

Water Emission and Absorption IRDC Core Envelopes

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Goal of Project

Determine gas dynamics in earliest stages of high-mass star formation.

Model molecular line observations of IRDC envelopes

Approach

Infrared Dark Clouds (IRDCs) seen in silhouette against Galactic Mid-IR emission but seen in emission in sub-mm. Cores in IRDCs are young and massive.

(Beuther et al. 2007)

Determine **physical 1D structure** of IRDC clumps from dust continuum between 70 to 850 microns

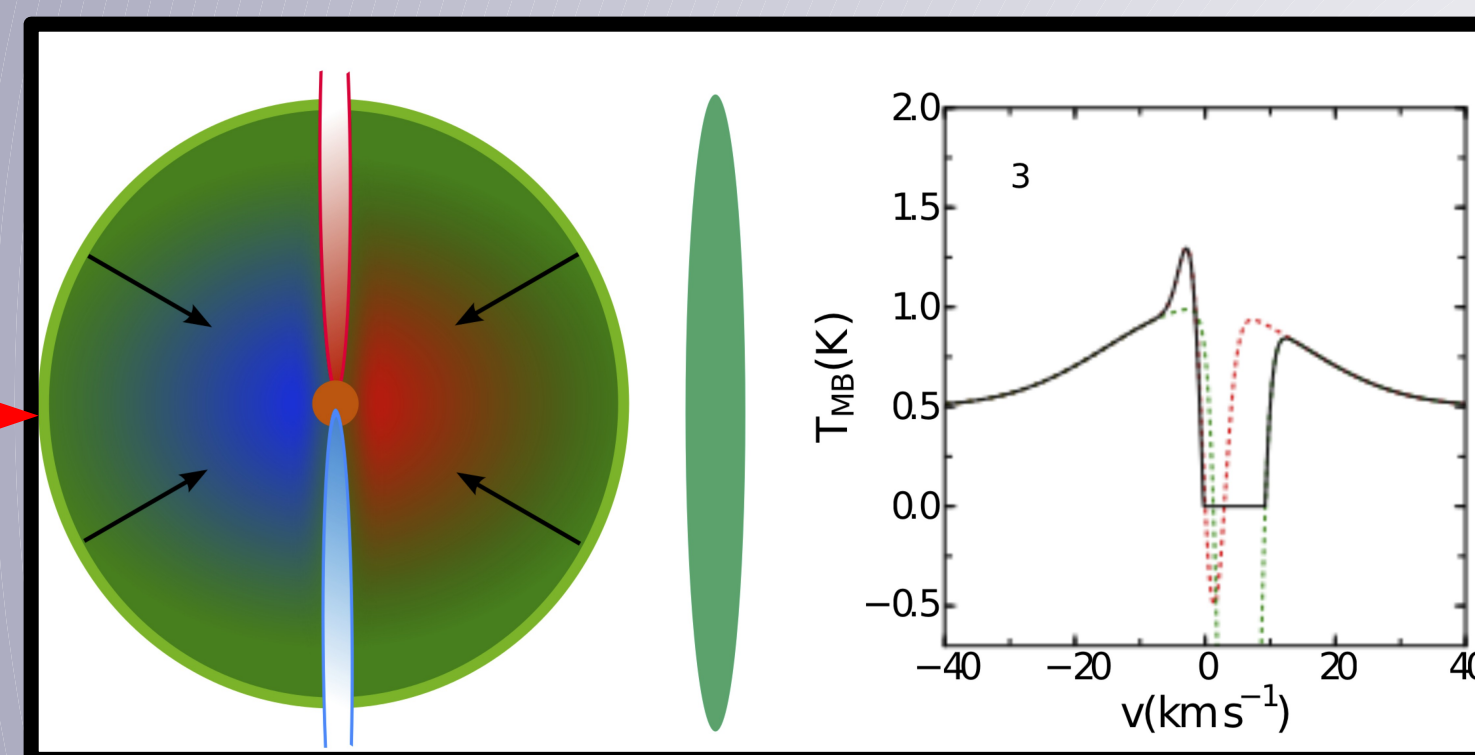
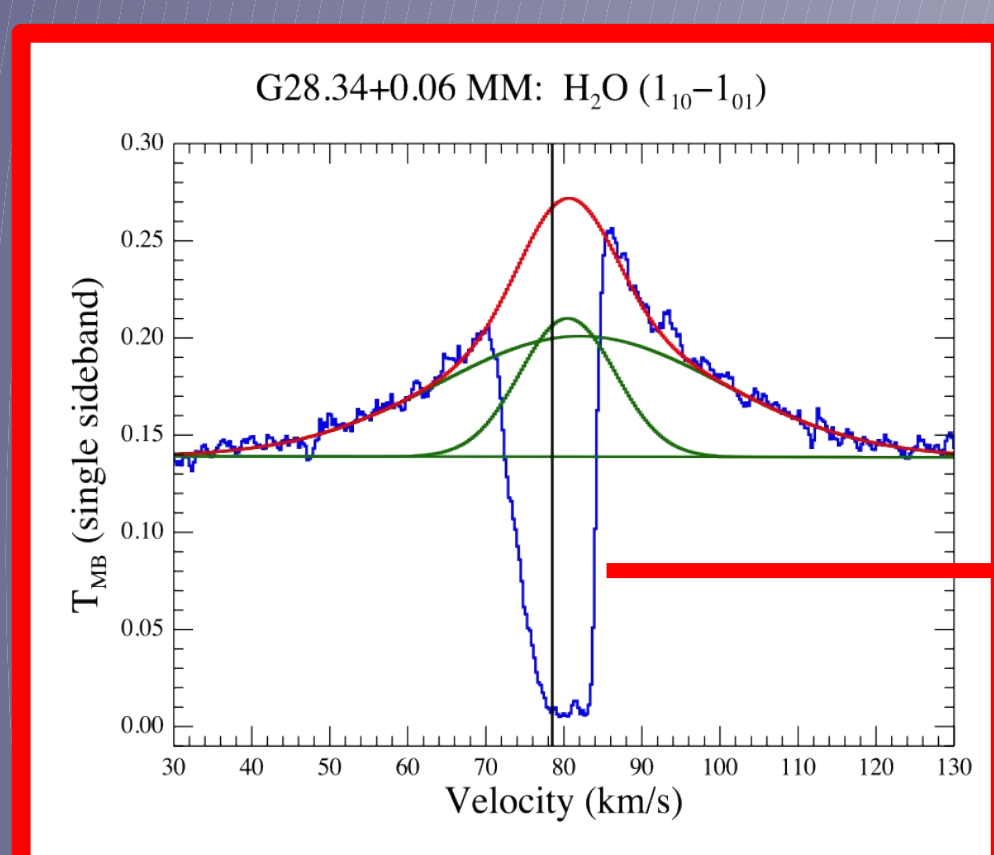
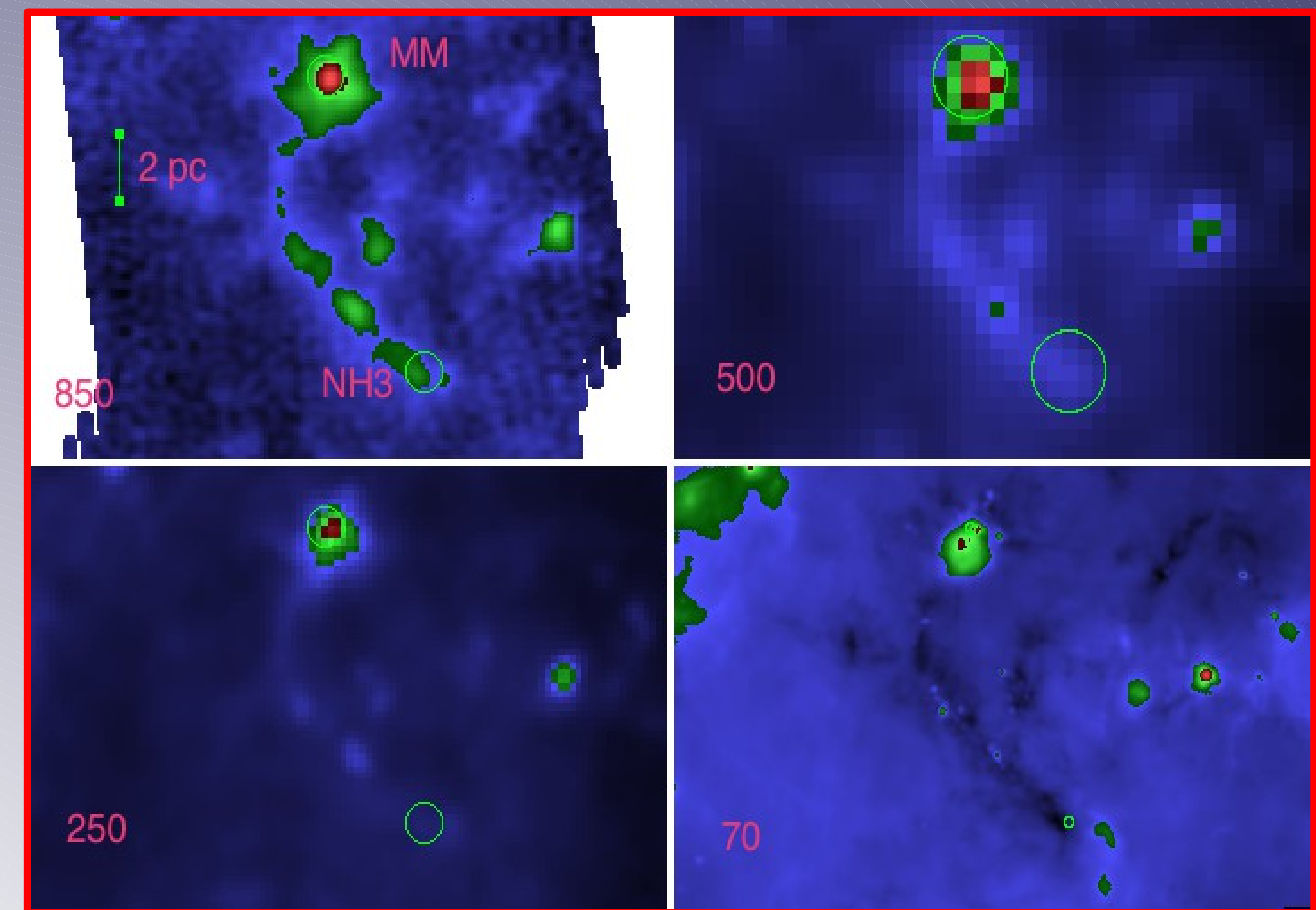
(Whitney et al. 2013, ApJS, 207:30m Stamatellos et al. 2010 MNRAS 409, 12–21)

RATRAN modeling molecular emission/absorption (Hogerheijde & van der Tak (2000, A&A 362, 697)

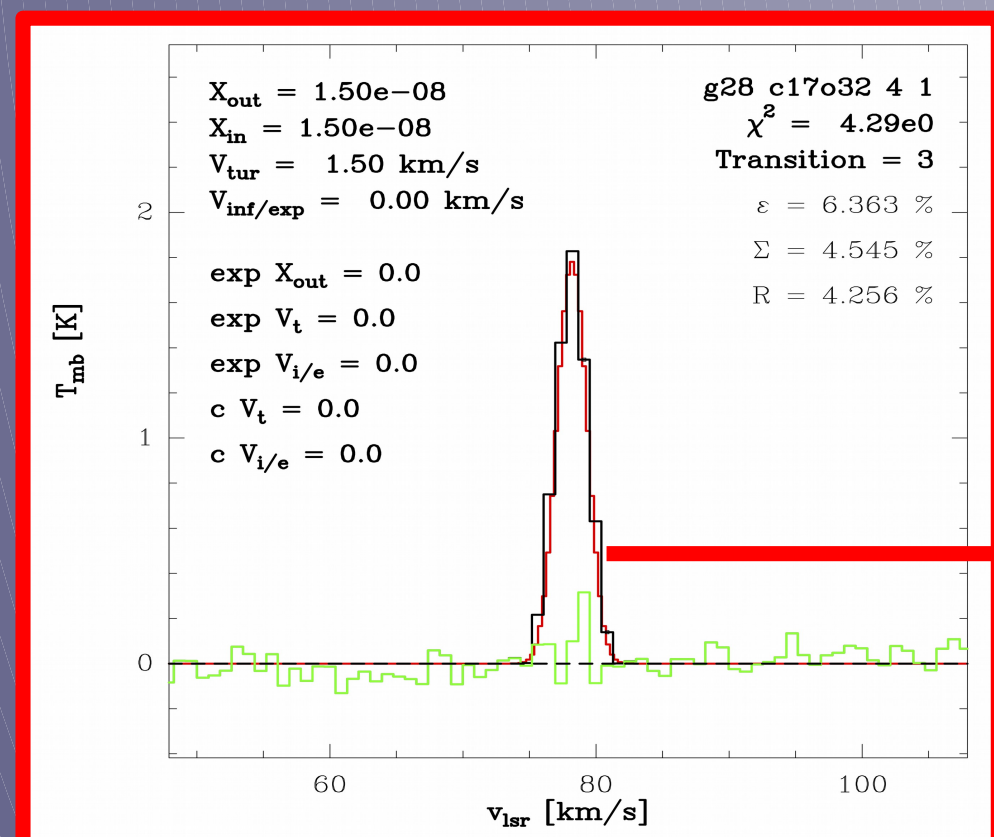
HIFI and APEX : H_2O ($1_{10}-1_{01}$), H_2^{18}O ($1_{10}-1_{01}$), N_2H^+ (6-5 and 3-2), C^{17}O (3-2), CH_3OH , C^{34}S (7-6)

IRDC Sources

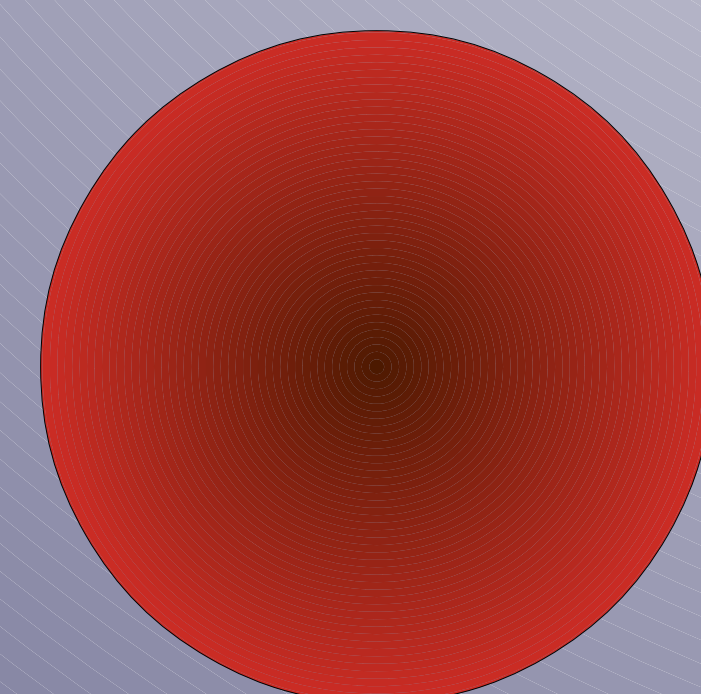
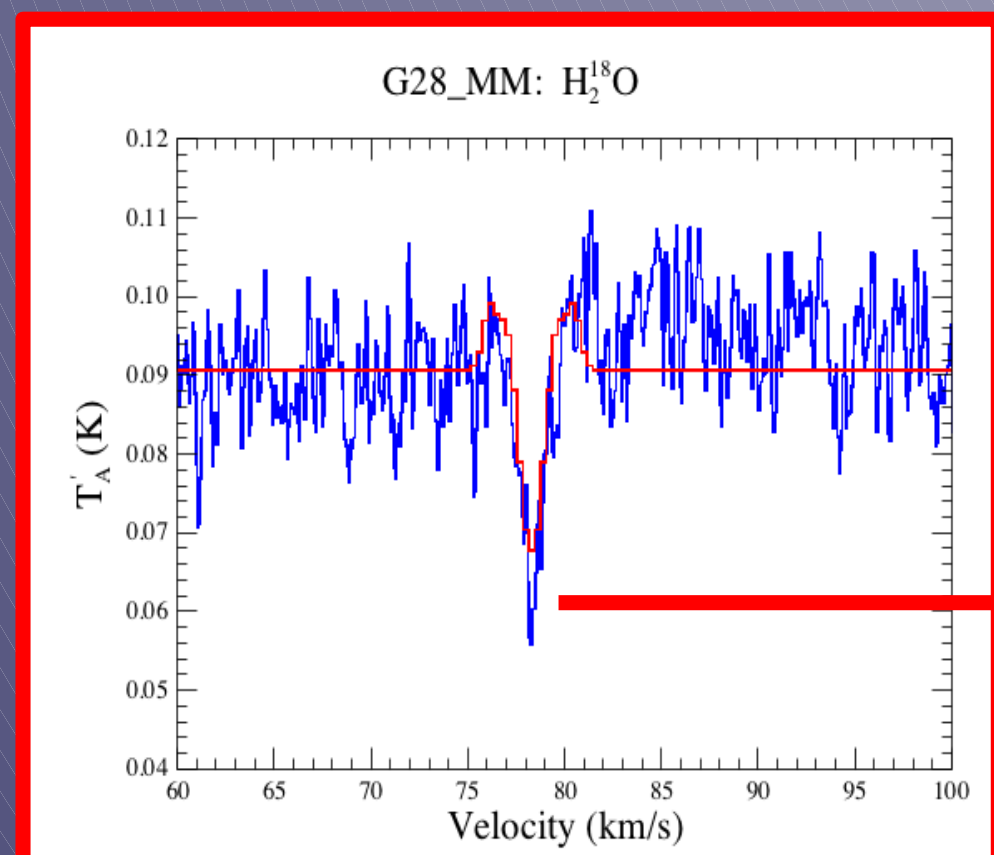
- **G28.34+0.06**, (G11.11-0.12 not shown)
- 2x Millimeter clumps: **signs** of star formation
- 2x NH_3 clumps: **no signs** of star formation



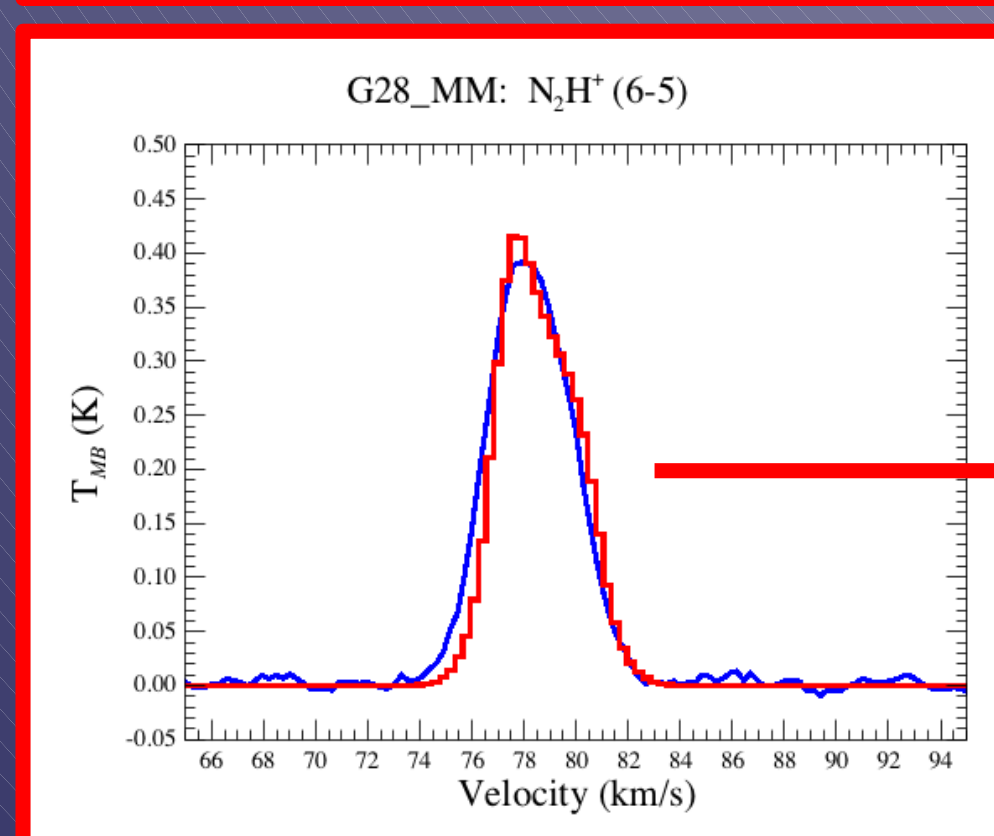
H_2O low density cloud falling on clump



C^{17}O
 $\Delta V \sim 1.5 \text{ km/s}$
no infall



H_2^{18}O Abundance decreasing inwards
no infall
 $\Delta V \sim 0.5 \text{ km/s}$



N_2H^+ (6-5)
Infall ?

Description G28.34 MM clump

- H_2O falling onto envelope: Contracting cloud complex?
- C^{17}O (3-2) Outer envelope, turbulence consistent w/ molecular cloud
- H_2^{18}O Quiescent outer envelope w/ decreasing abundance
- Preliminary N_2H^+ (6-5) models seem to indicate collapsing/contacting envelope
- N_2H^+ (3-2) data signs of self absorbed Infall-contracting cloud complex?

Description G28.34 NH_3 clump

- Model as starless envelope (increasing inner density, decreasing inner temperature)
- Dust heated by attenuated ISRF

Next Steps

- Complete modeling of N_2H^+ data
- Complete continuum model of NH_3 positions as starless envelopes
- Model H_2O and H_2^{18}O for NH_3 positions
- Model other molecules/transitions

Temperature and density profiles:
G28.34 clumps

