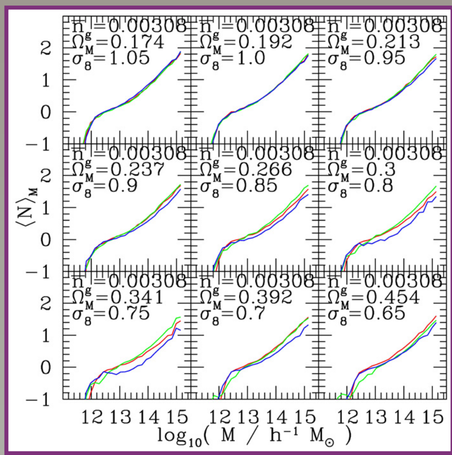
We populate the haloes of rescaled *N*-body simulations with galaxies from the Durham semi-analytic code, GALFORM, to produce synthetic galaxy catalogues.



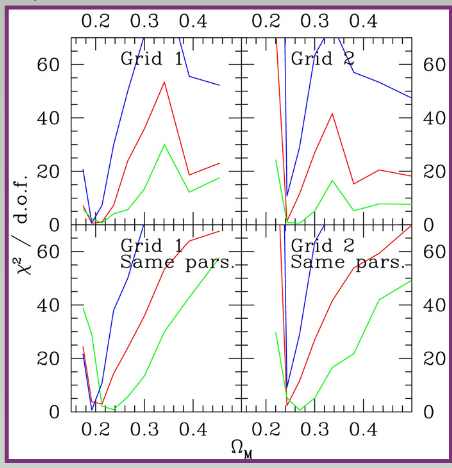
The projected correlation function $w_p(r_p)$ for Grid 1, with SDSS data in black. Three variants of our GALFORM models are shown:

- Red: Cole et al. (2000) model (Ω_b=0.02)
- Green: Cole et al. (2000) model with the now accepted value for Ω_b of 0.04 (Spergel et al. 2006) and conduction in massive haloes.
- Blue: A superwinds model (Benson et al. 2003).

For comparison, we also run each grid of models without altering GALFORM parameters to match the luminosity function ('Same pars.' on the right).



Mean occupation function (an important part of the HOD) predicted by three variants of GALFORM for one of our grids of cosmological parameters. This function gives the average galaxy population of a halo of given mass. Our future work includes using GALFORM models that incorporate AGN feedback (Bower et al. 2006).



We achieve tight constraints on cosmological parameters such as the matter density, Ω_M. Our assumptions are independent of those used in, e.g. CMB analysis, and our *statistical* errors on $\sigma_8\Omega_M^{-2}$ are comparable.

†Email: g.j.a.harker@durham.ac.uk

References

Cole S., Lacey C.G., Baugh C.M., Frenk C.S., 2000, MNRAS, 319, 168

Springel V., Yoshida N., White S.D.M., 2001, New Astronomy, 6, 79

Zheng Z., Tinker J.L., Weinberg D.H., Berlind A.A., 2002, ApJ, 575, 617

Benson A.J., Bower R.G., Frenk C.S., Lacey C.G., Baugh C.M., Cole S., 2003, ApJ, 599, 38

Springel, V., 2005, MNRAS, 364, 1105

Zehavi I. et al., 2005, ApJ, 630, 1

Bower R.G., Benson A.J., Malbon R., Helly J.C., Frenk C.S., Baugh C.M., Cole S., Lacey C.G., 2006, MNRAS, submitted (astro-ph/0511338)

Spergel D.N. et al., 2006, ApJ, submitted (astro-ph/0603449)

Durham University

Extragalactic & Cosmology Research Group

NAM2006 RAS National Astronomy Meeting

ICC

PPARC Particle Physics and Astronomy Research Council