Voids in the SDSS: Void Properties

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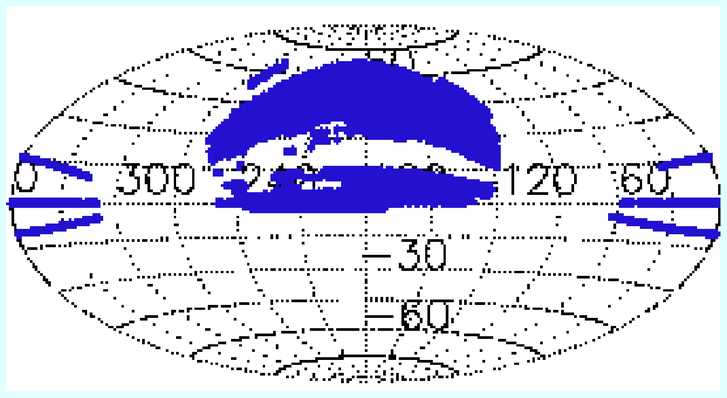
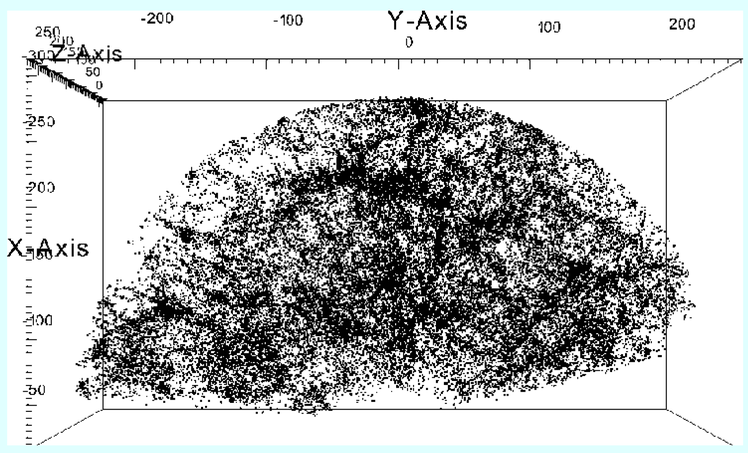
Summary

We present a catalog of 526 voids identified from a volume-limited sample of the SDSS, using the algorithm of Hoyle & Vogeley (2002). We find that voids traced by L* galaxies fill 50% of the volume of space. Measurements of the radial density profiles reveal the signiture of void growth by gravitational instability: nearly flat density profiles with $\delta\rho/\rho \sim -0.9$ in their central regions and a sharp rise in density at the walls of the voids. This behavior indicates that voids are dynamically distinct elements of large-scale structure. This catalog of voids is publically available.



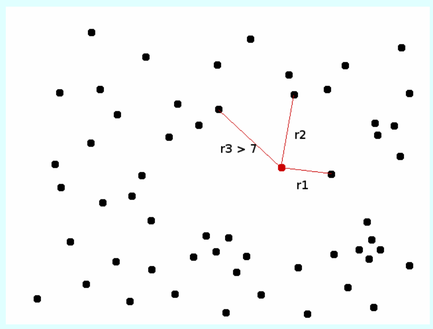
Sky distribution of the spectroscopy in SDSS Data Release 5
5740 square degrees
674,749 galaxies



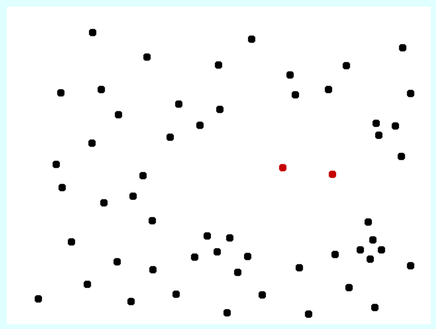
Volume limited catalog
Absolute magnitude limit
-20 + 5log(h)
zmax = 0.107
61,084 galaxies

How VoidFinder Works

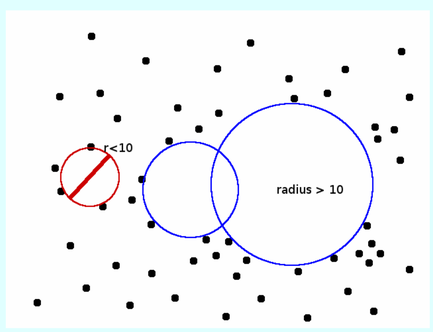
We use VoidFinder (Hoyle & Vogeley 2002) to locate the void regions and identify void galaxies. The method is illustrated below:



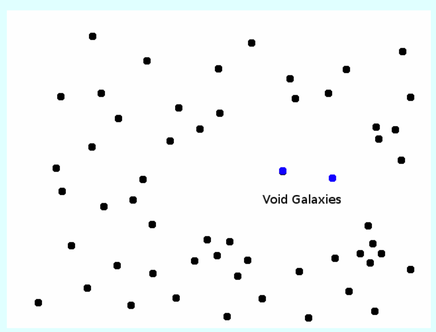
Distance to 3rd nearest neighbor, d3, is found for each galaxy



Galaxies with d3 larger than $7h^{-1}$ Mpc are low density galaxies



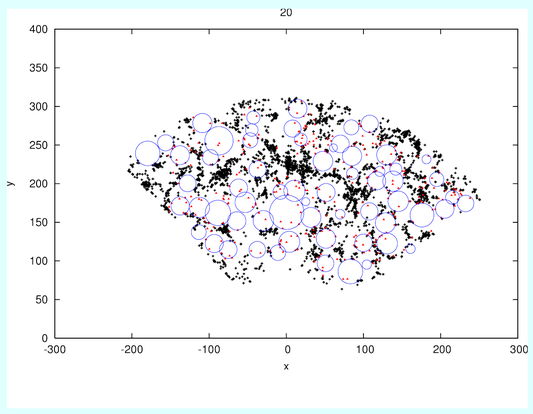
Maximal spheres are grown. Voids must have maximal spheres larger than $10h^{-1}$Mpc.



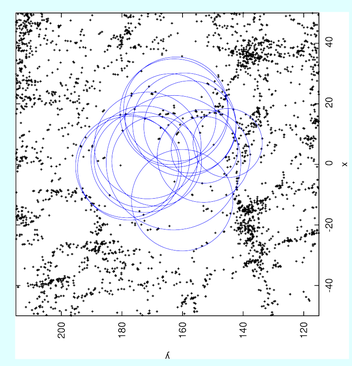
If a low density galaxy lies in a void region, it is a void galaxy

Results of Void Finder

VoidFinder finds 526 statistically significant voids in the SDSS DR5 that lie at distances between $100 < d < 300$ h^{-1} Mpc. These voids fill 50% of the volume of the sample and contain 5% of galaxies in the volume-limited sample.



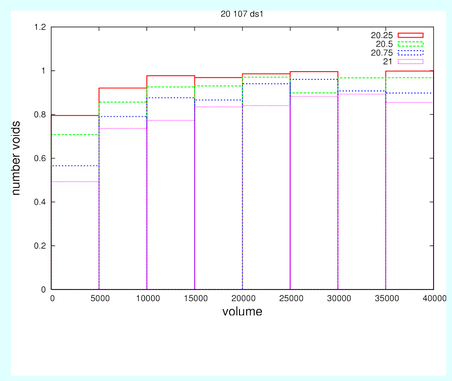
20 Mpc thick slice centered on the largest maximal sphere in the void sample. Void galaxies are red and wall galaxies are black. Intersections with all maximal sphere are shown.

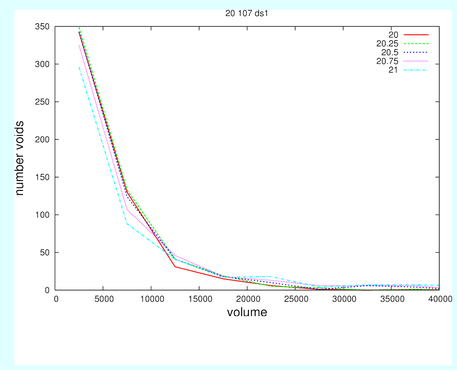


Zoom-in on the largest void. This 10 Mpc thick slice shows the magnitude limited sample along with the maximal sphers found with VoidFinder that make up a single void region.

Void Sizes

The number and volume of voids found in various volume limited samples are consistent for variations of the absolute magnitude limit from -20 to -21. Discrepancies occur only for the smallest, least statistically significant voids.

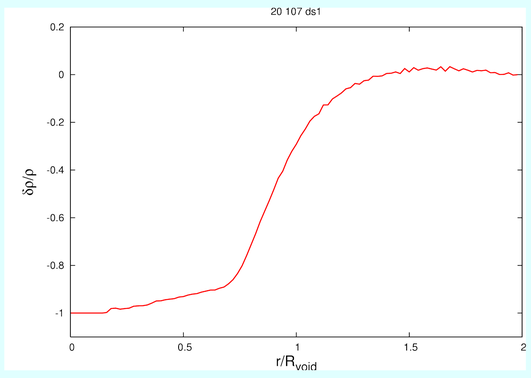




Left: Overlap fraction of various samples with the base void sample
Right: Number of voids found in each sample as a function of the volume of the void

Radial Density Profiles

The radial density profiles of the voids found are consistent with the predictions of void growth by gravitational instability. Voids are significantly underdense compared to their immediate environment. The bucket shape profile is in agreement with linear gravitation theory as predicted by Sheth and van der Weygaert (2004)



The density, $\delta\rho/\rho$ (enclosed), starting from the center of the maximal sphere of each void, averaged over the sample of 526 voids. Voids are significantly underdense in the central regions, rising sharply at the edge of the void as galaxies are encorporated into the voids.

Acknowledgements

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References

Hoyle, F. & Vogeley, M. S., 2002, ApJ, 2002, 566, 641
Sheth, R. K. & van de Weygaert, R., 2004, MNRAS, 350, 517