New results in the geometry of random fields, with applications to CMB and galaxy density

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TOPOLOGICAL ANALYSIS OF THE CfA REDSHIFT SURVEY[1]

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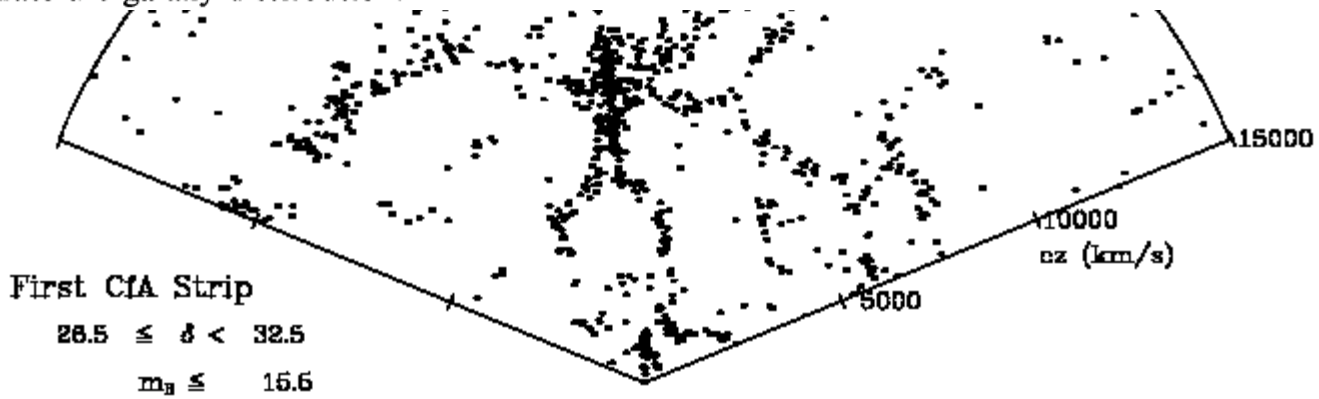
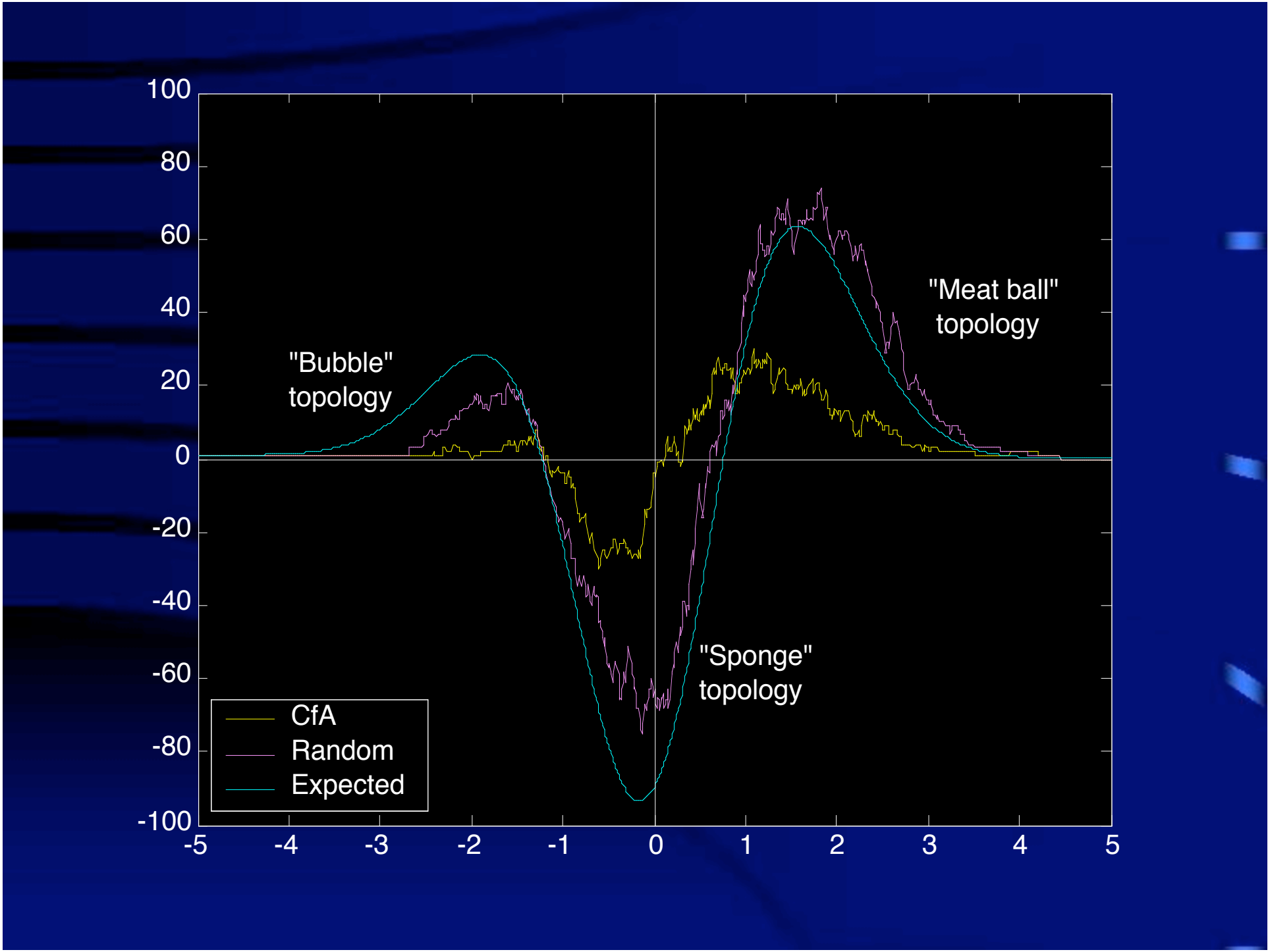
ABSTRACT

We study the topology of large-scale structure in the Center for Astrophysics Redshift Survey, which now includes $\sim$12,000 galaxies with limiting magnitude $m_B \leq 15.5$. The dense sampling and large volume of this survey allow us to compute the topology on smoothing scales from 6 to 20 h^{-1} Mpc; we thus examine the topology of structure in both the "nonlinear" and "linear" regimes. On smoothing scales $\leq 10\ h^{-1}$ Mpc this sample has 3 times the number of resolution elements of samples examined in previous studies. Isodensity surfaces of the smoothed galaxy density field demonstrate that coherent high-density structures and large voids dominate the galaxy distribution.

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-60
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-5
-4
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-2
-1
0
1
2
3
4
5
"Bubble"
topology
"Meat ball"
topology
"Sponge"
topology
CfA
Random
Expected

nature
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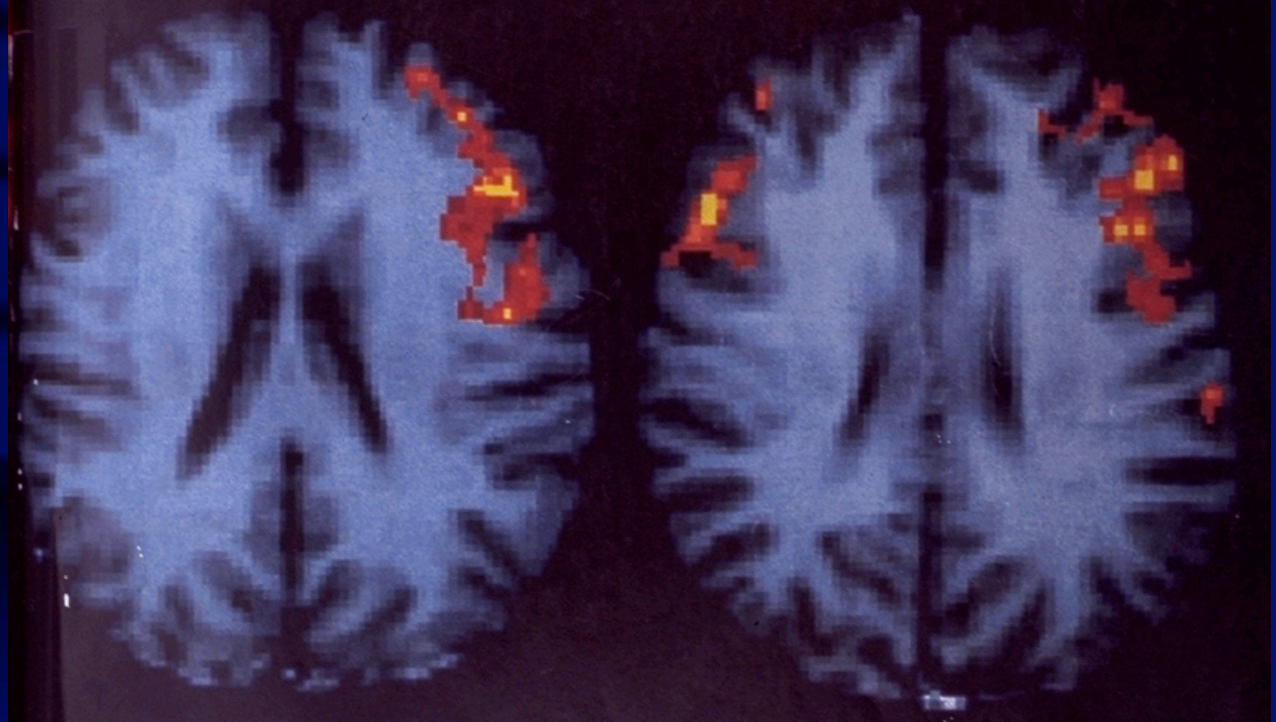
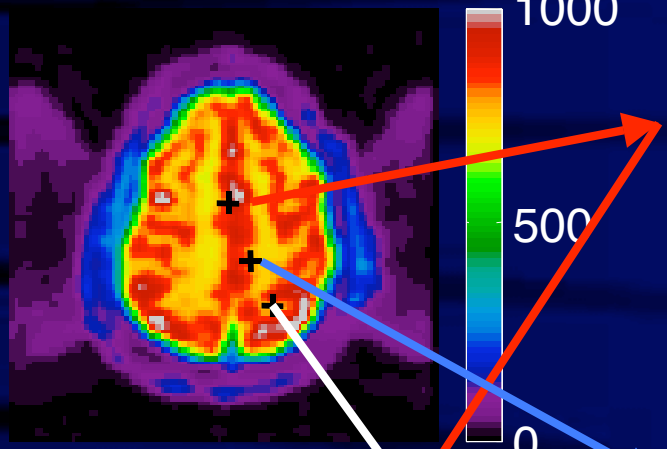


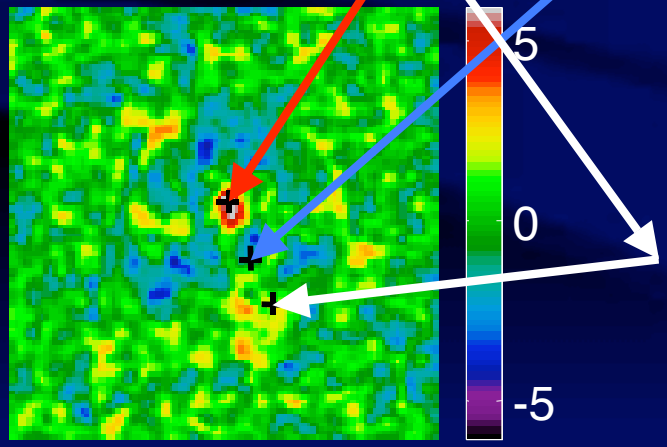
Gender and language

fMRI data: 120 scans, 3 scans each of hot, rest, warm, rest, hot, rest, …

First scan of fMRI data

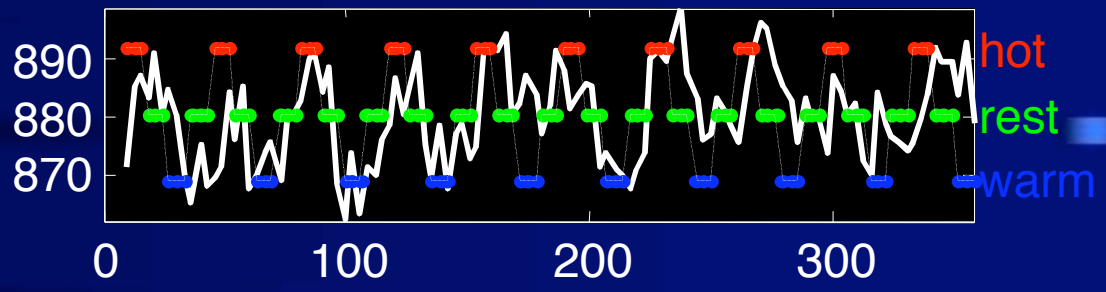


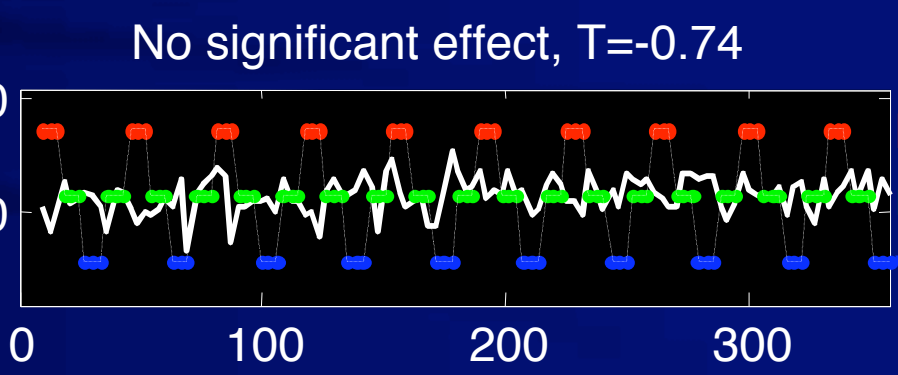
T statistic for hot - warm effect



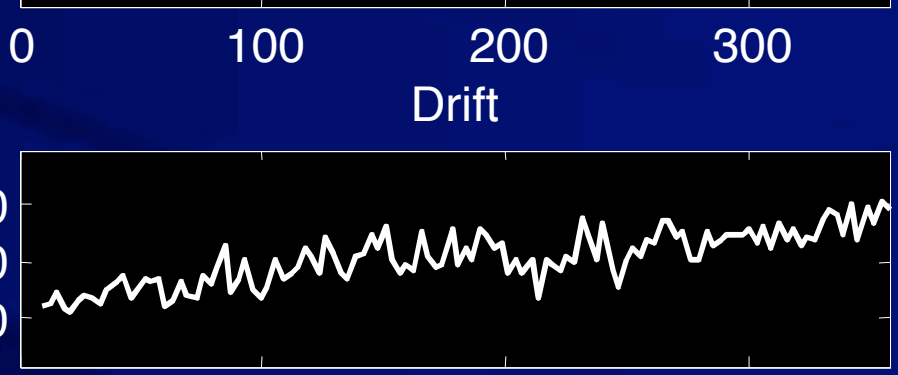
T = (hot – warm effect) / S.d.
~ t_{110} if no effect

Highly significant effect, T=6.59





No significant effect, T=-0.74

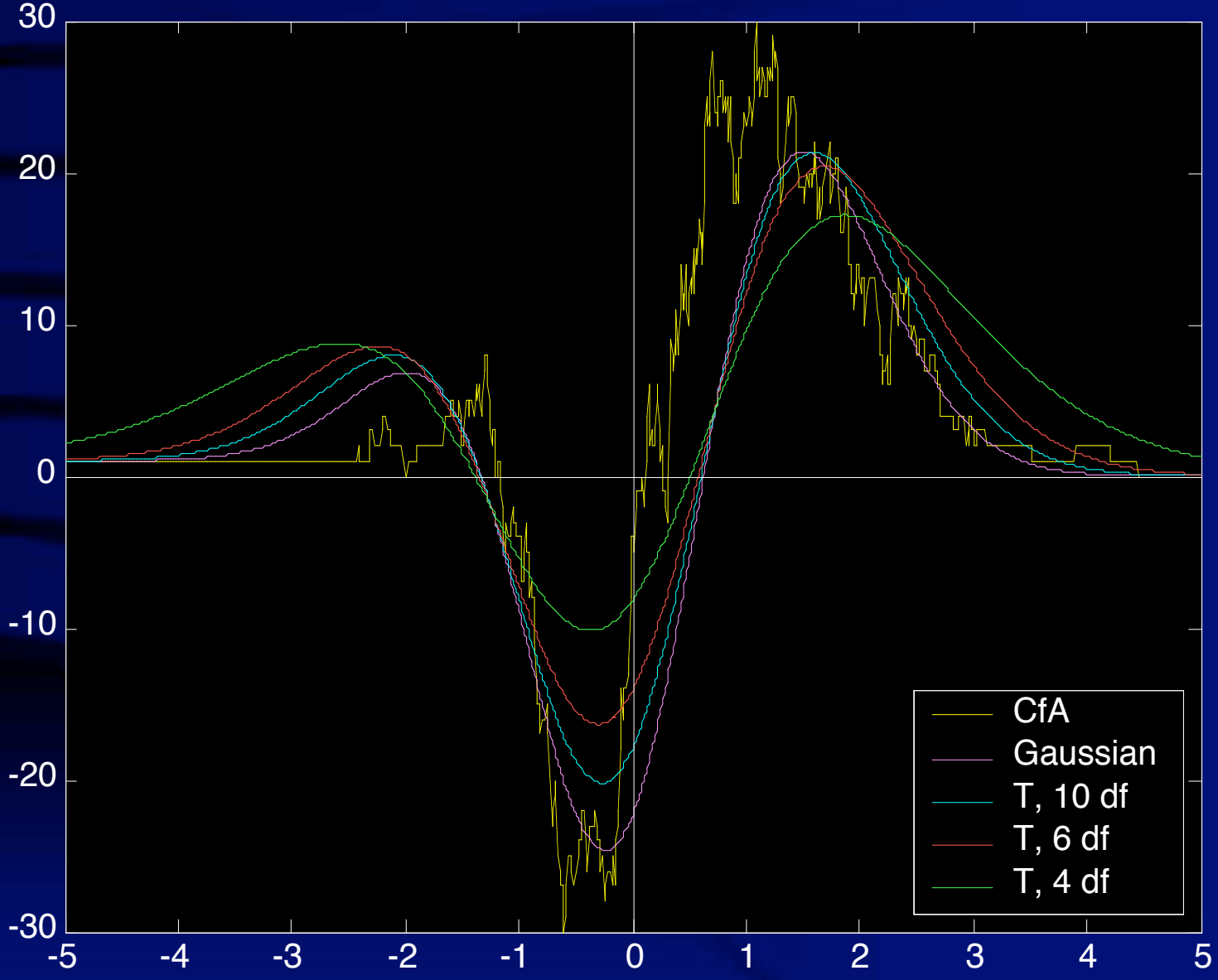


Drift

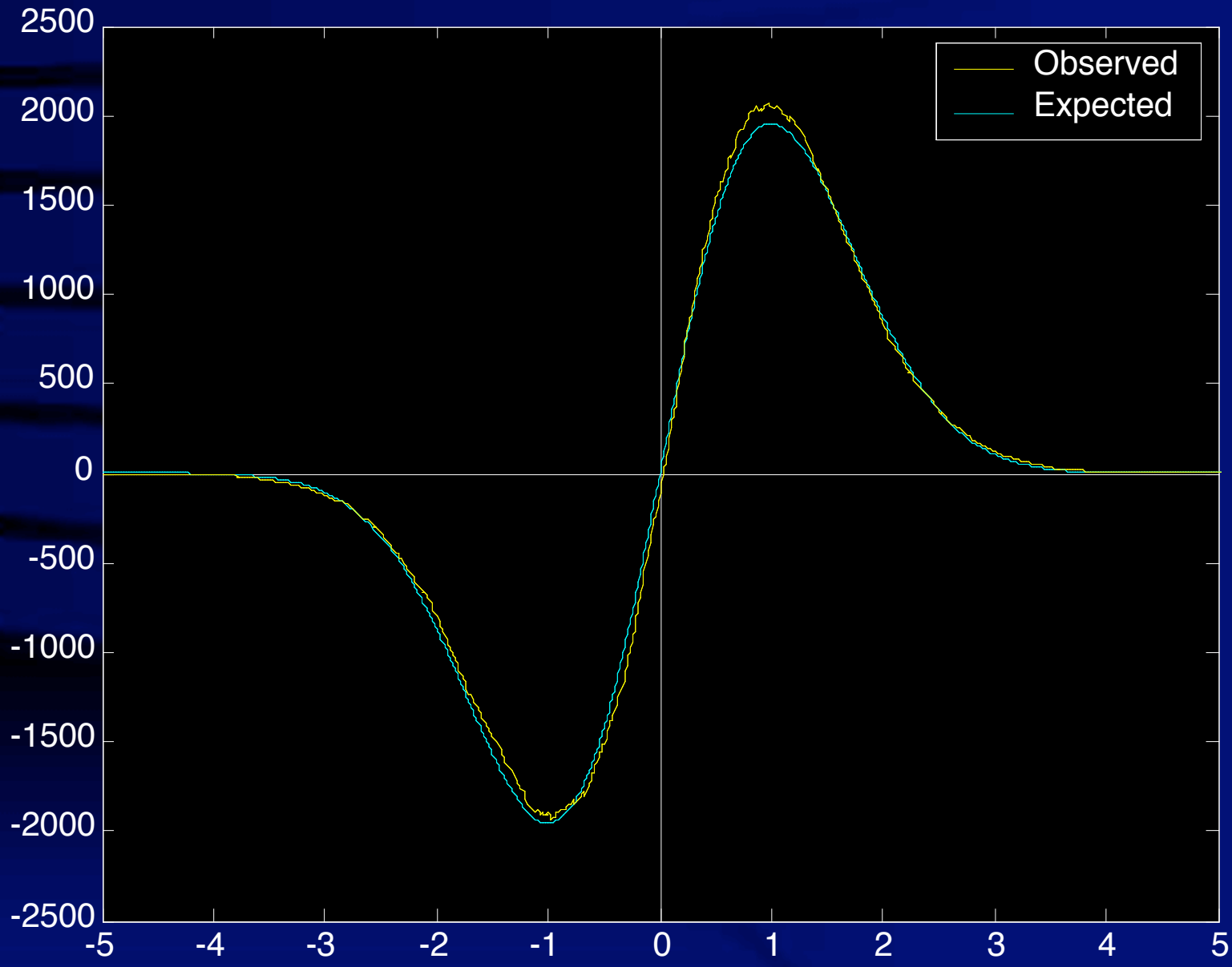
Time, seconds

Gaussianized χ^2 field?

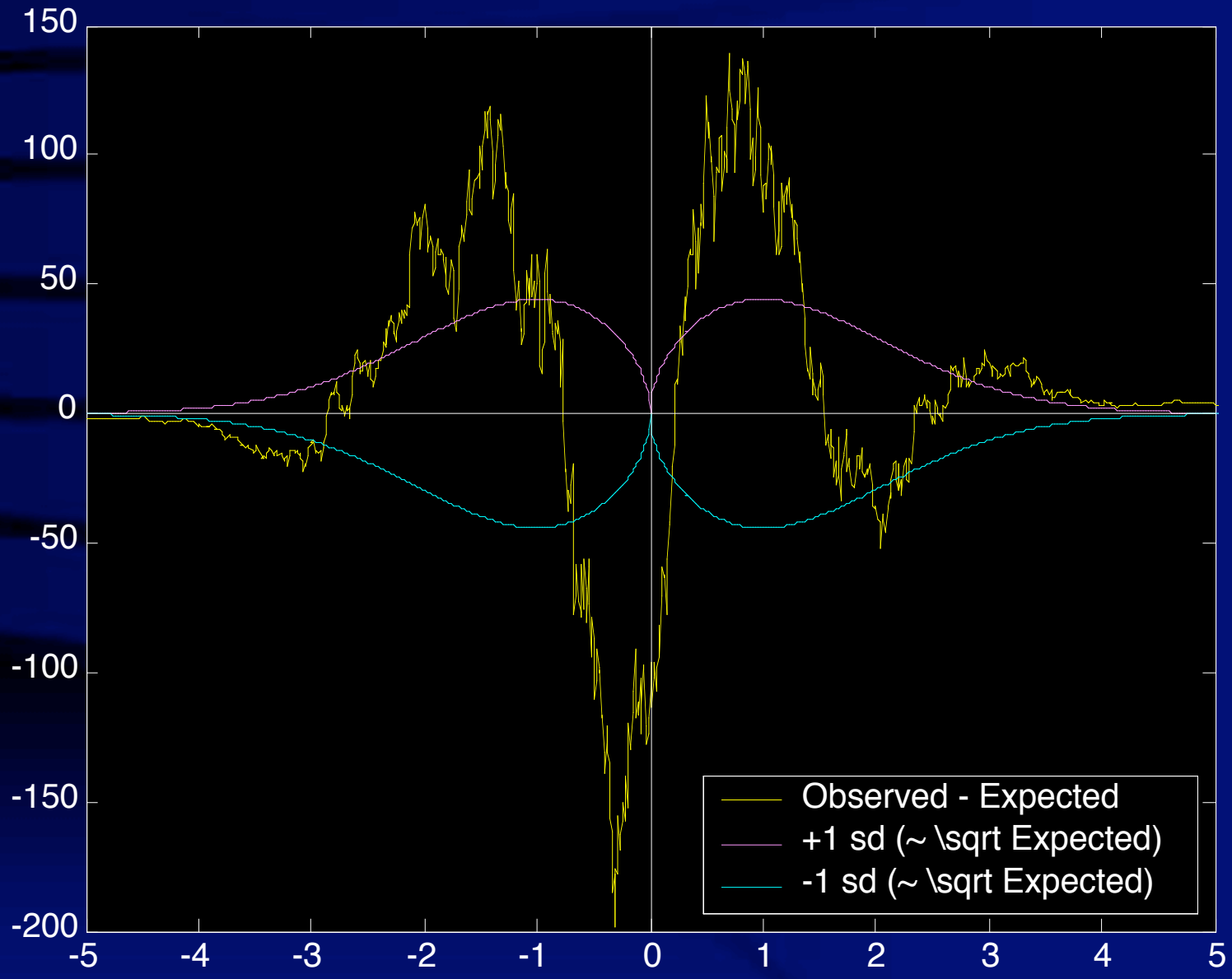
Gaussianized T field?



EC for WMAP, unsmoothed, FWHM = 1.6°

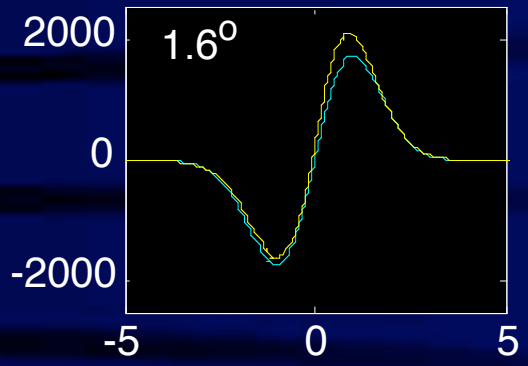


Observed – Expected EC, with Poisson sd in tails



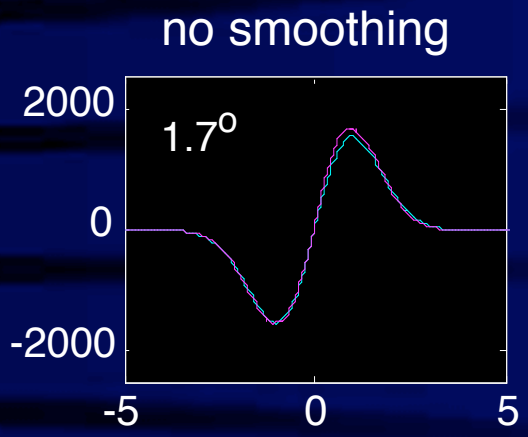
EC for WMAP smoothed to FWHM^{o} (expected)

no smoothing



scale space

Simulation (expected)



scale space

Scale space WMAP data