Title: Cosmology 3

Date: Jun 09, 2006 10:31 AM

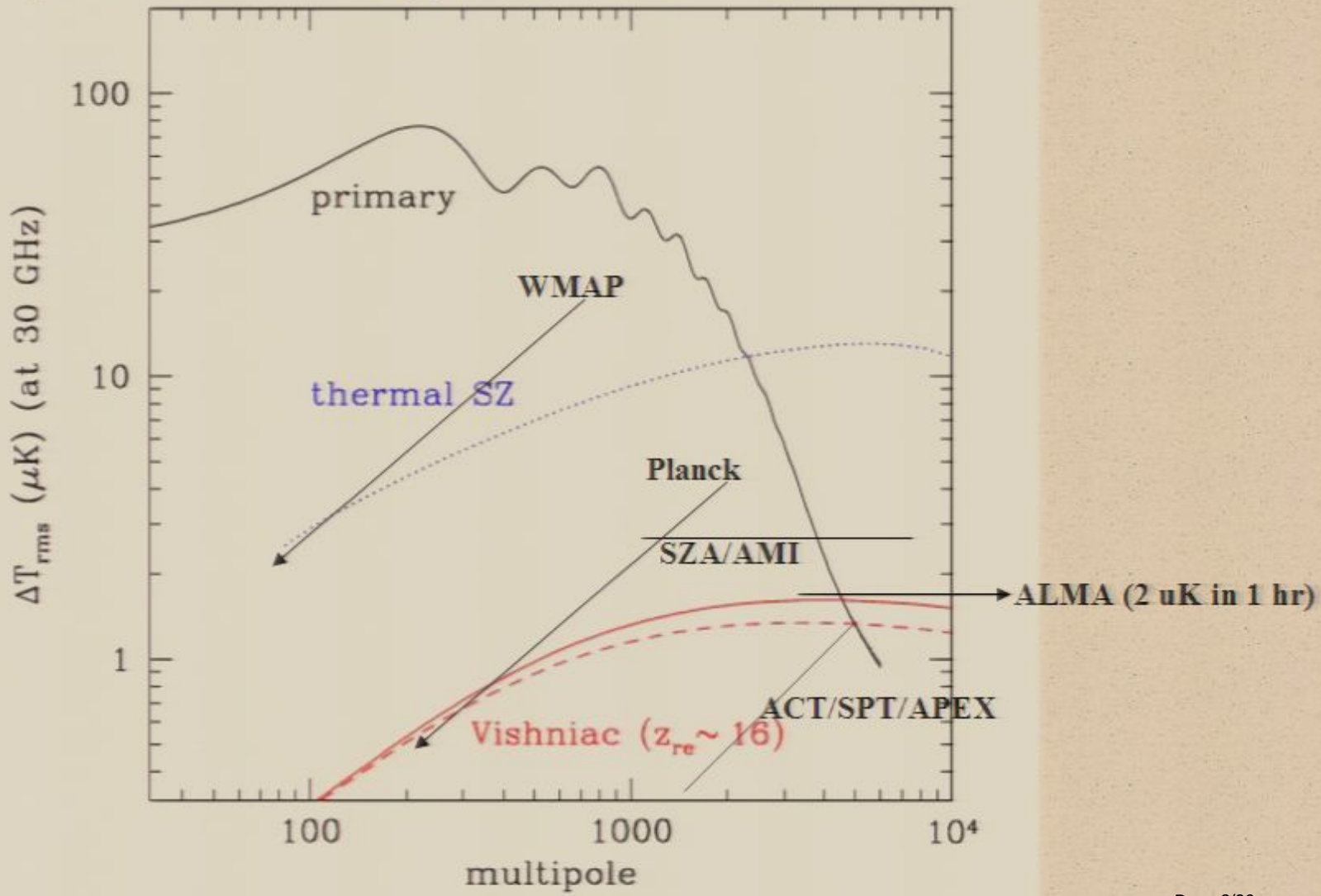
URL: http://pirsa.org/06060021

Abstract:

Outline/Summary

- Fine scale CMB measurement is a major new frontier
- Current evidence for a hint of more power than expected
- Excess power is difficult to explain with Sunyaev-Zeldovich effect

Measuring the CMB With Upcoming Instruments



Holder 2004

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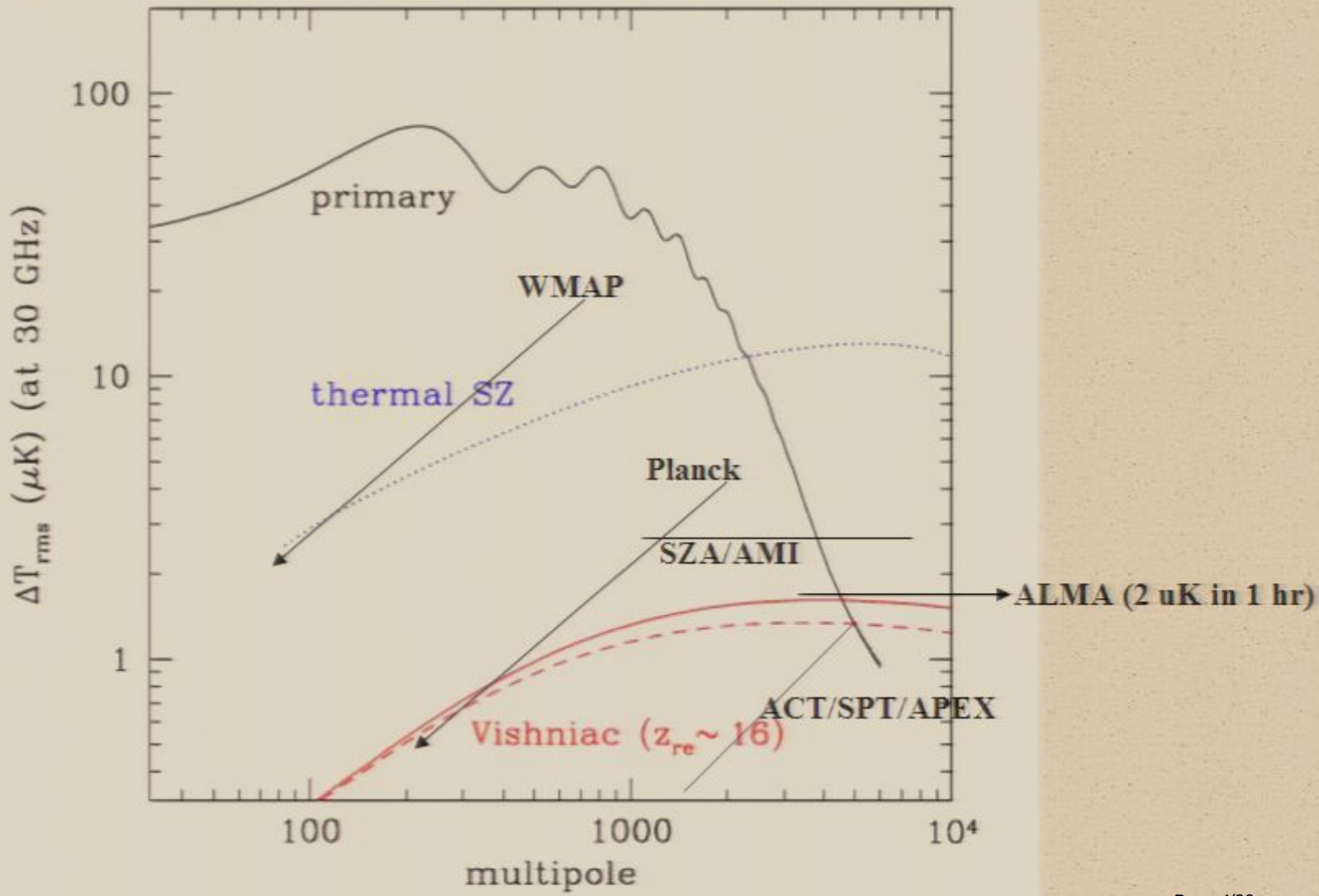
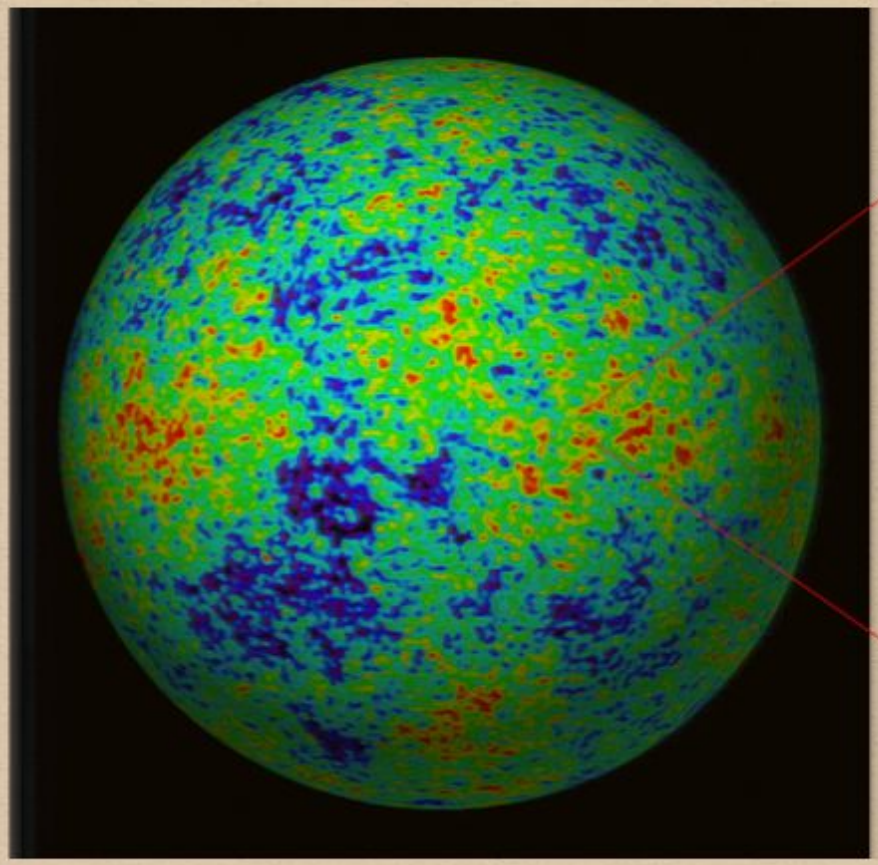


Holder 2004

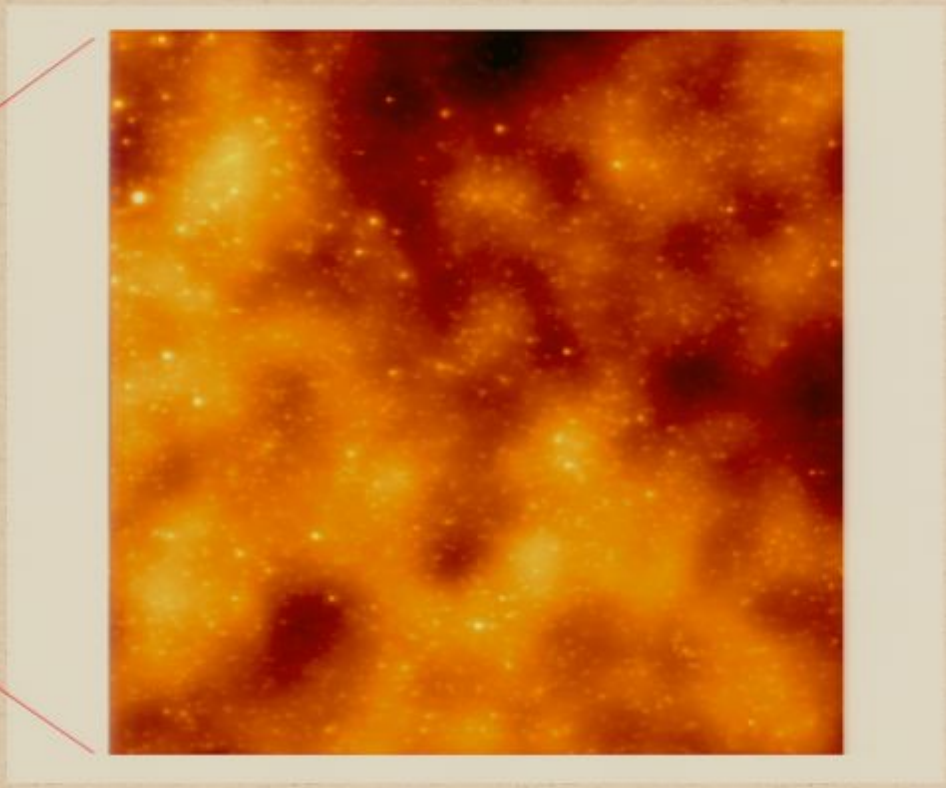
CMB Science Directions

- Reionization and the first stars
  - cosmic weather
- Tensor modes from GW from inflation
- Power spectrum
- Growth of structure
  - Dark energy
  - Neutrino mass
  - GR on largest scales

The CMB at High Resolution?

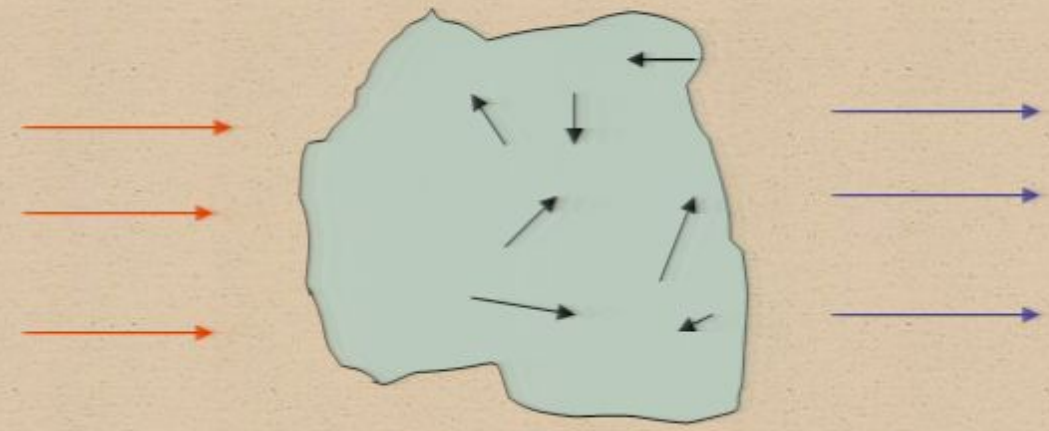


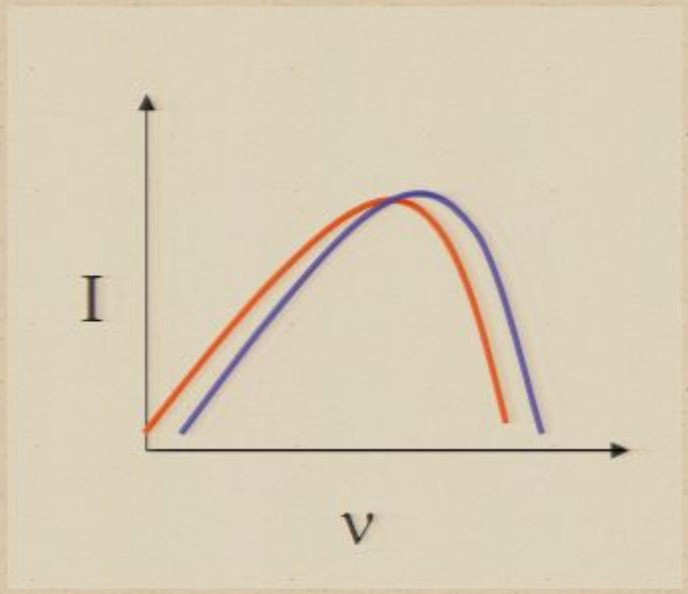
WMAP image (1 degree resolution) Bennett et al 2003



Simulated high resolution CMB map (2 degrees by 2 degrees)

Thermal Sunyaev-Zel'dovich Effect





Optical depth: $\tau \sim 0.01$

Fractional energy gain per scatter: $\frac{kT}{m_e c^2} \sim 0.01$

Typical cluster signal: ~500 uK

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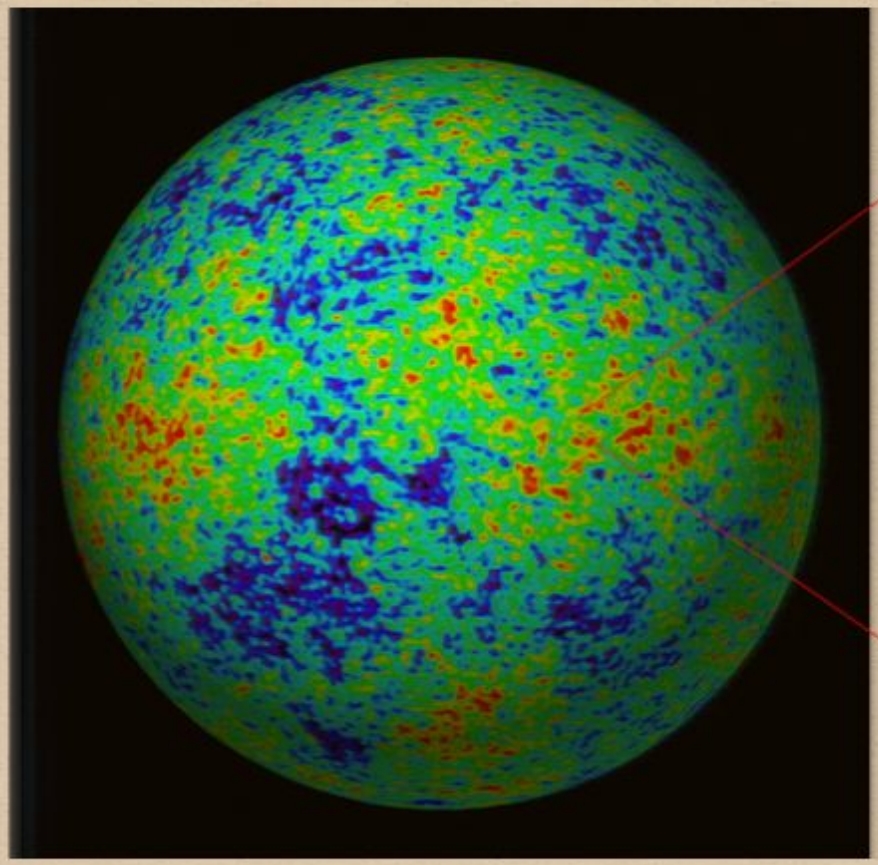

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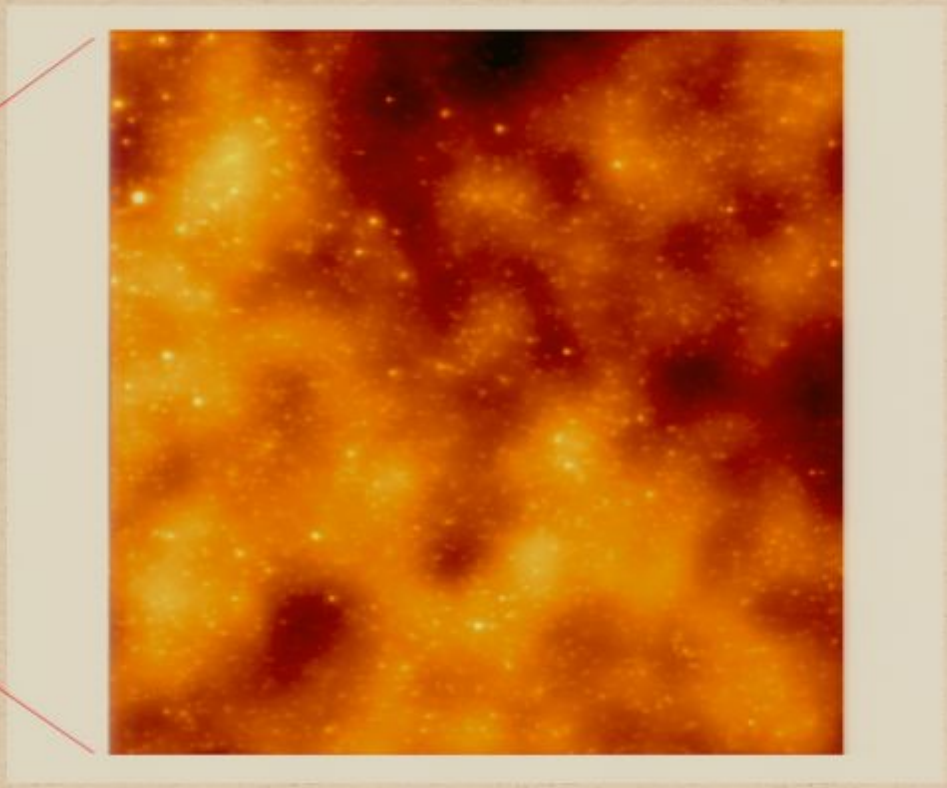

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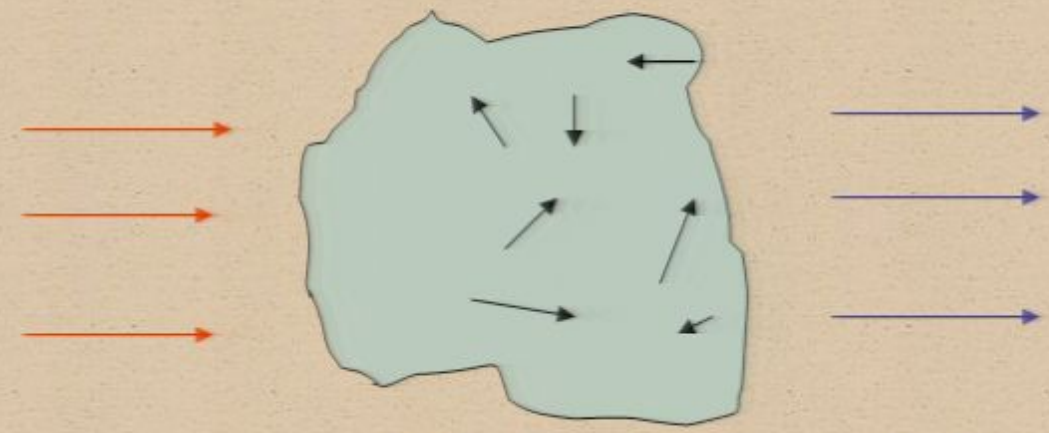

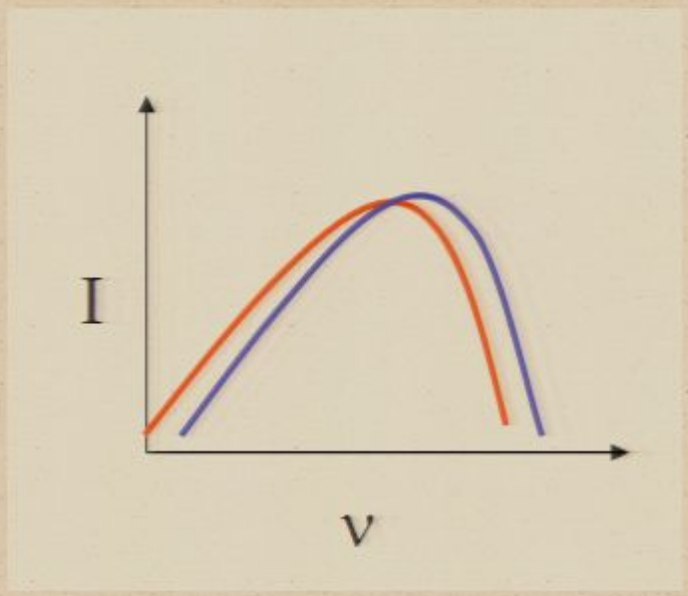

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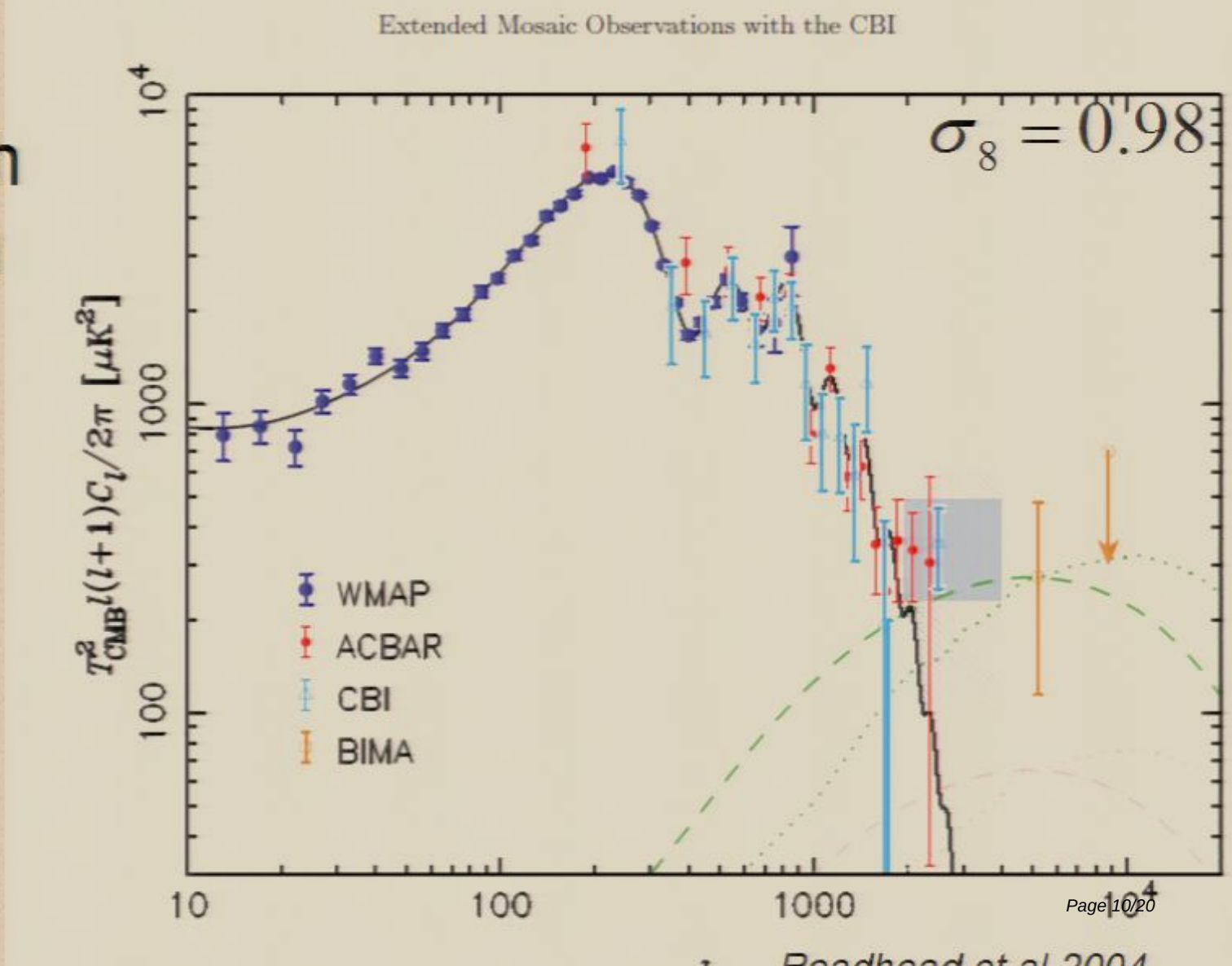
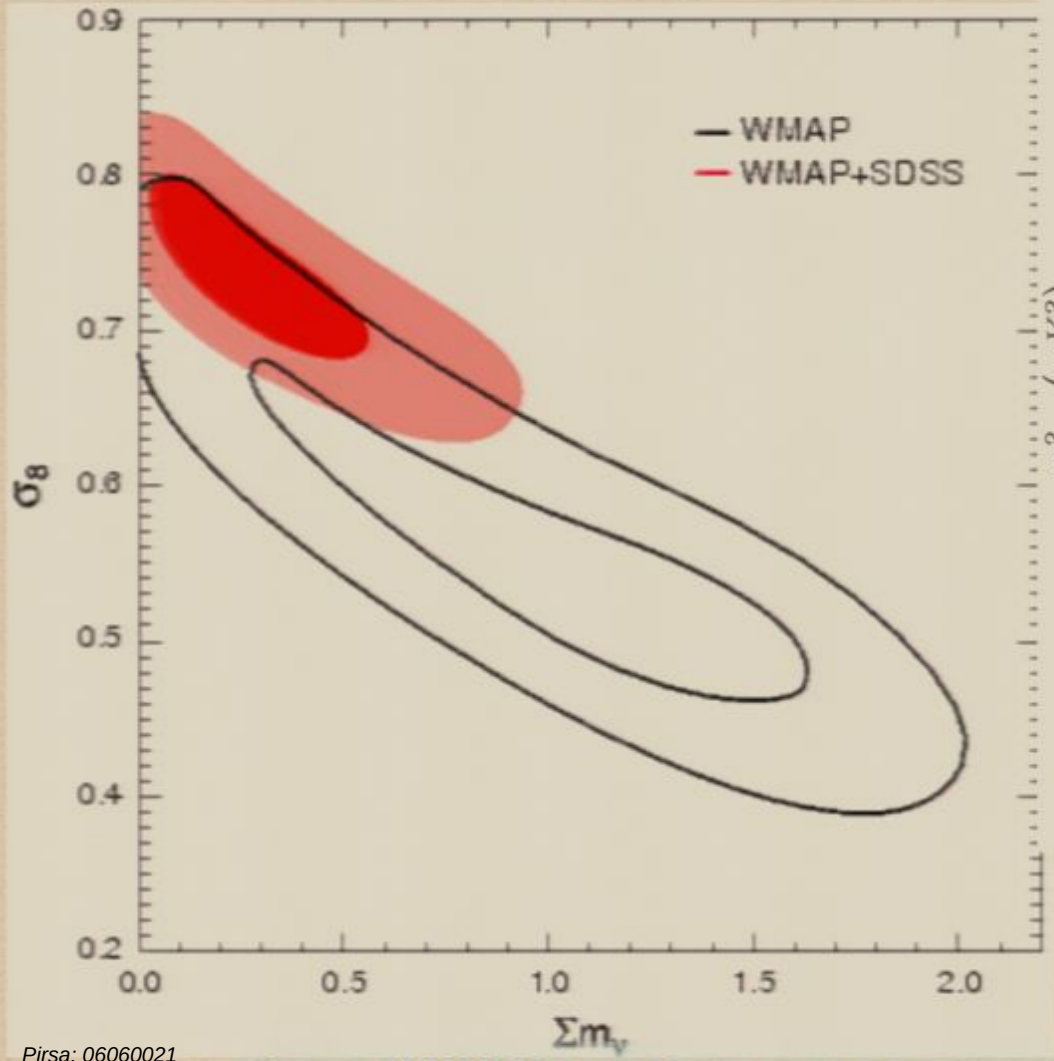
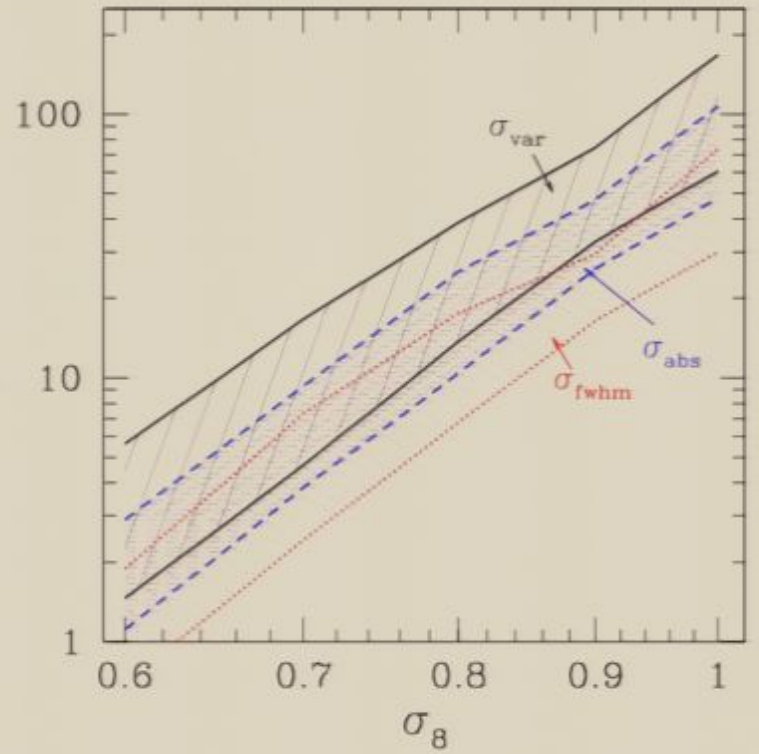
Small Scale Anomaly?

- Too much power on small scales?



SZ Amplitude Sensitivity





Power scales roughly as $\sigma_8^{\ 7}$!!!

from WMAP science team

Cosmic Disconcordance?

- High amplitude from SZ vs lower amplitude from primary CMB
- One possible escape: SZ power is strongly non-Gaussian

Angular power spectrum due to Poisson distribution

$$C_{l-sz} = \int dz \frac{dV}{dz} \int dM \frac{dn}{dM} \tilde{y}^2(l, M, z)$$

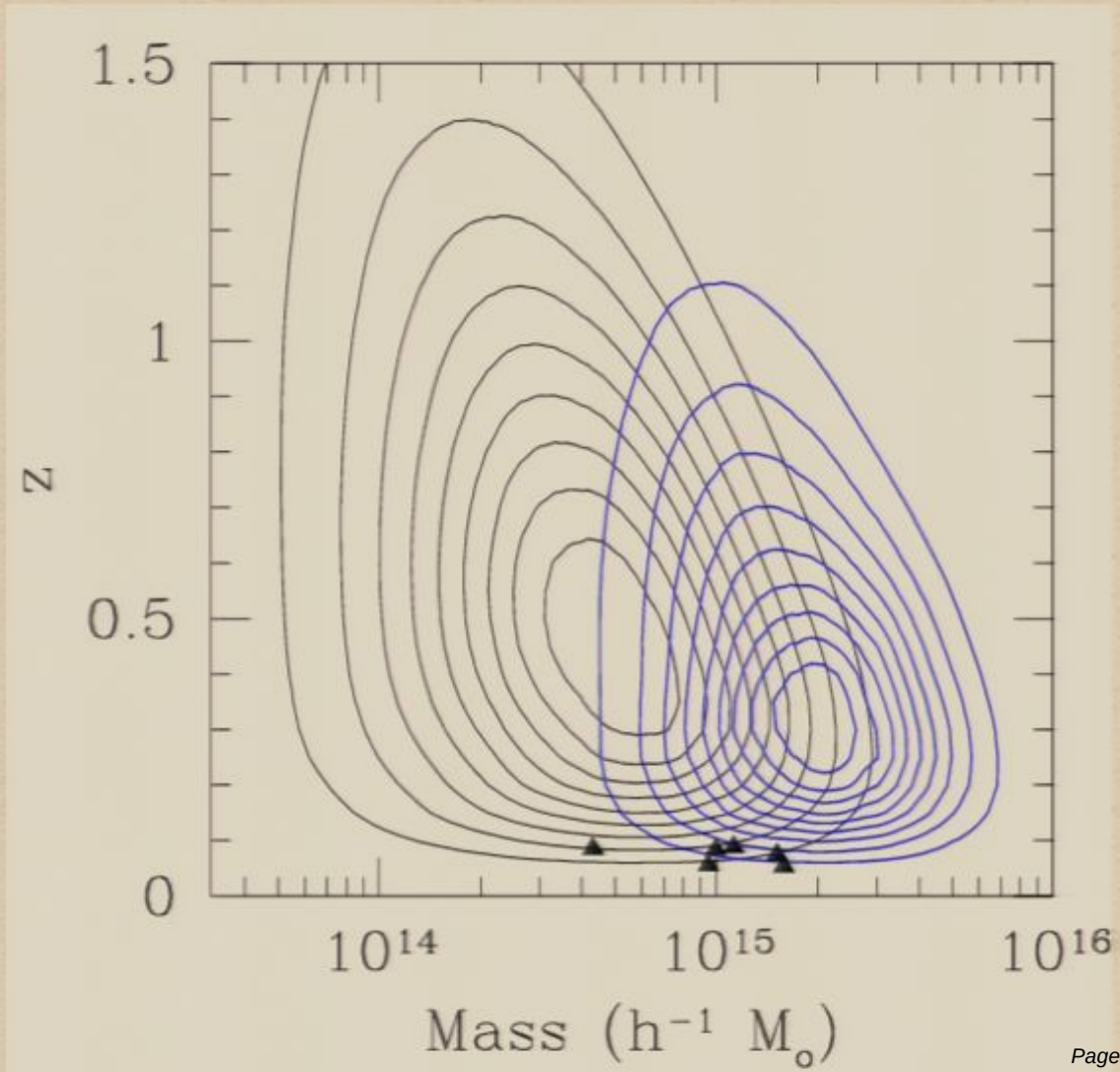
Trispectrum due to Poisson distribution - largest contribution to non-Gaussian variance

$$T_{l-sz} = \int dz \frac{dV}{dz} \int dM \frac{dn}{dM} \tilde{y}^4(l, M, z)$$

Cooray (2001); Komatsu & Seljak (2002)

Power and non-Gaussianity

- Non-Gaussianity strongly skewed toward very high masses
- Simulations need large volumes to capture variance
- Selection effects much more important



dX/(dz dlnM); contours show 10,20…,90% of peak at l=2500

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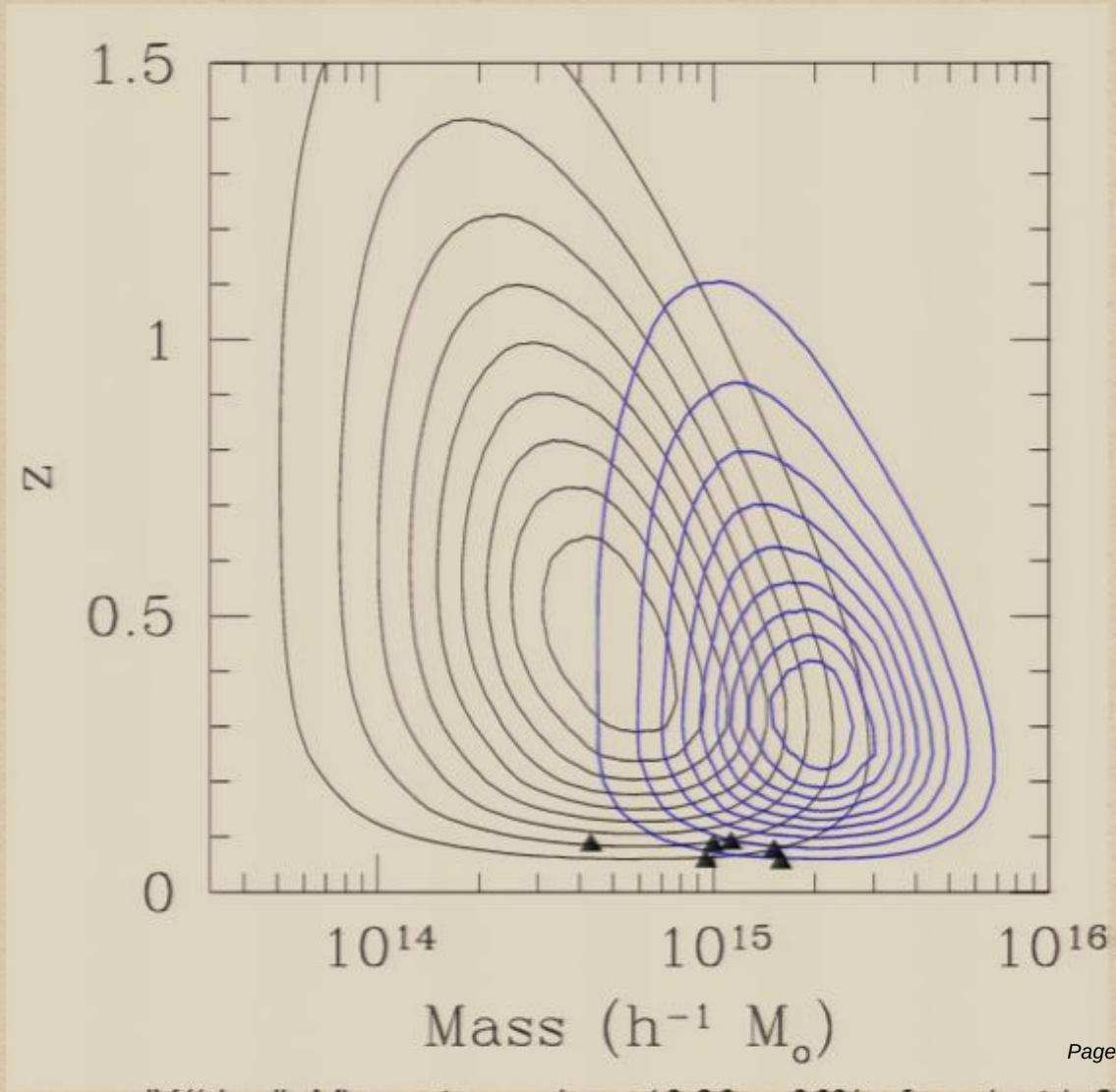

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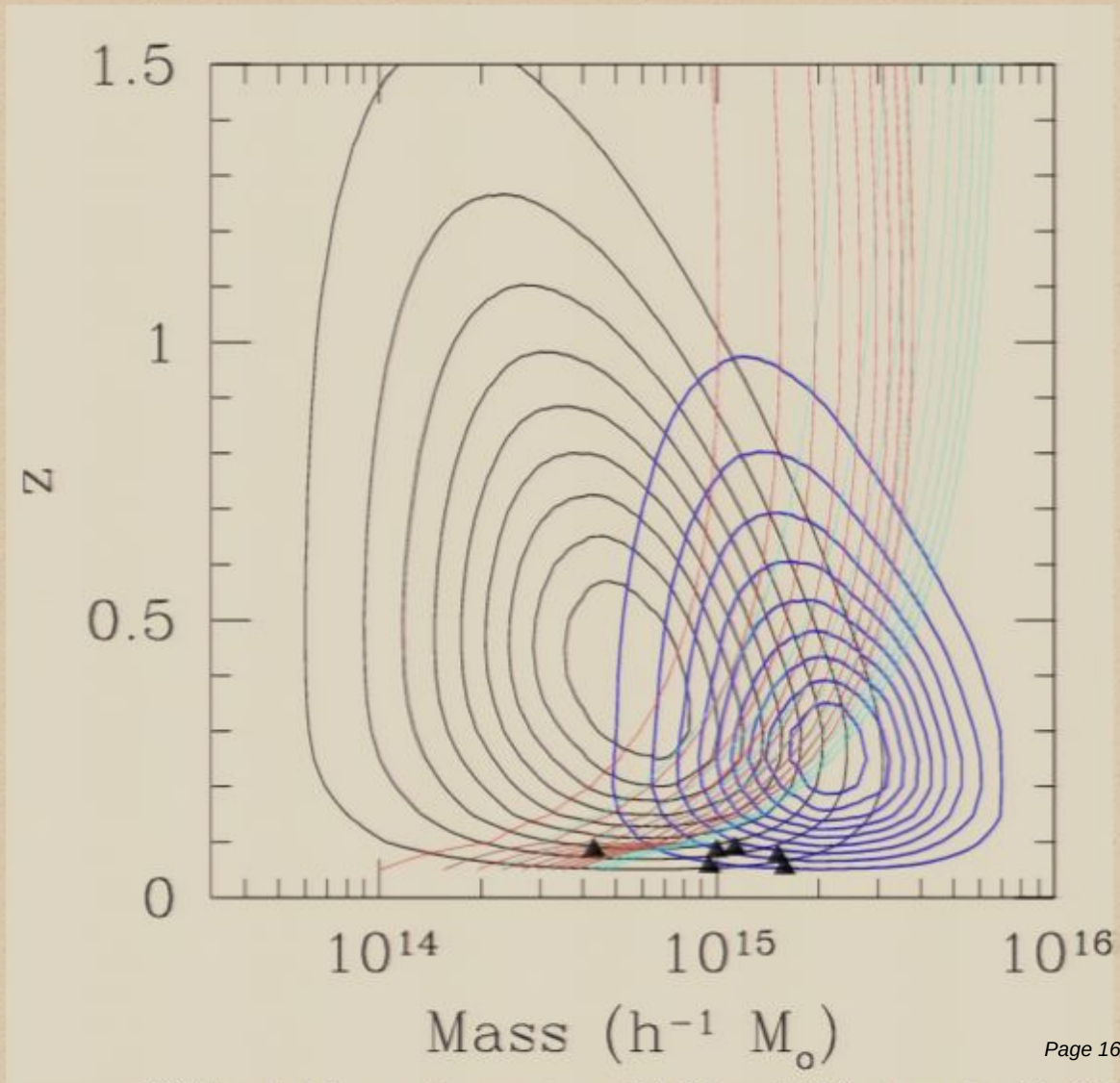

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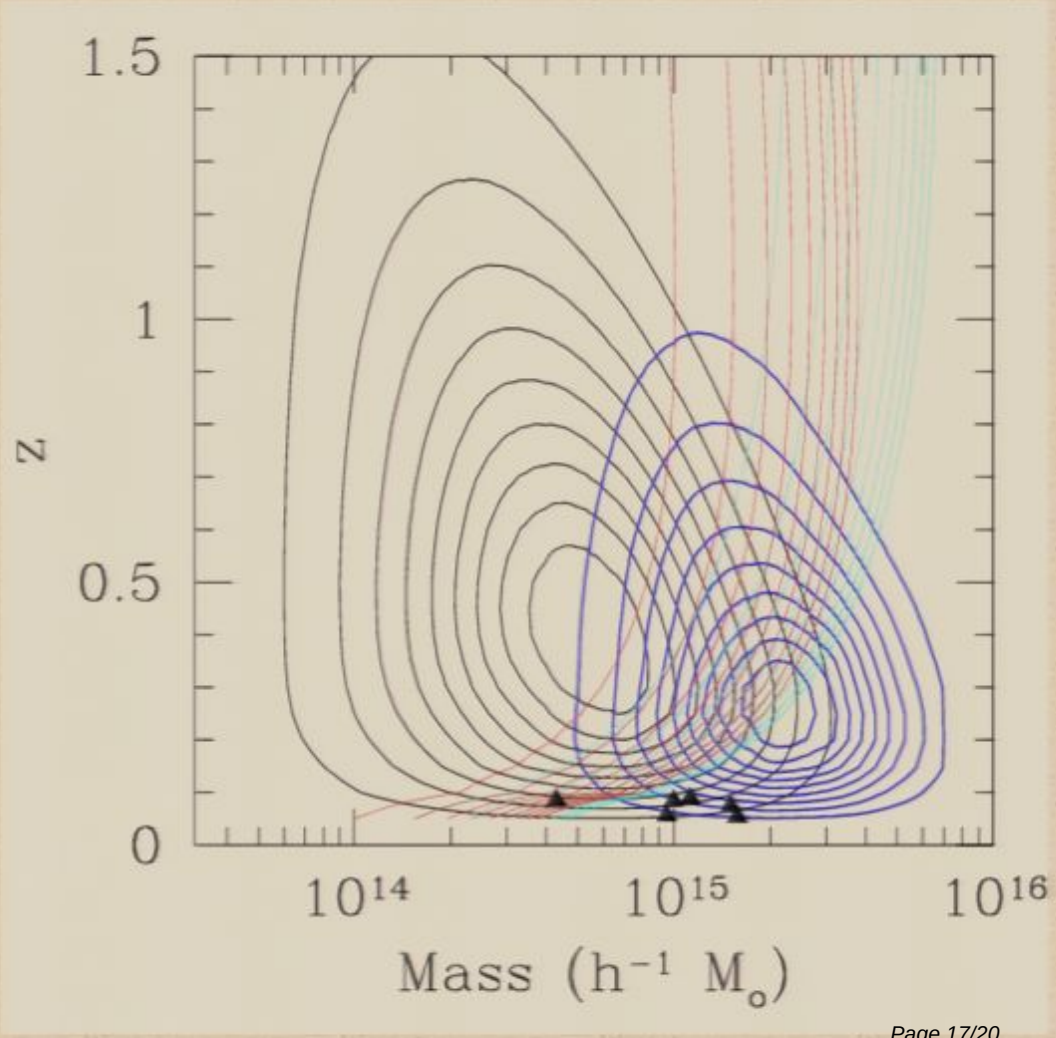
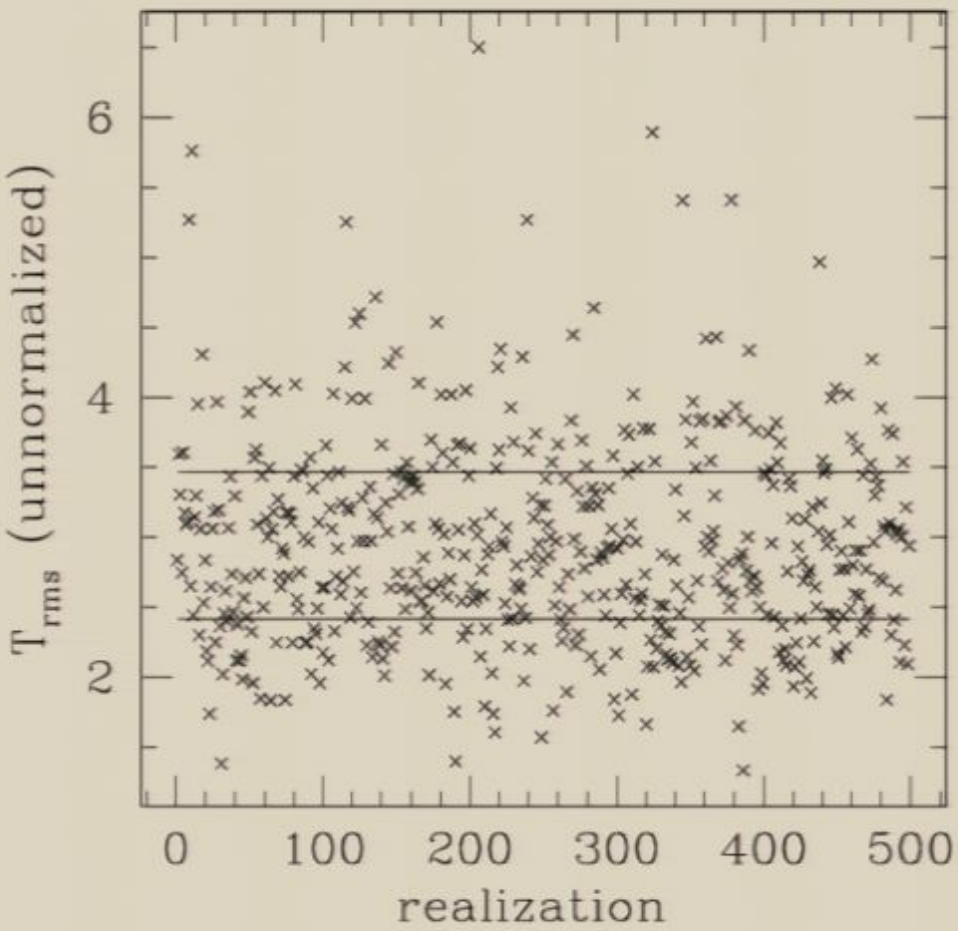
Implications

- If there is no massive cluster in your map, it probably isn't very non-Gaussian
- Non-Gaussianity will be driven by most massive cluster you can't detect



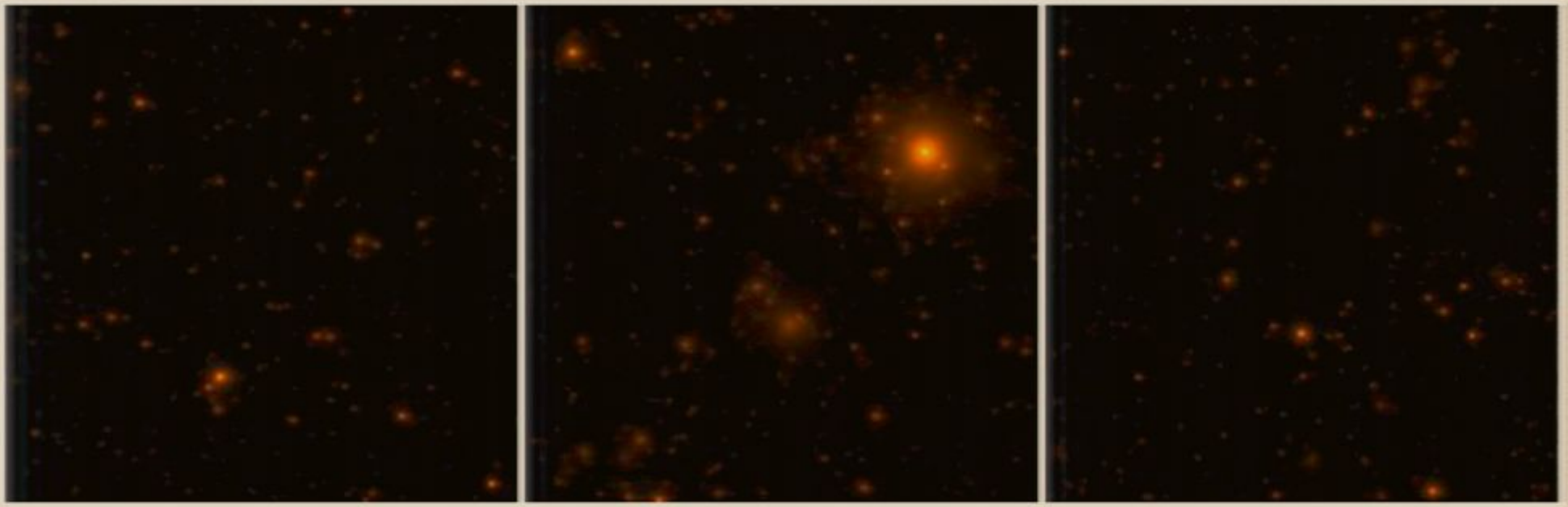
Results from simulated maps

- 500 realizations of CBI observing scheme (no noise, circular cluster profiles, using N-body initial conditions)
- Horizontal lines show Gaussian expectation
- Clearly possible to get huge excursions



Assumed σ_8=0.8

A non-Gaussian map



- 2 random maps and the biggest outlier in the previous distribution
- Each map roughly 1 deg on a side

Conclusions

- Curious goings-on at the small scale frontier
- Not easily explained by SZ effect (non-Gaussian explanation suggests observable object in the data)
- If not just noise fluctuations (currently about 2 sigma) then what?
- New data coming soon from new experiments…