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# Hot Core Molecular Chemistry in Infrared Dark Cloud G024.33+00.11

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## Motivation

**Hot Molecular Cores (HMCs) are the birth sites of massive stars. They are immediate precursors to ultracompact (UC) HII regions and are succesors to warm/cold molecular cores (Kurtz 2004). HMCs are compact (< 0.1 pc ), dense (n($H_2$) > $10^7$ $cm^{-3}$; eg. Cesaroni et al. 1994), hot (T > 100 K) and luminous (> $10^6$ $L_0$) molecular condensations. The mass of HMCs ranges from 10 to 10000 $M_0$ (Kurtz 2004).**

**HMCs are identified by very rich line emission from complex molecules. So far, HMCs were found in the vicinity of UC HII regions (eg. Cesaroni et al. 1994; Beuther et al. 2007). This method is based on the fact that massive stars form in clusters, and massive protostars will co-exist with the more evolved O-B stars. Our systematic study of InfraRed Dark Clouds (IRDCs) allows the identification of HMCs *not associated with centimeter emission*.**

**IRDCs are 8 μm extended absorption features (eg. Carey et al. 1998; Simon et al. 2006). Because IRDCs are dense ( > $10^5$ $cm^{-3}$) and cold (< 25 K), they absorb the galactic IR background . Recent studies show that IRDCs are precursors to star clusters (eg. Rathborne et al. 2006, 2007). The existence of HMCs in IRDCs establishes a firm link between IRDCs and early stages of high mass star formation (Rathborne et al. 2007).**

## Observations

**Rathborne et al. (2006) used the IRAM 30 m telescope to identify the MM1 continuum core toward the IRDC G024.33+00.11 (Figure 1). Using the Plateau de Bure (PdB) Interferometer at 1.3 mm and 3 mm Rathborne et al. (2007), found G024.33+00.11 MM1 to be a single, unresolved continuum source. The spectrum toward G024.33+00.11 MM1 has characteristic similar to HMCs: strong emission lines from complex molecules and emission from high excitation lines, Figure 2.**

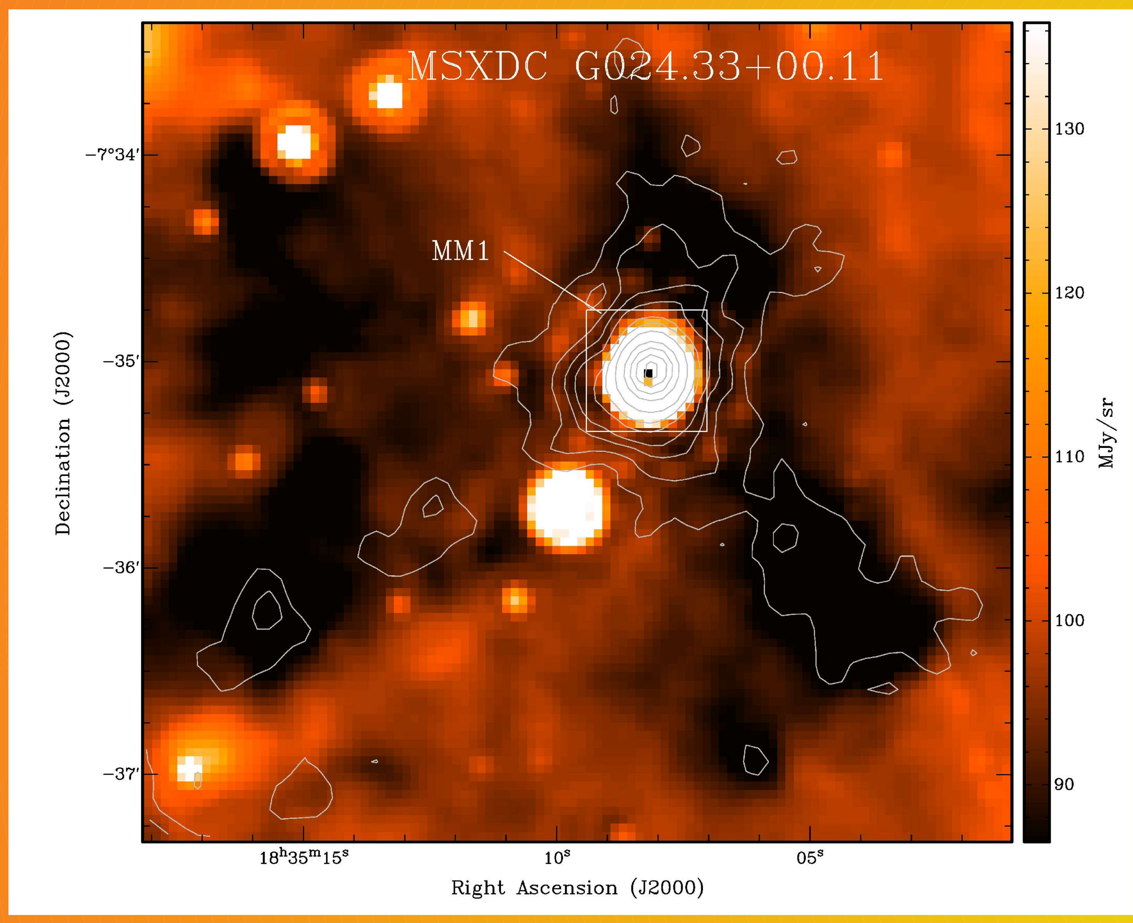



**Figure 1** : Spitzer/MIPS 24 m image of G024.33+00.11 overlaid with the IRAM 1.2 mm continuum emission contours (30, 60, 90, 120, 180, 240, 360, 600, 800, 1000, 1200 mJy beam $^{-1}$) . The box outlines the extent of the PdB Interferometry images

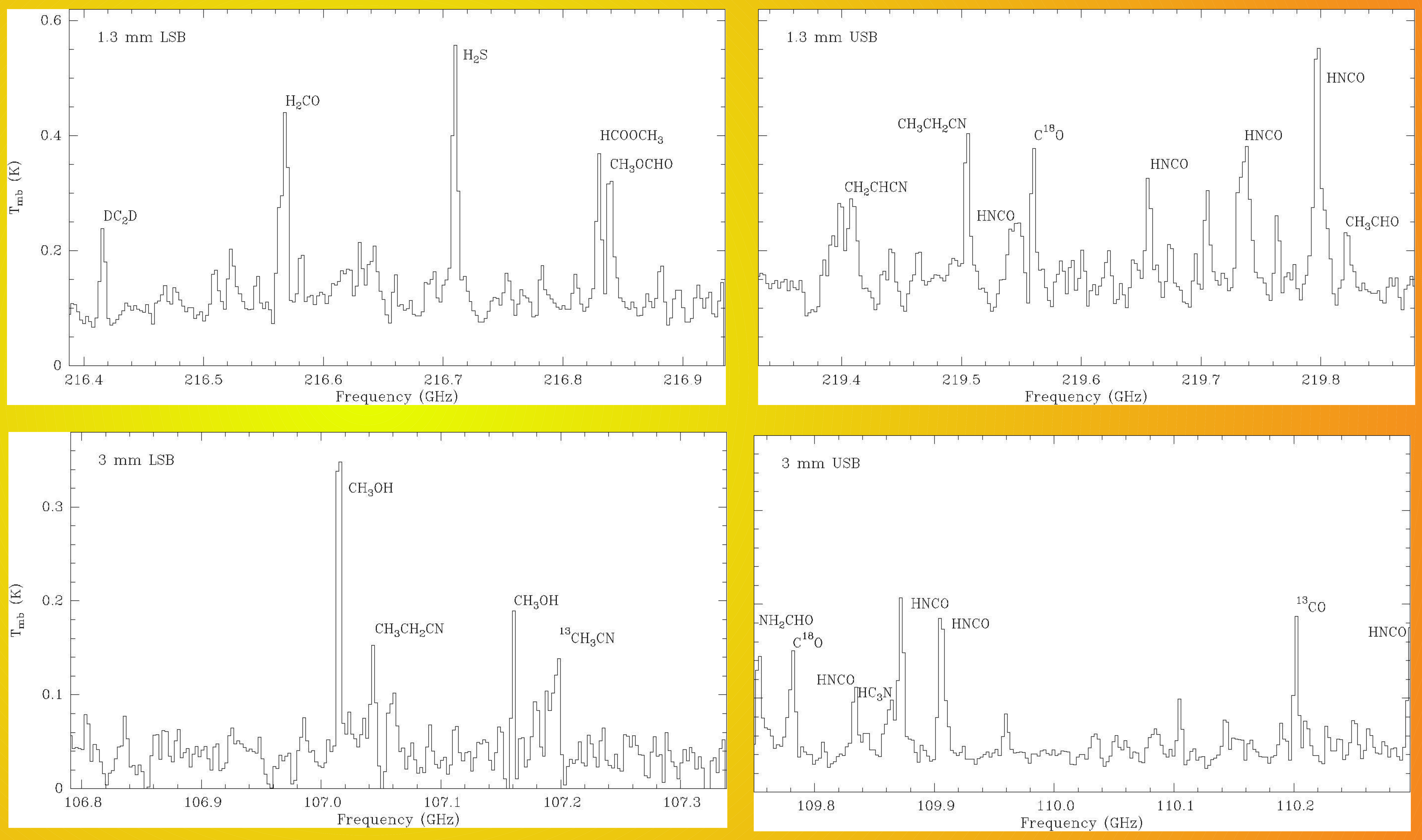
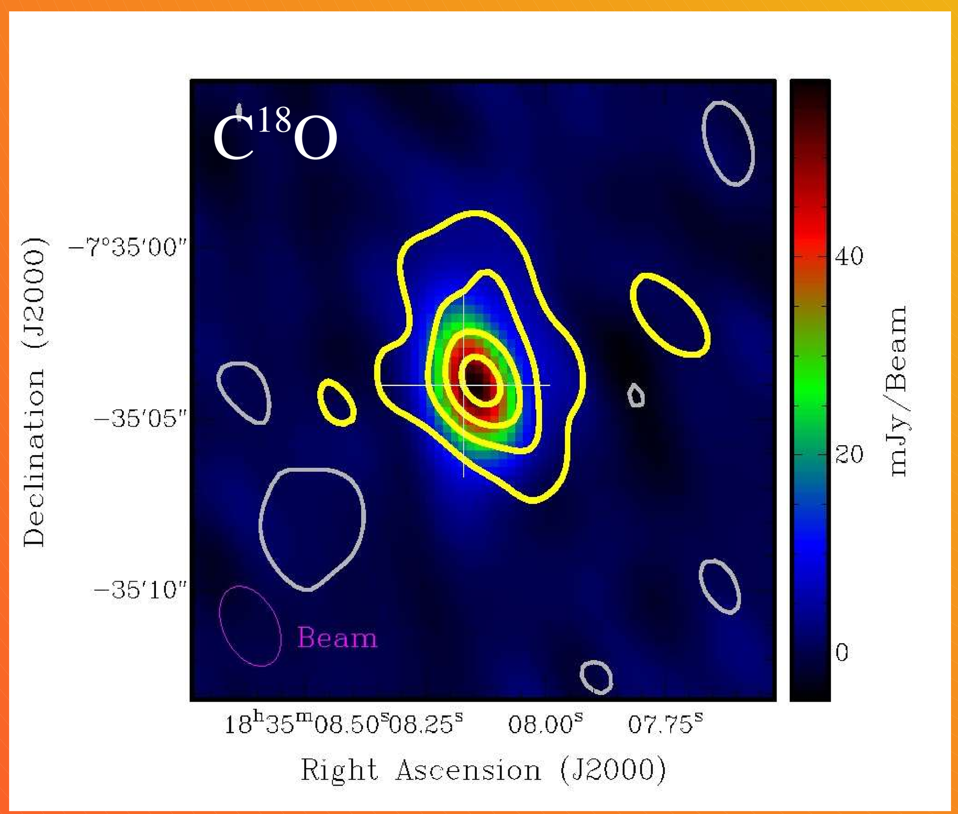
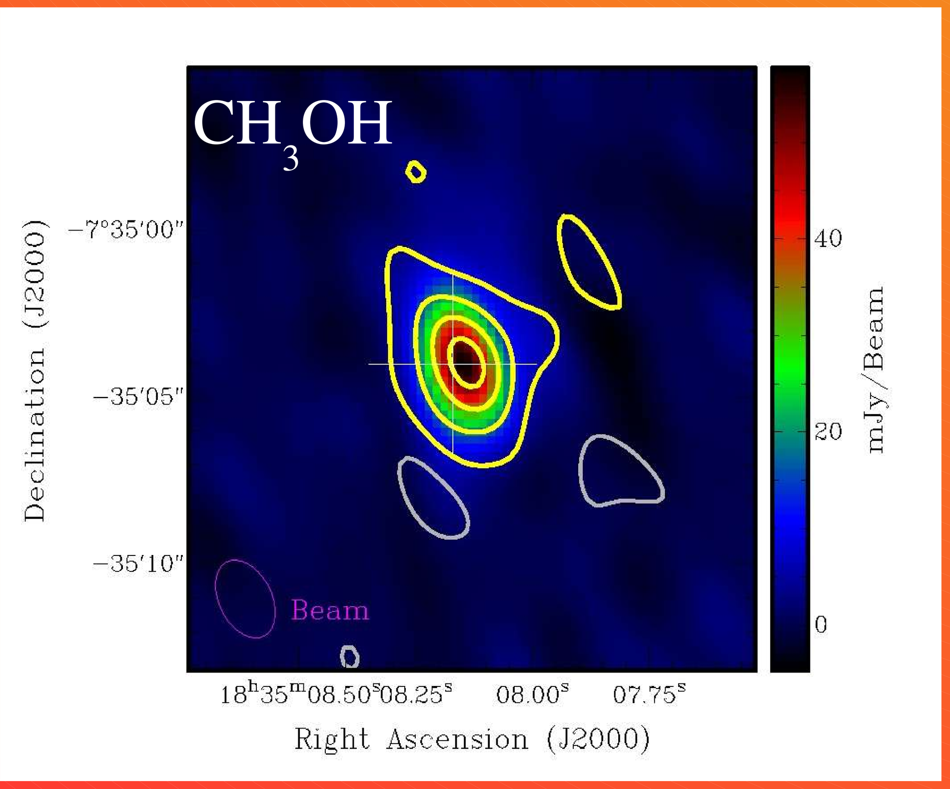



**Figure 2** : Hot Molecular Core Spectrum Toward G024.33+00.11 MM1 (PdB data)




## Results

**New integrated intensity images reveal strong molecular line emission exactly coincident with the unresolved 3 mm continuum emission. Assuming a dust temperature of 100 K, this source has a mass of 35 $M_0$ and size < 0.035 pc (Rathborne et al. 2007).**

**$^{13}CO$ and $C^{18}O$ trace the lower column density gas likely associated with the molecular surrounding of the hot core. In our integrated intensity maps both tracers show slightly extended emission. Figure 3 upper panel.**

**In contrast, emission from the hot core lines such as $CH_3CH_2CN$, $CH_3OCHO$, $CH_3OH$, etc., have similar morphology, unresolved at the 0.035 pc scale, see Figure 3 lower panel.**

**Figure 3** : *(upper panel)* Integrated intensity $C^{18}O$ line (3 mm USB) overlaid on the 3 mm continuum emission. Contours start at -0.5 Kkm/s and increase in steps of 0.5 Kkm/s. Cross symbol points at the location of a water maser detected using VLA; *(lower panel)* Integrated intensity $CH_3OH$ line (3mm LSB) overlaid on 3 mm continuum emission. Contours start at -1.3 Kkm/s and increase in steps of 1.3 Kkm/s.

### References

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