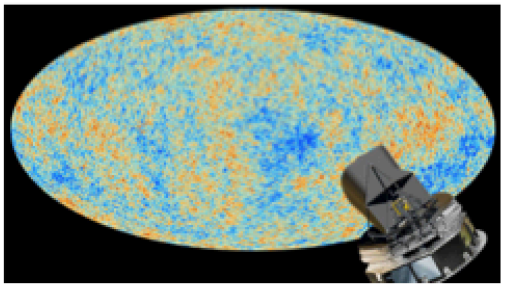
THE BANDMERGED PLANCK ERCSC

XI CHEN

NASA/IPAC Extragalactic Database (NED), Caltech

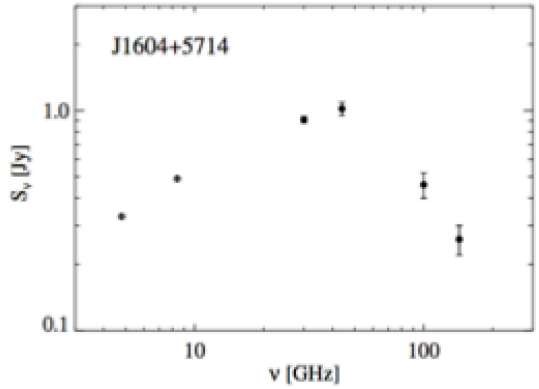
The Planck ERCSC



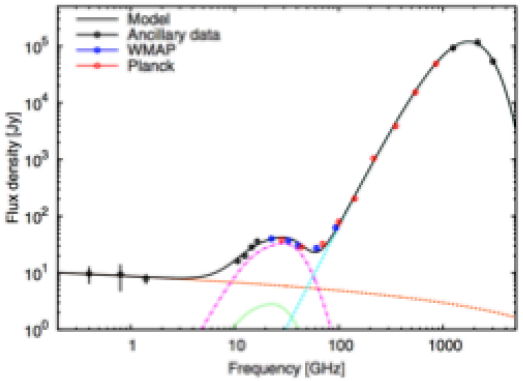
- First1.6 full-sky Planck maps
- Individual list of sources extracted per band
- Cumulative reliability > 90%

Band (GHz)	**30**	**44**	**70**	**100**	**143**	**217**	**353**	**545**	**857**
Beam FWHM (arcmin)	32.65	27.00	13.01	9.94	7.04	4.66	4.41	4.47	4.23
# of sources	705	452	599	1381	1764	5470	6984	7223	8988

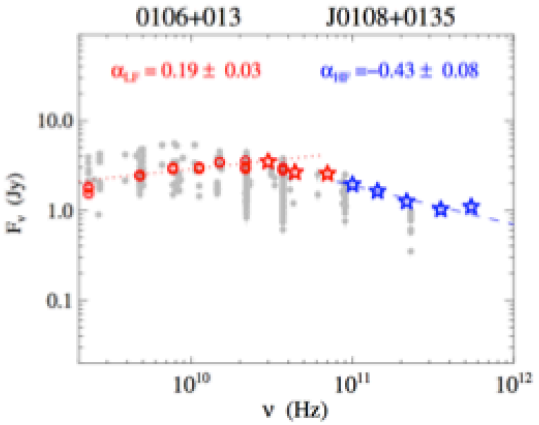
Multi-frequency power



Newly identified GPS source
(Planck Collaboration XIV 2011)



AME-G160.26-18.62 in the
Perseus molecular cloud
(Planck Collaboration XIV 2011)



SED of blazar J0108+0135
(Planck Collaboration XV 2011)

Cross-band matching

- Each of the 9 Planck bands used as 'seed' band once
- Search for matches in 'candidate' band (the rest 8 bands)
  - Rs = ½ FWHM of the larger beams of the 'seed' and 'candidate'
  - Save pointers to up to 3 qualifying matches per 'candidate' band

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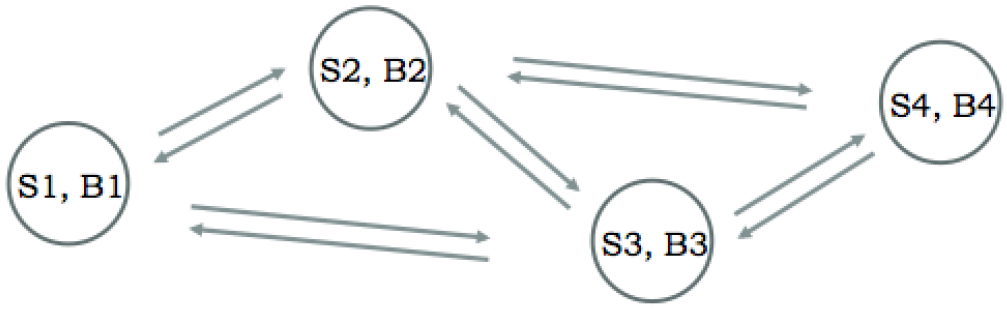
Main challenges

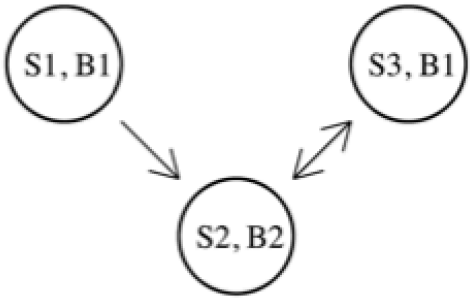
- Different resolution across the bands ⟹ source confusion
- Broad frequency coverage
  - ⟹ complications due to ISM emission
  - ⟹ synchrotron and free-free emission dominated frequencies transitioned to thermal dust emission dominated frequencies

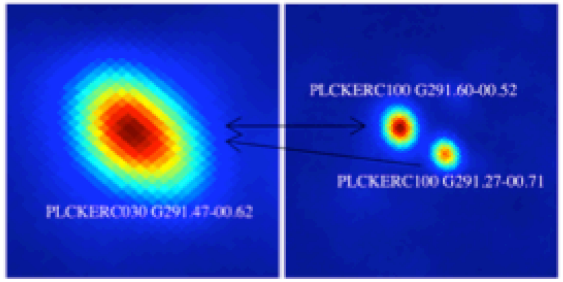


Confusion Processing (1)

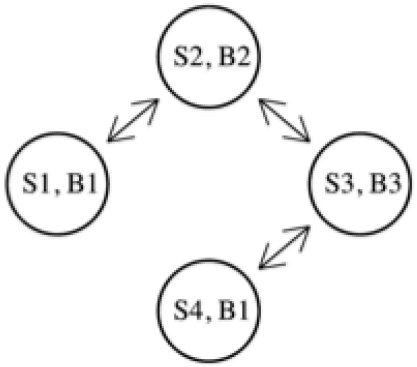
- Inconsistent Chain
  - A given seed source's 1st choice counterpart in a candidate band does not have a reciprocal 1st choice pointer back to the given source.

- Solution
  - Loop over all source records to check preferred pointers are symmetric. If not, follow the chain to find reciprocal relation and break the previous link. For the broken link, elevate 2nd choice pointer to 1st, repeat the process until only reciprocal links remain.



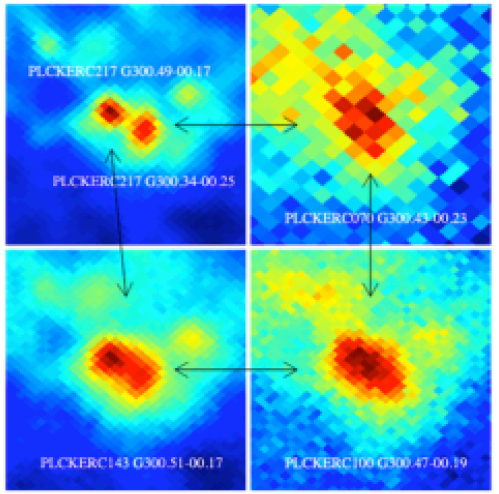


Confusion Processing (2)



- Excess Linkage
  - All the linkages in a chain are reciprocal, but the end of the chain points to a different detection than the one that started the chain.
  - Mostly caused by lower resolution detection resolved into multiple sources in higher resolution bands.

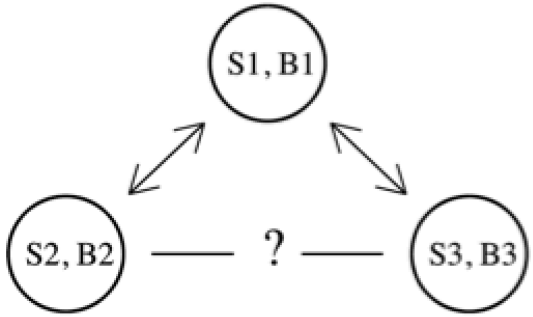
- Solution
  - Break the links between resolved detections and unresolved ones, and list them separately in the bandmerged catalog.

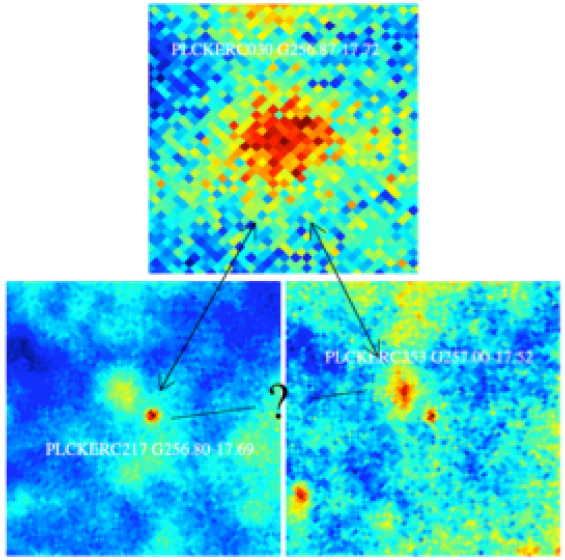


Confusion Processing (3)

- Linkage rejection
  - Not all detections in a single merged chain are linked to each other.
  - Mainly caused by difference in the beam sizes in different bands, hence the different Rs used for each pair of matches.

- Solution
  - Temporarily associate the unlinked detections if they are within 1FWHM of each other. Inspect the images to confirm the link or break it.

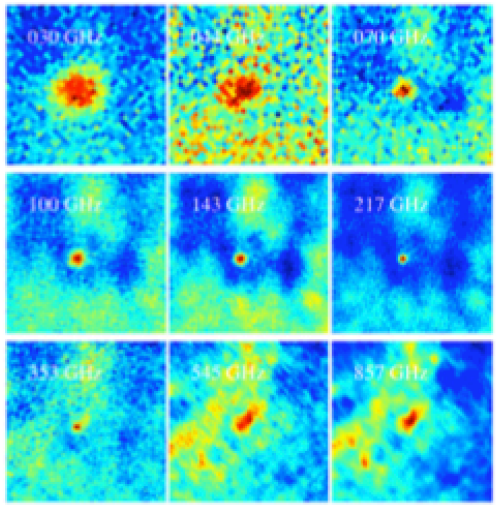


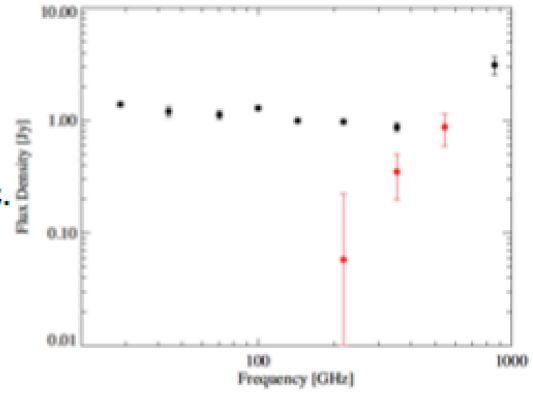


Confusion Processing (4)

- Cirrus contamination
  - ISM emission gets stronger between 353 and 857 GHz, Galactic cirrus features can be confused with compact sources.

- Solution
  - Select sources with bandmerged 217-545 GHz flux densities that differ significantly from the bandfilled flux densities. Break links of sources with EXTENDED flag set to 0 at 217 and 353 GHz, and 1 at 545 and 857 GHz.



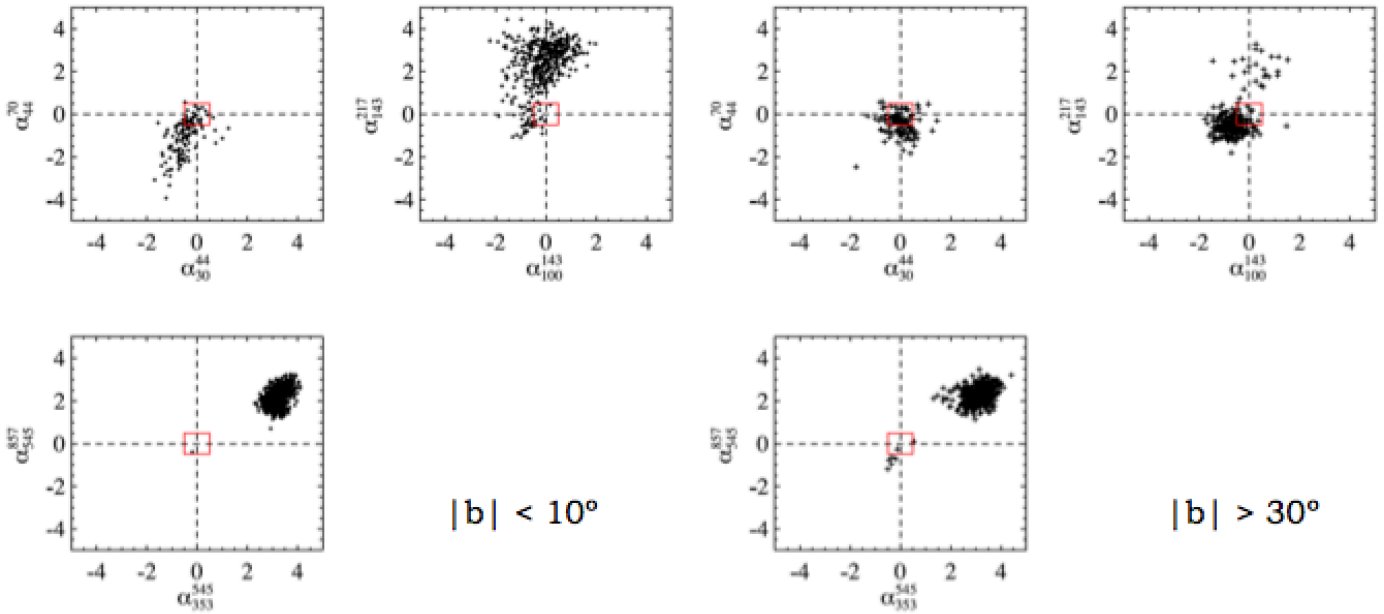


The Bandmerged Catalog

- 15191 entries (79 sources across all 9 bands, 6818 only in one band)
- Available at the NASA Planck Archive.

Parameter	Description
NAME	Source name
GLON	Galactic longitude (deg)
GLAT	Galactic latitude (deg)
RA	Right ascension in J2000 (deg)
Dec.	Declination in J2000 (deg)
NBAND	Number of *Planck* bands with detection
FLUX	Flux density (mJy) in the *Planck* bands, set to NaN if not available.
FLUX_ERR	Flux-density uncertainty (mJy) in the *Planck* bands, set to NaN if not available.
ERCSC_NAME	Name of the source in the ERCSC, set to blank if not available.
NOTE	Flag, set to 1 if there is an entry in the notes file.

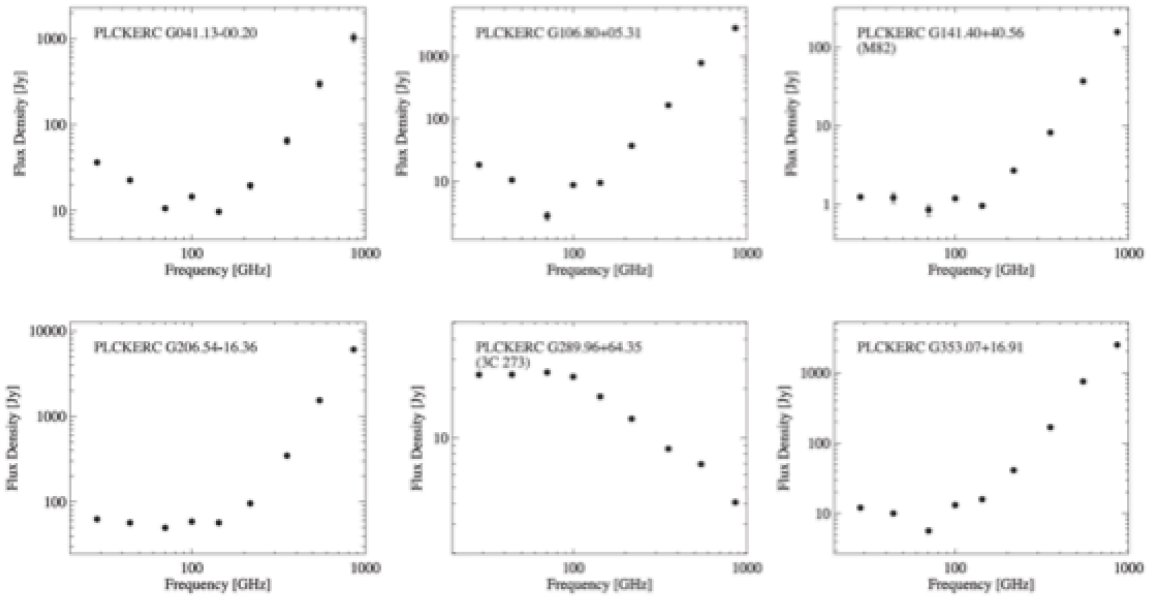
Spectral types



|b| < 10°

|b| > 30°

Sources detected in all 9 bands



- CO J = 1-> 0 line at 115 GHz falls within Planck 100 GHz channel bandpass (Planck HFI Core Team 2011).
- Probably Galactic, along the line of sight between the satellite and the source.
- Could be intrinsic, as a modest redshift (z~0.1) would shift the line further inside the 100 GHz bandpass.

Assess the flux excess due to CO - Approach I

- Select sources detected at 100 GHz, ≧2 lower frequency channels, and ≧2 higher frequency channels (367 total).

- Fit simple models to SEDs (excluding f_{100GHz}, 225 yield good fit).

(i) single power law

$$\log S = p_0 + p_1 \log \nu$$

(ii) quadratic fit

$$\log S = p_0 + p_1 \log \nu + p_2 (\log \nu)^2$$

(iii) double power law

$$S = p_0 (\nu/\nu_0)^{p_1} + p_2 (\nu/\nu_0)^{p_3}$$

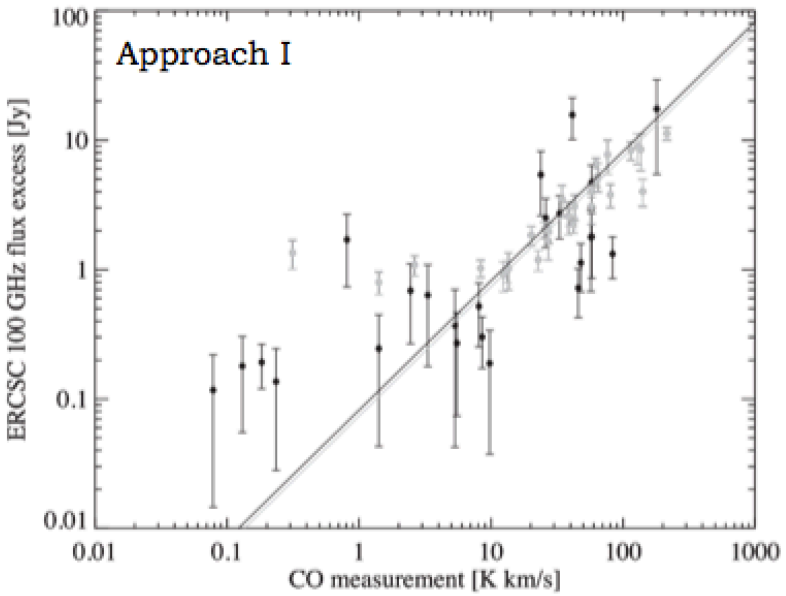
- Define flux excess as $S_{excess} > \boldsymbol{\sigma}_{excess}$ (123 have excess)

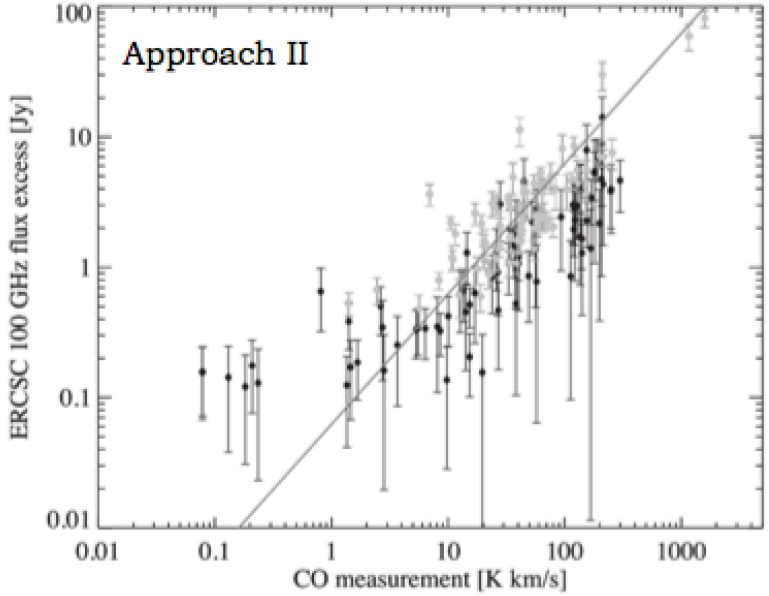
$$S_{\rm excess} = S_{100}^{\rm ERCSC} - S_{100}^{\rm model} \qquad \sigma_{\rm excess} = \sqrt{(\sigma_{100}^{\rm model})^2 + (\sigma_{100}^{\rm ERCSC})^2}$$

Assess the flux excess due to CO - Approach II

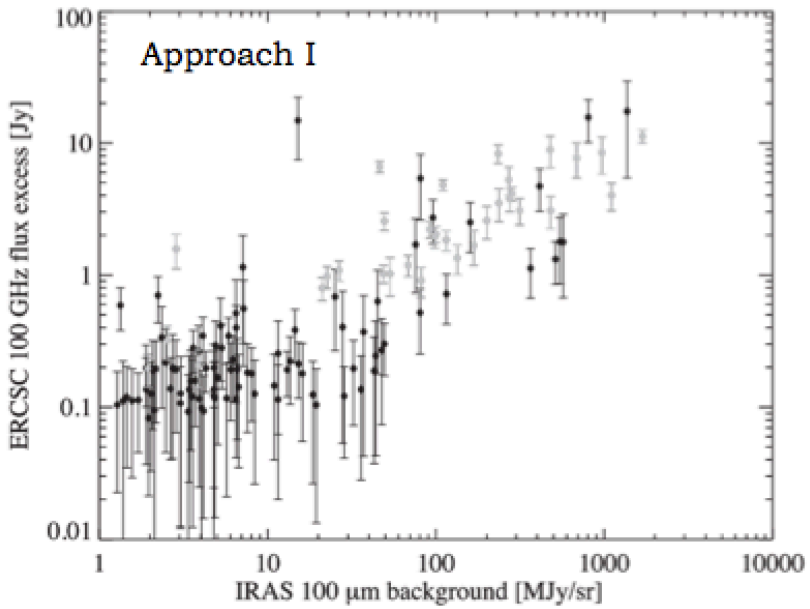
- Select sources detected at 70, 100 and 143 GHz channels (482 total).
- Interpolate between the 70 and 143 GHz flux densities to approximate the true 100 GHz flux density.
- Define flux excess as $S_{excess} > \sigma_{excess}$ (254 have excess).

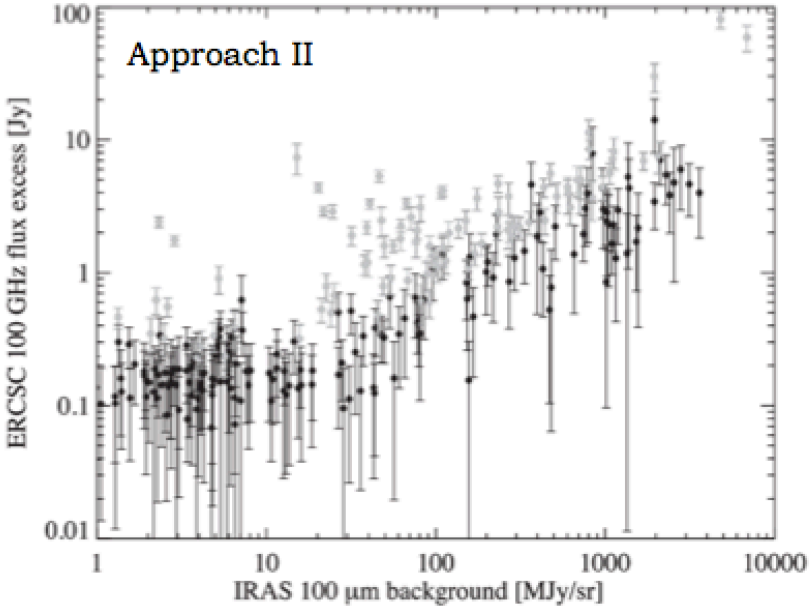
Comparison with Dame et al. (2001) CO map





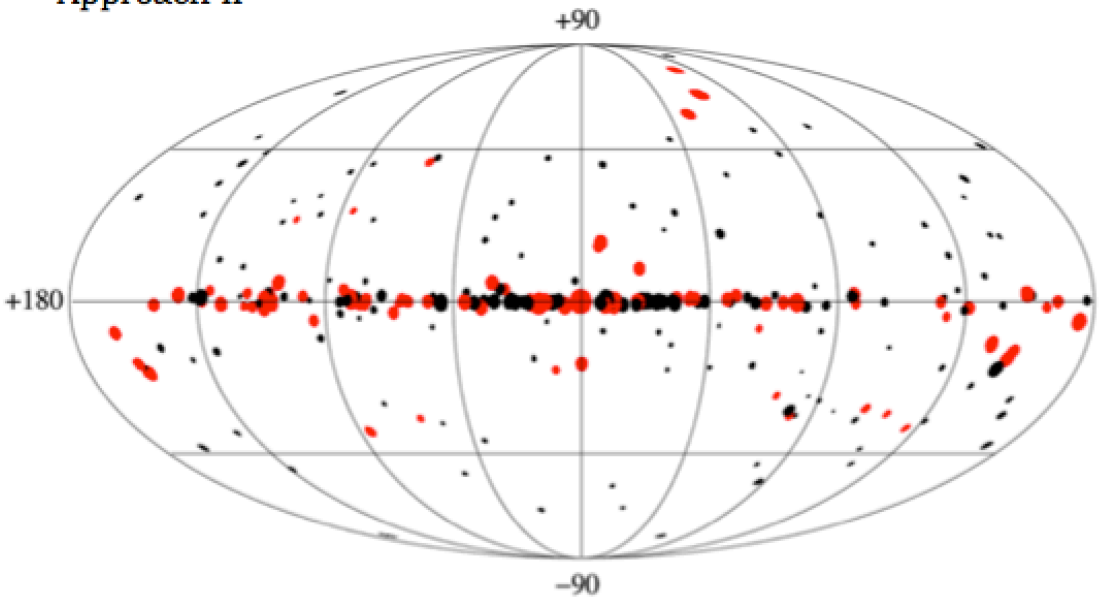
Comparison with IRAS 100 μm map





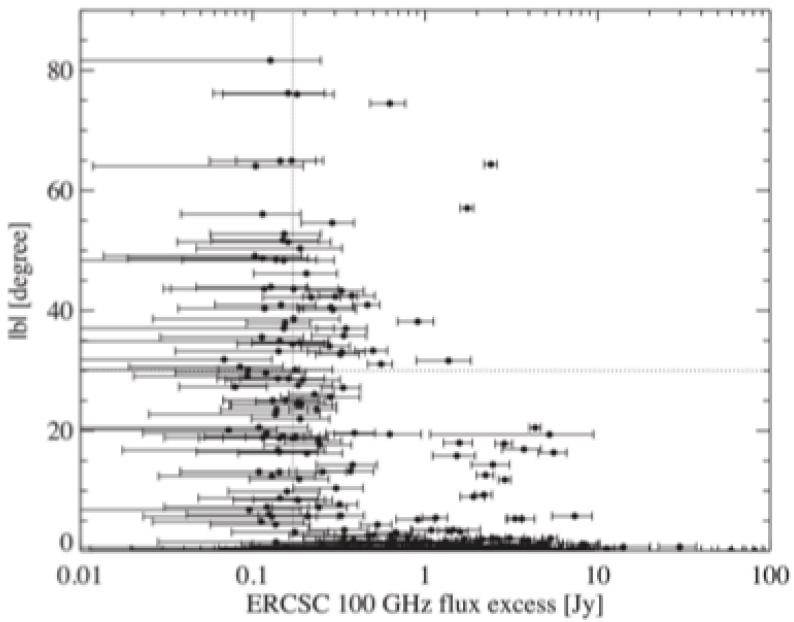
Sources with 100 GHz flux excess

Approach II



- Majority are radio-loud AGNs, especially at high |b|.
- Median(z) ~ 0.5, CO line would be redshifted out of the 100 GHz bandpass.
- Mostly Galactic CO along the line of sight to the source.

Probing CO at high Galactic latitudes



- A plateau for 53 sources at $|b| > 30°$, likely due to Eddington bias.
- Median excess for all 147 $|b| > 30°$ sources is ~4.5% of the 100 GHz flux densities, and cannot be accounted for by beam uncertainties or calibration.
- Translates to 0.5±0.1 K km s^{-1} CO clumped on the scale of the Planck 100 GHz beam (~10 arcmin).

Happy birthday, Ned!