Millimetre ATCA Results

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ATCA at 3 & 12 mm – Current Status

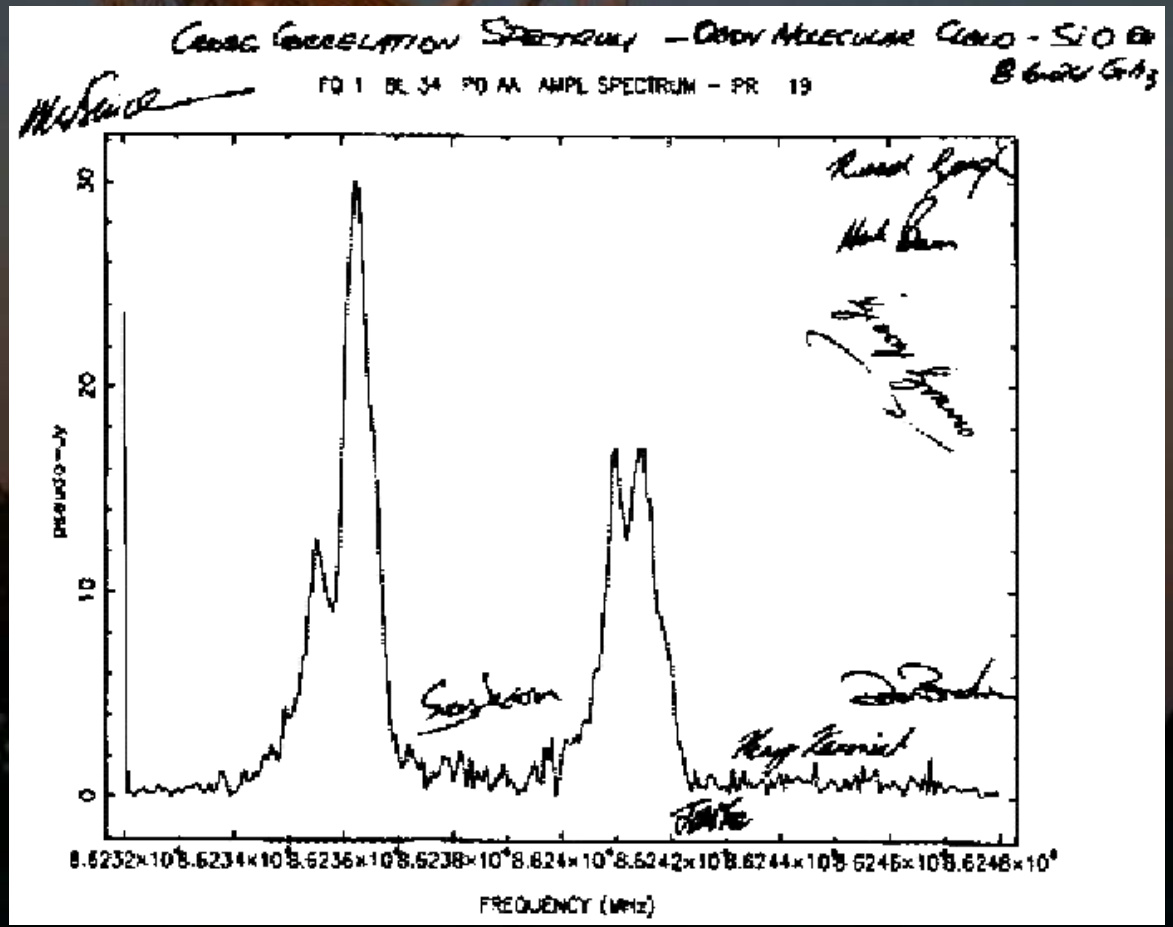
3 mm system

- Frequency range:
  (1) 84.906-87.305 GHz
  (2) 88.506-91.305 GHz
- 3 baselines, 2 pol.:
  CA02, CA03, CA04
- System temperature:
  250 – 400 K
- Bandwidth : 128 MHz

12 mm system

- Frequency range:
  16-26 GHz
  (no tuning needed !)
- 15 baselines, 2 pol.:
  CA01, CA02, CA03, CA04, CA05, CA06
- System temperature:
  60 – 70 K

First light on 30th Nov. 2000



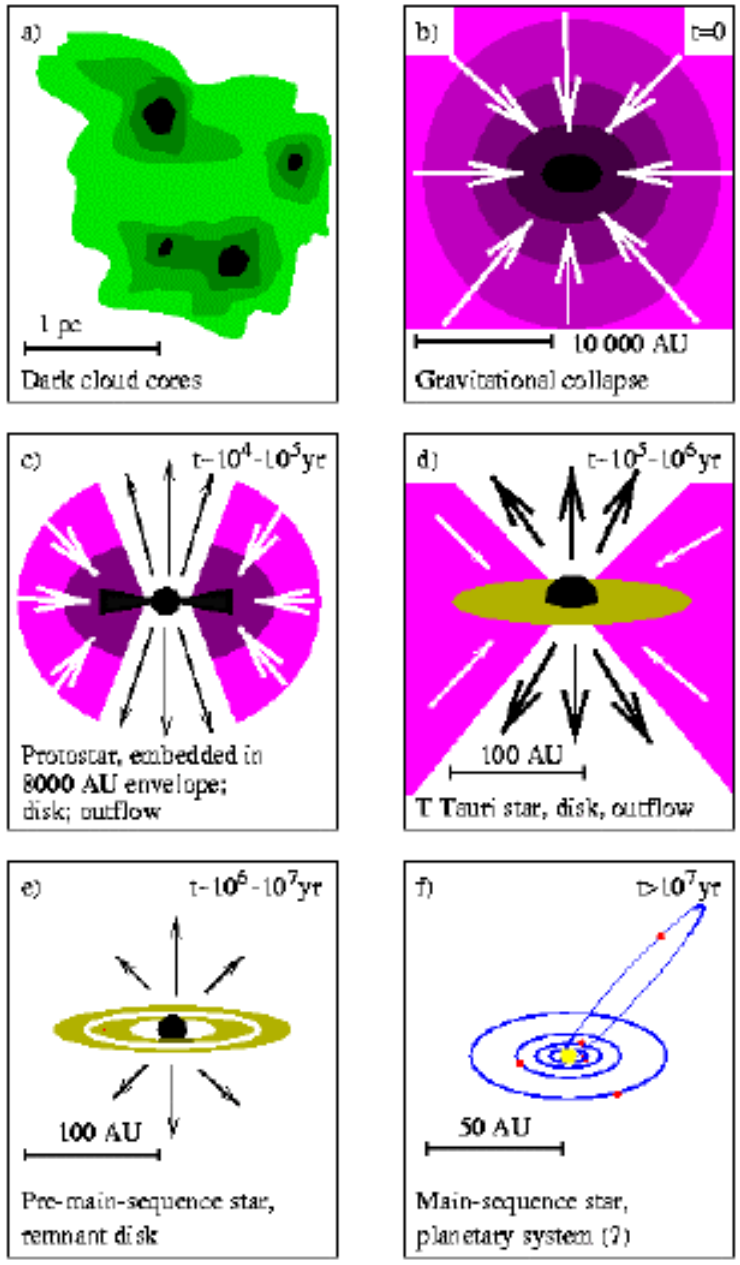
Orion SiO

86.243 GHz

Recent Results at 3 and 12 mm

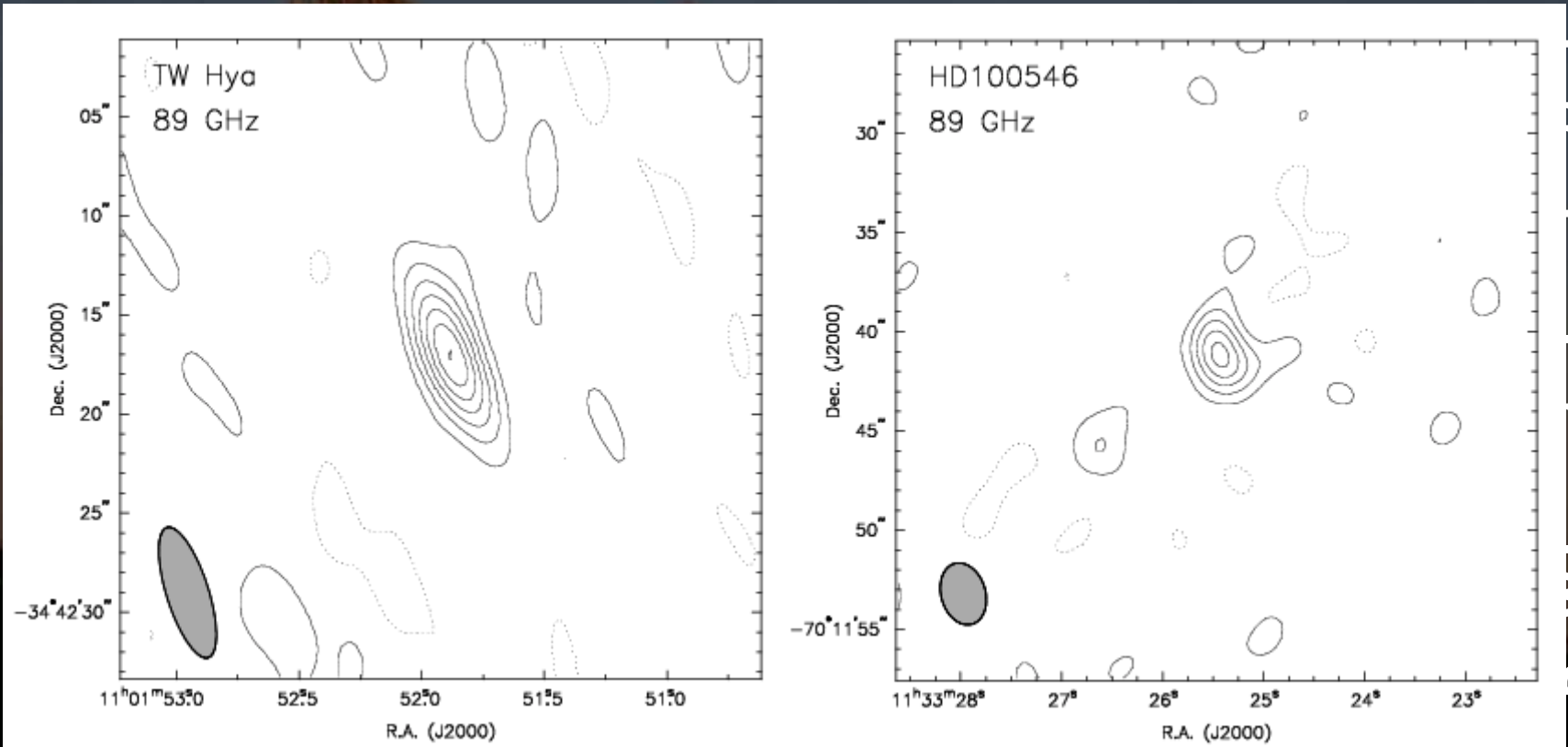
- Pre-planetary disks around young stars (Wilner, Bourke, Wright, Jorgensen, van Dishoeck, Wong, 2002)
- Planetary water masers in extra-solar systems (Minier, Lineweaver, Burton, Purcell, Longmore, Norris, 2003)
- Search for biomolecules in Sgr B2 (Jones, Hunt, 2002)
- Massive star formation in the Galactic Plane (Minier, Burton, Wong, Purcell, Hill, Longmore, Barnes, 2002 – 2003)
- Late-type stars (AGB, CSE, SiO masers) (Olofsson, Lindqvist, Wong, 2002)
- Massive star formation in the LMC (N113: Wong, Ott, Mizuno et al., 2000 – 2002; Water vapour masers: Beasley, Claussen, Marvel & Staveley-Smith)
- SNR1987 (Manchester et al. 2002)
- Molecular gas in nearby galaxies (Koribalski et al. 2001)

1. Pre-planetary disks around young stars



Hogerheijde 1998, after Shu et al. 1987

Dust in Pre-planetary Disks



D. Wilner et al., submitted

TW Hya
T Tauri star
41±4 mJy

HD 100546
Herbig Be star
36±3 mJy

2. Planetary water masers in extra-solar systems

Water vapour masers in giant planet atmospheres

Shoemaker-Levy 9 collision: 17th July 1994

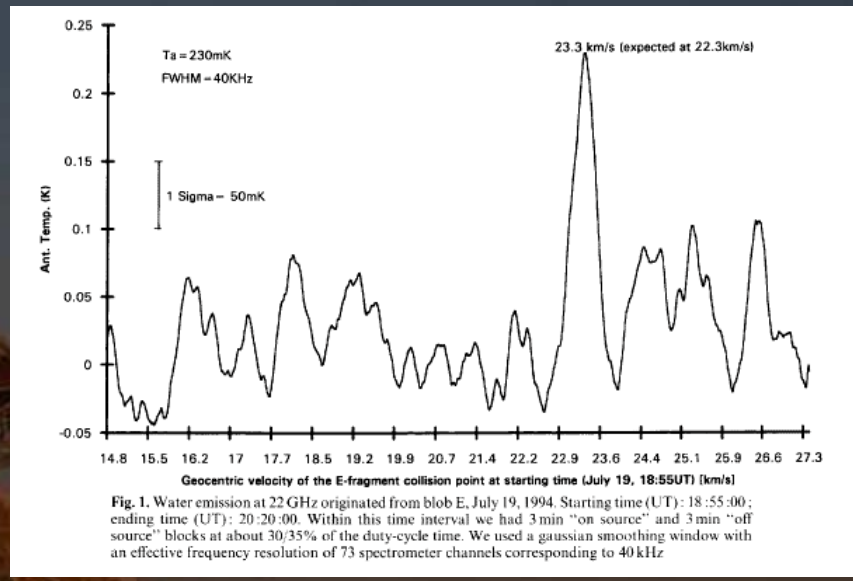


Fig. 1. Water emission at 22 GHz originated from blob E, July 19, 1994. Starting time (UT): 18:55:00; ending time (UT): 20:20:00. Within this time interval we had 3 min "on source" and 3 min "off source" blocks at about 30/35% of the duty-cycle time. We used a gaussian smoothing window with an effective frequency resolution of 73 spectrometer channels corresponding to 40 kHz

Cosmovici et al. 1996

- September 2002, Cosmovici et al. announced the detection of water masers in 4 exo-planetary systems (e.g. Eps. Eridani).
- December 2002, the detections were not re-confirmed with the VLA despite a sensitivity of a few mJy/beam.

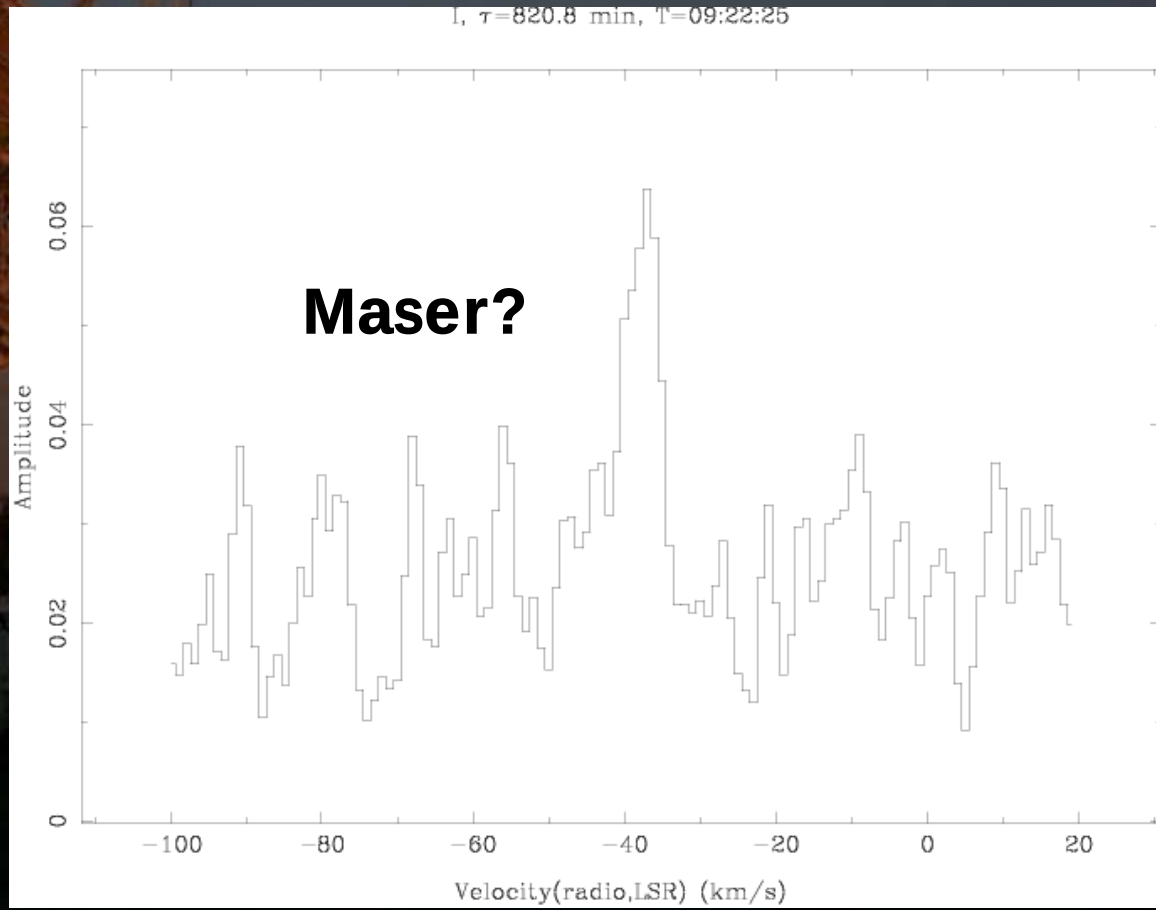
Search for water masers toward very young “solar systems” (1-2 Gyr)

12 mm system

- Frequency range:
  22.23508 GHz

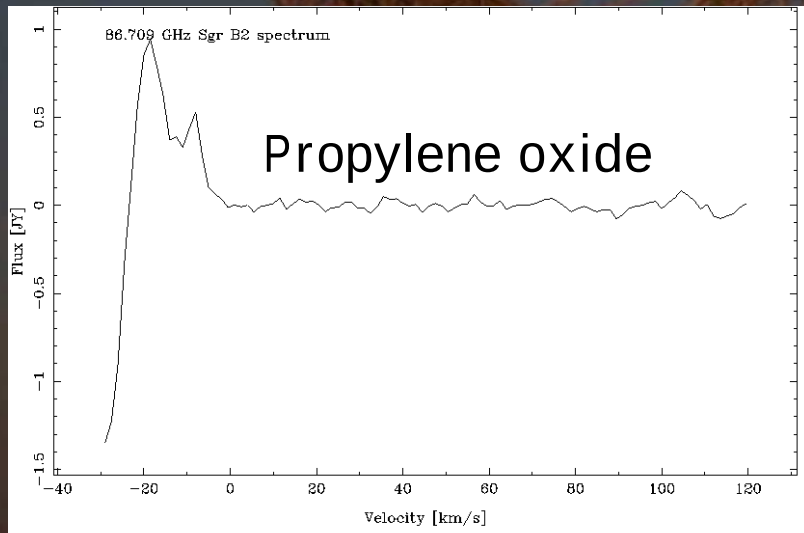
- EW352+antenna 6
  ➔15 baselines, 2 pol.:
  CA01, CA02, CA03,
  CA04, CA05, CA06

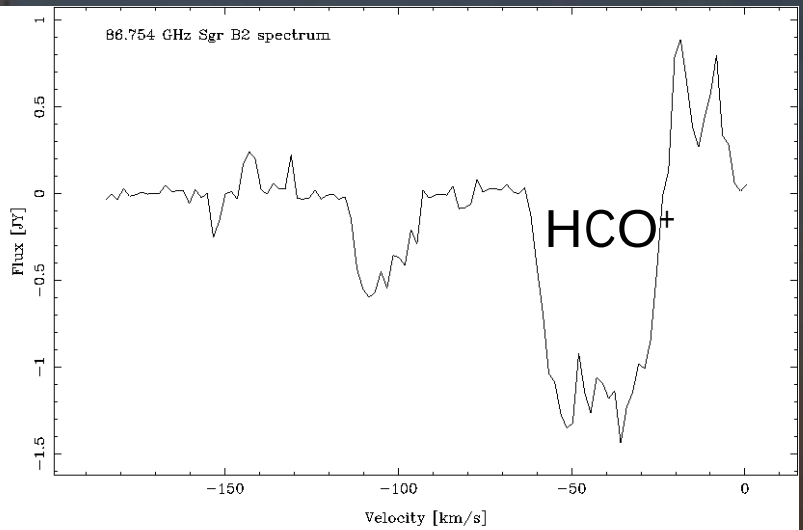
- Tsys & sensitivity:
  60 – 70 K
  20-40 mJy

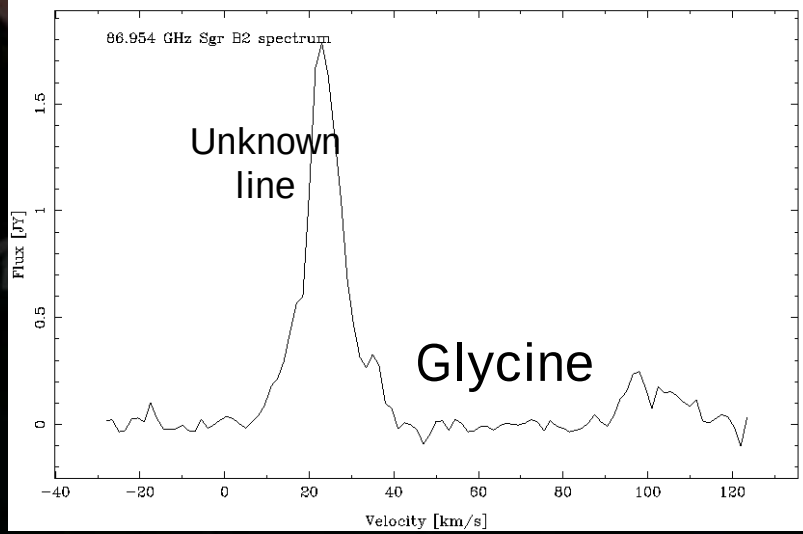


3. Search for biomolecules in Sgr B2

Search for glycine (87 GHz) and propylene oxide (86.7 GHz)



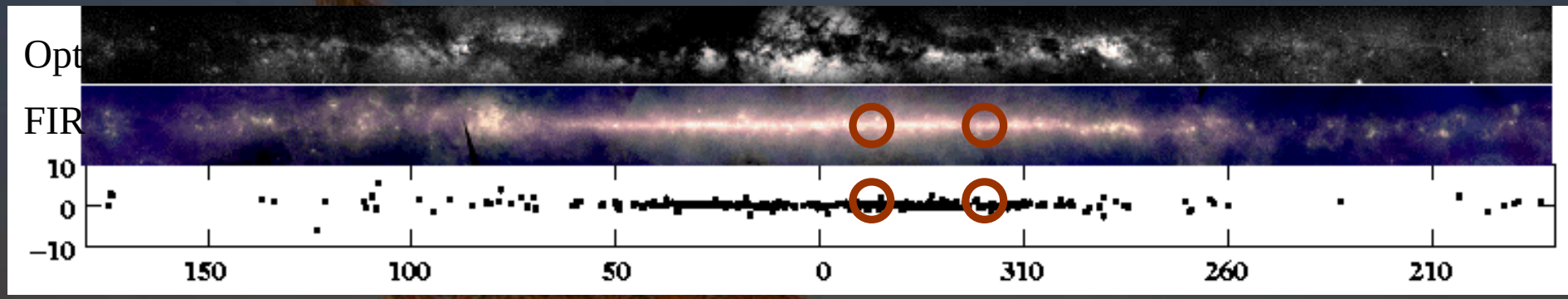




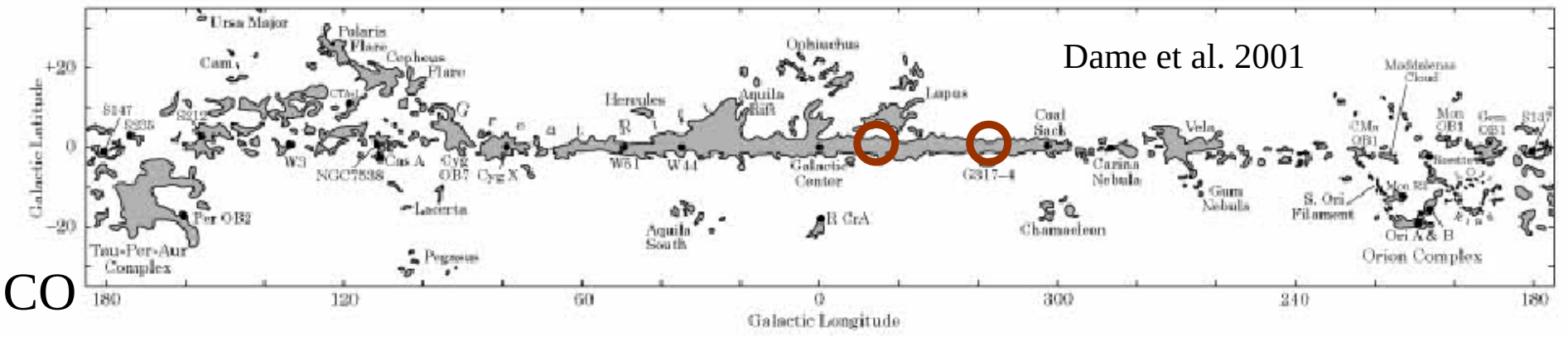
No detection down to 30 mJy/beam.

4. Massive star formation in the Galactic Plane

Galactic plane

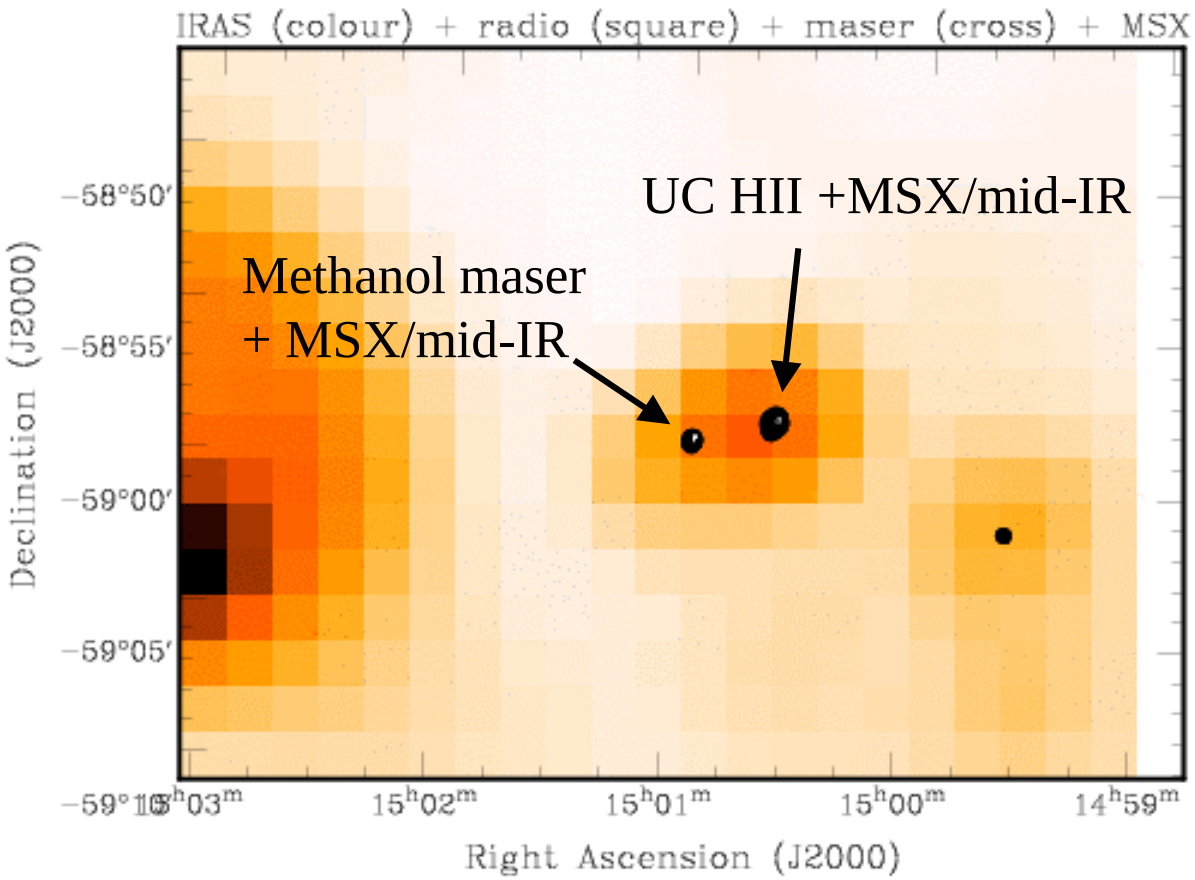


Methanol masers as tracers of massive star formation



G318.95-0.20 (IRAS 14567-5846)

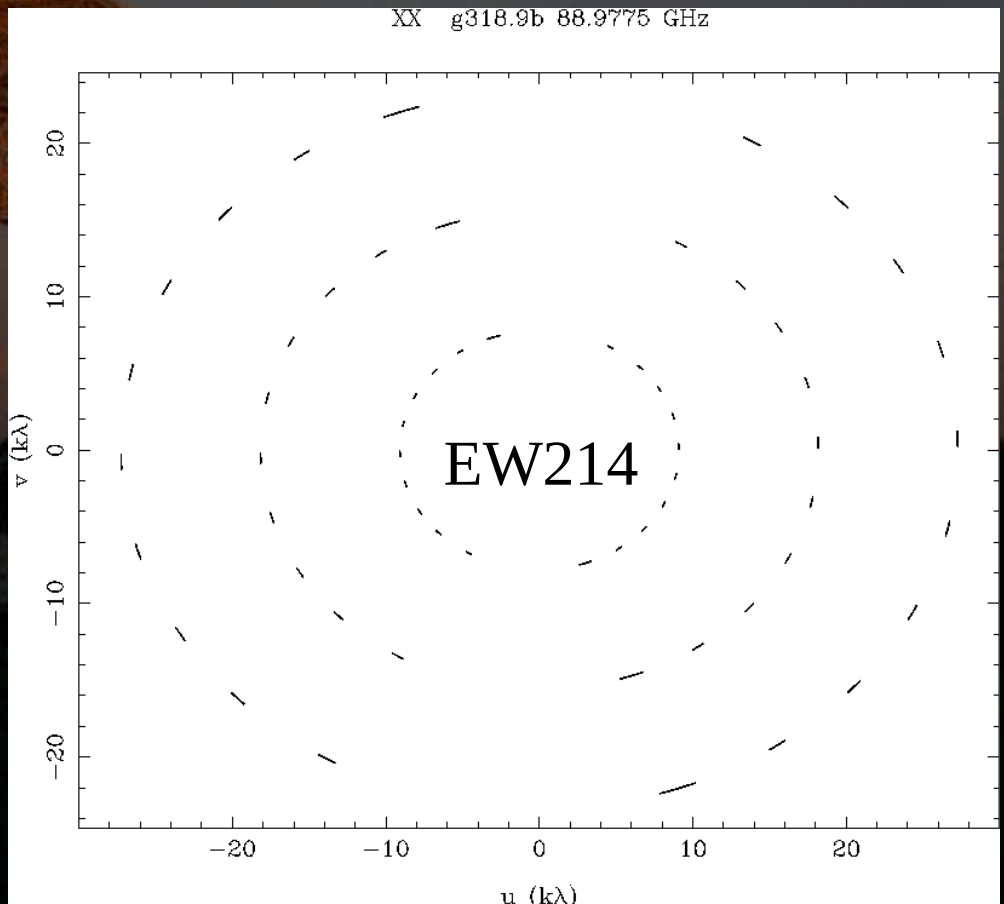
ATCA at 6.7 and 8.6 GHz



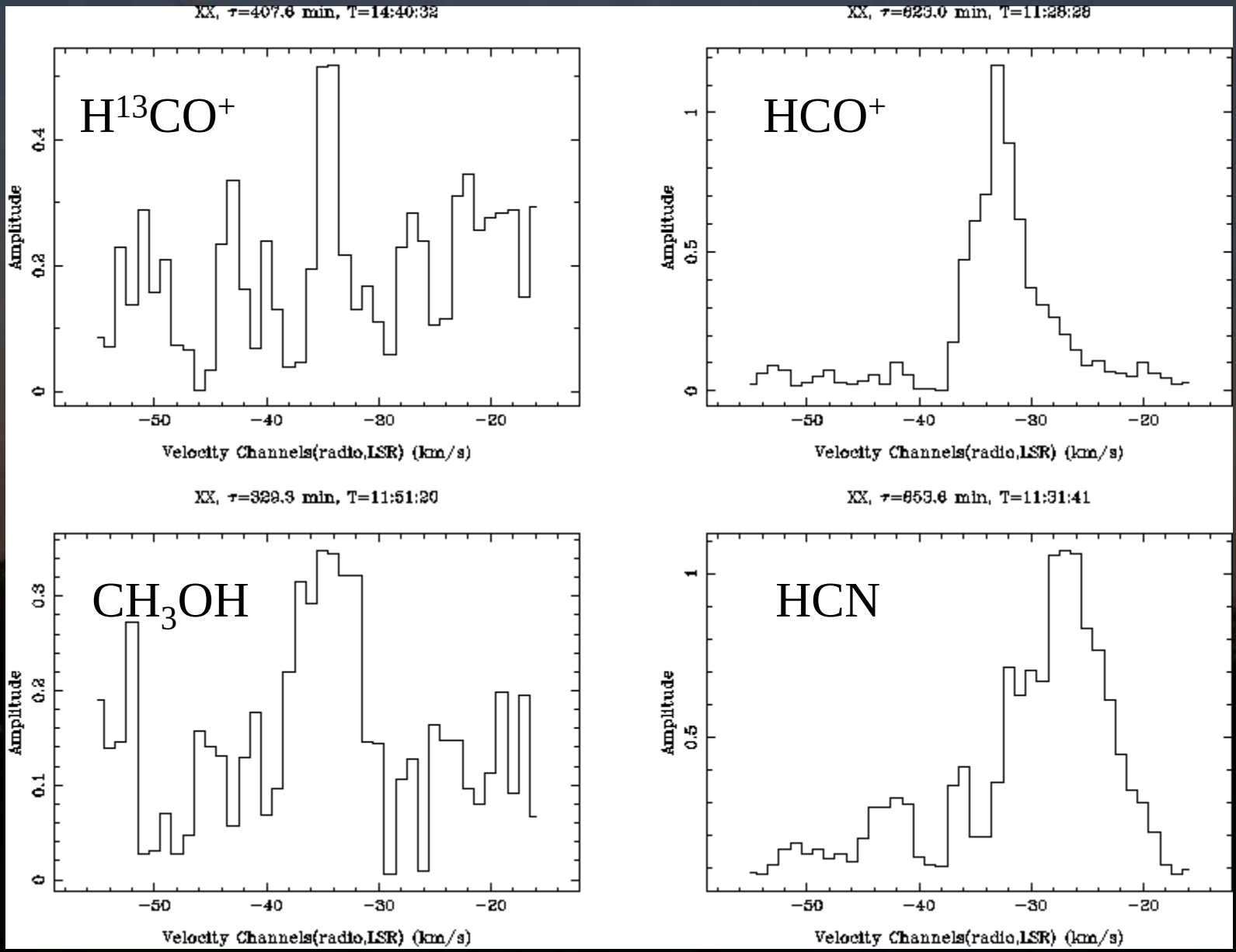
IRAS source is resolved in 2 cores

G318.95-0.20 (IRAS 14567-5846)

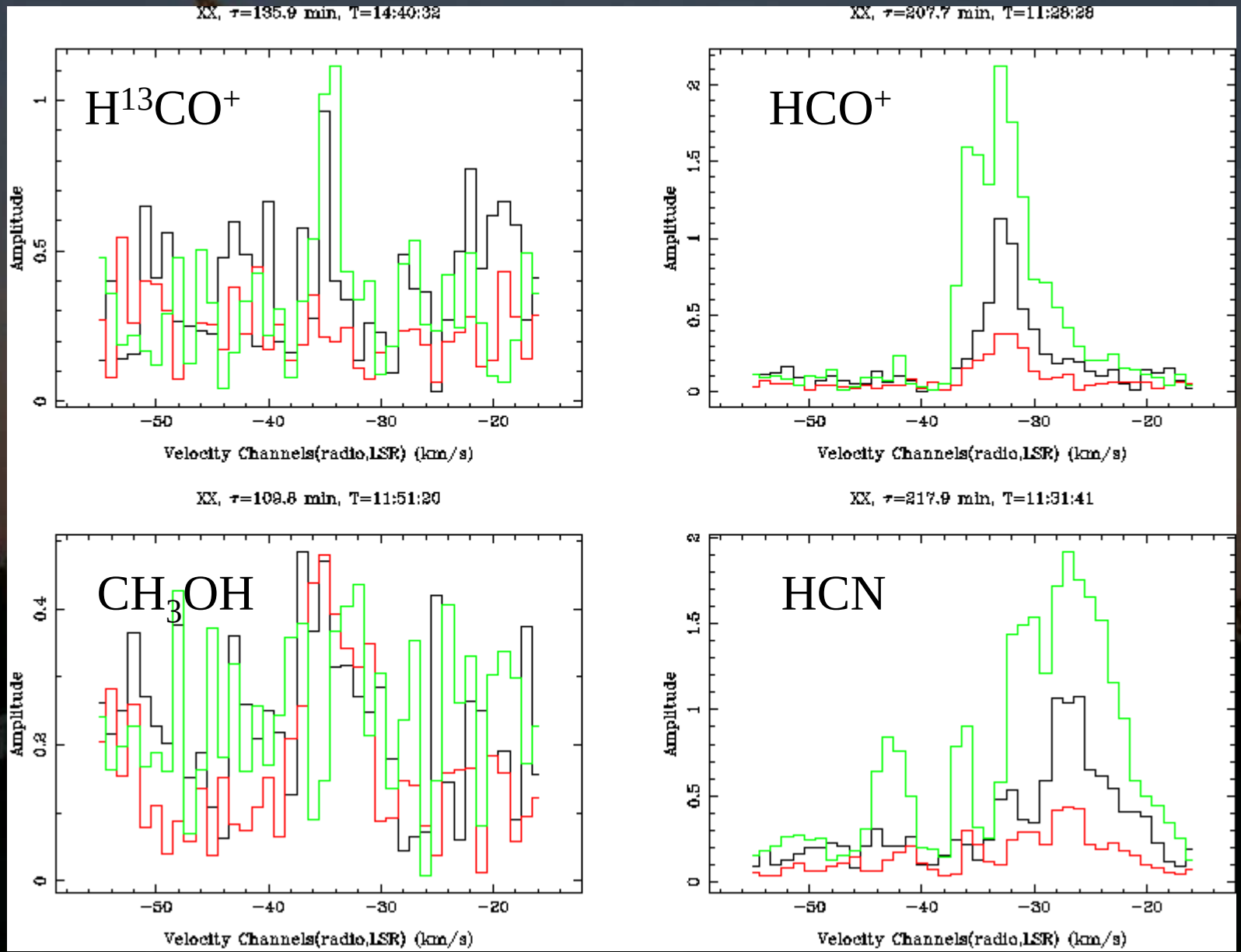
- HCN, HCO^+(Mopra); $H^{13}CO^+$, HC_3N, CH_3OH: all dense gas tracers (>10^5 cm^{-3}).
- ATCA-3mm + EW214 (6 – 20 arcsec).
- 750A ➔ resolved out or large phase errors on long baselines
- EW352 (bad weather)
- RMS=80-100 mJy/beam



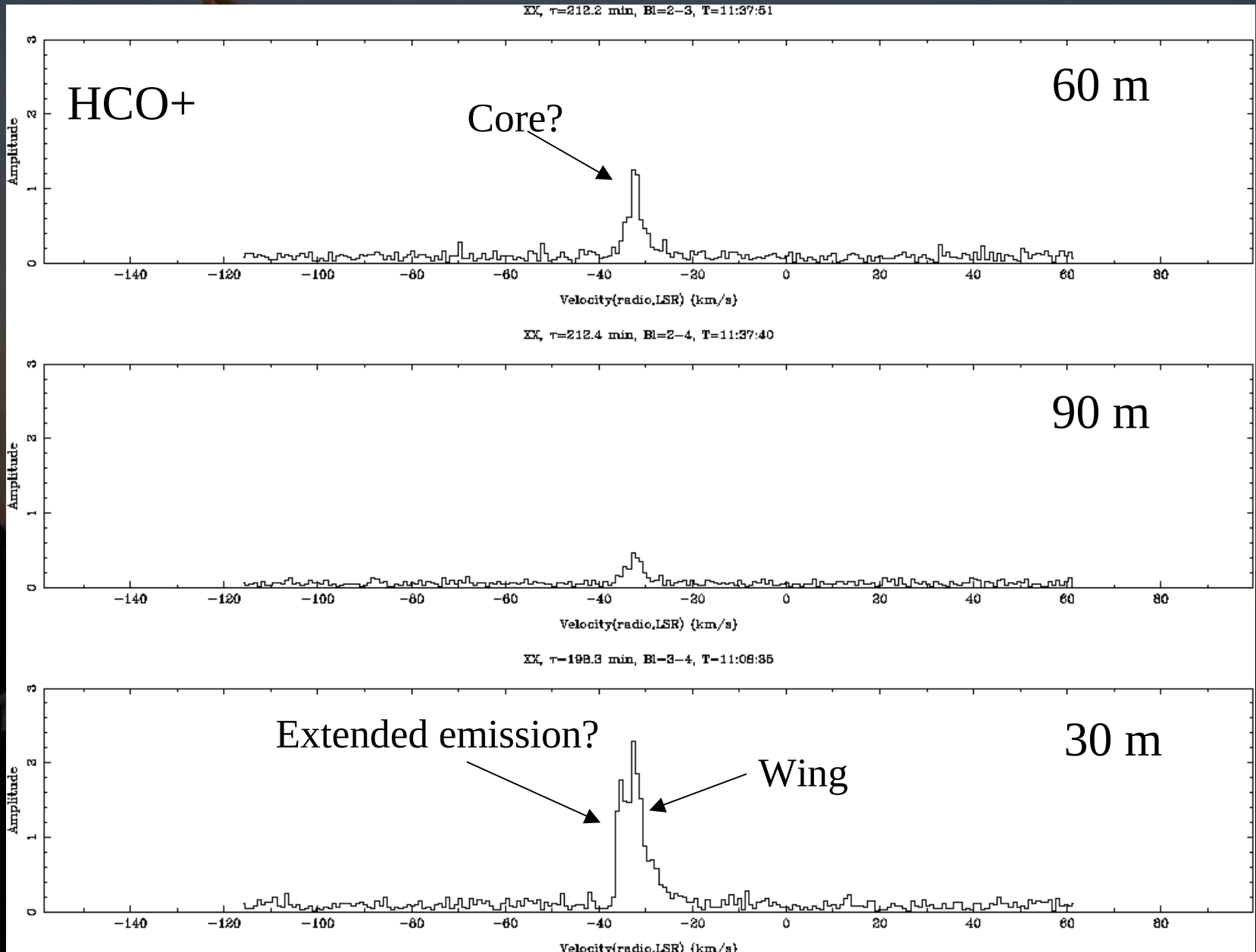
Averaged spectra



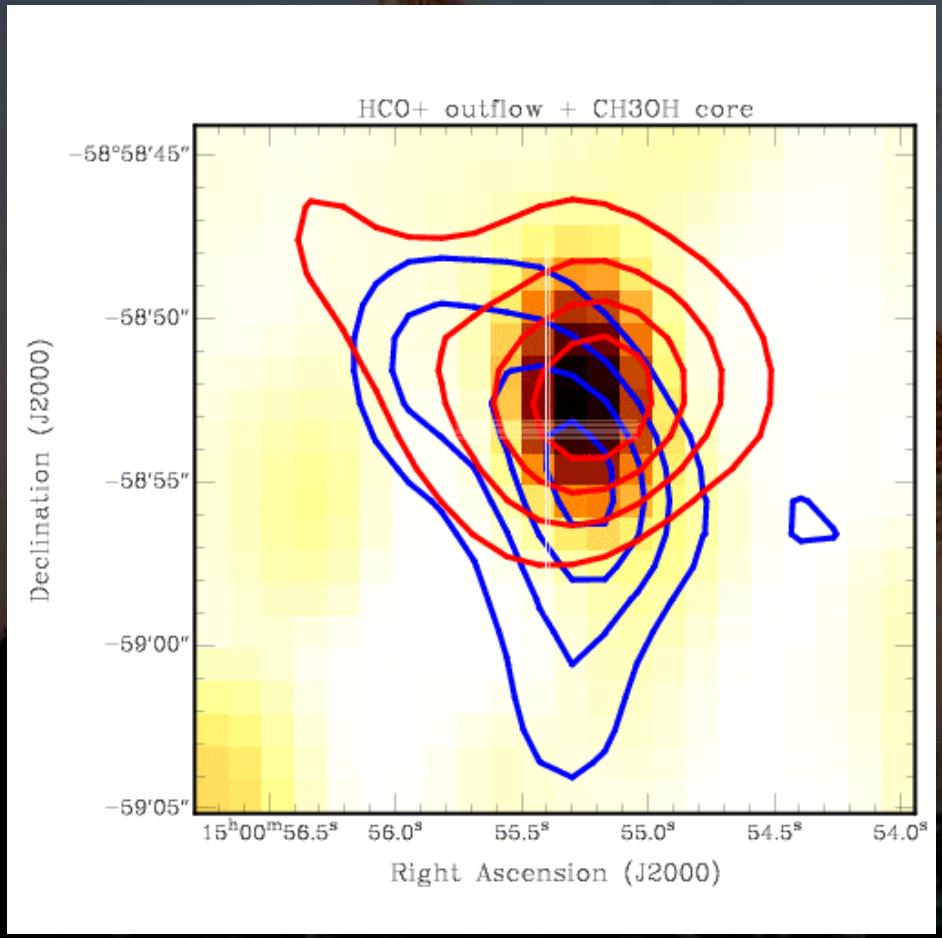
Cross-correlated spectra



G318.95-0.20 (IRAS 14567-5846)



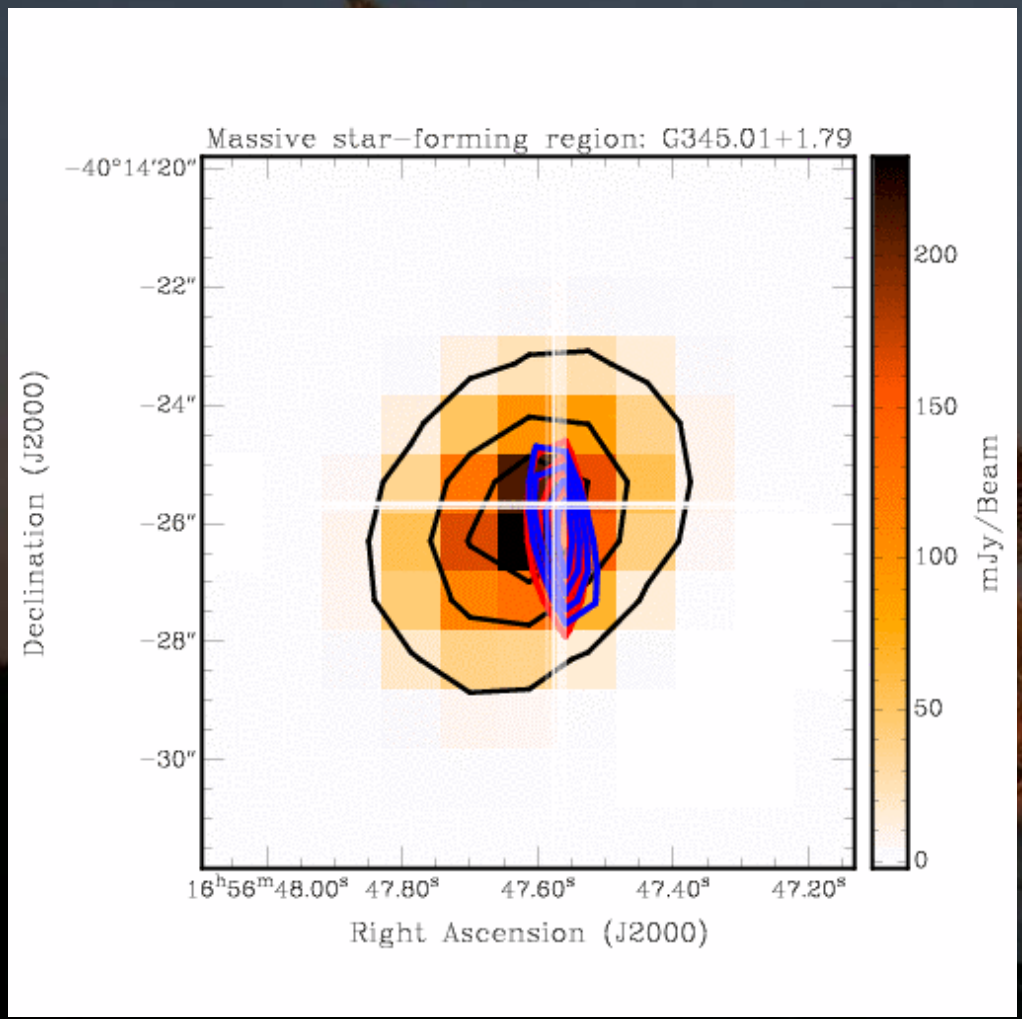
G318.95-0.20 (IRAS 14567-5846)

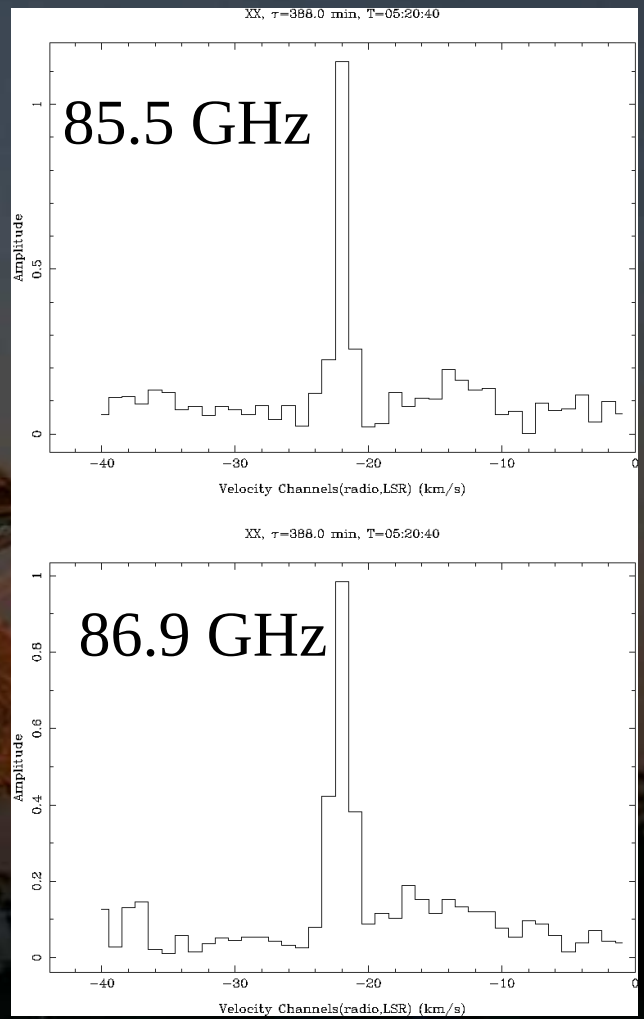


- The methanol masers in G318.95-0.20 coincide with a dense molecular core.
- HCO^+ bipolar structure = molecular outflows.
- No UC HII region is detected.
- G318.95-0.20 = a massive protostar?

- CH_3OH, HCO+ → $M_{vir} = 126(R_{pc})(\Delta v_{km/s})^2 = 120 - 400\ M_\odot$
- $n_{gas} = 6 \times 10^7\ cm^{-3}$

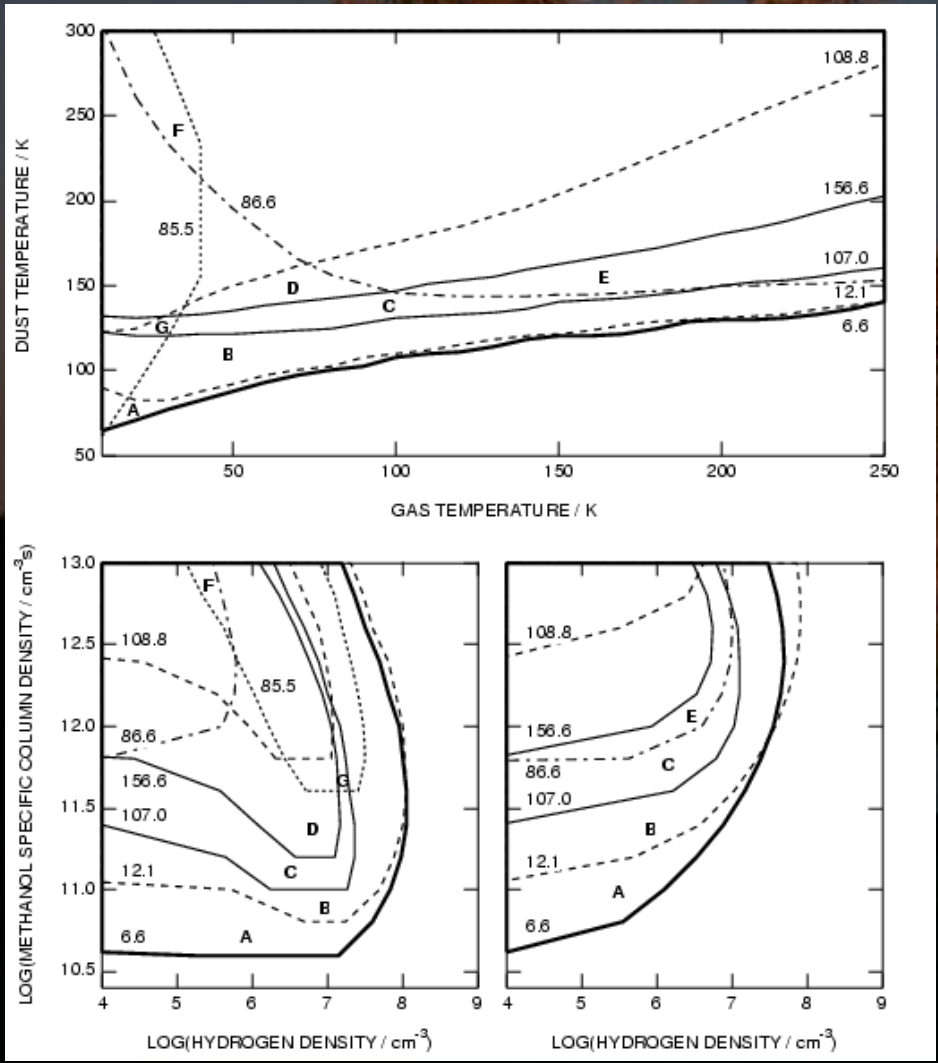
Methanol masers in G345.01+1.79





All masers coincide in velocity and position ➔ coincide in space

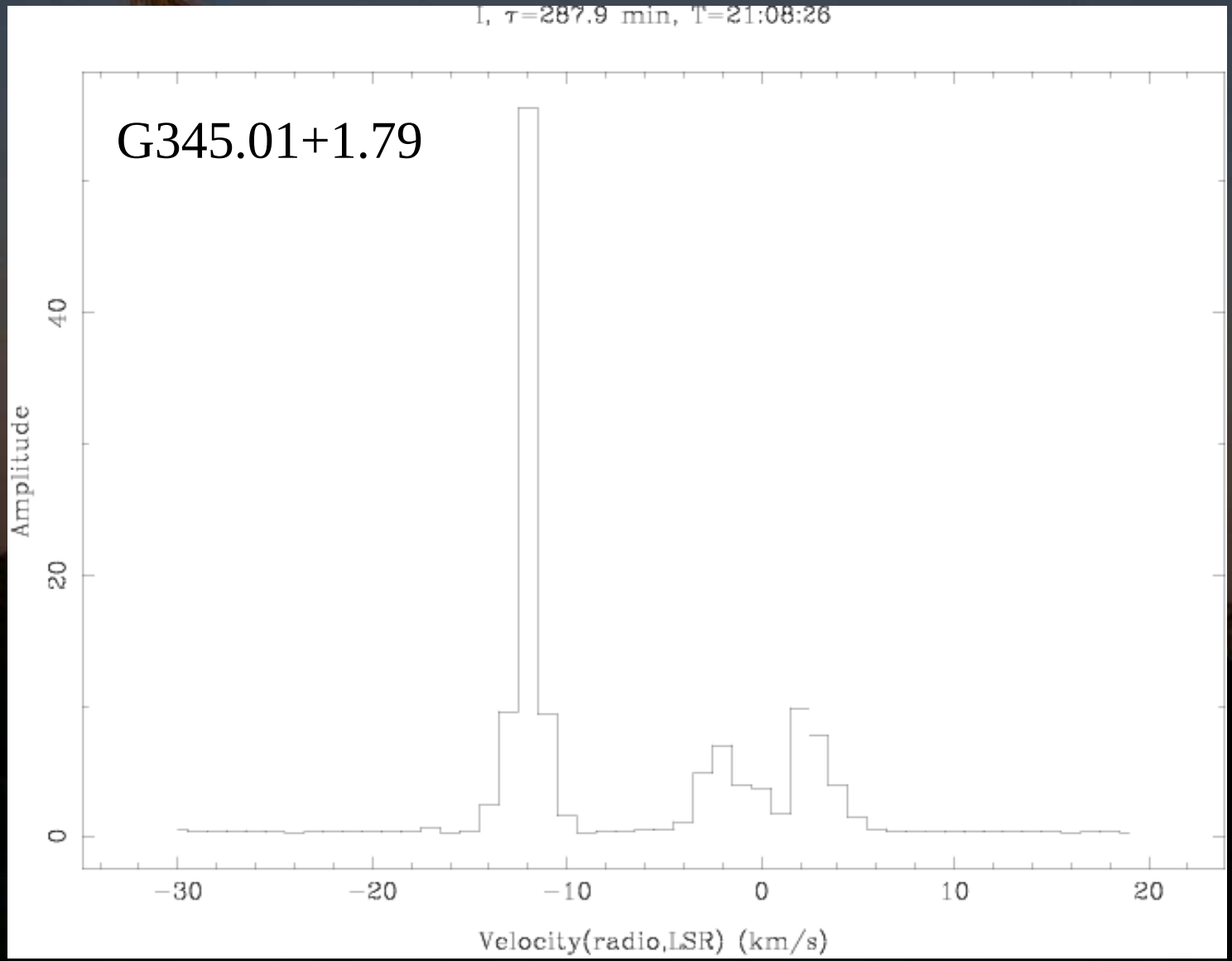
Probing gas/dust conditions with methanol masers



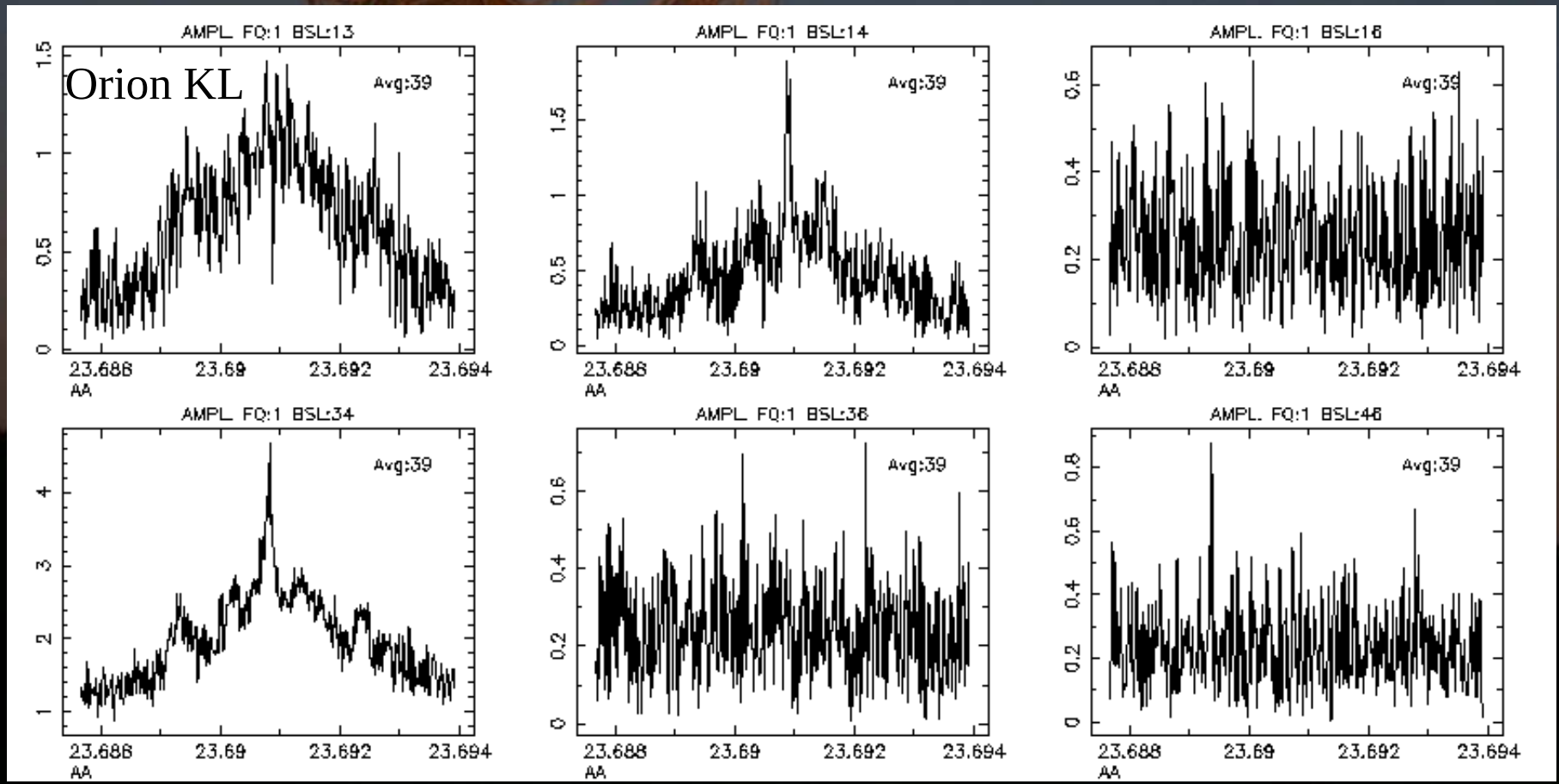
Ellingsen et al. 2003, accepted in MNRAS

- Using model by Cragg et al. (2001).
- Hot gas 200-300 K
- Cold dust <50 K
- As expected for a massive protostellar core.

Water masers in MSF regions



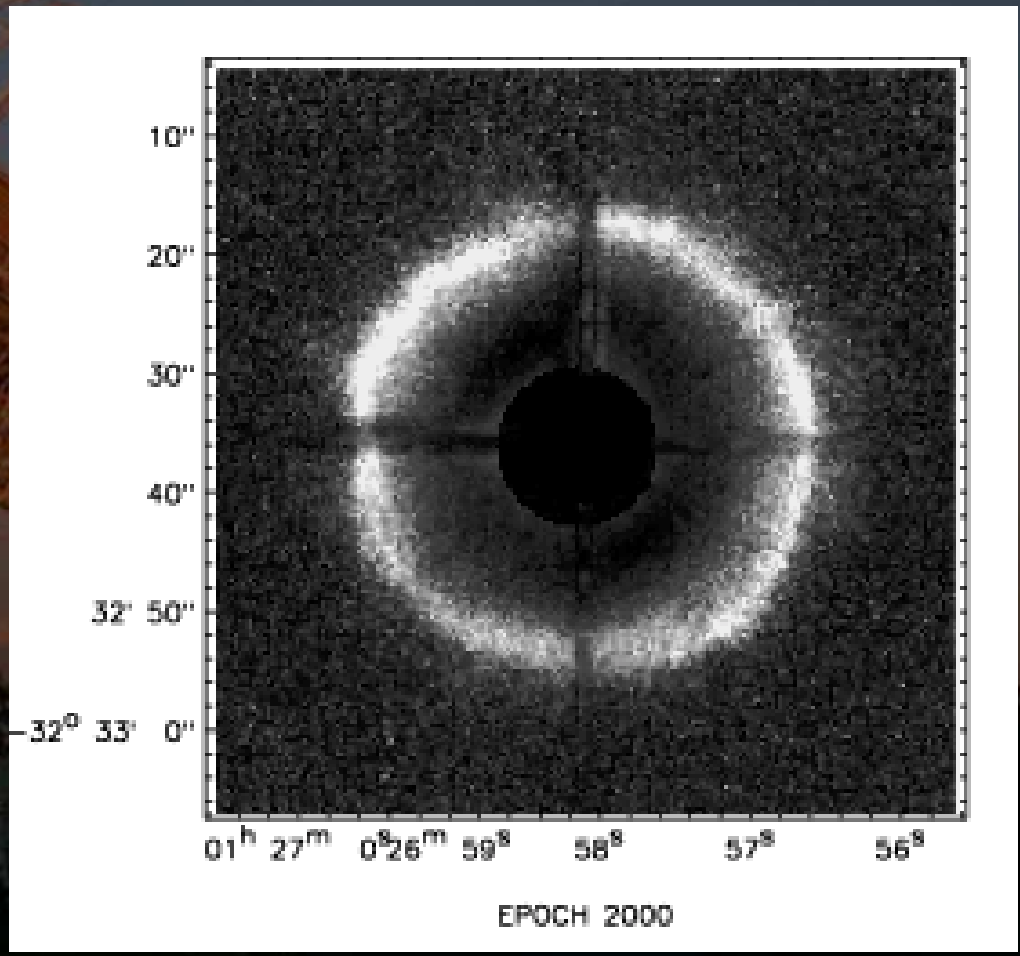
NH_3 emission (23.7 GHz)



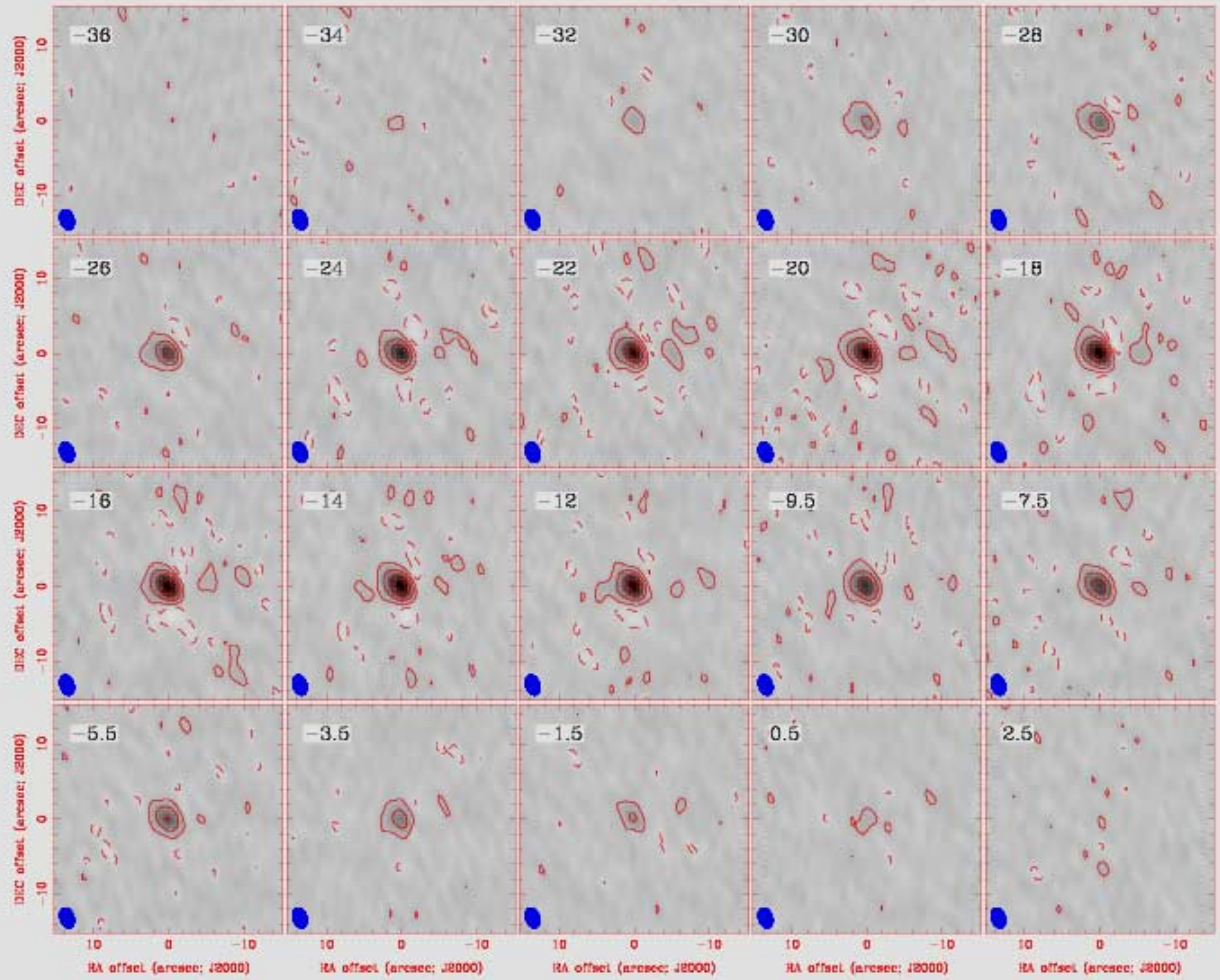
5. Late-type stars

Circumstellar Shell Around R Scl

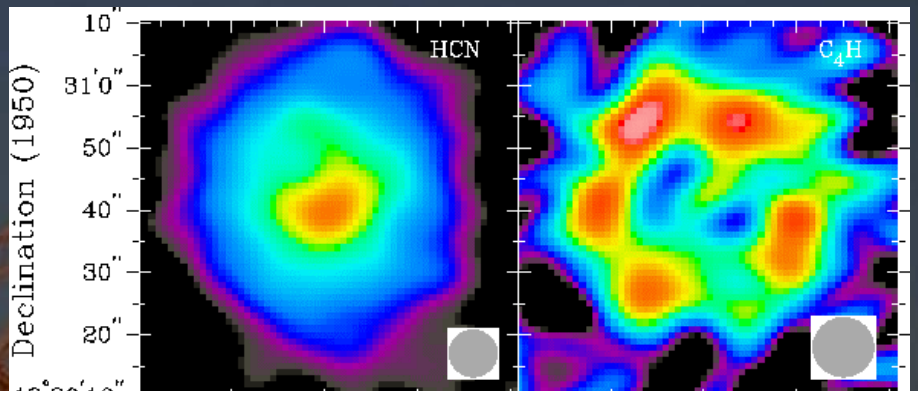
- R Sculptoris has been inferred from SEST CO (3-2) observations to have a 10”-radius detached shell (Olofsson+ 1996).
- Also, a dust shell with radius ~20” is seen in polarised scattered light (González Delgado et al 2003).



No shell emission (3σ = 75 mJy)



AGB star IRC+10216



BIMA images

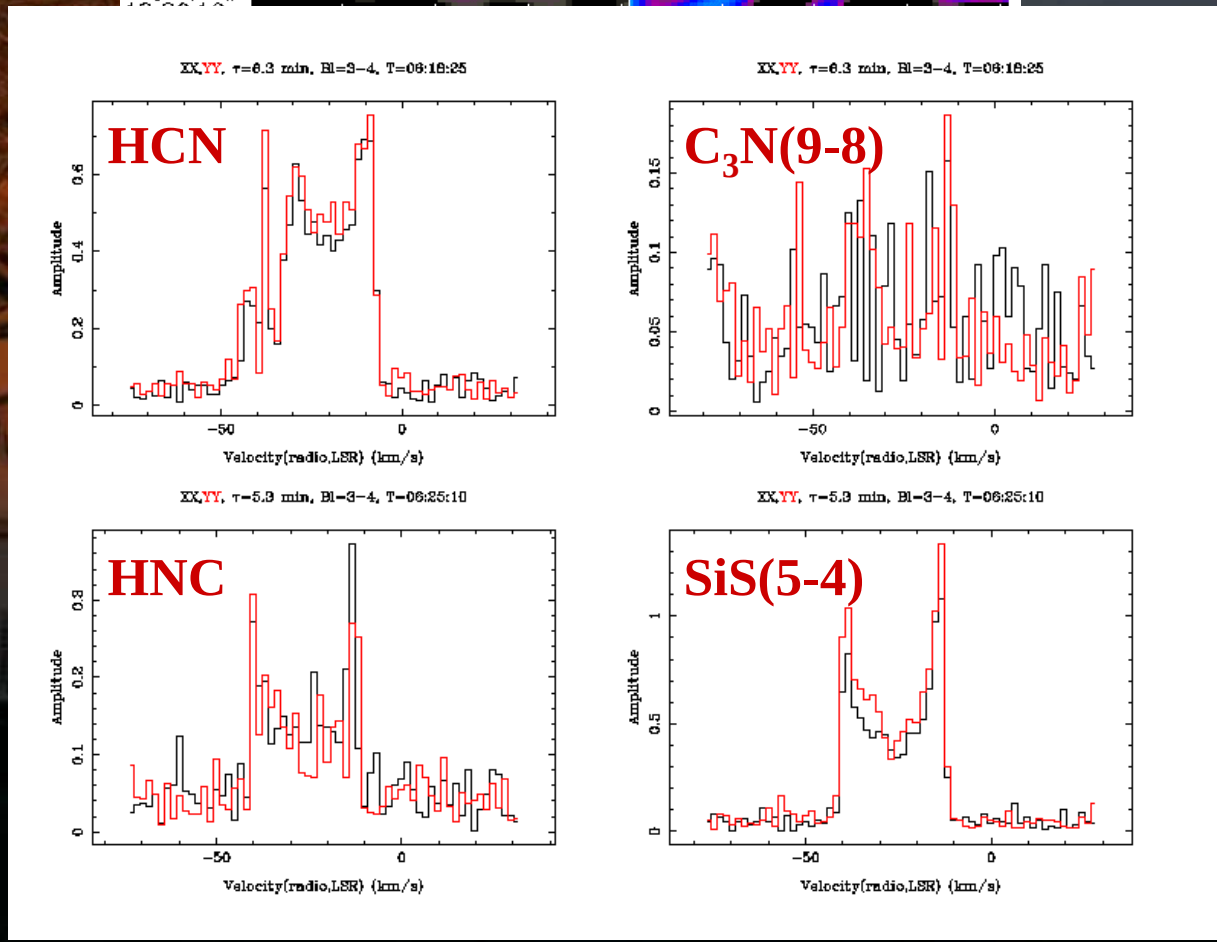
ATCA

July 2001

30m baseline

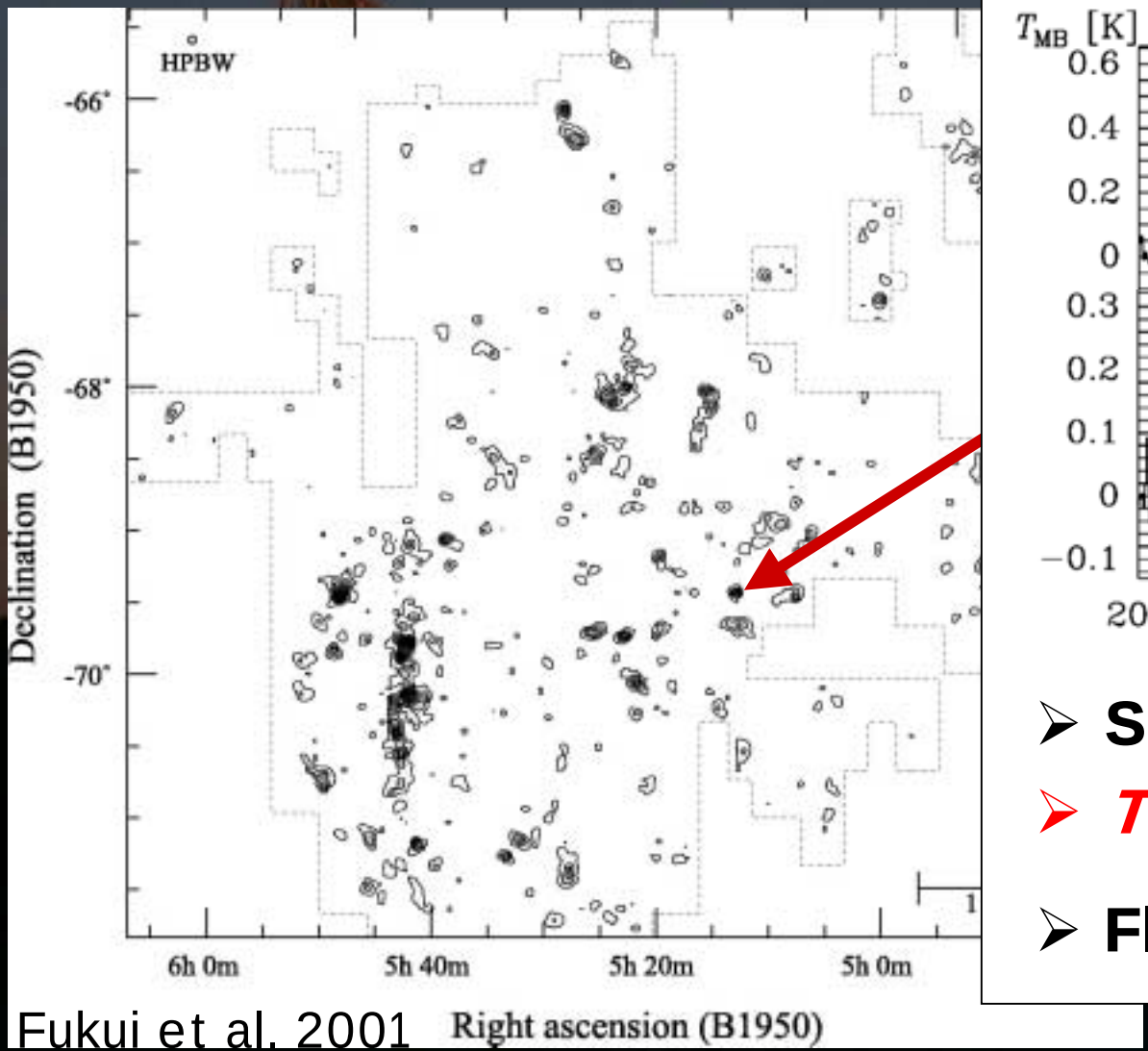
2 pol.

uncalibrated



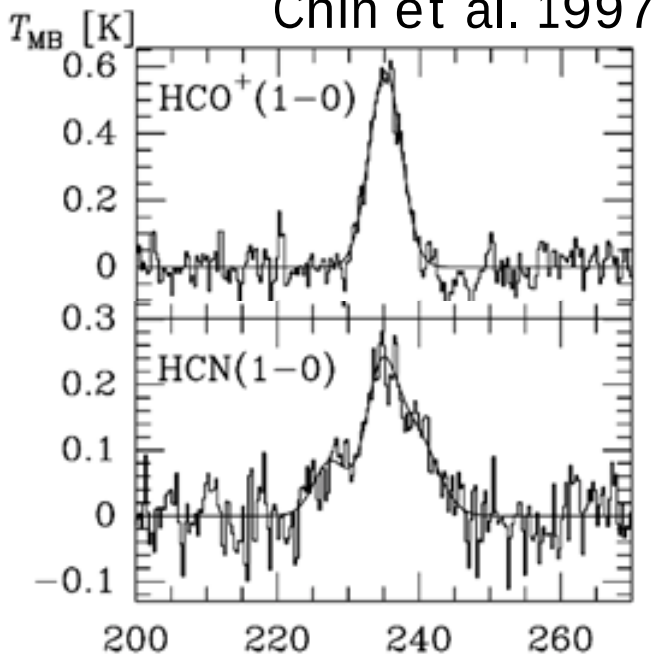
6. Massive star formation in the LMC

HCO^+/HCN in N113



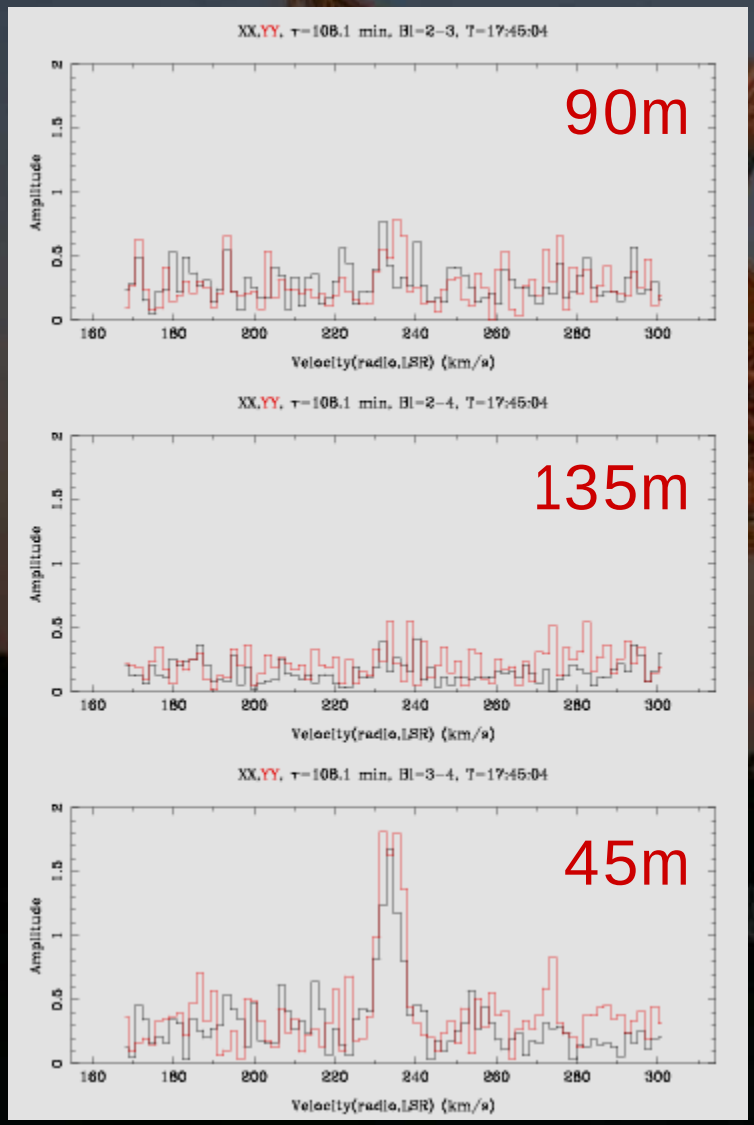
Fukui et al. 2001

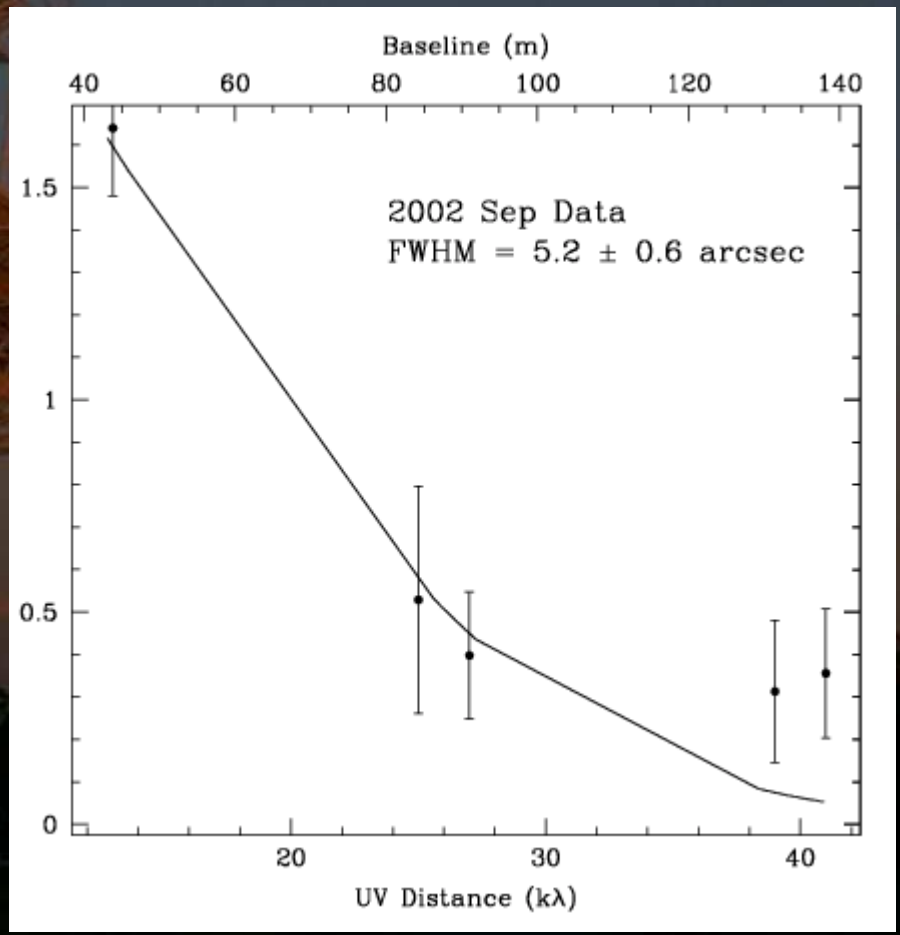
Chin et al. 1997



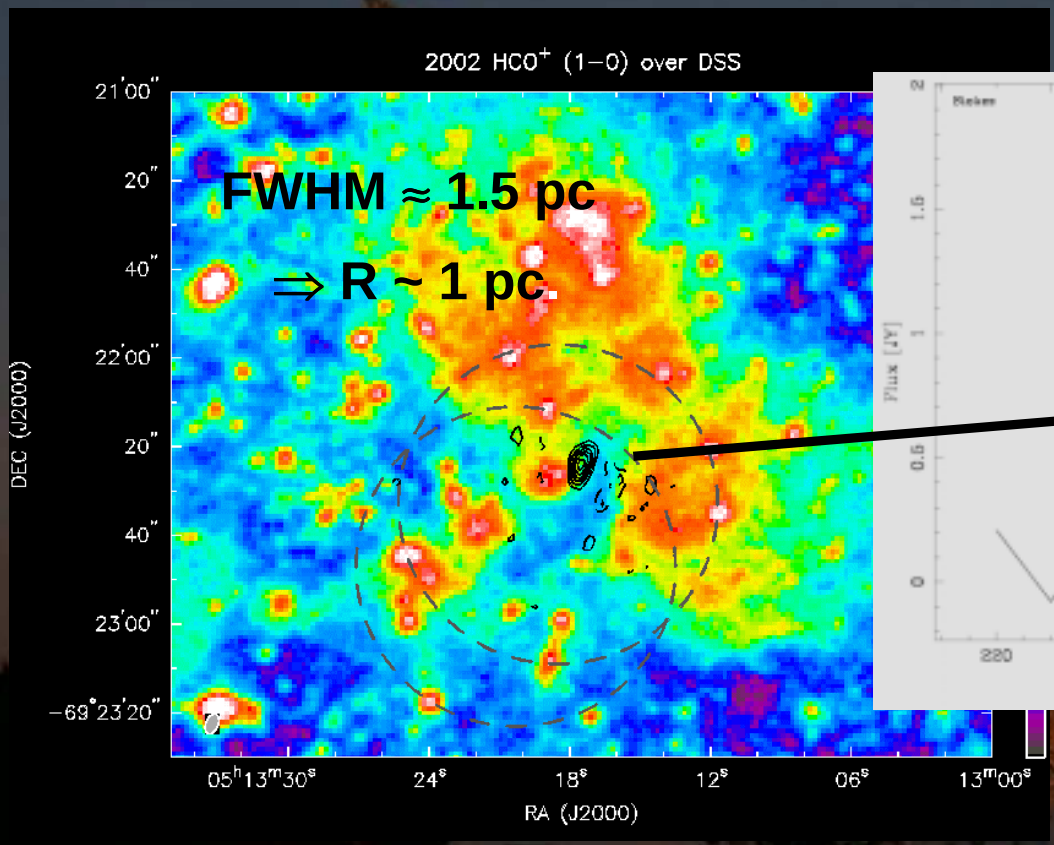
- **SEST 58” beam**
- **$T_{mb}(HCO^+) \approx 0.6$ K**
- **Flux ≈ 15 Jy**

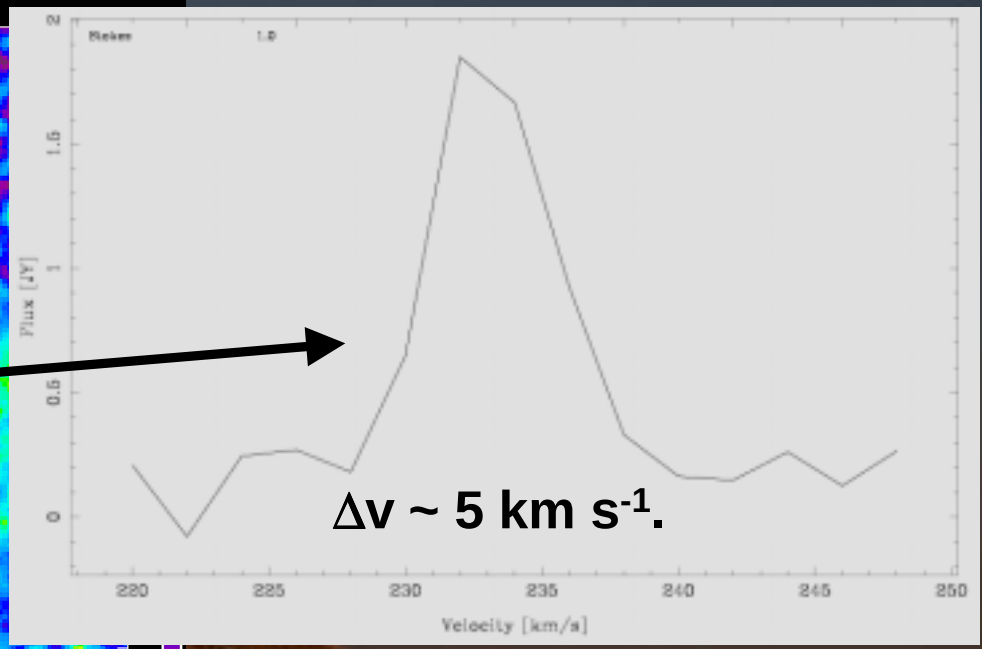
2002 Observations





HCO^+ contours over DSS image

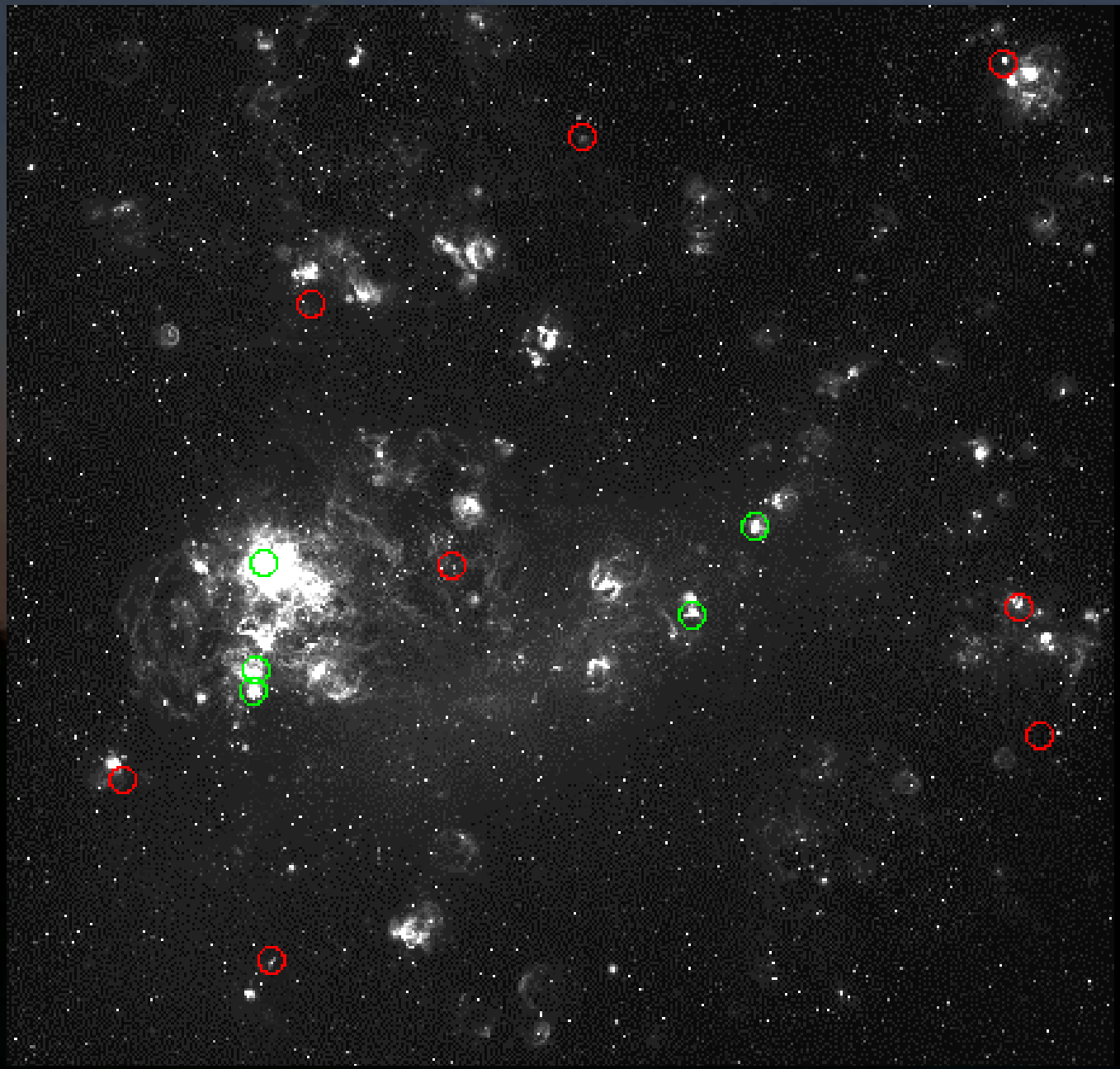




- For a virialized cloud, ignoring optical depth effects,

  $M \approx 200(R_{pc})(\Delta v_{km/s})^2 \approx 5000\ M_\odot$.

- For constant density, $n_H \sim 5 \times 10^4\ cm^{-3}$.



Previous Parkes detections

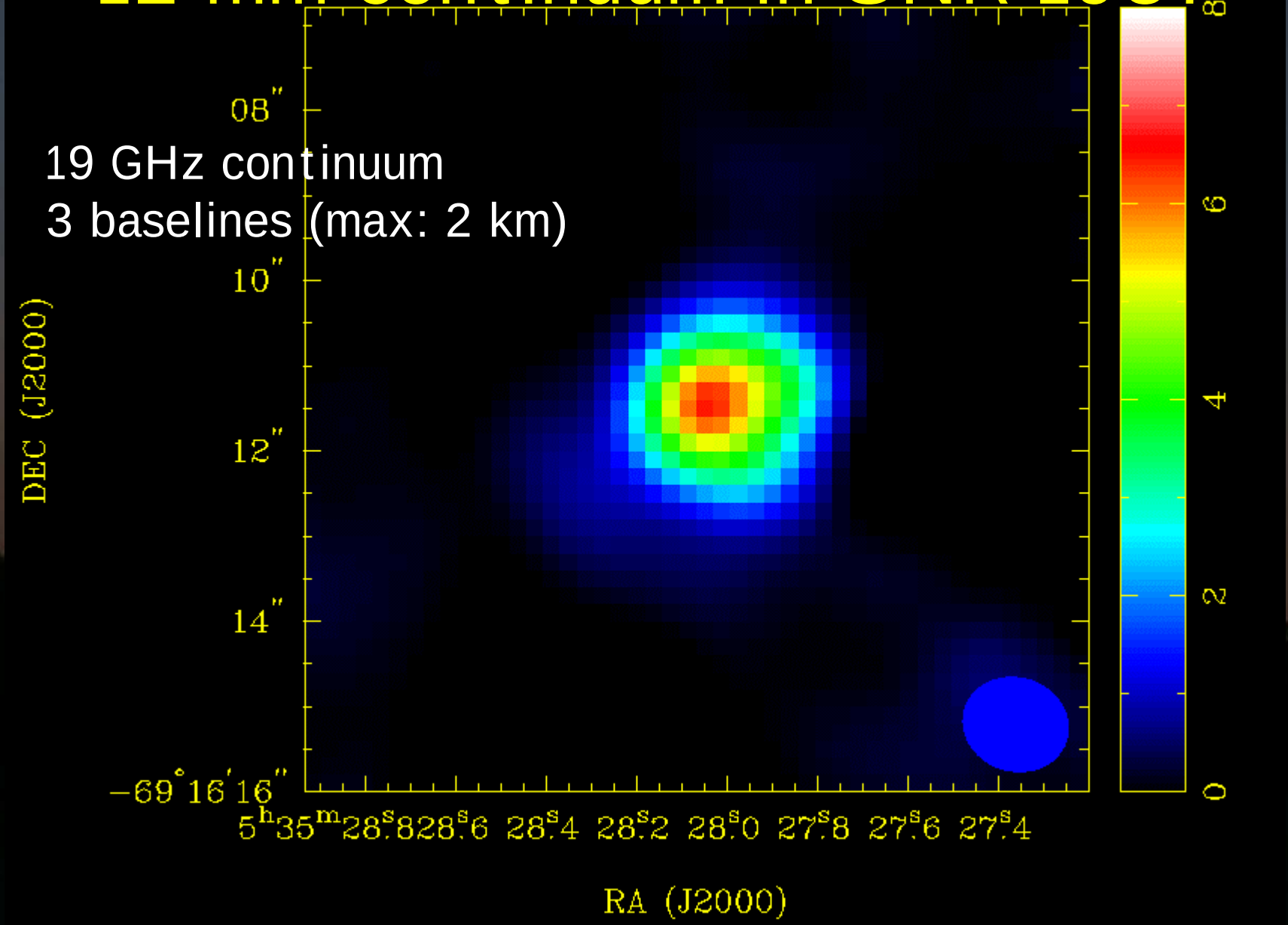
(Scalise & Braz 1982; Whiteoak et al. 1983; Whiteoak & Gardner 1986)

New ATCA detections

22 GHz water masers in LMC

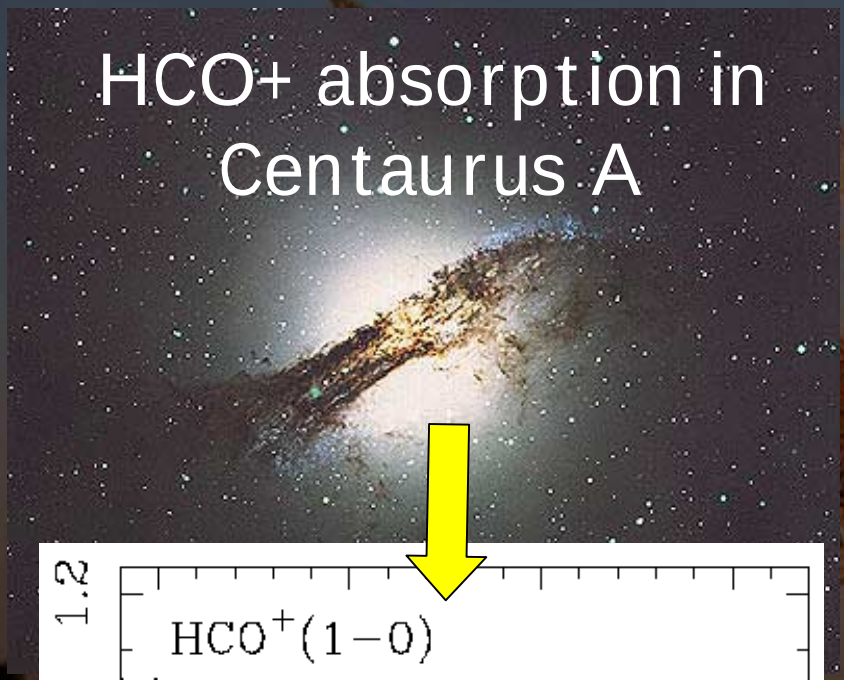

7. SNR 1987

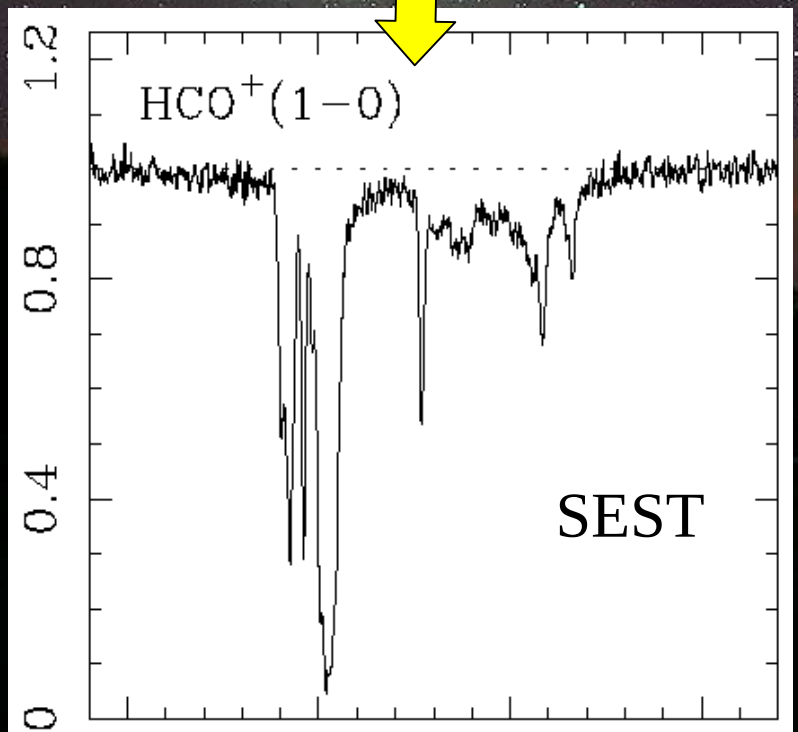
12 mm continuum in SNR 1987



8. Molecular gas in nearby galaxies

The radio galaxy Centaurus A

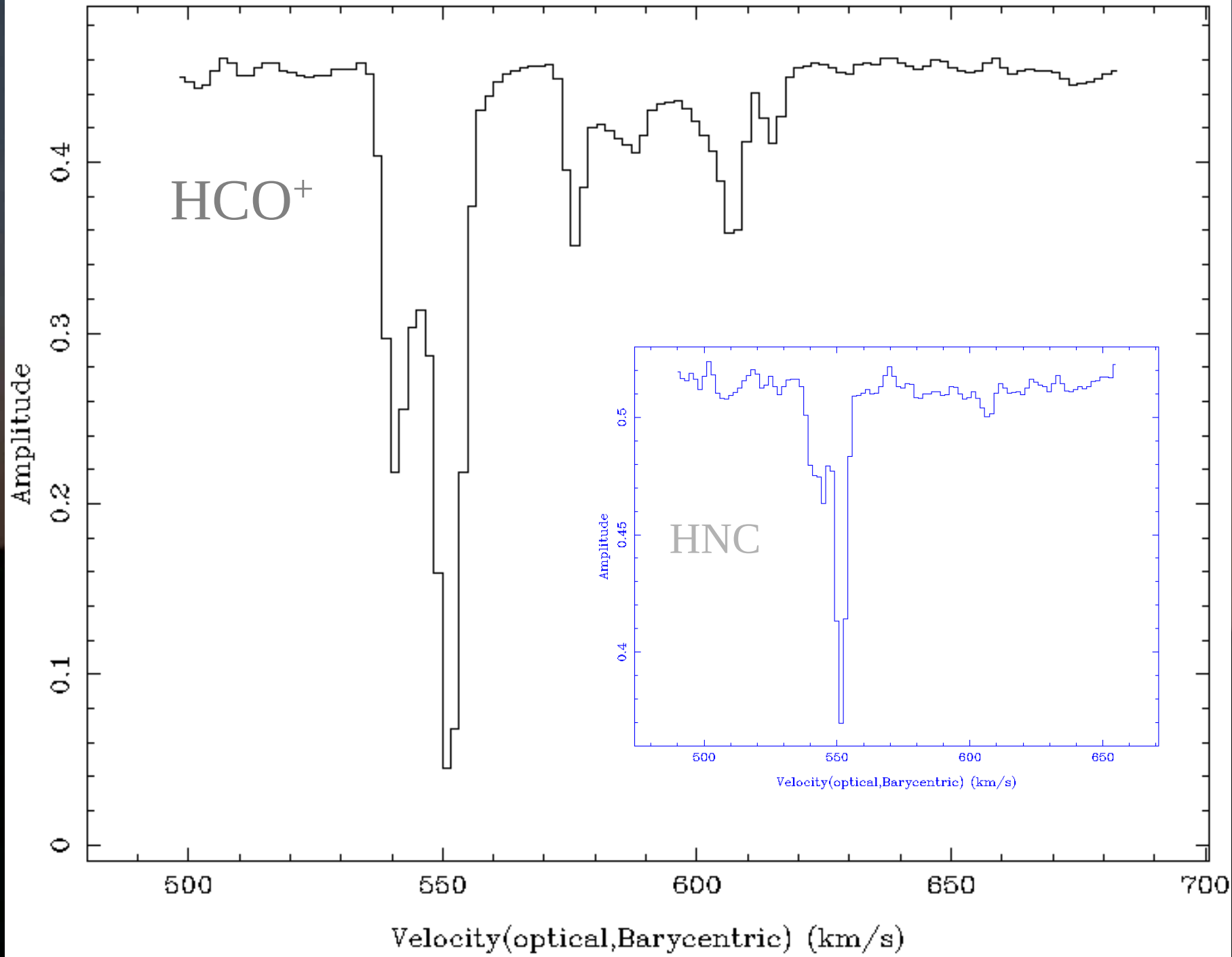




Observing parameters

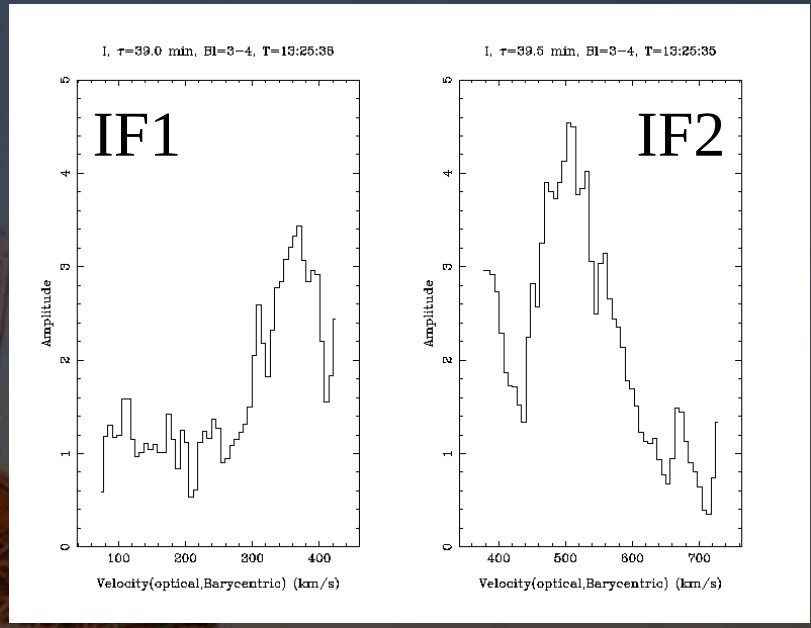
- 2 IFs: BW= 64 MHz
  128 channels, each
- IF1: 89.010 GHz
  IF2: 90.485 GHz
- velocity range: 500 - 680 km/s
- EW352: 45, 75, 120m

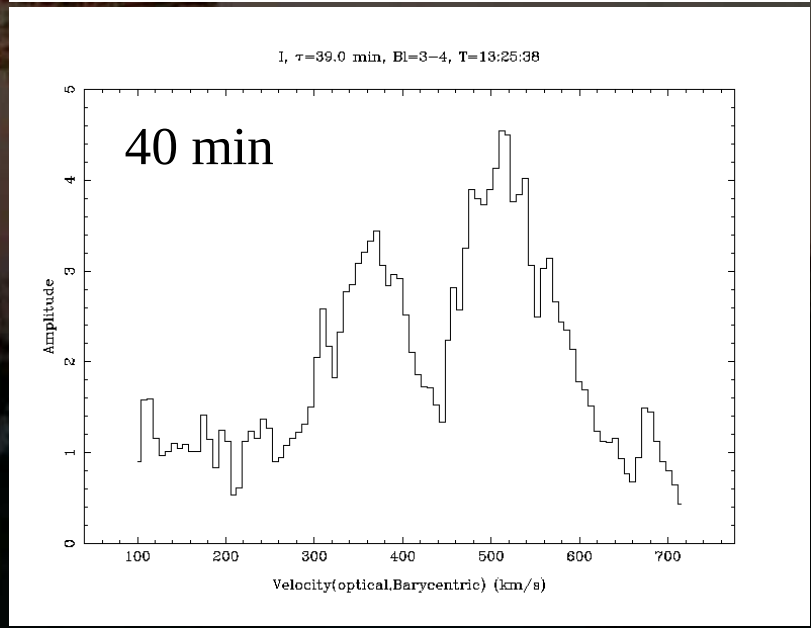
Wiklind & Combes 1997


HCO+
HNC
Amplitude
0
0.1
0.2
0.3
0.4
500
550
600
650
700
Velocity(optical,Barycentric) (km/s)
Amplitude
0.4
0.45
0.5
500
550
600
650
Velocity(optical,Barycentric) (km/s)

The Circinus Galaxy

- 10 July 2001
- 30m baseline
- HCO+(1-0)
- Tsys about 350 K
- 2IFs, 128 MHz BW, 64 channels each
- IF 1: 89.110 GHz
- IF 2: 89.020 GHz





Recent Results at 3 and 12 mm

- Pre- … er, Bourke, Wright, Jo…
- Plan… …ems (Minier, Lin…
- Sea… …2002)
- Mas… …ne (Minier, Burton, Wo…
- Late… …ofsson, Lindqvist, V…
- Mas… …, Ott, Mizuno et al., 2000… …y-Smith)
- SNR…
- Molecular gas in nearby galaxies (Koribalski et al. 2001)

NEXT PROPOSAL DEADLINE :

JUNE 15th