Origin of the radio background

- ARCADE and the radio background
- General constraints
- Rejected hypotheses
- Very faint radio sources

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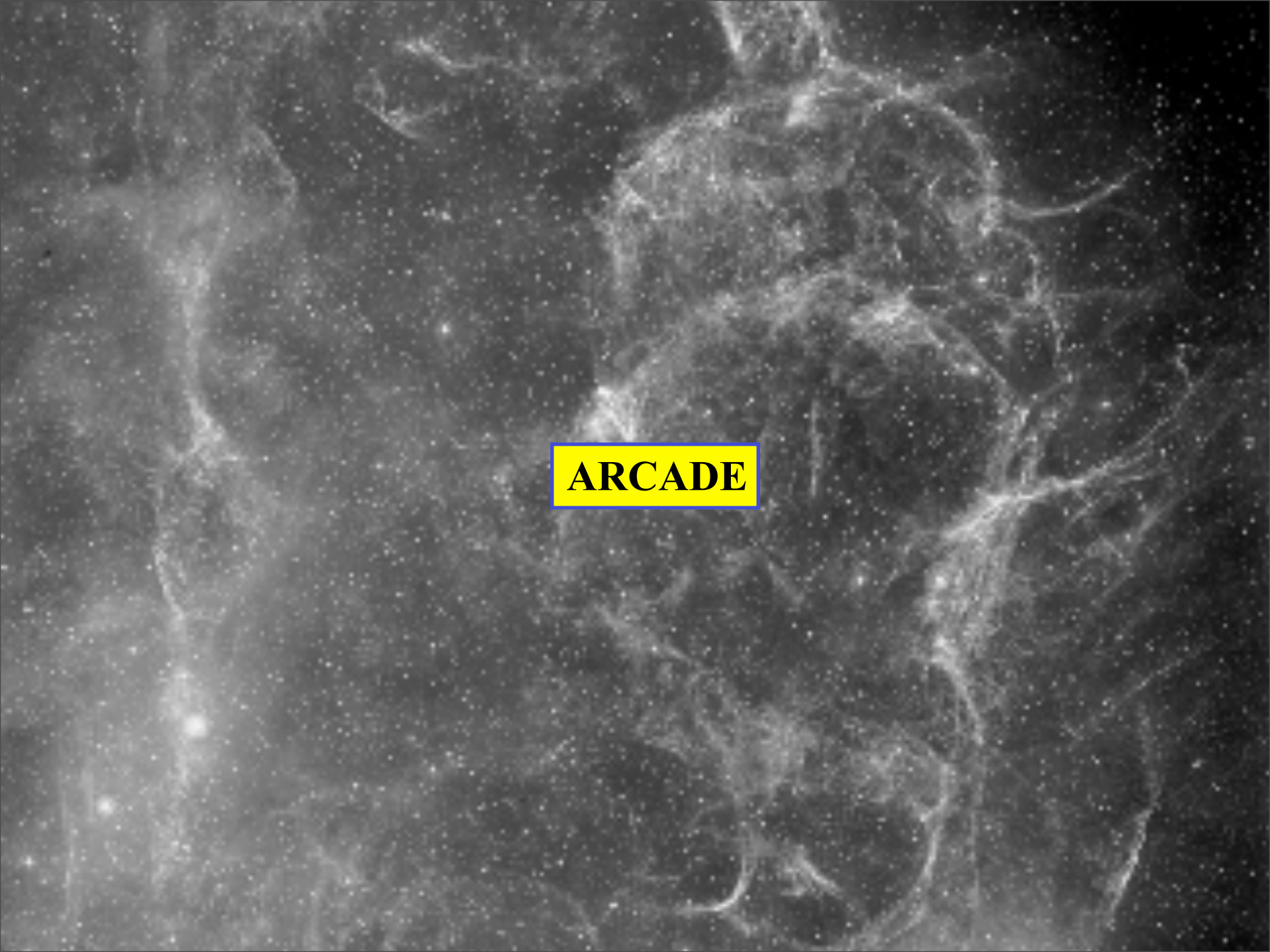

ARCADE

ARCADE experiment

Instrument paper :
Singal et al 2009

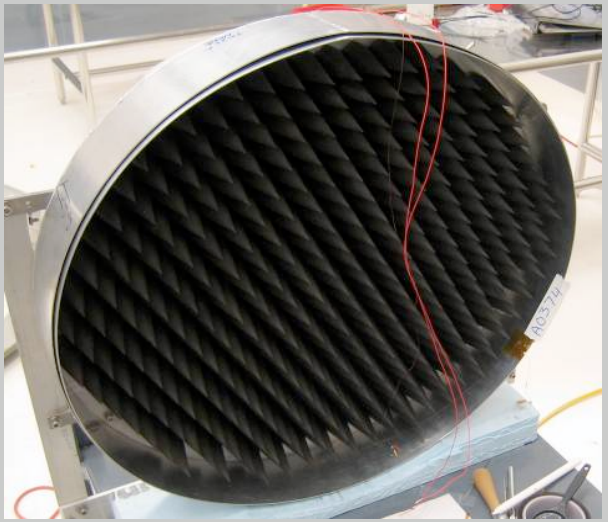
Absolute radiometry of sky 3-90 GHz

PI : A.Kogut

Balloon flight July 2006

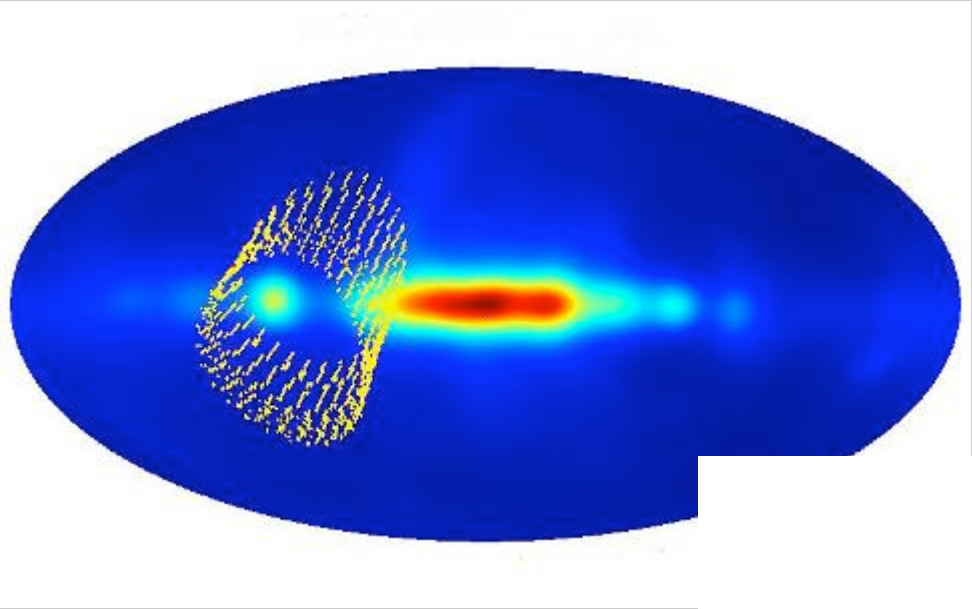
Feed Horns view either sky or calibrator

Calibrator one of blackest microwave objects ever made

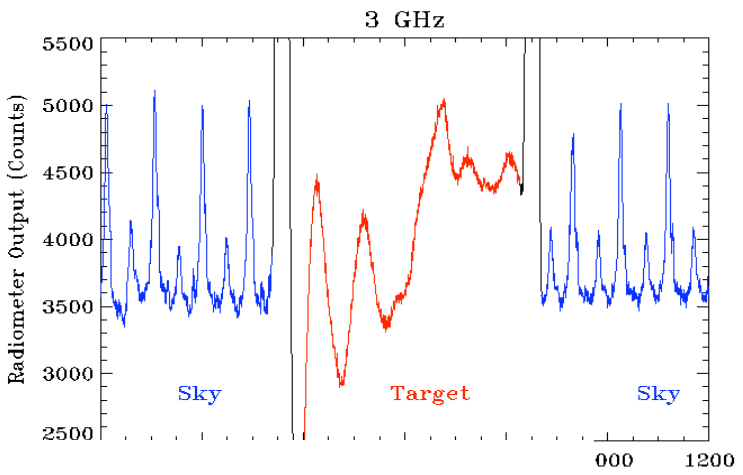


ARCADE measurements

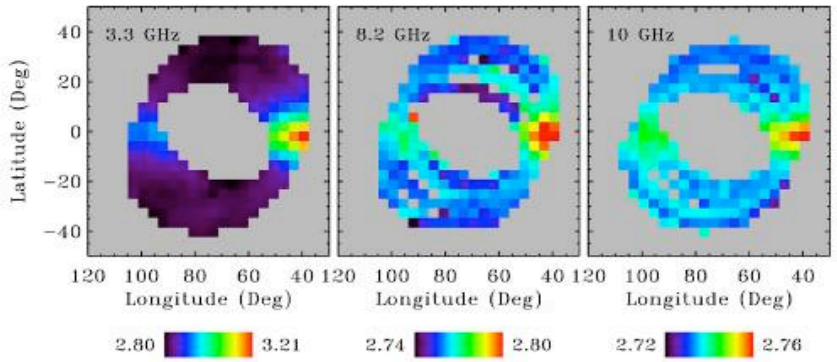
Raw measurements



Flight pattern on top of WMAP 22GHz map



Binned Skymap

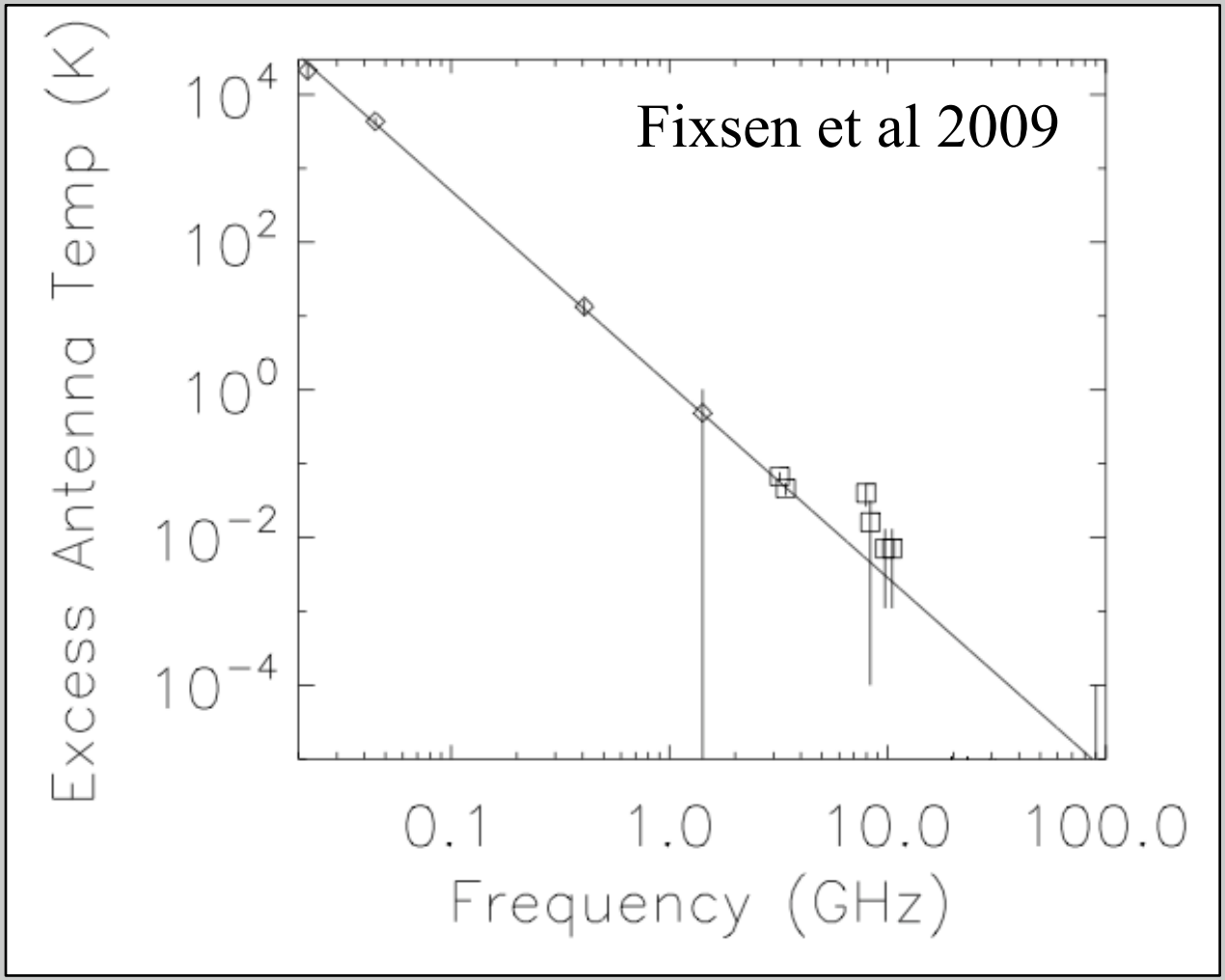


Result

Galactic foreground model linear combn of 408MHz and 158μm CII map

Results combine ARCADE, FIRAS, and low-frequency surveys

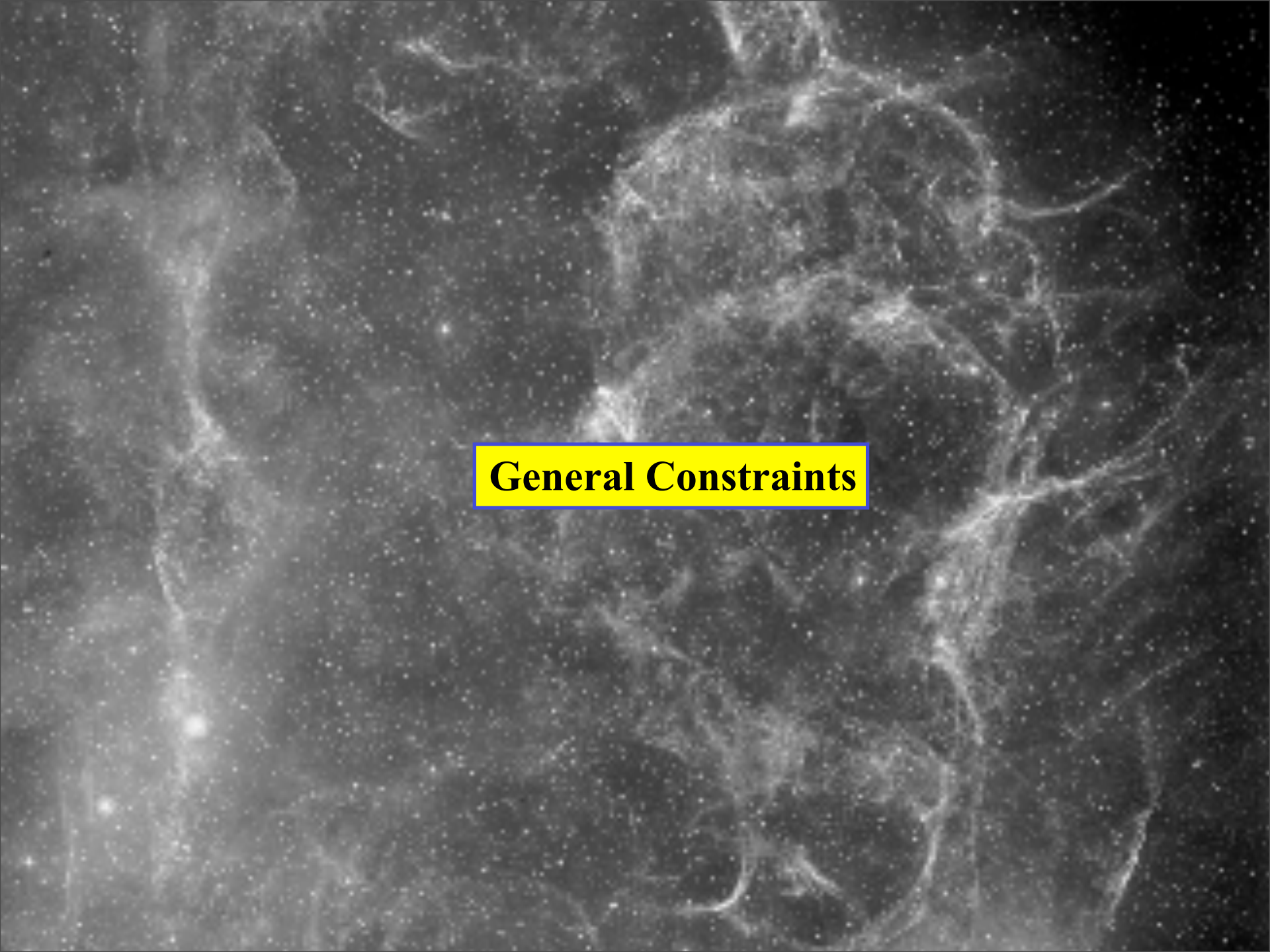
Looks like synchrotron



$$T_{BGND}(\nu) = T_R \left(\nu / 1\,GHz \right)^{\beta}$$

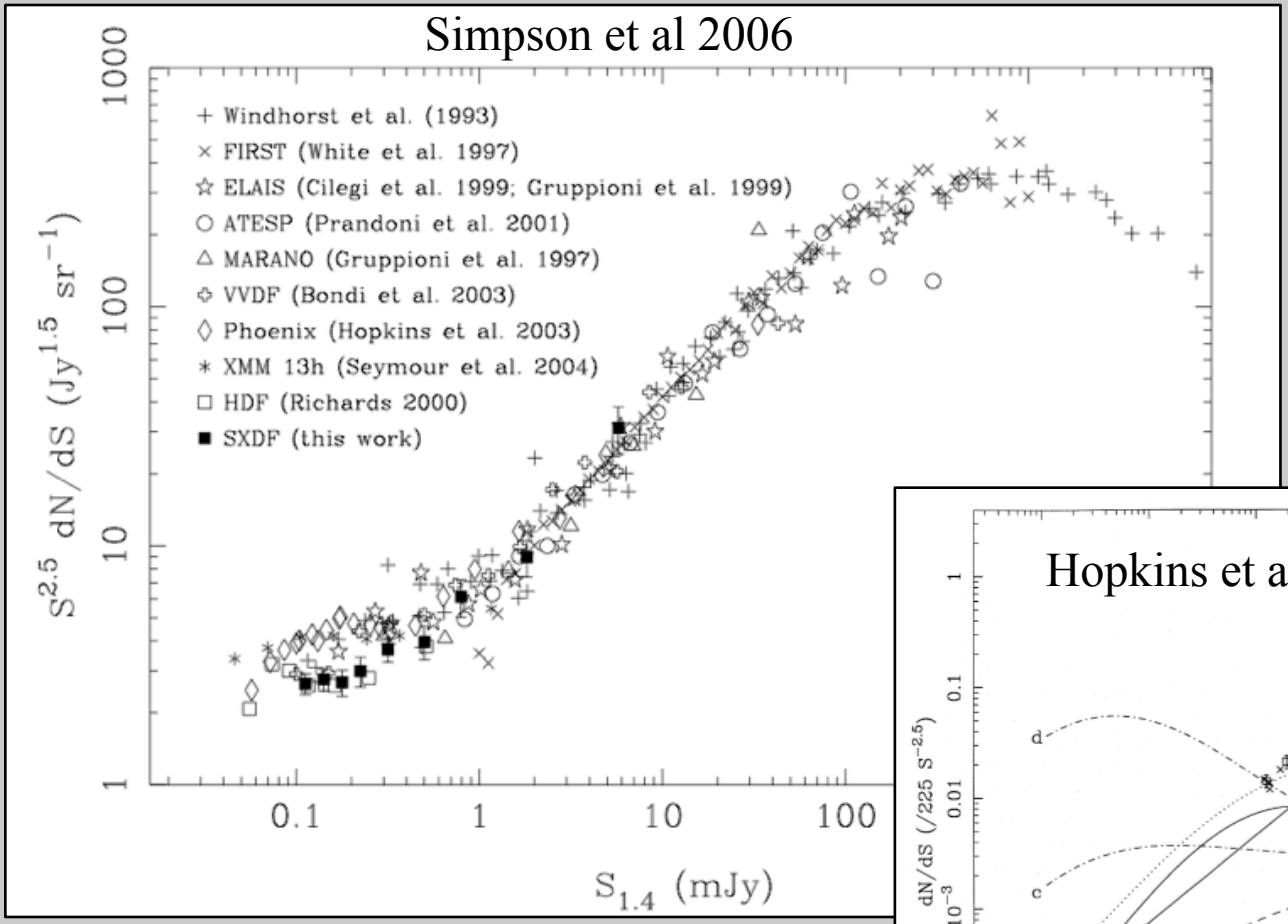
T_R = 1.17 ± 0.12K @ 1 GHz,

β = -2.60 ± 0.04


General Constraints

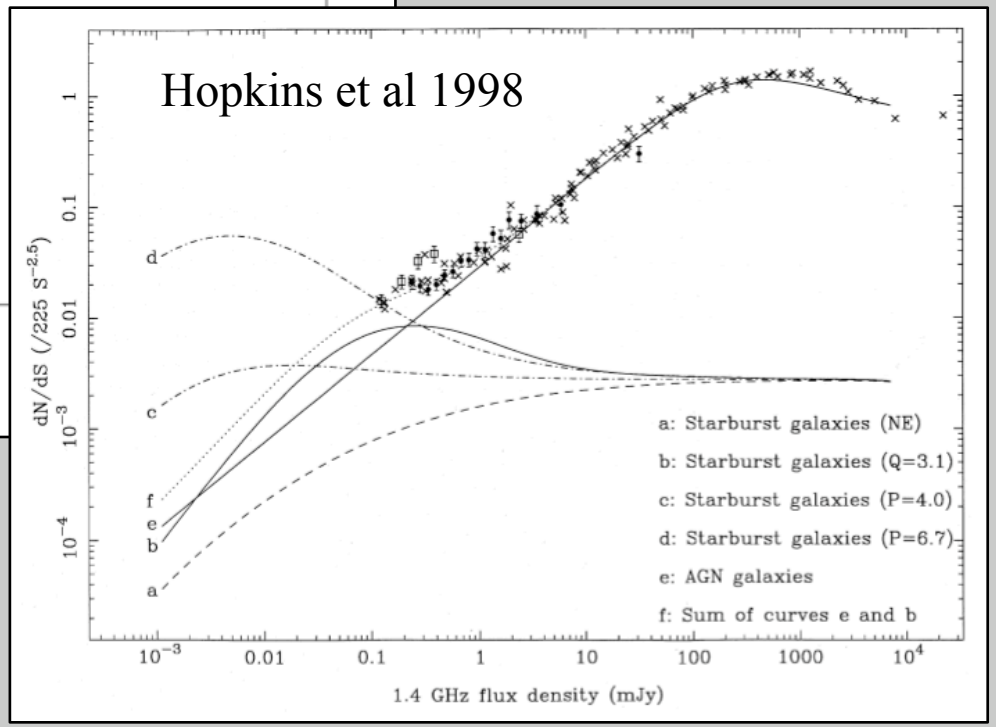
Not currently known radio sources

Simpson et al 2006



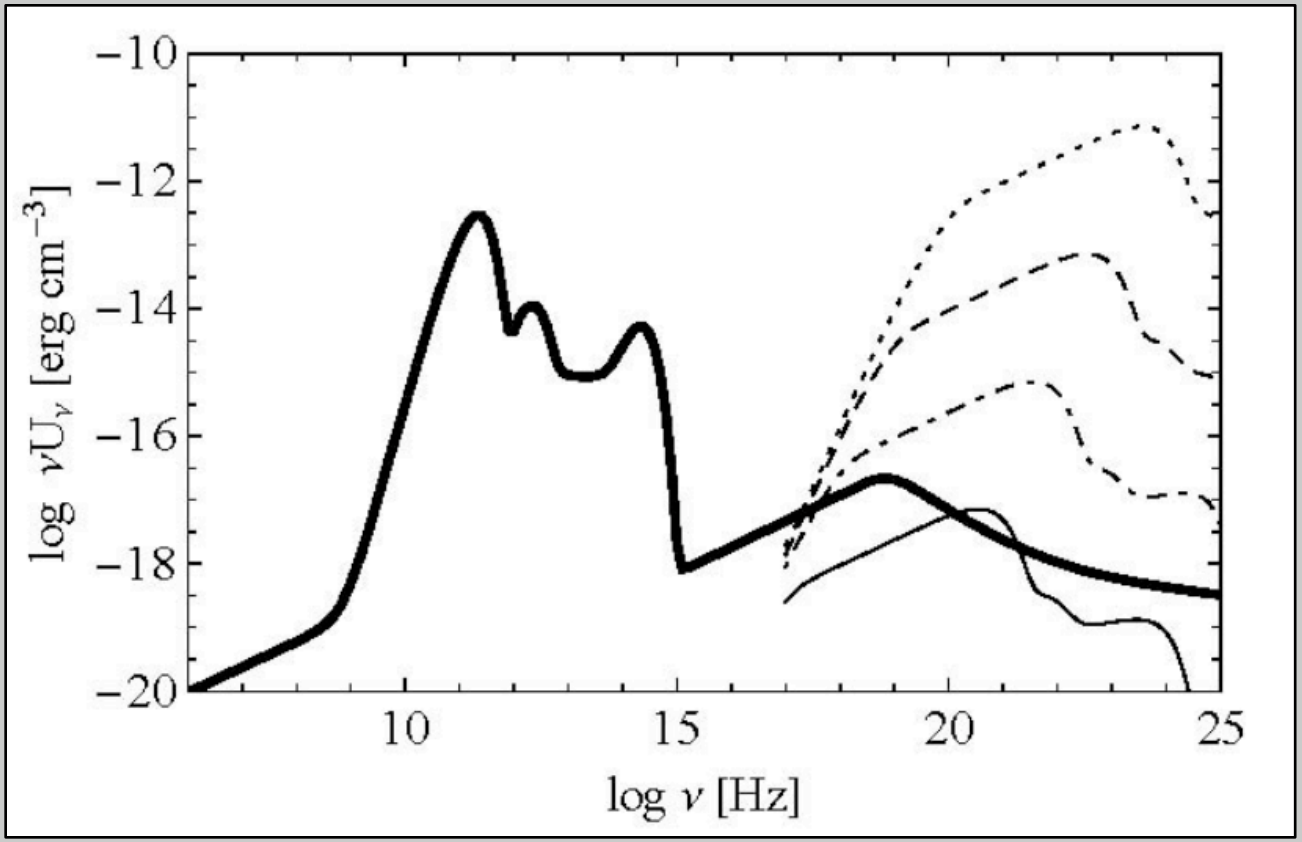
Popular models predict turn over just below current limits

Hopkins et al 1998



Background 6 x larger than integrated source counts

Mag field limit



Same electrons make IC x-γ background : ratio depends on B

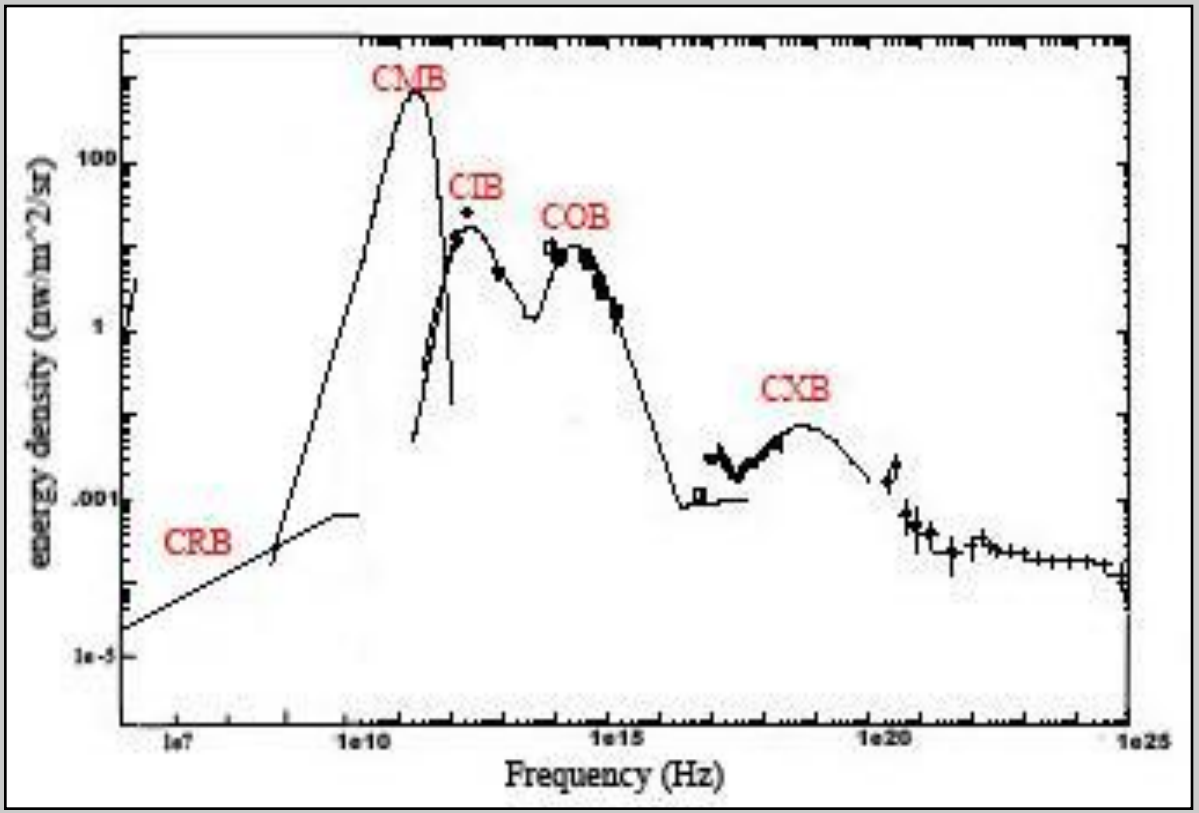
B>1μG

Not in IGM (nano-Gauss)

Similar to known radio galaxies and SNRs

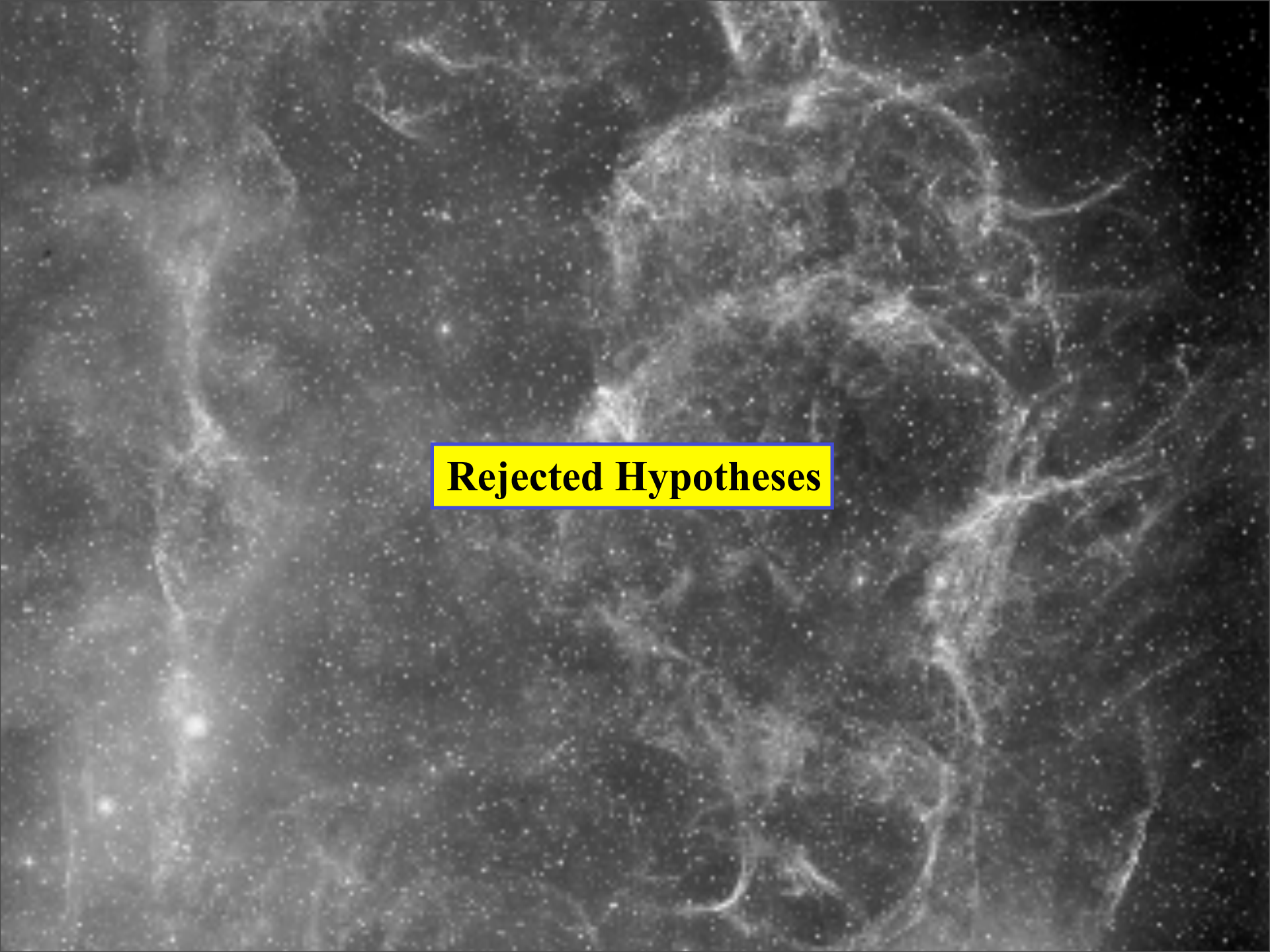
Note also α=0.6

IR background



Sources obeying standard radio/IR correlation also make FIR background

==> at most 40% of the CRB

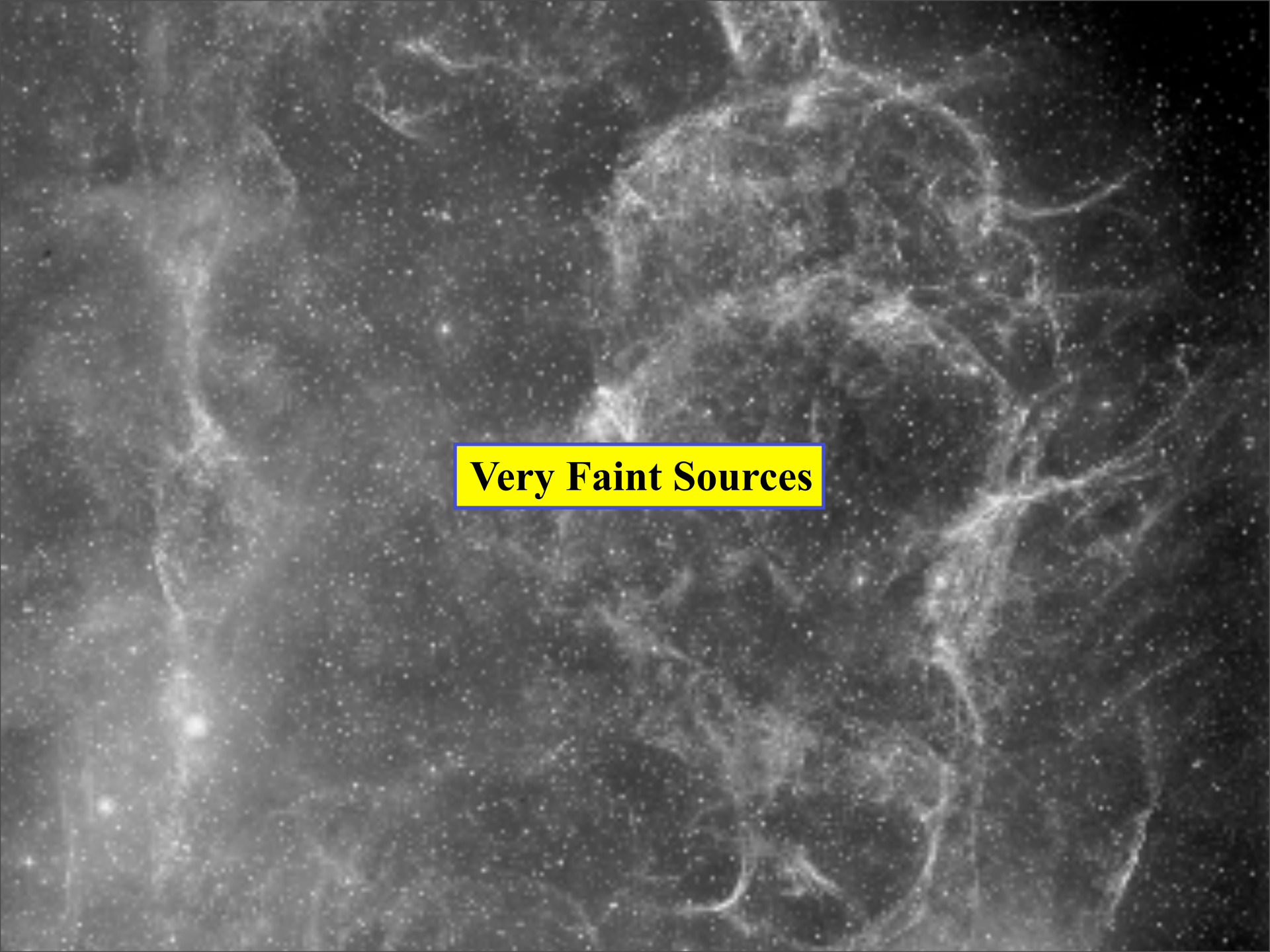

Rejected Hypotheses

Missing Low Surface Brightness emission

- FRI tails ? No - too steep
- Cluster relic sources ? No - too steep
- Missing LSB population ?
  - No - new ATLB survey suggests maybe +50%
- Bad beam correction in faint surveys ?
  - No - repeats at different resolutions agree

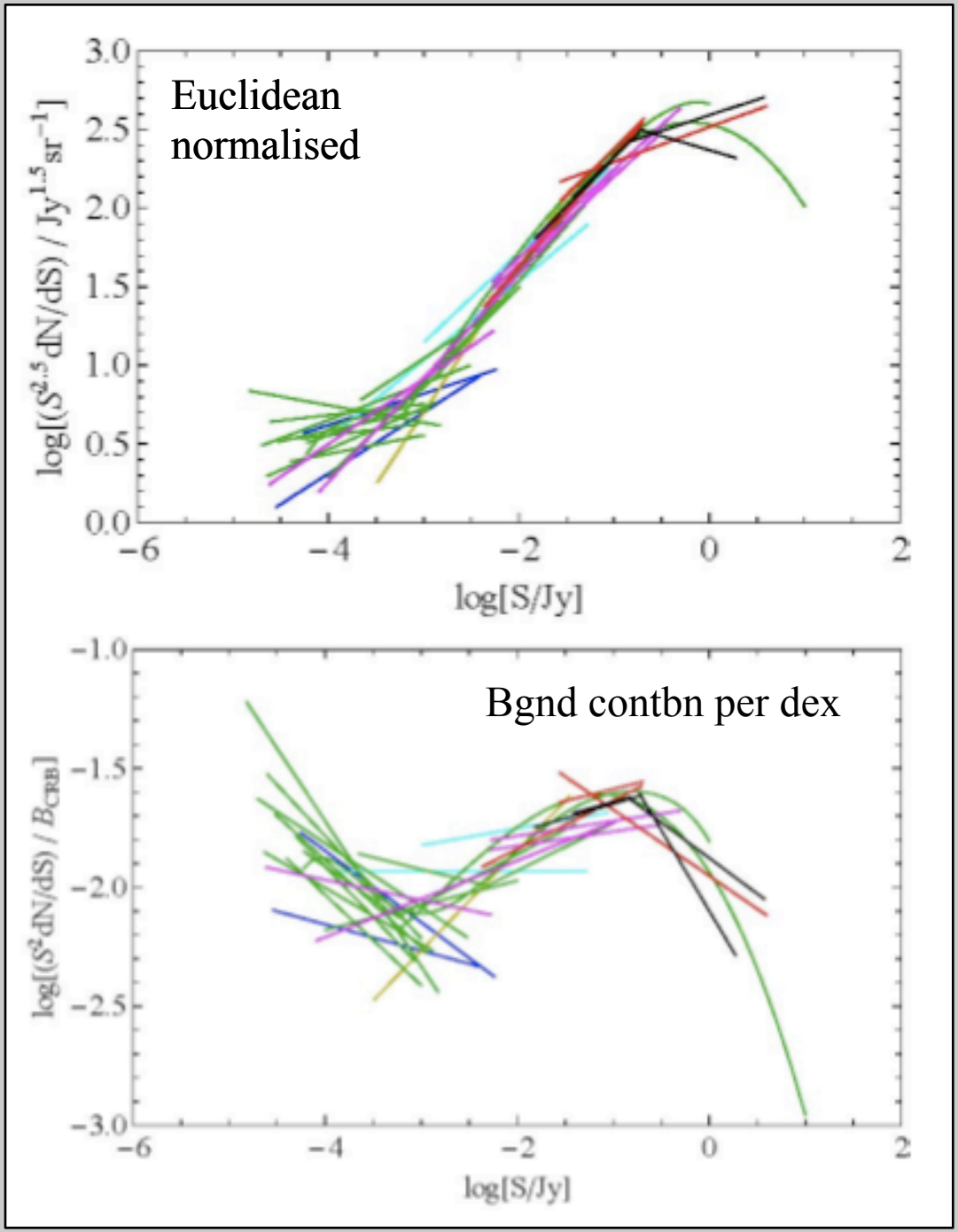
Known Types of Source

- Radio Loud AGN : 16%
- Radio Quiet Quasars : <4%
  - otherwise exceed optical counts
- Radio Supernovae : 0.1%
- Star forming Galaxies
  - known sources : 10%
  - max contbn if obey IR/radio : <40%


Very Faint Sources

Counts compilation

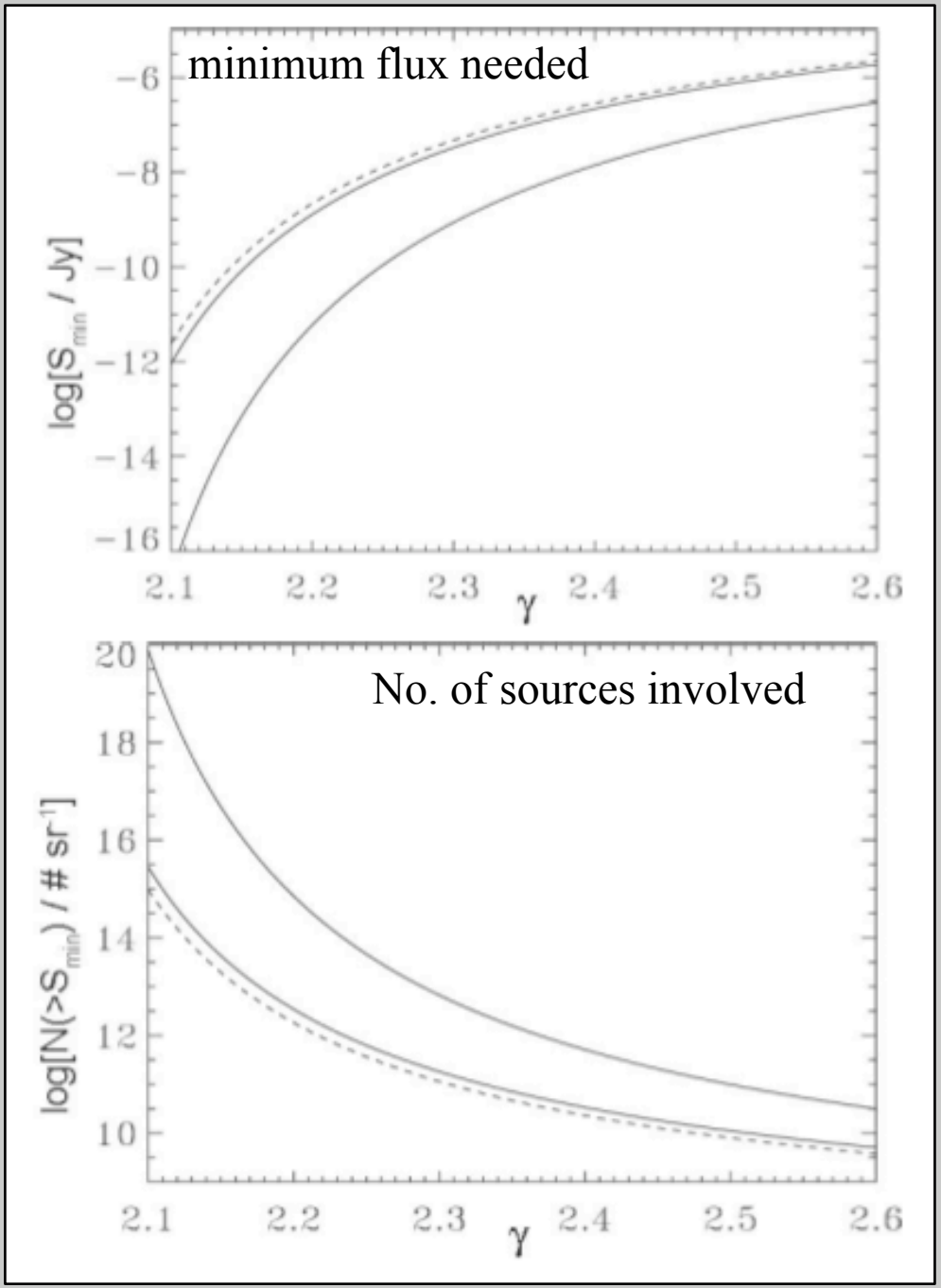
Can extrapolated counts explain background ?



Bgnd from very faint sources

If close to Euclidean :

S(min) ~ 0.1 μJy
N(sky) ~ 10^{11} sources



Ordinary galaxies

- 10^{11} ~ galaxies in observable universe
  - HDF : 3000 gals in 2 arcmin : N=1.1x10^{11}
  - local lum fn : 0.02 gals/Mpc^3 (>0.1 L_*)
  - in volume to z=6 : N=5.7x10^{10}
- S=0.1μJy ~ 10^{22} W/Hz at z=3
  - ==> 10^9 L_{sun} FIR equivalent
  - boring normal spirals, not LIRGs

Excess radio

- So ordinary star forming galaxies makes sense
- But requires radio/IR higher at high z
  - yes : Vlahakis et al 2007; Seymour et al 2009
  - no : Ibar et al 2008, Ivison et al 2009

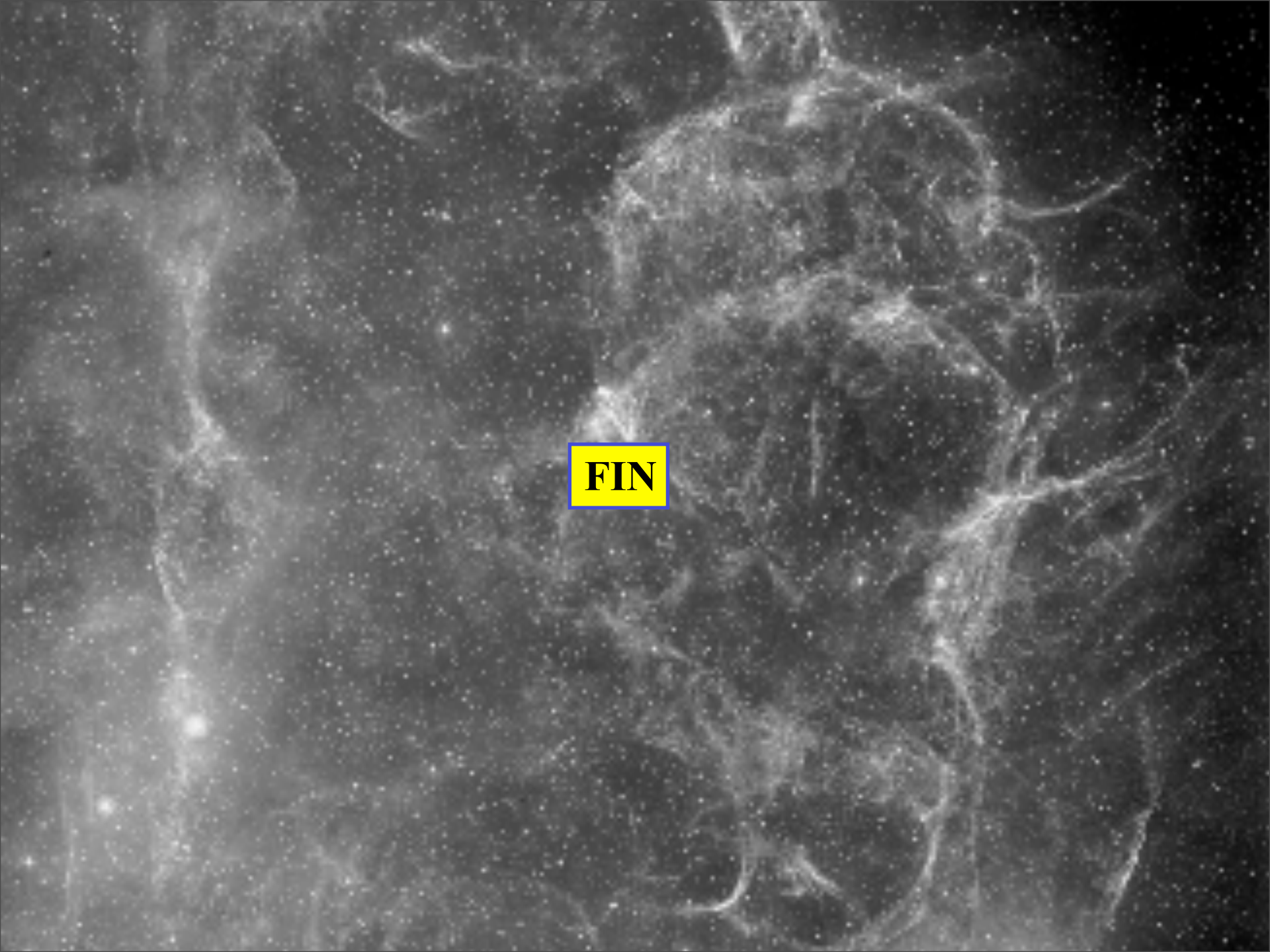
- Physical reason : at high-z
  - More efficient CR formation ?
  - Higher B ?
  - Larger AGN fraction in normal galaxies ?

Further possible consequences

- SF history dominated by trickles not bursts ?
- or
- Early black holes more radio-active ?

- and

- SKA may be confusion limited ?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