Voids in the SDSS: Void Shapes

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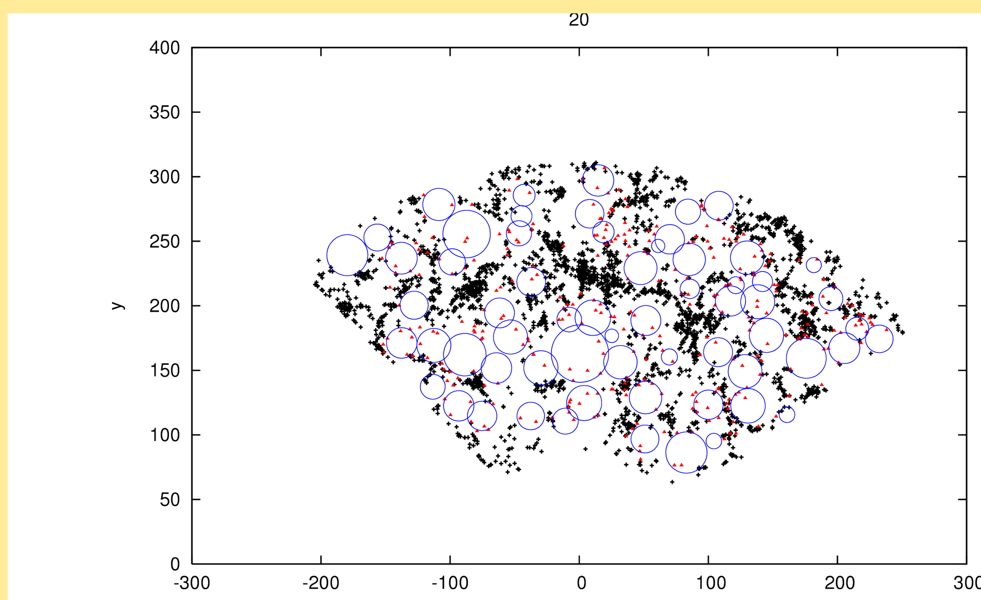
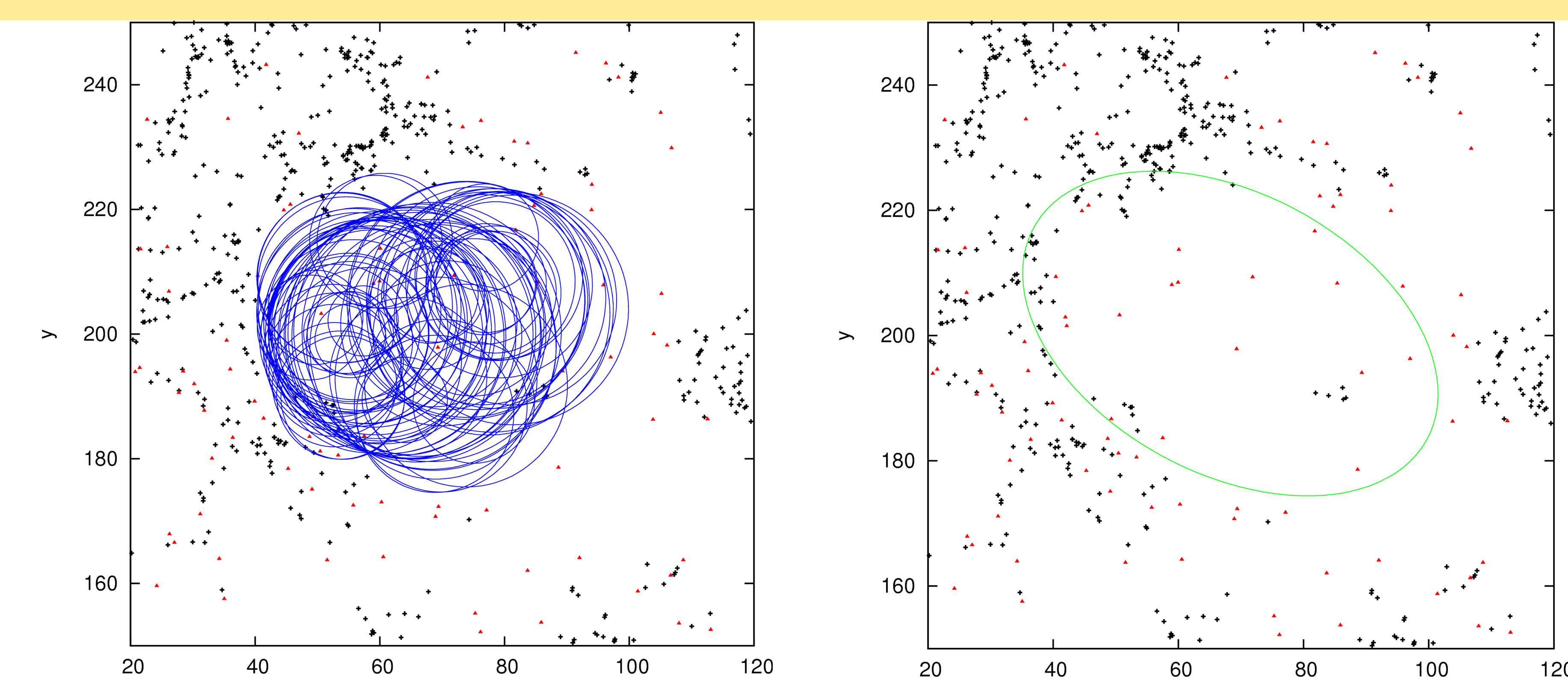
Voids in the Universe are believed to evolve spherically in shape as predicted by linear gravitation theory (Icke 1984). Voids in redshift space can have different shapes from voids in real space either due to nonlinear redshift space distortions along the line of sight, or linear infall onto structures. These effects cause asphericity in the voids. To measure this effect, we compute the ellipticity of voids from the sample of 526 voids in the SDSS DR5 void catalog (Pan et al. 2008). For each void, we determine the best-fit ellipsoid for the volume. We calculate the line of sight projections of the major axes and determine possible effects of redshift distortions by comparing to effects in a mock catalog provided by Park et al.



20 Mpc thick slice showing the intersections of maximal void spheres with the slice plane. Void galaxies are shown in red while wall galaxies are black.

Measuring Ellipticity



From the sample of holes that make up a void region, the best fit ellipsoid is determined. For each void, the shape-tensor S_{ij} is calculated by gridding up the void volumes and assigning each element equal weight.

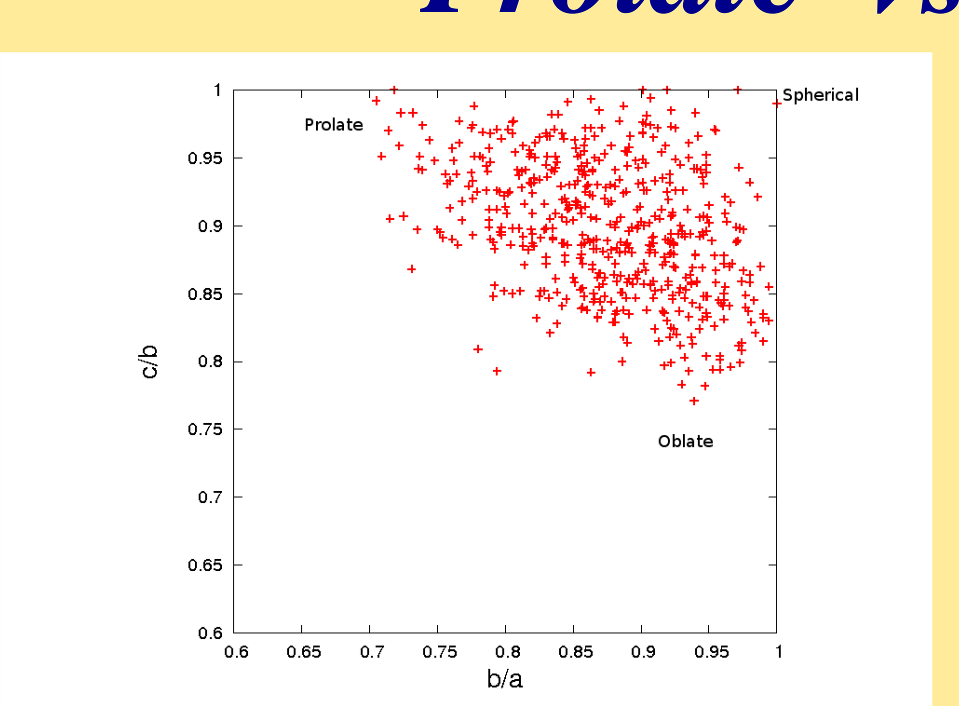
$S_{ij} = Sx_{ki}x_{kj}$ (offdiagonal)

$S_{ii} = S(x_k^2 - x_{ki}^2)$ (diagonal)

The eigenvalues and eigenvectors of S then describe the best fit ellipsoid.

$a_i = 5/(2N)\ [e_j + e_k - e_i]$

Prolate vs. Oblate



This plot shows the distribution of void ellipticities in SDSS. Voids in general appear to be more prolate than oblate. A large number are scalene in shape. The mock samples, both in real and redshift space appear similar to the SDSS sample.

Acknowledgements

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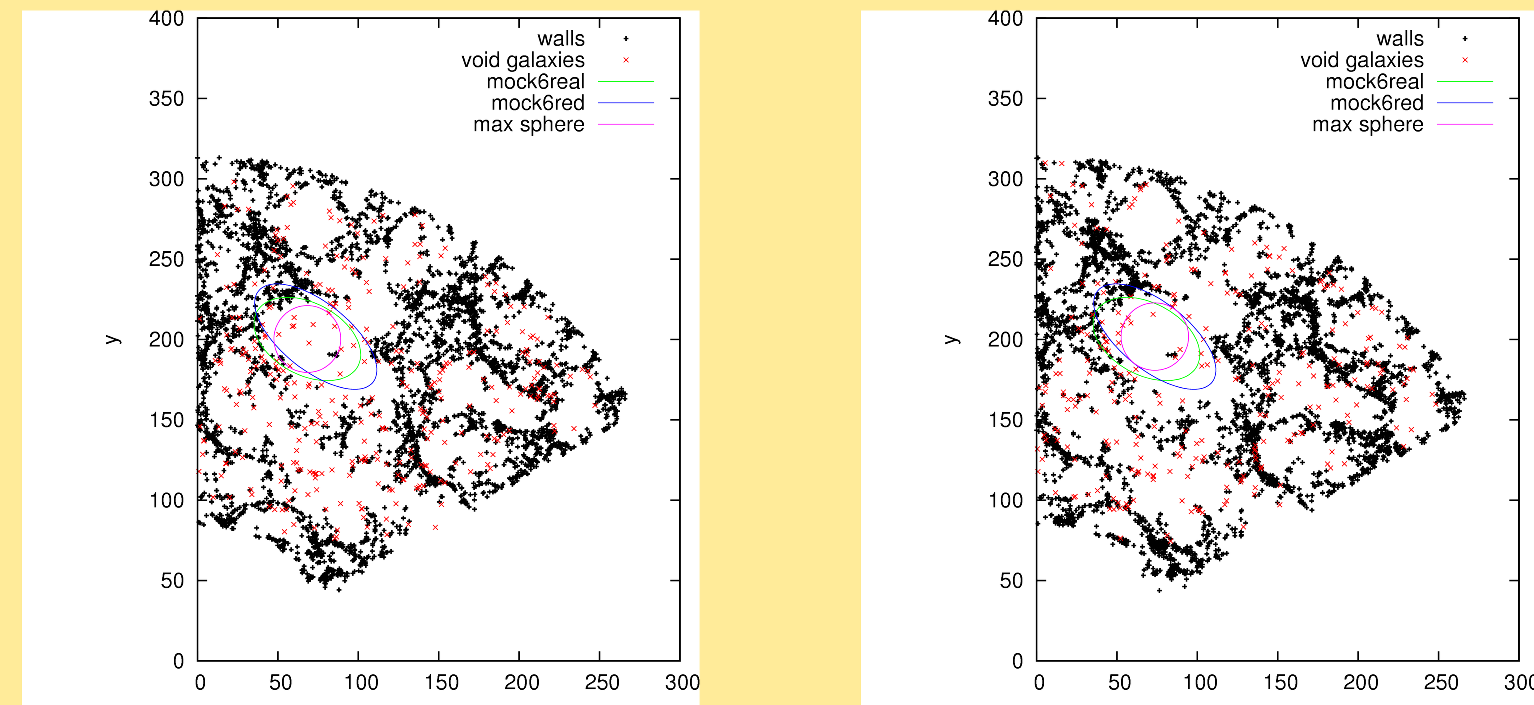
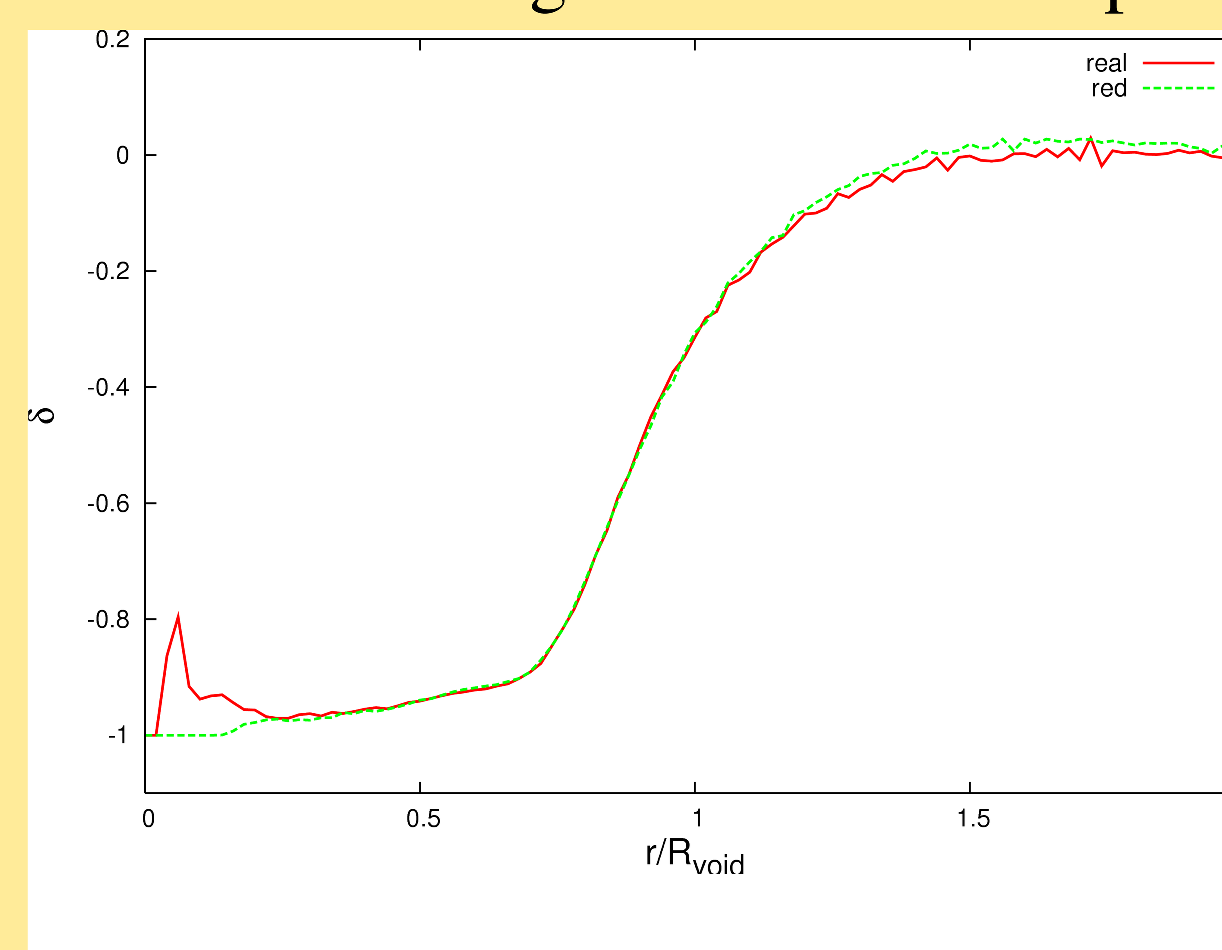
Real and Redshift space

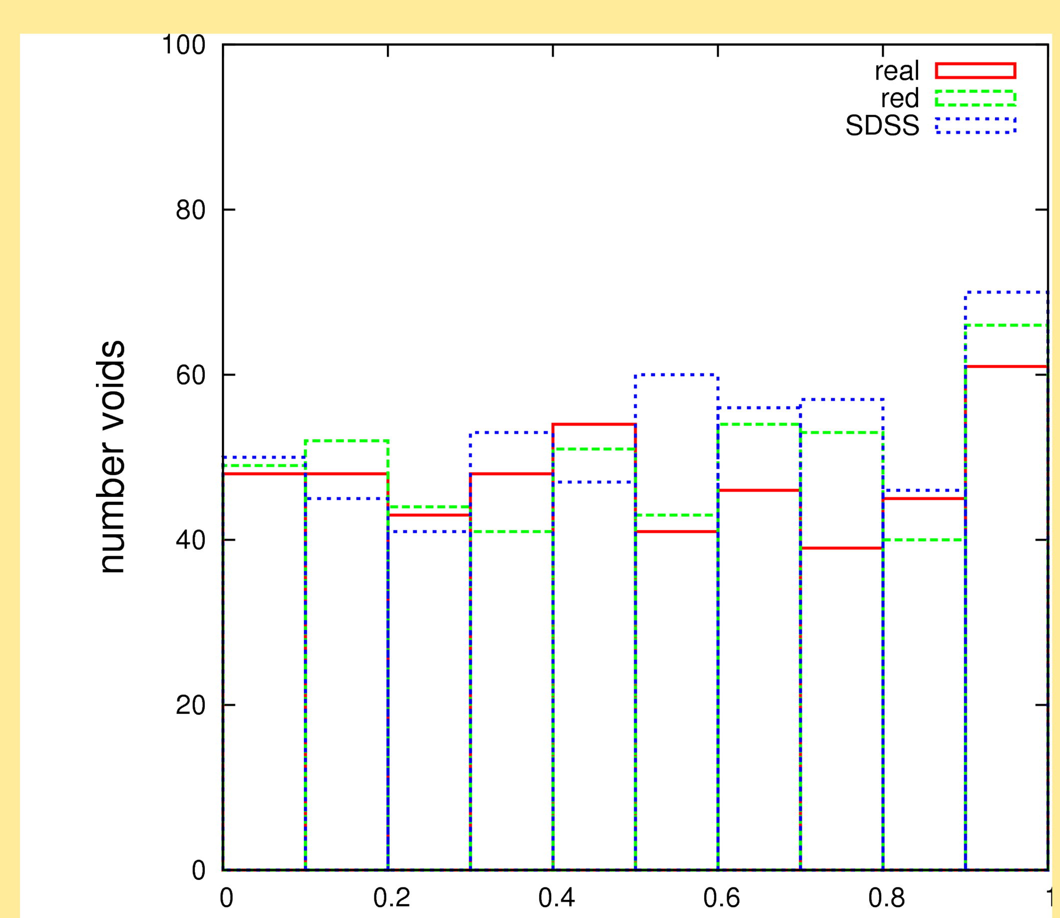


These 20 Mpc thick slices are centered on the largest maximal sphere in the respective mock void samples, real space on the left, redshift space on the right. Intersections with the maximal sphere and best fit ellipsoids are shown. It can be seen that the redshift space void is larger and more elongated in this example.

This figure shows the radial density profile of the mass enclosed with respect to the effective radius of voids. There is no significant difference in the profiles of voids in real and redshift space.



Voids are Randomly Aligned



This histogram shows the distribution of the number of voids with the cosine of the angle of the major axis. Similarities can be seen from the mock sample as well as the SDSS voids. There appears to be no preference for the direction of the major axis, even in redshift space.

Future Work

- Measure redshift distortion effects on the edges of voids
- Assess possible ISW effects
- Matching ΛCDM models
- Measuring evolution of void sizes with redshift

References

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