Molecular Gas Near Unusual Galactic Center Radio Source N3

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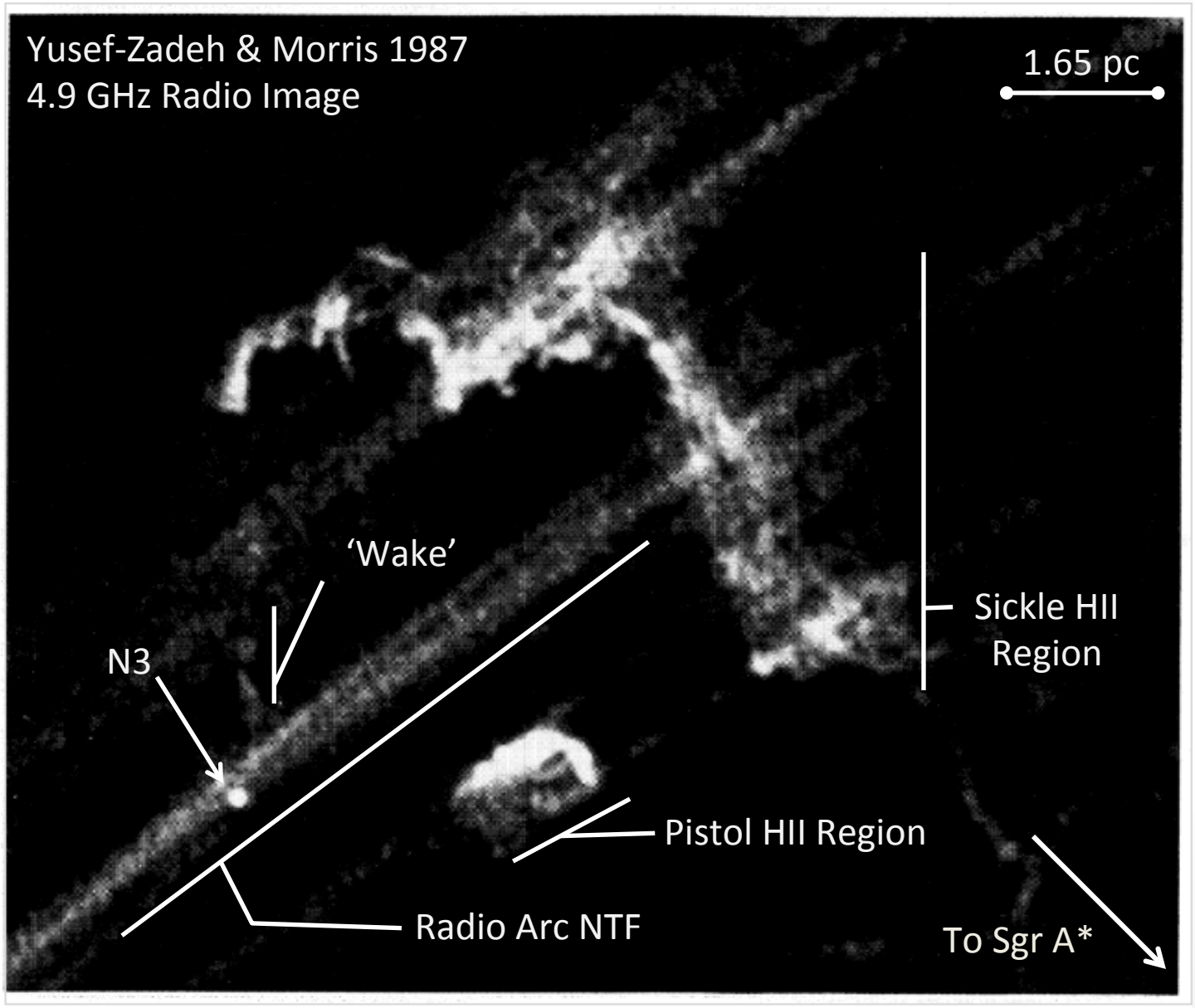
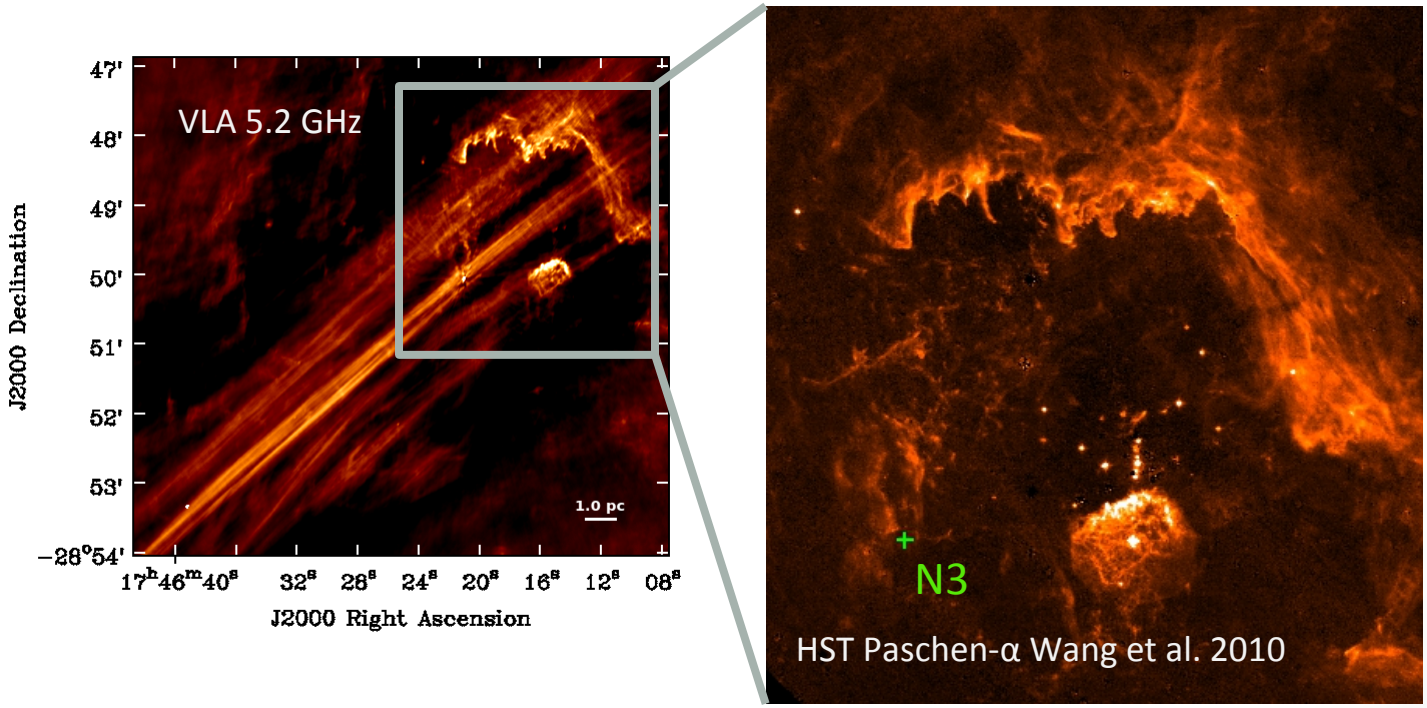
The Radio Source N3



VLA Continuum Observations

- C-Band (4-6 GHz), X-Band (10-12 GHz), K-Band (24-26 Ghz), Ka-band (30 GHz, 36 GHz), and Q-band(44 GHz, 48GHz)
- No Paschen Alpha emission visible from N3
- N3 is unresolved at 260 mas x 110 mas
  - 0.011 pc x 0.0045 pc assuming 8.5 kpc
- N3's spectral index is non-thermal



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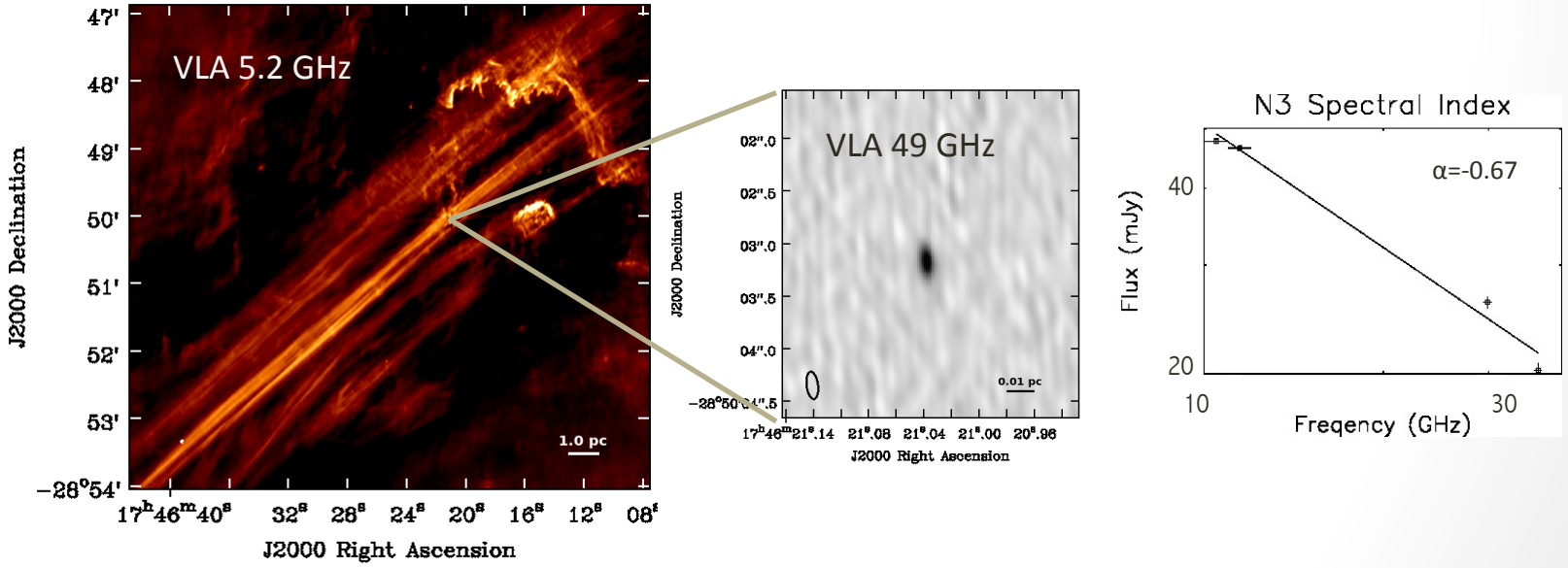
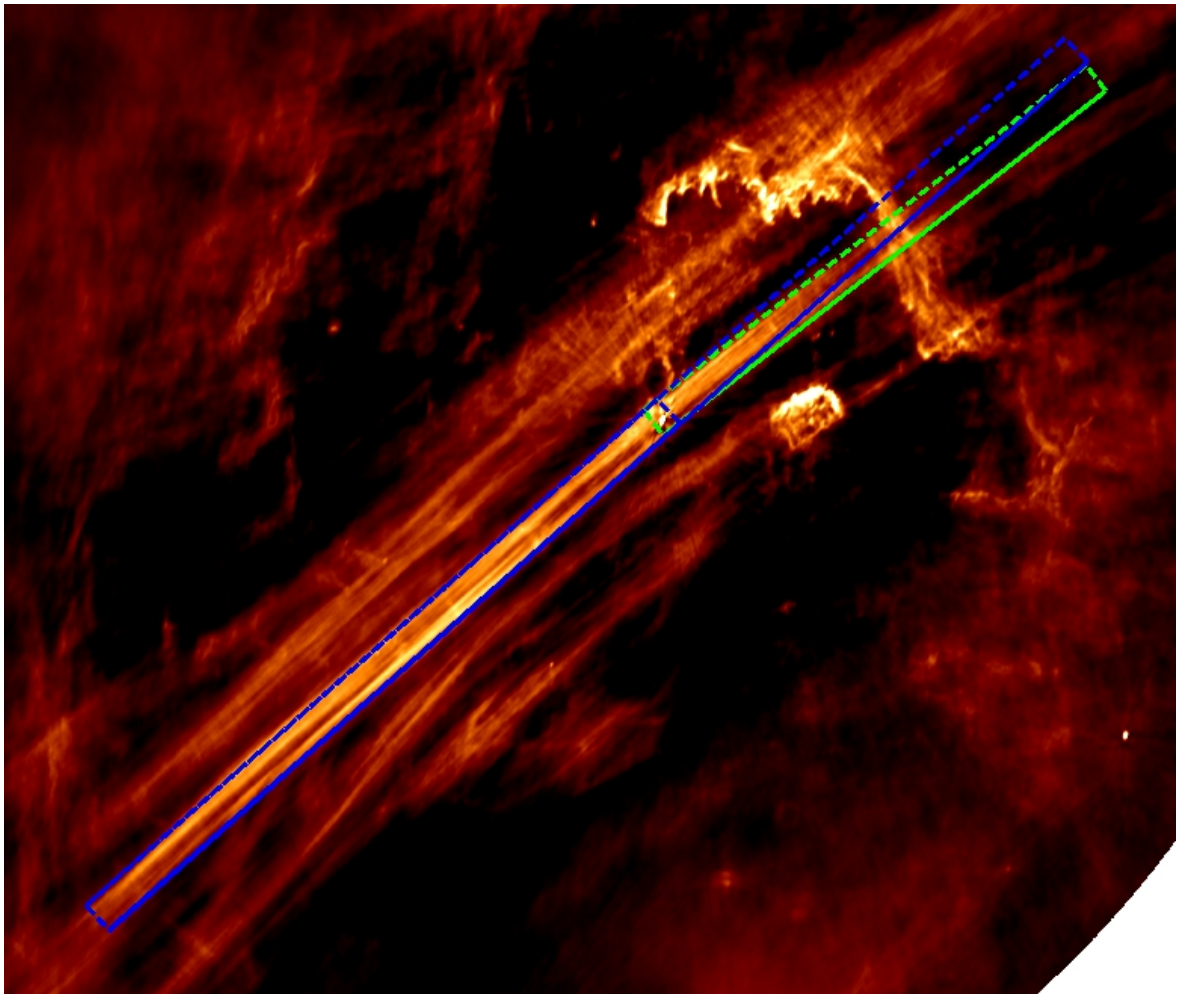


NTF Curvature Near N3



The N3 Molecular Cloud

- The N3 molecular cloud exhibits the brightest ammonia emission in the region
- The cloud measures 20”x26”
  - 0.82 x 1.07 pc at Galactic Center

Detected Transitions:

Shock Tracers:

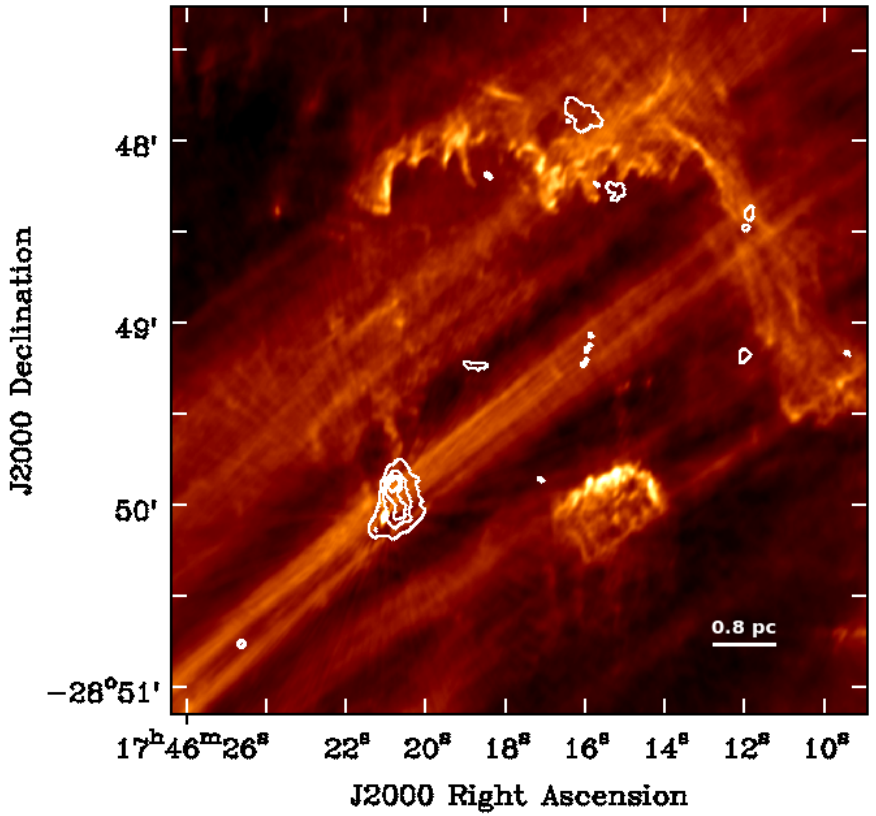
- SiO
- HNCO (K_{-1}=0)
- CH_3OH (Class 1 36 GHz and 44 GHz Masers)

Dense Gas:

- NH_3 (1,1) (2,2) (3,3) (6,6)
- CH_3CN
- HC_3N (Warm and Dense)
- SO

Photodissociation Regions:

- CS



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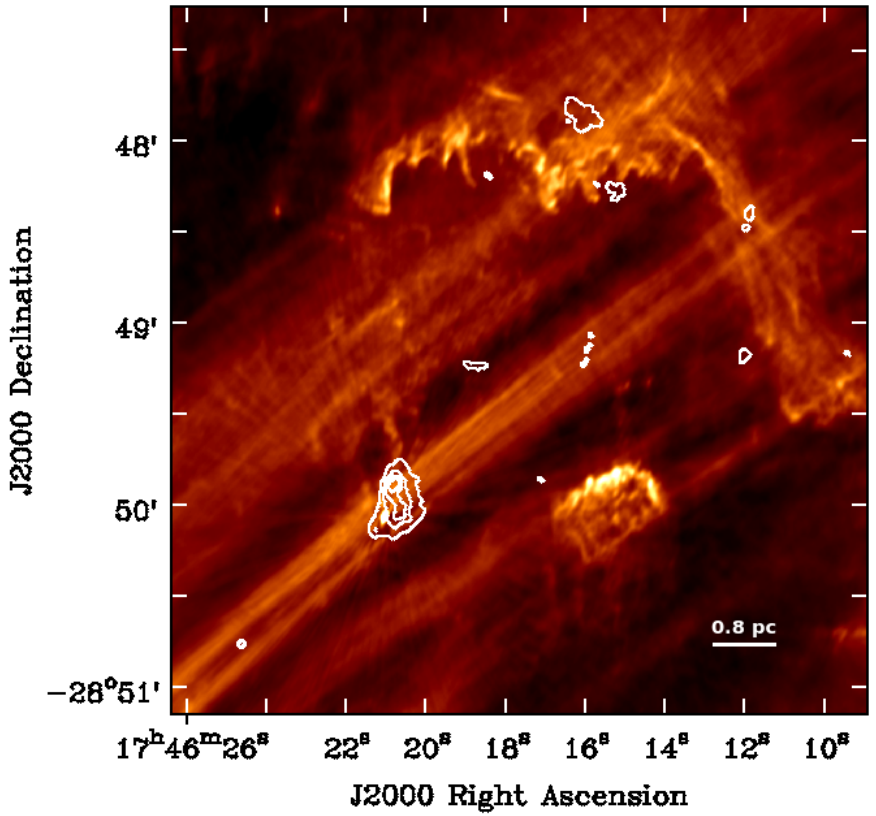
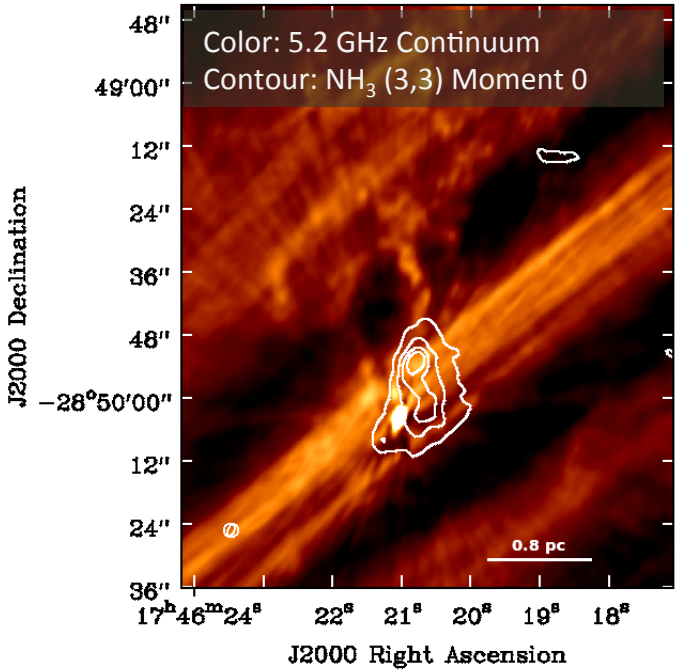
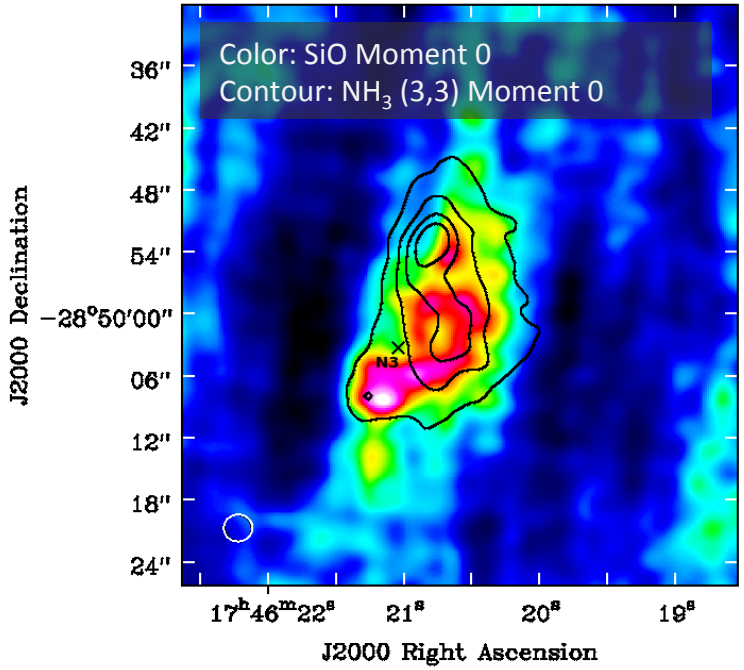


N3 Cloud Morphology

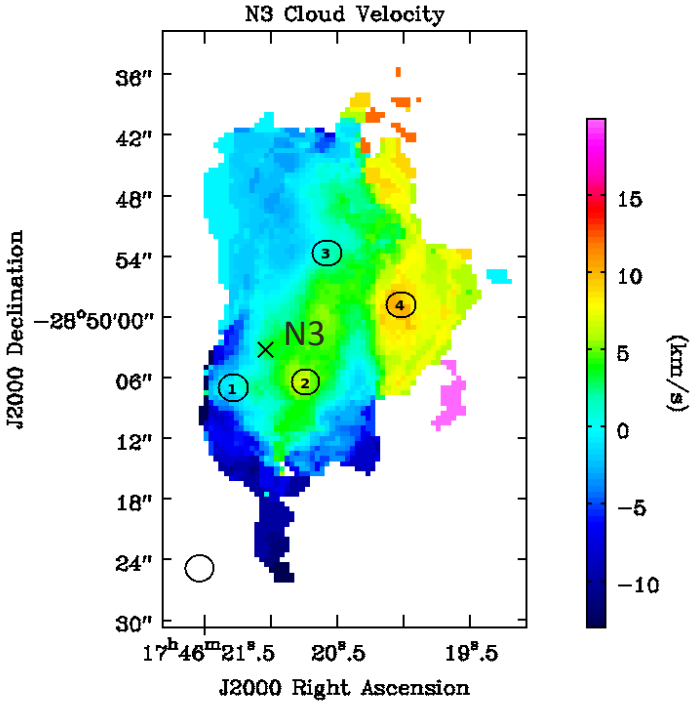
- The molecular gas is seen within the brightest filament
- The molecular emission terminates where the ‘wake’ encounters the NTF
- SiO emission seems to wrap around N3

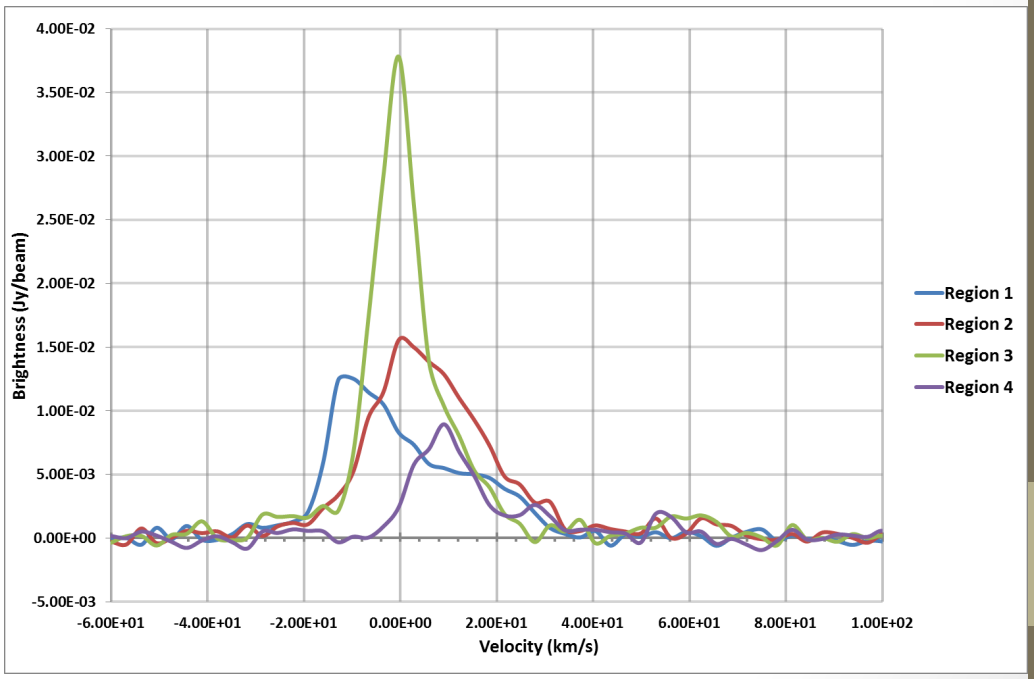




Kinematics of the N3 Cloud

- Multiple Velocity Components Observed
- Broad lines (> 10 km/s)
- Evidence of cloud-cloud collision?

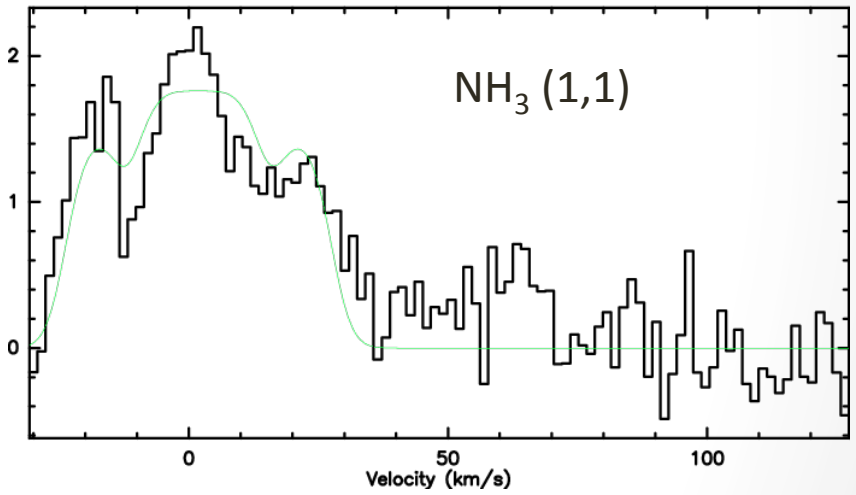




Temperature and Optical Depth

- The temperature of the gas can be determined by comparing NH3 (3,3) and (6,6) transitions
- For the (3,3) and (6,6) transitions, Gas Temperatures
  T_R = 79 K, T_K = 95 K
- Disk clouds have T ~ 10-20 K, while Galactic Center clouds are typically hotter (T = 50 – 300 K)

Optical Depths are typical, with the (1,1) and (2,2) lines being optically thick while higher transitions are optically thin.



Conclusions

- Is N3 interacting with the NTFs?
  - N3 lies within the brightest NTF, and the NTF bends near the location of N3.
- Is the molecular gas located in the Galactic center?
  - Observed transitions, temperatures, and line widths are typical of GC clouds.
- Is the molecular gas interacting with the NTFs?
  - Edges of the molecular gas coincide with the NTF.
  - The 'Wake' also appears to be interacting with the NTFs.
- Is N3 interacting with the molecular gas?
  - Observed SiO emission appears weak around N3.

Temperature Equations

What do you do?

1. Convert from Jy/beam * km/s → K * km/s

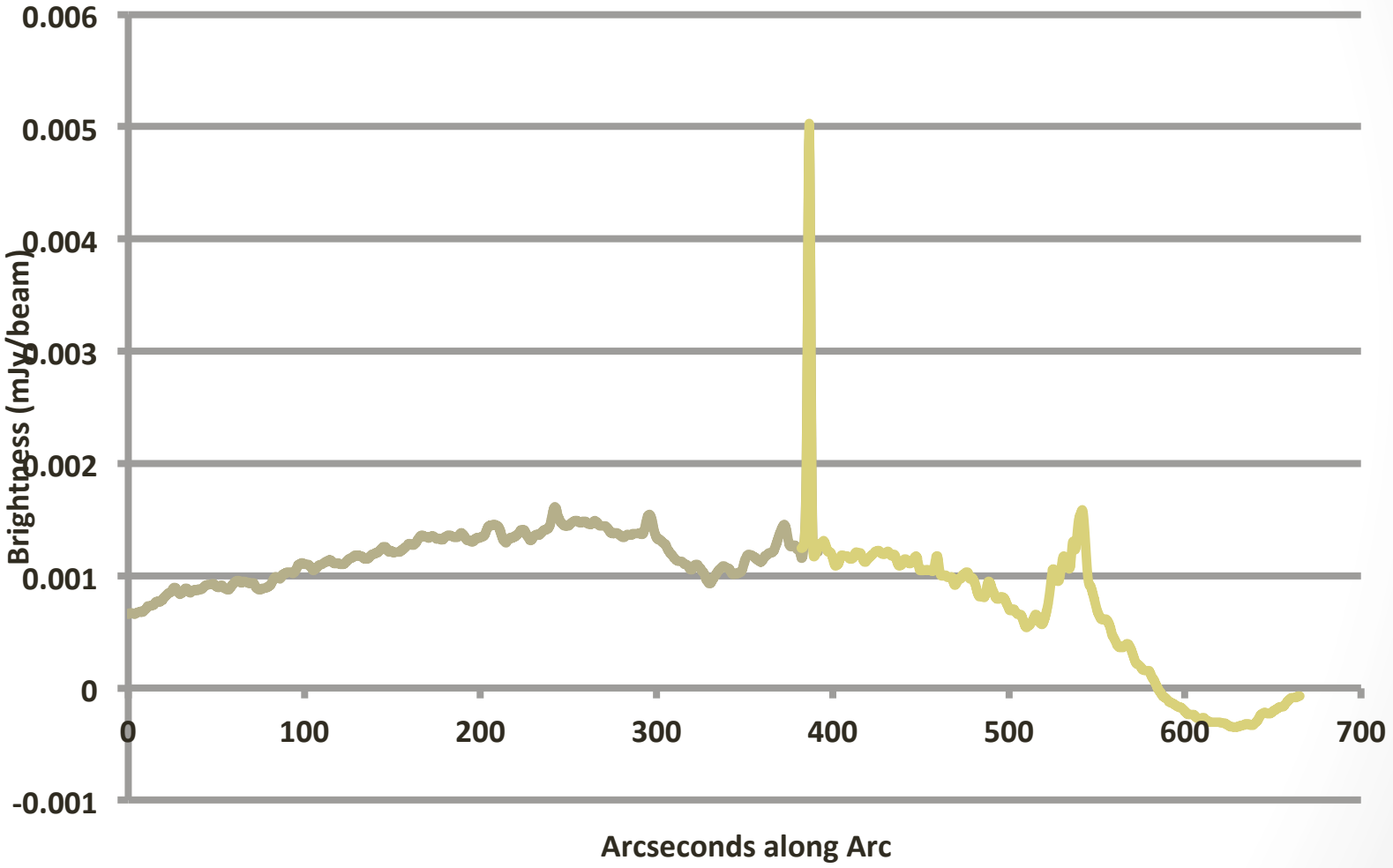
$$T_B(K) = \frac{1.224 \times 10^6 \; F_\nu(\mathrm{Jy})}{[\nu(GHz)]^2 \; \theta(")^2}$$

2. Calculate the corrected column density

$$N(J,K) = \frac{1.55 \times 10^{14} \; \mathrm{cm}^{-2}}{\nu} \frac{J(J+1)}{K^2} \int T_{\mathrm{mb}} \mathrm{d}v,$$

3. Calculate the (rotational) temperature

$$\frac{N_u(J',\ J')}{N_u(J,\ J)} = \frac{g_{\mathrm{op}}(J')}{g_{\mathrm{op}}(J)} \frac{2J'+1}{2J+1} \exp\left(\frac{-\Delta E}{T_{JJ'}}\right)$$


0.006
0.005
0.004
0.003
0.002
0.001
0
-0.001
Brightness (mJy/beam)
0
100
200
300
400
500
600
700
Arcseconds along Arc