Halo Occupation Distribution in the CFHTLS Wide

J. Coupon¹, H. J. McCracken², M. Kilbinger³, Y. Mellier², O. Ilbert⁴, S. Arnouts⁵

1. Astronomical Institute, Tohoku University, Sendai, Japan, 2. Institut d’Astrophysique de Paris, France, 3. Excellence cluster Universe, Munich, Germany, 4. Laboratoire d’Astrophysique de Marseille, France, 5. CFHT, Hawaii, USA

Abstract. By measuring the matter power spectrum in the Universe one is able to study the properties and evolution of the Dark content. In the framework of the Dark Matter halo model, we can predict the galaxy clustering in a simple and powerful parameterization called Halo Occupation Distribution. We present here the ongoing results of the Canada-France-Hawaii Legacy Survey (CFHTLS). We constructed and used a photometric redshift catalogue of 3,000,000 reliable objects (i < 22.5) over 171 deg² in four independent fields in the CFHTLS Wide. We then measured the galaxy clustering on volume-limited samples, dividing our sample into redshift (0.2 < z < 1.1), luminosity and galaxy type. We use Population Monte Carlo (PMC) to put constraint on HOD parameters. Preliminary results show a good agreement with existing HOD models on most scales and first constraints on parameters are promising. Small and large scales probably need further investigation.

1. Photometric redshifts in the CFHTLS Wide

In collaboration with O. Ilbert, S. Arnouts, Terapix and VIPERS teams, we used the T0006 Terapix release (Mellier et al. 2009) of photometric redshifts in the CFHTLS wide. The data set includes the full CFHTLS observations in five bands (ugriz), calibrated with spectroscopic redshifts. We estimated photometric redshifts using Le Phare (Arnouts & Ilbert) and following the method outlined in Ilbert et al. (2006) and Coupon et al. (2009):
- correction of systematic offsets,
- adaptation of galaxy templates,
- use of a n(z) prior.
Systematic offsets were calibrated with spectroscopic data from VVDS “deep” and “F22” samples (Le Fèvre et al. 2005, Garilli et al. 2008), DEEP2 redshift survey (Davis et al. 2007), and the zCOSMOS sample (Lilly et al. 2007). A precise (tile-wise) photometric correction has been applied over the entire survey based on SDSS data (http://www.sdss.org) and stellar colors.

2. Clustering measurements

We measured galaxy clustering in the CFHTLS Wide from a parent sample composed of:
- 3,000,000 reliable photometric redshifts at i < 22.5,
- in 4 independent fields,
- on a total area of 171 deg².
We divided our sample into volume-limited sub-samples in the range 0.2 < z < 1.1. We separated galaxies into red and blue as well as in several luminosity bins. Each sample contains about 20,000 objects. We measured the 2-point correlation function using the Landy & Szalay (1993) estimator:
\[ \xi(\theta) = \frac{w(\theta) - 2D \bar{D} - 3D^2}{\bar{D}^2} \]

3. HOD parameterization

Using the successful Halo model to describe the Dark Matter distribution in the Universe and a simple parameterization of how galaxies populate single halos, one is able to predict the galaxy clustering over a wide range of scales. The Halo Occupation Distribution relates the number of galaxies per halo to the mass. By studying different samples selected in redshift, type and luminosity we intend to study redshift evolution and luminosity dependence of galaxies. We take advantage of the wide coverage of the CFHTLS to probe galaxy clustering on large scale up to redshift 1.0. We adopted a standard ΛCDM Cosmology and allowed only HOD parameters to vary. We used the model developed by Berlind & Weinberg (2002,2003), Zheng (2005), Tinker et al. (2008), Brown et al. (2008) and Zehavi et al. (2010) to separate contribution from central and satellite galaxies and to include halo exclusion.

4. Preliminary results

We present in this section our preliminary results on clustering measurement (left) and HOD parameter constraints (right). The HOD model shows a good agreement with the data and we are currently using Population Monte Carlo (Kilbinger et al. 2009 and references therein) to put constraints on HOD parameter with respect to redshift and luminosity. Discrepancies at very small and large scales are under investigation.

Fig. 1. CFHTLS Wide fields with overlapping spectroscopic data. One blue square is one Megacam pointing (1deg²).

Fig. 2. Photometric redshifts versus spectroscopic redshifts in the three Wide fields with spectroscopic data available.

Fig. 3. Absolute magnitude distribution versus redshift. Red rectangles represent our volume-limited sample selection.

Fig. 4. Colors vs magnitude of red and blue galaxies for different redshift bins. The separation between populations is based on galaxy best fit templates (in order to take into account galaxy reddening).

Fig. 5. Number of galaxies per halo with respect to mass, following HOD parameterization. Figure from Brown et al. (2008).

Fig. 6. Log(10) probability distribution using Le Phare (Arnouts & Ilbert) and following the method outlined in Ilbert et al. (2006) and Coupon et al. (2009):

- correction of systematic offsets,
- adaptation of galaxy templates,
- use of a n(z) prior.
Systematic offsets were calibrated with spectroscopic data from VVDS “deep” and “F22” samples (Le Fèvre et al. 2005, Garilli et al. 2008), DEEP2 redshift survey (Davis et al. 2007), and the zCOSMOS sample (Lilly et al. 2007). A precise (tile-wise) photometric correction has been applied over the entire survey based on SDSS data (http://www.sdss.org) and stellar colors.