Galaxy properties and their environmental dependence in GAMA survey

Unnikrishnan Sureshkumar[1], Anna Durkalec[2], Agnieszka Pollo[1·2],
Maciej Bilicki[3] and the GAMA Collaboration

1. Astronomical Observatory of the Jagiellonian University, ul. Orla 171, 30-244 Kraków, Poland
2. National Centre for Nuclear Research, ul. Pasteura 7, 02-093 Warszawa, Poland
3. Center for Theoretical Physics, Polish Academy of Sciences, Al. Lotników 32/46, 02–668 Warszawa, Poland

We present preliminary results on the dependence of galaxy clustering on luminosity in different photometric bands and on stellar mass in the redshift range $0.1 < z < 0.16$ using galaxies from Galaxy and Mass Assembly survey (GAMA)[1]. We measure luminosity-marked and stellar mass-marked correlation functions for a set of volume-limited subsamples. We then compare them to see which luminosity is a more accurate tracer of stellar mass and the underlying dark matter distribution.

1 Introduction

Galaxies trace an underlying network of gravitationally dominant dark matter. However, the spatial distribution of galaxies is *biased* with respect to distribution of the underlying dark matter, and this bias is also known to depend on galaxy properties. In many studies, galaxy luminosity and/or stellar mass is used as a convenient proxy of its host dark matter halo. However it also has been observed that clustering of luminosity-selected and stellar mass-selected samples are not identical (e.g. Marulli et al., 2013; Durkalec et al., 2018). This means that luminosity and stellar mass are correlated with environment differently. But, which one is better correlated with environment? Is this correlation similar for all the photometric bands? Answers to these questions may help us establish better constraints on galaxy formation and evolution models. In this work, we try to provide them using marked correlation functions measured for the galaxies from the GAMA survey (Driver et al., 2011) in the redshift range $0.1 < z < 0.16$.

2 Data

The GAMA spectroscopic survey provides a sample of galaxies with reliable measurements of their properties (such as luminosity and stellar mass, Taylor et al., 2011). Moreover, its large area (the equatorial regions covering a total of 180 deg^2) and spectroscopic measurements of faint galaxies ($r_{\rm petro} < 19.8$) make it a perfect resource for statistical studies of galaxy properties and distribution. We use luminosities in u, g, r, K-bands and stellar mass, where stellar masses were estimated based on synthetic stellar population models, to define samples and use these properties as marks. We define five different volume-limited samples using these five properties, each complete on its corresponding property. The properties of all the samples selected for this work are given in Tab. 1.

[1]The GAMA website is http://www.gama-survey.org/.

Tab. 1: Properties of the volume-limited samples, as used in this study. The columns represent the property in which the sample is complete, the cut used to select the sample and the number of galaxies.

Property	Limiting value	N_{gal}
u-band	$M_{\mathrm{u}} < -17.6$	32651
g-band	$M_{\mathrm{g}} < -19$	29831
r-band	$M_{\mathrm{r}} < -19.6$	28062
K-band	$M_{\mathrm{K}} < -19.8$	31285
Stellar mass	$\log(\mathrm{M}_\star/\mathrm{M}_\odot) > 9.3$	32150

3 Measurement methods

The galaxy two point correlation function (2pCF) $\xi(r)$, is a common statistical tool used to measure the galaxy clustering. Clustering dependence on galaxy properties is usually studied by defining several galaxy samples based on the property of interest. However, in the process of the $\xi(r)$ measurement itself these properties are not considered, as each galaxy in these samples is weighted equally. A modified version of CF - the marked correlation function (MCF) - allows us to study clustering dependencies directly, by taking into account the physical properties (called *marks*) of each galaxy in the sample. These marks can be any measurable property of the galaxy (Sheth et al., 2005).

Therefore, MCF allows for the efficient study of the spatial distribution of galaxy properties and their correlation with the environment in the same time (Skibba et al., 2013). The two-point marked correlation function is defined as,

$$M(r) = \frac{1 + W(r)}{1 + \xi(r)}, \tag{1}$$

where $\xi(r)$ is the galaxy two-point CF and $W(r)$ is the weighted CF computed by weighting each real galaxy in the pair according to their chosen property. Such a weight enhances the significance of galaxy pairs in which both galaxies have a given property more pronounced, e.g. both of them are relatively massive (or relatively luminous) with respect to the rest of the sample.

4 Results and conclusions

Two-point and marked correlation functions were measured in the five volume-limited samples (as described in Table 1) selected from the GAMA survey in the redshift range $0.1 < z < 0.16$. For each sample the marked correlation functions were measured using the corresponding property (in which they are complete) as the mark.

The left panel of Fig. 1 shows the 2pCF measured for the volume-limited samples, while the right panel shows the MCF measured for the same samples. While we do not observe almost any difference between the 2pCF measured for galaxies selected according to their different properties measurements of MCF clearly show that the distinct properties trace the structure in a different way, with stellar mass being

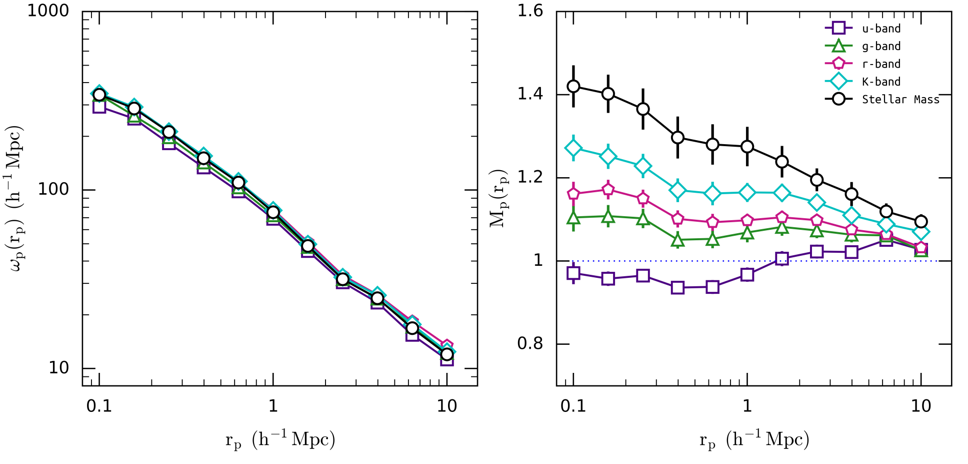

Fig. 1: Projected correlation functions (left panel) and corresponding projected marked correlation functions (right panel) for the five volume-limited samples listed in Tab. 1.

more dependent on environment than any of the luminosities. Among the different photometric bands, the reddest (K) passband is confirmed to be the best (but not perfect) proxy of stellar mass.

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