The Cosmic Mass Density Field Reconstruction from the SDSS Group Catalog

J.C. Muñoz-Cuartas, V. Müller, and J.E. Forero-Romero

Abstract Based on the group catalog (GC) of the SDSS-DR4 [Yang et al., ApJ 671, 153 (2007)] we implemented a halo-based density field reconstruction method introduced by [Wang et al., MNRAS 394, 398 (2009)]. The method uses the mass distribution in and around dark matter structures computed from cosmological simulations to map the cosmic mass distribution. This approach enables us to make reconstructions of the density field avoiding the use of arbitrary smoothing functions and including information about the mass distribution in the environment of halos. We present the results of our reconstruction as well as the identification of different environments. The reconstructed density field will be further used in the investigation of environmental dependence of galaxy properties.

1 Description and Results

Following [2] we estimate the mass distribution in and around dark matter structures from a simulation of the spatially flat ΛCDM cosmology in a box of $100\,\mathrm{h}^{-1}$Mpc and 512^3 particles run with a set of cosmological parameters compatible with those of WMAP3. To compute the average mass distribution in and around halos we binned them by mass in the range of [11.5,14.2] in $\log(M_{\mathrm{vir}}/\mathrm{h}^{-1}\mathrm{M}_{\odot})$ with each mass bin having a width of 0.3 dex. Figure 1 shows two of such distributions.

For the reconstruction we choose groups in the GC [3] with redshifts between 0.01 and 0.1, which offers an almost complete sample of halos with masses down to $10^{11.5}\,\mathrm{h}^{-1}\mathrm{M}_{\odot}$. Our final sample contains 88687 groups. Assuming the mass estimated for each dark matter halo in the catalog and the mass distribution we obtained from the simulations, we derive a realization of the density field from the

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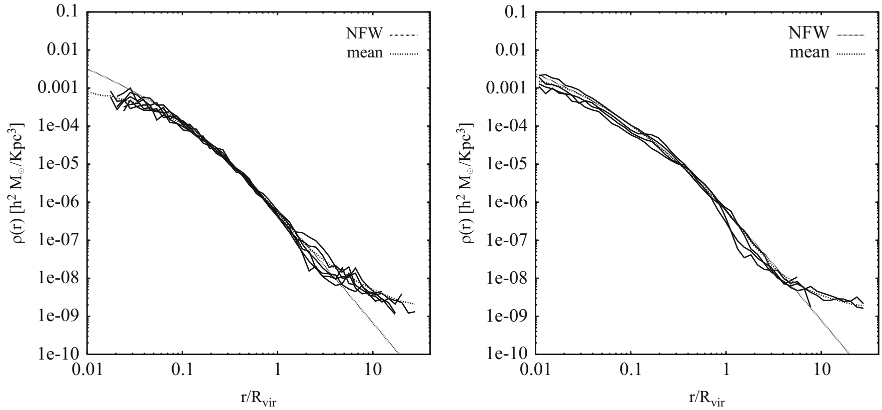

Fig. 1 Mass distribution obtained from the simulations for two different mass bins, $M = 10^{11.5}$ (*left*) and $M = 10^{13}\,h^{-1}M_\odot$(*right*). The small-dotted line shows the typical NFW density profile for that halo mass. The average density profile we estimate from the simulation is shown with the long-spaced doted line. The thin solid lines show some of the individual density profiles for each halo in that mass bin. Note the extension of the density profile out to 30 times R_{vir}, in the region defined as the domain of the halo

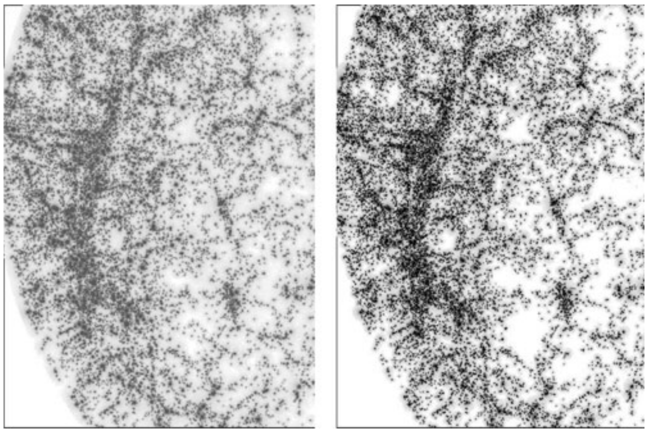

Fig. 2 (*Left*) A $300 \times 400\,h^{-1}$Mpc slice of the reconstruction for the north cap of the survey, where the structure of the great attractor can be clearly seen. (*Right*) Regions classified as peaks and filaments which clearly follows the distribution of galaxies in the large scale structure. It is possible to observe as well the empty regions (*white*) corresponding to voids in the density field

group catalog in redshift space. Our reconstruction consists on a set of $\sim 4 \times 10^7$ tracer *particles* of the density field following the mass distribution traced by the halos in the group catalog. For illustration, Fig. 2 shows a piece of the reconstructed density field.

Following [1], we classify a point in the density field as belonging to a void, sheet, filament or peak environment. Figure 2 (right) shows the identification of filaments and peaks (for a given threshold of the eigenvalues of the deformation tensor λ_{th}). To quantify the effects of the survey boundary and the influence of redshift distortions on our classification, we built a mock catalog from a cosmological simulation with a box size of $1\,h^{-1}$ Gpc and $1{,}024^3$ particles. We found that the volume fractions of the catalog representing the redshift space sample have been affected by a global factor of 20%, reflecting the increase in the mean density in non empty regions due to the effect of redshift distortions.

References

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