Voids in the Universe: SDSS and 6dF

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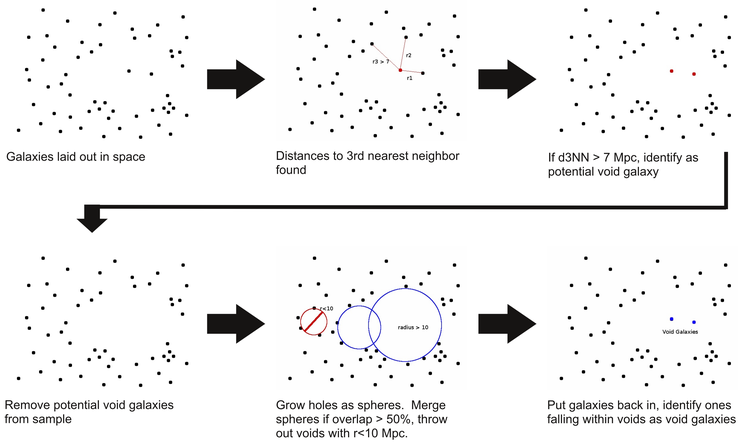
Abstract

We present a catalog of ~1000 voids in the Universe from SDSS, and ~200 voids in the Universe from 6dF. The voids were found using VoidFinder (Hoyle and Vogeley 2002) and matched to the underlying density field using the Delaunay Tesselation Field Estimator (Schaap et al. 2000). Voids identified using VF match up very well with voids identified in the density field. VF identifies over 50% of the volume in the Universe to lie in considerably underdense regions, δ<-0.9. The distinct bucket shape density profiles of the voids indicate that they are indeed dynamically distinct elements of large scale structure.

VoidFinder Method

VoidFinder finds galaxy voids using a nearest neighbor algorithm (Hoyle & Vogeley 2002; El-Ad & Piran 1996). The method works as follows:



Galaxies laid out in space

Distances to 3rd nearest neighbor found

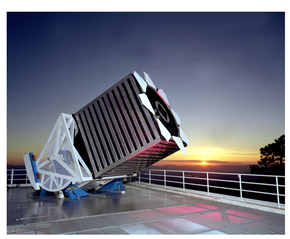
If d3NN > 7 Mpc, identify as potential void galaxy

Remove potential void galaxies from sample

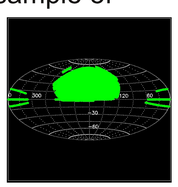
Grow holes as spheres. Merge spheres if overlap > 50%, throw out voids with r<10 Mpc.

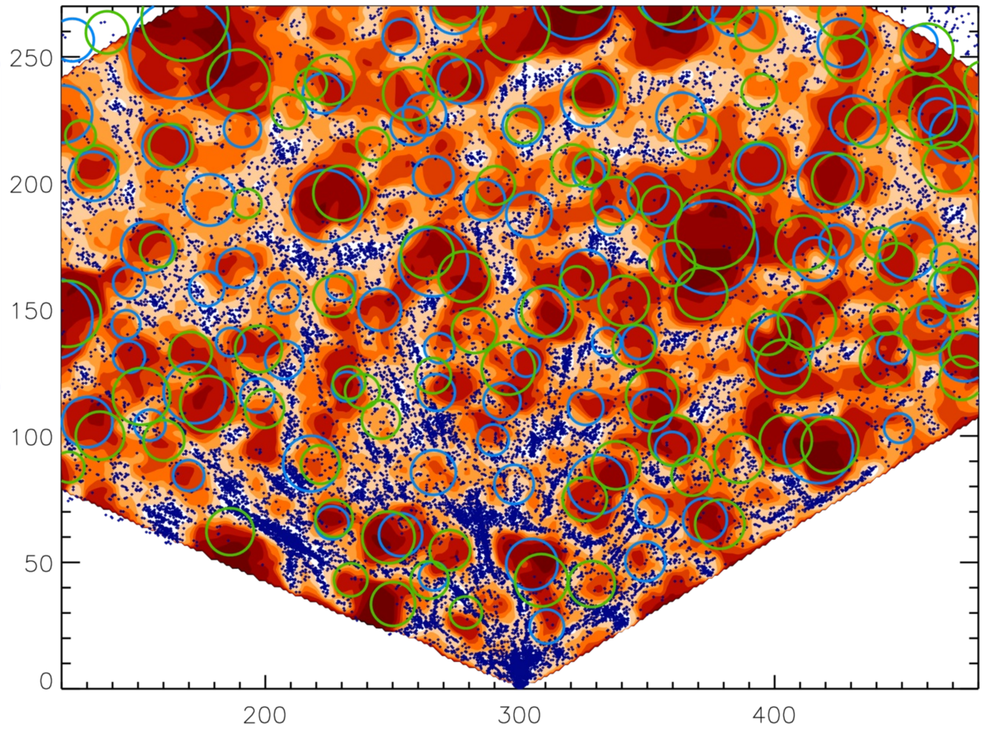
Put galaxies back in, identify ones falling within voids as void galaxies

SDSS



Data Release 7
8,032 sq. deg. in the Northern Sky
Volume Limited subsample of
928,567 galaxies
M < -20
115,220 galaxies
z < 0.107

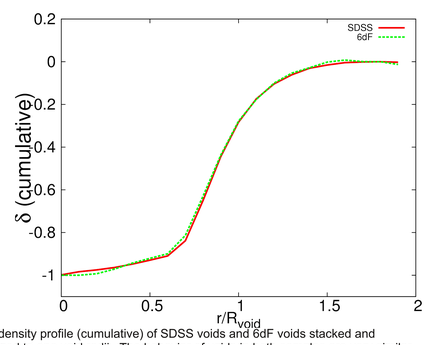




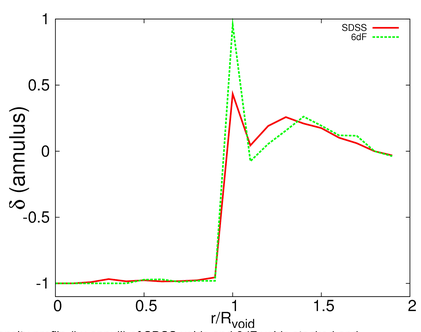
This plot shows the voids found by VoidFinder (green), the voids found by identifying low density regions in the density field reconstruction (blue), overplotted on the density field (color gradient), with SDSS galaxies as blue dots.

Void Statistics

	SDSS	6dF
Number Voids	932	219
Void Sizes (average radius)	17.3 Mpc	17.86 Mpc
Number Void Galaxies		
Volume limited sample	7201	~1300



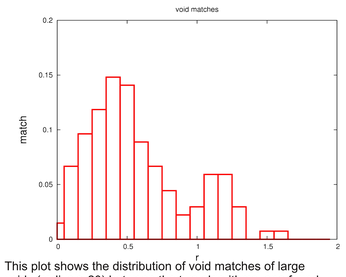
Radial density profile (cumulative) of SDSS voids and 6dF voids stacked and normalized to one void radii. The behavior of voids in both samples are very similar, and the turning point is an indication of the asphericity of the voids.



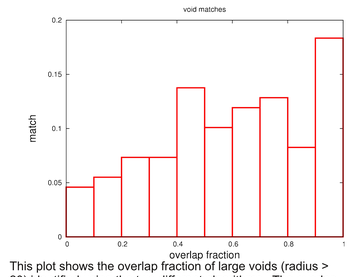
Radial density profile (by annuli) of SDSS voids and 6dF voids stacked and normalized to one void radii. A clear bucket shape can be seen here, indicating that the borders of the voids are very steep and densely populated walls compared to the interior of the void.

Comparison Results

Voids derived from the two methods agree well on the location of the voids. A comparison of the larger voids (radius > 20 Mpc) show a bimodal distribution of void center locations. This can be explained as a direct match of voids (peak around r_{match} of 0.5), and a secondary match (peak around r_{match} just over 1). A secondary match occurs when two (or more) voids are identified in one method while the other method returns one large void. This is to be expected due to the differences in the method and definition of void finding in the two algorithms.



This plot shows the distribution of void matches of large voids (radius > 20) between the two algorithms, one found by VoidFinder, and the other identified by the density field. The x-axis is the distance r = r_{match}/r_{void} where r_{void} is the radius of the void as found by VoidFinder.



This plot shows the overlap fraction of large voids (radius > 20) identified using the two different algorithms. The overlap fraction is defined by $V_{overlap}/V_{VF}$ where V_{VF} is the volume of the void in VoidFinder.

Void Catalog available

Void Galaxy/Void catalog available at:
http://www.physics.drexel.edu/~pan
dcp37@drexel.edu
Included in catalog:
List of void galaxies (vol. limited and mag. limited)
List of voids
- Locations of void centers
- List of holes making up the void

6dF INFO

Data Release 3
~25,000 sq. deg. in the Southern Sky
Volume Limited subsample of
117,191 galaxies
M < -20
21,641 galaxies
z < 0.05