Durham University

ICC

Imprints of super-structures on the CMB

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with
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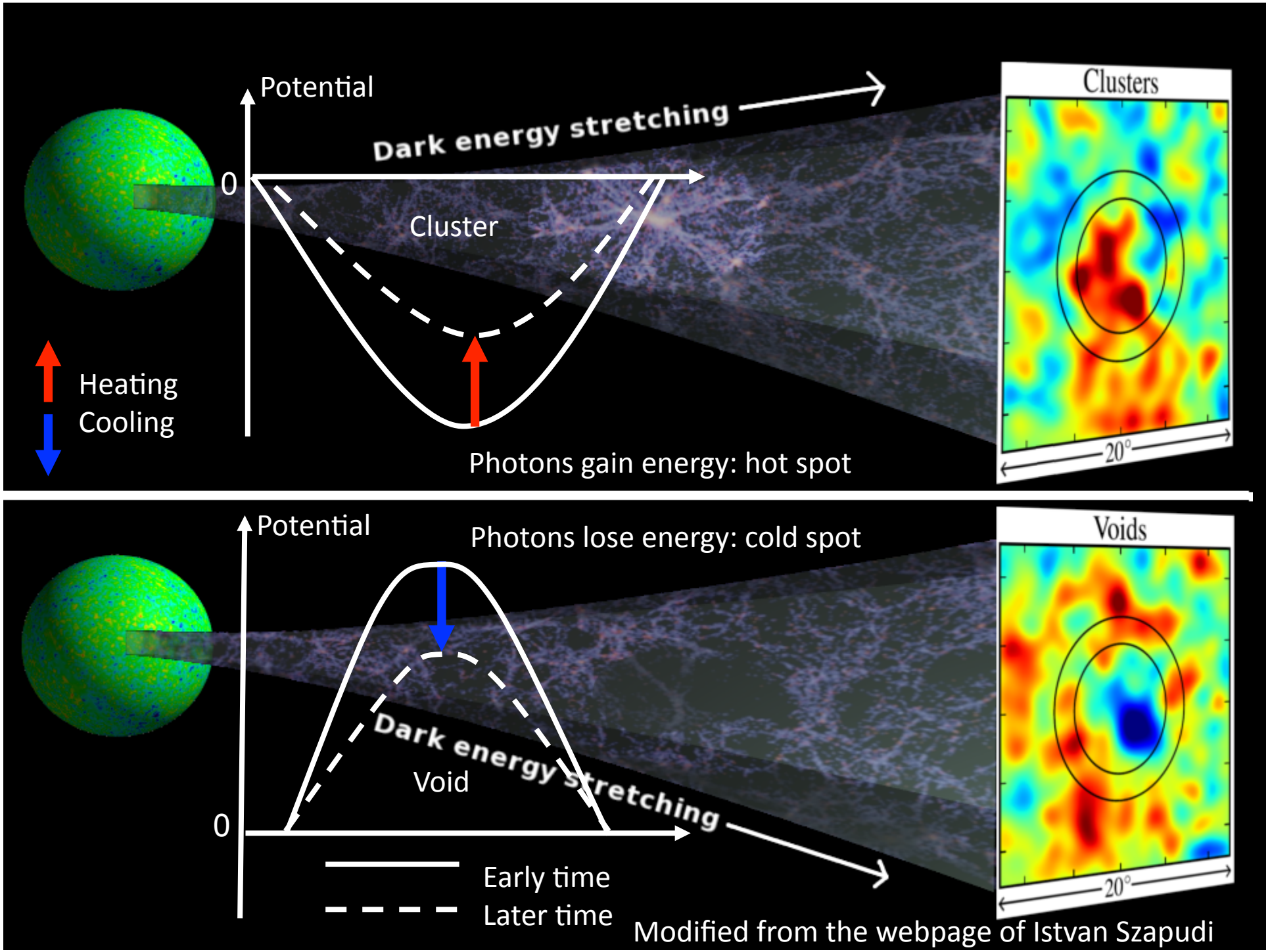
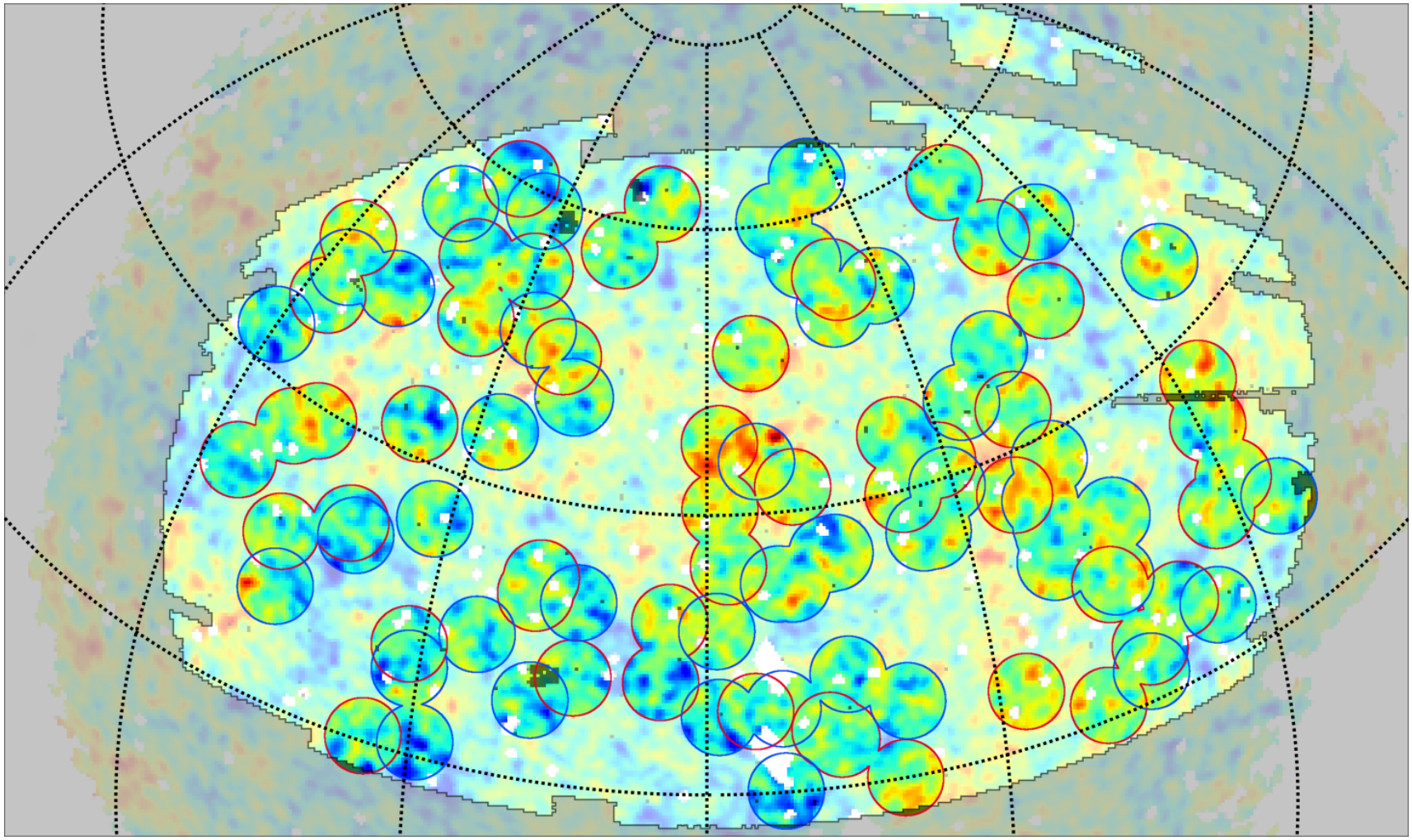
Outline

- ISW from stacking of super-structures
- Results from SDSS-DR6-LRG super-structures
- Comparison with simulations
- Results from SDSS-DR7 voids
- Summary


Potential
Dark energy stretching
0
Cluster
Heating
Cooling
Photons gain energy: hot spot
Clusters
20°
Potential
Photons lose energy: cold spot
Dark energy stretching
Void
0
Early time
Later time
Voids
20°
Modified from the webpage of Istvan Szapudi



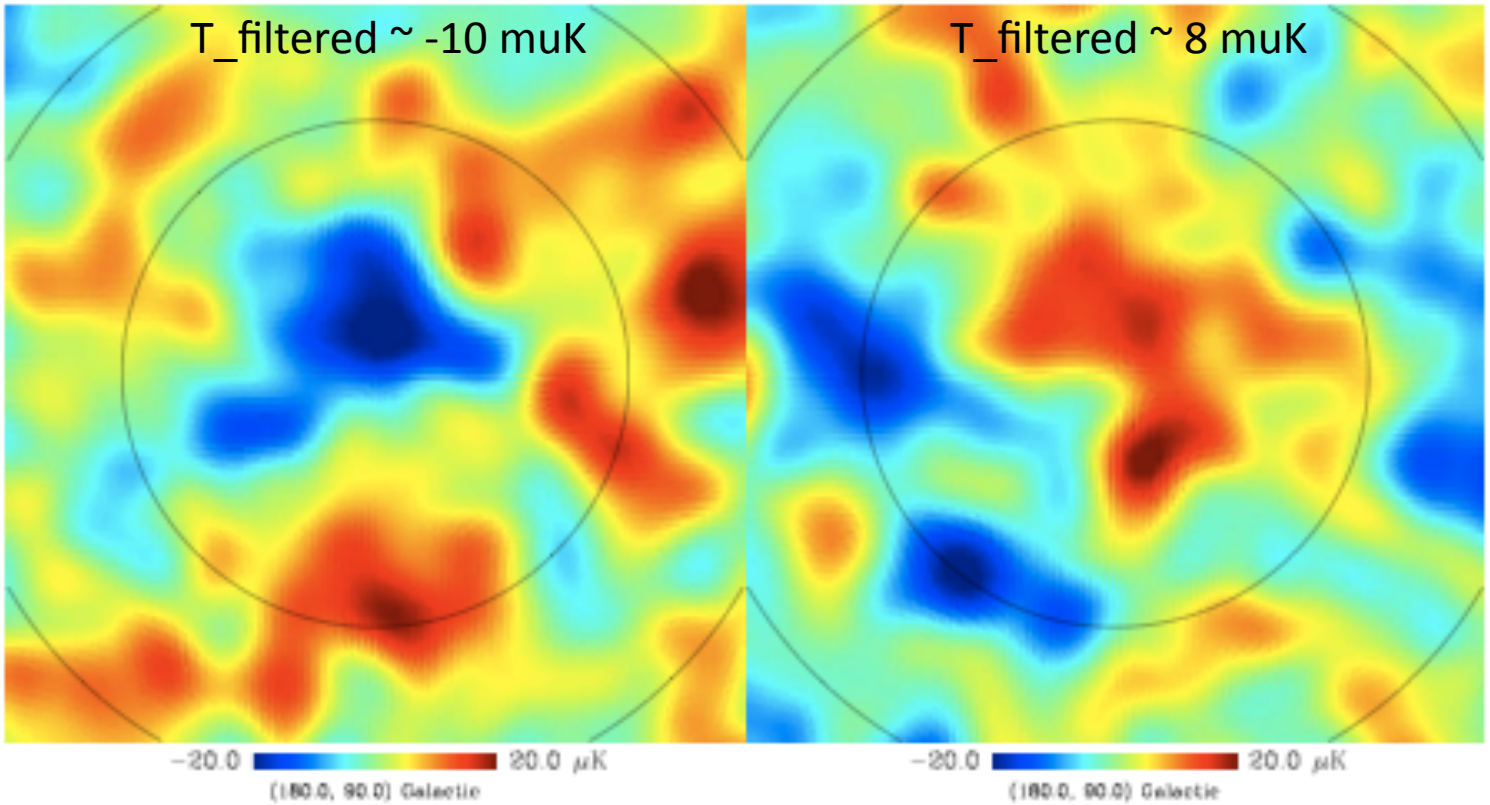
50 super voids/clusters (ZOBOV/VOBOZ) from SDSS DR6, LRG Mega-Z catalogue, z ~ 0.4-0.75

Granett et al. 2008

Stacking of voids/clusters

cold spot surrounded by hot ring

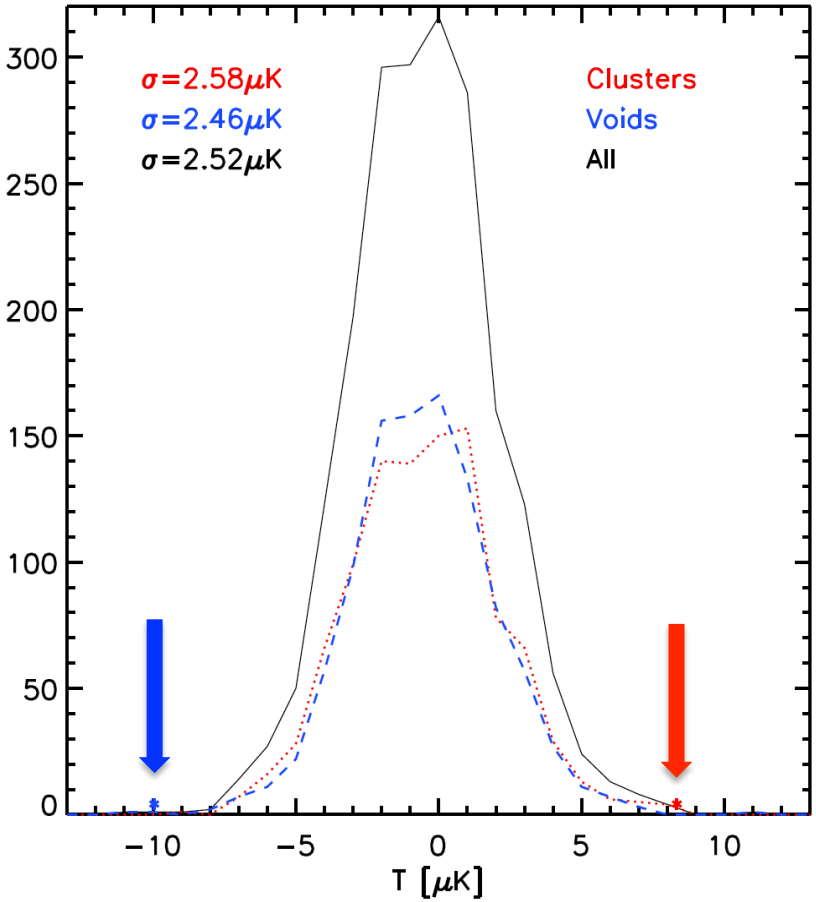
hot spot surrounded by cold ring



Stacked CMB temperature from WMAP5 V-band, using
50 voids and 50 clusters positions from SDSS galaxy
Weak frequency dependence

Reproducing Granett et al. 2008

4-sigma detection of ISW, a problem?



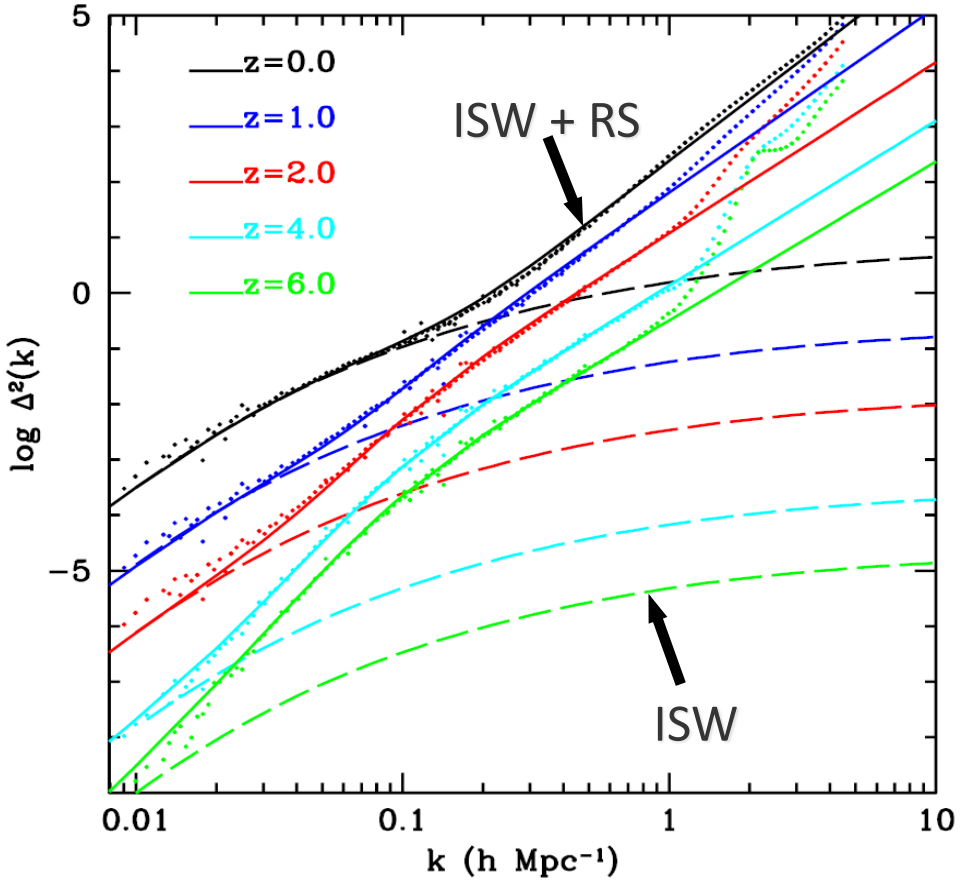
Stacked CMB temperature, filtered by compensated filter of 4-deg radius, R~100 Mpc/h at z~0.5

If ISW, the amplitude (~10 muK) is too high compared to LCDM expectation (3-sigma?), e.g.
Granett et al. (2008), Papai et al. (2011), Nadathur et al. (2012), Flender et al. (2013), Hernandez-Monteagudo & Smith (2013)

The same stacking on the reconstructed ISW map from galaxy density field find no signal
Granett et al. (2009)

a tension? what's missing?

Power spectra of $\dot{\Phi}$



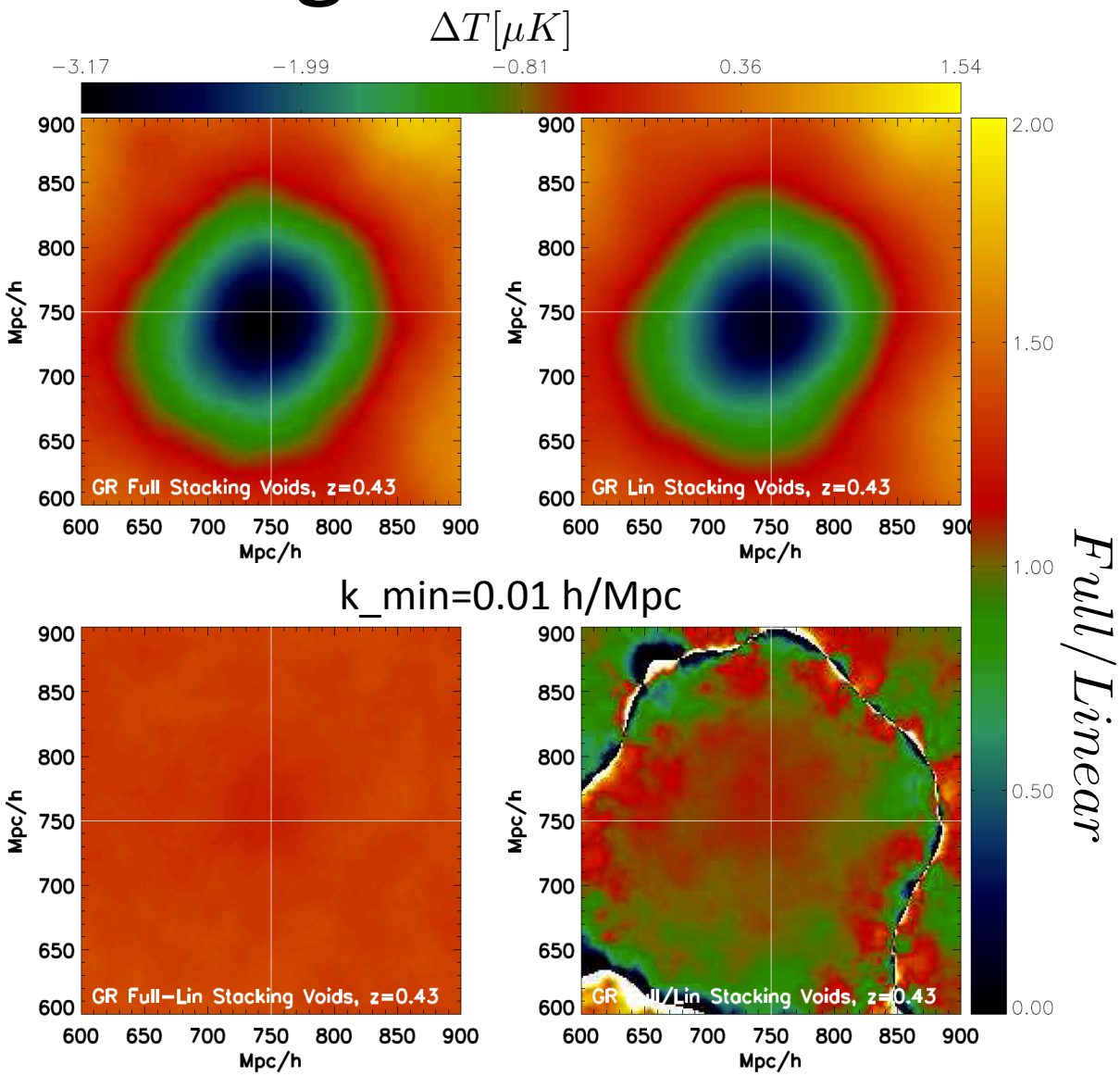
Deviation from linear theory occurs on larger scales at higher redshift.

Filters with sharp feature may pick up large difference

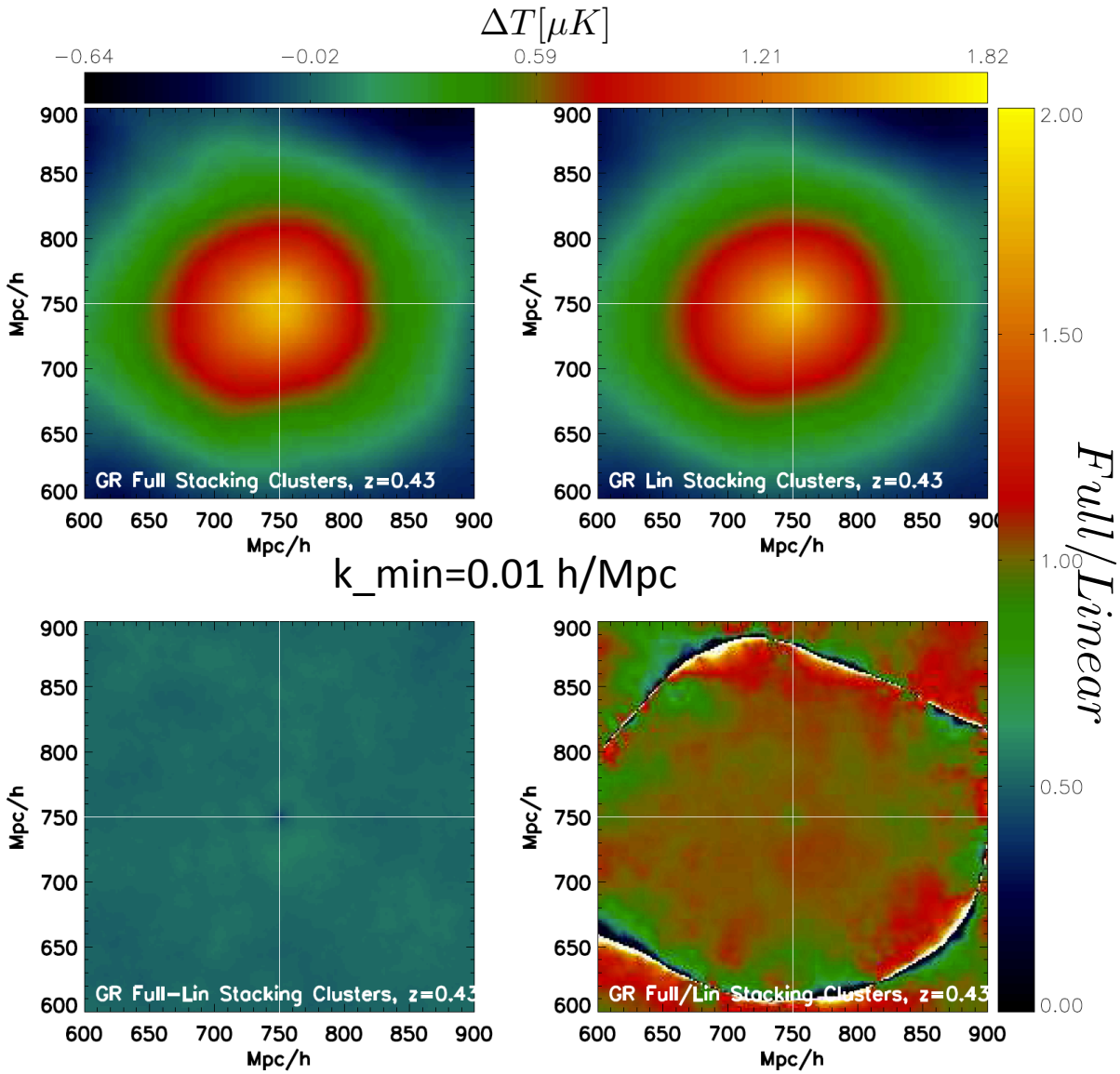
$$\mathcal{P}_{\Phi'\Phi'}(k,z) \equiv P_{\delta\delta}(k,z) - 2\frac{P_{\delta\delta'}(k,z)}{H(z)} + \frac{P_{\delta'\delta'}(k,z)}{H(z)^2}$$

Cai et al. 2009

Stacking of simulated voids

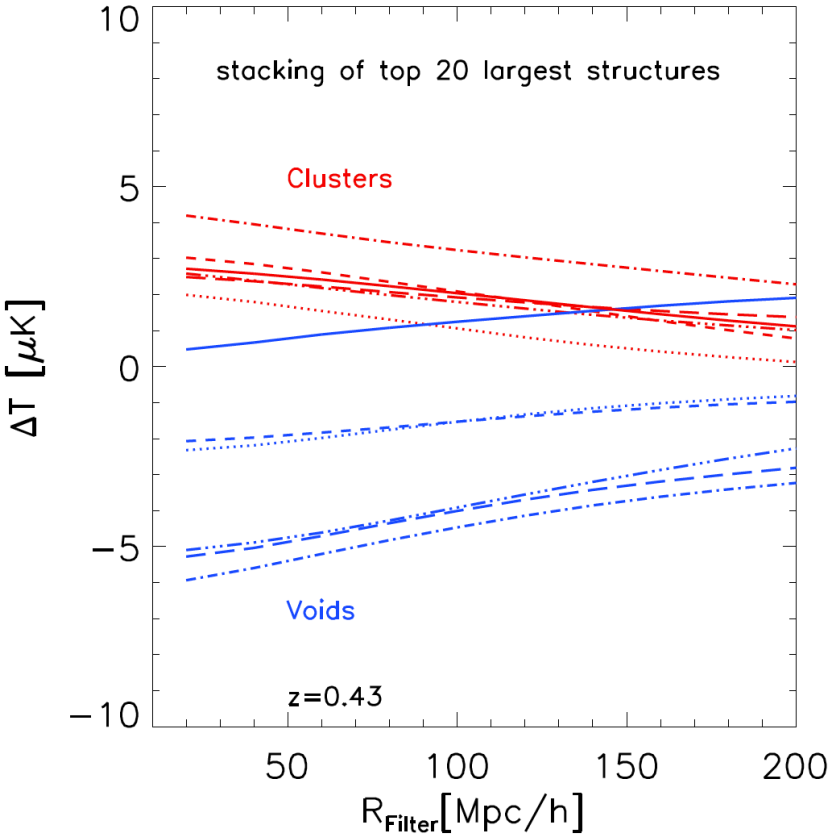


Stacking of simulated clusters

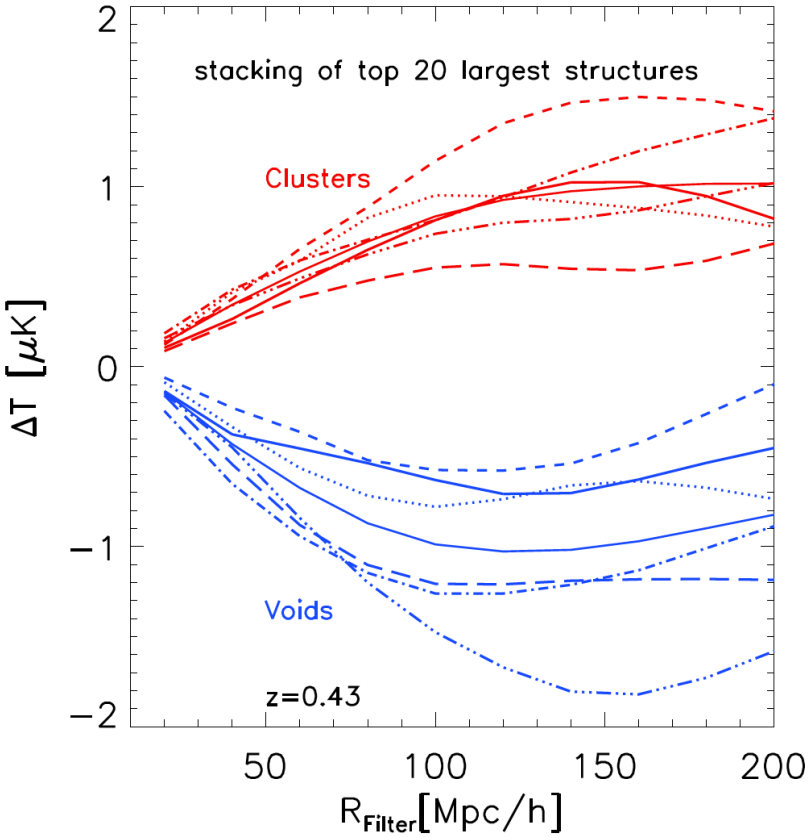


Stacked temperature profile

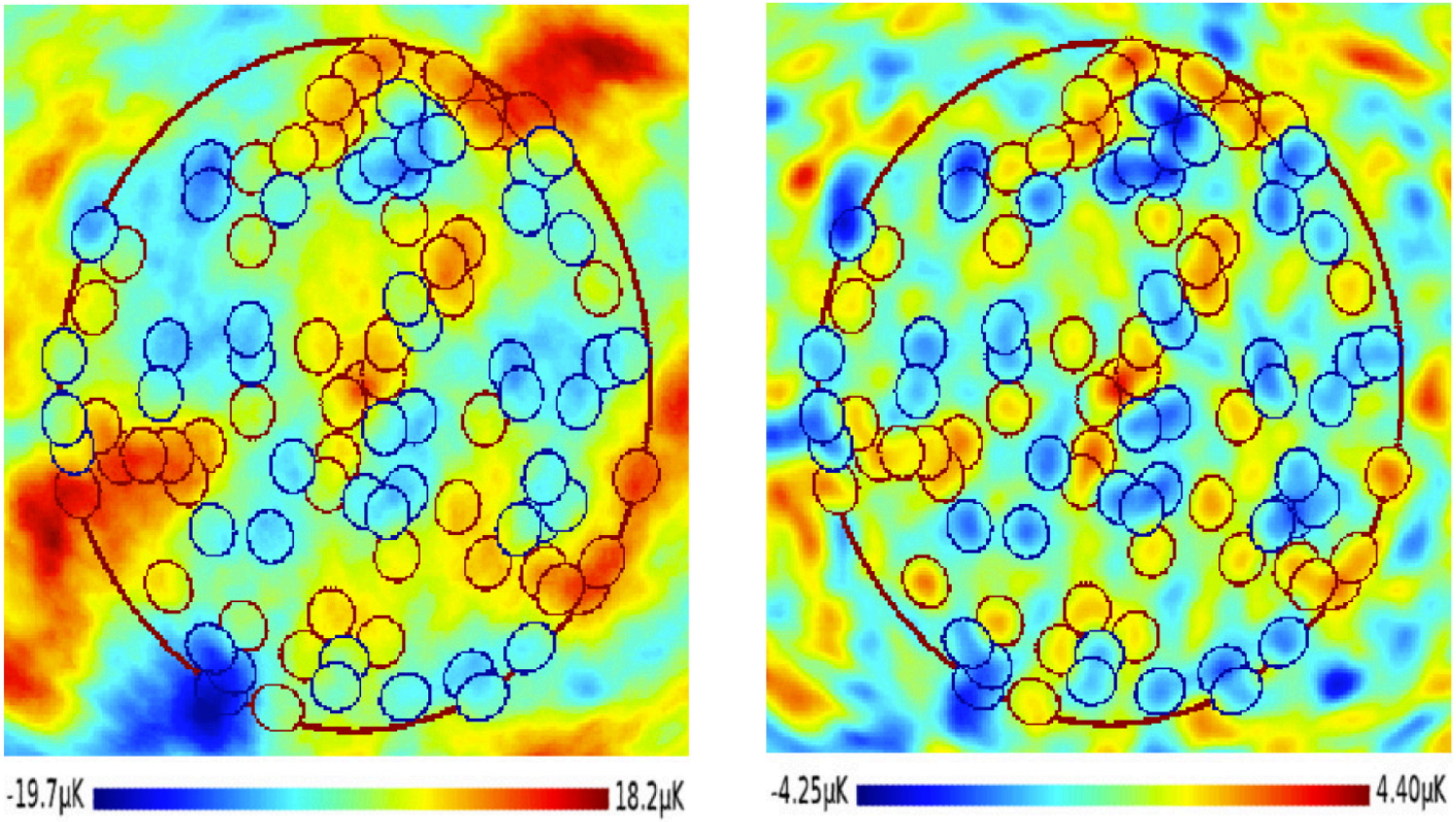
Temperature profile



Compensated filtered T

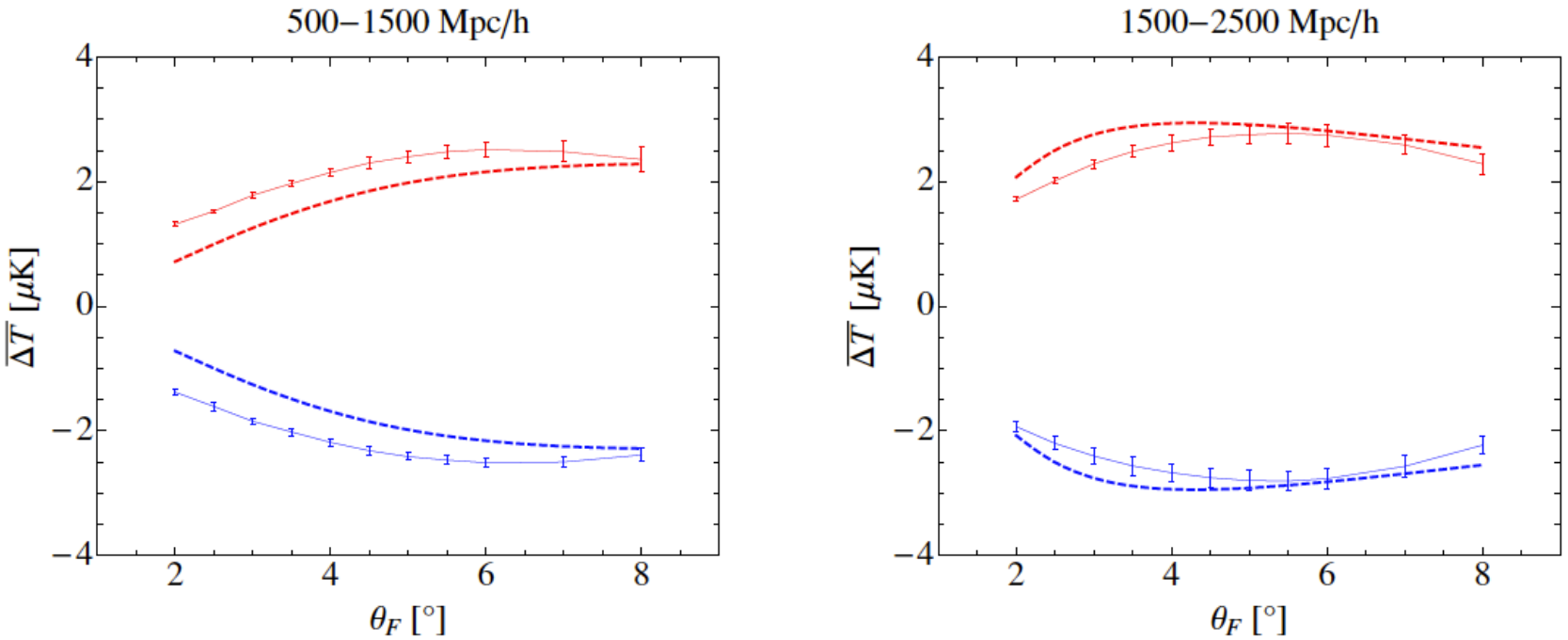


Tension with LCDM?



Flender et al. (2013), using simulated ISW maps from Cai et al. (2010)

Tension with LCDM?



Flender et al. (2013), using simulated ISW maps from Cai et al. (2010)

SDSS-DR7 void catalogues

Sutter et al. 2012

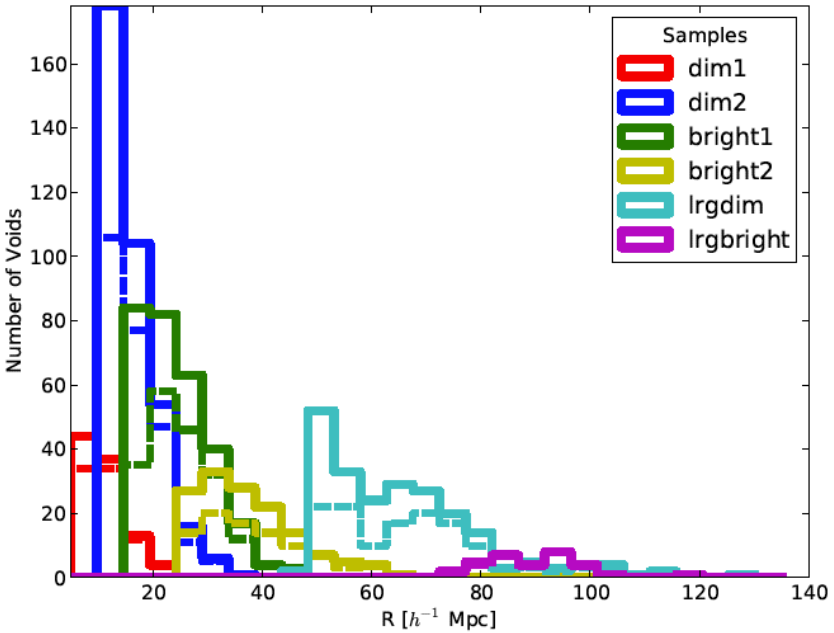
VOLUME-LIMITED SAMPLES USED IN THIS WORK.

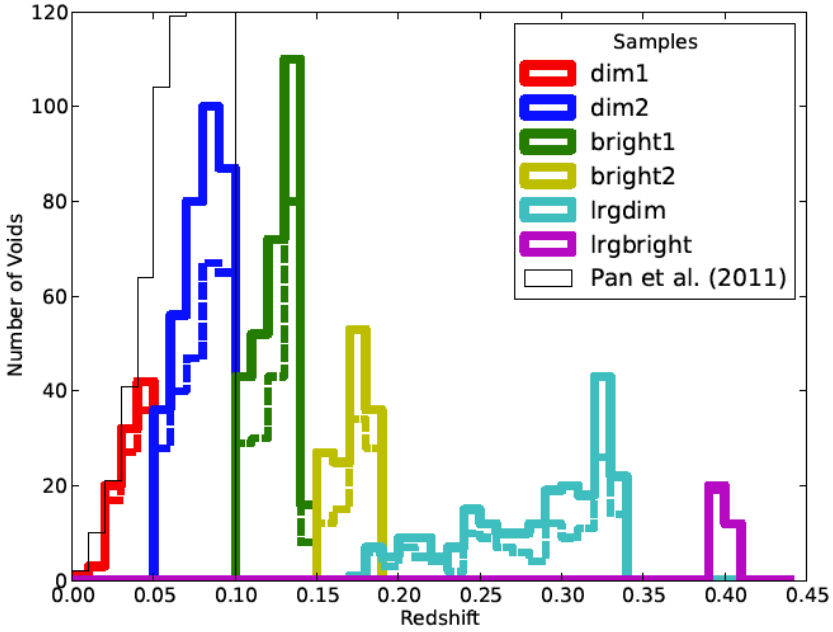
Sample Name	Catalog	$M_{r,\max}$	$z_{\min}$	$z_{\max}$	Number of Galaxies	Mean Spacing (h^{-1}Mpc)
dim1	NYU VAGC	-18.9	0.0	0.05	63639	3
dim2	NYU VAGC	-20.4	0.05	0.1	156266	5
bright1	NYU VAGC	-21.35	0.1	0.15	113713	8
bright2	NYU VAGC	-22.05	0.15	0.2	43340	13
lrgdim	LRGs	-21.2	0.16	0.36	67567	24
lrgbright	LRGs	-21.8	0.36	0.44	15212	38

- Use ZOBOV (Neyrinck 2008) to find voids
- 1495 voids at 0<z<0.44 from P. Sutter@V.Feb. 2013, or 1521 voids from M. Neyrinck

SDSS-DR7 void catalogues

Sutter et al. 2012



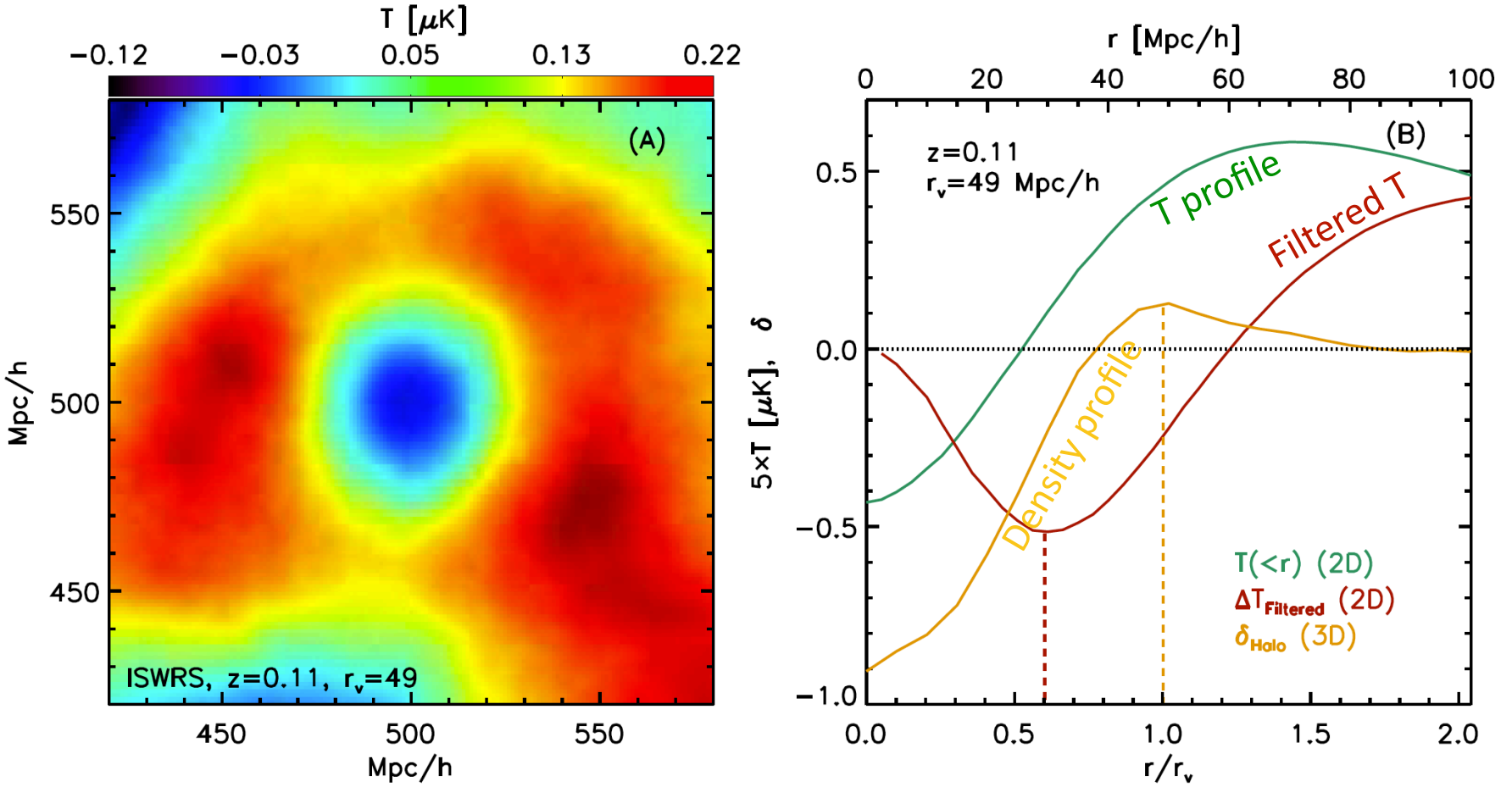


Risky to use all voids because:

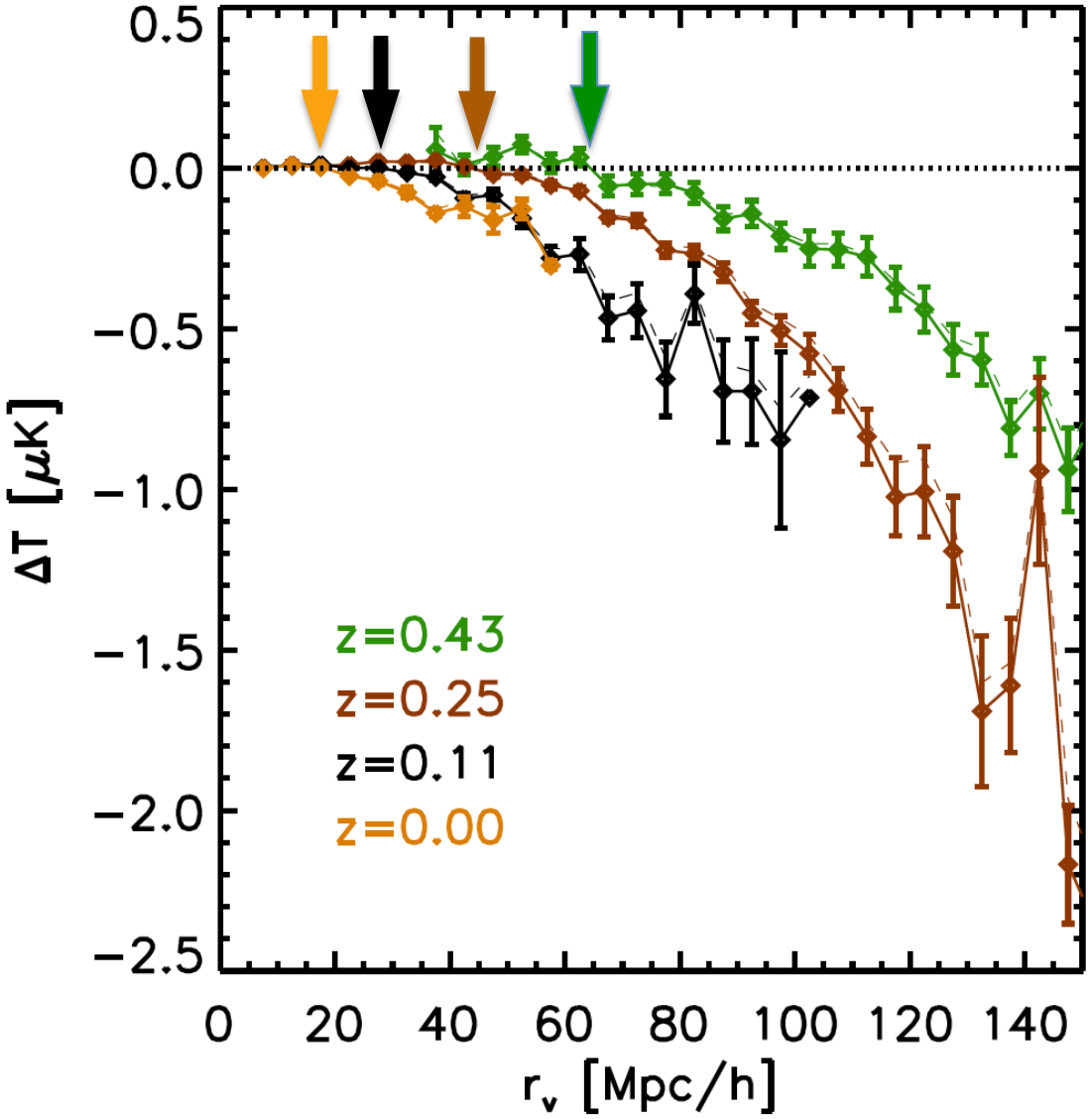
1. Void sizes close to the mean galaxy spacing
2. Void-in-cloud

What is the optimal filter size?

What's the optimal filter radius



Where to draw the cut



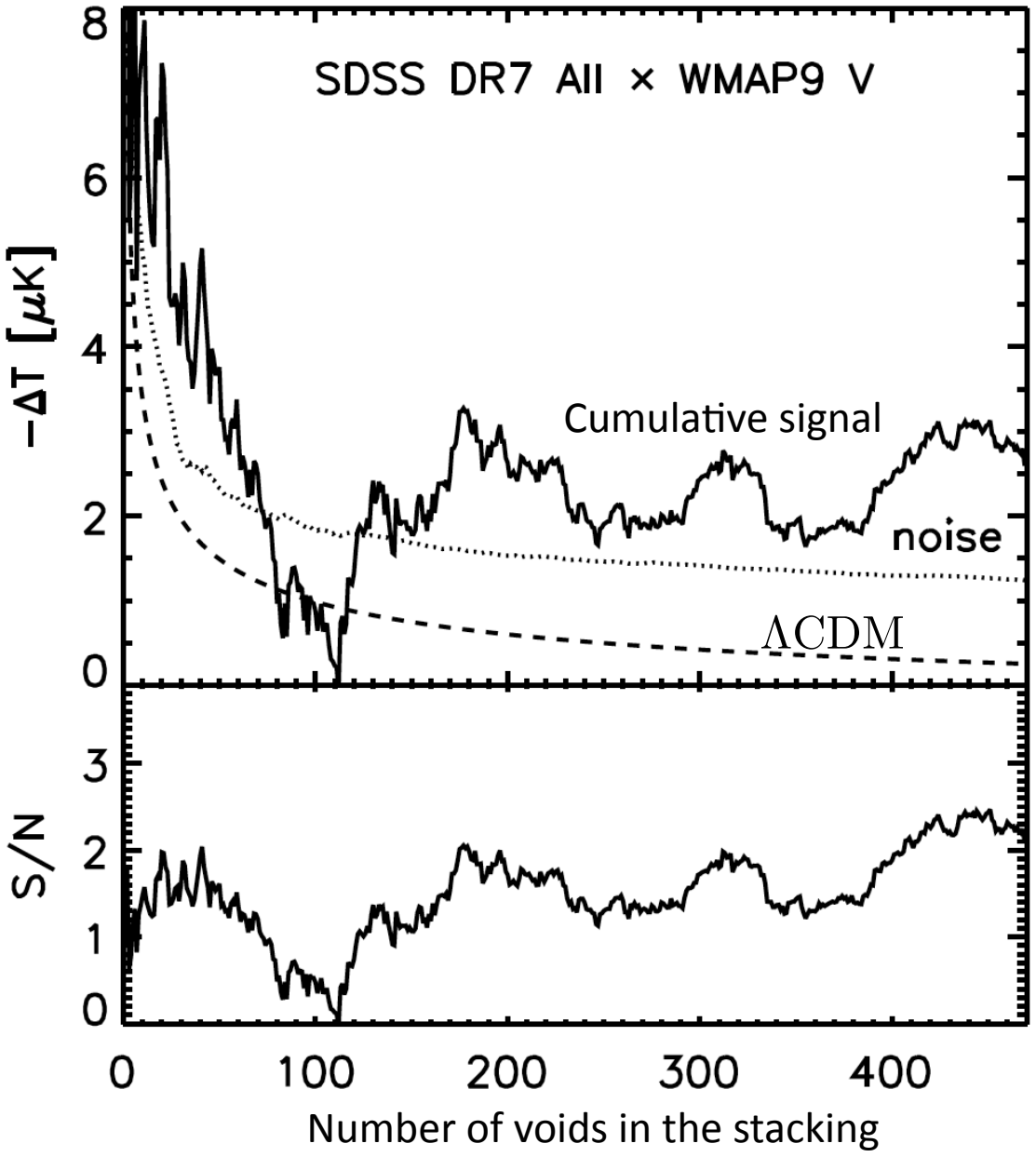
Simulations:

Omega_m =0.24
Omega_L = 0.76
n_s = 0.958
Sigma_8 = 0.77
h = 0.73

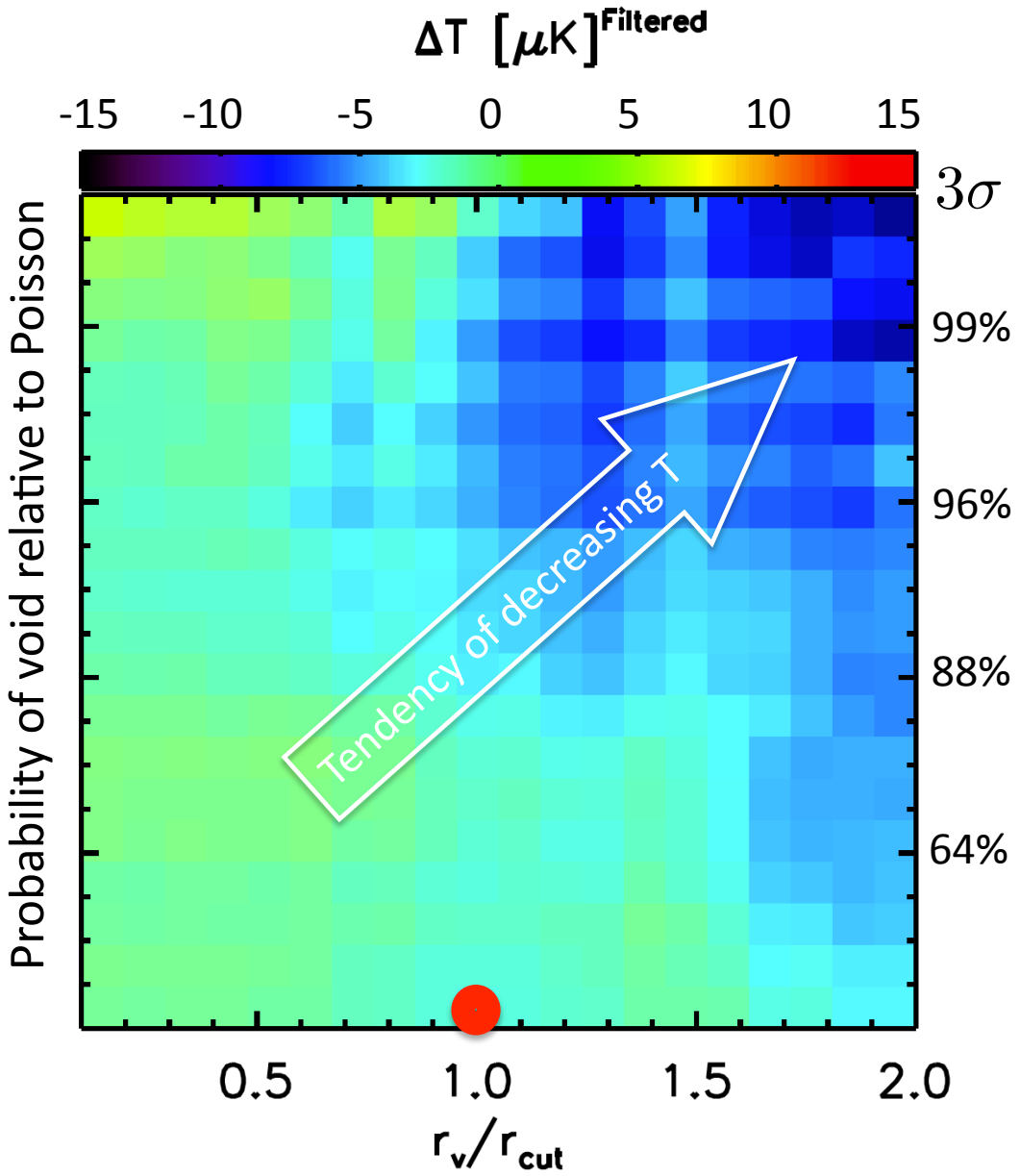
Different boxsizes and mass resolution to match the number density of galaxies in SDSS

For the 6 SDSS sub-samples

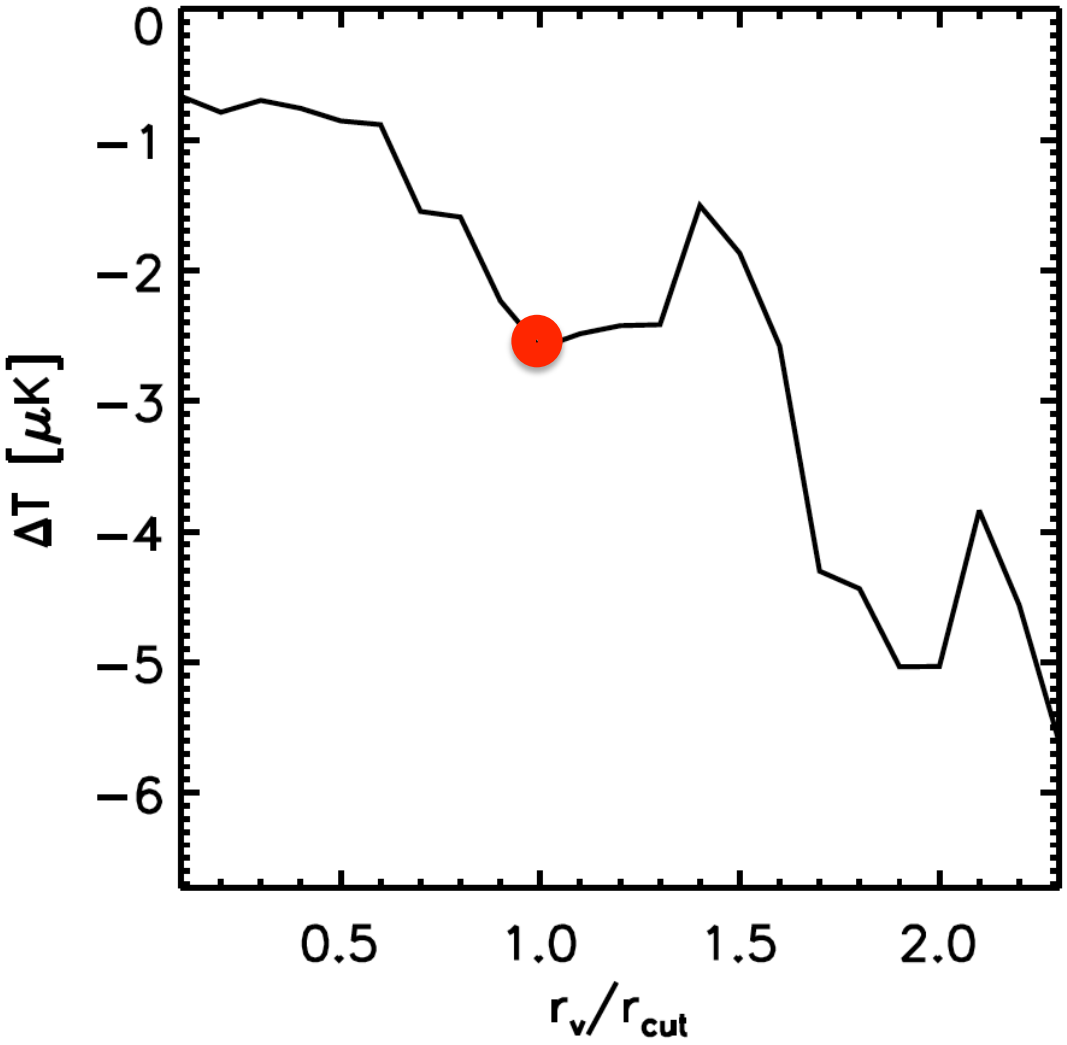
$r_{\rm cut} = [20, 25, 30, 35, 45, 65] {\rm Mpc}/h$


SDSS DR7 All × WMAP9 V
−ΔT [μK]
Cumulative signal
noise
ΛCDM
S/N
Number of voids in the stacking

2.2σ

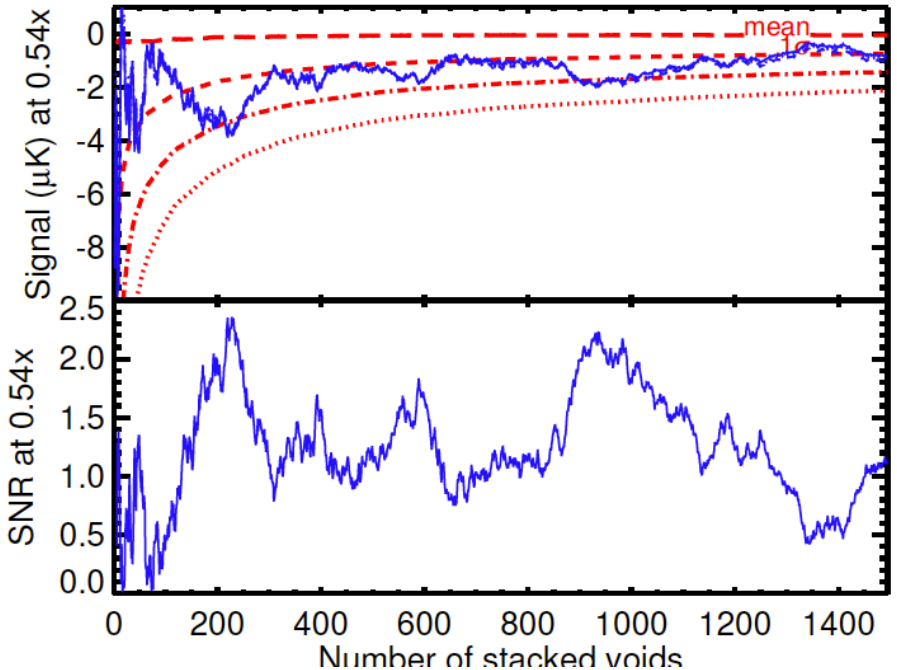

ΔT [μK]Filtered
-15
-10
-5
0
5
10
15
3σ
99%
96%
88%
64%
Probability of void relative to Poisson
Tendency of decreasing T
0.5
1.0
1.5
2.0
rv/rcut

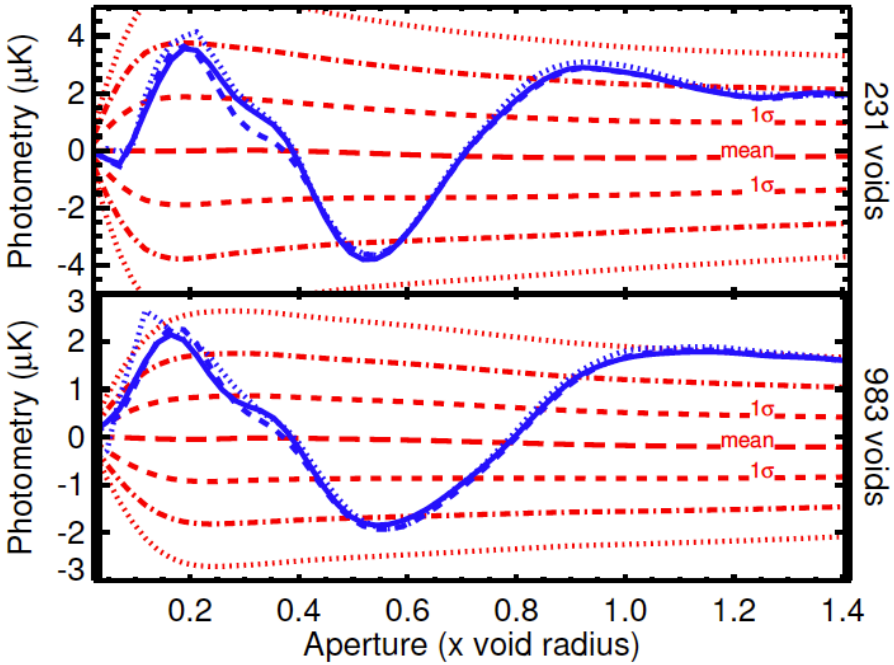
Weighted by void probability

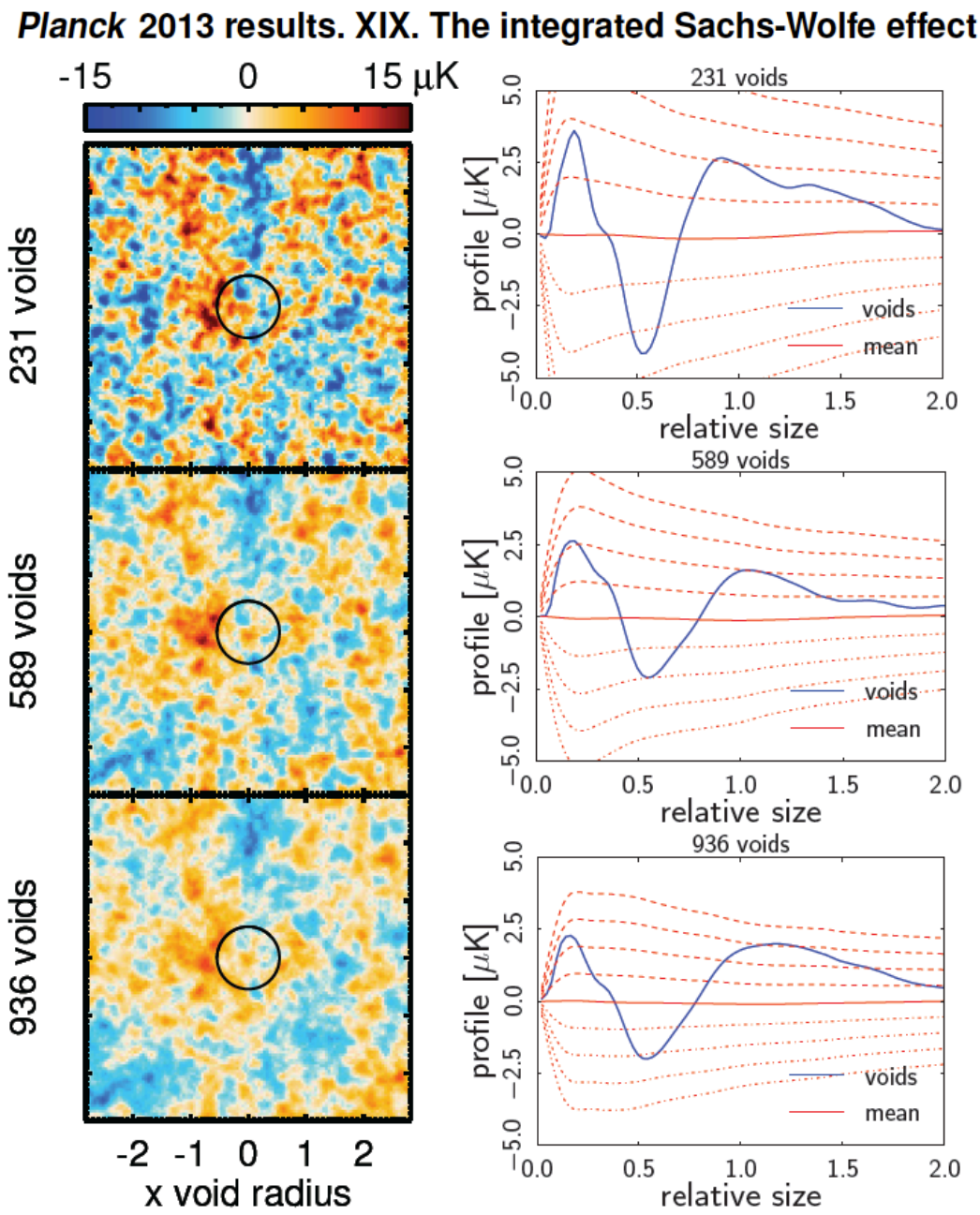


On the detection of the integrated Sachs-Wolfe effect with stacked voids

Stéphane Ilić, Mathieu Langer, Marian Douspis 2013







Ade et al. 2013

Summary

- 4-sigma detection of ISW from stacking of super-voids/ clusters from SDSS-DR6-LRG catalog
- Simulated super-voids/clusters gives similar cold/hot spot as in observation, but the amplitude seems lower
- Hint for ~2 sigma ISW signal in the SDSS-DR7 catalog, not as significant as in SDSS-DR6-LRG catalog
- Puzzle remains, more volume is needed