Spectroscopy With CCAT

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Summary

- ALMA more sensitive
- ALMA has higher spatial resolution
- CCAT: large areas/structures and finder scope for ALMA
  - Wide fields
    - Array receivers
  - Wide bands (>10 GHz, ideally 0.1 km/s resolution)
    - Combination essential to explore the highest frequency windows
  - Zero spacing data
- Lines probe a wide range of unique environments and conditions
- Role for spectrophotometry?

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Mapping

- CCAT twice the diameter of an ALMA dish
  - half the beam size
    - Need 4x pointings to map the same area
- ALMA has 10 times the area
  - ALMA 40x faster for mapping than CCAT with a single pixel to reach a given rms in T.
  - BUT with >40 pixels CCAT would be faster
- Small source or known position - ALMA
- Extended source or unknown position – CCAT with array receiver
- Spectral coverage – CCAT (?)

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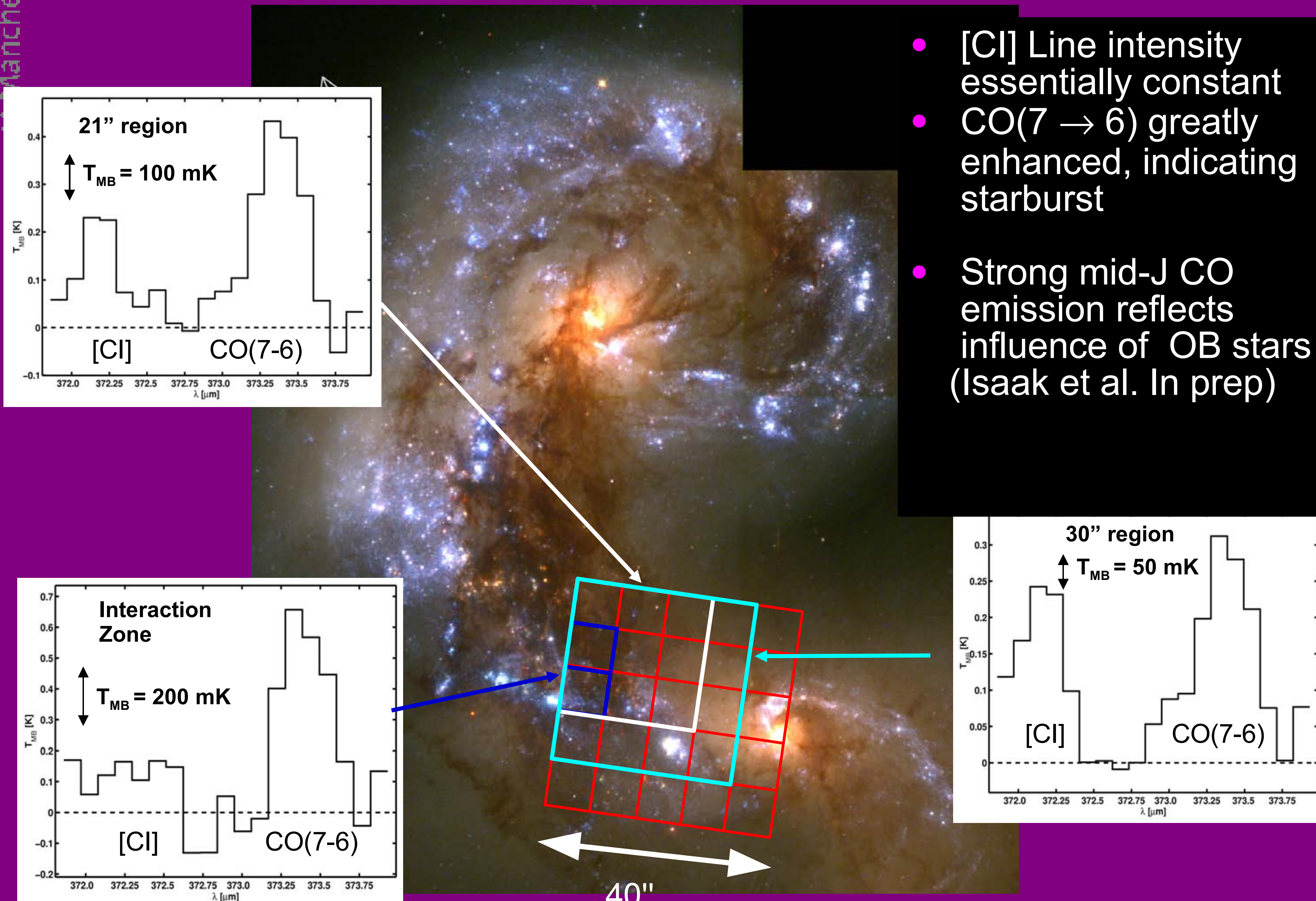
Wide Field Science

- Blind Z surveys
- Local galaxies
  - Interaction regions
  - Identifying clouds complexes
  - PDRs
- Large scale structure in clouds
  - Outflows and their effects
  - Triggers for star formation
  - PDRs
  - Large scale flows and velocity structure
  - Clump populations
  - Blind surveys for cold depleted regions
- Molecular inventory of sources

CO(7-6) and [CI] from NGC 4038/4039

- [CI] Line intensity essentially constant
- CO(7 → 6) greatly enhanced, indicating starburst
- Strong mid-J CO emission reflects influence of OB stars (Isaak et al. In prep)



8" pixels ~ ALMA primary beam

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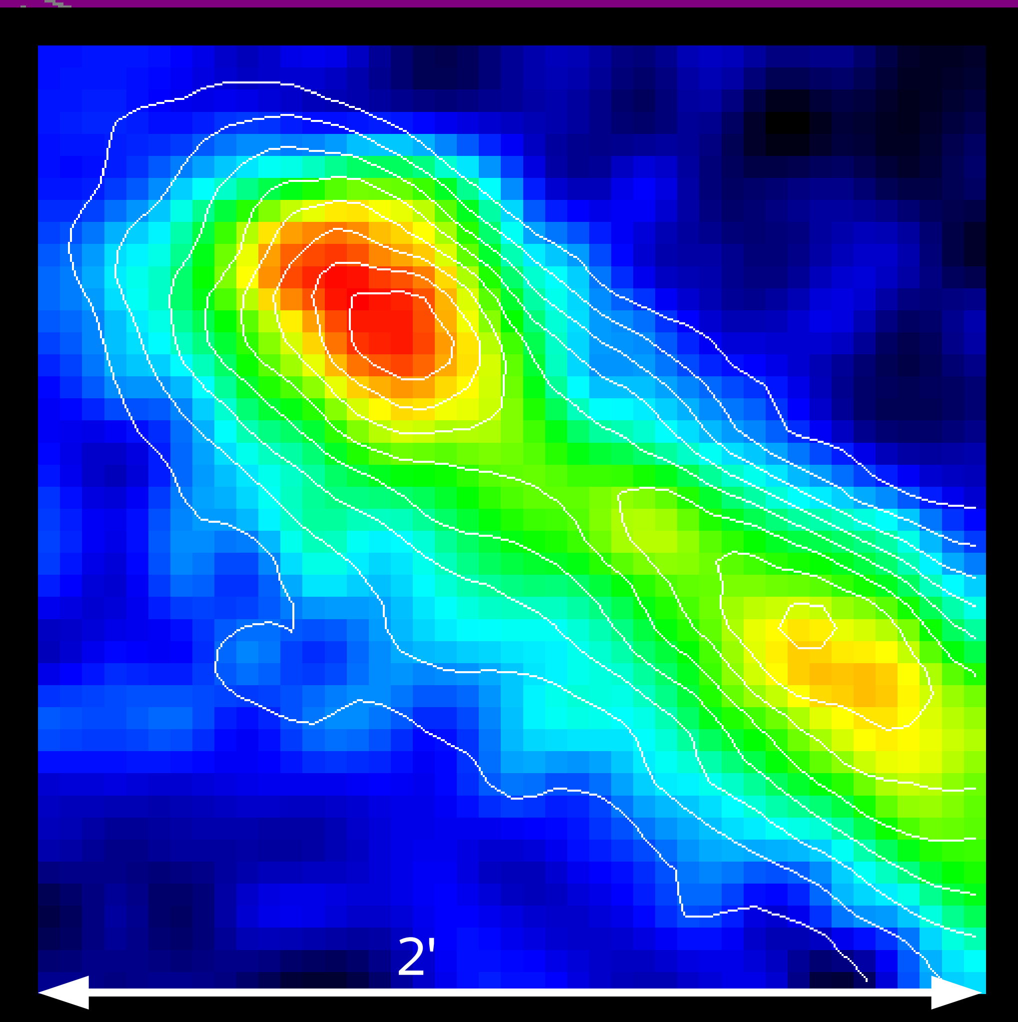
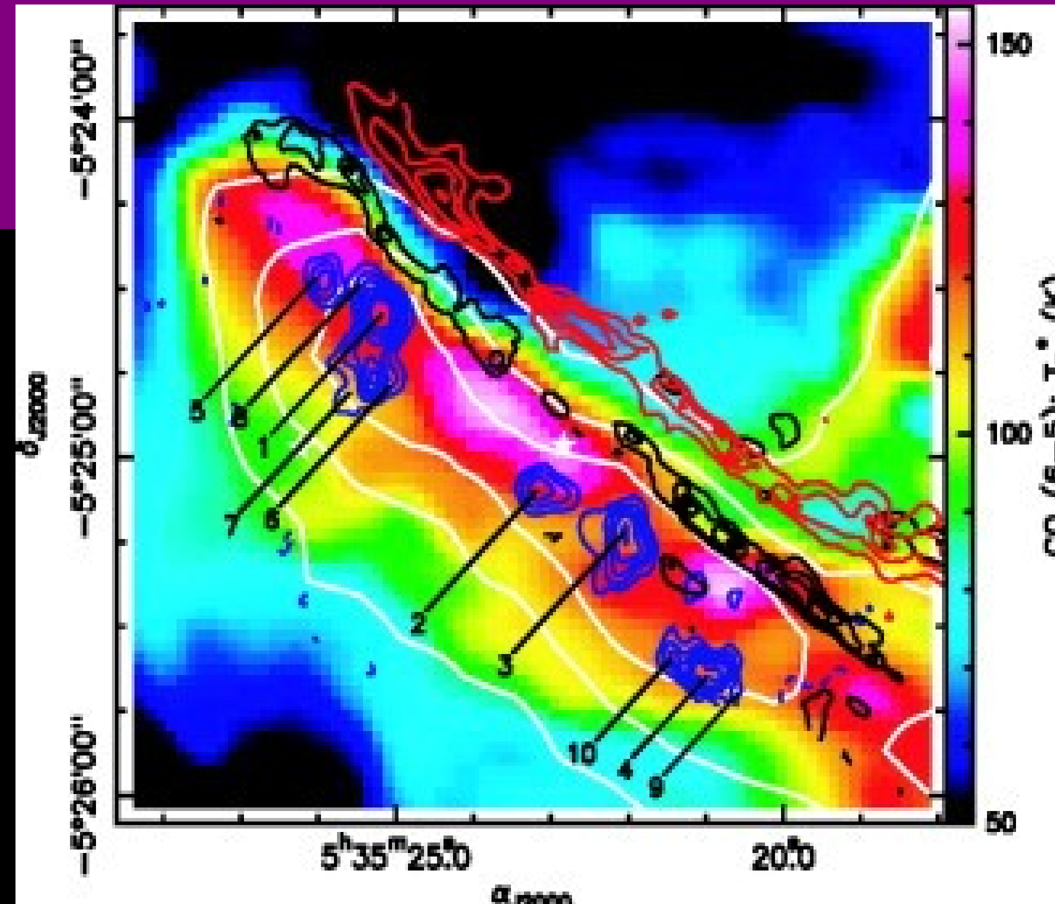
Galactic PDR



JCMT SLS HCN 3-2, $C^{18}O$ 3-2



CO J=6-5 - colour scale
$H^{13}CN$ J=1-0 – blue contours
(Lis & Schilke 2003)

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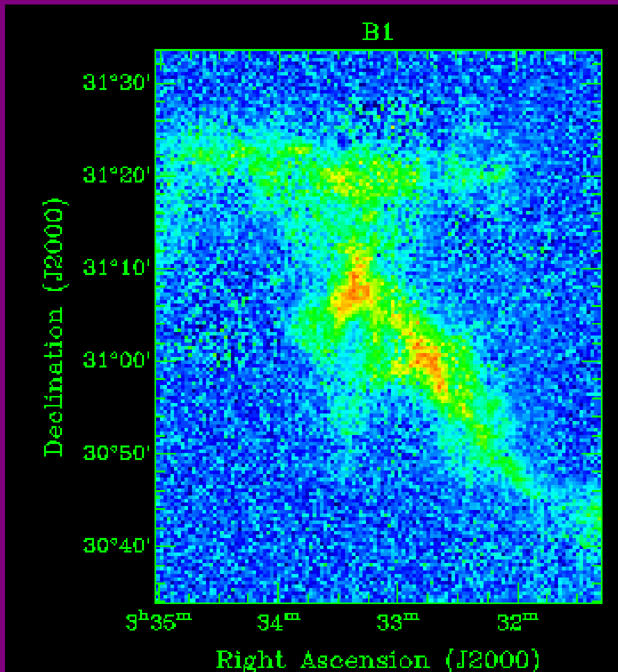
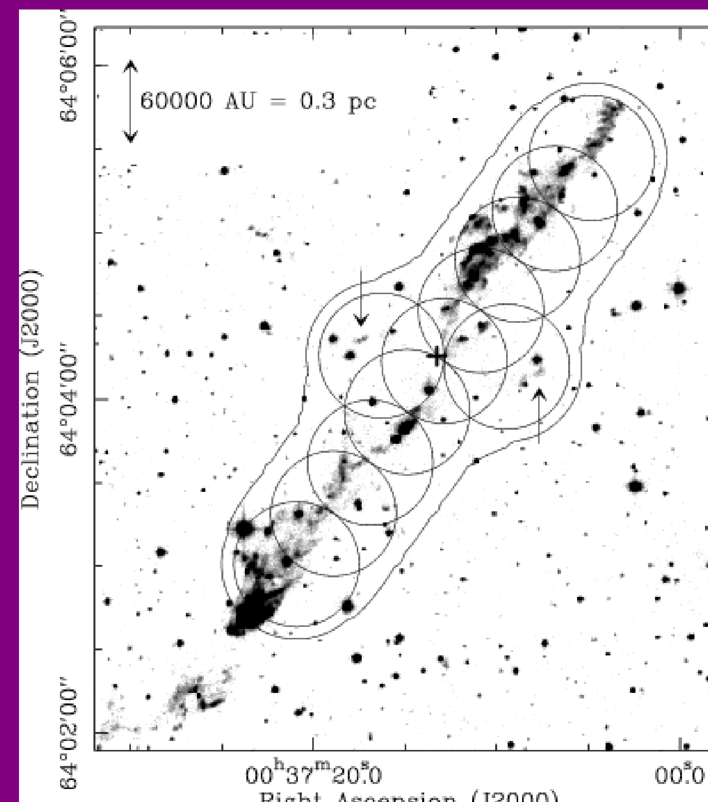


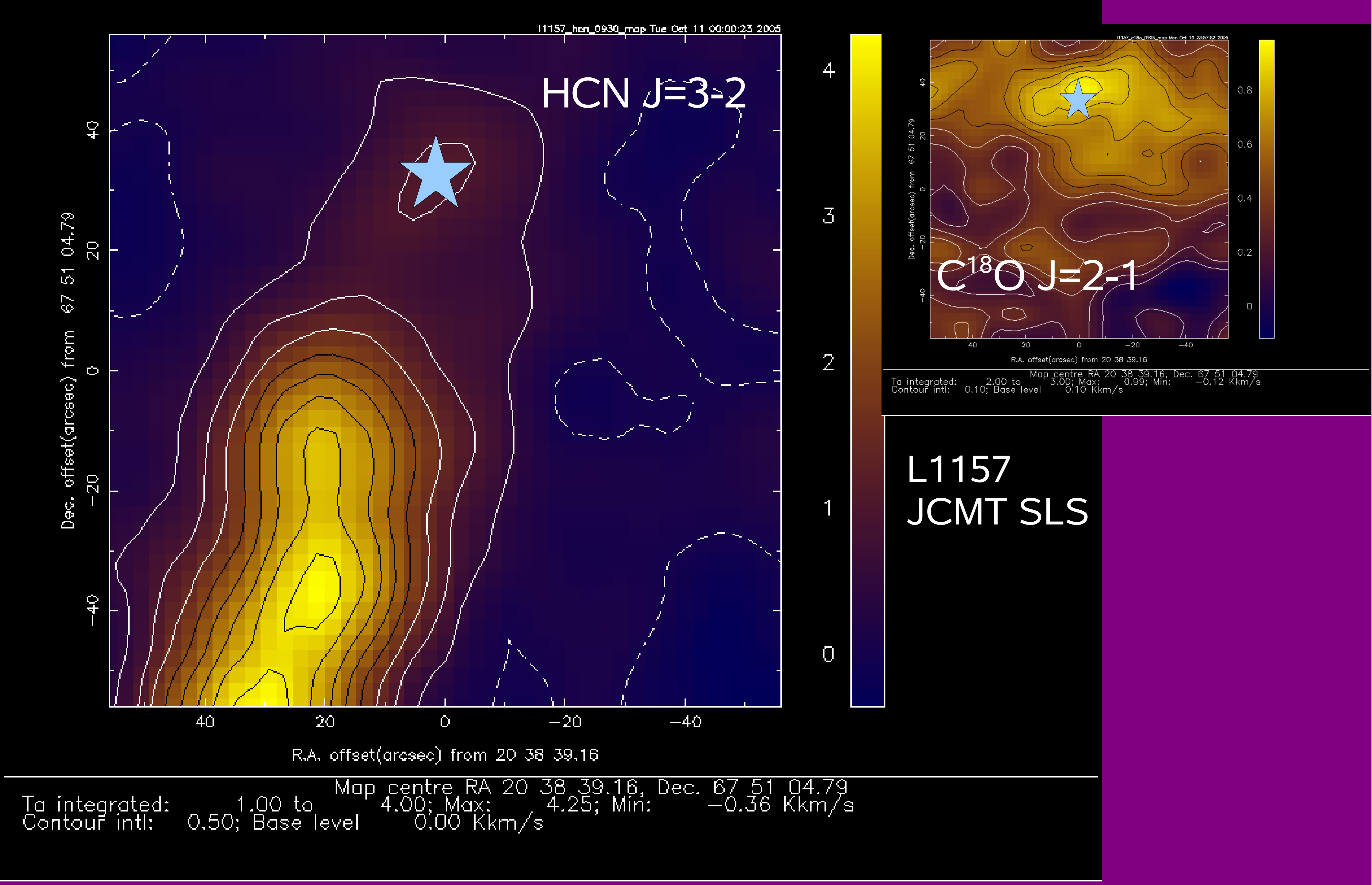
1° == 5.5 pc

Perseus B1
$C^{18}O$ J=1-0

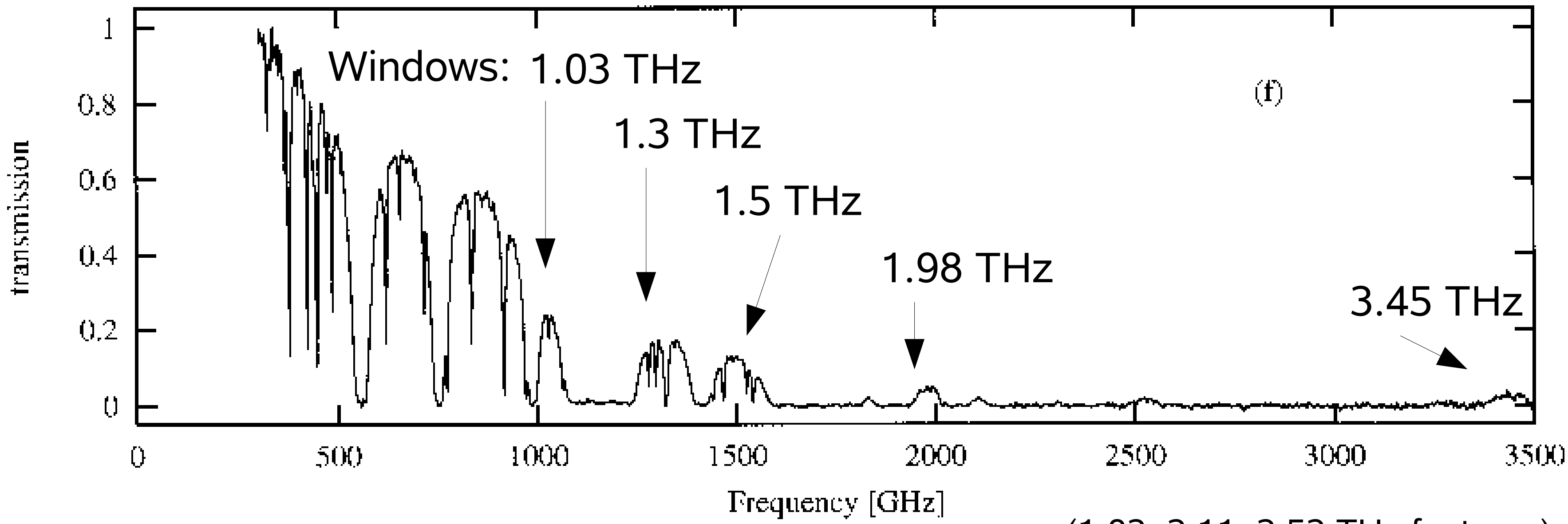
(Hatchell et al.)

HH288
(IRAM)





Lines selective to conditions



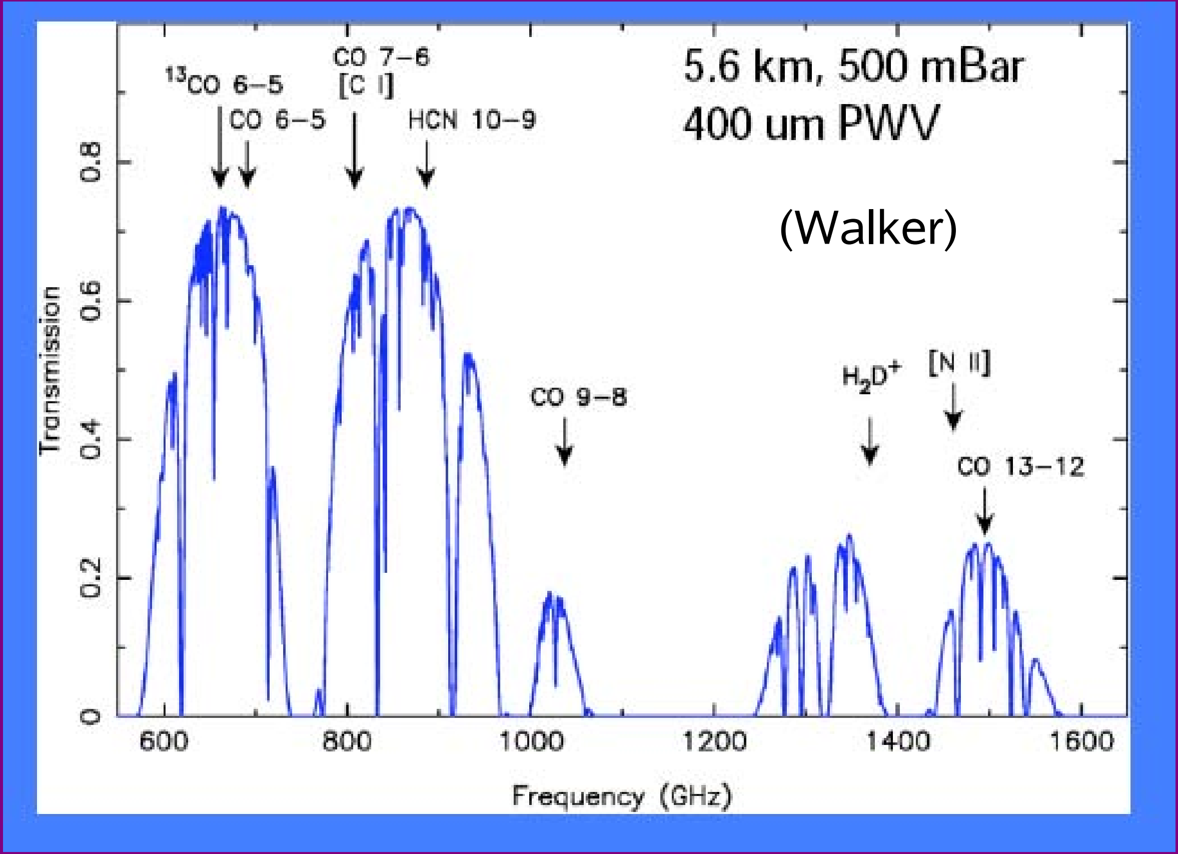
(Paine et al. 2000)

FIG. 3.—*Continued*

(1.83, 2.11, 2.52 THz features)

- High excitation lines
- Important coolants
- Atomic lines
  - CI, NII
- Tracer of cold, depleted gas
  - H_2D^+

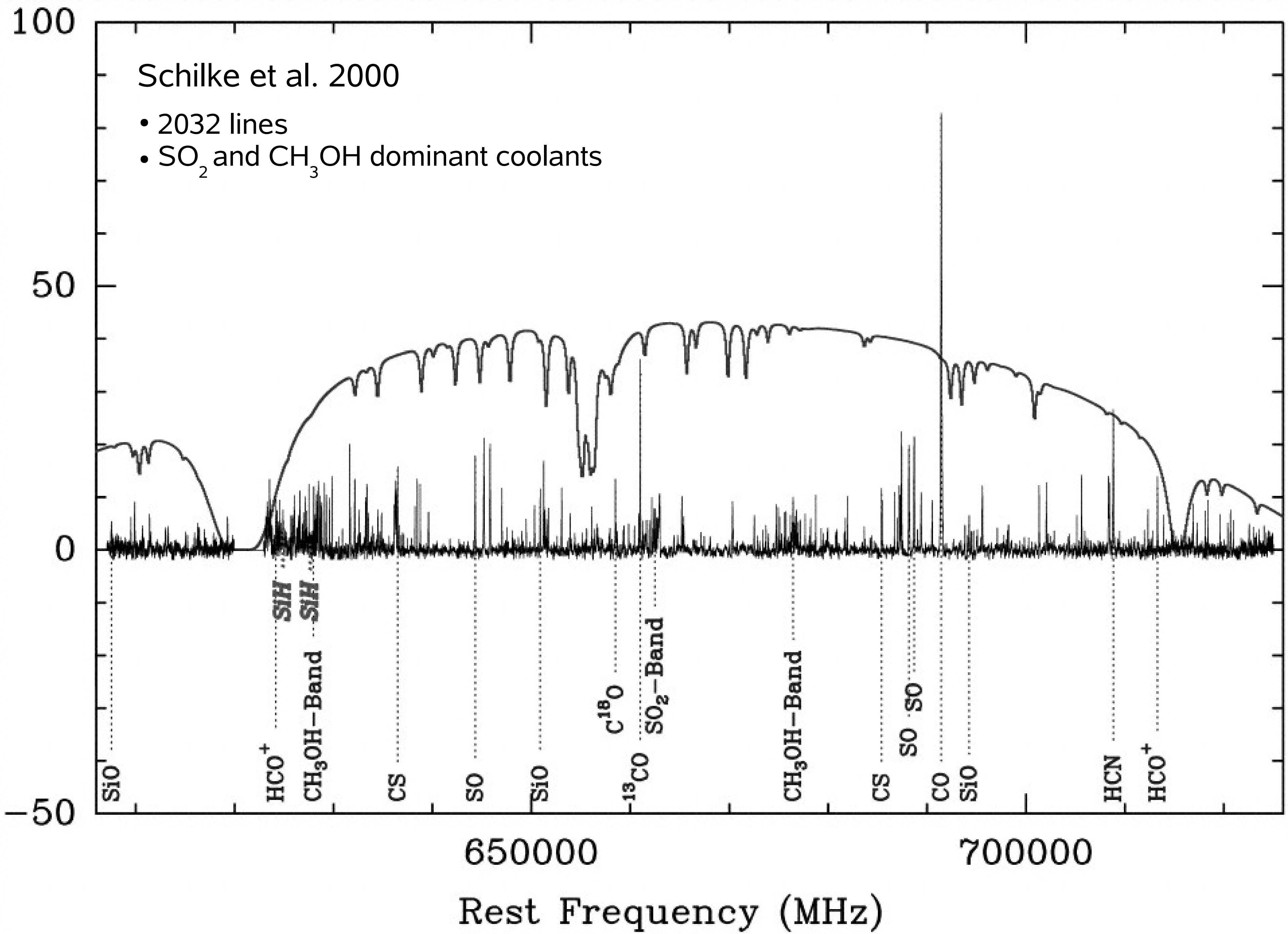
To maximise science from best conditions in poor windows need arrays



607 to 725 GHz Survey

Schilke et al. 2000

- 2032 lines
- SO_2 and CH_3OH dominant coolants



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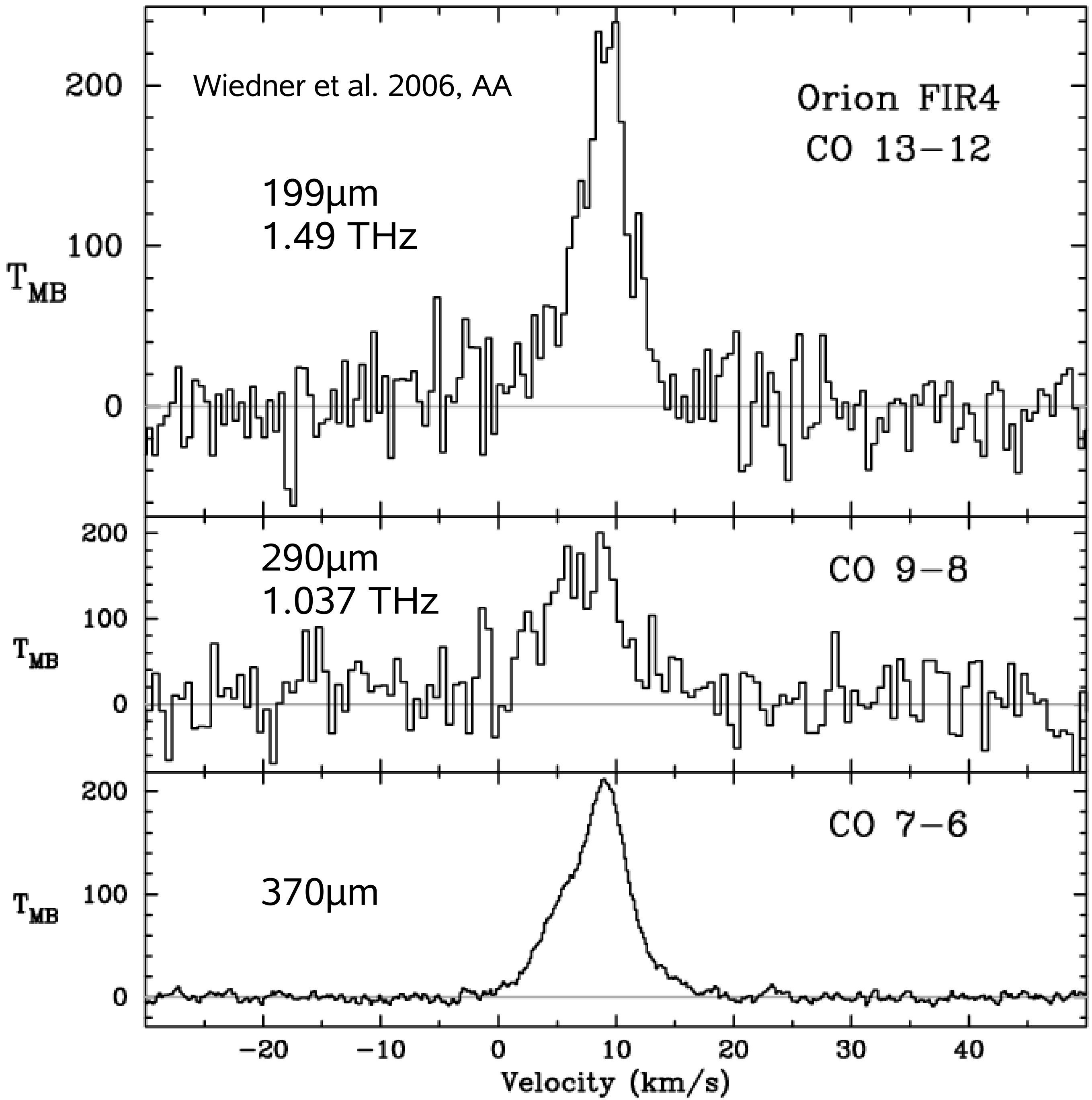
First results from CONDOR on Apex

From hot, dense gas: 300-500K, 3×10^{5}-5×10^{7} cm^{-3}



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UK Heterodyne Array Experience

- HARP-B/ACSIS - MRAO/ATC
  - 345 GHz
  - 16 pixels
  - 2GHz bandwidth
- OMAR - Manchester/UMass
  - 230 GHz
  - 16 pixels x 2 polarizations
  - 8 GHz bandwidth

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Questions & Requirements

- Current CCAT plans for heterodyne receivers?
- Frequency band?
- Requirements:
  - >10 of pixels
  - >8 GHz
  - 0.1 km/s channels (small scale turbulence/thermal lines)

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Summary

- CCAT for large structures/areas - finder scope for ALMA
  - Wide fields
  - Wide bands (>10 GHz, ideally 0.1 km/s resolution)
    - Combination essential to explore the highest frequency windows
  - Zero spacing data
- Lines probe a range of conditions and a range of physics