

HOPS – The H_2O southern Galactic Plane Survey



Image Courtesy: Cormac Purcell

HOPS – The H₂O southern Galactic Plane Survey

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Summary at: <http://www.jcu.edu.au/astronomy/awalsh/HOPS/>

Image Courtesy: Cormac Purcell

AIMS

- Survey the southern Galaxy with Mopra at 12mm
- 90 square degrees at 2 arcminute resolution: $l=300^\circ - 30^\circ$; $|b| < 0.5^\circ$
- Use MOPS zoom mode to survey multiple lines

Main lines surveyed

- H₂O maser
- NH₃ (1,1), (2,2), (3,3), (6,6), (9,9)
- HC₃N (3-2)
- H69 α radio recombination line
- Many CH₃OH lines
- Many others including H62 α , H64 α , H65 α , NH₃ (non-metastable), CCS, HC₅N

Main lines surveyed

H₂O maser

- Identifies specific sites of star formation, evolved stars, extragalactic megamasers in an untargetted way
- Results can be compared to MMB survey to determine relative occurrence of CH₃OH and H₂O masers in star forming regions

Main lines surveyed

NH_3 (1,1), (2,2), (3,3), (6,6), (9,9)

- Very important tracer of dense gas in our Galaxy
 - * does not show up in outflows
 - * robust against depletion
- Multiple lines \rightarrow optical depth, column density, temperature (15 – 850K)



Main lines surveyed



- Star formation tracer
 - Occurs in pre-stellar clouds
 - Abundance enhanced $T > 90\text{K}$

Main lines surveyed

H69 α radio recombination line

- Traces ionised gas (HII regions)

Main lines surveyed

Many CH₃OH lines

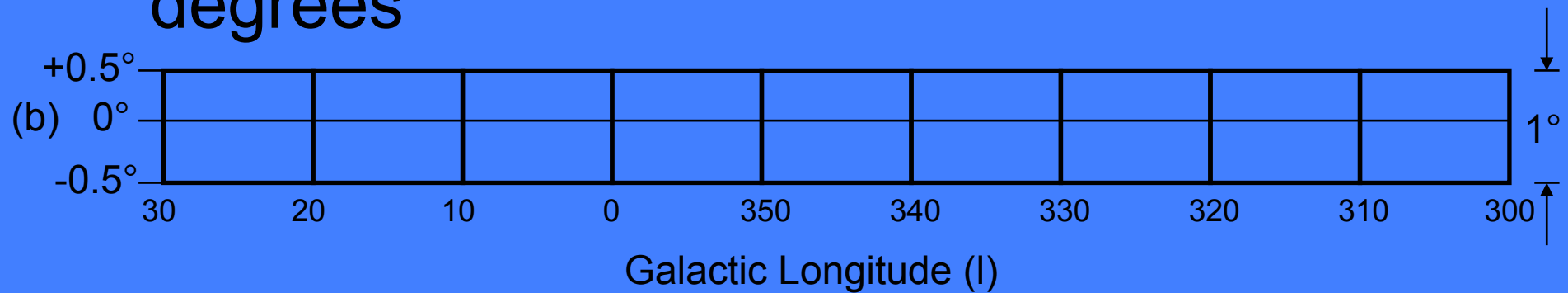
- Class I and II masers
- Thermal emission
- More star formation

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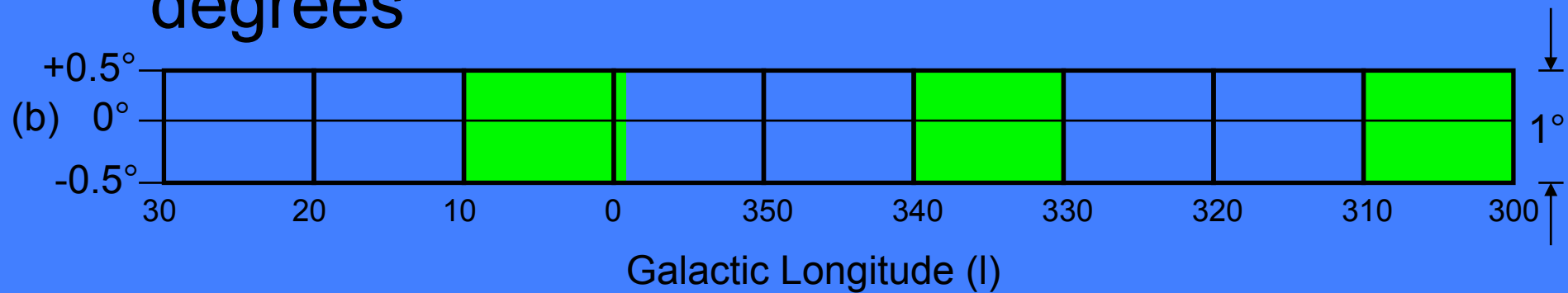
Current status

- Feb/March 2008: completed 31 square degrees



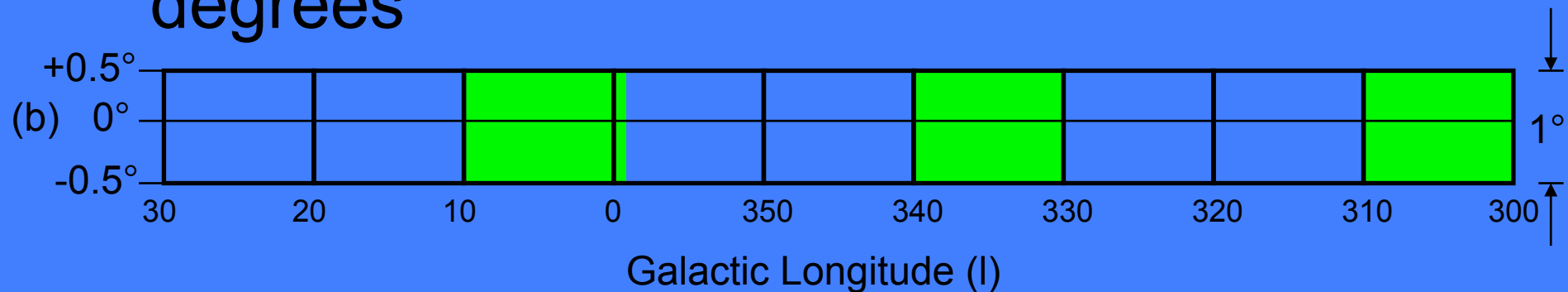
Current status

- Feb/March 2008: completed 31 square degrees



Current status

- Feb/March 2008: completed 31 square degrees



- ~700 hours observations
- Lost only ~50 hours due to weather +technical

$l=300-310$

H₂O maser peak temperature

H₂O Masers

NH₃ (1,1) peak temperature

NH₃ (1,1)

NH₃ (3,3) peak temperature

NH₃ (2,2)

NH₃ (3,3) peak temperature

NH₃ (3,3)

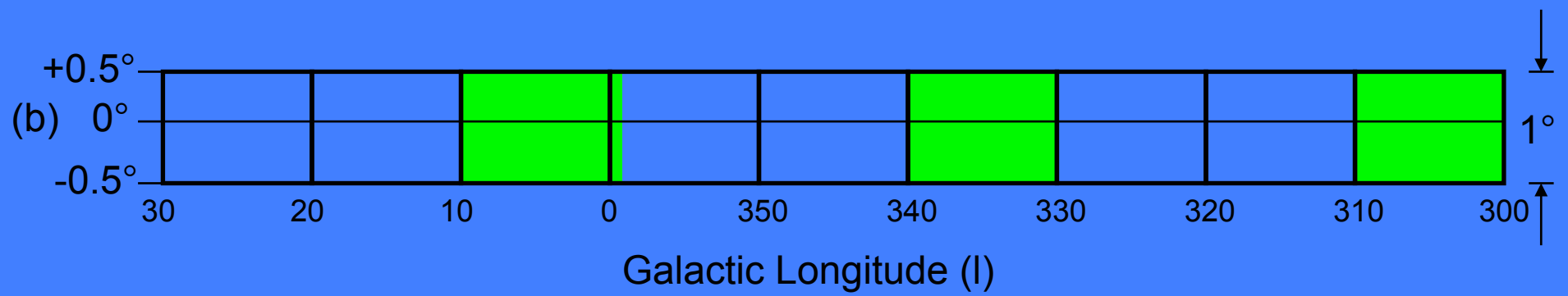
HCCCN (3-2) peak temperature

HC₃N(3-2)

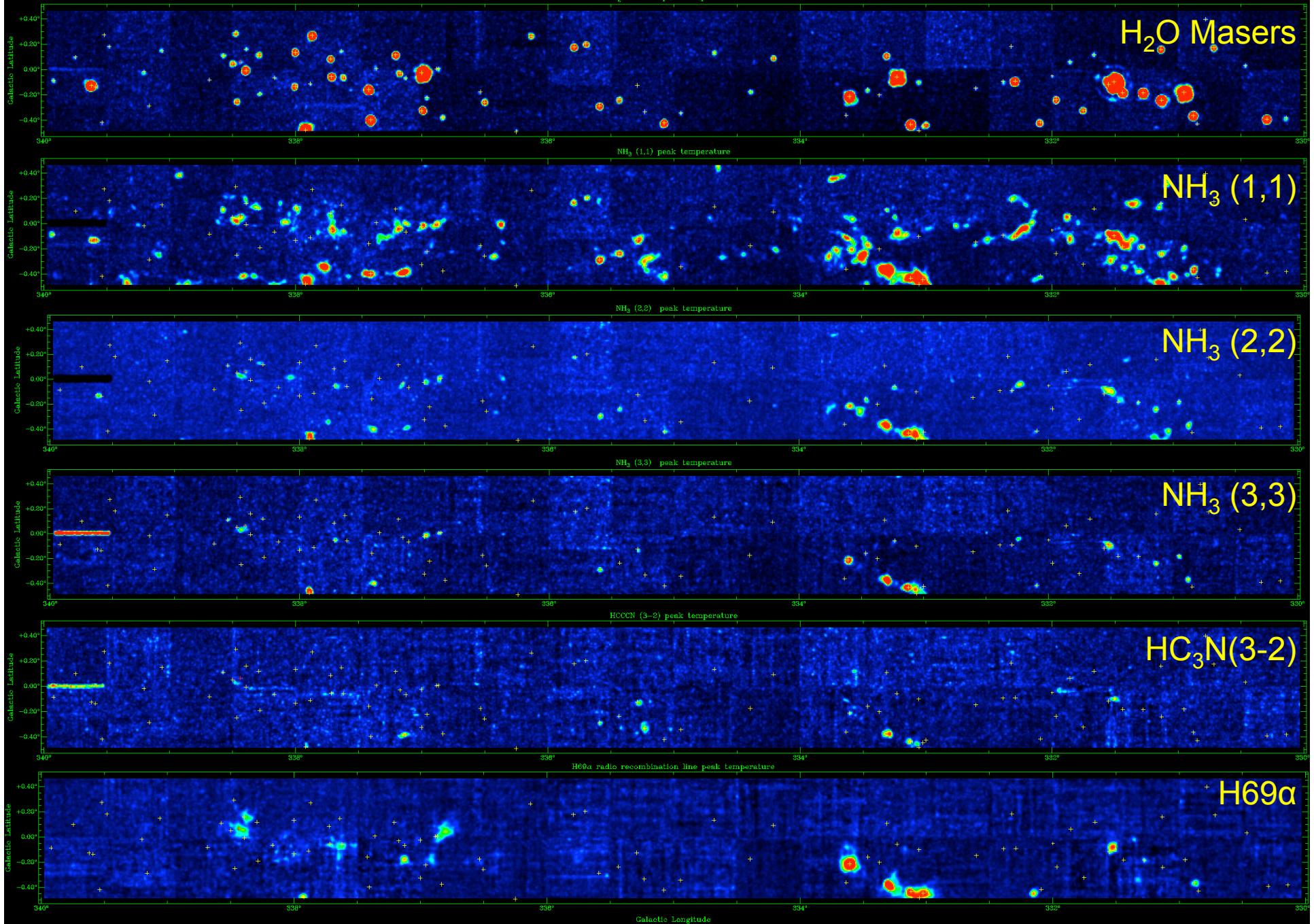
H69 α radio recombination line peak temperature

H69 α

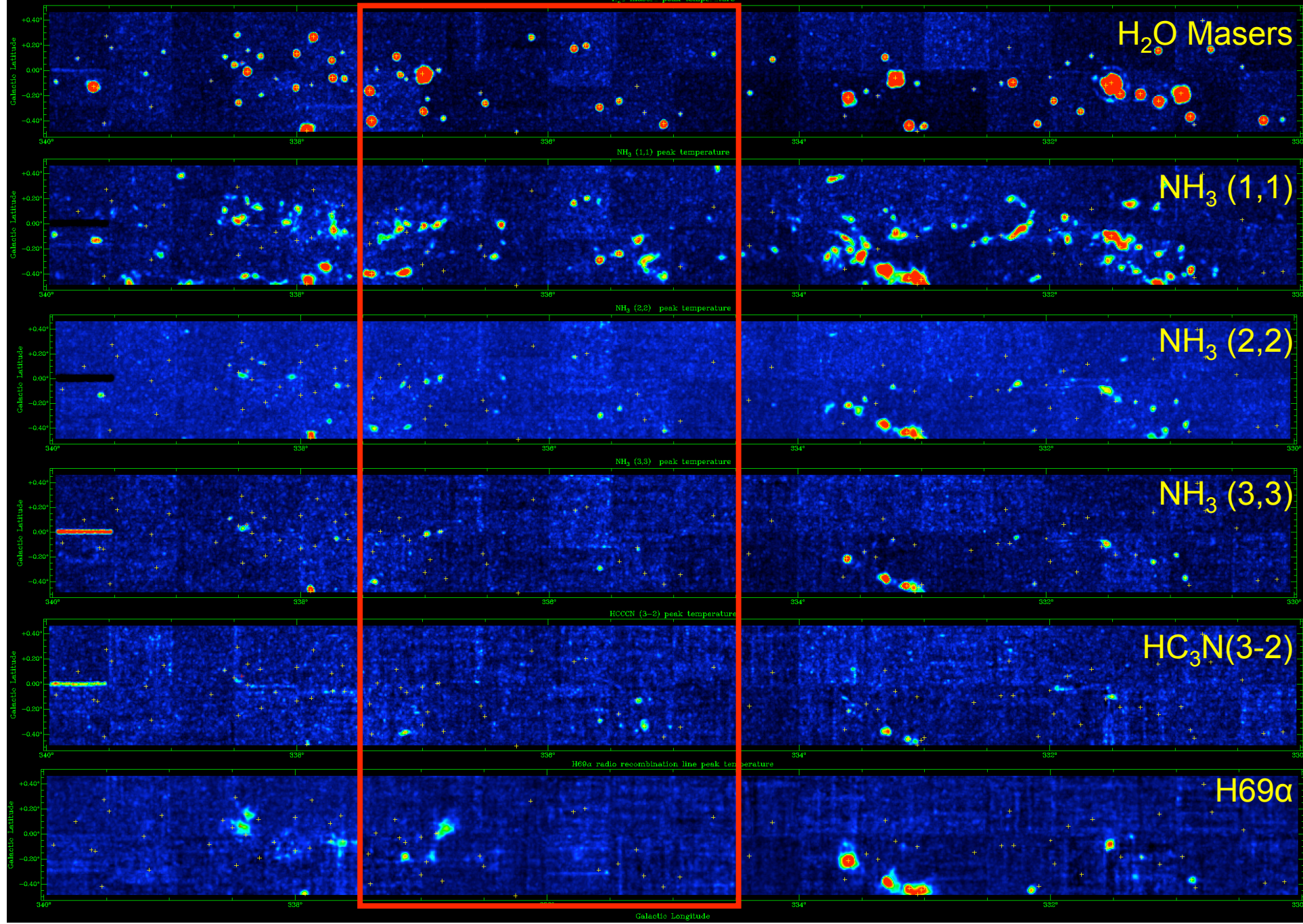
Galactic Longitude



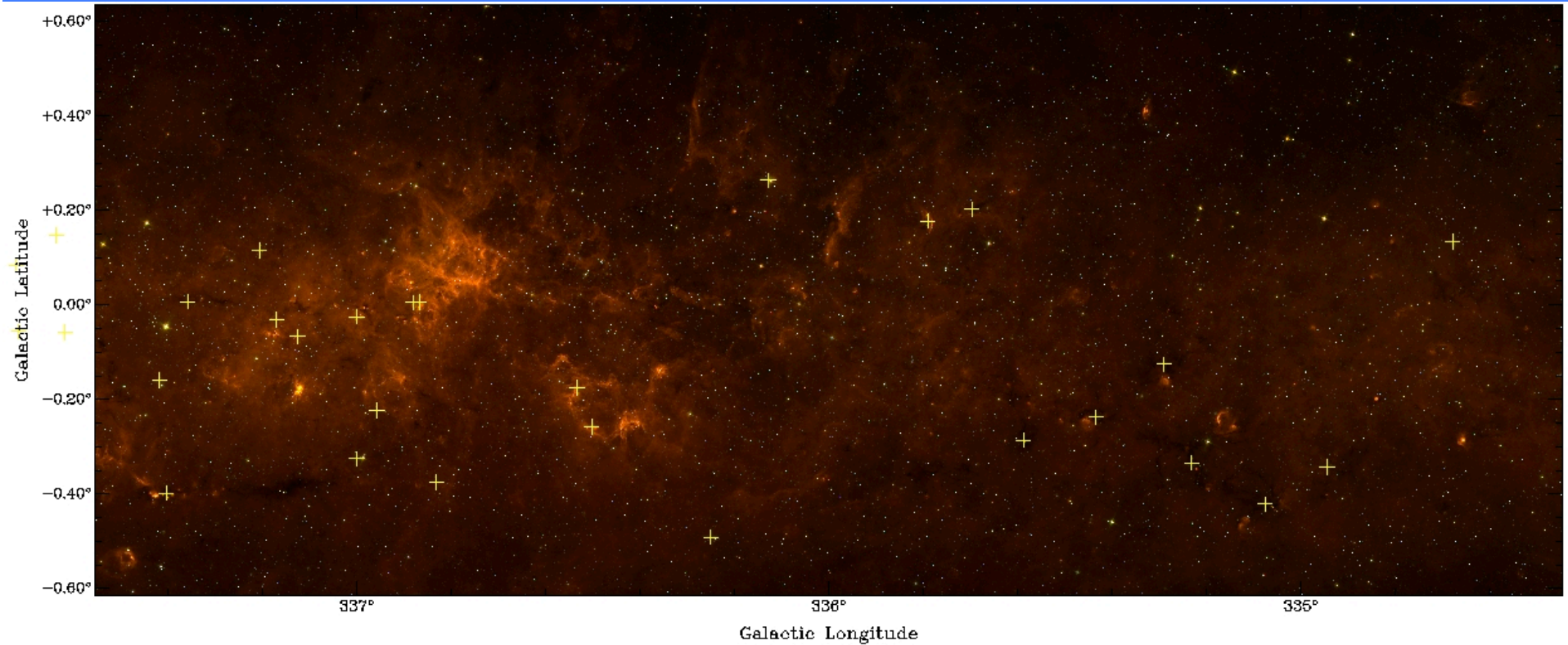
$l=330-340$



$l=330-340$



Water Masers (+)



GLIMPSE *Spitzer* 3-colour image (3.5, 5 and 8 microns)

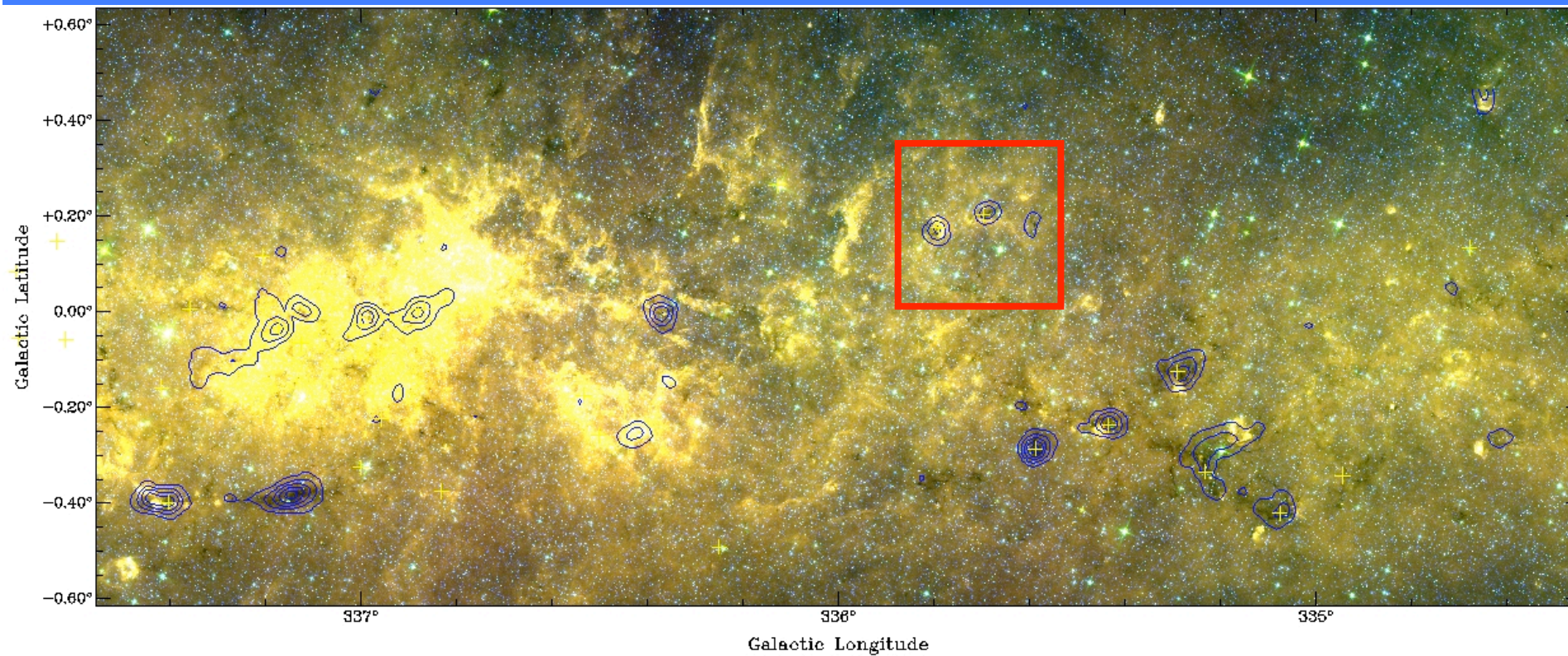
Water Masers (+)

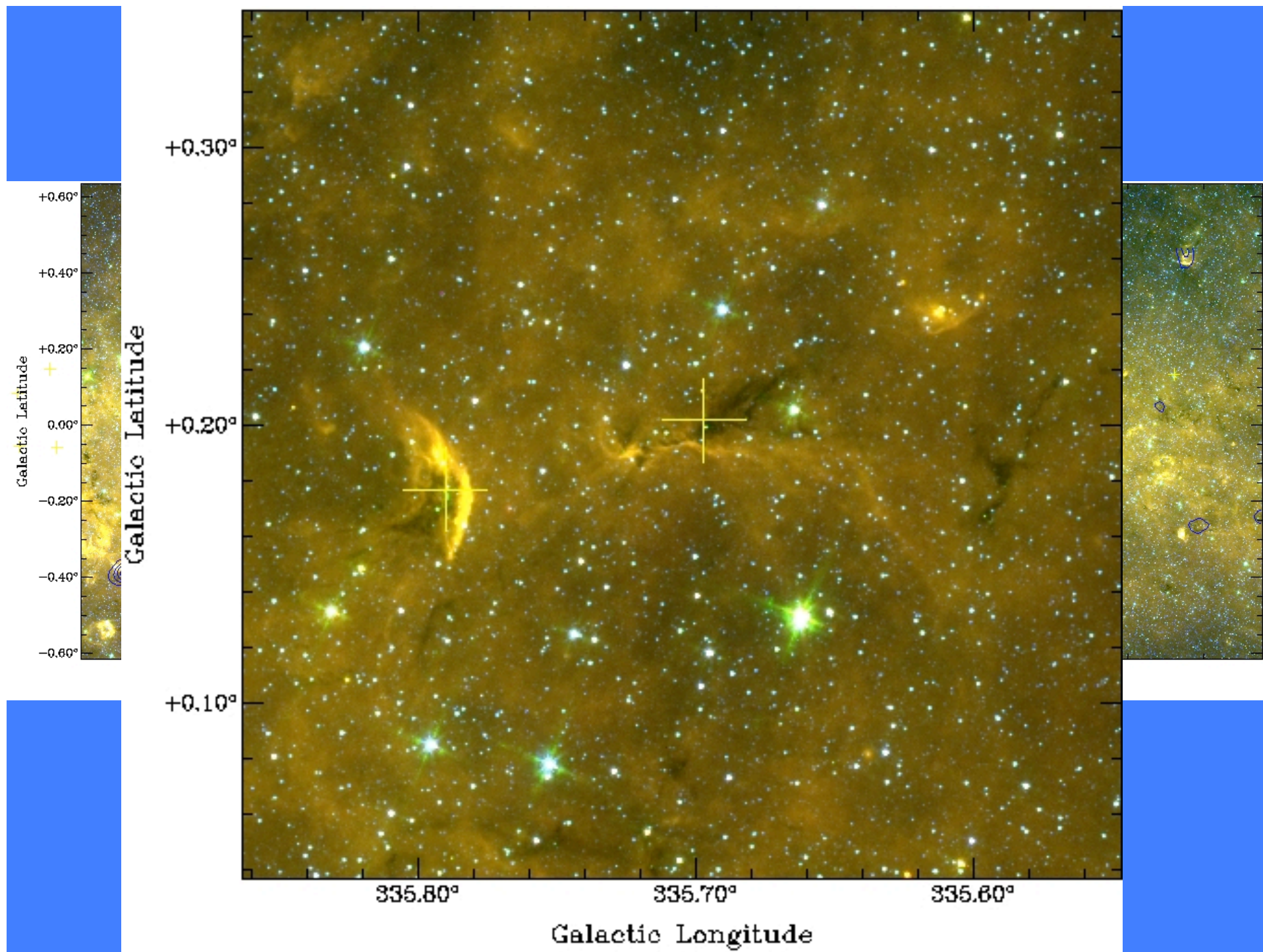


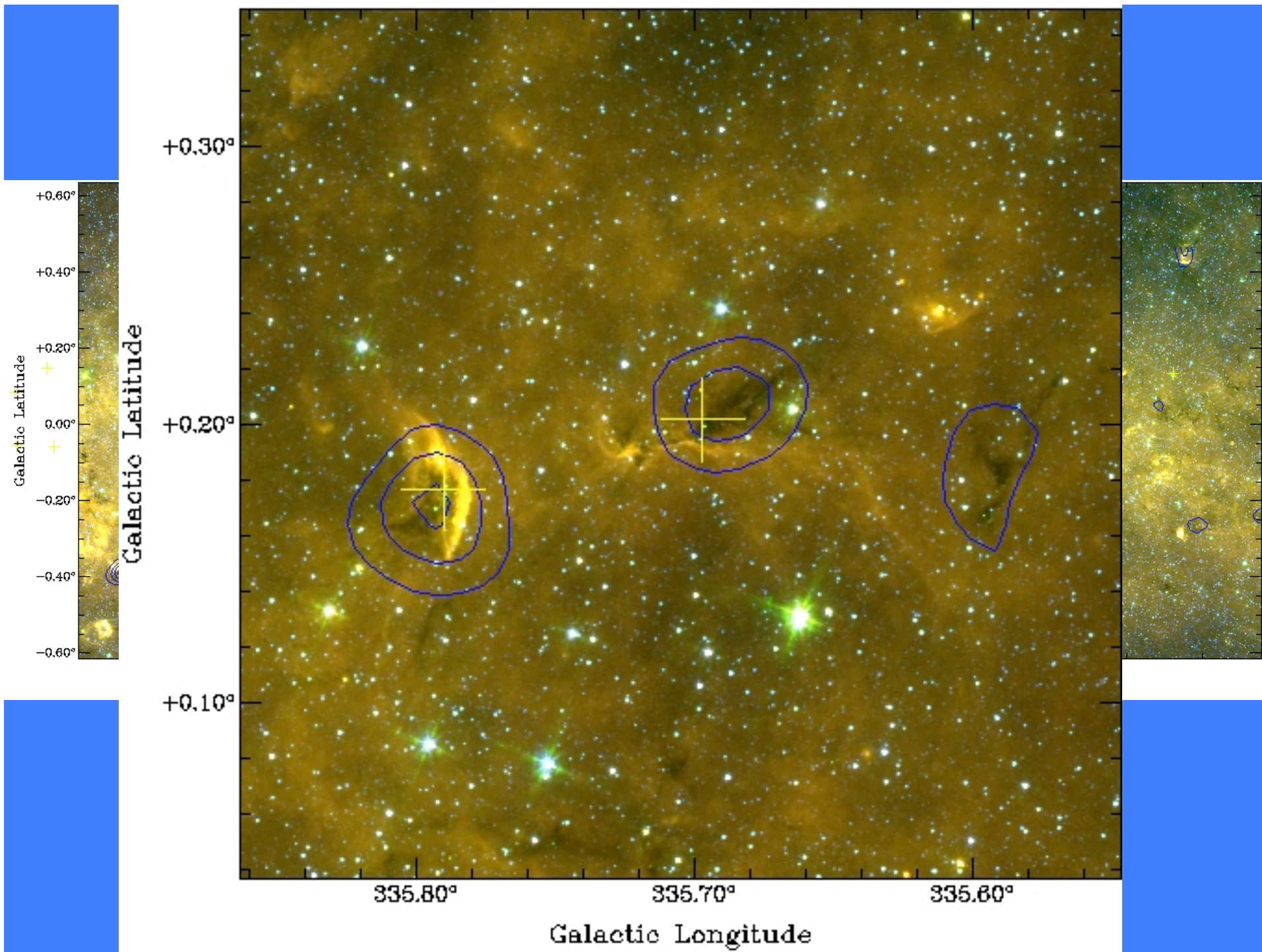
H69 α Radio Recombination Line



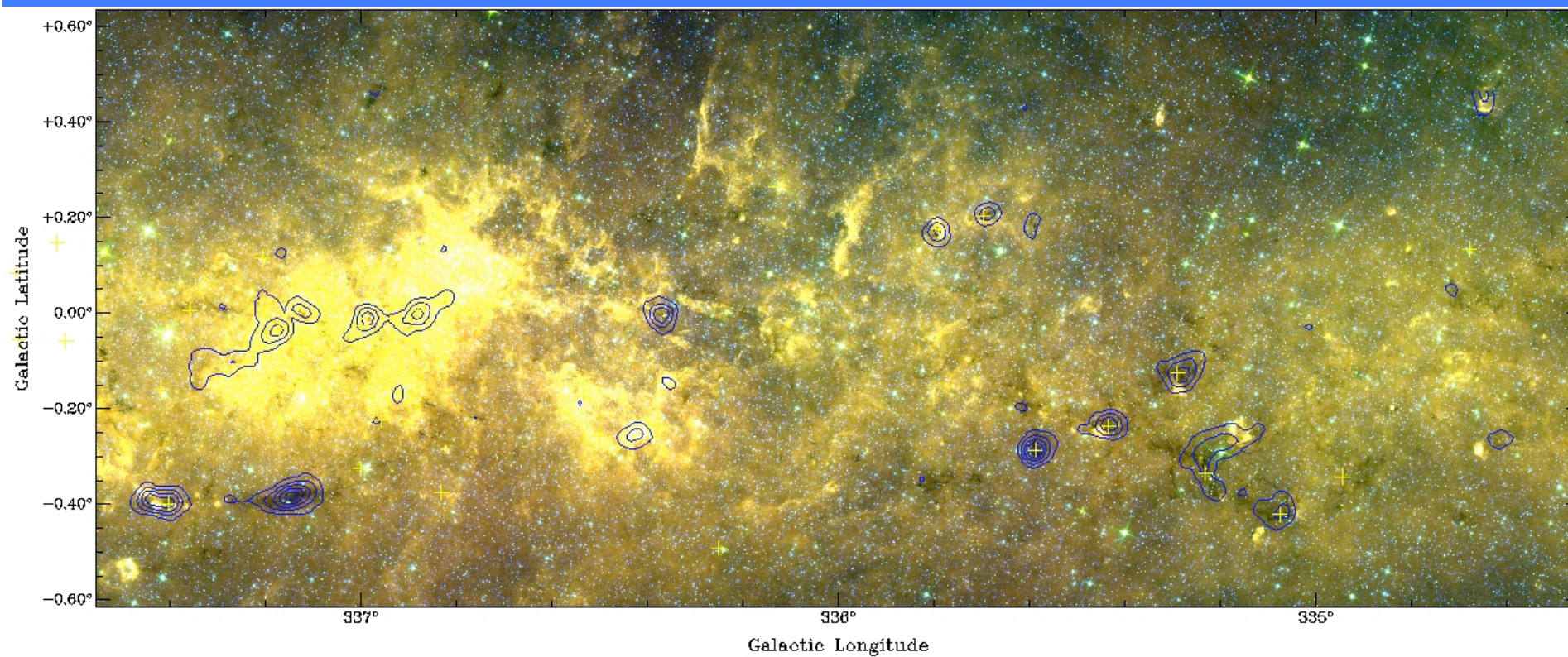
NH_3 (1,1)





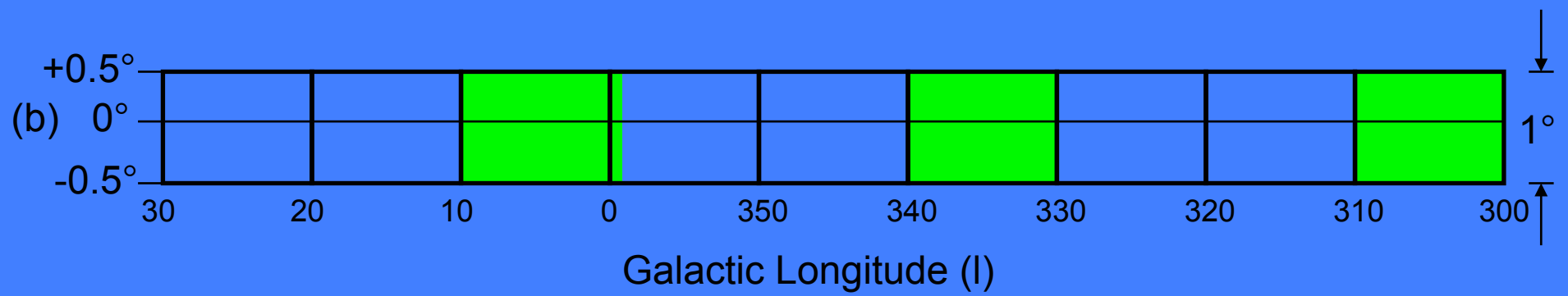


NH_3 (1,1)

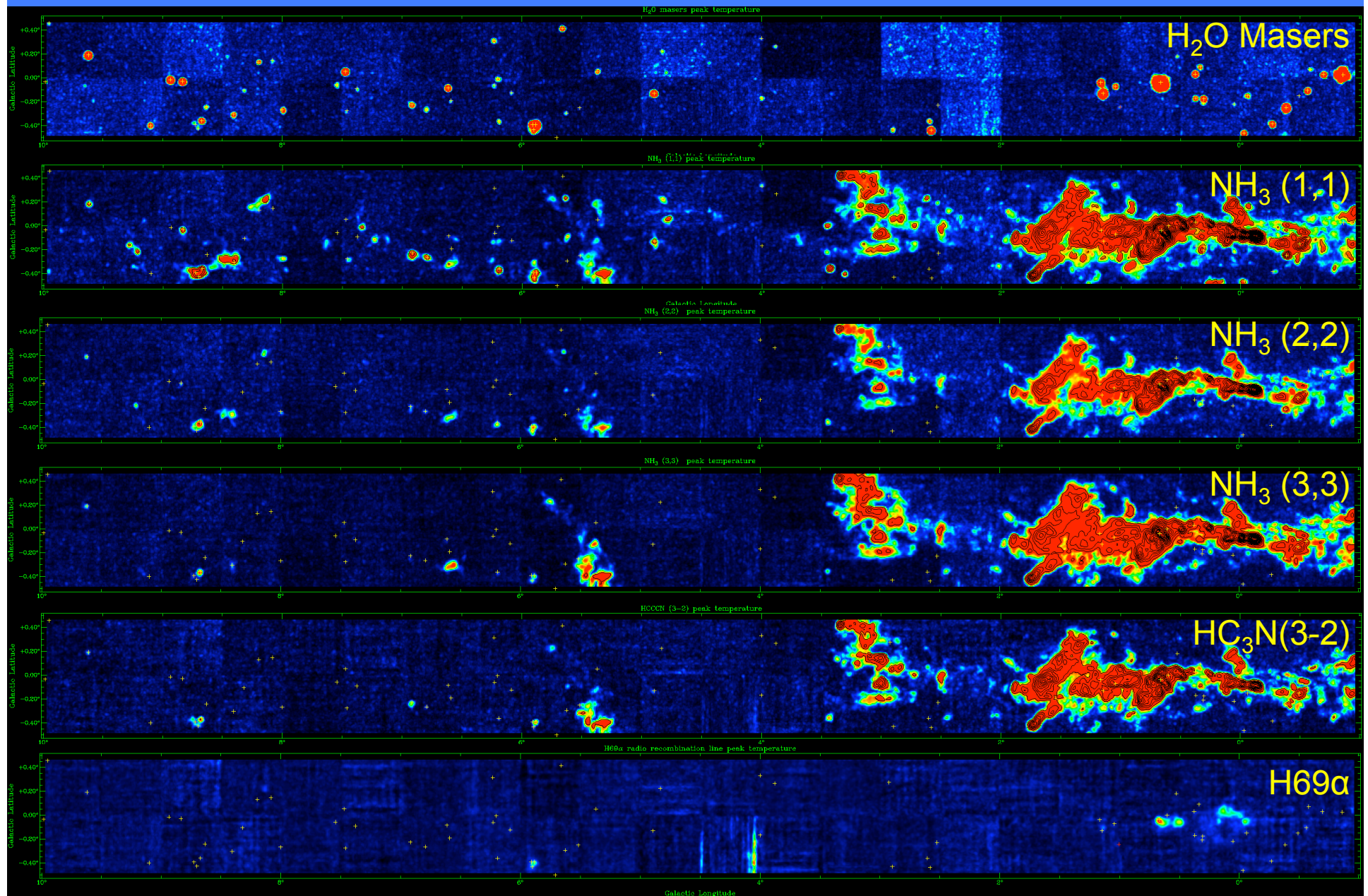


HCCCN (3-2)



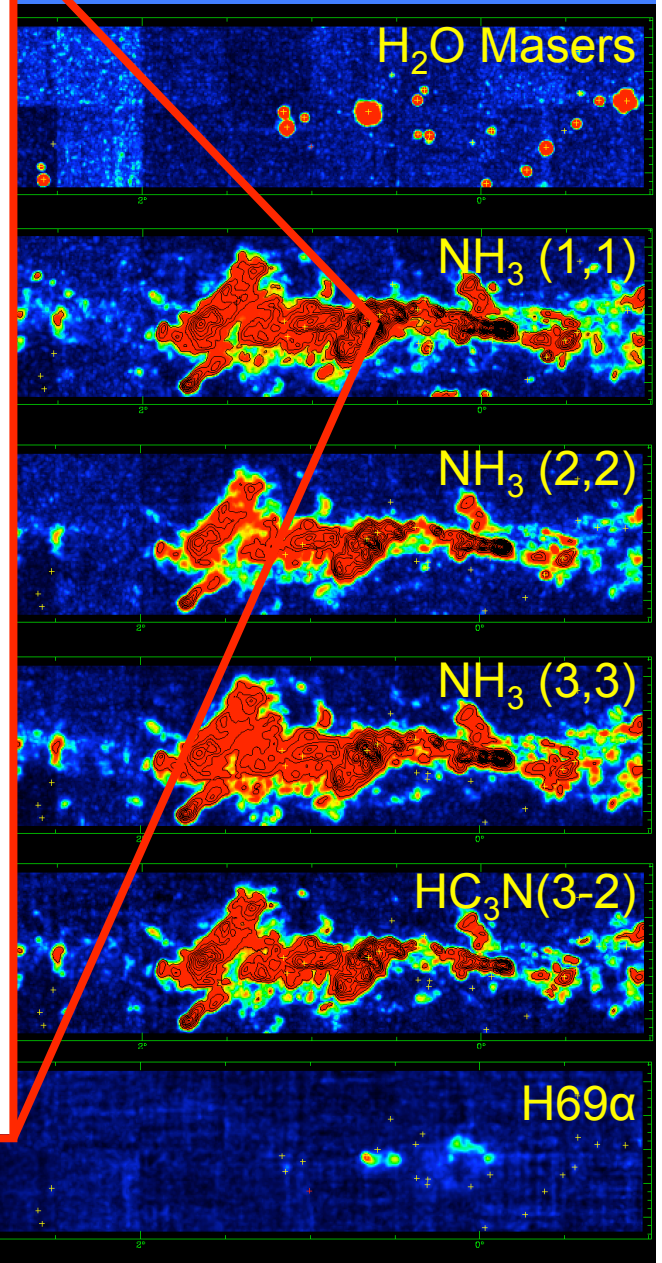
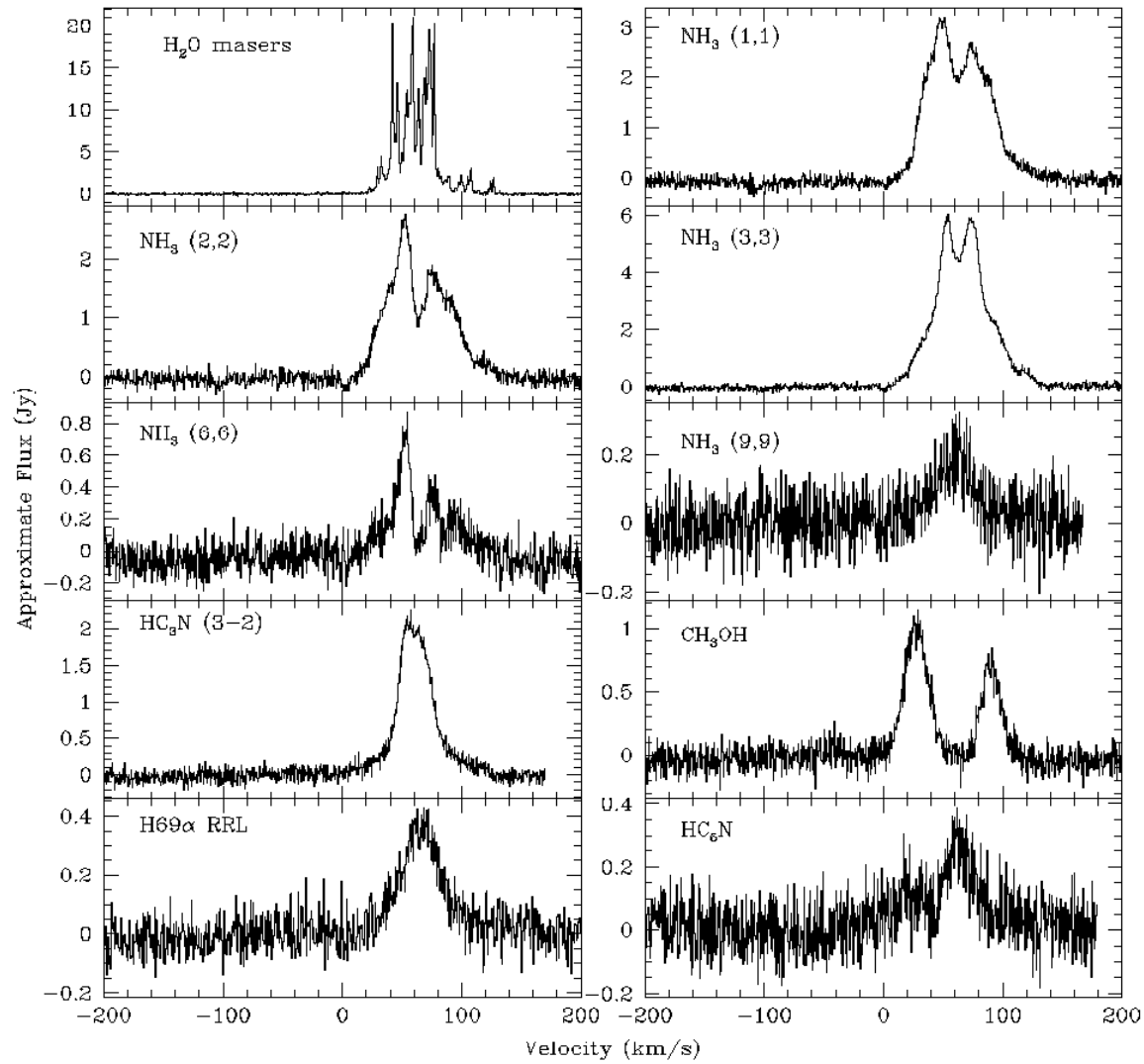


l=359-010

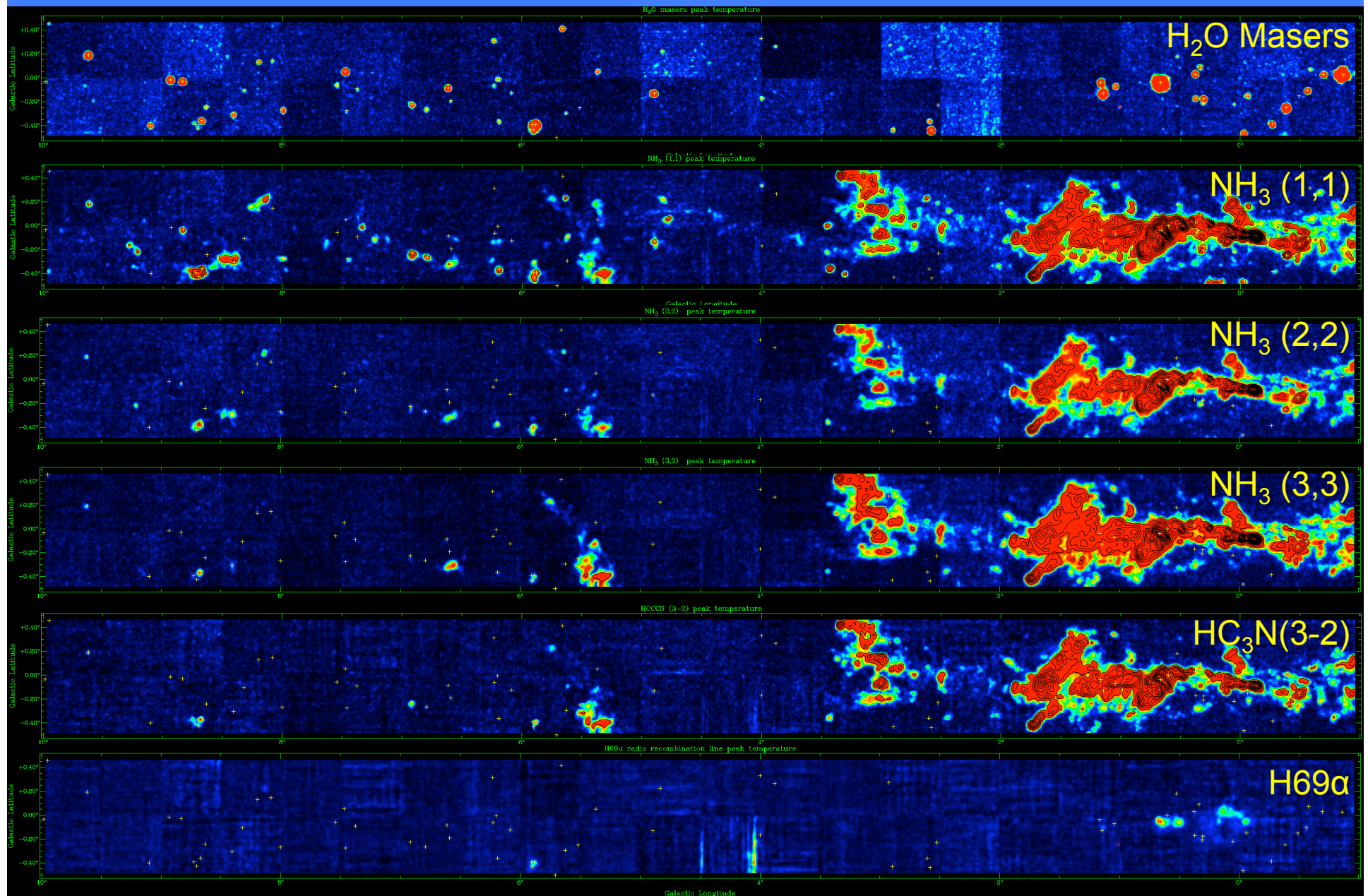


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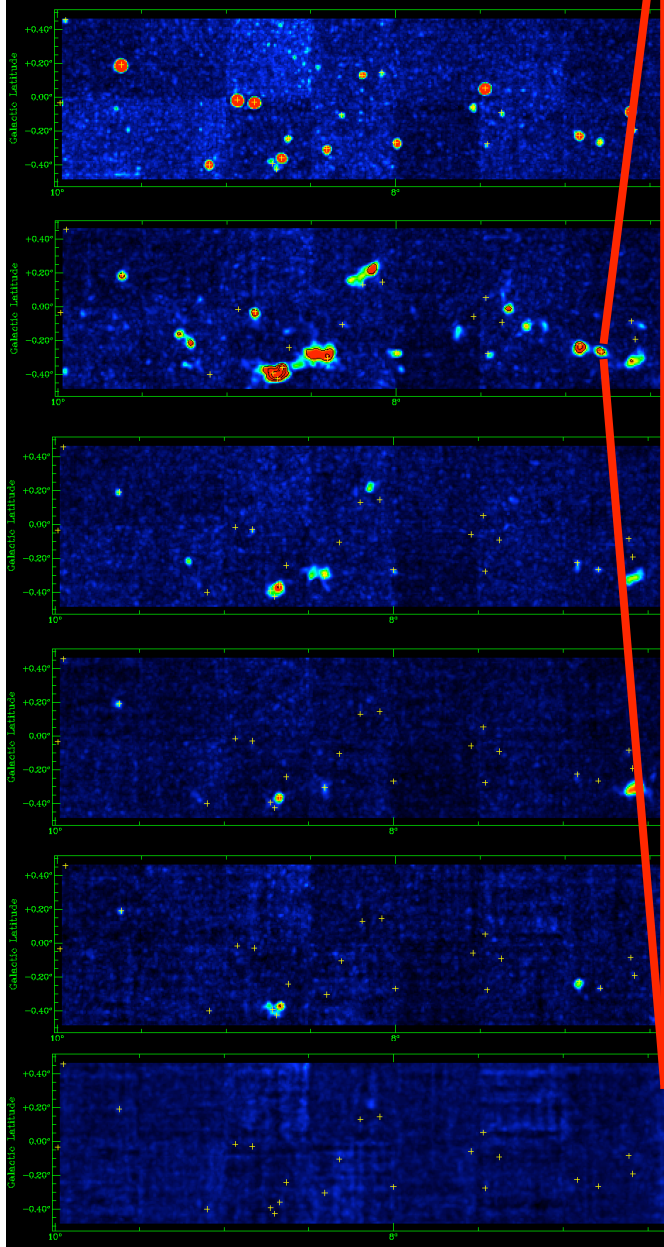
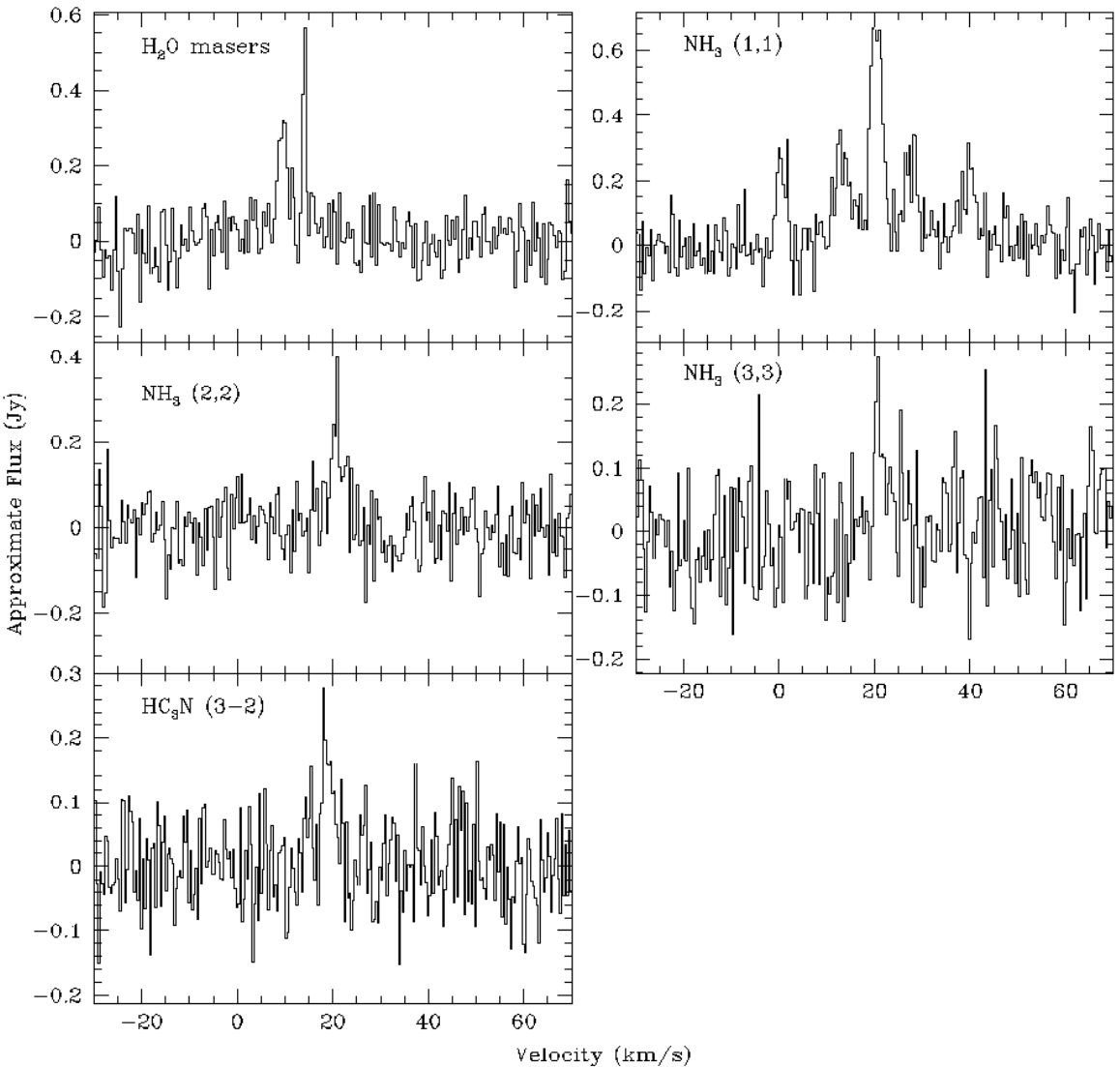
Sgr B2



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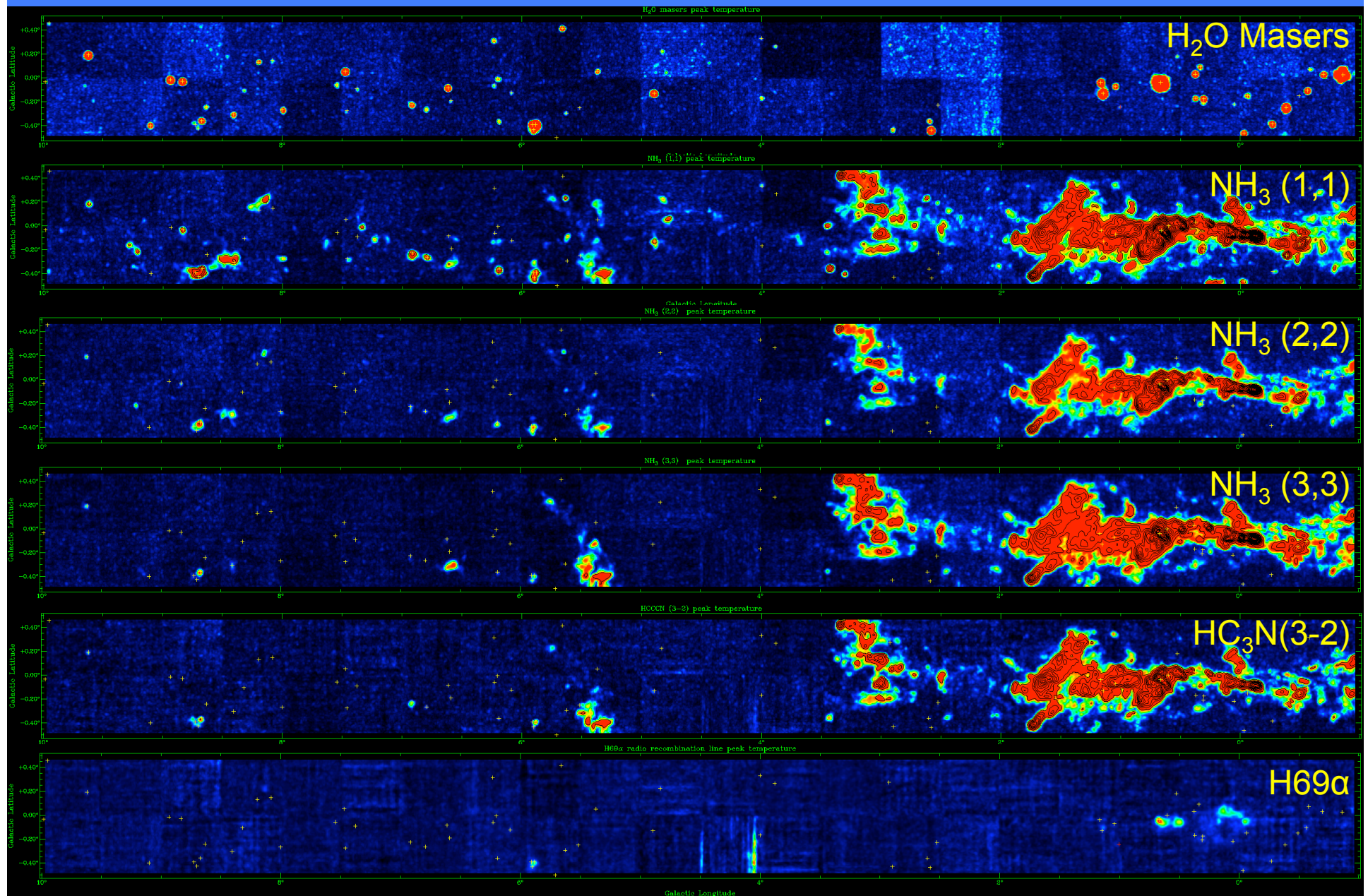
G6.79-0.26



F69a

Galactic Longitude

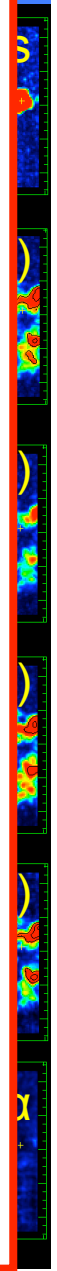
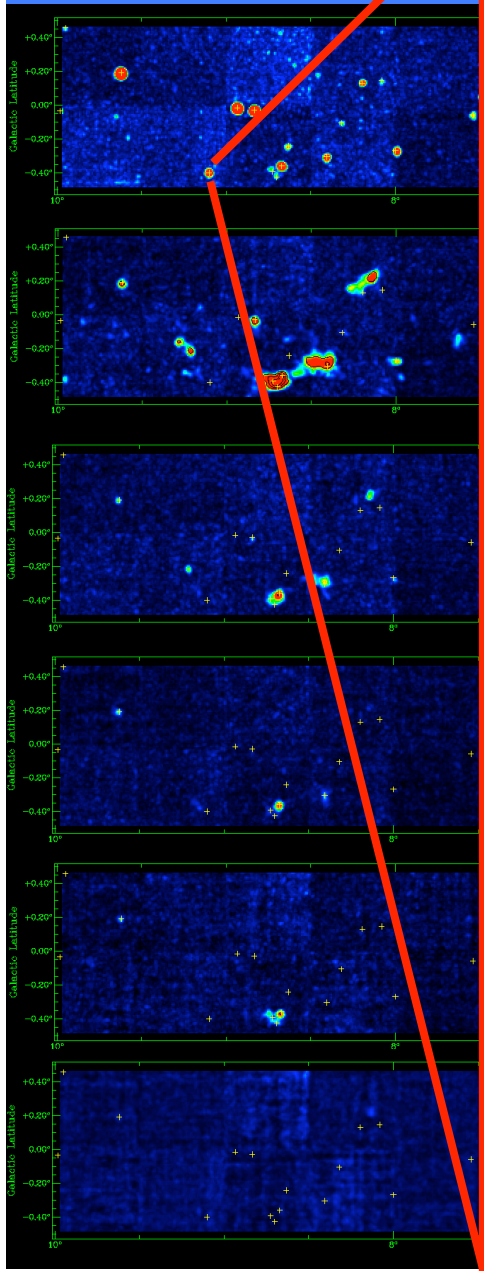
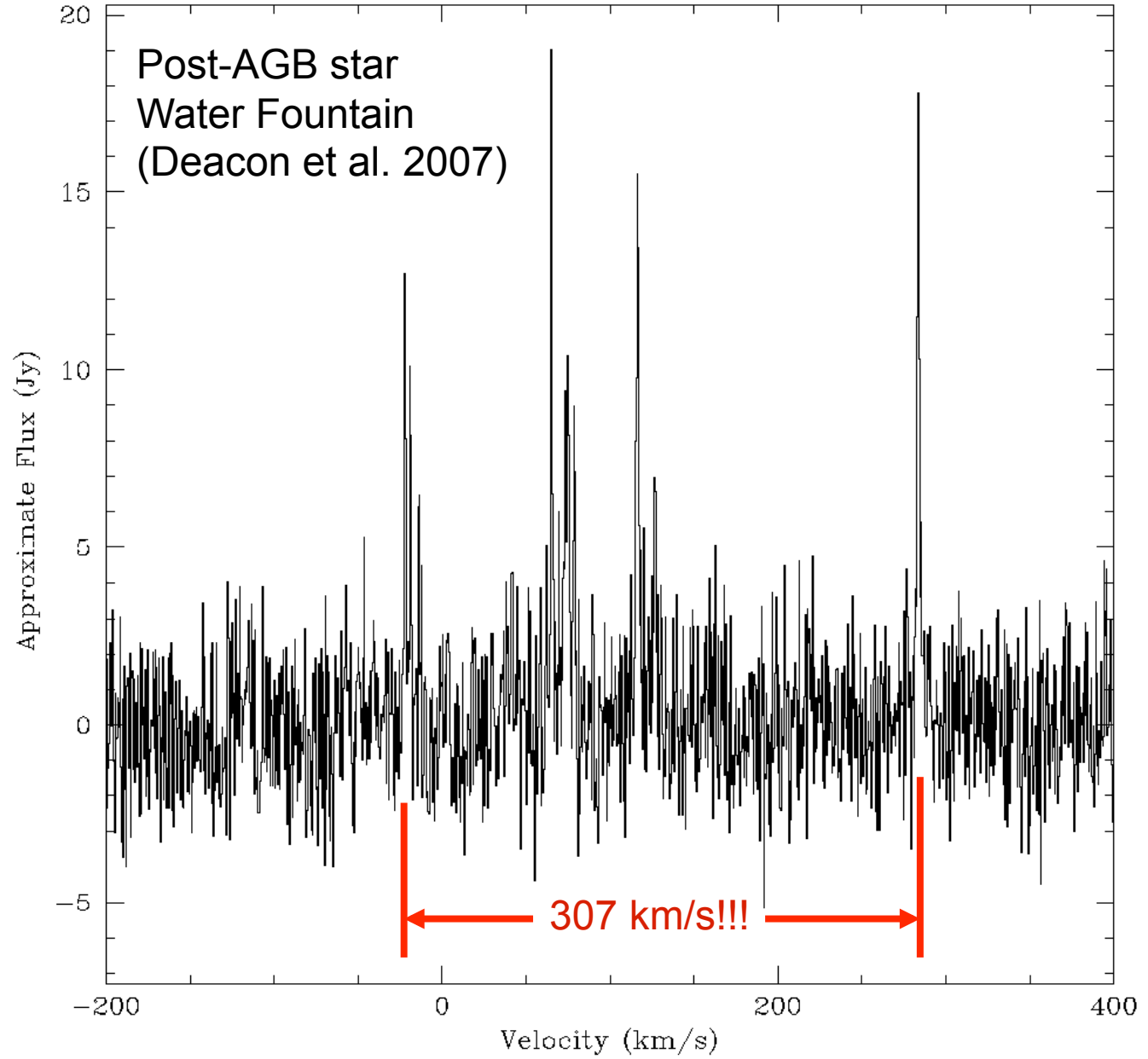
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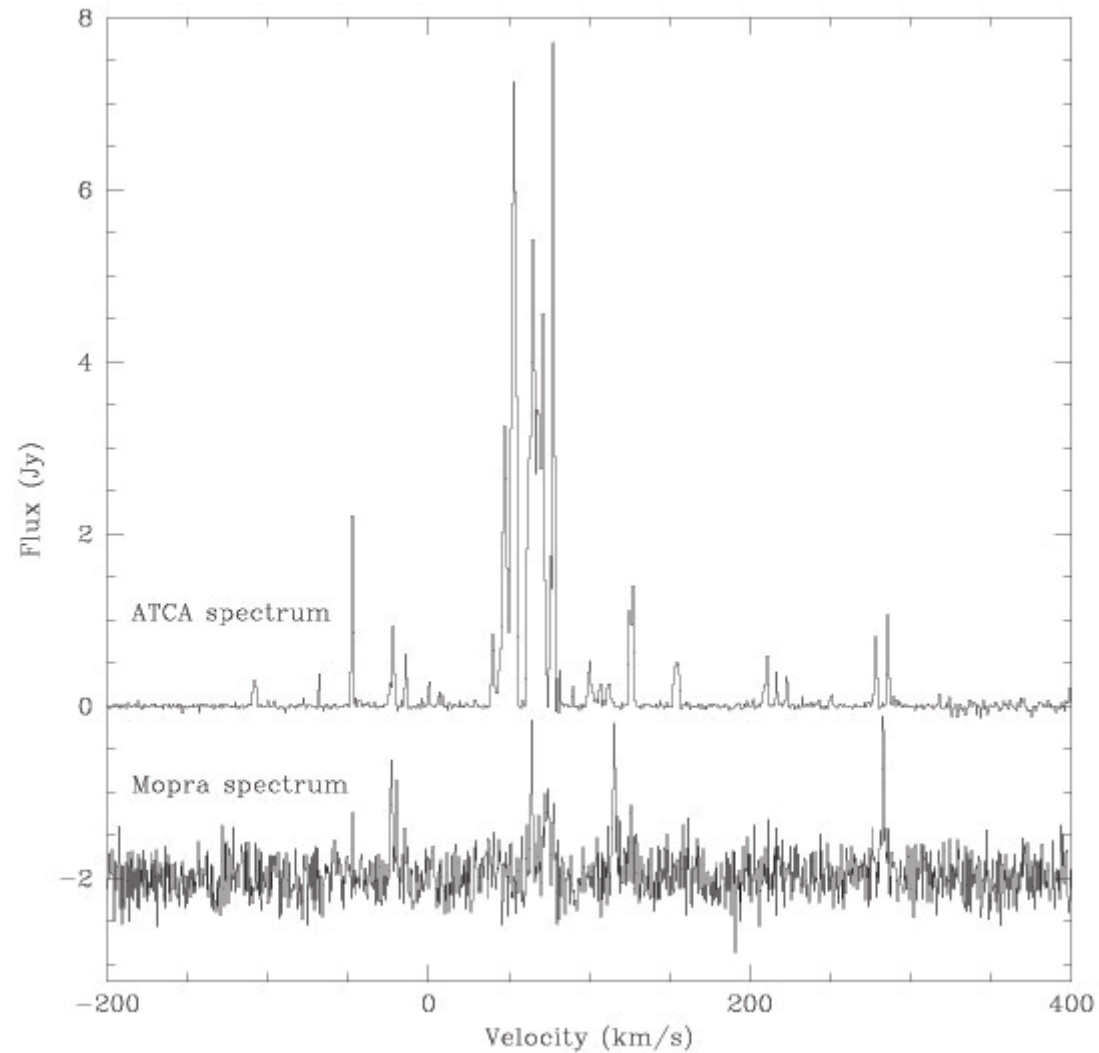
L 050 040

G9.1-0.4 H₂O masers

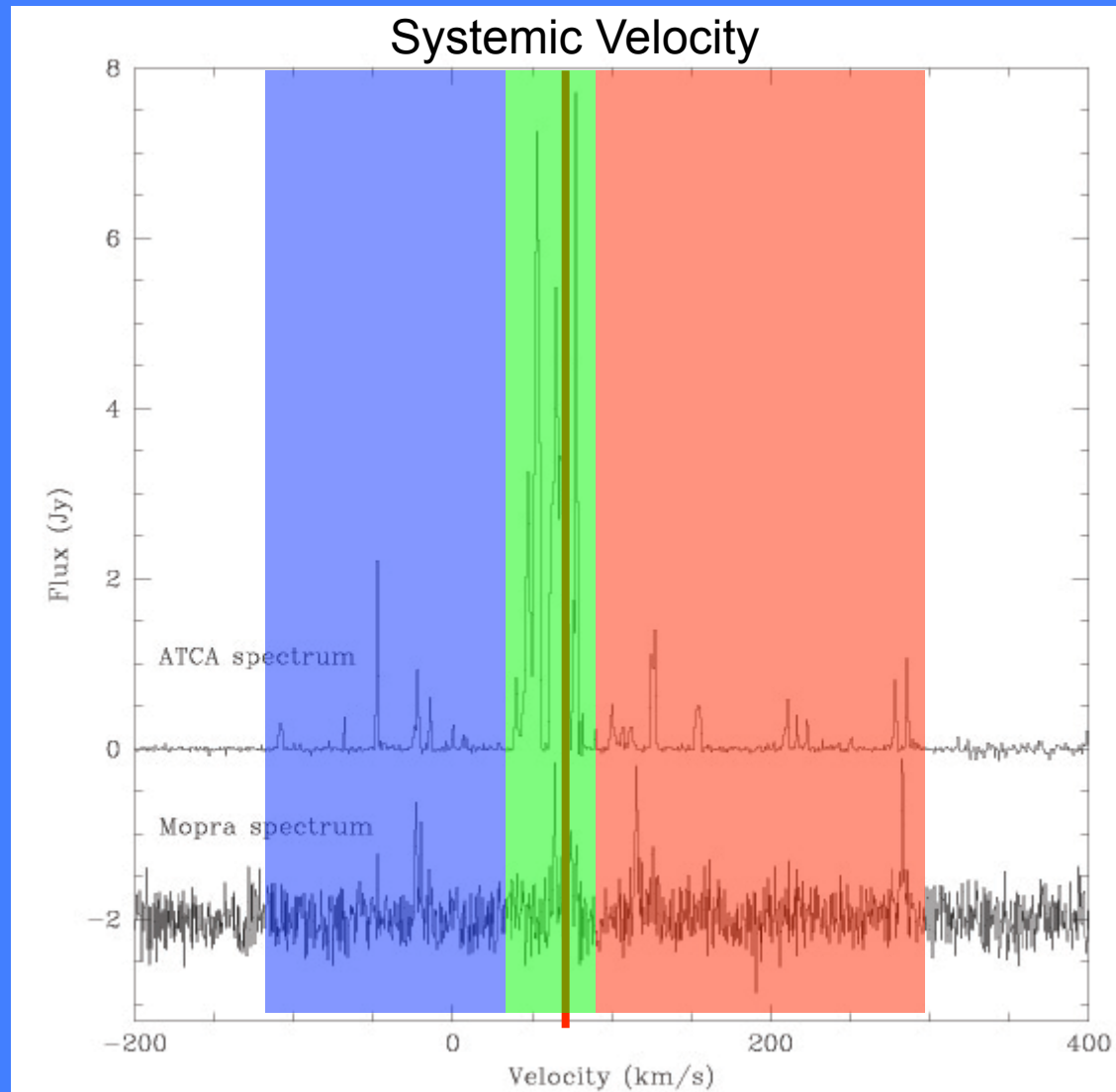
Post-AGB star
Water Fountain
(Deacon et al. 2007)



G9.1-0.4 Water Fountain



G9.1-0.4 Water Fountain



Results (I)

- 203 H₂O maser sites (154 New = 76%)
- 6.5 maser sites per square degree (5.0 new per square degree)

Results (II)

- ~500 NH_3 (1,1) “clumps” – widespread
- Widespread detections in NH_3 (2,2), (3,3), HC_3N (3-2), radio recombination lines
- Occasional detection of CH_3OH lines at 24928, 24933, 24934, 24959, 25018, 25124MHz, HC_5N , NH_3 (6,6) and (9,9)

Comment on future surveys

Lessons learned:

- Power in observing multi-transitions
- Picking the peaks, but useful science
- Can do a 7mm survey with no extra hard/software
- Need something extra for 3mm surveys
- Very efficient for maser surveys

Comment on future surveys

There will be more than one survey

- 7mm survey has a lot of potential with CS (1-0), SiO (1-0) and Class I CH₃OH maser
- 3mm survey at 90GHz – HCCCN, HCO⁺, CH₃CN, SO, N₂H⁺, HCN, HNC, SiO
- 3mm survey at 110GHz – ¹²CO, ¹³CO, C¹⁸O

Comment on future surveys

Need a team name:

- Millimetre Astronomers
Large-area multi-Transition
(MALT) team