New Planck results:
A study of AME in Galactic clouds with Planck

Planck collaboration

Presented by

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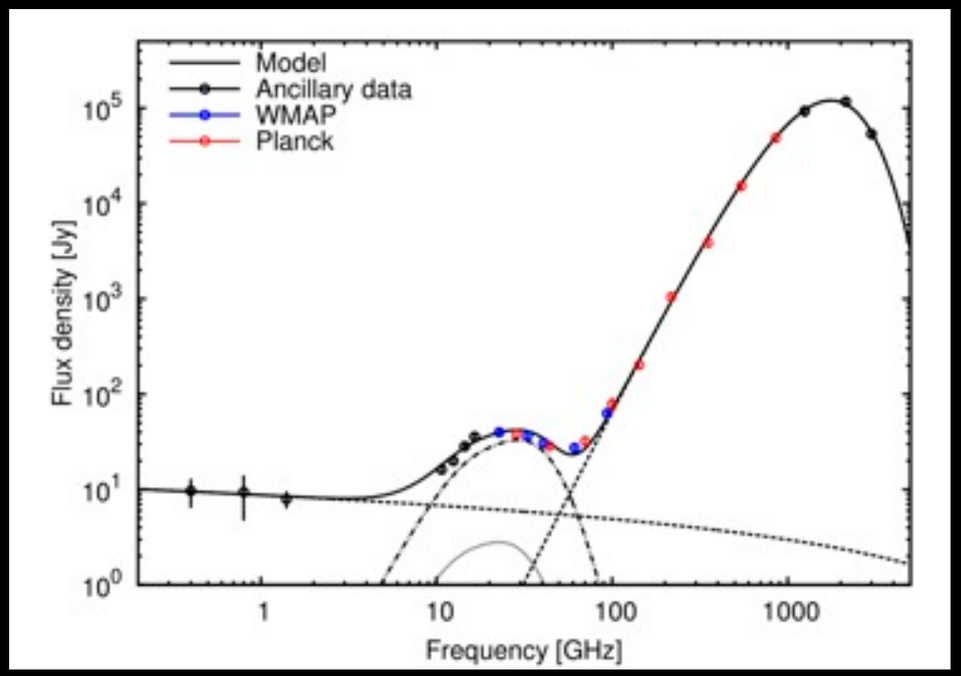
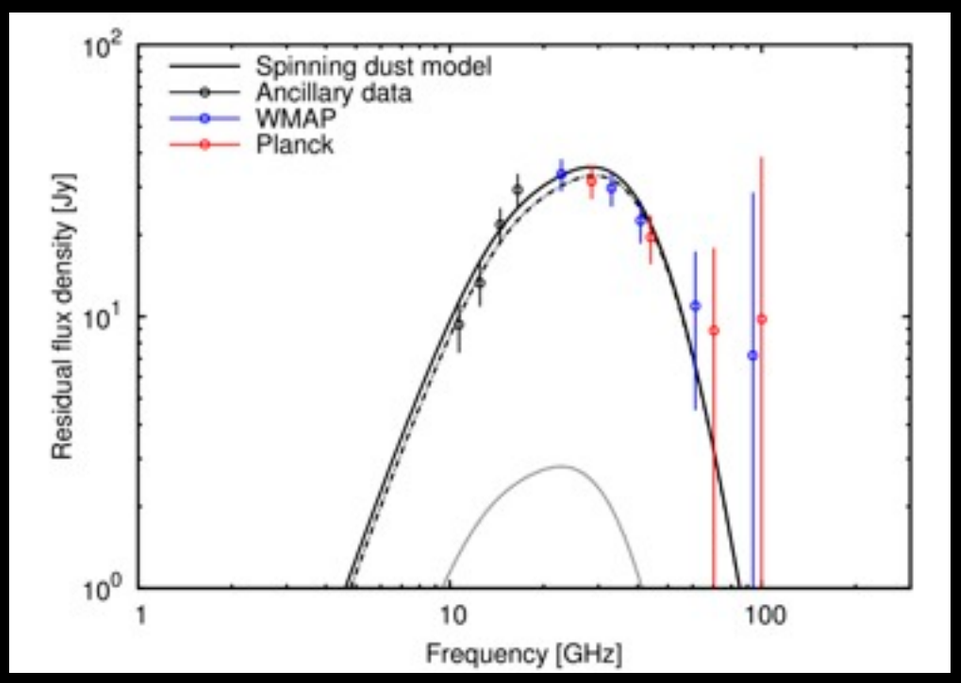
The scientific results that we present today are a product of the Planck Collaboration, including individuals from more than 50 scientific institutes in Europe, the USA and Canada

Planck is a project of the European Space Agency -- ESA -- with instruments provided by two scientific Consortia funded by ESA member states (in particular the lead countries: France and Italy) with contributions from NASA (USA), and telescope reflectors provided in a collaboration between ESA and a scientific Consortium led and funded by Denmark.

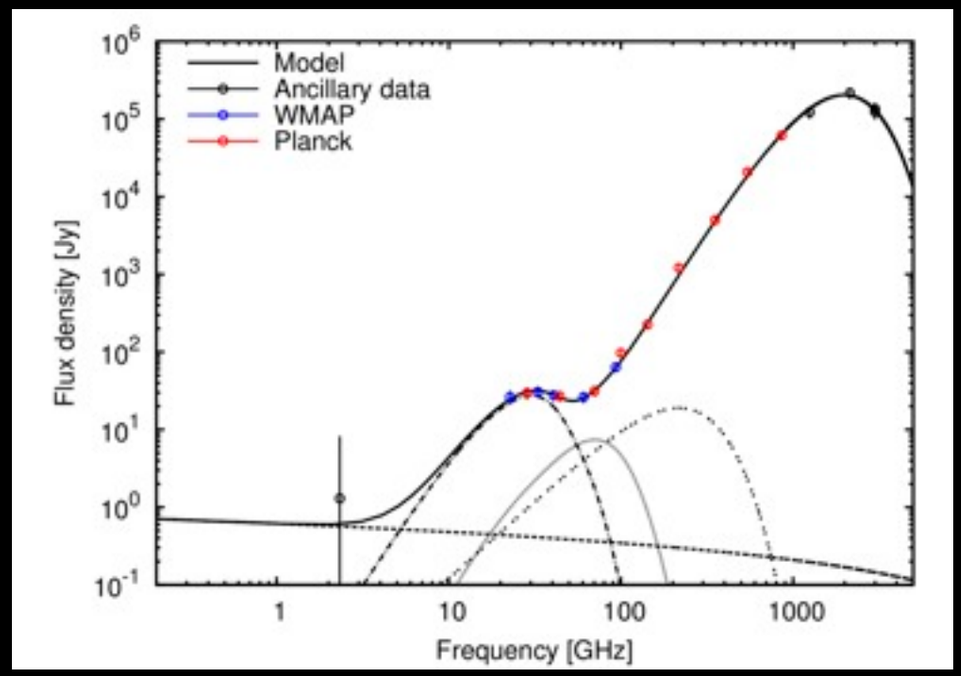
Early paper XX: Planck collaboration et al. (2011), A&A, 536, A20

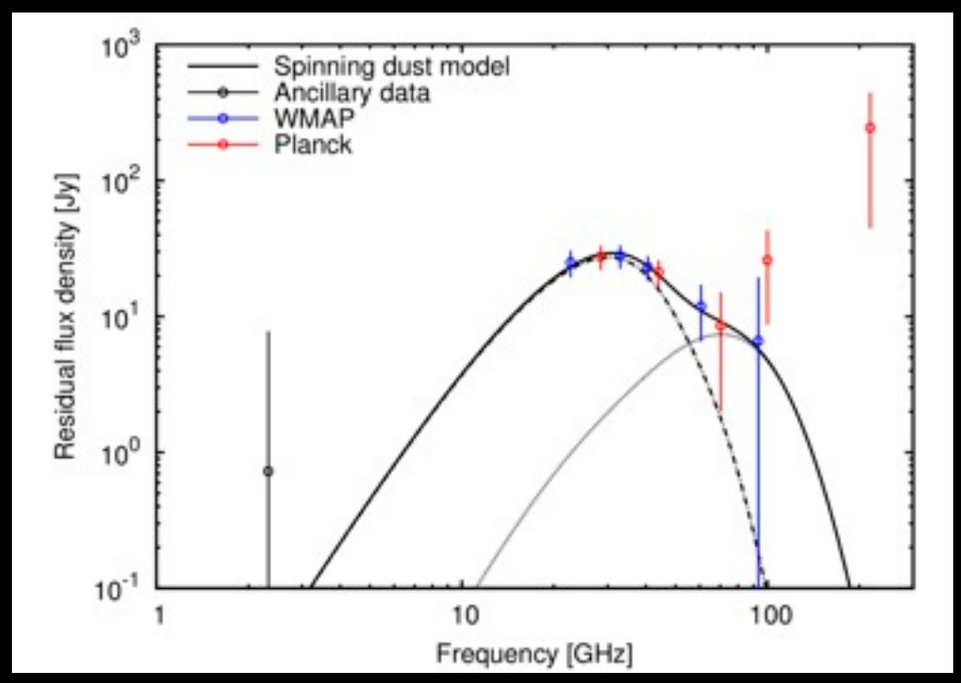
- Most precise spectra to-date for Perseus and ρ Ophiuchi clouds
  - Strong evidence for spinning dust model





Perseus (G160.26-18.62)

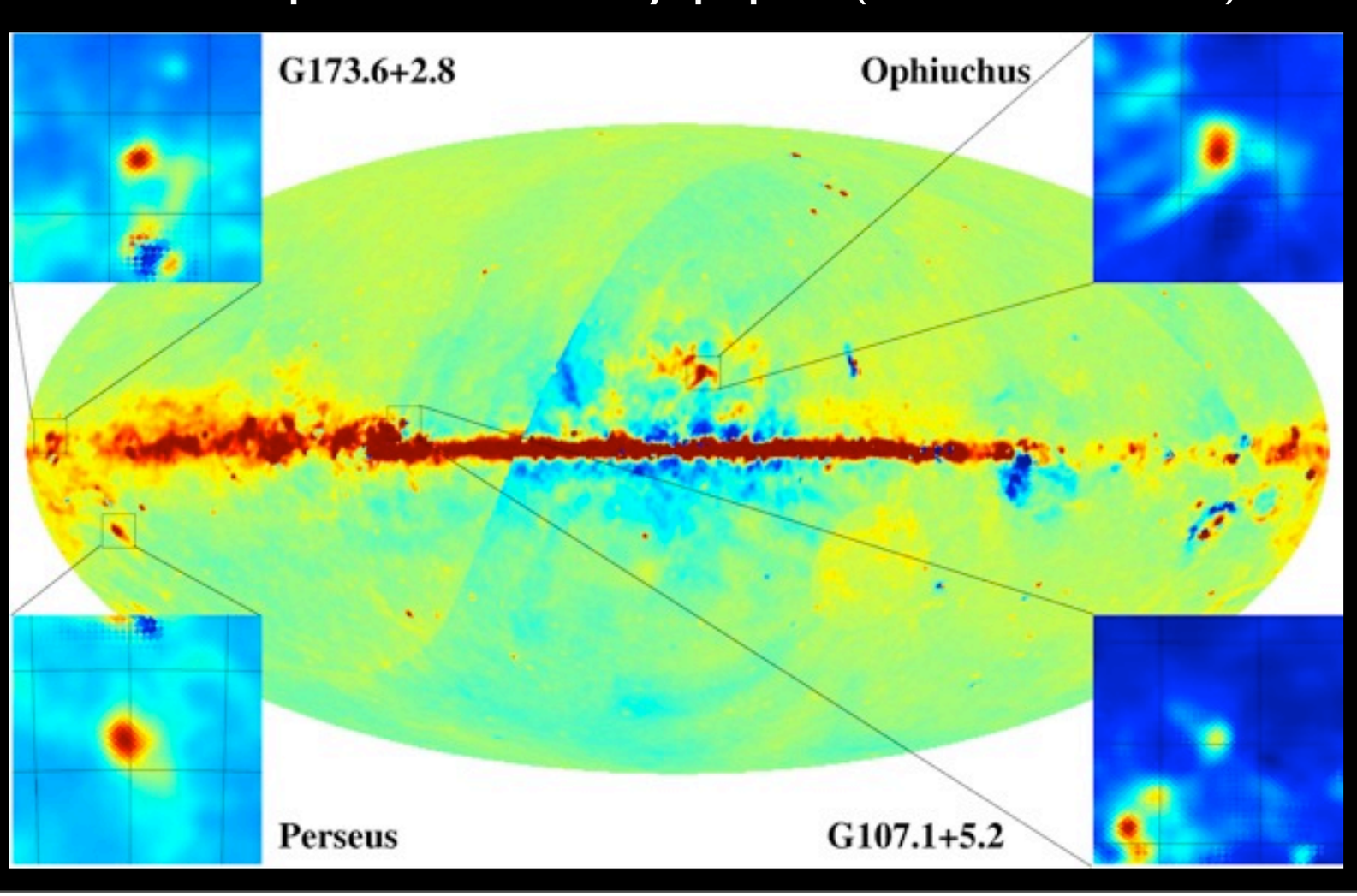




ρ Ophiuchus (G353.05+16.90)

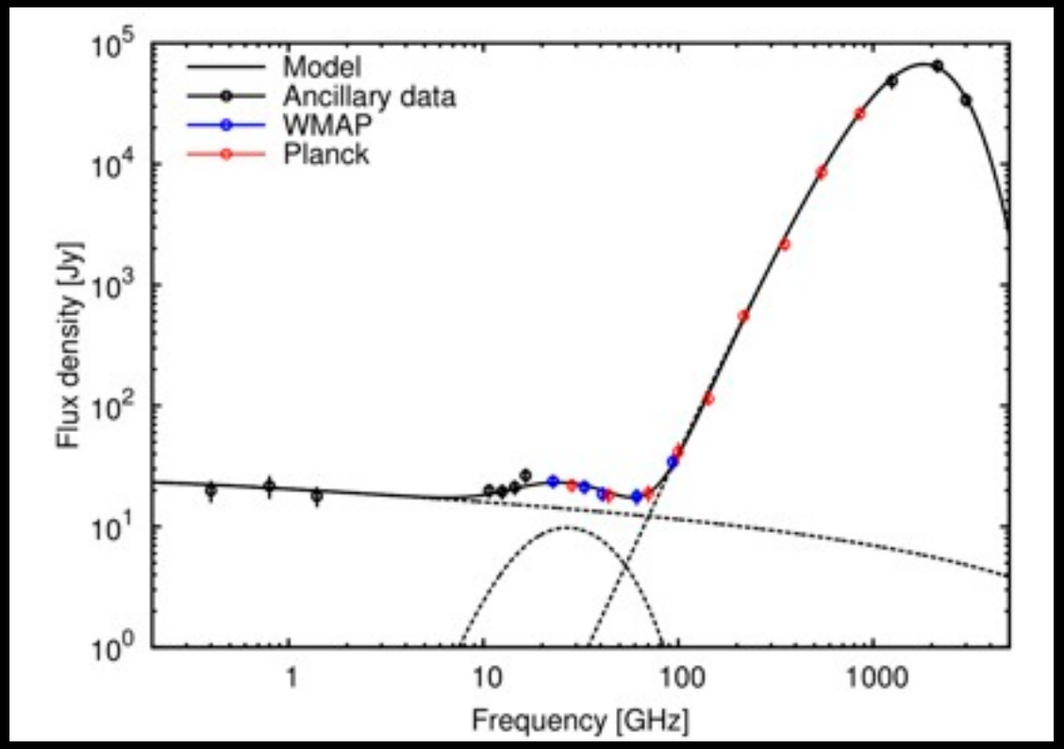
Early paper: Finding new AME regions (1)

- Use simplistic approach to remove synchrotron, free-free, thermal dust from Planck 28.5 GHz map
  - Use templates and extrapolate!
- Residual map inspected in detail to find AME regions
  - ~50 candidates inspected for early paper (2 were chosen)

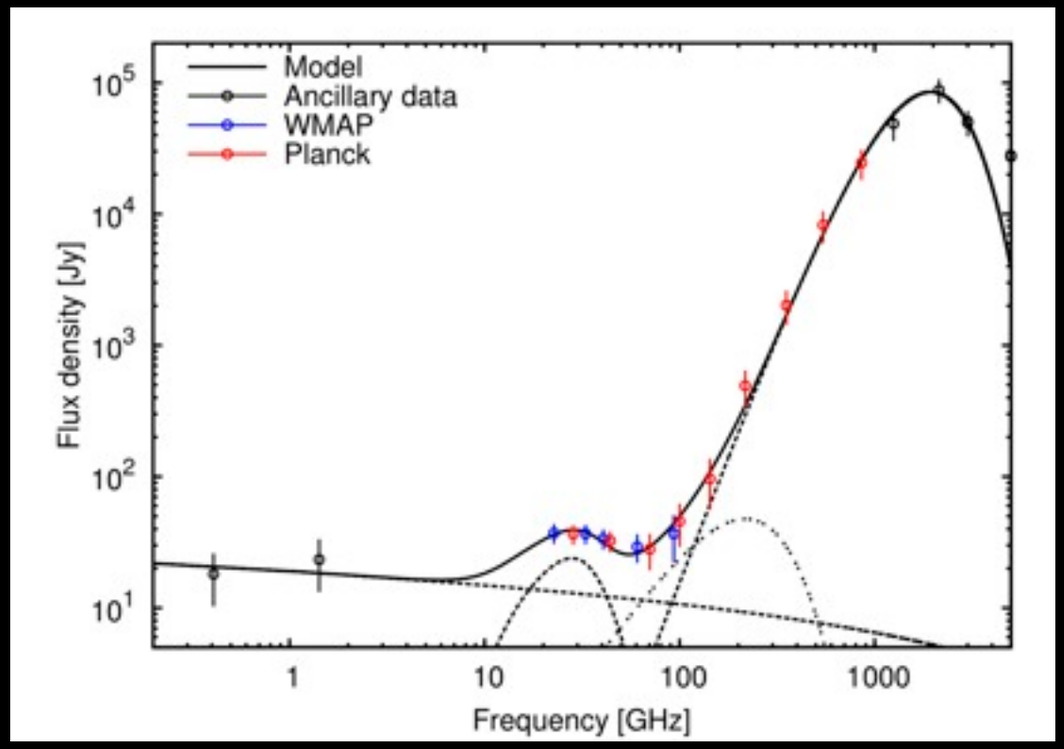


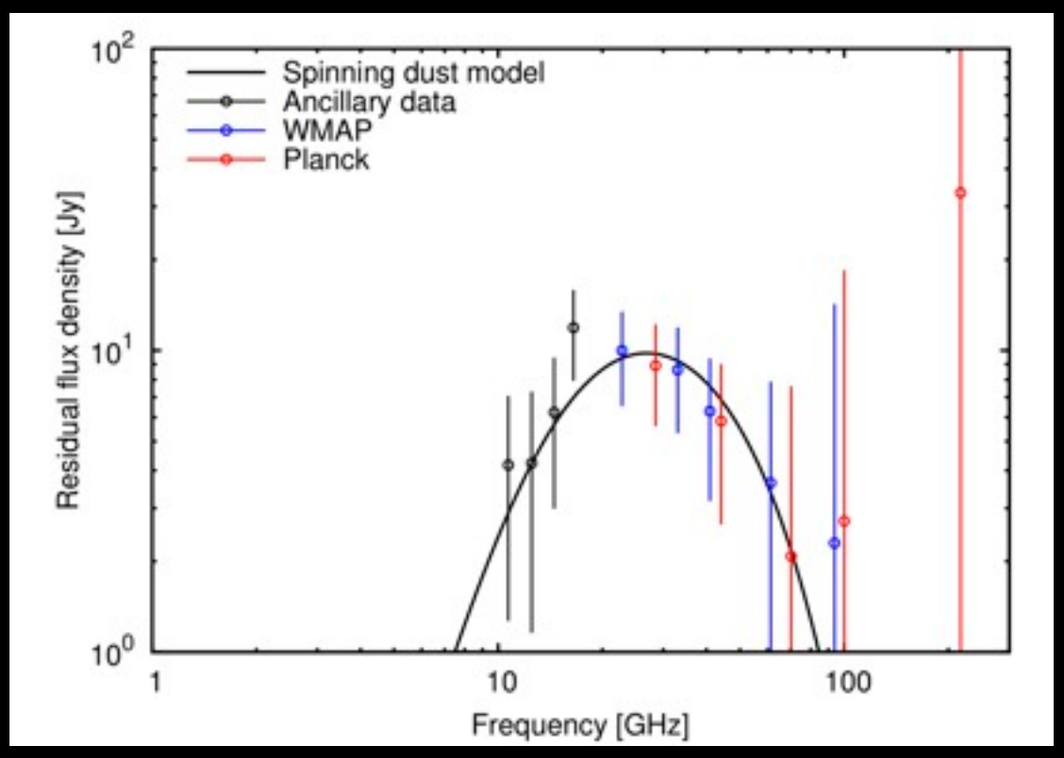
New AME regions spectra from early paper

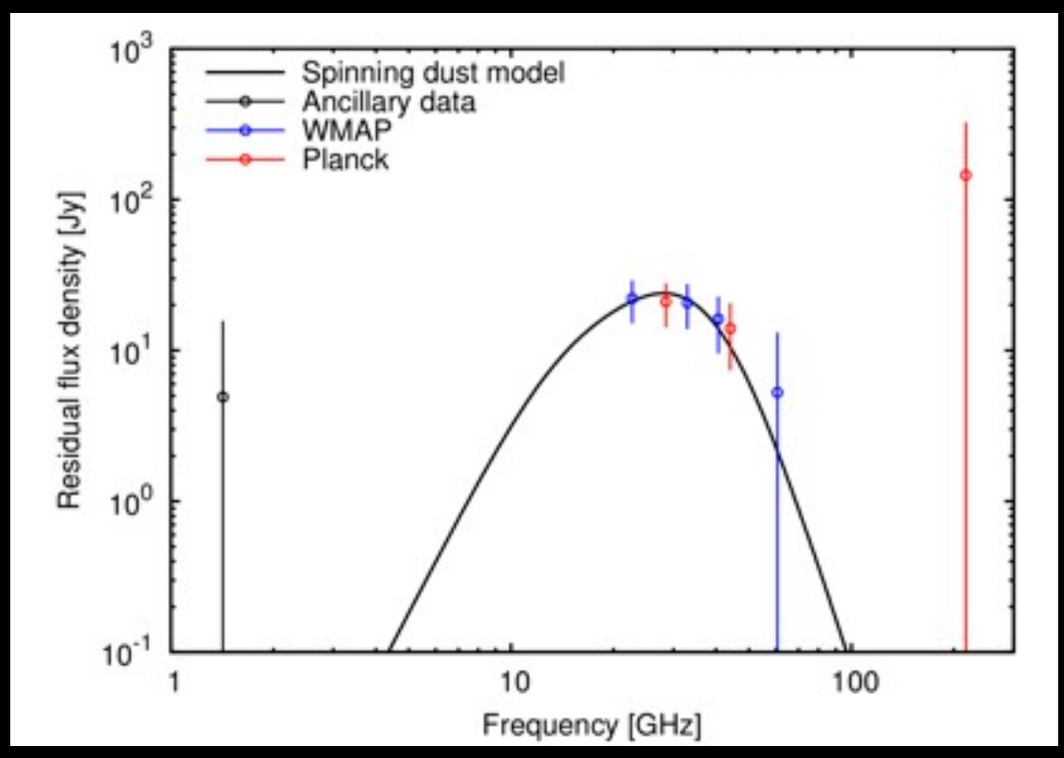
G173.6+2.80 (S235)



G107.1+5.20 (S140)





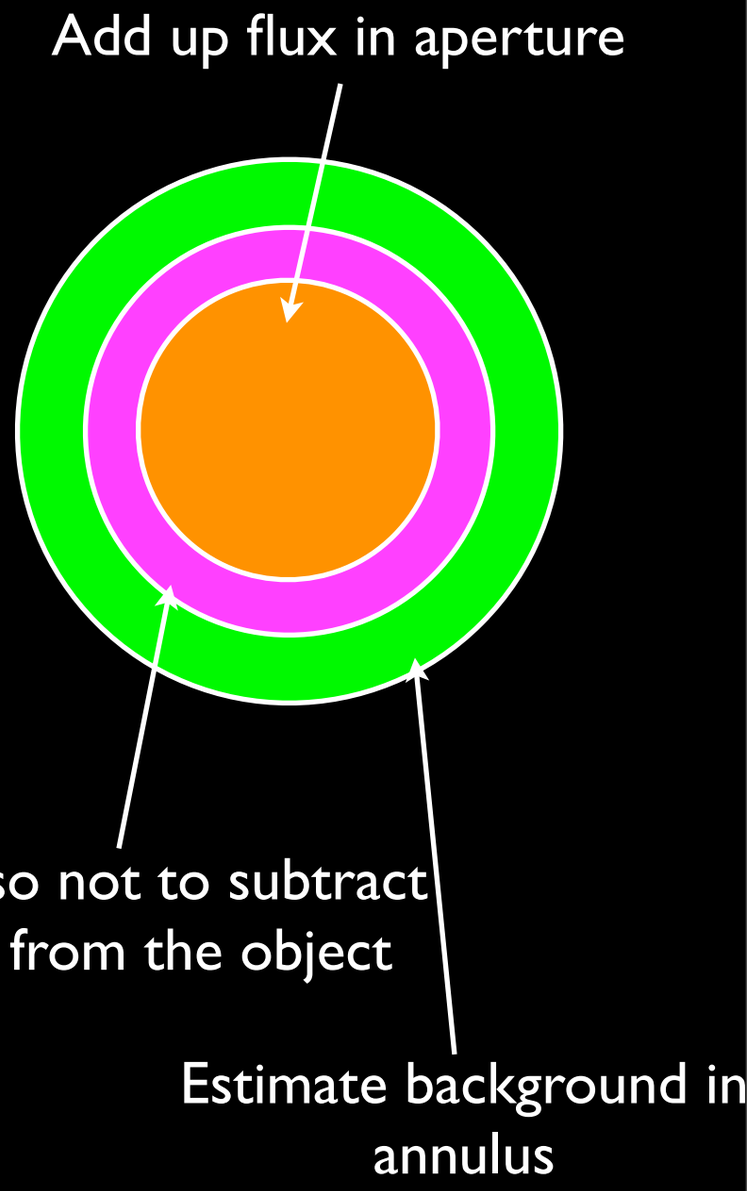


Planck intermediate paper

- Aim: Identify new AME candidates and make first statistical analysis
- Find reliable bright sources that are bright at all Planck frequencies
  - Typically HII regions!
  - Keep good non-AME HII regions to compare with AME regions!
- Source detection (SExtractor) at 70 GHz
  - Band-merge (cross-match) with 30 and 100 GHz
  - Remove extragalactic, SNRs, PNe etc.
  - 164 sources
- Remove sources that are not well-defined in the map or weak (<<10 Jy@30 GHz)...
  - 99 sources left (currently)

Aperture Photometry

- Integrated flux density (Jy) in 60 arcmin radius aperture
  - Background subtracted in annulus between 80 and 120 arcmin
  - Uncertainty estimated from scatter in the background annulus
  - Apply colour corrections
- Use data from Planck +WMAP + DIRBE/IRAS + low frequency radio surveys at 0.408, 1.42 and 2.3 GHz
- Very conservative error bars, especially for low frequency data (~20%)

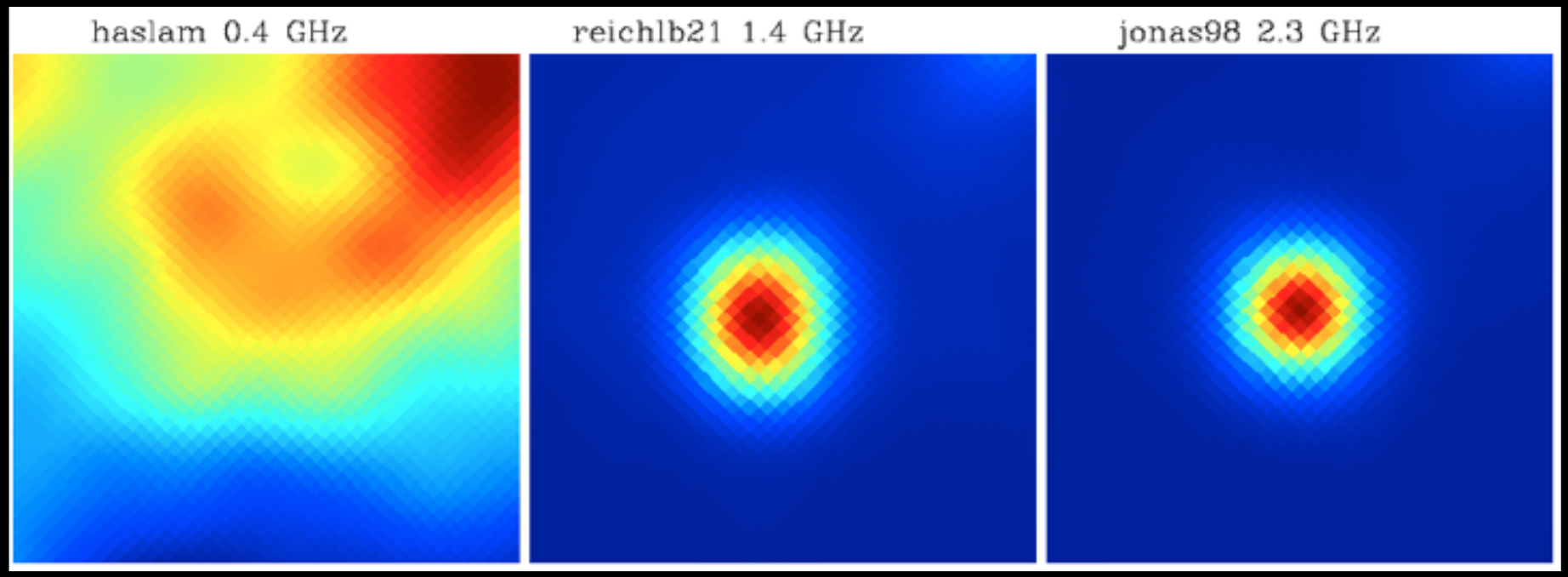


Haslam et al. 408 MHz map

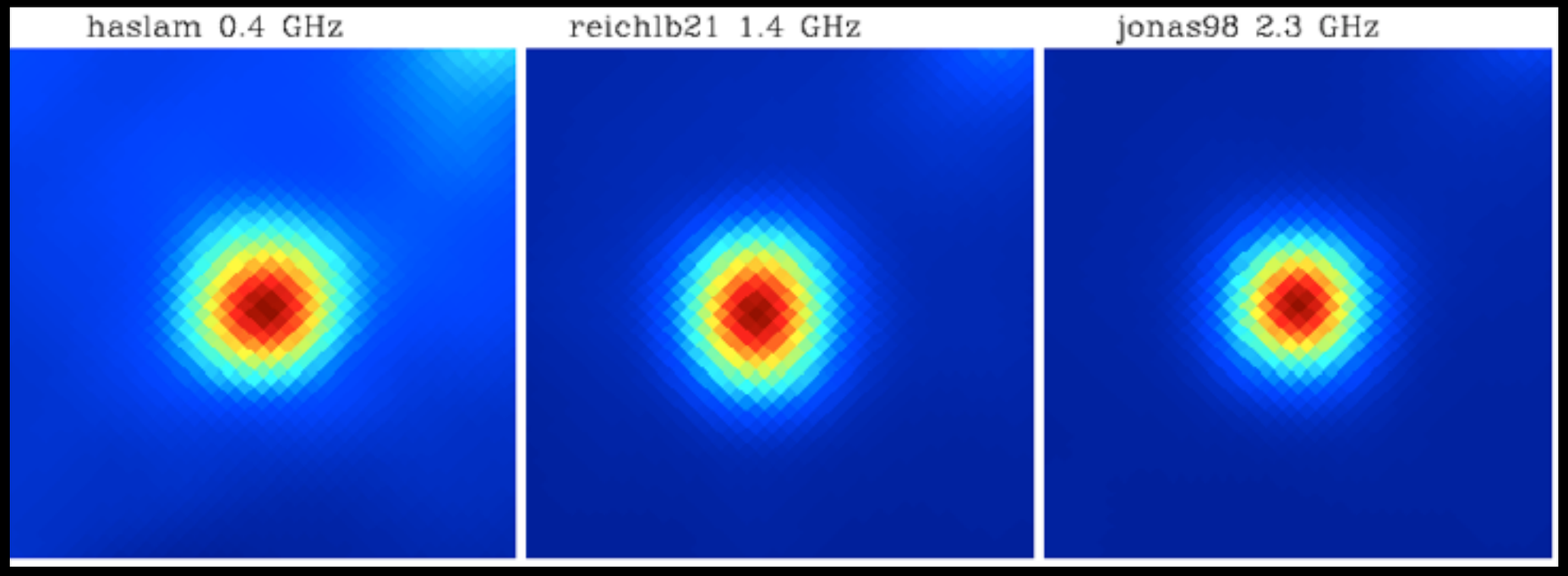
Radio maps must not be source-subtracted!

(Haslam et al. 408 MHz map on LAMBDA website no good for this)

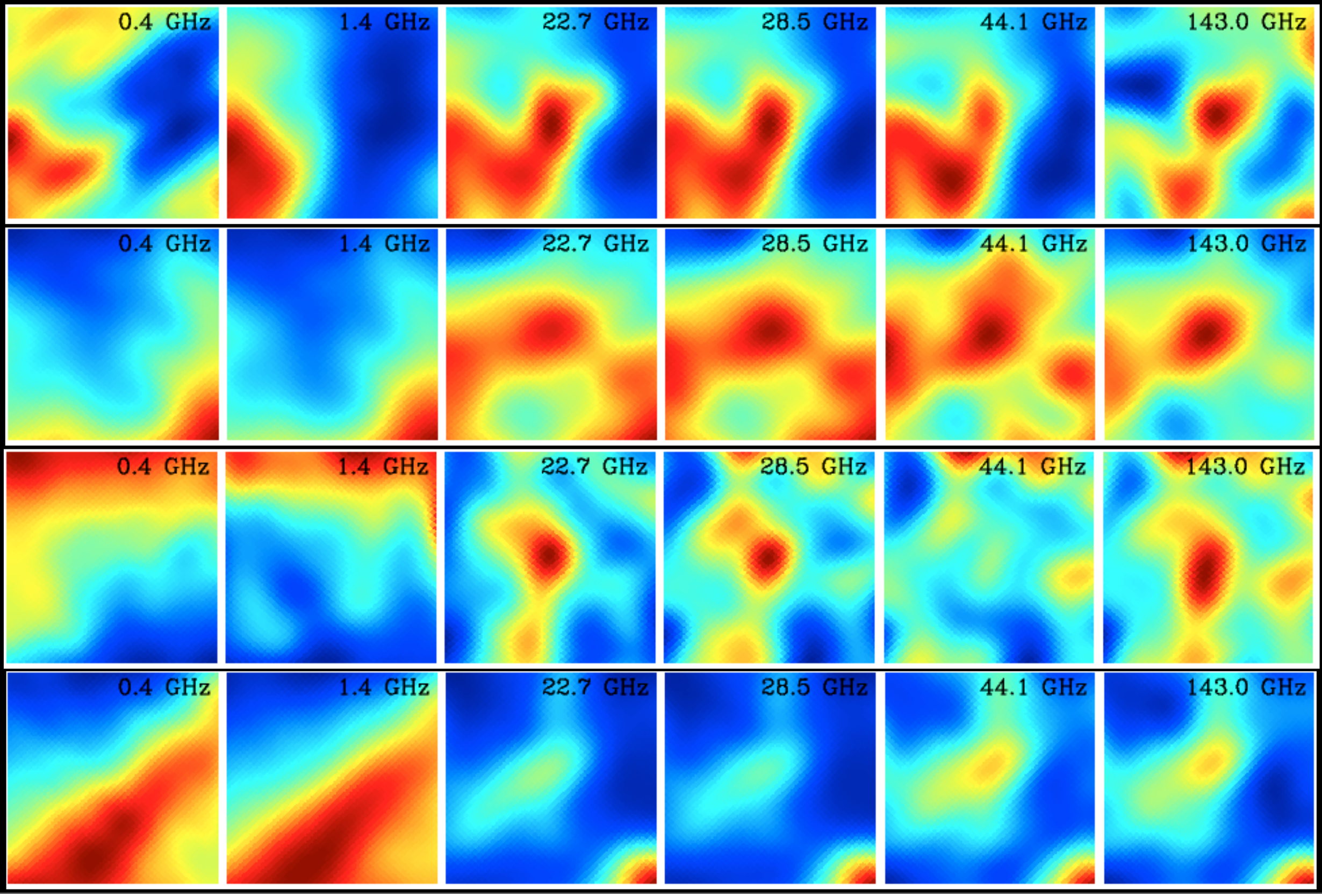
LAMBDA (NCSA)



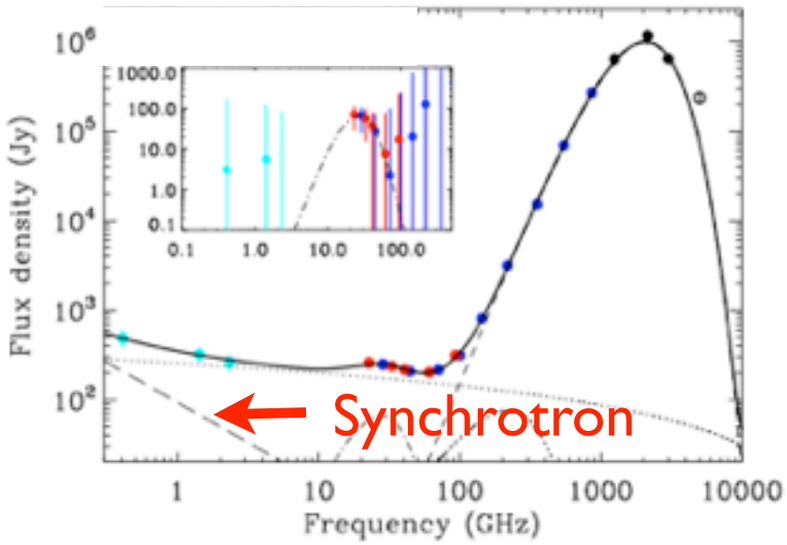
"Original"

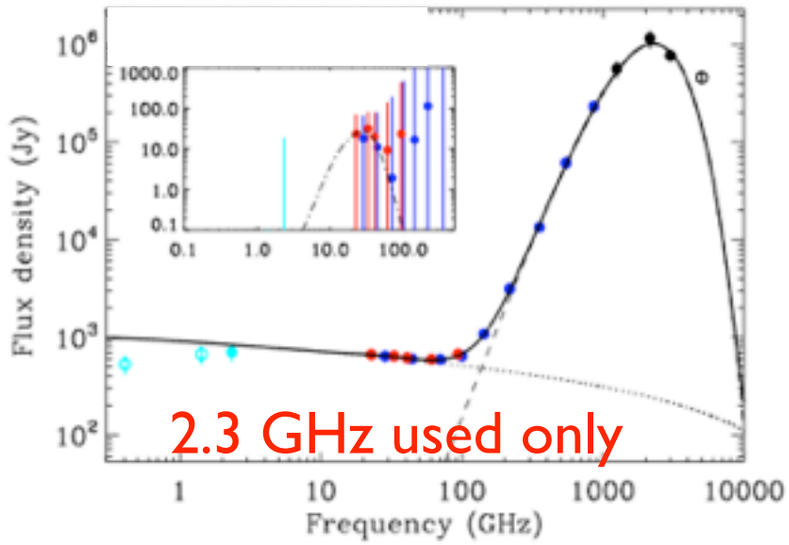


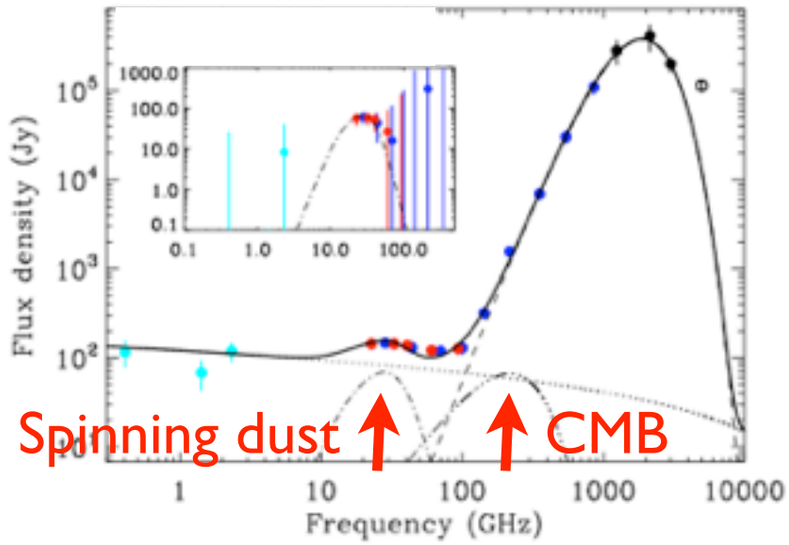
Maps of new AME regions

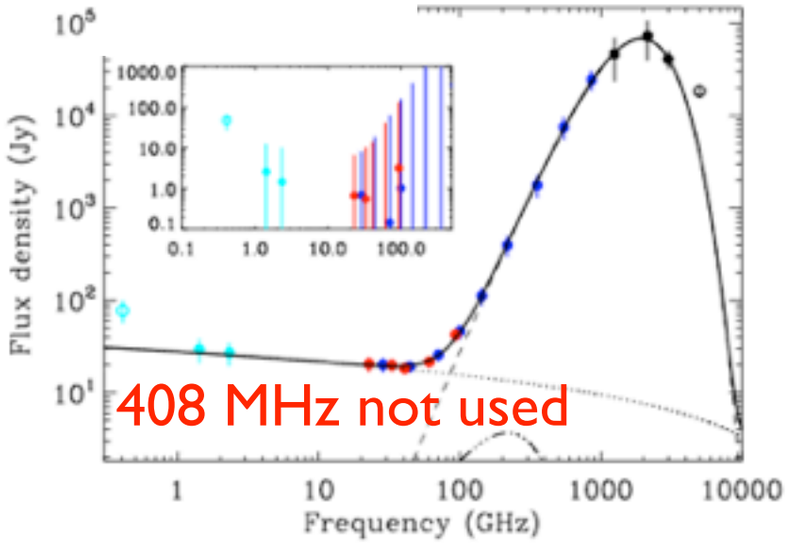


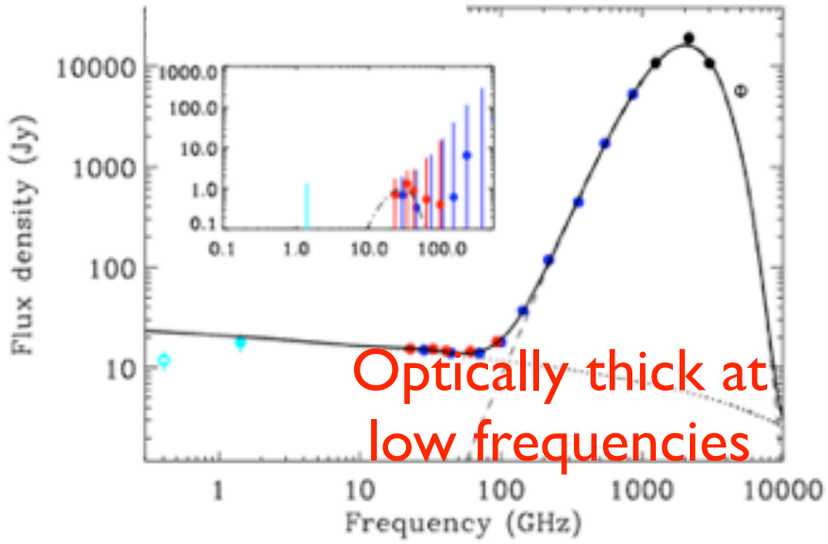
Example spectra

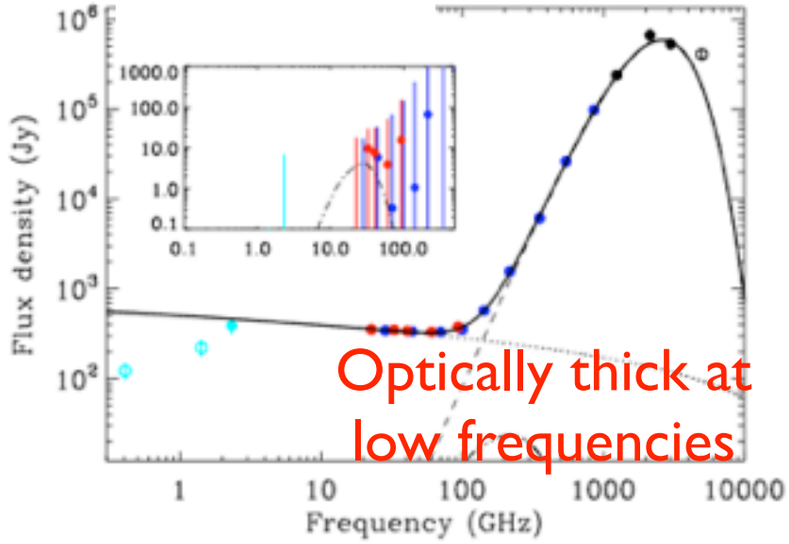


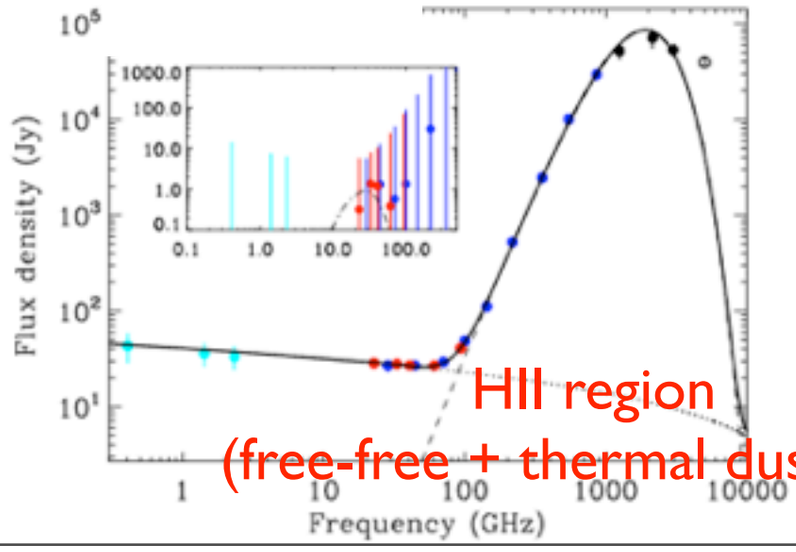


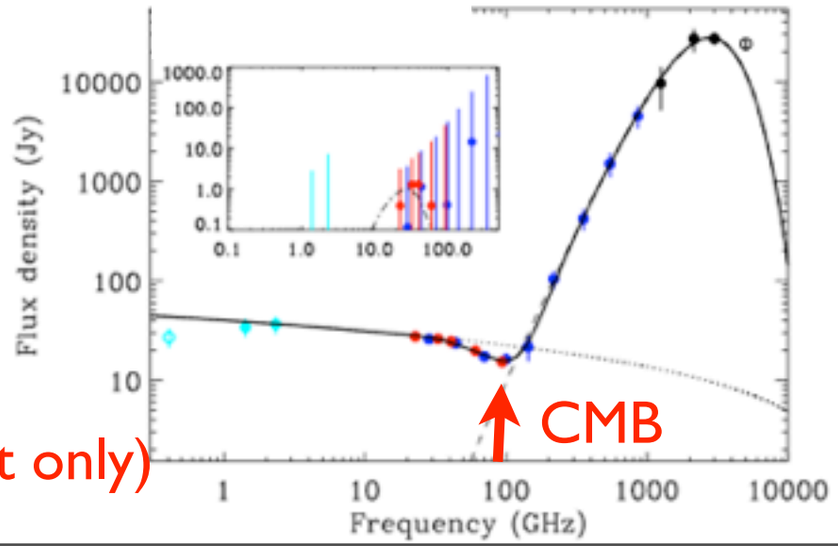


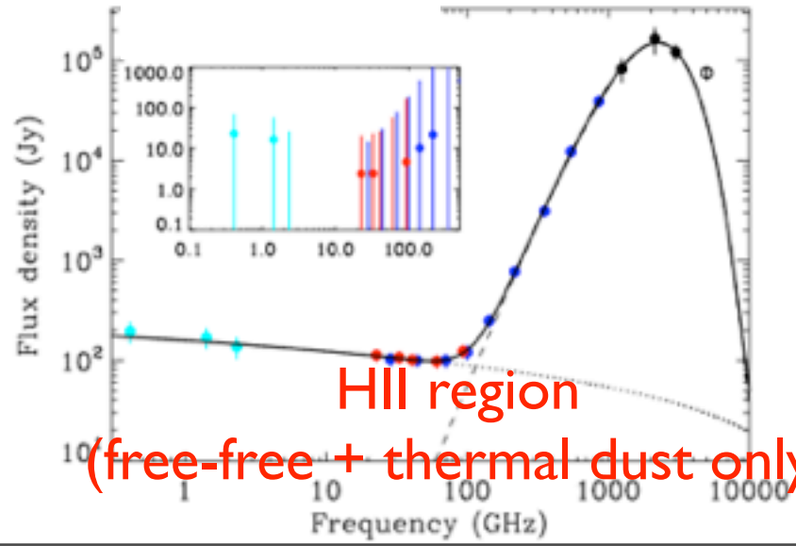




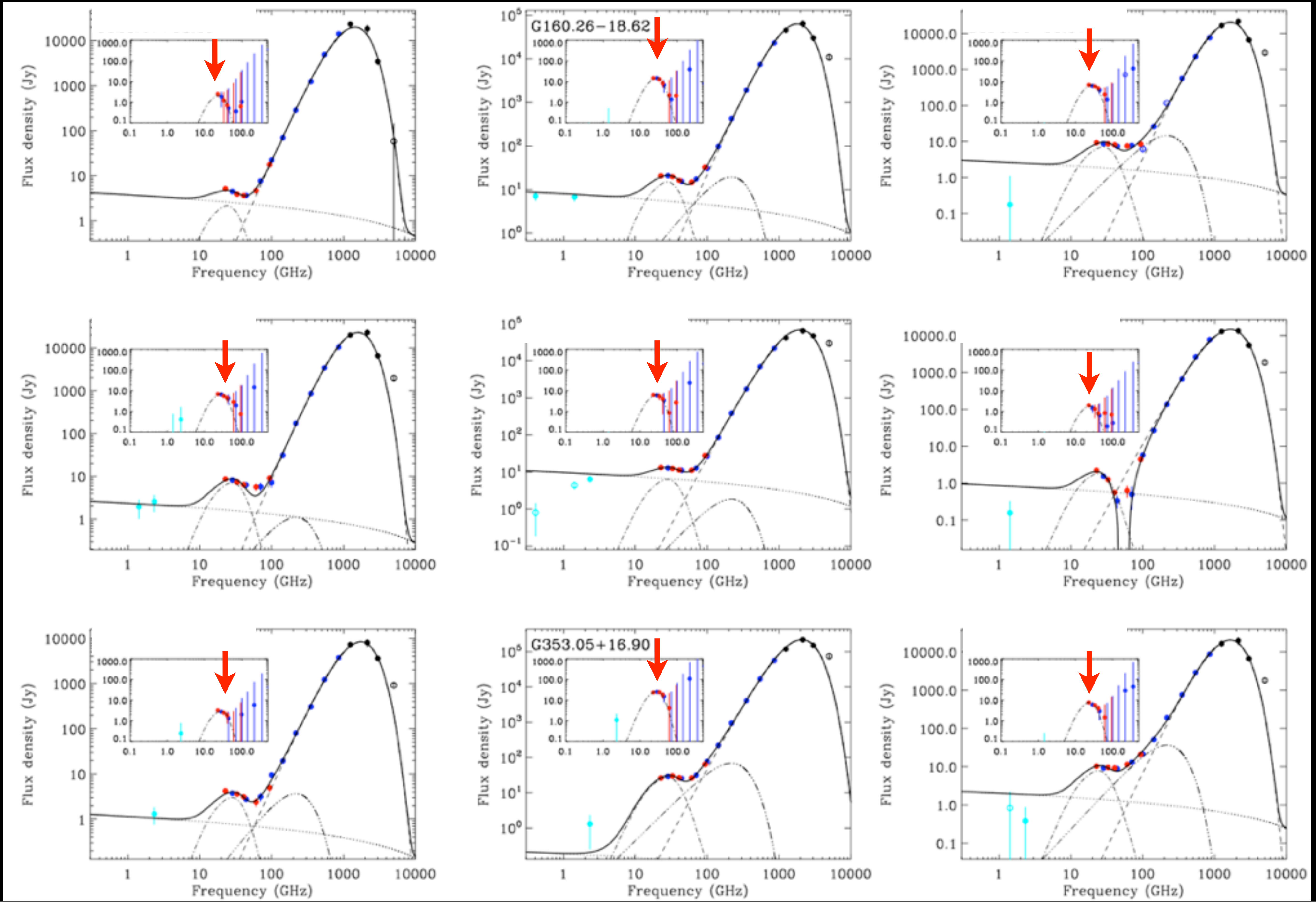






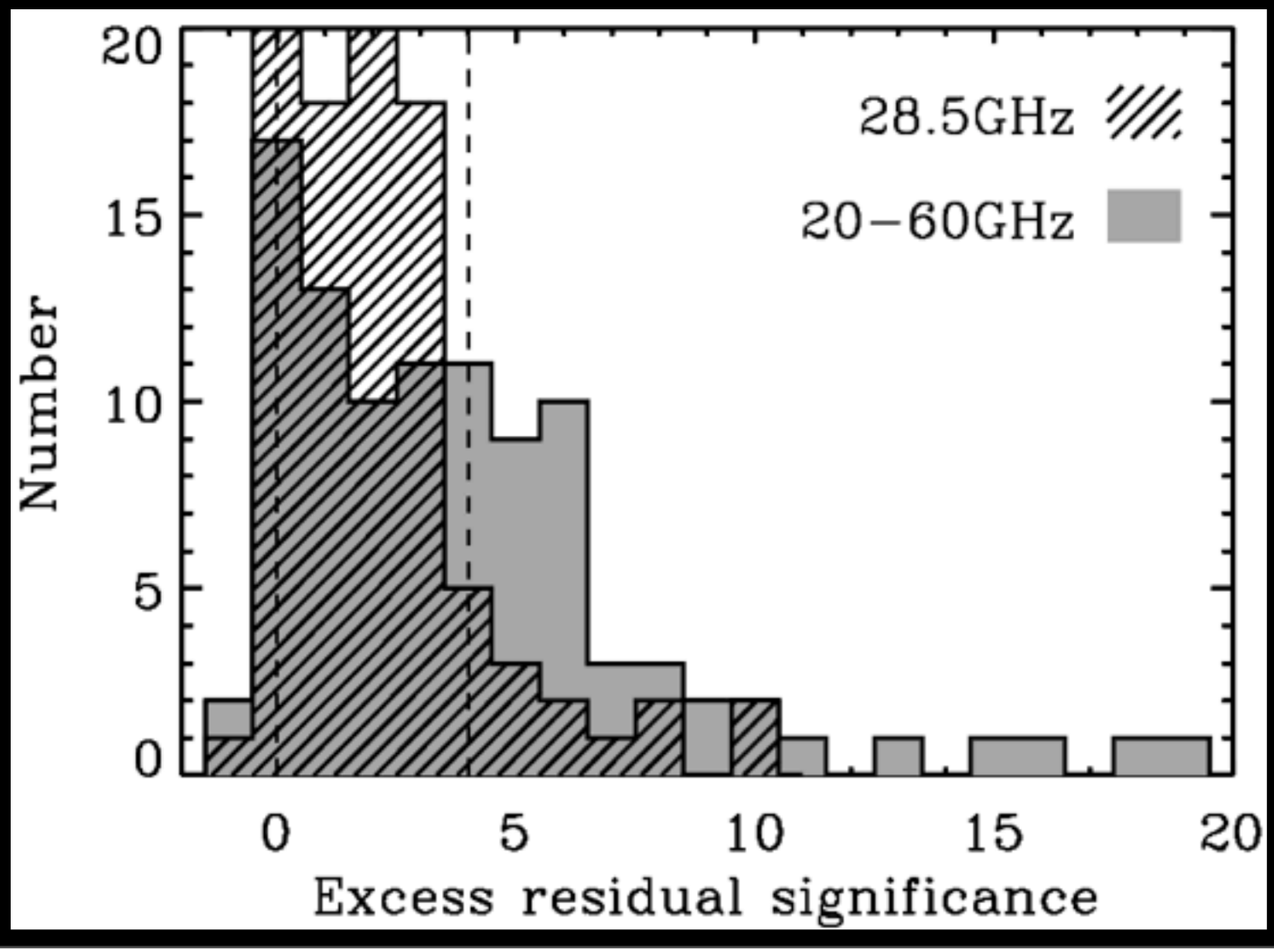


Example spectra with significant spinning dust



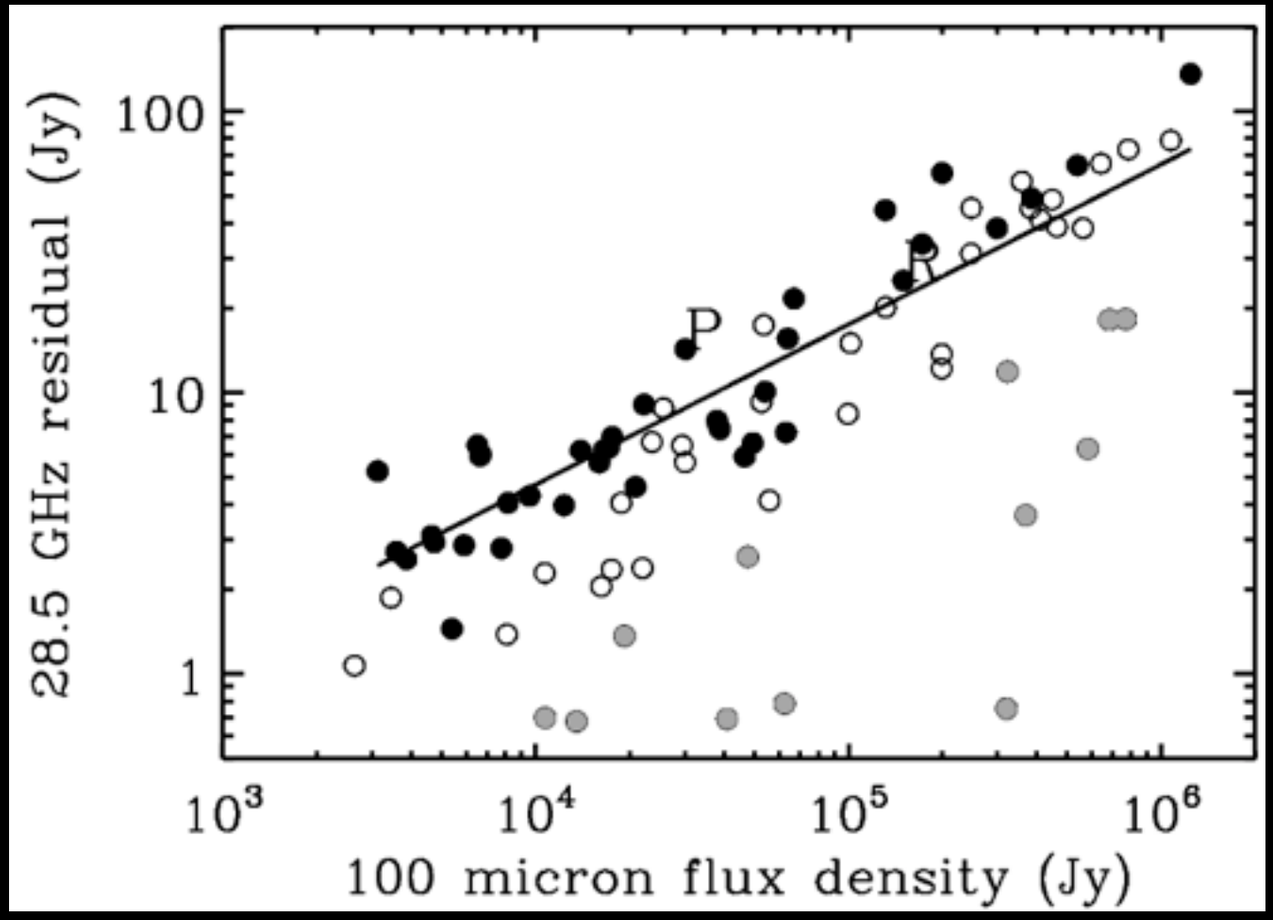
Significance

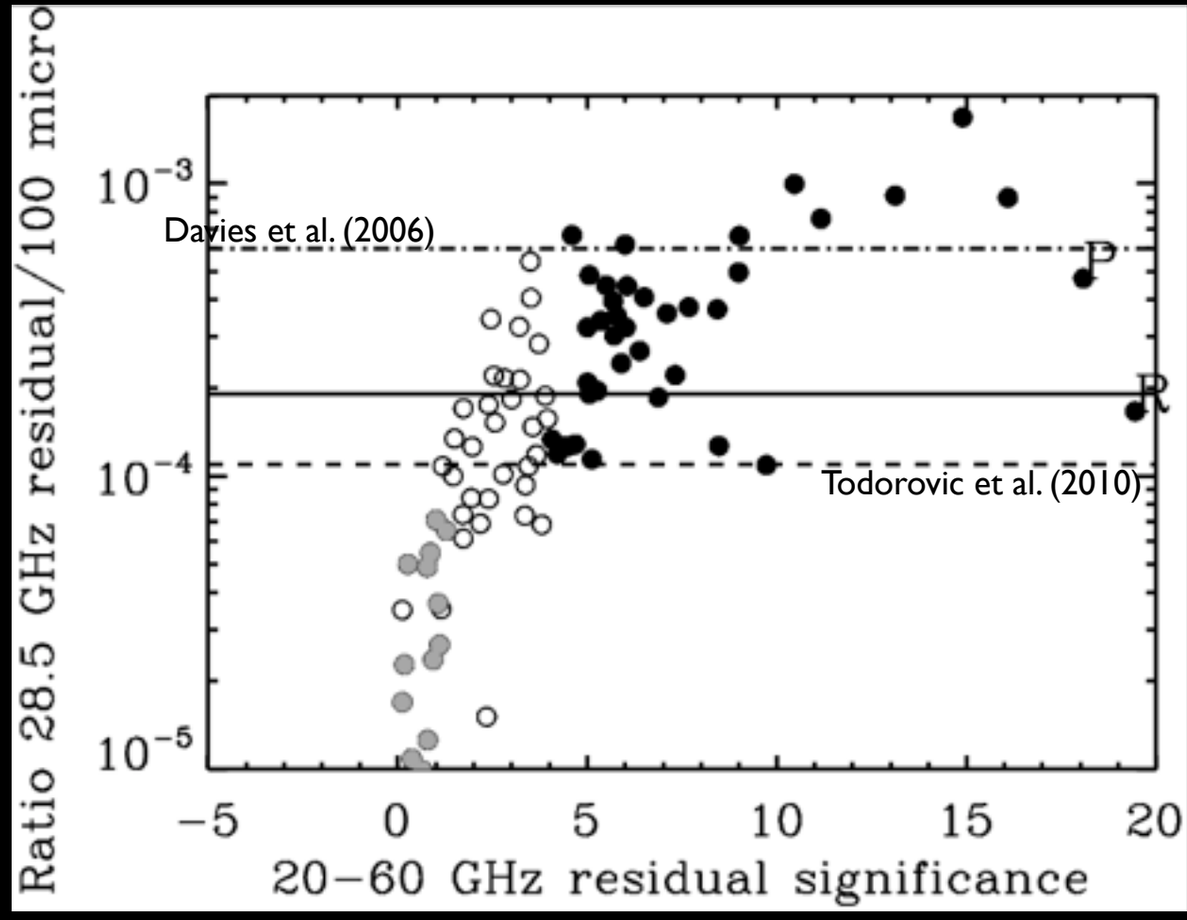
- Many sources show evidence of excess emission ~20-60 GHz
- ~20-30 show high significance (>4σ at 20-60 GHz and >20% AME)
  - Similar number show no significance (<1.5σ and <5% AME content)
  - Similar number in between (possible small AME contribution)



AME vs 100 micron

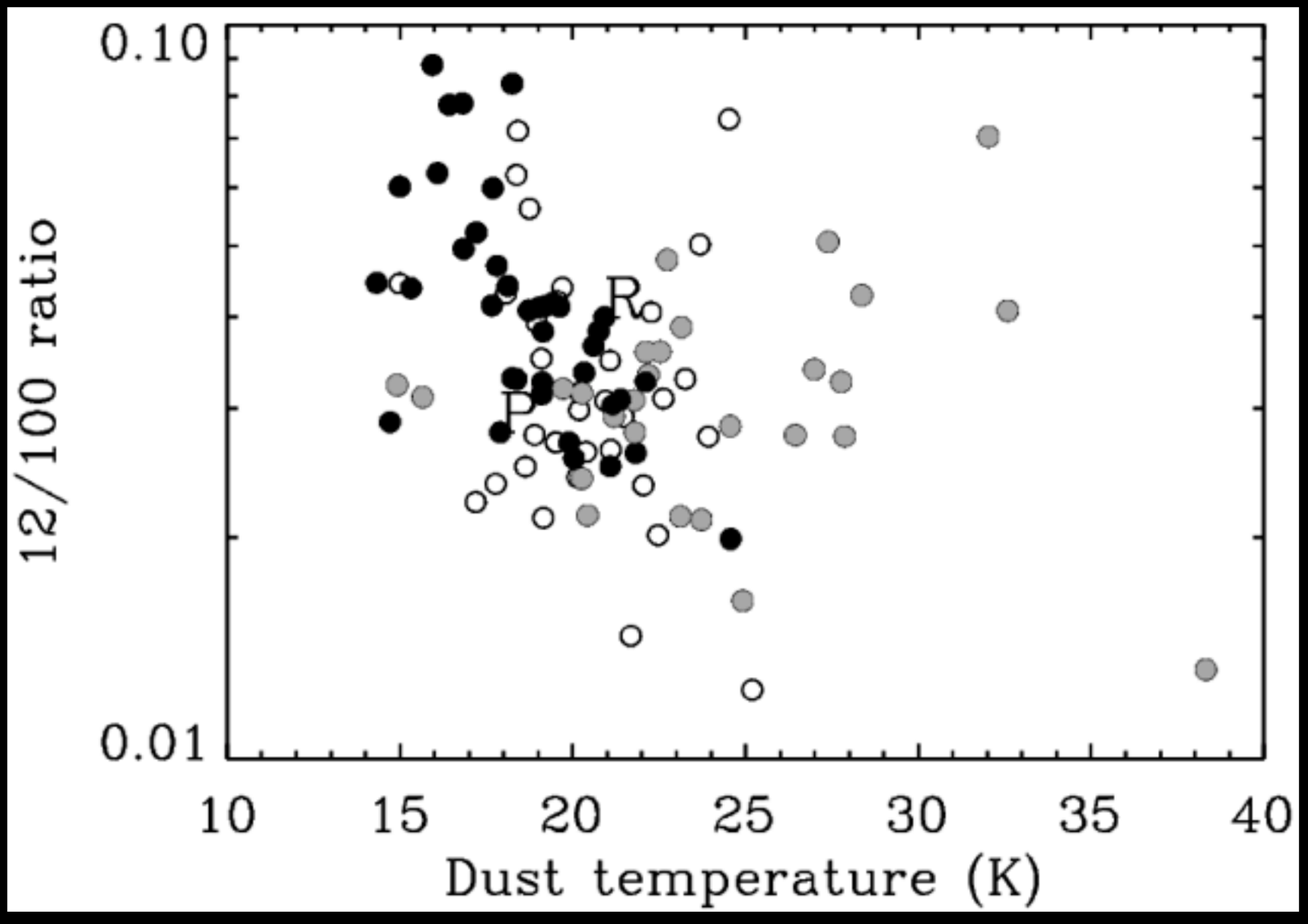
- Strong correlation with thermal dust
  - AME objects show much tighter correlation (as expected)
  - r~0.95 vs r~0.5
- Emissivity has a large range (factor of ~10)
  - Level compatible to other clouds and high latitude AME





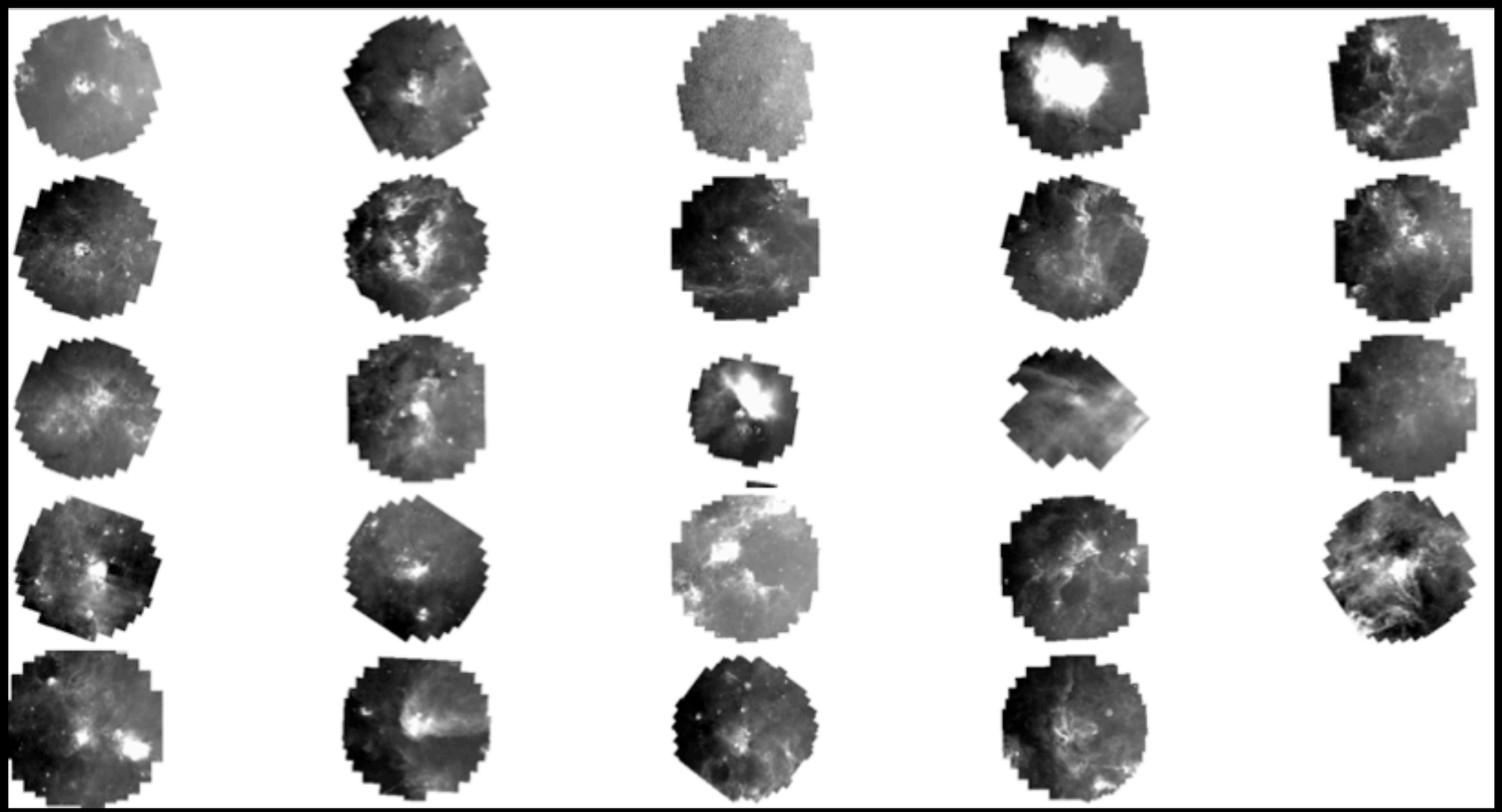
Some interesting trends...

- AME bright sources appear to have
  - Slightly colder dust temperatures (on average)
  - Higher 12/100 micron ratios



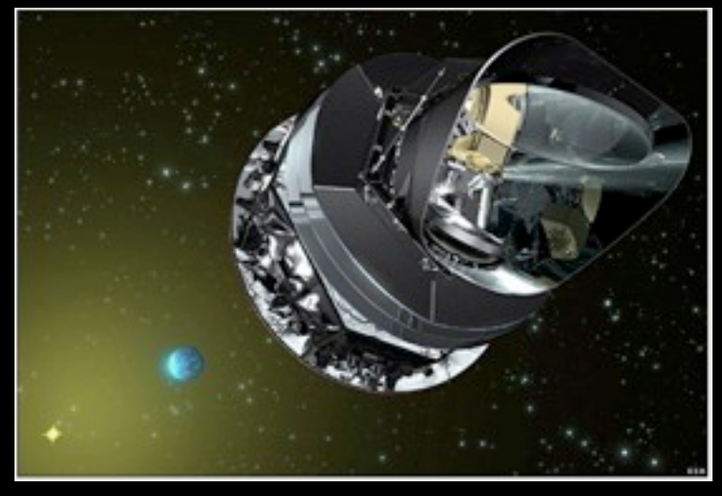
Lots of work in progress...

- Lots of correlation plots!
- Sub-sample of ~24 where Spitzer data available at 8 and 24 microns
- Possible inclusion of COSMOSOMAS (11-17 GHz) data for ~6-8 sources



Conclusions

- Early paper: (Planck collaboration et al., 2011, A&A, 536, A20)
  - Planck + ancillary data have allowed us to produce precise spectra of AME with plausible physical model
  - Spinning dust is now generally accepted (at least for a few Galactic clouds)
- Intermediate paper (Planck collaboration, in prep.):
  - New sample of clouds with at least ~1/3 showing significant AME at 20-60 GHz
  - Spinning dust generally fits well with a wide range of emissivities
  - A few interesting trends are seen which may give us a hint to the nature of spinning dust and its environment (why do some regions not show AME at all?)
- Watch out for the published paper!



Special Issue on AME

Lead guest editor: Roberta Paladini
Guest editors: Clive Dickinson & Laurent Verstraete

Contributions wanted on all aspects of AME!
(theory, modelling, latest observations, extragalactic view, history...)

http://www.hindawi.com/journals/aa/si/962430/cfp/

Manuscript deadline: Friday 8 June 2012