Observing the Perseus Molecular Cloud with the Arcminute Microkevlin Imager and the Green Bank Telescope

AMI Small Array

Green Bank Telescope

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Collaborators

AMI Collaborators

- Anna Scaife
- Clive Dickinson
- Roberta Paladini
- Rod Davies
- Richard Davis
- Bob Watson
- Keith Grainge

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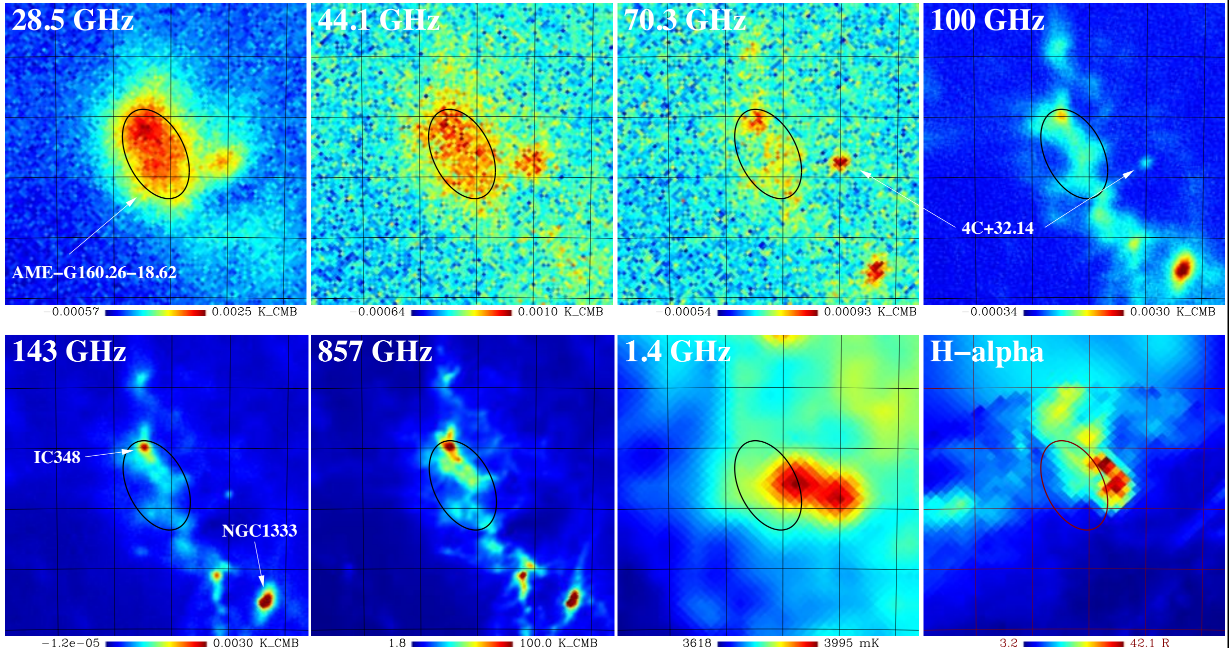
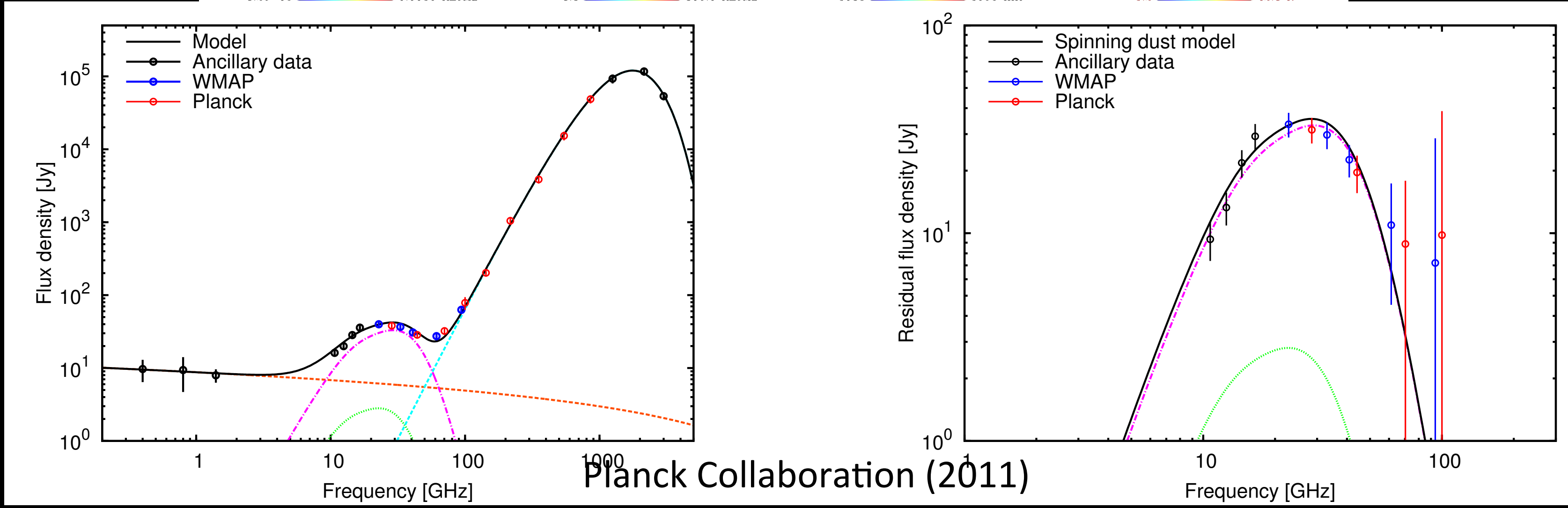
- Roberta Paladini
- Clive Dickinson
- Brian Mason
- Kieran Cleary
- Simon Casassus
- Rod Davies
- Richard Davis
- Bob Watson

Planck Observations

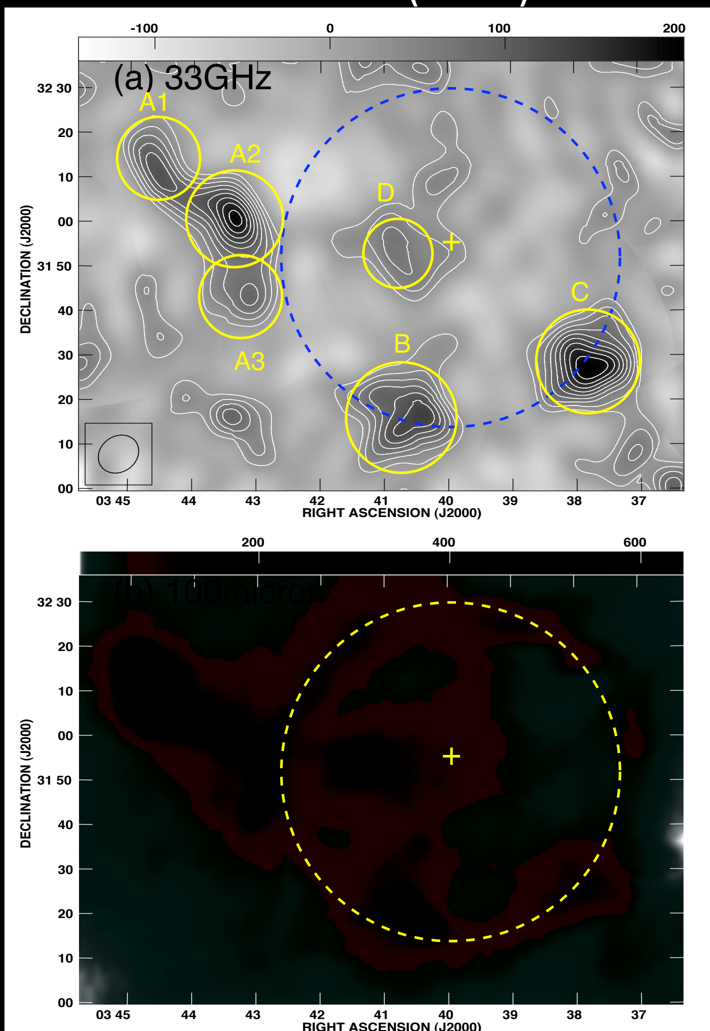


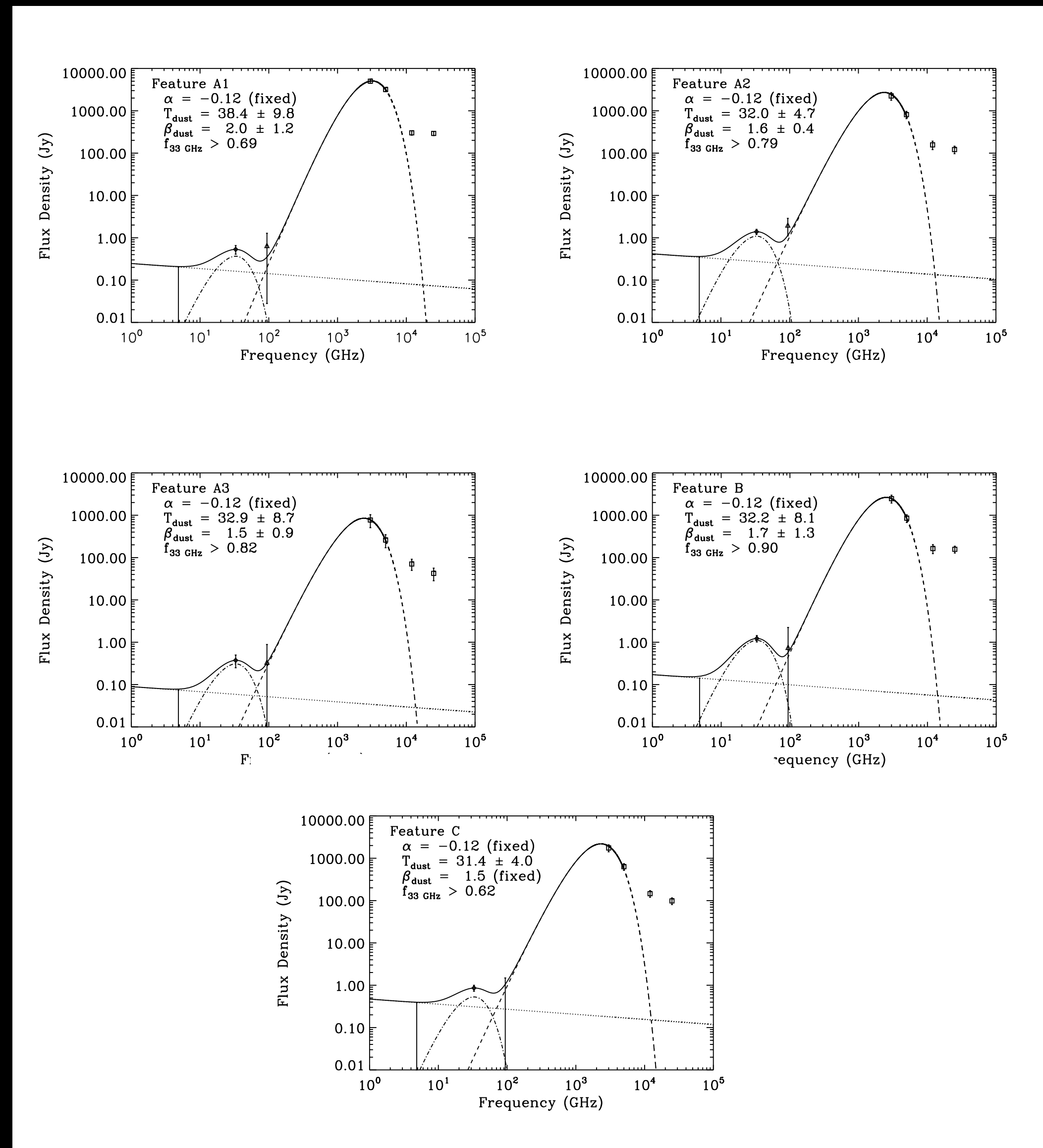


Planck Collaboration (2011)

VSA Observations

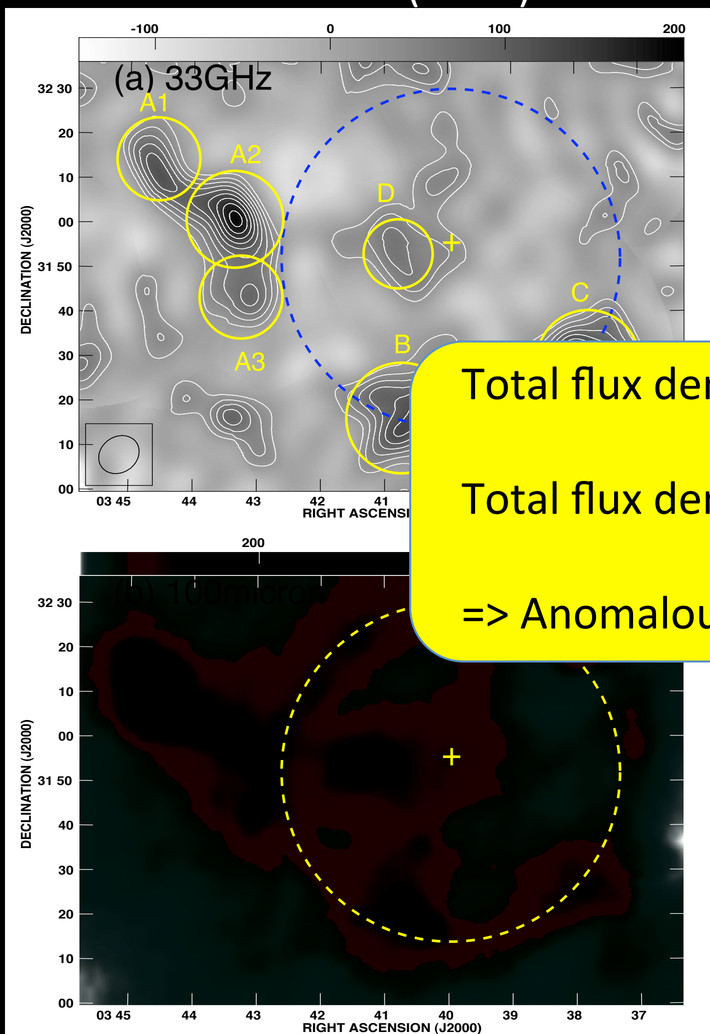
Tibbs et al. (2010)

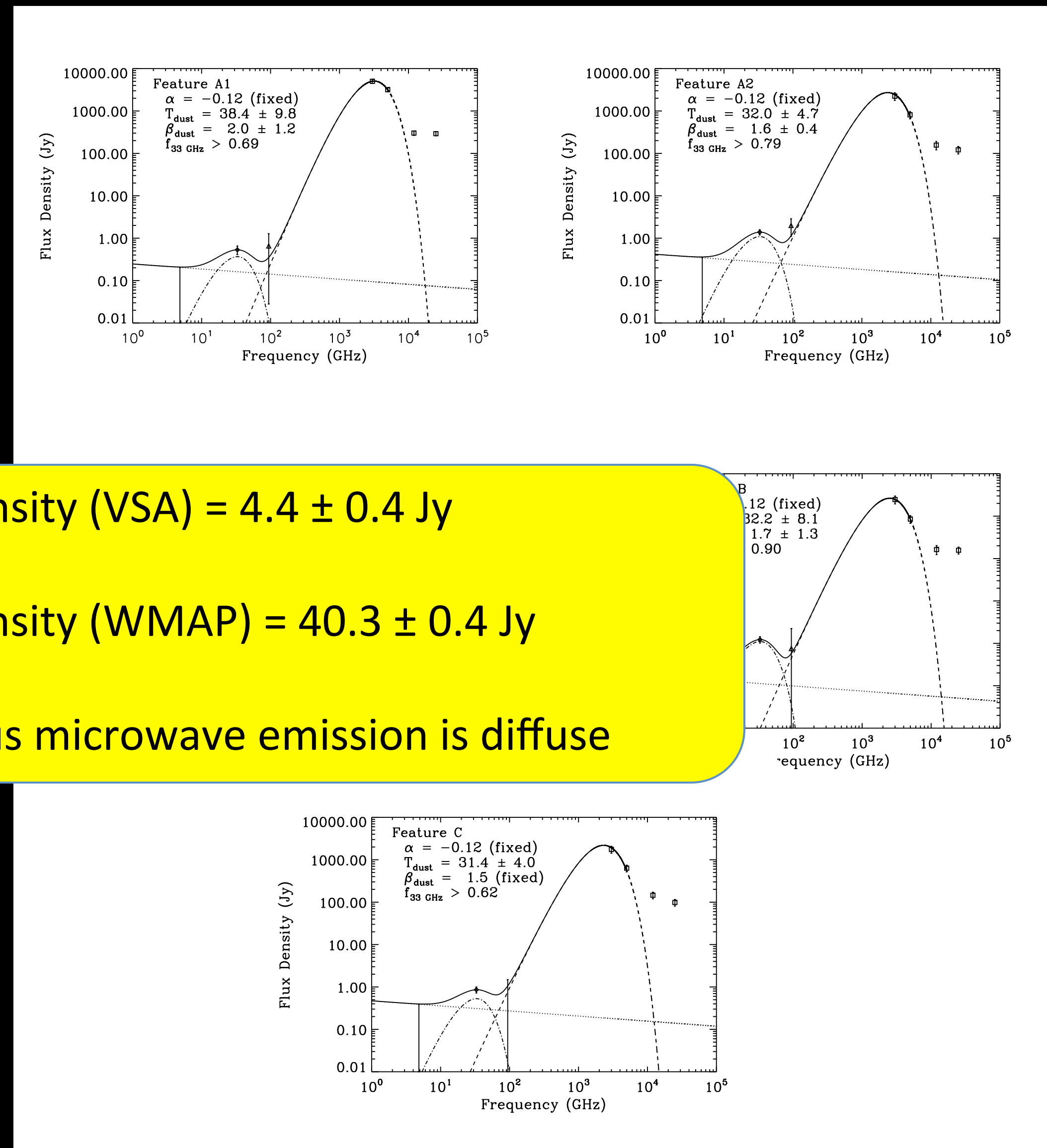




VSA Observations

Tibbs et al. (2010)





Total flux density (VSA) = 4.4 ± 0.4 Jy

Total flux density (WMAP) = 40.3 ± 0.4 Jy

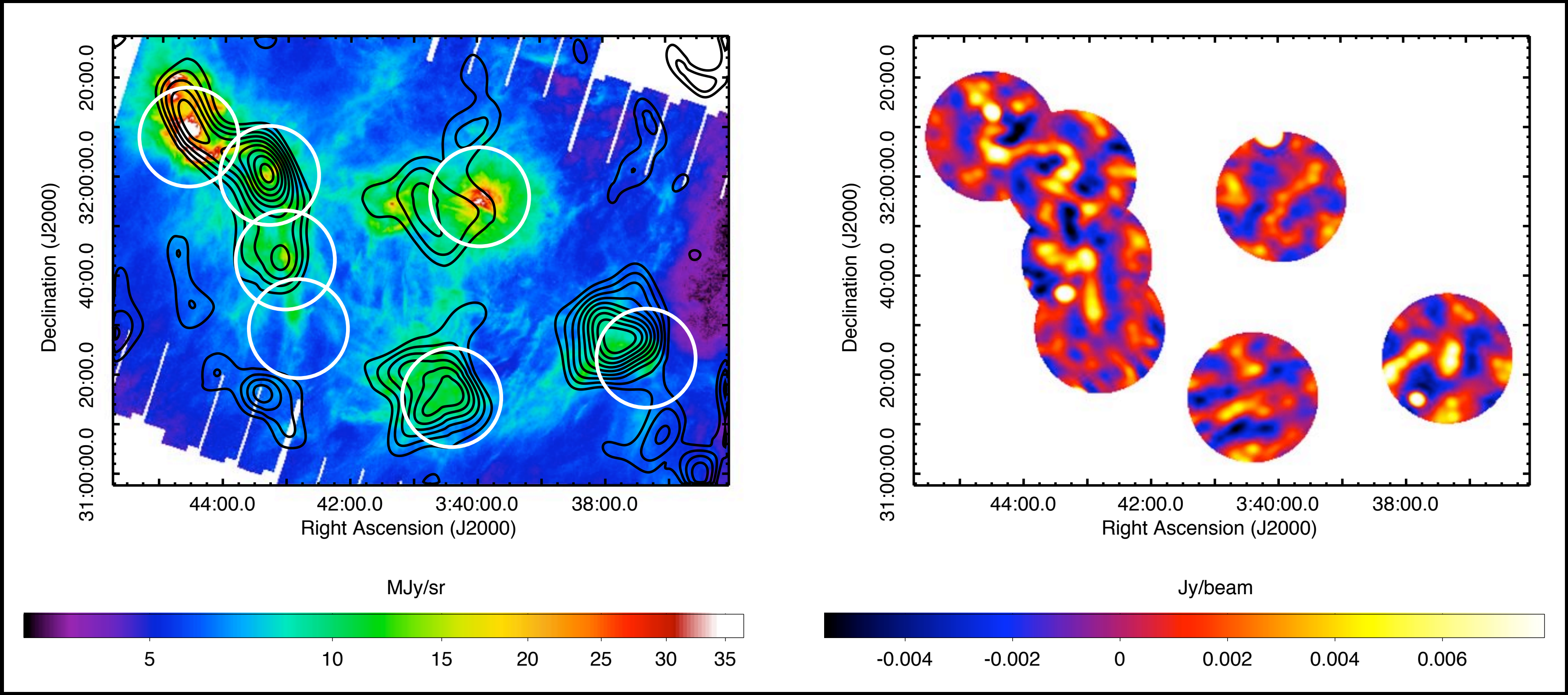
=> Anomalous microwave emission is diffuse

Tibbs et al. in prep. (2012b)

AMI Observations

MIPS 24μm/VSA 33GHz

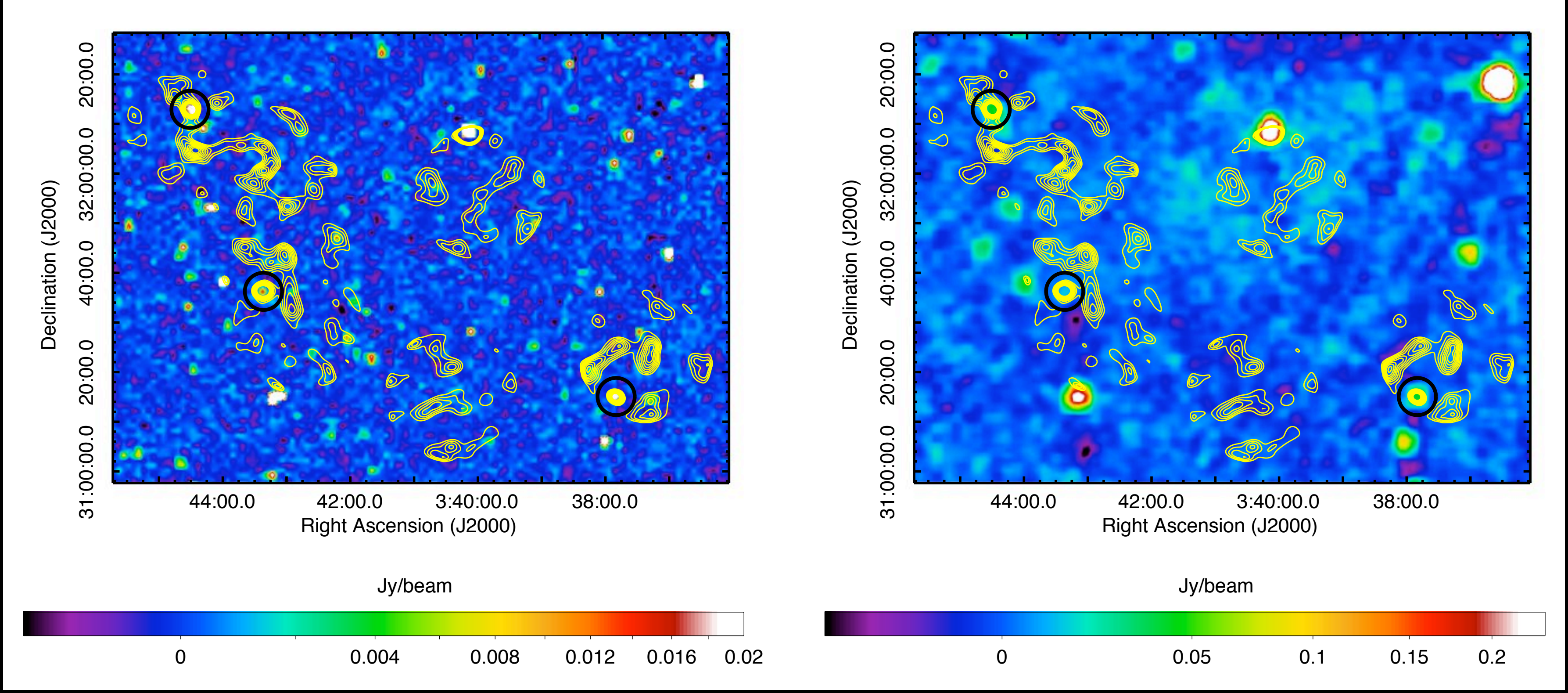
AMI 16GHz



Tibbs et al. in prep. (2012b)

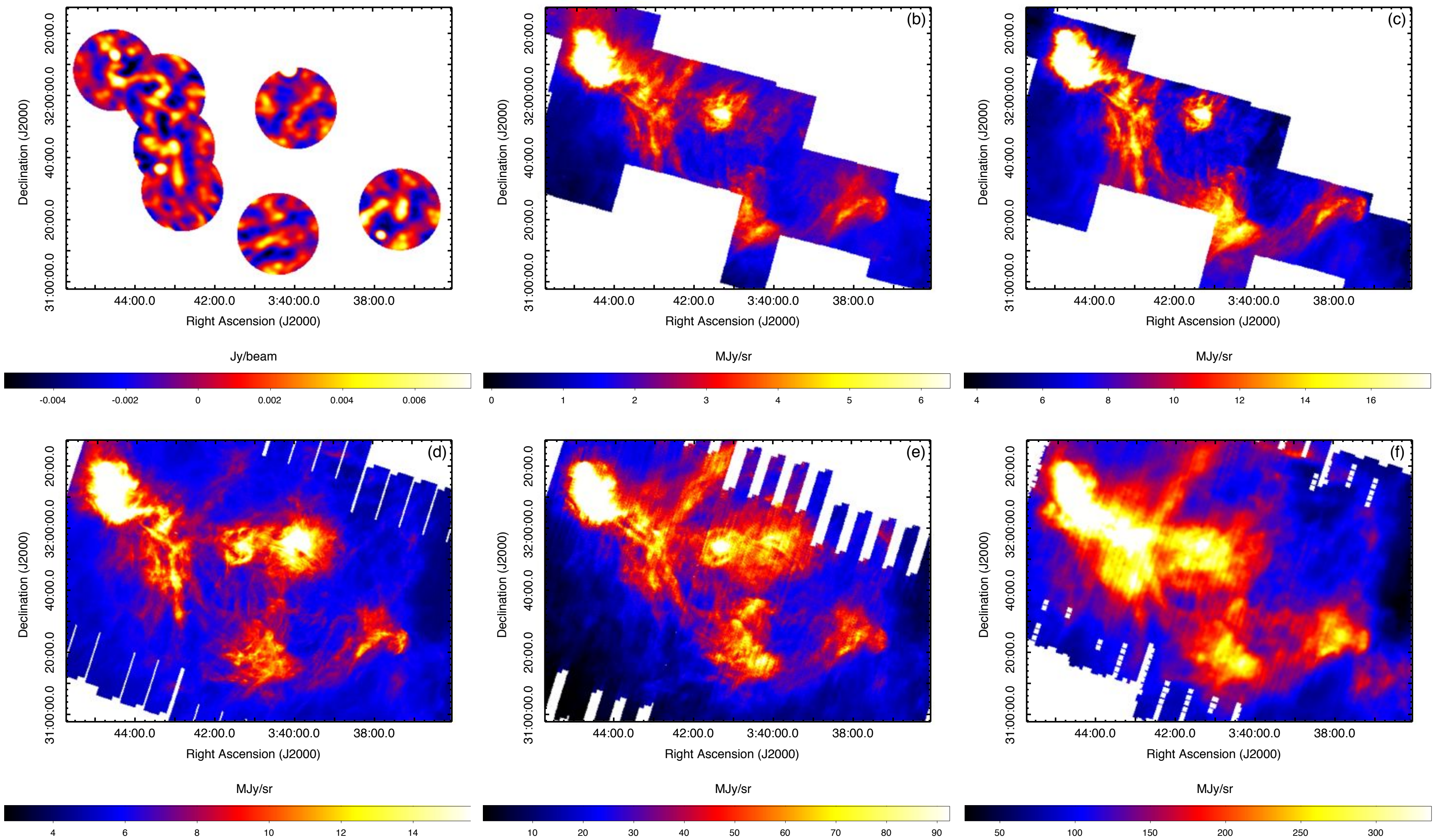
AMI Observations

NVSS 1.4GHz/AMI 16GHz GB6 4.85GHz/AMI 16GHz



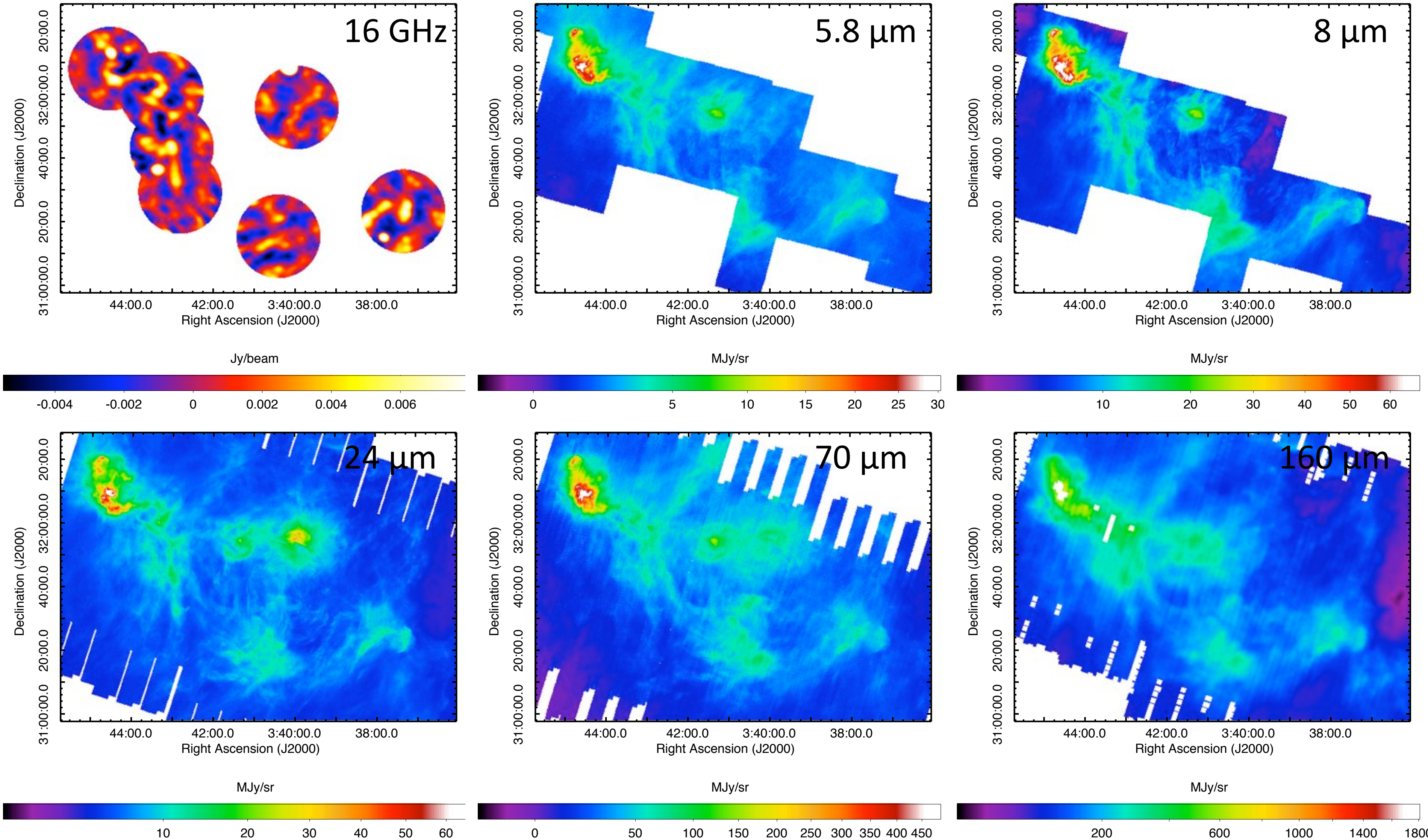
Tibbs et al. in prep. (2012b)

AMI Observations



Tibbs et al. in prep. (2012b)

AMI Observations



Tibbs et al. in prep. (2012b)

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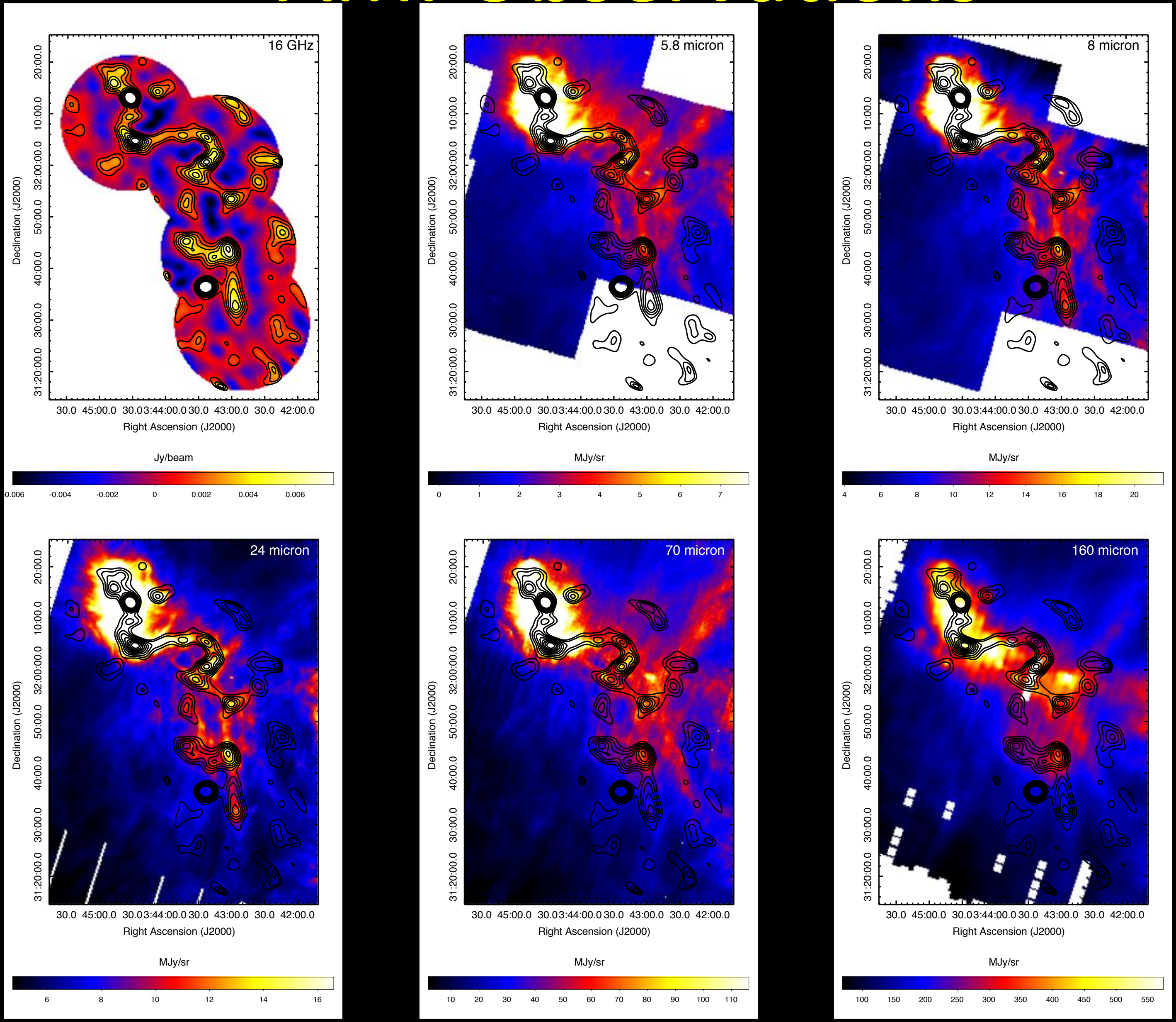

Tibbs et al. in prep. (2012b)

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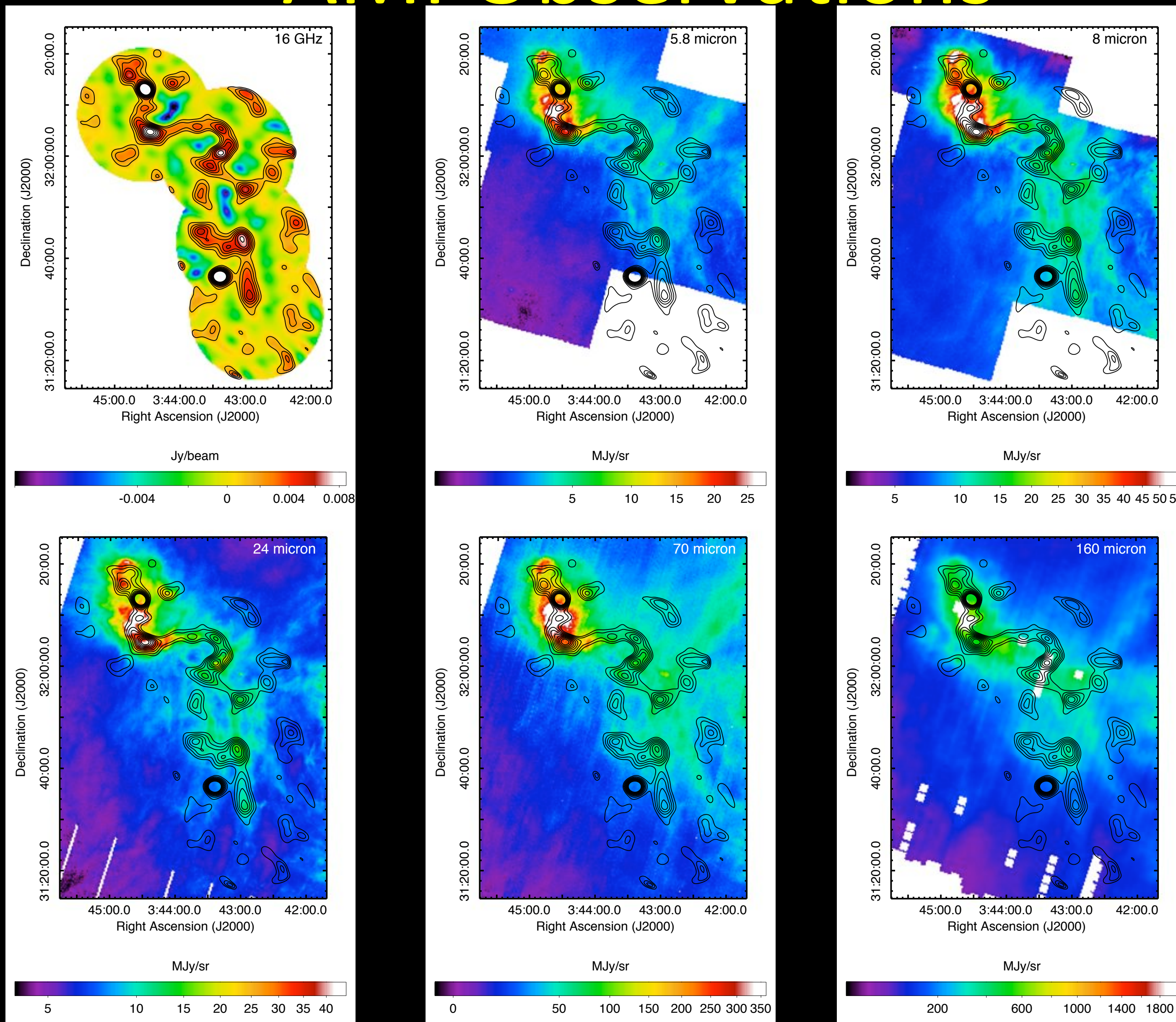

Tibbs et al. in prep. (2012b)

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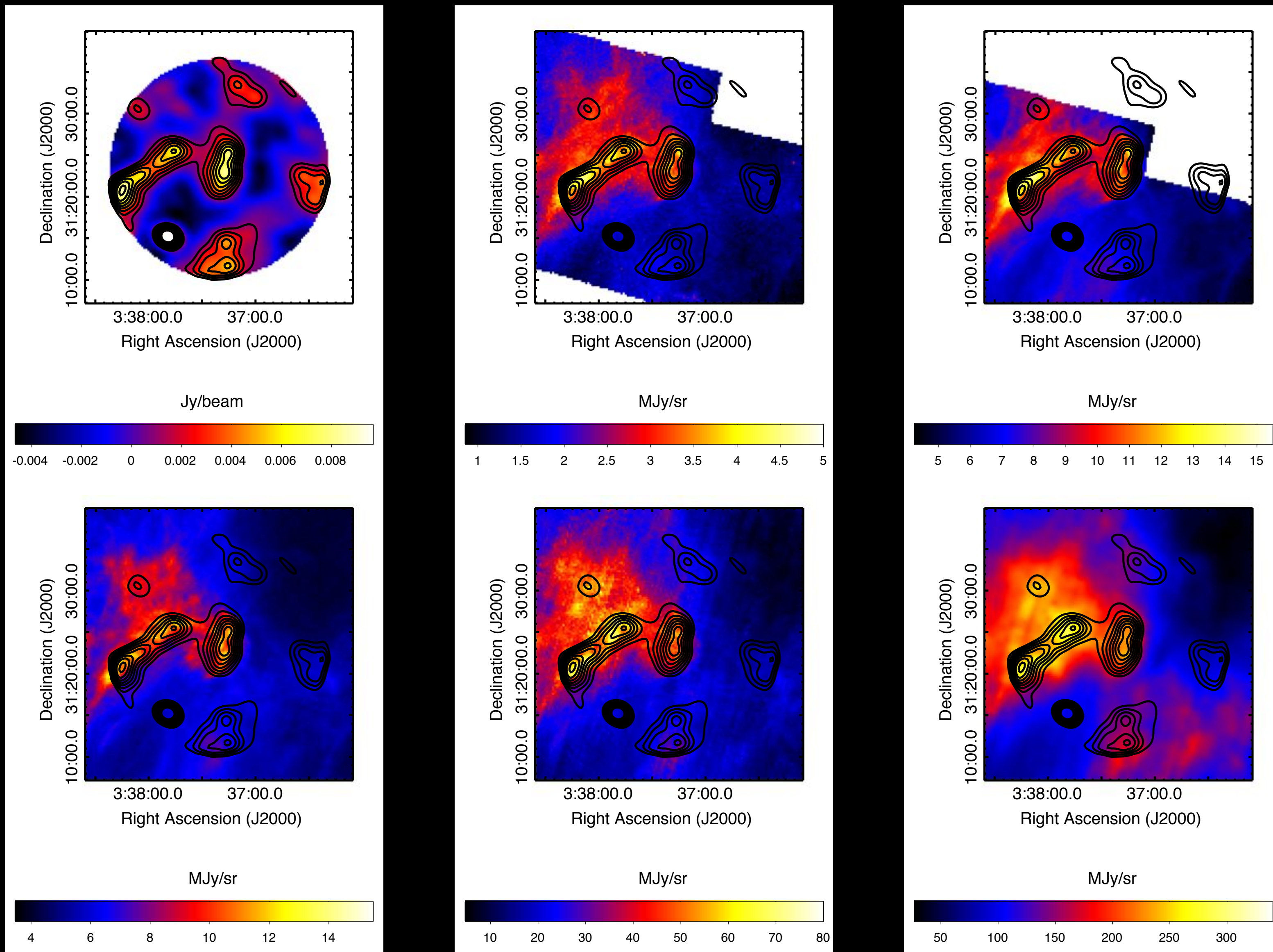
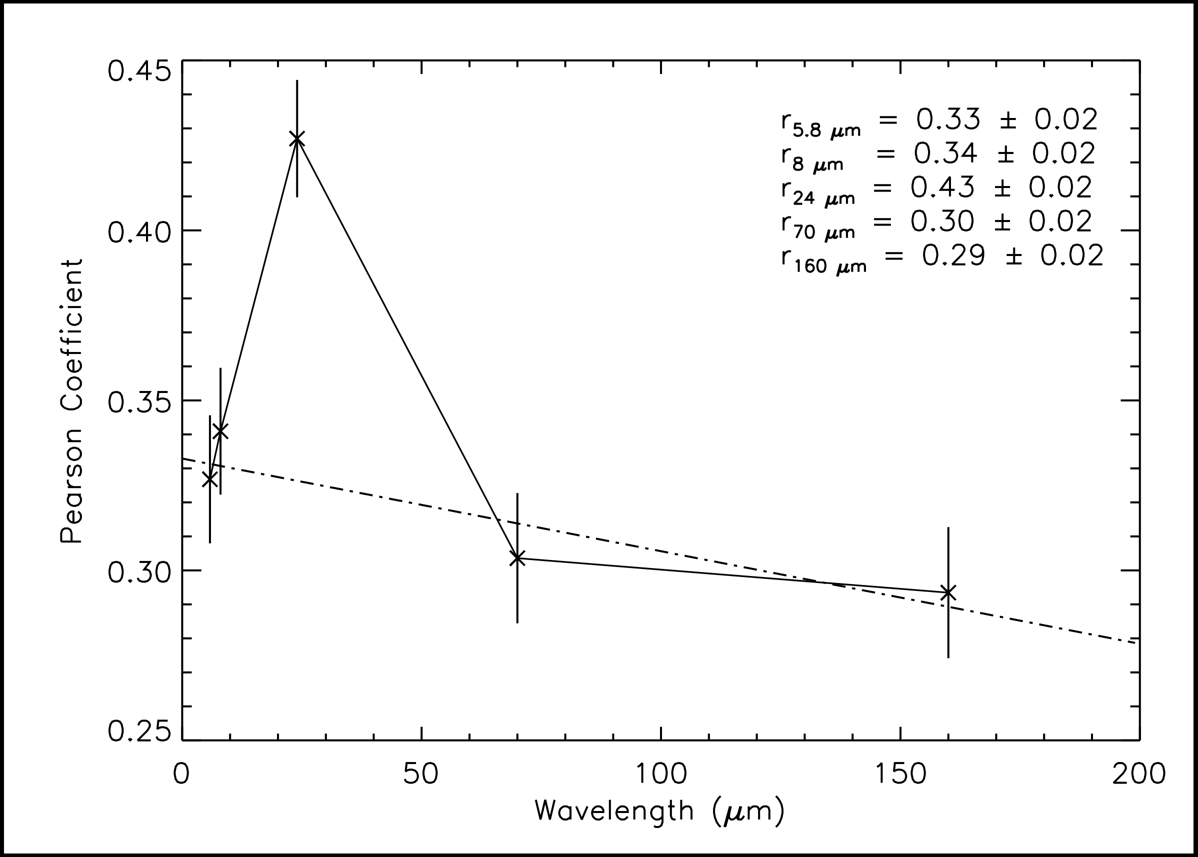


Tibbs et al. in prep. (2012b)

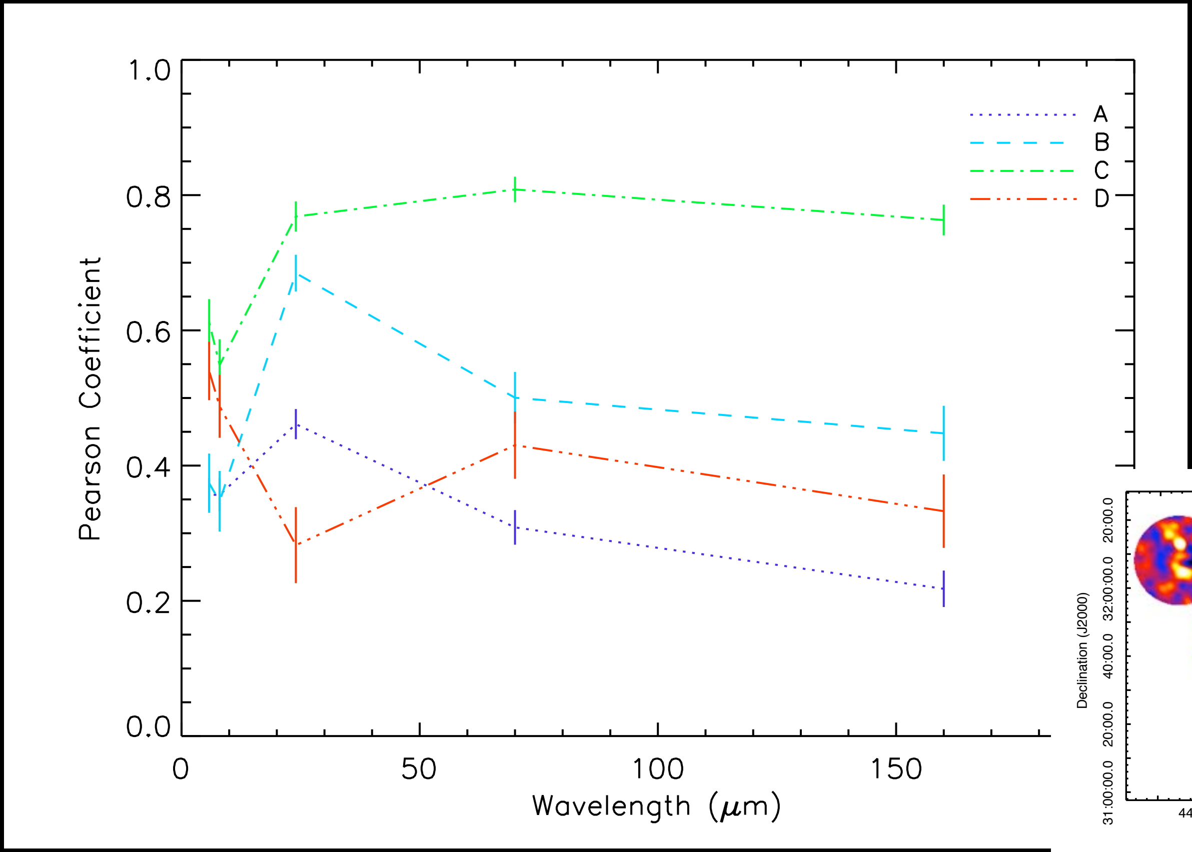
AMI Observations

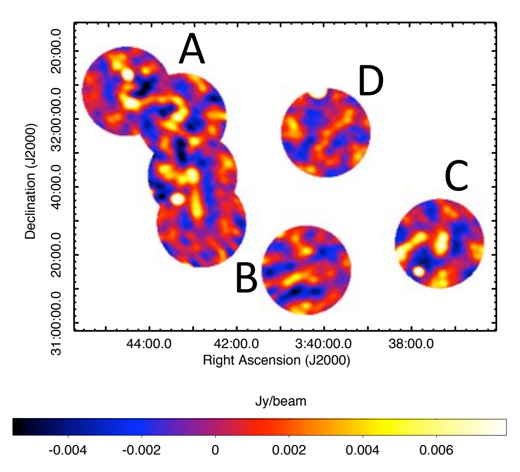


- Clear peak in the correlation at 24μm (5.8σ)
- Even ignoring the 24μm data point, there is a non-zero correlation which increases with decreasing wavelength (1.8σ)

Tibbs et al. in prep. (2012b)

AMI Observations





- Region A and B peak at 24μm with region C also strongly correlated with 24μm.
- Region D is not strongly correlated with 24μm, but this is the location of the OB star and is surrounded by very hot gas => 24μm emission possibly due to thermal emission => lack of correlation.

Tibbs et al. in prep. (2012b)

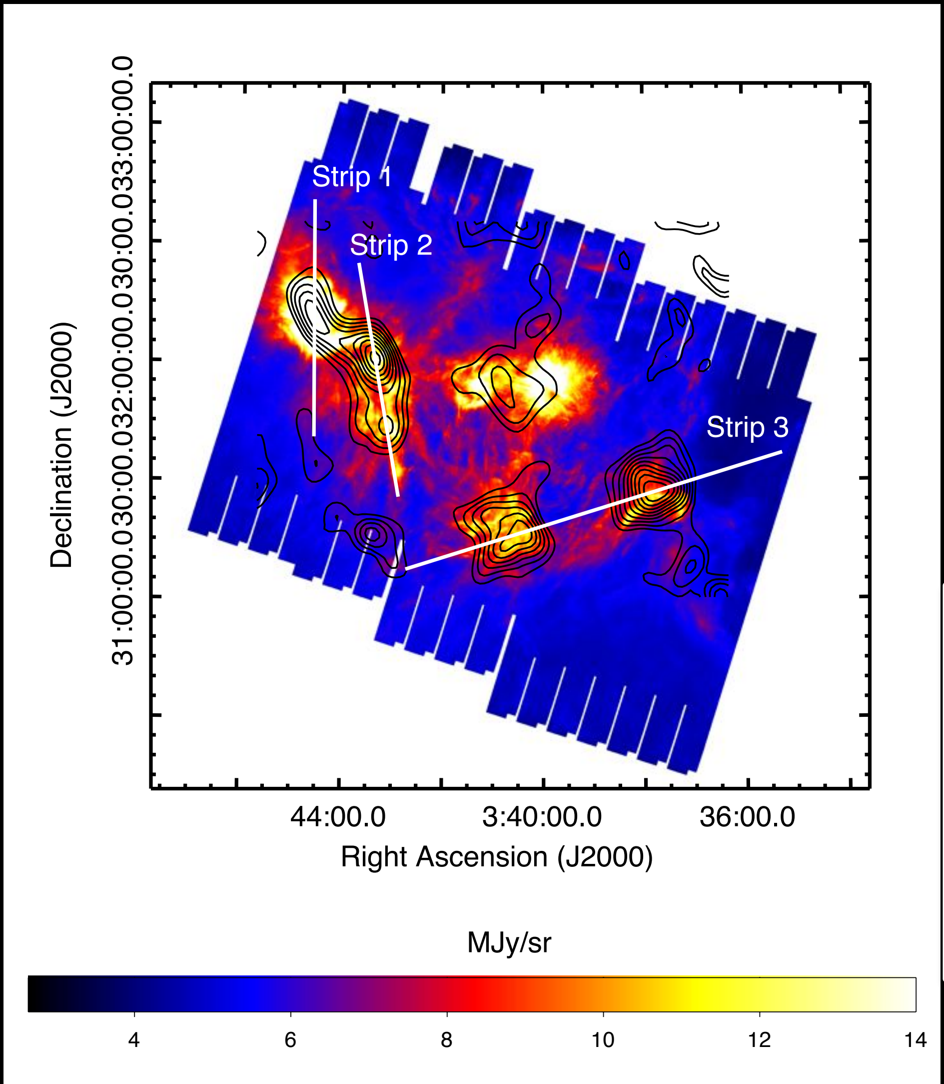
AMI Observations

- AMI observations confirm that the microwave-IR correlation observed at larger angular scales of ≈10-40 arcmin is still present at angular scales of ≈ 2 arcmin.
- We find a preference for the microwave emission to correlate with the 24um emission rather than the shorter wavelengths.

Is the AME due to spinning VSGs?
or
Is the AME more dependent on the excitation than the abundance of the carriers?
or
Is the AME due to spinning molecules that are not traced by the 5.8 or 8um Spitzer bands?

Tibbs et al. in prep. (2012c)

GBT Observations



- Using the GBT, we performed observations of 3 strips covering the AME features observed with the VSA.
- Observations performed at L-Band (1.4 GHz) and C-Band (5 GHz)
- Observations allow an accurate estimate of the free-free emission on the same scales as sampled by the VSA.

Target	Scan length (°)	# of scans (L-Band)	# of scans (C-Band)
Strip 1	0.93	90	81
Strip 2	0.93	90	75
Strip 3	1.55	75	90

Tibbs et al. in prep. (2012c)

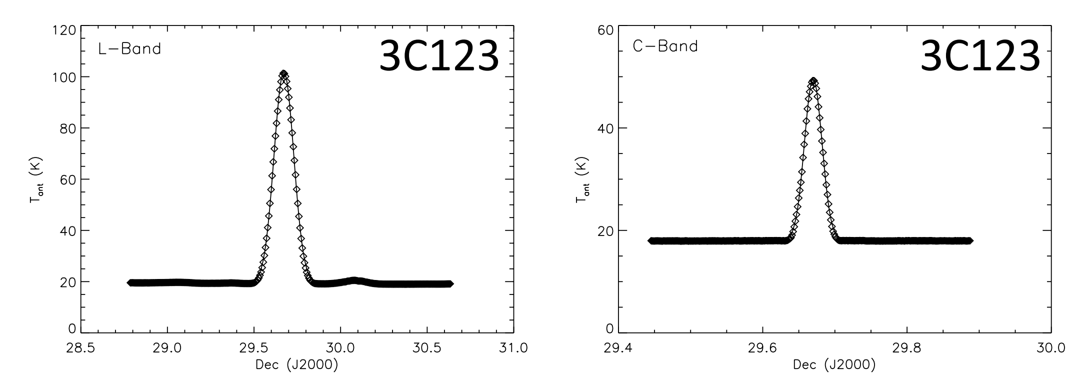
GBT Observations

- Raw data converted to antenna temperature using the noise tube diode which was repeated switched on and off during the observations using

$$T_{ant} = \left\langle \frac{T_{cal}}{P_{cal_{on}} - P_{cal_{off}}} \right\rangle \cdot \frac{(P_{cal_{on}} + P_{cal_{off}})}{2} \text{ K}$$

from Maddalena (2002).

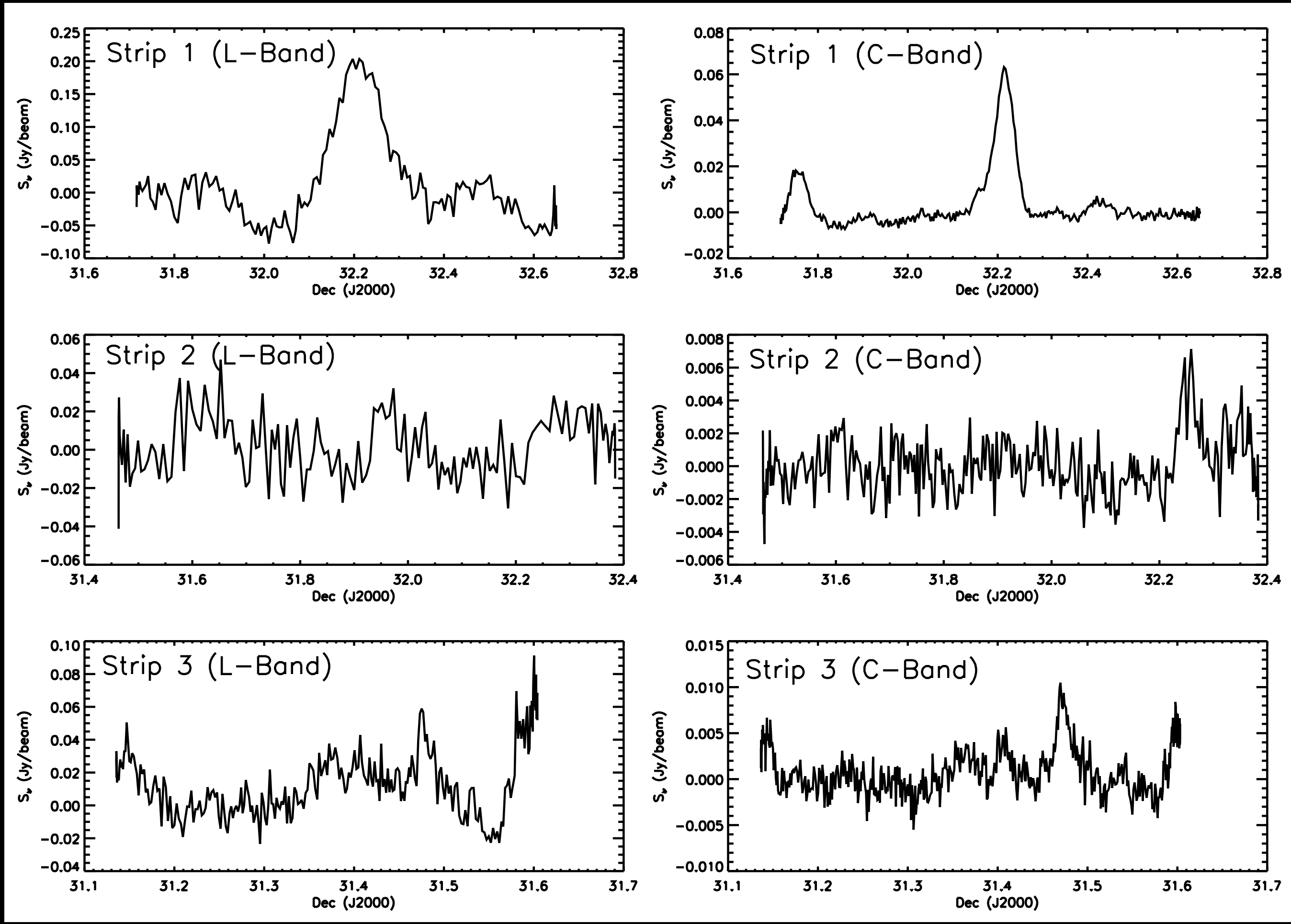
- Calibration observations of 3C123 used to calibrate the data. Also used to optimize the telescope pointing and focus.



- Apply the calibration to the data scans.
- Ignore data scans suffering from RFI or atmospheric effects.
- Perform a baseline subtraction to remove offsets or gain variations.
- Stack all the data for each scan and compute the median of each stack to produce the final scan.

Tibbs et al. in prep. (2012c)

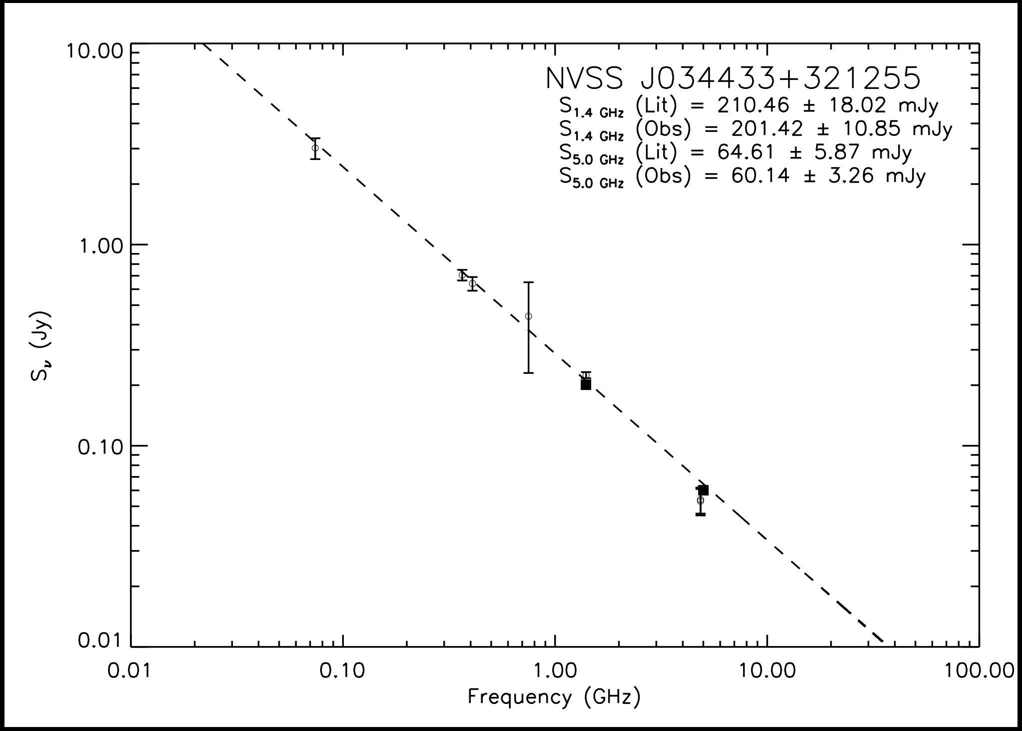
GBT Observations



- Final scans for the 3 strips at both L-Band (left) and C-Band (right).
- Can identify the point source NVSS J03443+321255 in Strip 1
- Low level, extended emission present in the strips.

Tibbs et al. in prep. (2012c)

GBT Observations

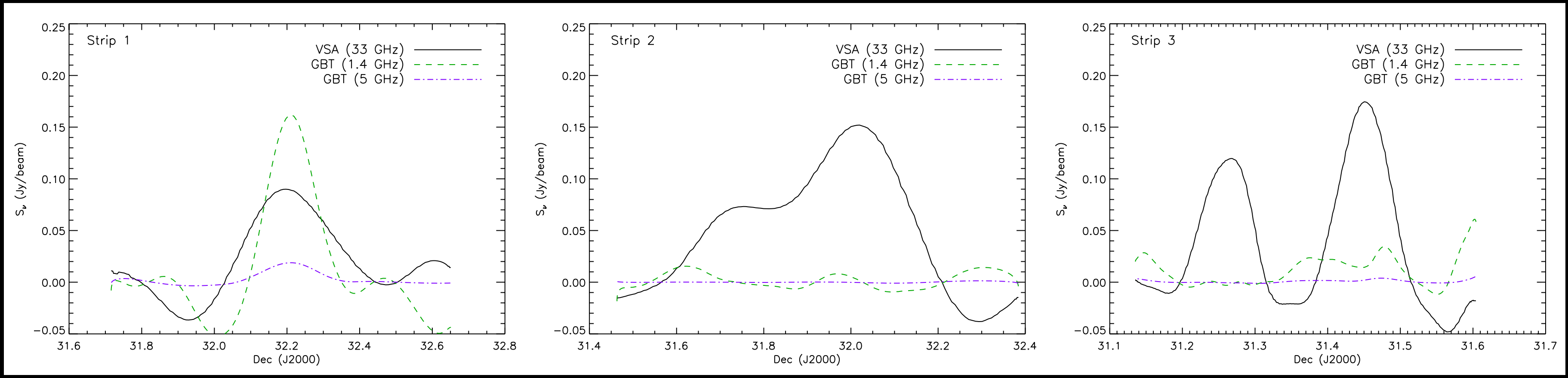


Good consistency between the values measured from the GBT scans and the values from the literature, which confirms the accuracy of the GBT data.

- Spectrum for the source NVSS J03443+321255.
- We fitted a power-law with fixed spectral index to the data from the literature (open circles) and found α=0.928±0.004.
- This results in an expected flux density of:
  - $S_{1.4GHz}$ = 210.46±18.02 mJy
  - S_{5GHz} = 64.61±5.87 mJy.
- We measured the flux density from the GBT observations (filled squares) and found:
  - $S_{1.4GHz}$ = 201.42±10.85 mJy
  - S_{5GHz} = 60.14±3.26 mJy.

Tibbs et al. in prep. (2012c)

GBT Observations



- Since we fit a 1st order polynomial baseline, the GBT scans are only sensitive to angular scales less than the length of the scans. However, since the scans are ≈ 50 – 90 arcmin, they are cover the range of angular scales to which the VSA is sensitive.
- Convolve the C-Band scan and the VSA map to 9arcmin to match the L-Band scan and extract the flux from the convolved VSA map.
- Plots show that the VSA emission is clearly dominant (even in Strip 1 were the point source will be much weaker when scaled to 33 GHz).

Conclusions

- AMI observations of the Perseus molecular cloud (Tibbs et al. in prep 2012b)
  - The AMI observations show that the microwave emission is still highly correlated with the IR emission down to angular scales of ≈ 2 arcmin.
  - This microwave-IR correlation peaks at 24μm, which suggest that either the AME is due to VSGs and not PAHs, or that the excitation mechanism is more important than the actual carrier of the emission.

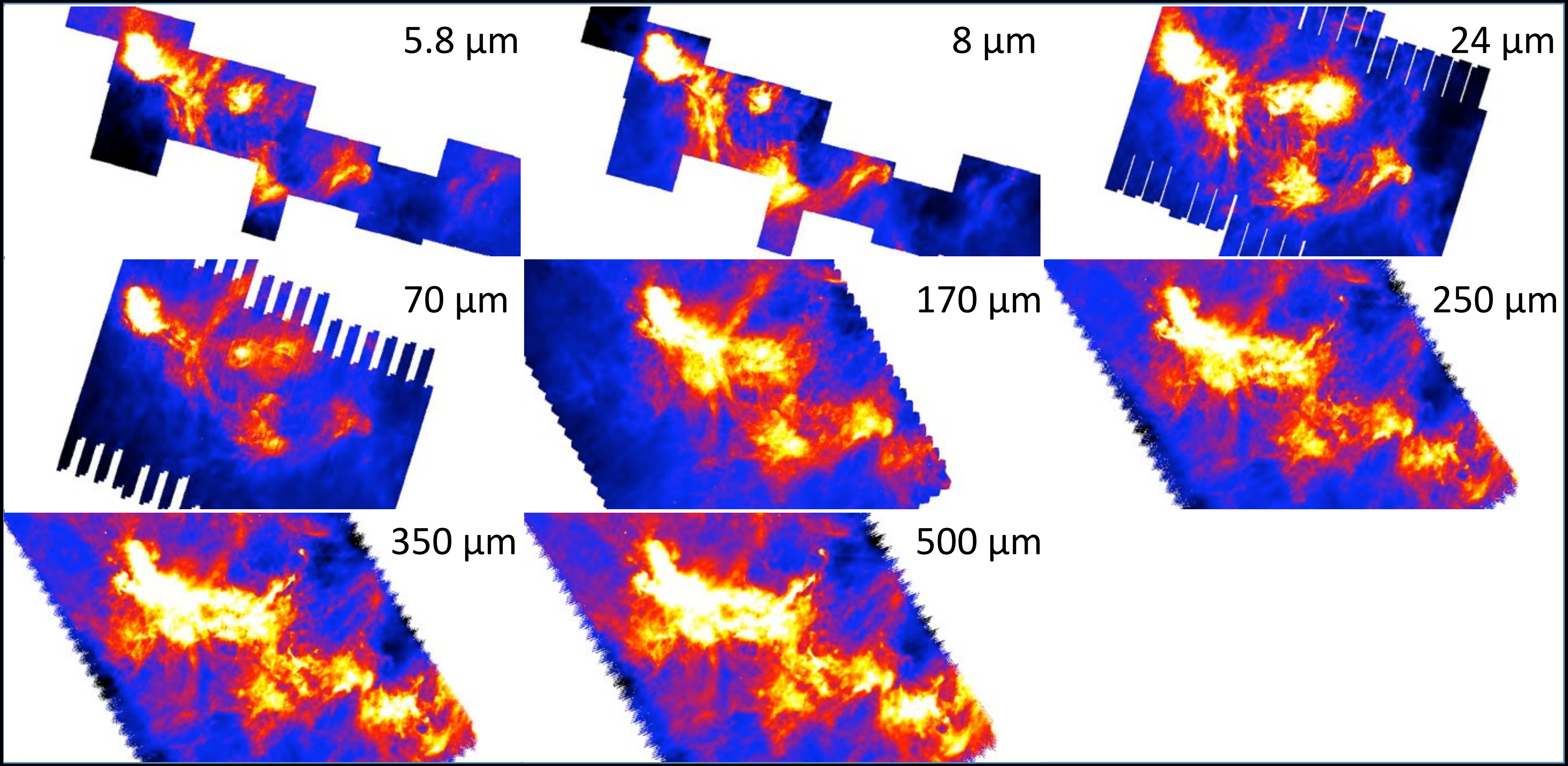
- GBT Observations of the Perseus molecular cloud (Tibbs et al. in prep. 2012c)
  - The emission at 1.4 and 5 GHz does not spatially replicate the emission observed at 33 GHz.
  - The level of the low frequency emission is such that it cannot account for a substantial fraction of the emission at 33 GHz observed with the VSA.

Additional Slides

Perseus Molecular Cloud: Optical

Perseus Molecular Cloud: Optical

Perseus Molecular Cloud: mid- to far-IR



Spitzer/Herschel observations of the Perseus molecular cloud