Notes on the Simulations for Void-Studies

For the first set of simulations generated for studying voids the following cosmology was chosen:

$$\Omega_{\rm CDM} = 0.27, \quad \Omega_{\rm bar} = 0.044, \quad \Omega_\Lambda = 0.68, \quad h = 71 \text{ km/s/Mpc}. \tag{1}$$

The initial conditions were generated with 512^3 particles on a 512^3 mesh. For the 256^3 particle runs we reduced the 512^2 particles by averaging over every eight particles. The initial power spectrum was generated using a fit for the transfer function suggested by Klypin and Holtzman. This fit takes baryonic supression into account but not baryonic wiggles. The power spectrum is normalized to $\sigma_8 = 0.84$. The physical box size for all simulations is L=256 Mpc/h, the starting redshift chosen to be $z = 50$ and the final redshift is $z = 0$. All simulation were run with 500 time steps. The following table summarizes the different simulations performed:

	# of particles	# of grid points	Smoothing=1	Smoothing=2
Run 1	256	256	$\rho_{\rm min} = 1.16 \cdot 10^{-2}$	$\rho_{\rm min} = 3.5 \cdot 10^{-2}$
Run 2	256	1024	$\rho_{\rm min} = 1.28 \cdot 10^{-2}$	$\rho_{\rm min} = 3.3 \cdot 10^{-2}$
Run 3	512	256		
Run 4	512	512		

For every run we generate a density at the final redshift. Since we are interested in the void region, i.e. the "empty regions" we smooth the density with a Gaussian filter in order to avoid zero density regions. The filtering is done as follows: we start with the density field in grid units and by employing a 3 dimensional FFT transform it into k-space. Then we multipli the k-space density with the following filter:

$$f(k) = e^{-0.5r^2(k_x^2+k_y^2+k_z^2)}, \tag{2}$$

where r is the filter given in grid units and k the wave number also given in grid units. To be more precise k_x, k_y, and k_z are defined as

$$k_x = k_y = k_z = \frac{2\pi}{\rm ng}(i-1) \quad \text{for} \quad i = 1, {\rm ng}/2, \tag{3}$$

$$k_x = k_y = k_z = \frac{2\pi}{\rm ng}(i - {\rm ng} - 1) \quad \text{for} \quad i = {\rm ng}/2+1, {\rm ng}, \tag{4}$$

where ng is the grid size in one dimension. After the multiplication with $f(k)$ we use again a 3 dimensional FFT to go back to x-space. Finally, we calculate δ from ρ by subtracting and deviding by the mean of the density.