

The mm-wave Emission of Galaxy Clusters and Implications for SZE Surveys

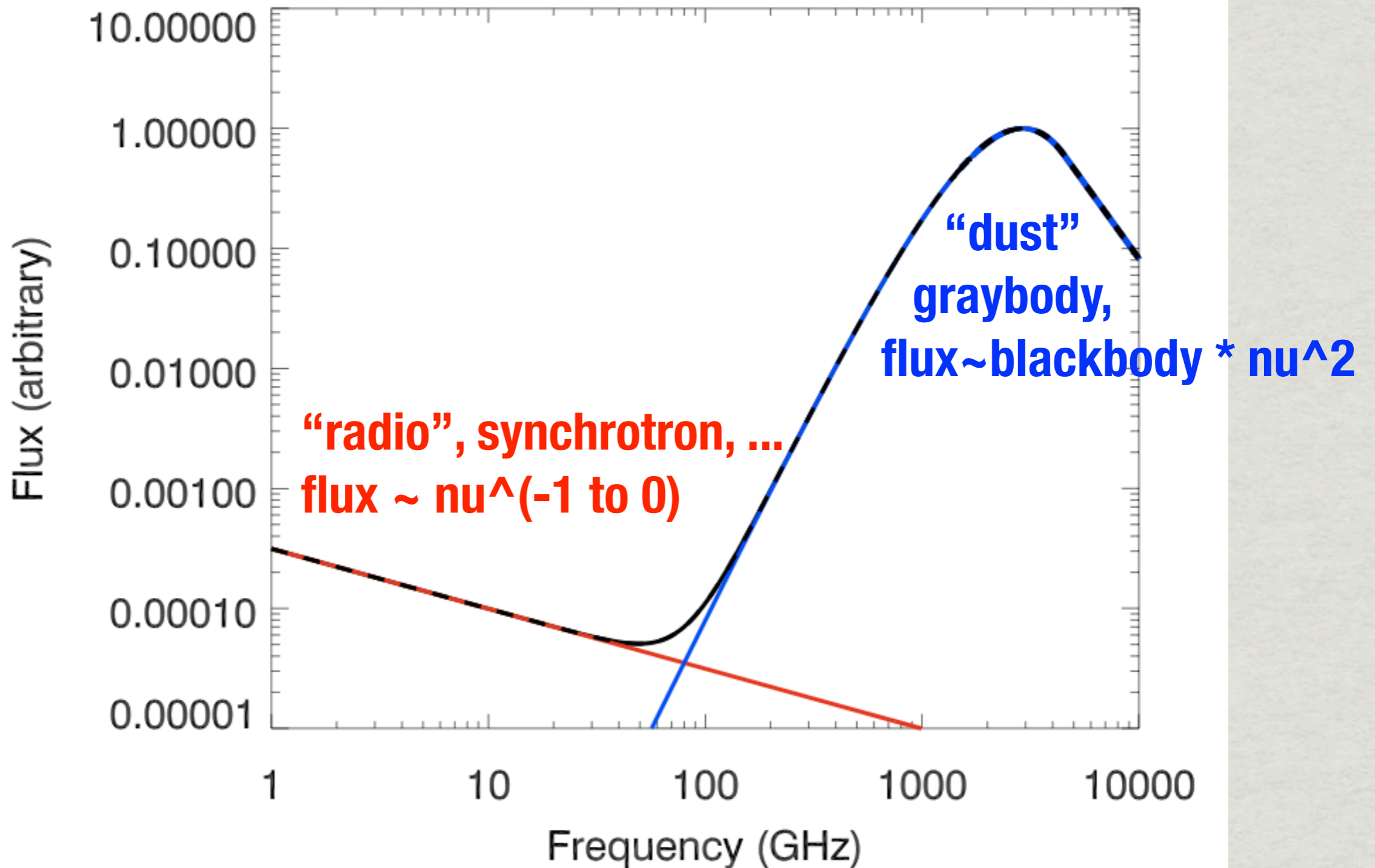
**Ryan Keisler, University of Chicago
Great Lakes 2010**

Galaxy clusters host...galaxies

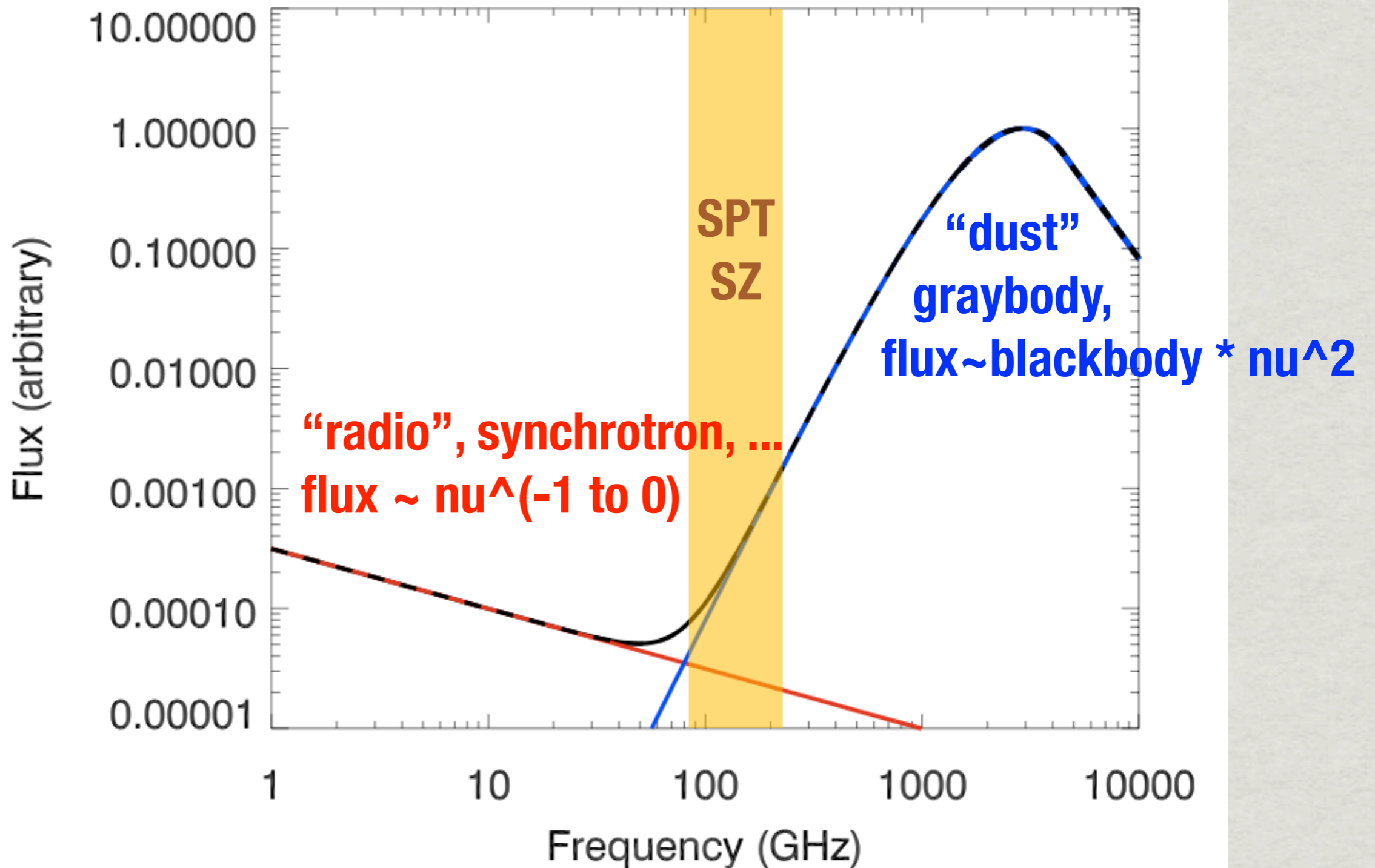
- * These galaxies **emit** in the mm.
- * This emission **contaminates the SZ signal from galaxy clusters**. Biases mass estimates and cosmo results from SZE surveys like SPT or ACT. See talk by Keith Vanderlinde.
- * This contamination is present at some unknown, hopefully small level.

So how big is it?

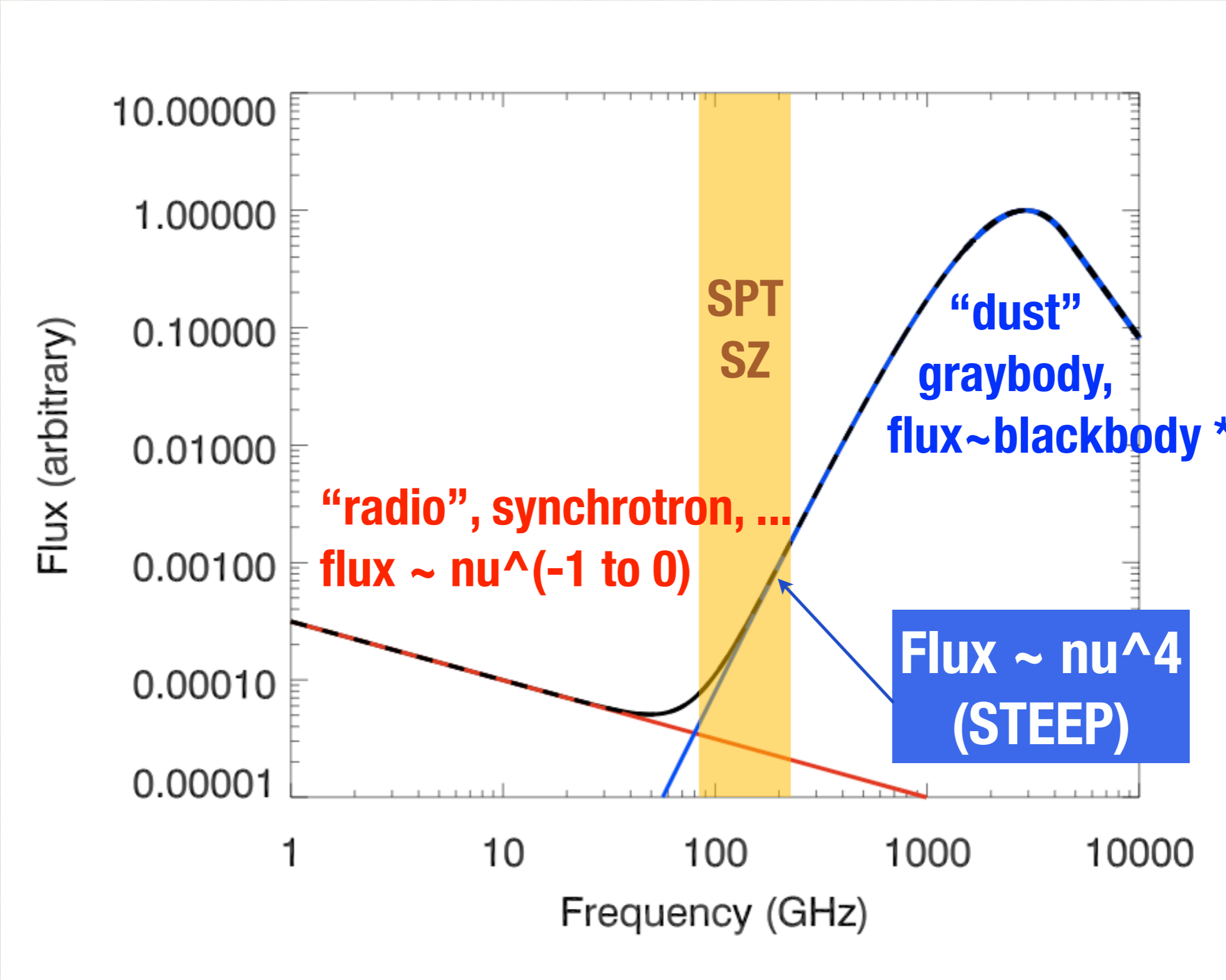
Emission Mechanisms



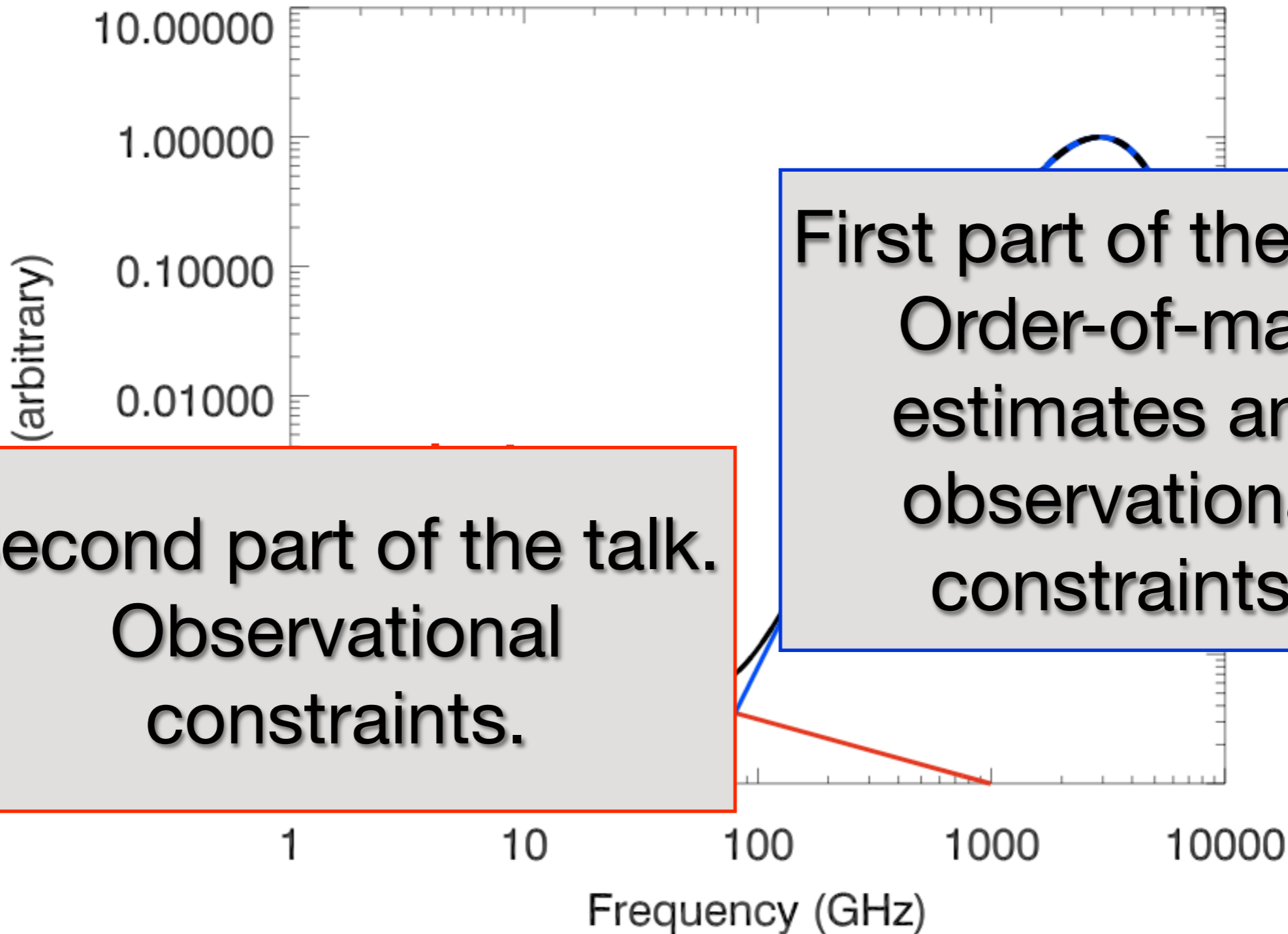
Emission Mechanisms



Emission Mechanisms



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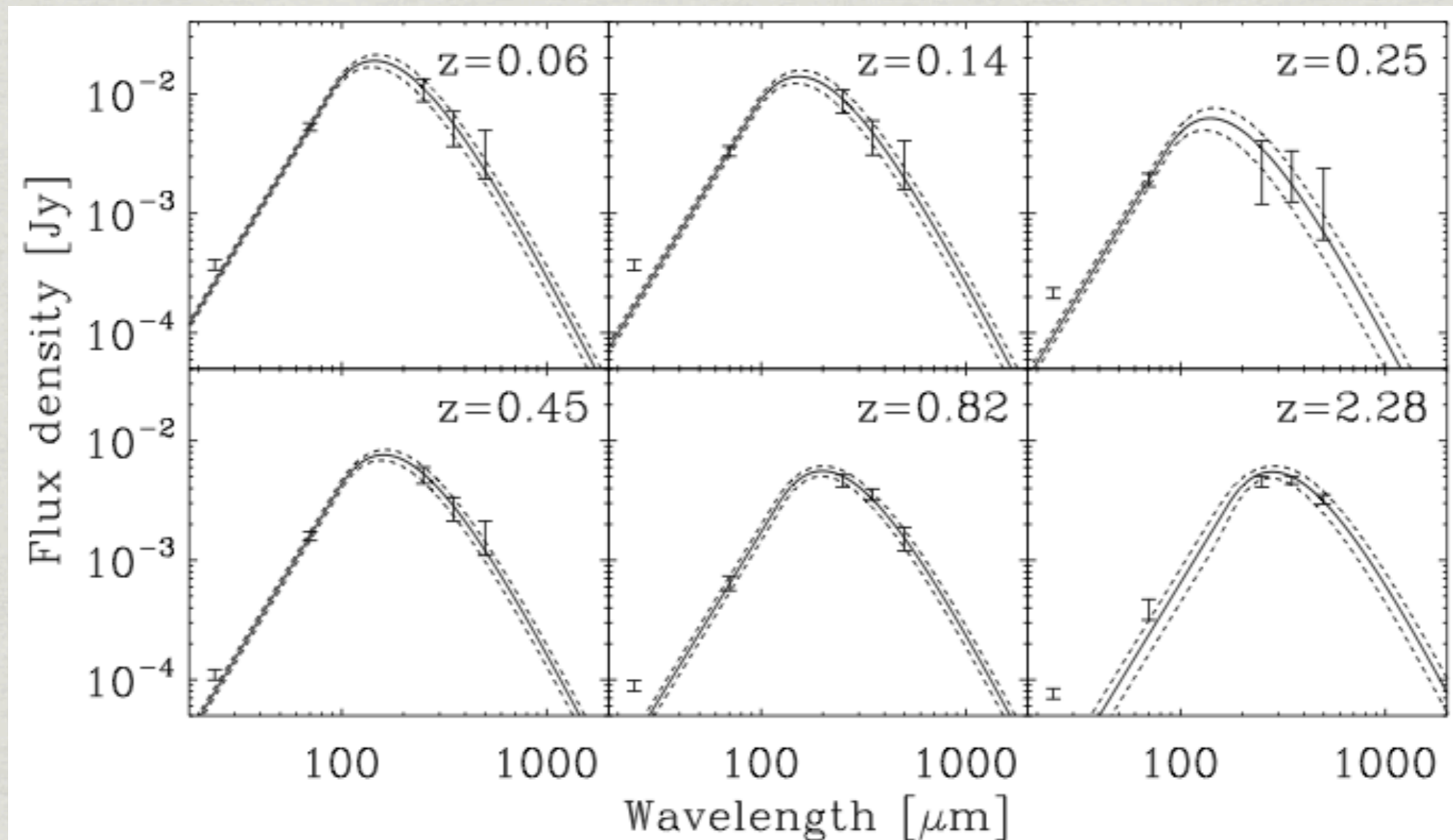


Second part of the talk.
Observational
constraints.

First part of the talk.
Order-of-mag
estimates and
observational
constraints.

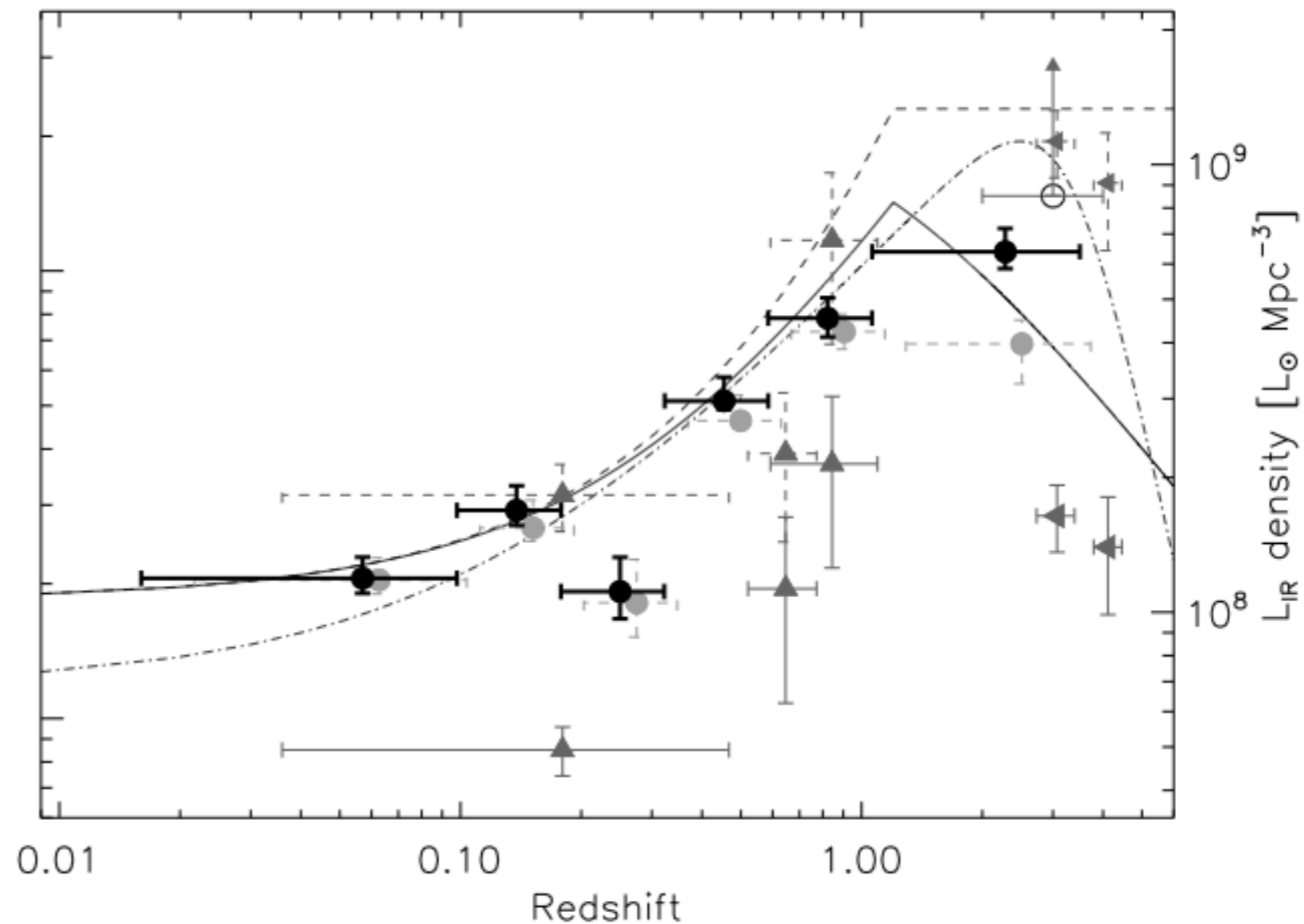
Dusty emission from the field

- ✳ BLAST has measured the average sub-mm flux of galaxies in the GOODS-S field.
(Pascale et al, astro-ph/0904.1206)

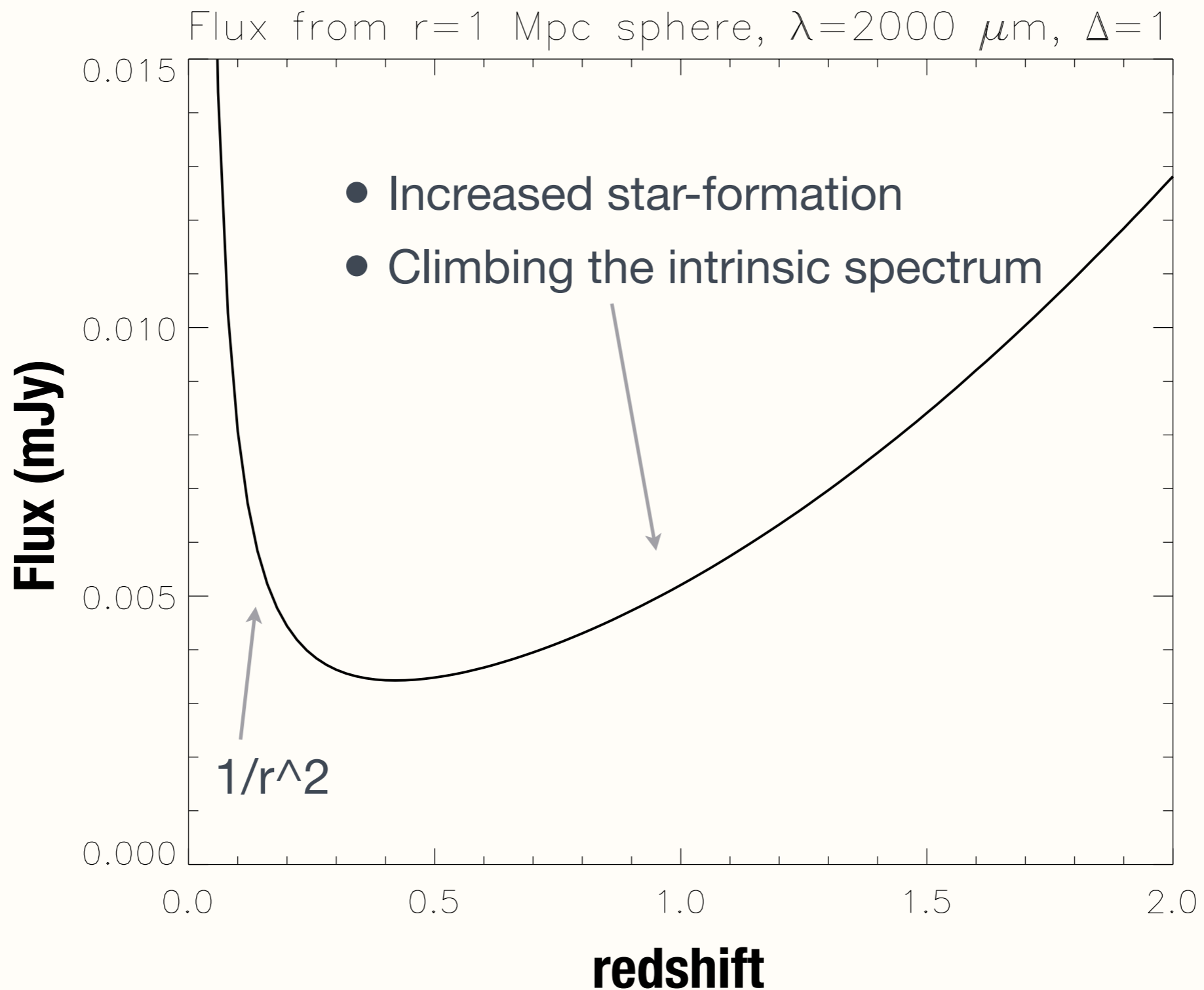


Dusty emission from the field

Luminosity Density (L_{SUN} per Mpc^3)
VS
redshift



Emission from a cluster-sized sphere (1 Mpc radius) at main SPT band, 2 mm.



overdensity & environment

* Clusters are **overdense** relative to field, say 500X denser than the field.

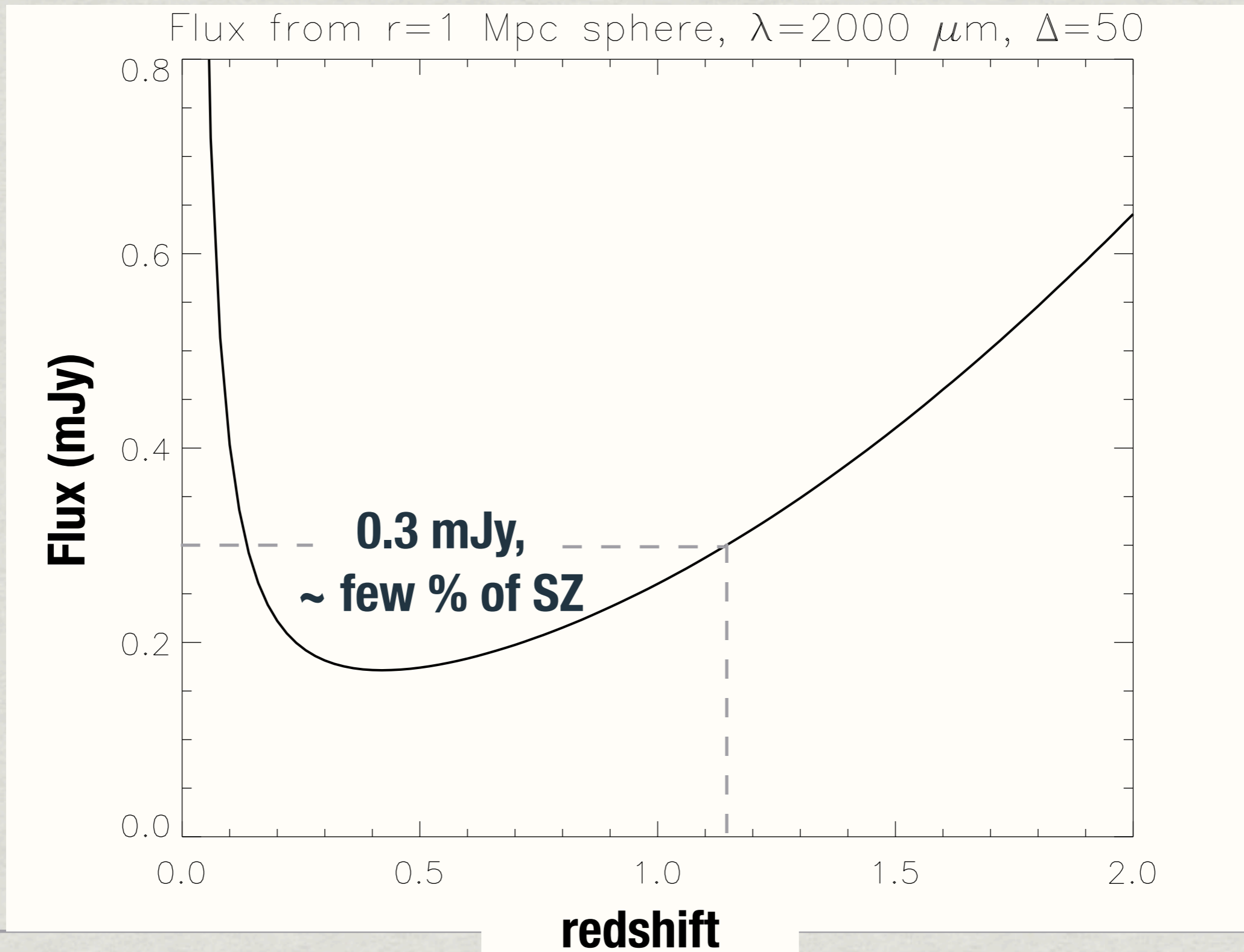
-> **x 500**

* But star-formation per mass is **suppressed** in cluster environments (at least for massive clusters out to $z=0.8$. See Bai et al, 2007, 2009).

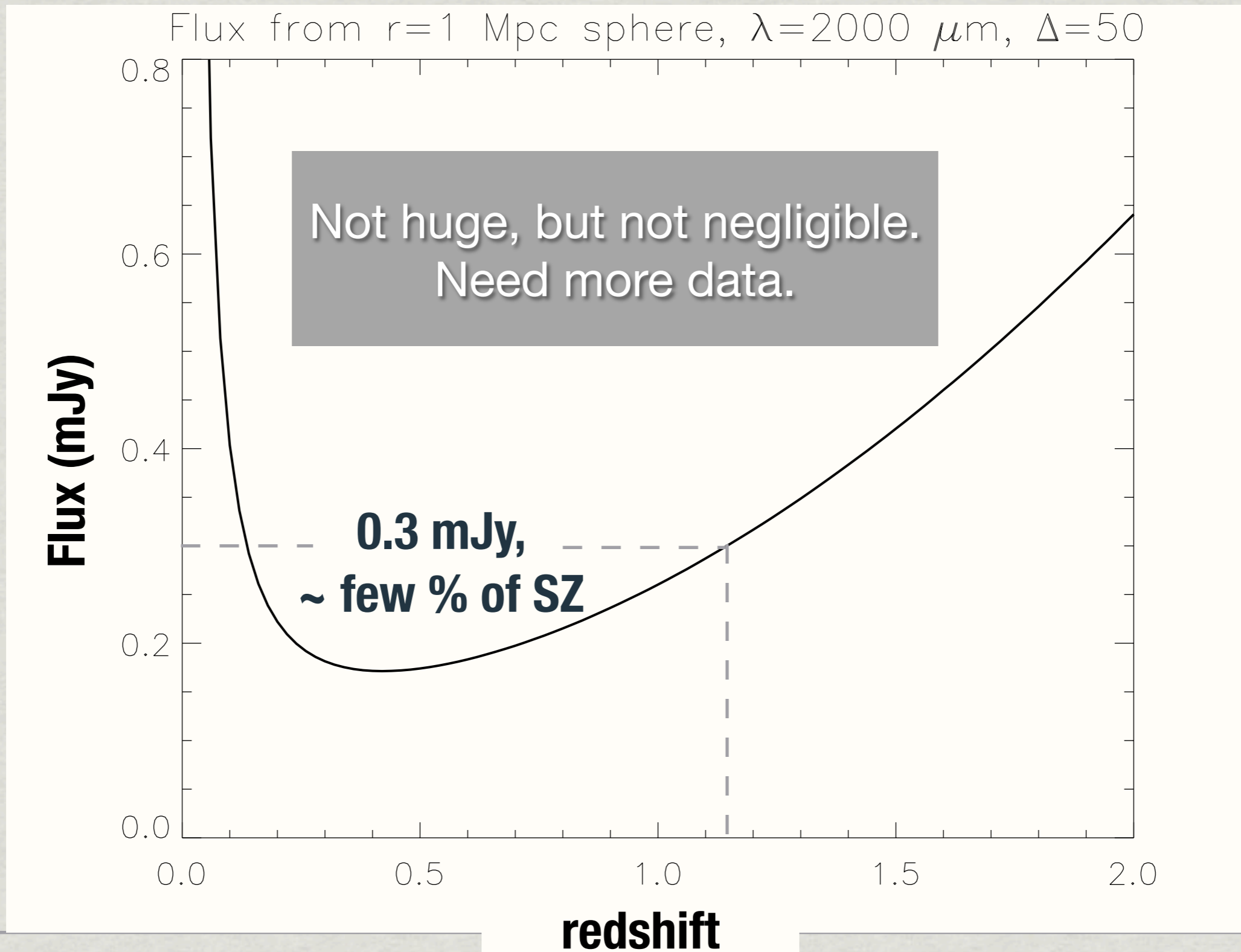
-> **÷ 10** (uncertain, especially at $z > 1$).

* So scale naive spherical estimate by **x 50**.

putting it all together

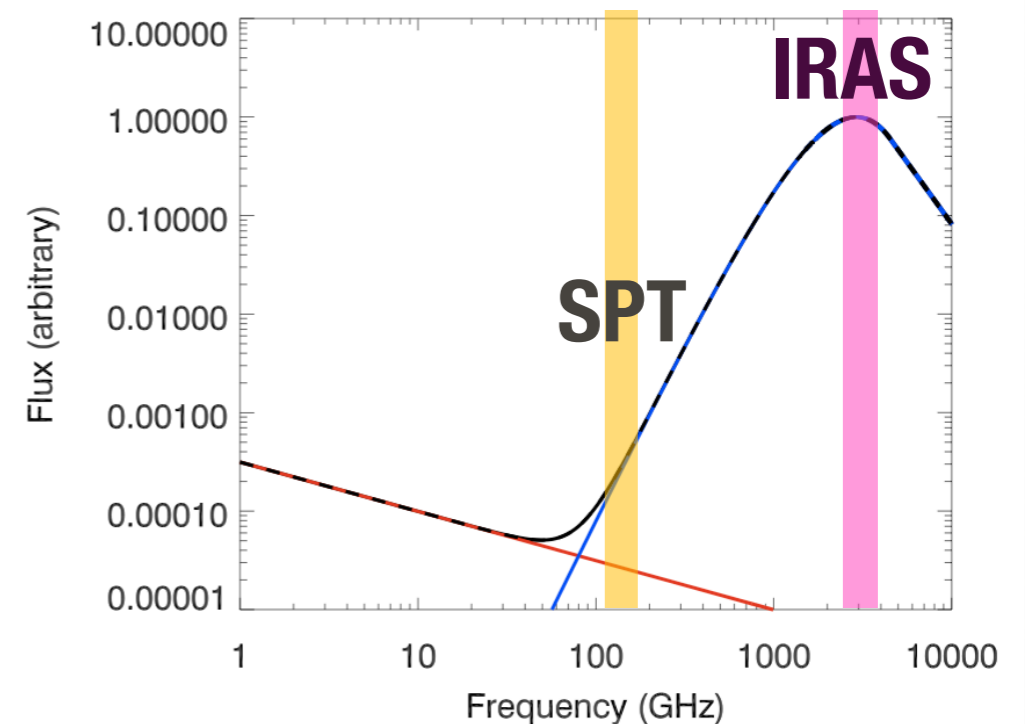


putting it all together

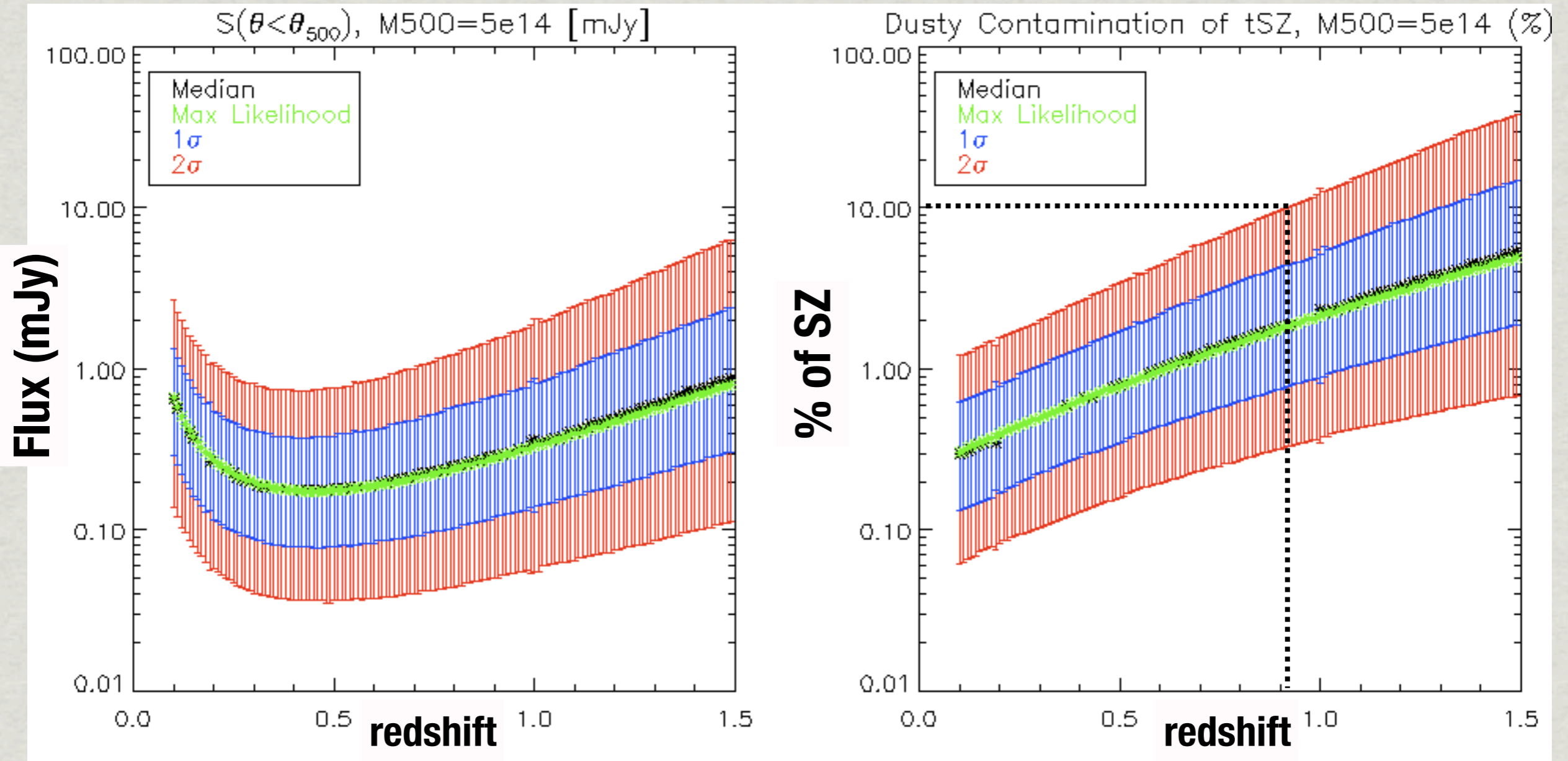


Archival data

- * Stack IRAS 100 μ m data at locations of ~ 400 X-ray-selected clusters. $z \sim 0.2$, $M \sim 5e14 M_{\text{sun}}$.
- * Use BLAST results to convert from 100 μ m to 2000 μ m (SPT) as a function of redshift.
- * Constrain contamination of SZ.



Results

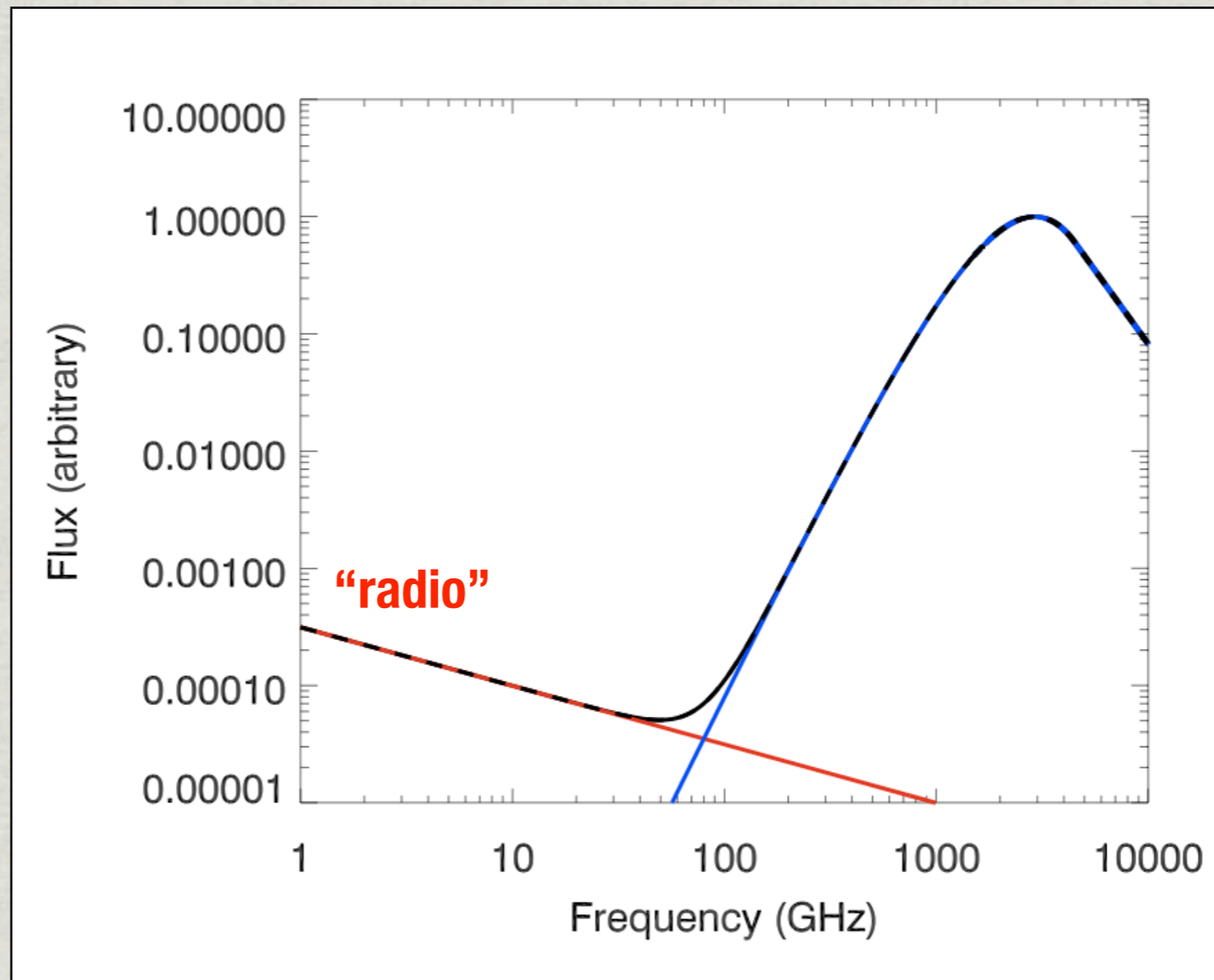


- * 5-sigma detection of cluster emission.
- * Systematics dominated.
- * Dusty flux is **<10% of SZ signal at z=1.**

Results

- * 10% was good enough for first generation of SPT results, but won't be next time. Redshift evolution?
- * Need deep imaging of **high-z, massive clusters** at **longer wavelengths** (closer to SZ bands).
 - BLAST - long wavelength, high-z, but not in clusters.
 - IRAS - clusters, but low-z, and short wavelength.
- * HERSCHEL (individual clusters) and PLANCK (stacking) will help a lot.

Part 2, “Radio”

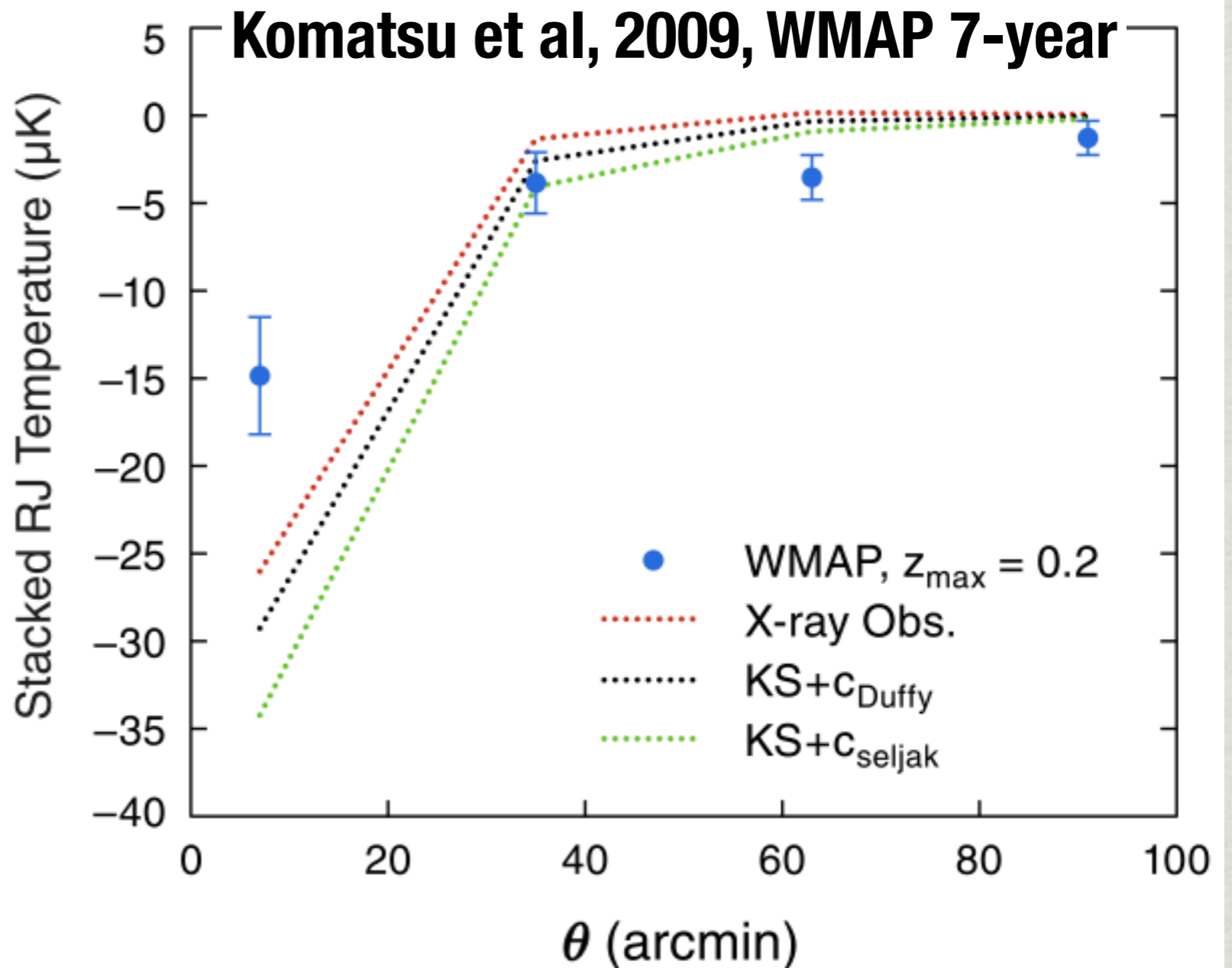


- * The literature* on radio sources in galaxy clusters suggests that contamination is small and/or rare.

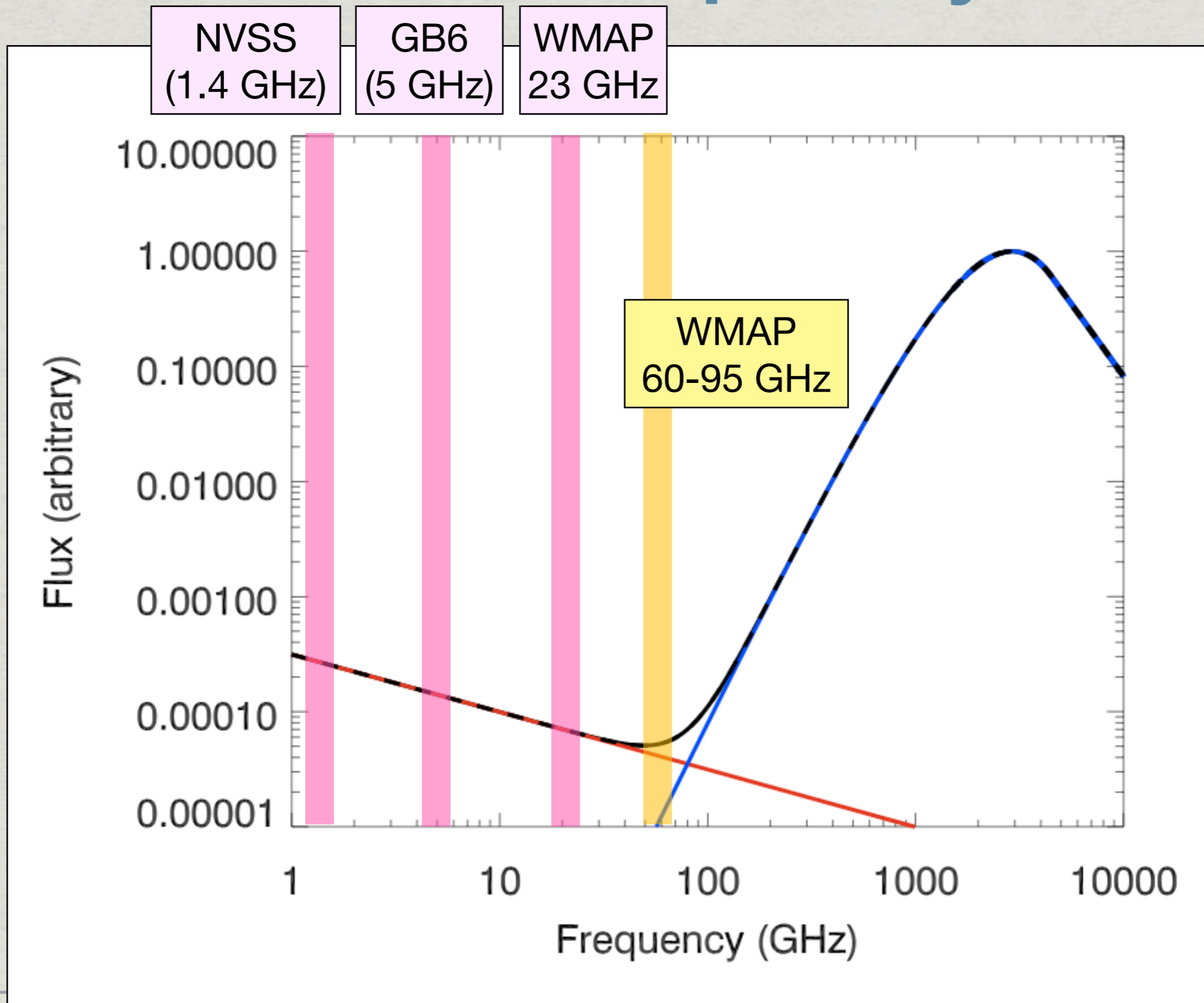
* See Lin & Mohr, 2007; Coble et al, 2007; Lin et al, 2009; Gralla et al, in prep, 2010; etc.

Radio contamination in WMAP SZ analysis?

- ✱ WMAP measures less SZ flux than you'd expect given the X-ray observations of the same clusters.



Stack Low-Frequency Data

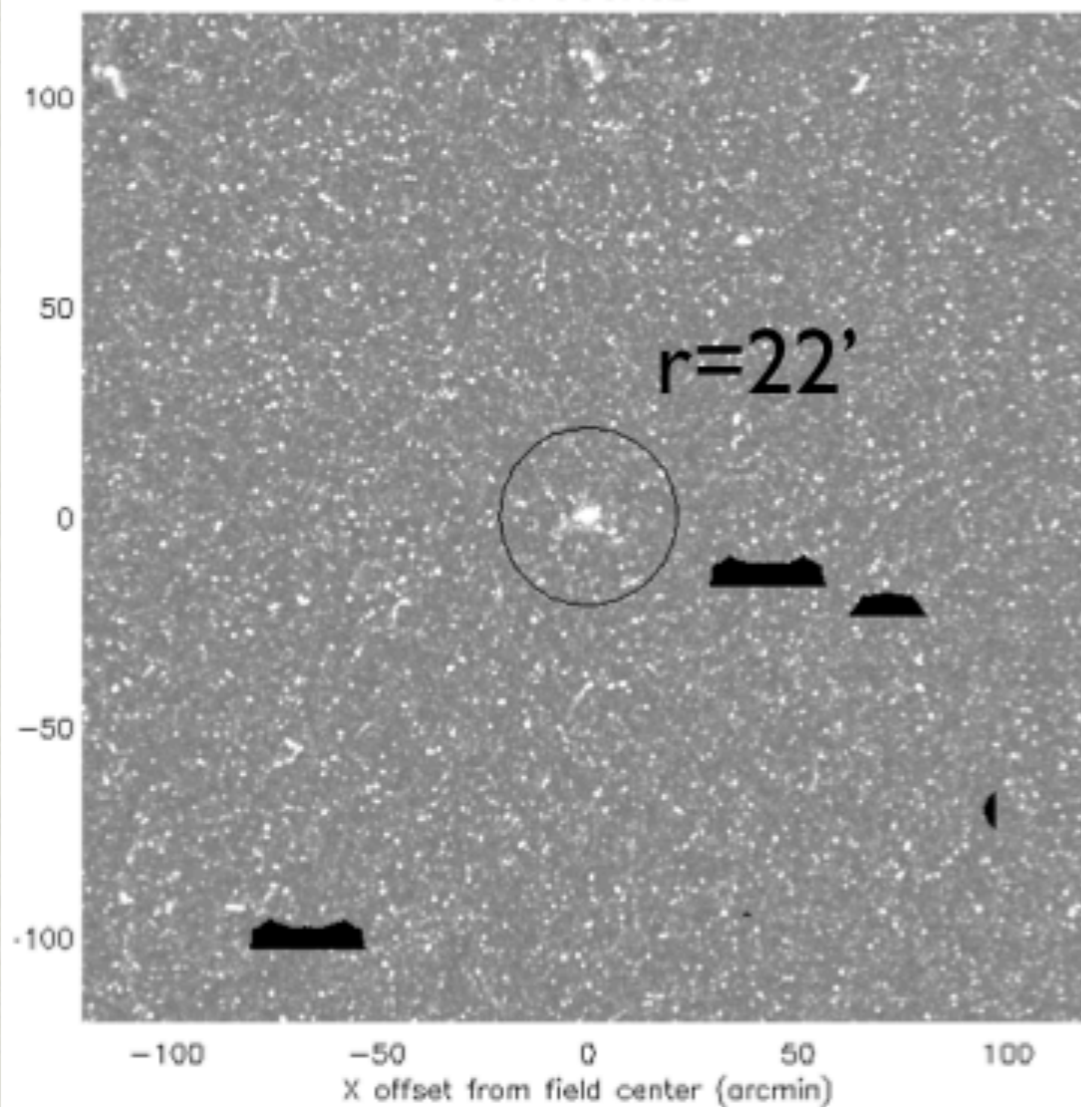


Stack Low-Frequency Data

NVSS
(1.4 GHz)

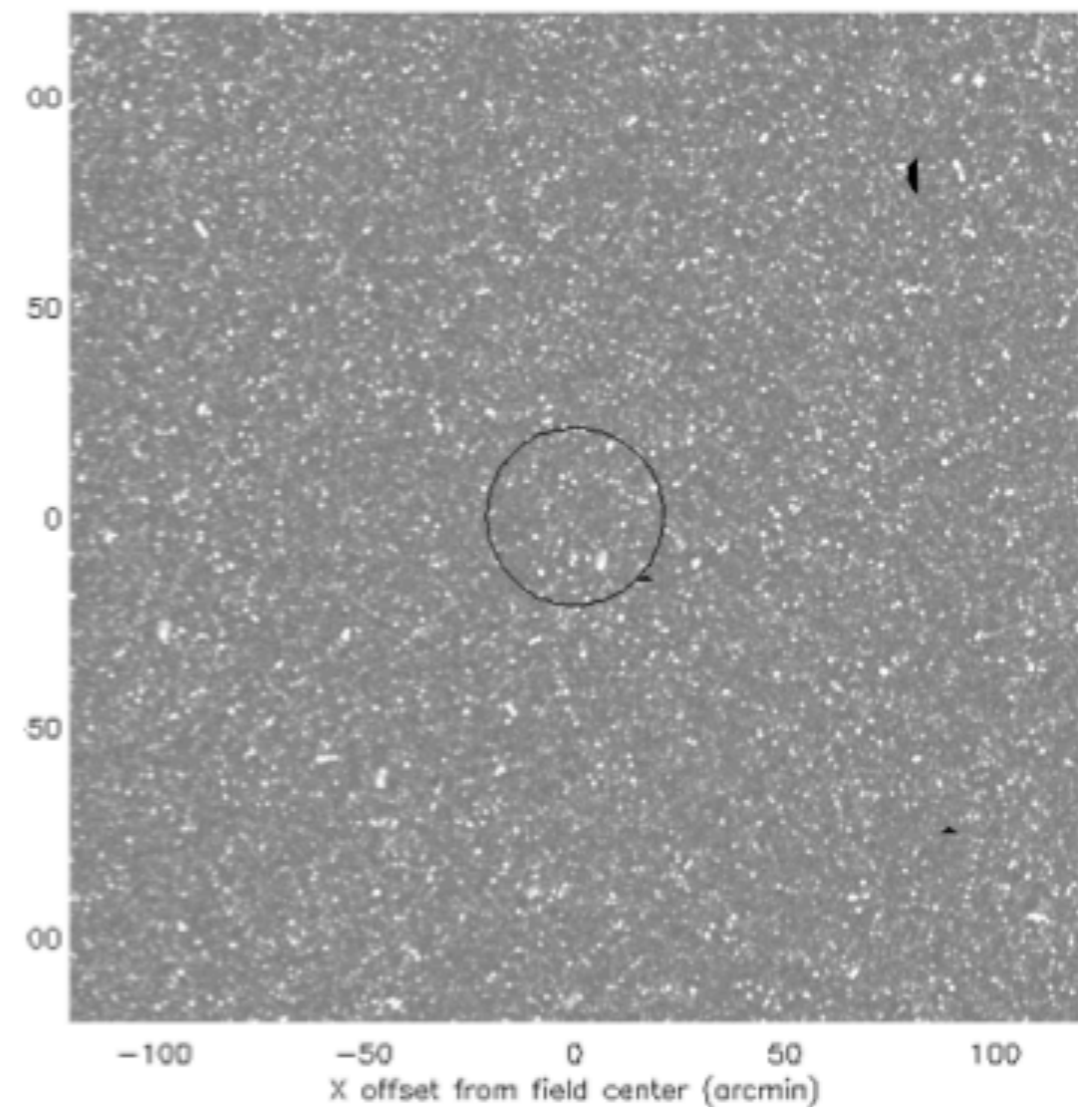
wmap7 clusters

ON SOURCE



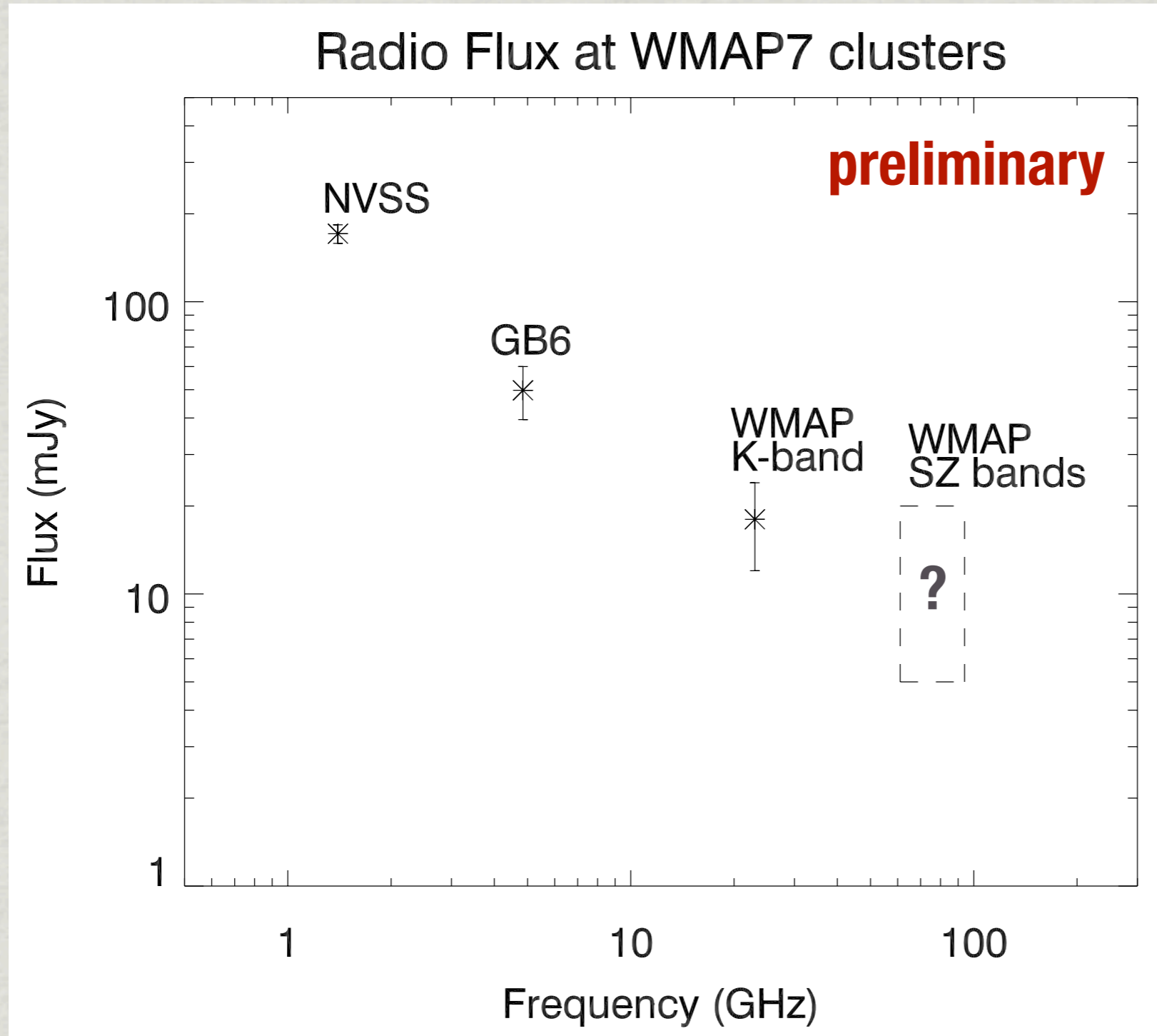
random positions

OFF SOURCE

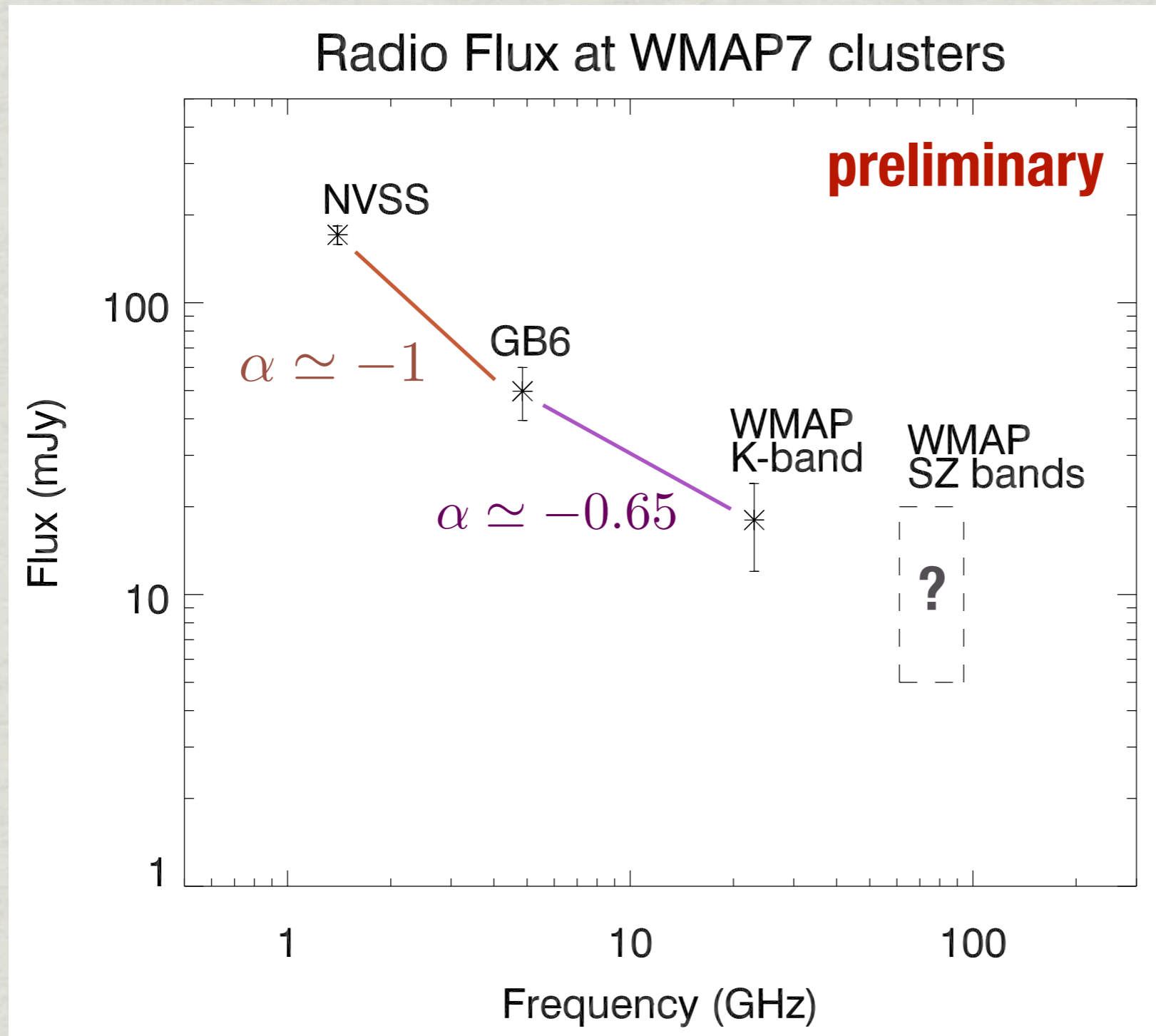


~10-sigma, 180 mJy excess

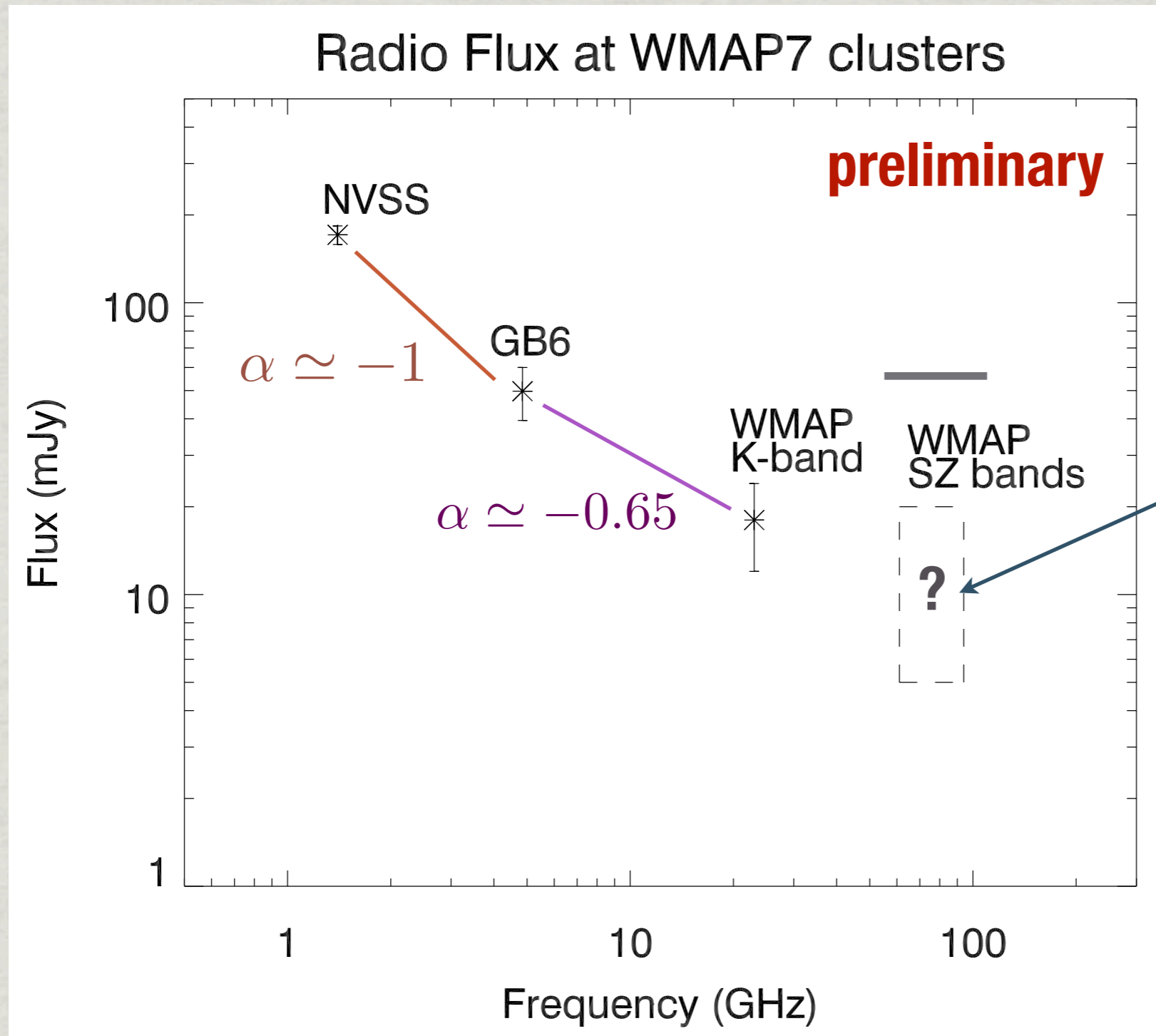
Stack Low-Frequency Data



Stack Low-Frequency Data



Stack Low-Frequency Data



- About 10% of measured SZ. Within a factor of a few of what's needed to reconcile WMAP7 with X-ray observations (or to be totally negligible).

- work in progress

Summary

- * Emission from cluster members contaminates the SZ signal (by some small amount).
- * IRAS and BLAST suggest dusty contamination is <10% of SZ signal for massive clusters at $z \sim 1$. Herschel and Planck will help.
- * WMAP7 SZ analysis may have significant level of radio contamination, but this is a work in progress.