Voids, superclusters and the ISW effect

Shaun Hotchkiss

(with Seshadri Nadathur)

(also Subir Sarkar, Samuel Flender and Jubilee)

University of Sussex

What I want you to take from this talk

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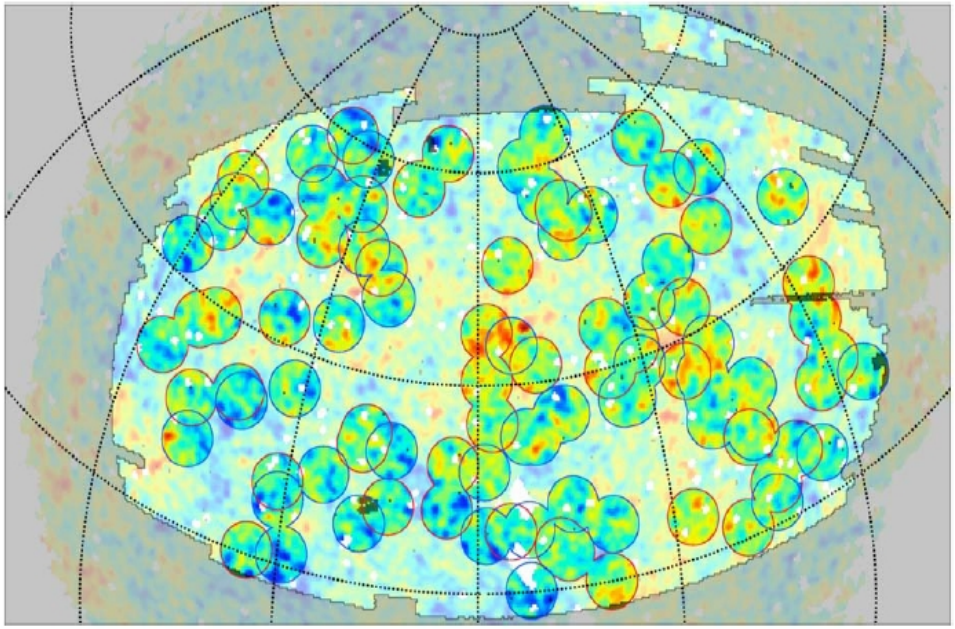
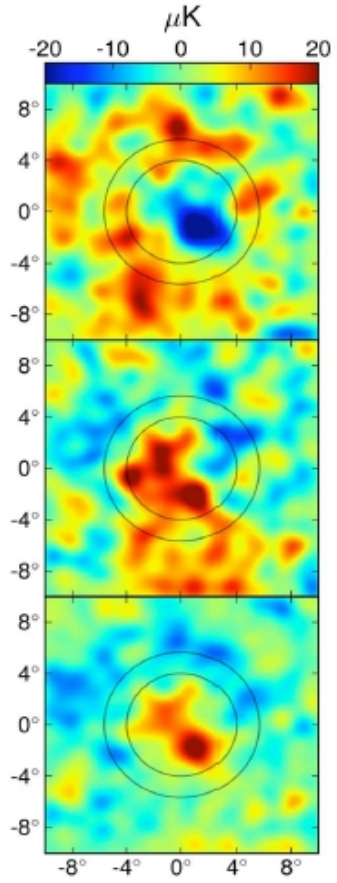
Knowledge that the ISW effect from voids in LCDM is extremely small (unobservable)

A > 4σ anomaly, it would seem...



Granett, Neyrinck, Szapudi 2008

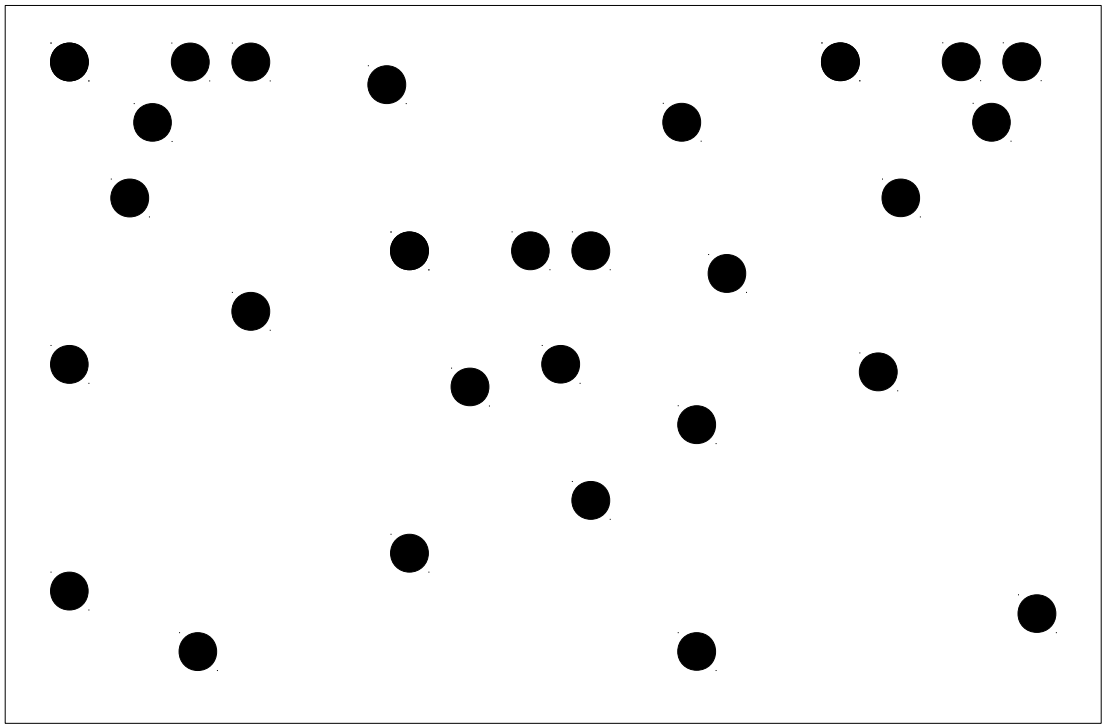


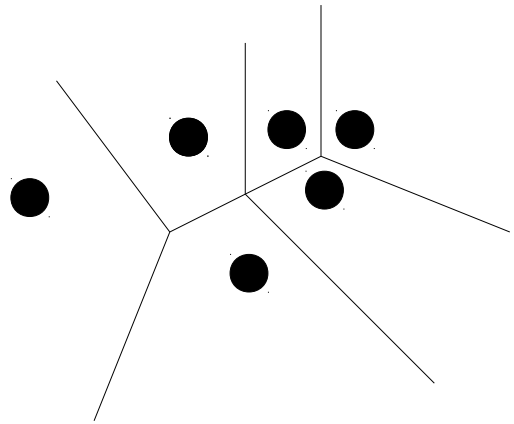
Why are voids interesting?

How to find these things?

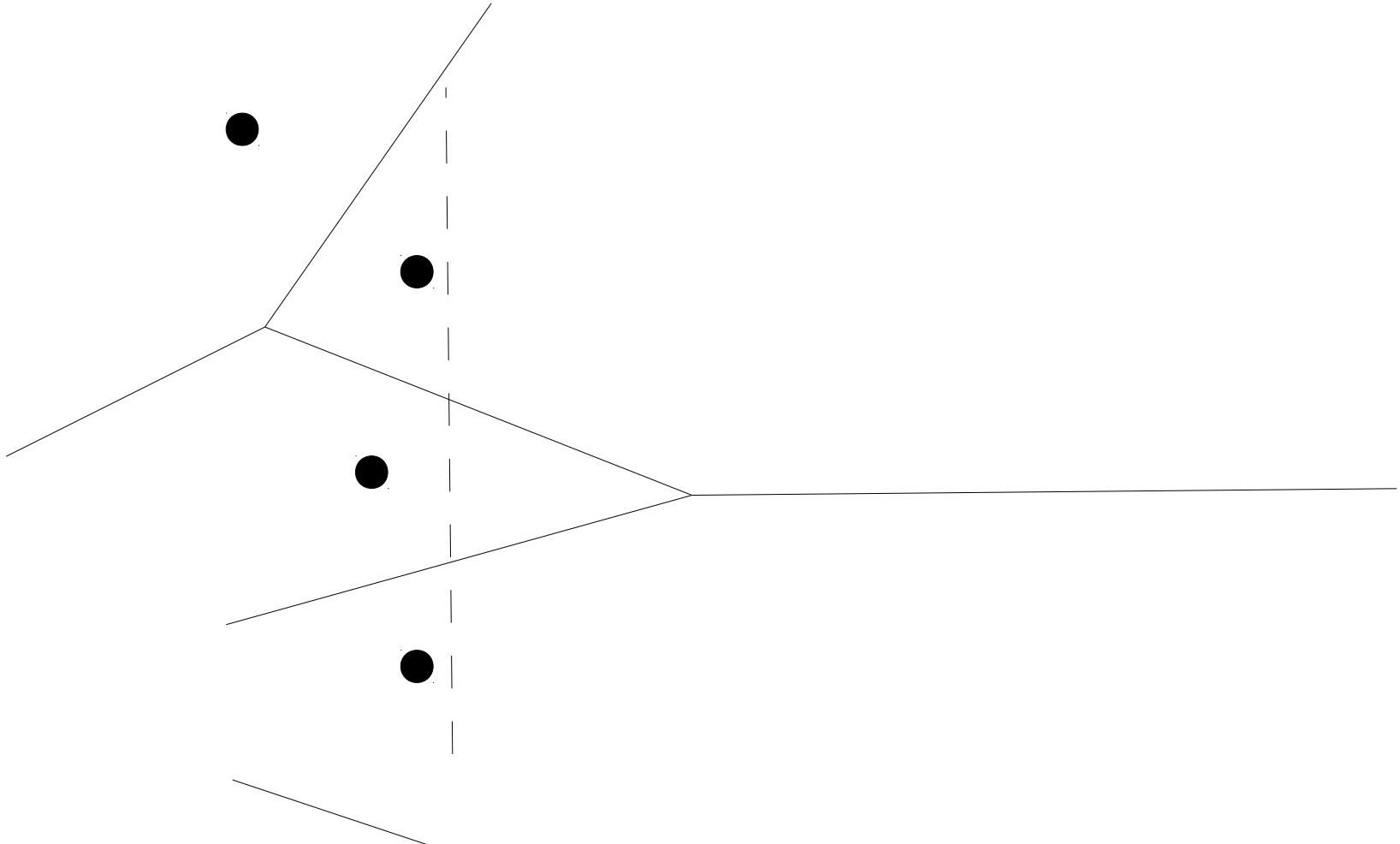
ZOBOV (Neyrinck 2008)

Voronoi tesselation





Voronoi tesselation at survey edge



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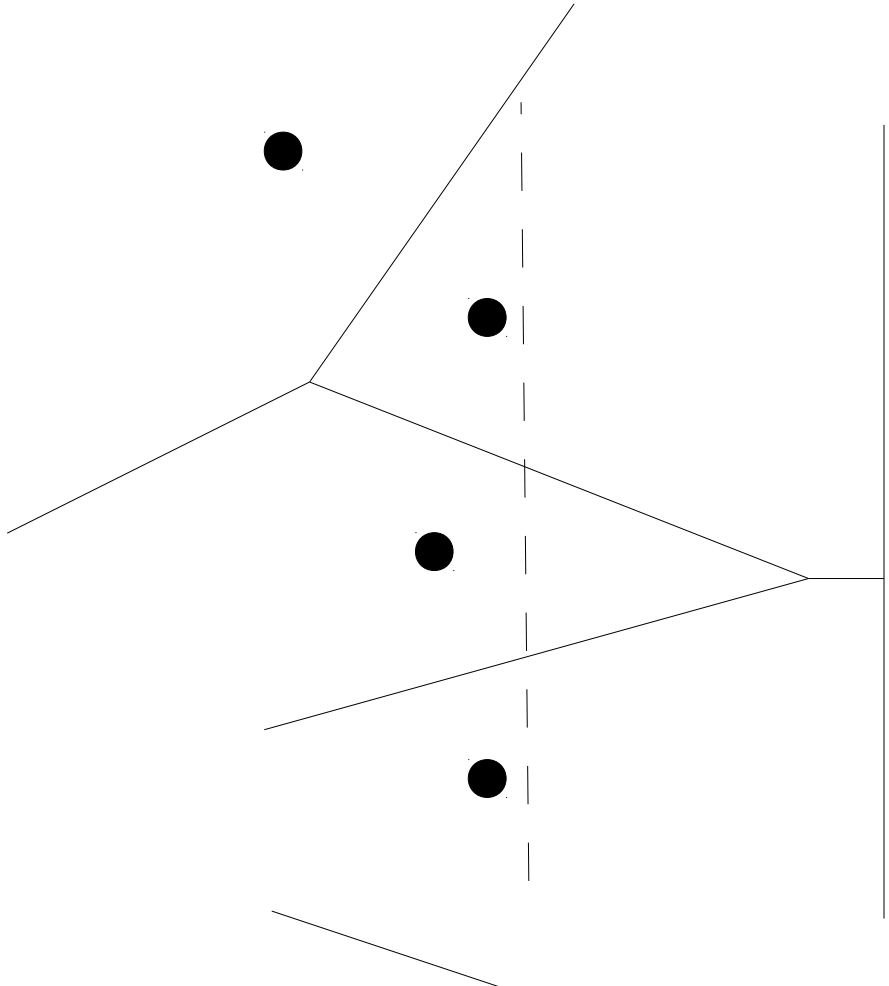

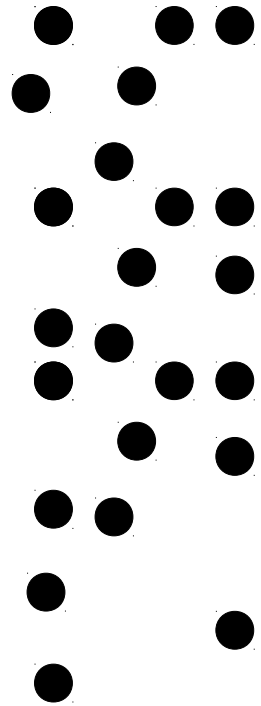

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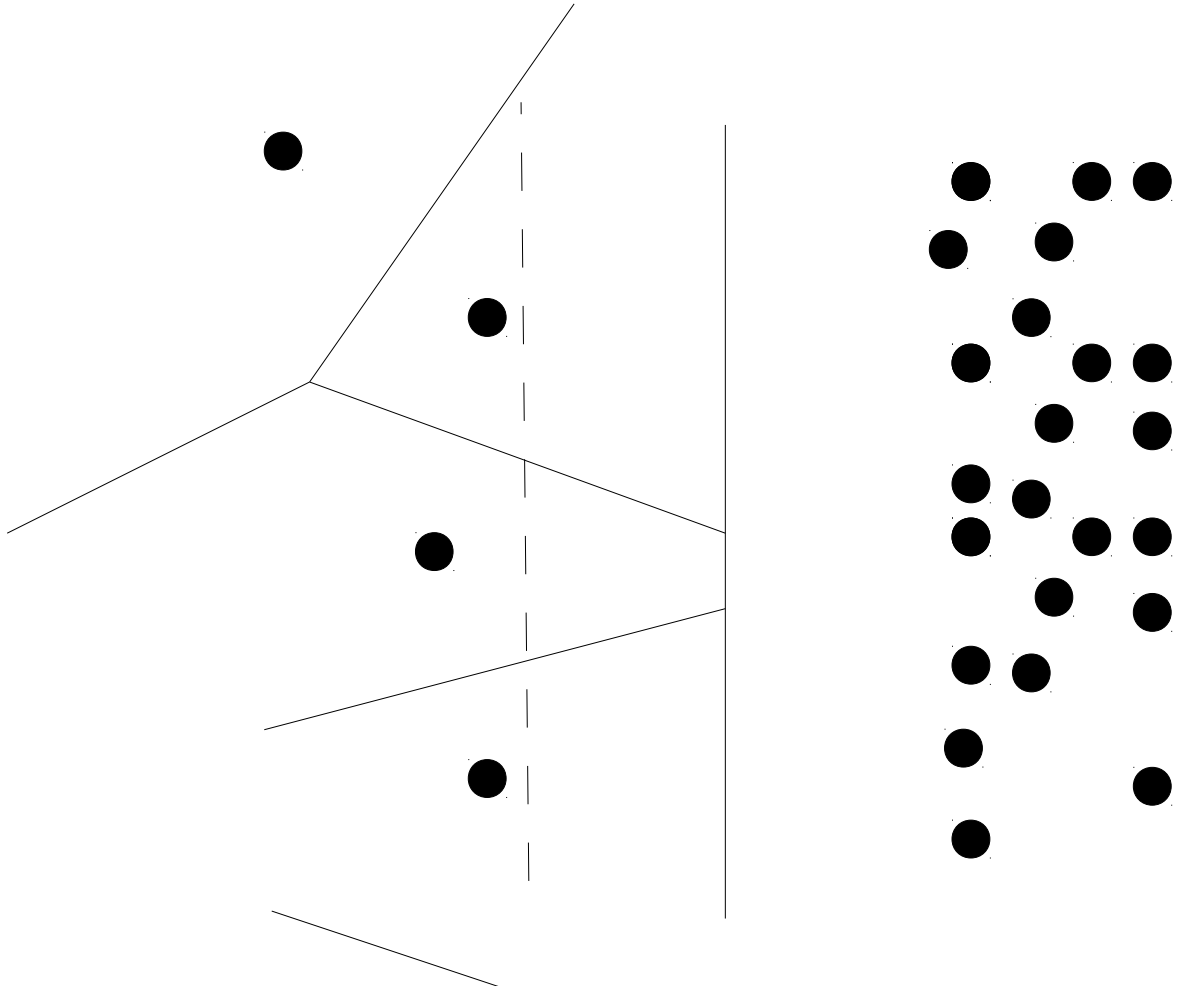
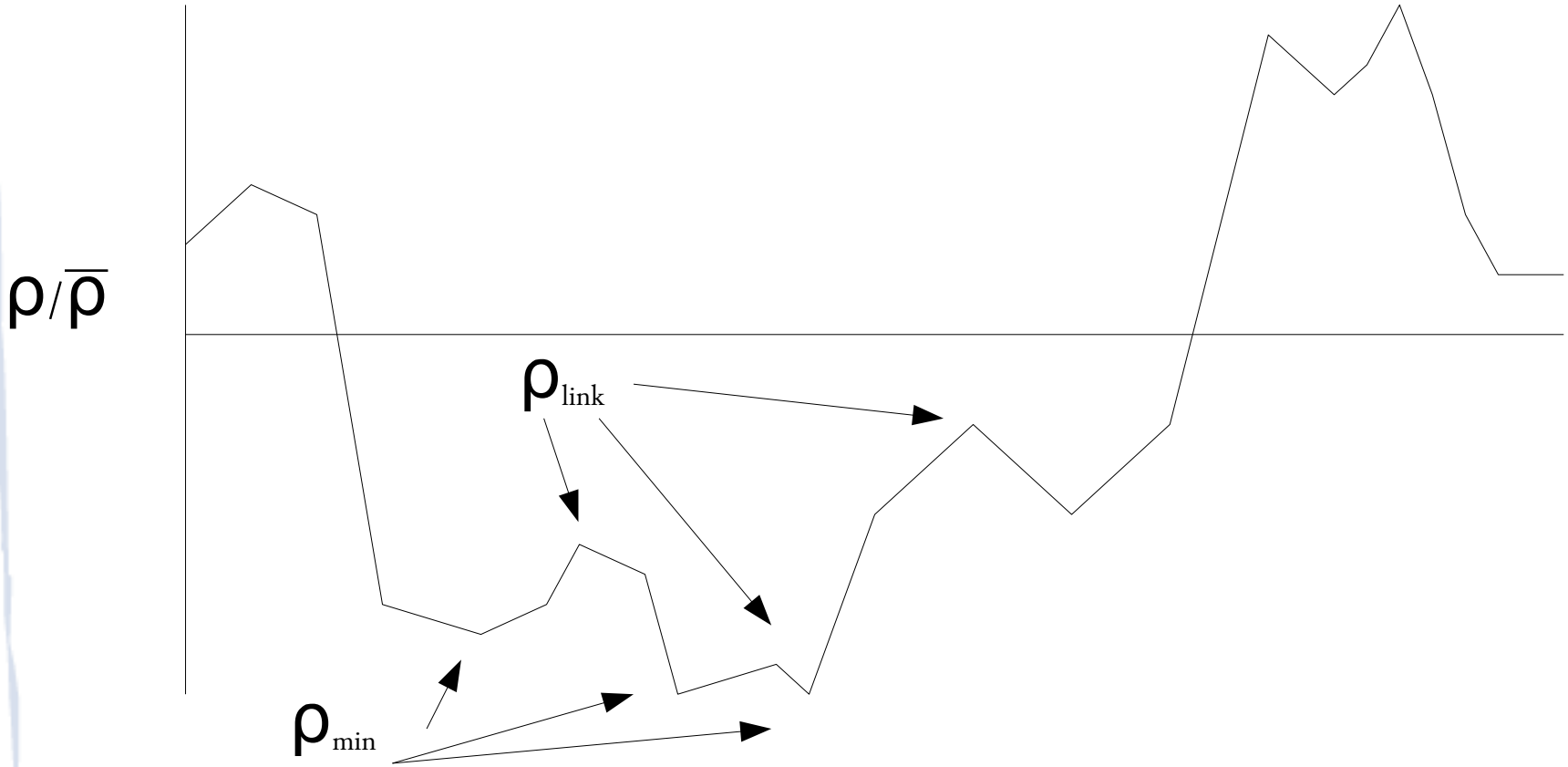
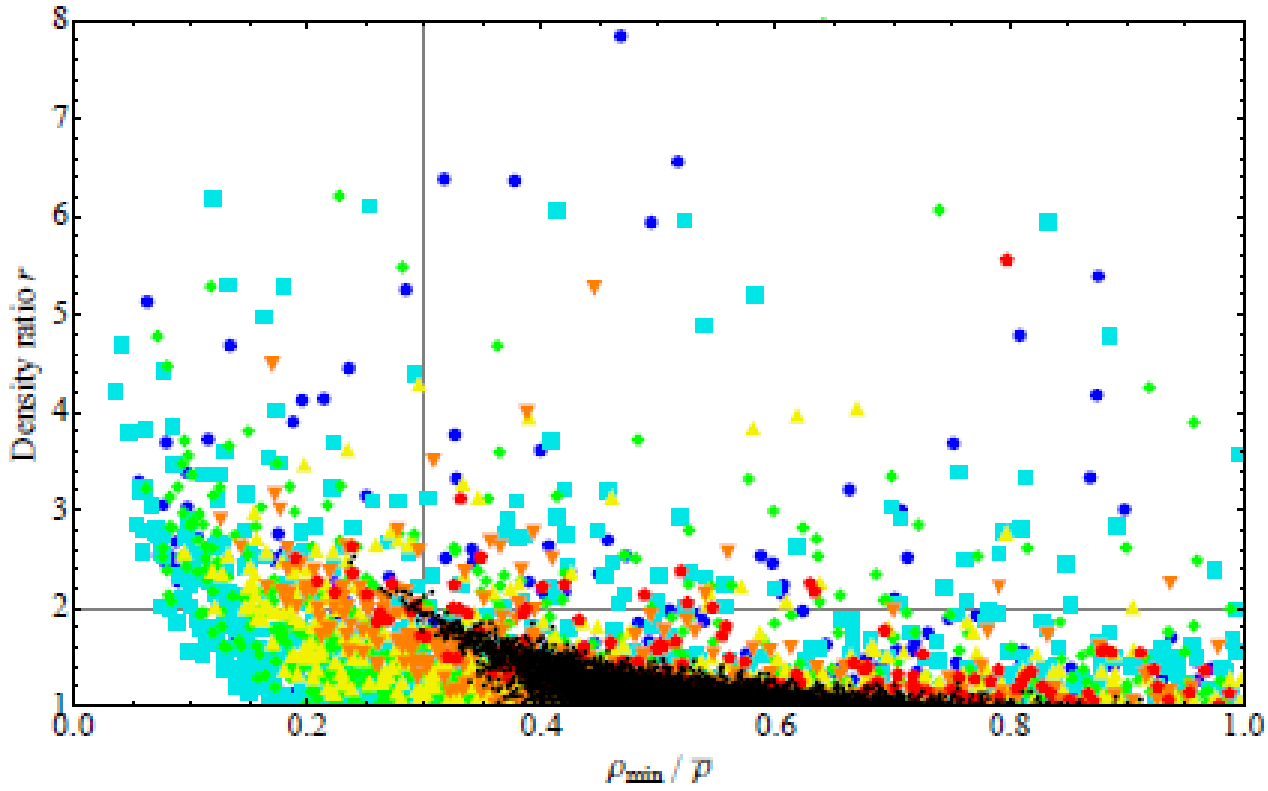


ZOBOV and the density field



Distinguishing from Poisson



Type 1: $\rho_{min}<0.3$

and also Type 2:

ρ_{min} and $\rho_{link}<0.2$

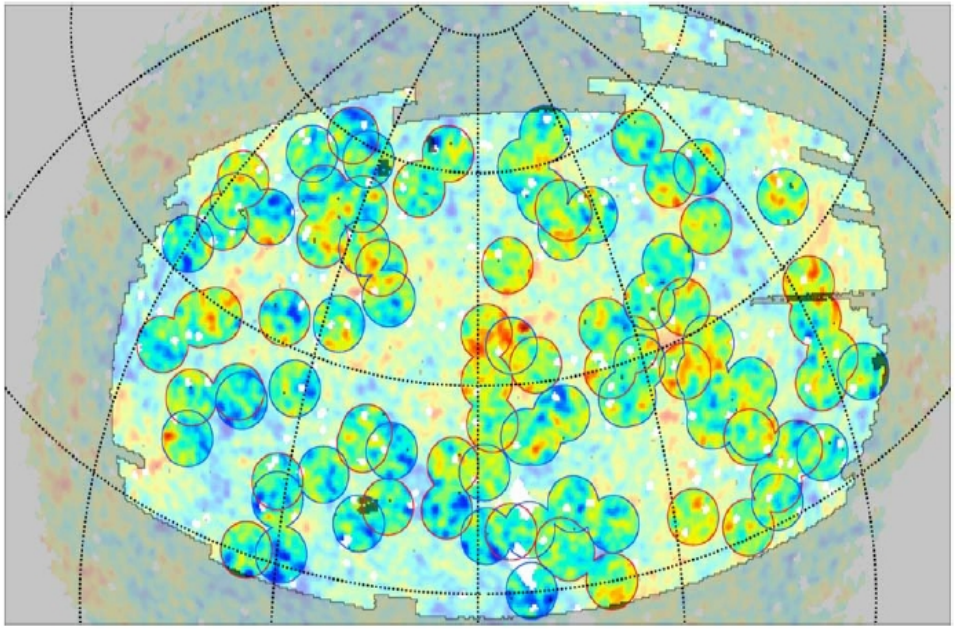
Where is the void and how big is it?

$$\mathbf{X}_v = \frac{1}{\sum_i V_i} \sum_i \mathbf{x}_i V_i$$

$$R_{\mathrm{eff}} = \left(\frac{3}{4\pi} V \right)^{1/3}$$

The “ISW” effect of superstructures

A > 4σ anomaly, it would seem...



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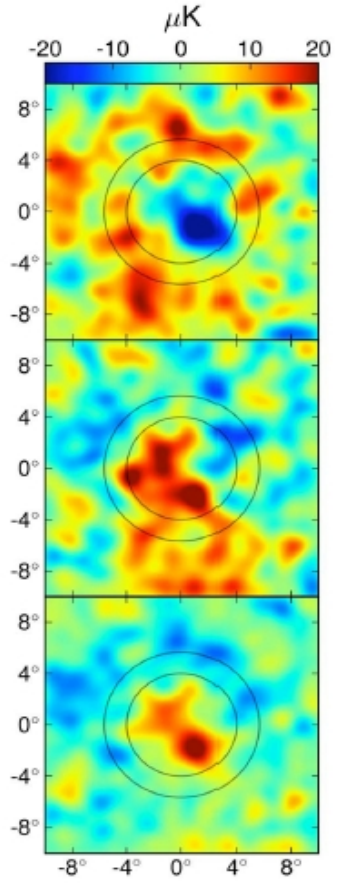
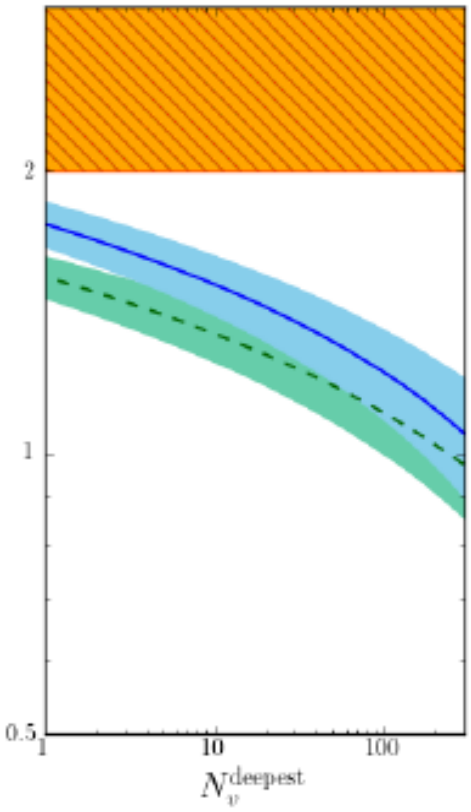
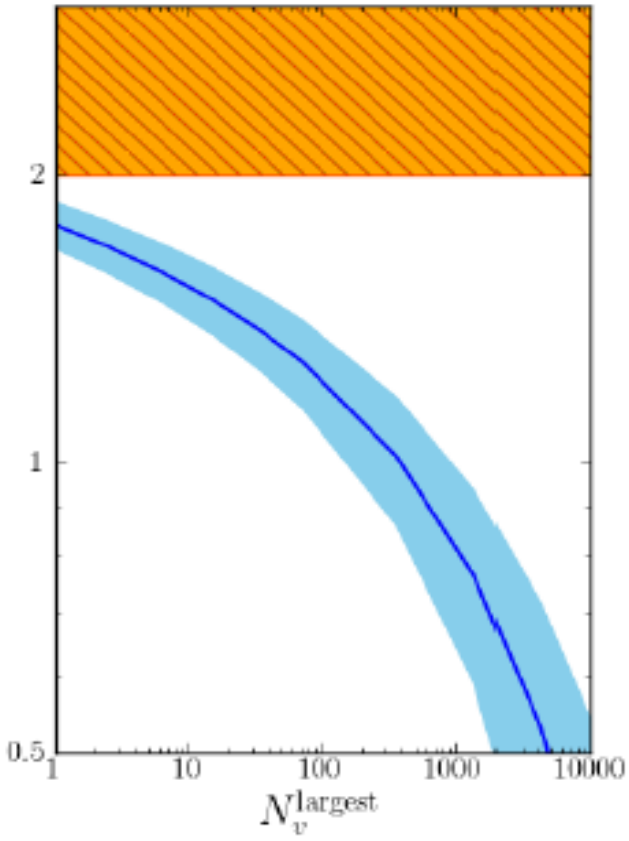
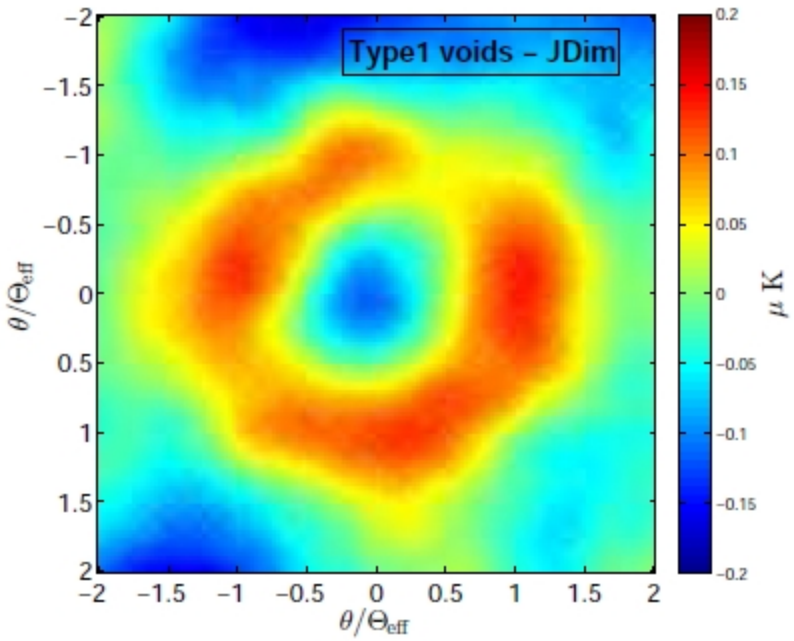


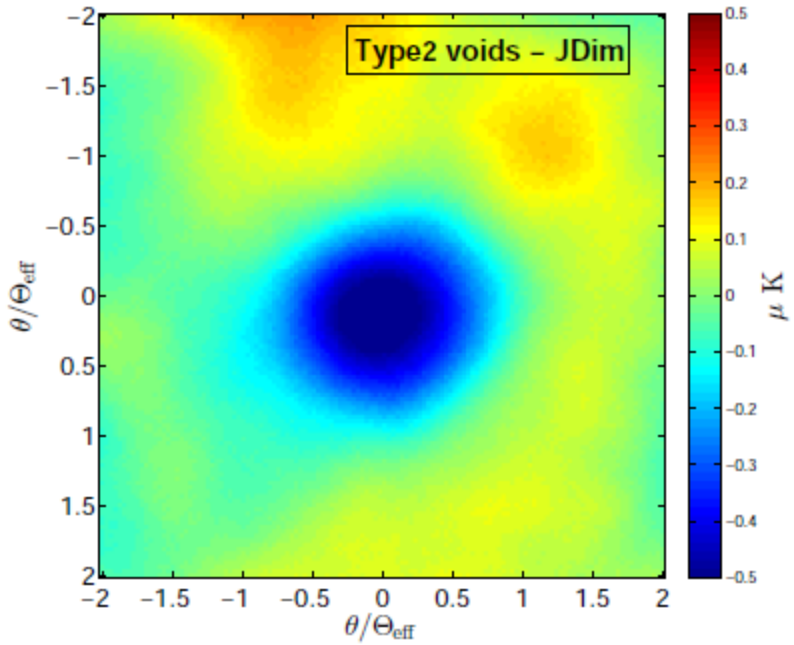
Theory (us)


2
1
0.5
1
10
100
N_v^{deepest}

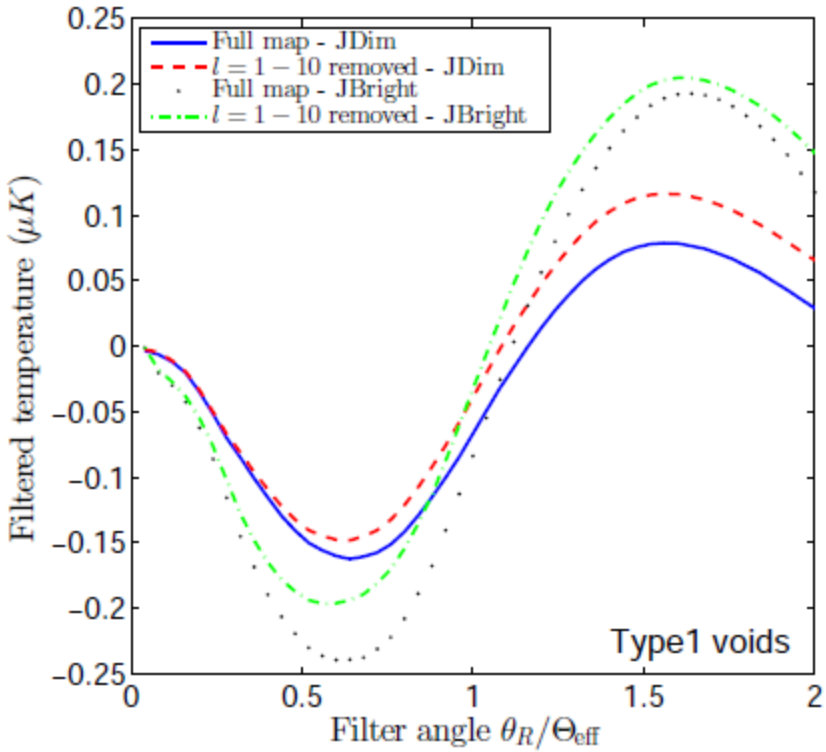

2
1
0.5
1
10
100
1000
10000
N_v^{largest}

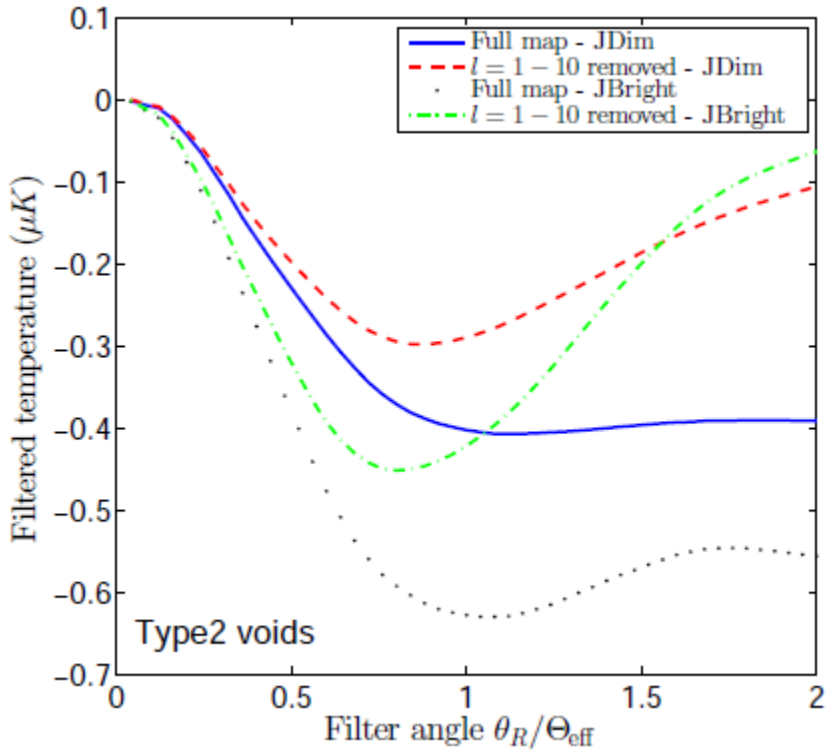
Jubilee et al. (us)



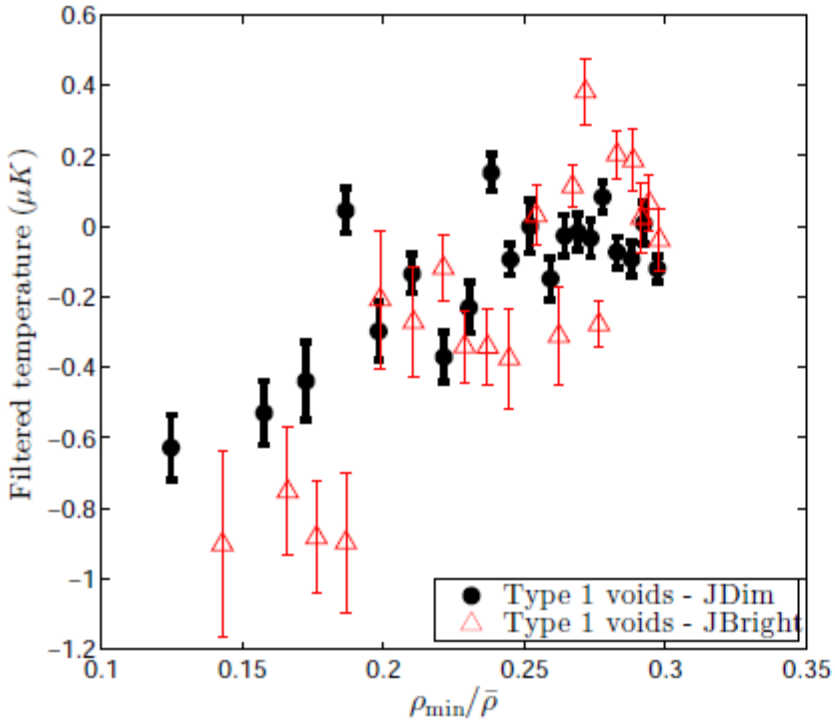


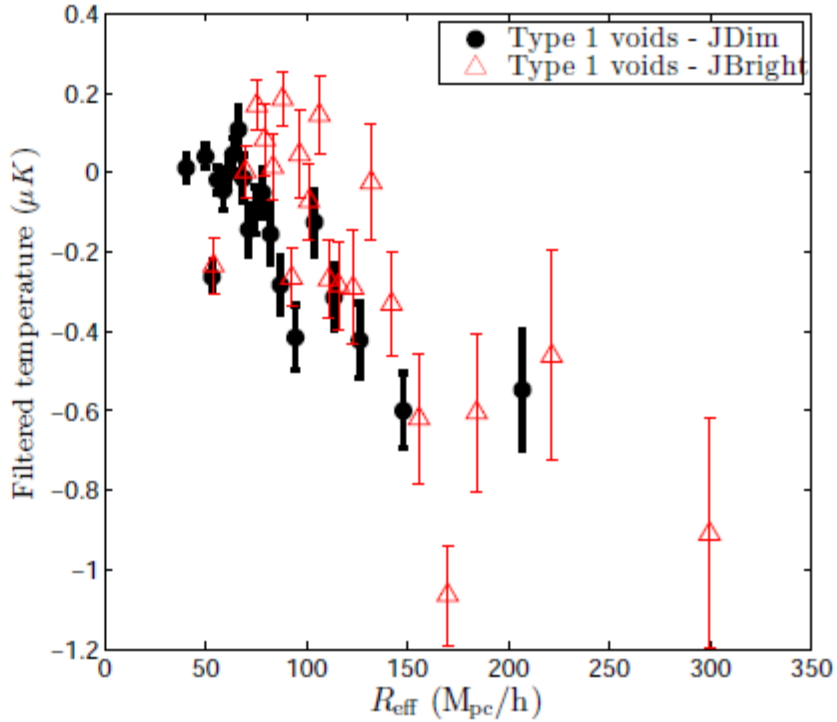
Jubilee et al. (expectations)



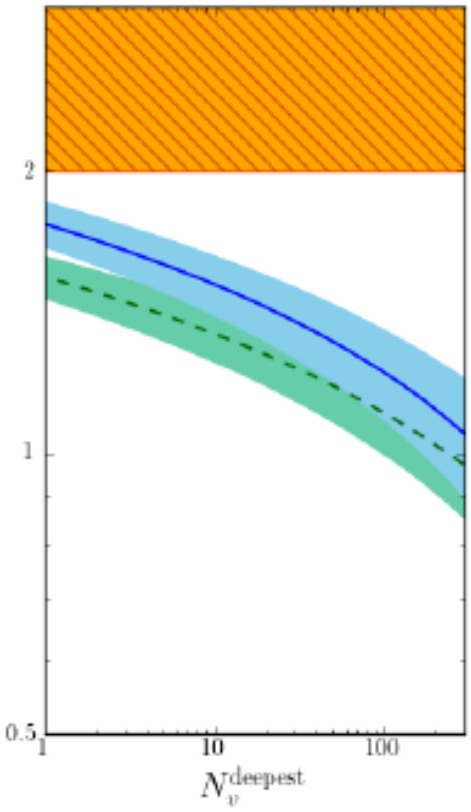


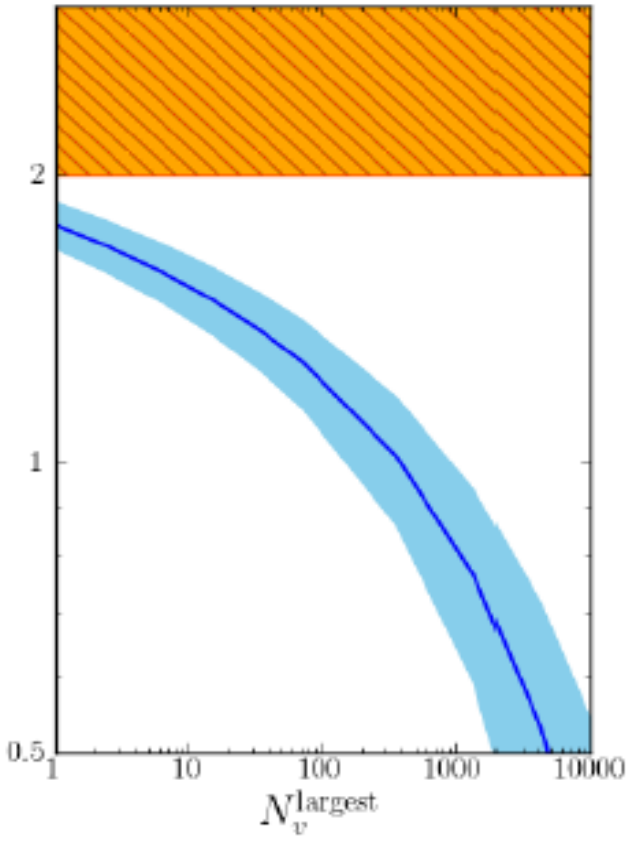
Jubilee et al. (most extreme)





Theory (most extreme)





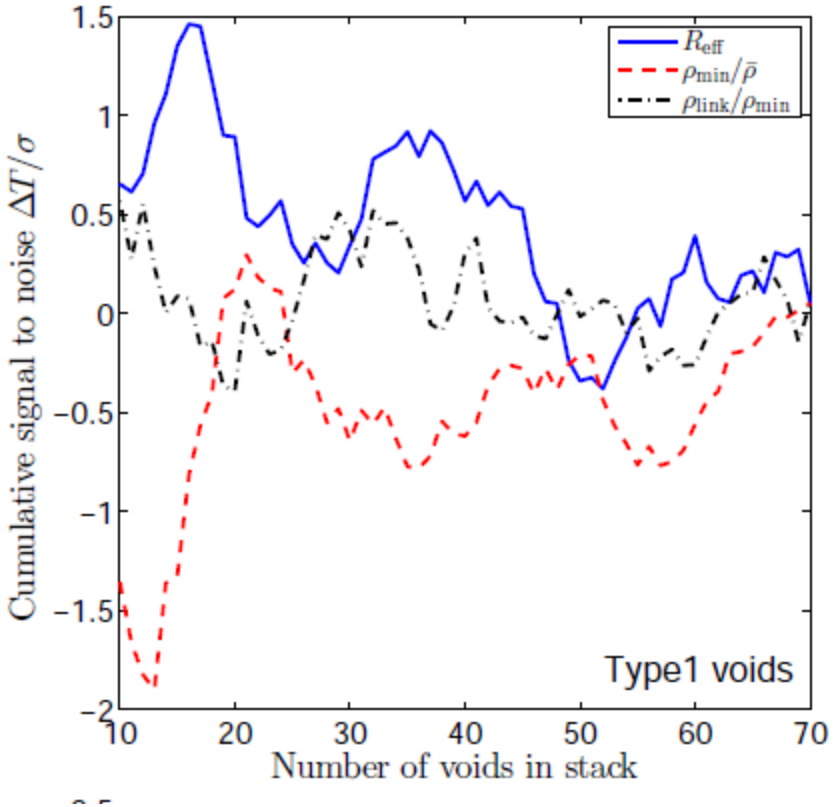
What about the real world?

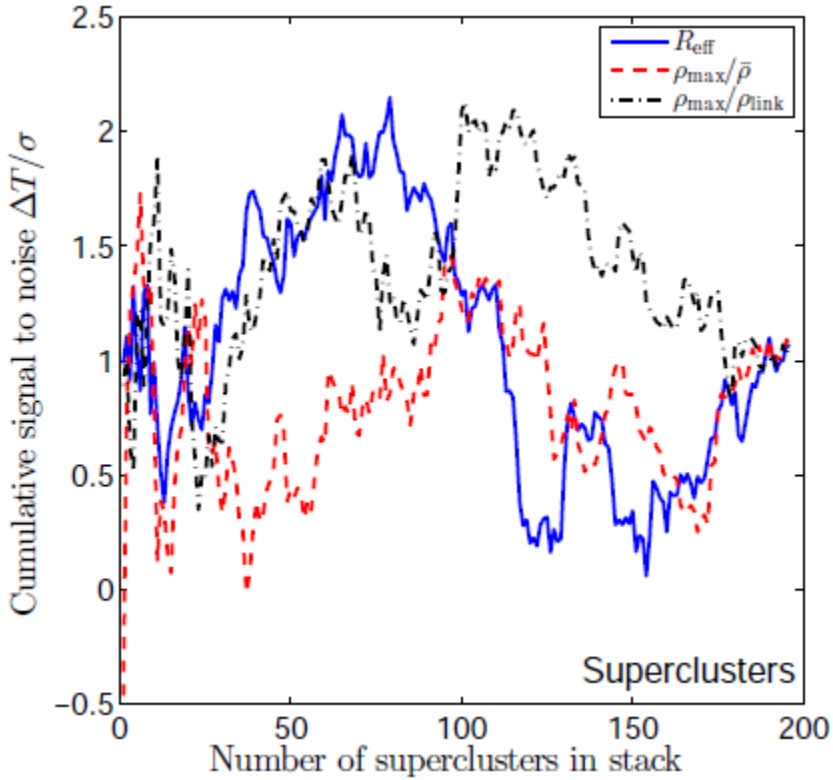
Nothing!

Nothing!

(as expected)

Really, nothing!





A Supervoid Imprinting the Cold Spot in the Cosmic Microwave Background

Fabio Finelli, Juan Garcia-Bellido, Andras Kovacs, Francesco Paci, Istvan Szapudi

(Submitted on 7 May 2014 (v1), last revised 8 May 2014 (this version, v2))

The Cold Spot is one of the anomalies in the Cosmic Microwave Background, and could be of primordial origin, or caused by a foreground structure. The recently constructed WISE-2MASS all-sky infrared catalogue has a projected underdensity in the direction of the Cold Spot with an angular size 10's of degrees, and as deep as $\delta \simeq -0.12$ in the center. We show that a spherically symmetric Lemaitre-Tolman-Bondi (LTB) void model can simultaneously fit the underdensity in the WISE-2MASS catalogue and the Cold Spot as observed by both the Wilkinson Anisotropy Probe and Planck satellites. Such an LTB supervoid gives a perfect explanation, via a Rees-Sciama effect, of the Cold Spot anomaly, and is strongly preferred (using a Bayesian analysis) over the null hypothesis (statistical fluctuation) or a texture model. When the galaxy bias, measured from the large-scale angular power spectrum, is taken into account, a simultaneous three-parameter fit for the void model and the temperature profile gives $z_0 = 0.16 \pm 0.04$ for the mean redshift of the supervoid, $r_0 = 195 \pm 35\, h^{-1}$ Mpc for its size, and $\bar{\delta} = -0.10 \pm 0.03$ for the top-hat-projected average depth of the void. These parameters are in excellent agreement with the results of \cite{SzapudiEtal2014}, who used additional photometric redshifts from Pan-STARRS1 for direct tomographic imaging of the void.

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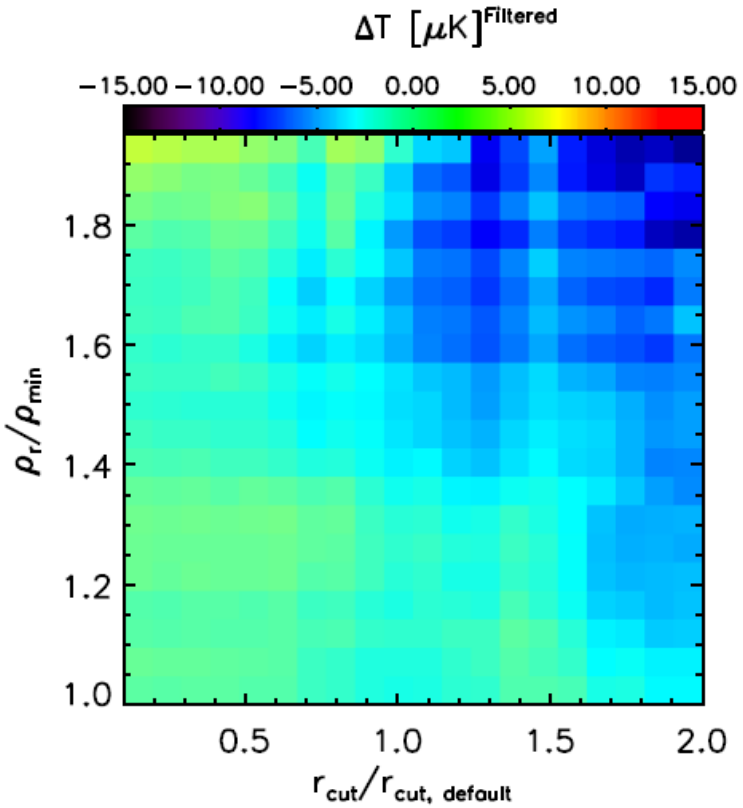
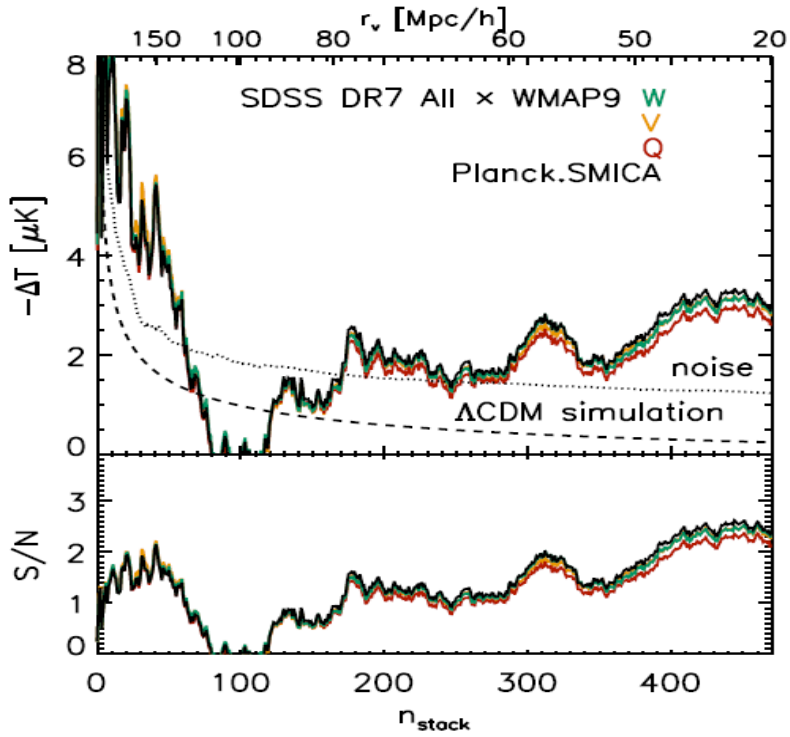
Cai et al (a reproduction?)





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