Unveiling galaxy bias via the halo model, KiDS, and GAMA

Andrej Dvornik with Henk Hoekstra, Konrad Kuijken, Peter Schneider, et al.

Galaxy bias

Galaxy bias is the relation between the distribution of galaxies and the underlying dark matter. In its simplest form this relation can be described by a single number. As galaxy formation is a complex process, it would be naive to assume that such a relation is also a simple one. The majority of previous studies showed that it is neither linear nor deterministic.

With this study we measure the scale dependence and the origin of non-linearity and stochasticity of the galaxy bias.

Data

The galaxy bias can be measured using a combination of galaxy-galaxy lensing and galaxy clustering, which one can combine to a bias function Γ. We use:

- KiDS (Kilo Degree Survey) for our weak lensing measurements
- GAMA (Galaxy and Mass Assembly) survey for our clustering measurements and lenses

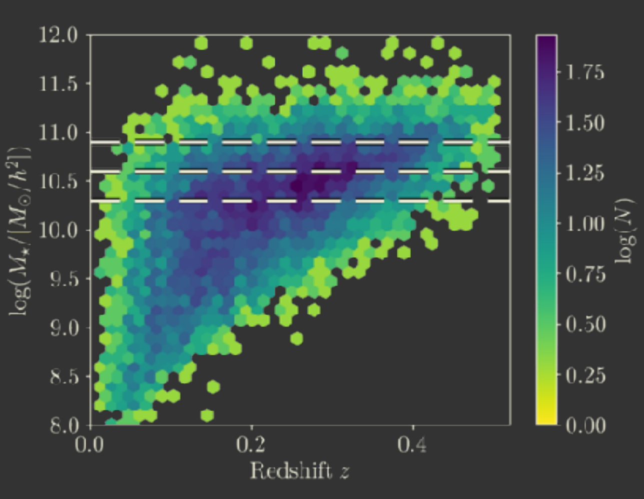

Figure 1: Stellar mass versus redshift of galaxies in the GAMA survey that overlap with KiDS. The three horizontal lines show boundaries between the 3 stellar mass bins used in this study.

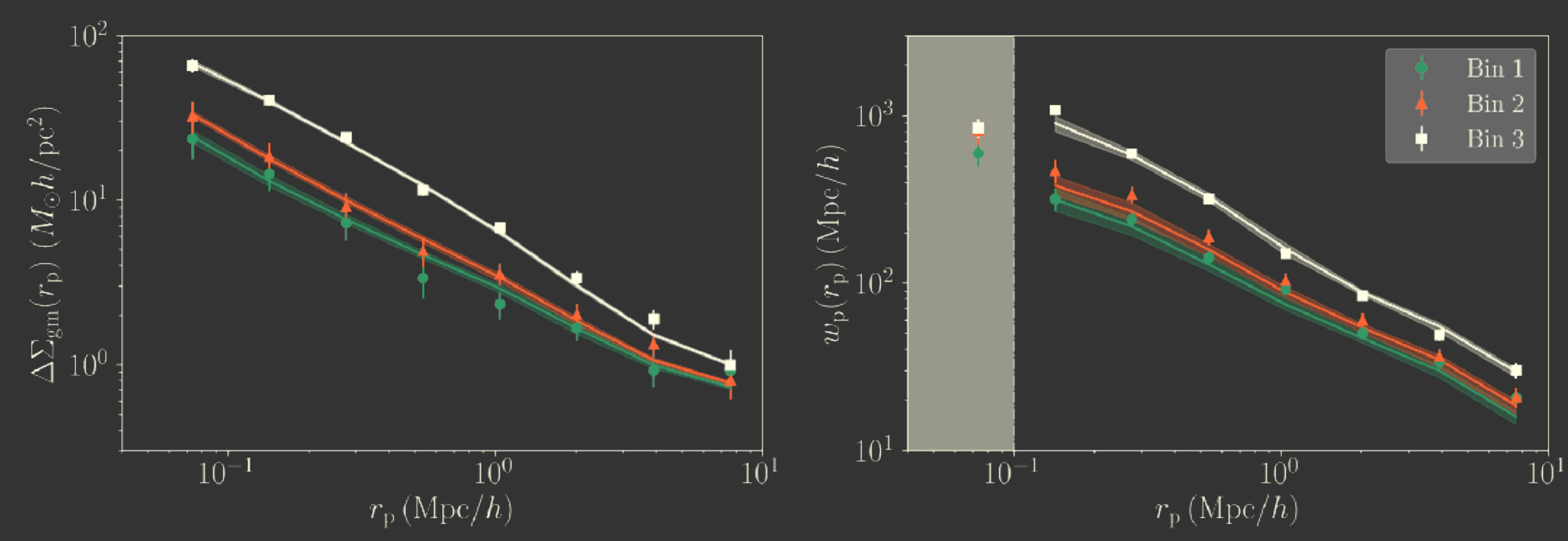

Figure 2: The stacked ESD profile (left panel) and projected galaxy clustering signal (right panel) of the 3 stellar mass bins of our GAMA galaxy sample. The solid lines represent the best-fitting halo model as obtained using an MCMC fit, with the 68 percent confidence interval indicated with a shaded region. Using those two measurements we obtain the bias function Γ.

Methods

We use the galaxy bias formalism as presented in Cacciato et al. 2012, which redefines the usual biasing formulation using the halo occupation framework. This means that the biasing relation can be described using halo masses and galaxy distributions in the form:

$$b(M) \propto \frac{\langle N \mid M \rangle}{M}$$

Results

Given the halo occupation distribution constraints, galaxy bias is:

Non-linear (due to presence of central galaxies)

Stochastic (due to non-Poissonian distribution of satellite galaxies and their spatial distribution that is different of the dark matter one)

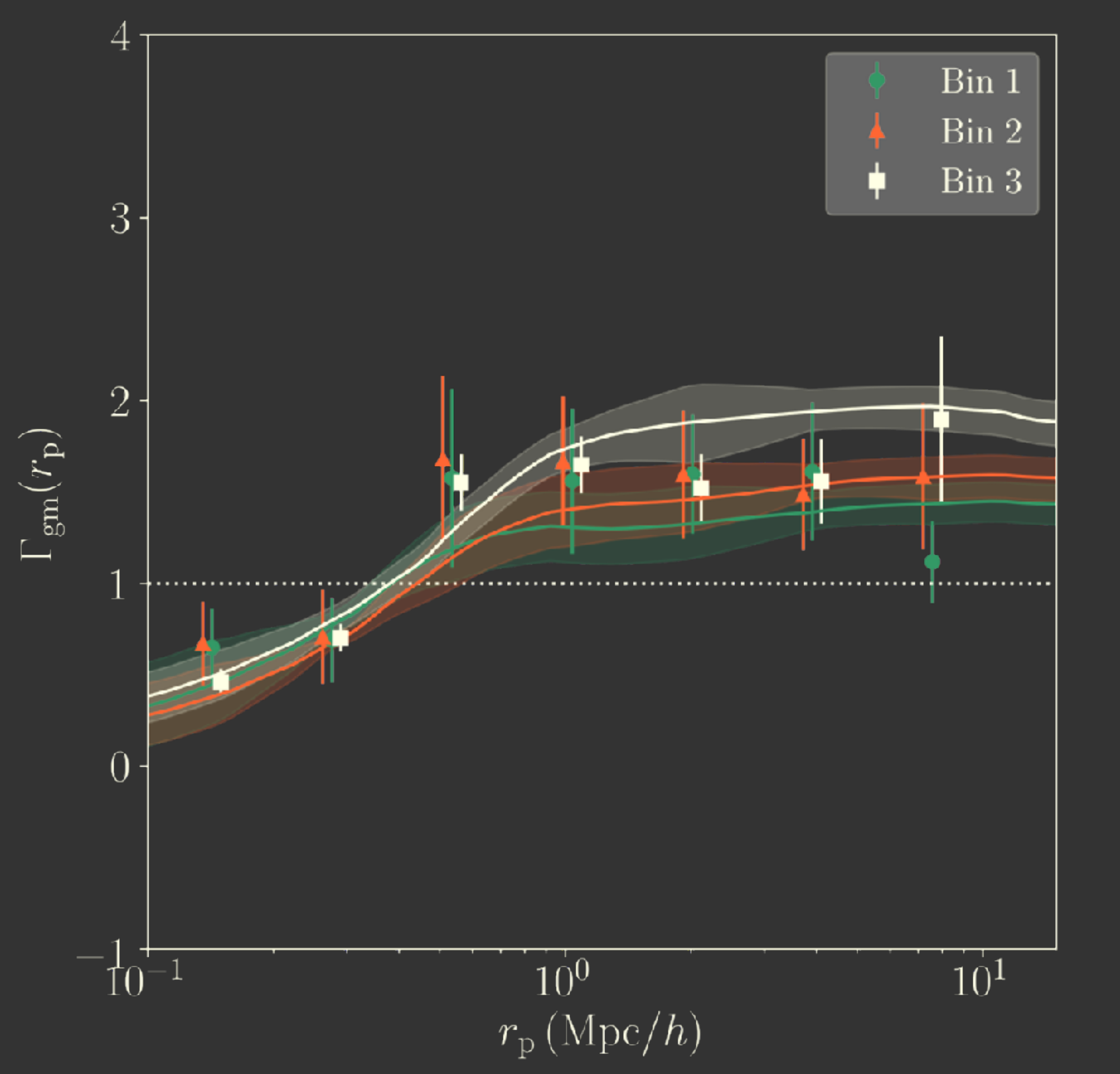

Figure 3: The Γ bias function as measured using a combination of projected galaxy clustering and galaxy-galaxy lensing signals, shown for the 3 stellar mass bins of our GAMA sample. The solid lines represent the best-fitting halo model.

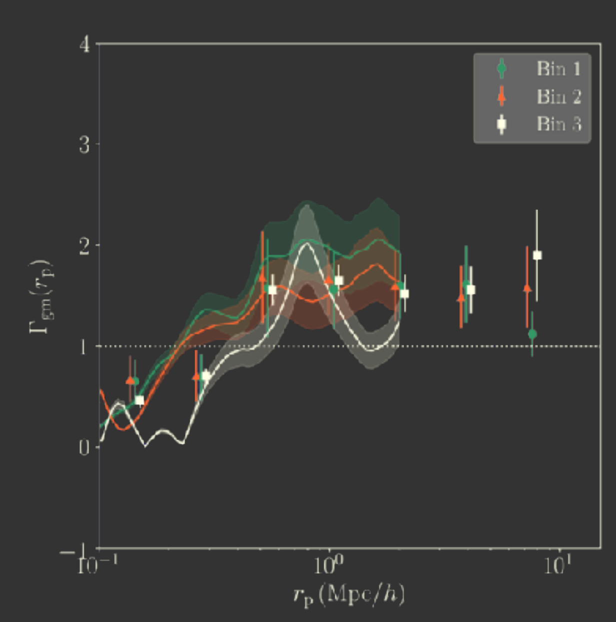

Figure 4: Similar scale dependence of galaxy bias is also seen in hydrodynamical simulations like EAGLE.

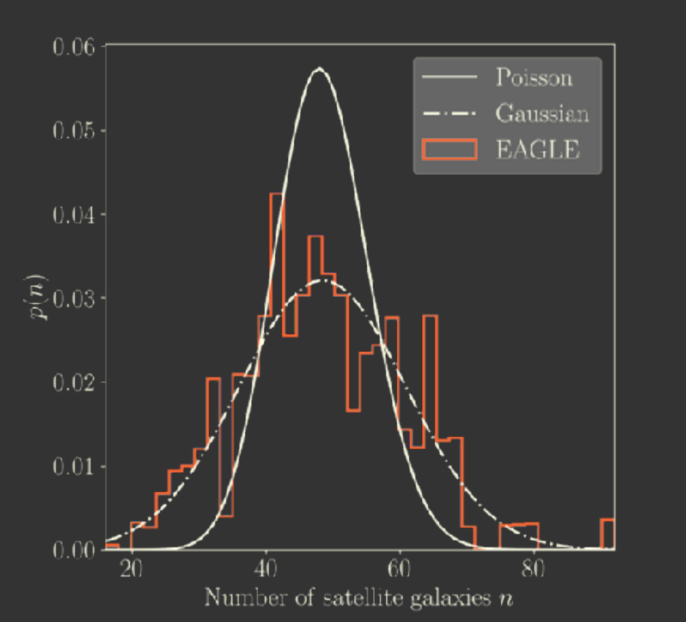

Figure 5: Distribution of satellite galaxies of EAGLE simulation within a halo of a fixed mass does not follow a Poisson distribution with the same expected mean.

References: Dvornik A. et al., 2018, MNRAS, sty1502 (arXiv: 1802.00734)

Andrej Dvornik | dvornik@strw.leidenuniv.nl | andrejdvornik.wordpress.com

KiDS Universiteit Leiden Sterrewacht Leiden