The Zeldovich Universe:
Genesis and Growth of the Cosmic Web
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Color and magnitude dependence of galaxy clustering

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Abstract. A quantitative study of the clustering properties of galaxies in the cosmic web as a function of absolute magnitude and colour is presented using the SDSS Data Release 7 galaxy redshift survey. We compare our results with mock galaxy samples obtained with four different semi-analytical models of galaxy formation imposed on the merger trees of the Millenium simulation.

Keywords. Cosmology: obserations - cosmology: theory - galaxies: statistics

1. Data and mock sample selection

We study galaxy clustering using the SDSS redshift survey DR. We use a large contiguous region of the Northern Galactic cap with 7500 deg^2. Photometric calibration and k-correction to redshift $z = 0$ is done in standard way using the New York University Value-Added Galaxy Catalog by Blanton *et al.* (2005).

Starting from the observed R-band magnitude and redshift distributions, we define volume-limited galaxy samples m1 to m12 (Mueller *et al.* 2011) to investigate the dependence of the correlation function on absolute magnitude and of color taking a separation line $U - R = 1.8 - 0.05 \times (R + 19)$ between red and blue galaxies.

For comparison we use four sets of mock galaxy samples constructed using the Millenium simulation and semi-analytical models of galaxy formation from merger trees of haloes in the simulation due to Croton *et al.* (2006, C06), De Lucia & Blaizot (2007, D07), Font *et al.* (2008, F08), and Guo *et al.* (2011, G11)

2. Correlation analysis

The correlation functions are evaluated using the full selection mask of the survey. Errors are estimated with 10 bootstrap resamplings of the data, cp. Fig. 1. The solid line in the left panel shows the result corresponding to all galaxies for the sample m1. We fit a power law at the correlation length, $\xi(r_0) = 1$, with slope 1.4. The dashed line for red galaxies lie about 0.2 dex above that of the full galaxy sample, the dot-dashed line for blue galaxies are 0.15 dex below. For the other samples we get similar results, only the difference of the clustering between red and blue galaxies gets smaller as magnitudes increase. The right panel shows the ratio between the full correlation functions of the sample m4 and all four mock catalogues. The correlation functions of models C06 (solid line) and G11 (dot-dashed line) reproduce the shape of the observed correlation function over almost all spatial scales. However, the clustering amplitude is underpredicted by about 20 percent. Acceptable results are also obtained for the model D07, while F08 overpredicts the clustering of close pairs by up to a factor of two.

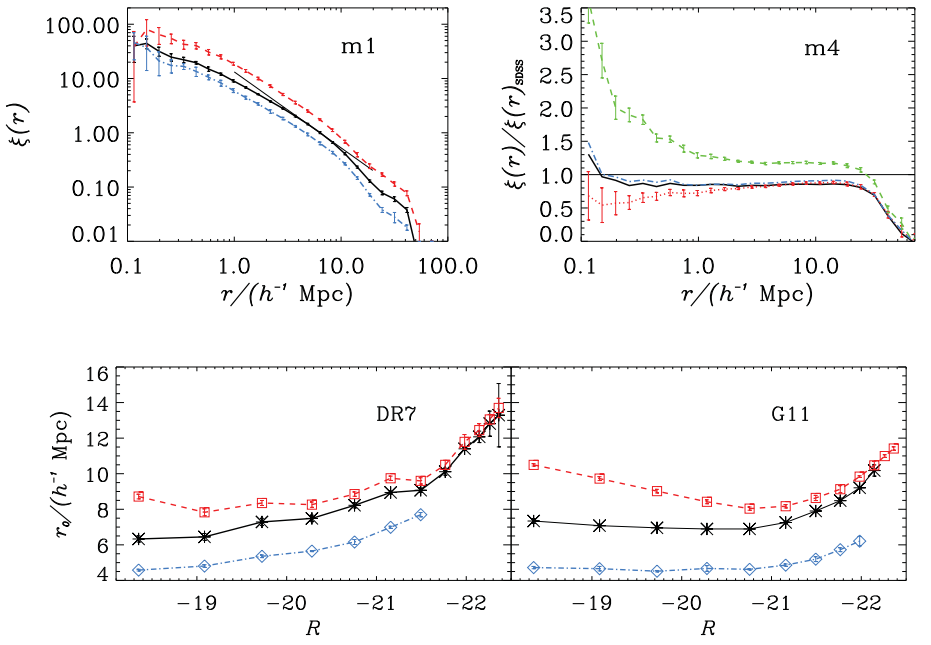

Figure 1. *Upper left:* Two-point correlation function for sample m1 with all galaxies (solid line), red galaxies (dashed line) and blue galaxies (dot-dashed line). *Upper right:* Ratio between model correlation functions and SDSS galaxies for the m4 sample. The mock samples are due to C06 (solid line), D07 (dotted line with error bars), F08 (dashed line with error bars), and G11 (dash-dotted line). *Lower left:* Correlation length as a function of mean R-magnitude for samples from m1 to m12 for all galaxies (stars and solid line), red galaxies (open squares and dashed lines), and blue galaxies (open diamonds and dash-dotted line). *Lower right:* Corresponding mock samples in the G11 model with 2 σ error bars.

The results can be collected in a compact way by the magnitude dependence of the correlation length. The left panel of the lower Fig. 1 shows the correlation length for samples m1 to m12. The solid, dashed and dot-dashed lines correspond to all, red, and blue galaxies, respectively. The right panel shows the results of the G11 model. The correlation lengths of all and blue galaxies stay nearly constant between $R = -18.4$ and $R = -21$, while the correlation length of red galaxies decreases. This is due to the large number of satellites present among faint galaxies. At brighter magnitudes the correlation length increases due to the higher bias of more massive haloes. The remaining semi-analytical models display similar trends. They reproduce qualitatively the clustering dependence as a function of magnitude and colour. However, quantitatively, there exist significant differences, with the F08 model showing the smallest discrepancies for scales above 1 h^{-1} Mpc. Mark correlations complement these results.

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