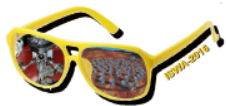


# PROPERTIES OF DENSE CONDENSATIONS EMBEDDED IN MUSCA DERIVED FROM $^{13}\text{CO}$ , $\text{C}^{18}\text{O}$ AND $\text{NH}_3$ EMISSION LINES

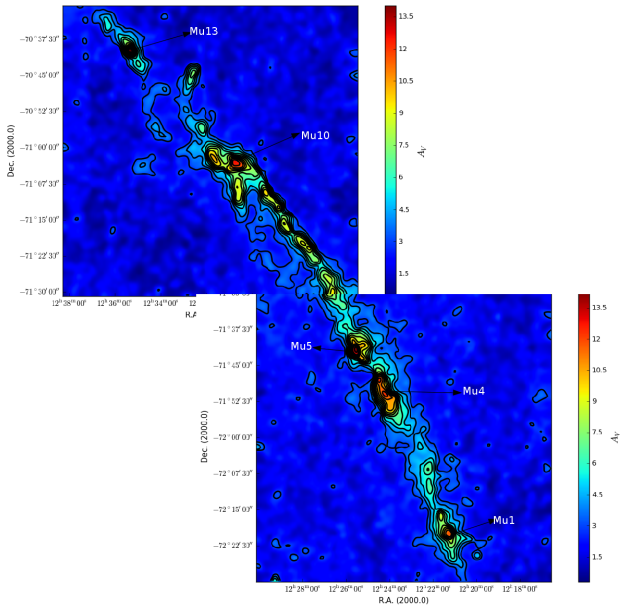
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Germán A. Racca

**INTERNATIONAL SYMPOSIUM AND  
WORKSHOP ON ASTROCHEMISTRY**

Understanding extraterrestrial molecular complexity  
through experiments and observations



# Studied cores



átomos espécies moleculares

2	$H_2, OH, SO, SH, SO^+, SiO, SiS, SiC, SiN, HCl, NaCl, KCl, AlCl, AlF, NH, NO, NS, HF, CH, CH^+, CN, CO, CO^+, C_2, CS, CP, PN, PO$
3	$H_2O, H_2S, HNO, HCO, HCO^+, H_3^+, N_2H^+, NH_2, N_2O, OCS, C_2H, HCS^+, CO_2, C_2O, C_2S, C_3, MgCN, MgNC, NaCN, HCN, HNC, KCN, CH_2, SO_2, SiH_2, SiC_2, HOC^+$
4	$NH_3, H_3O, H_2CO, H_2CS, HNCO, HNCS, C_3N, HCO_2^+, C_3H, C_3O, C_3S, C_2H_2, CNH_2^+, HC_2N, H_2CN, H_3O^+, SiC_3$
5	$SiH_4, CH_4, HCOOH, HC_3N, CH_2NH, NH_2CN, H_2C_2O, C_4H, CH_2CN, C_5, SiC_4, C_3H_2, HC_2NC, HC_3N, H_3COH^+$
6	$CH_3OH, NH_2CHO, CH_3CN, CH_3NC, CH_3SH, C_5H, HC_2CHO, CH_2CH_2, H_2C_4, HC_3NH^+, C_5N, C_6^-, C_5S$
7	$CH_3CHO, CH_3NH_2, CH_3C_2H, CH_2CHCN, HC_5N, C_6H, C_7^-, CH_2OCH_2$
8	$CH_3CO_2H, CH_3C_3N, C_7H, H_2C_6, C_8^-$
9	$CH_3CH_2OH, CH_3OCH_3, CH_3CH_2CN, CH_3C_4H, HC_7N, C_8H, C_9^-$
10	$CH_3COCH_3, CH_3C_5N$
11	$HC_9N$
13	$HC_{11}N$

van Dishoeck &amp; Blake, 1999

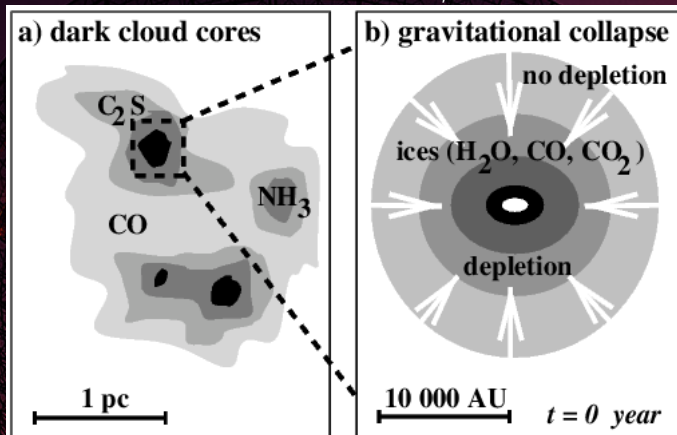
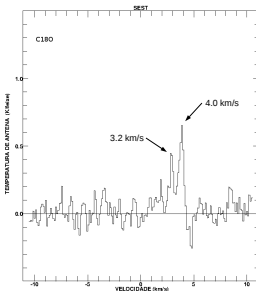
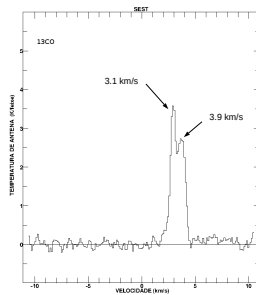
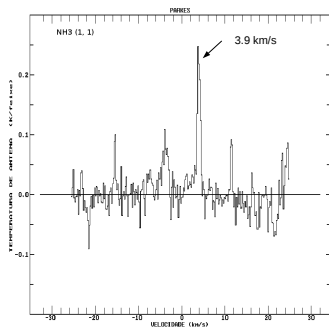
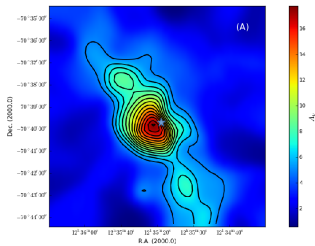
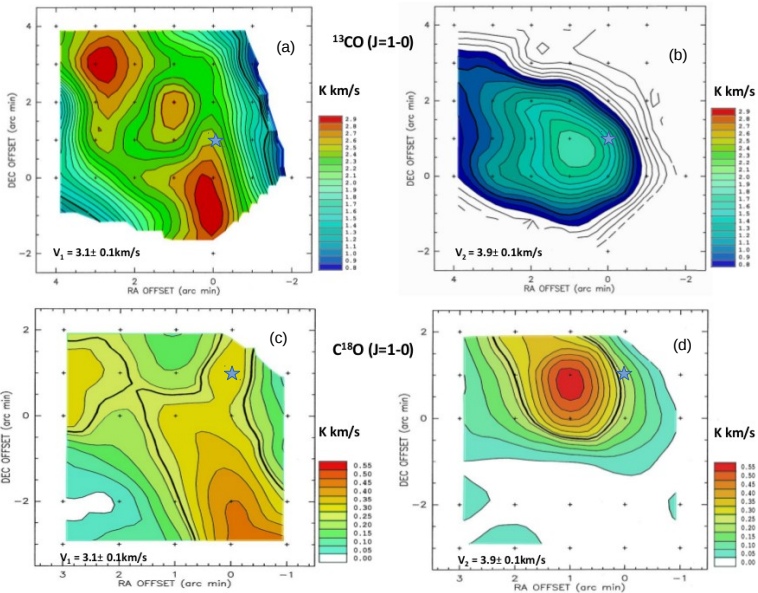


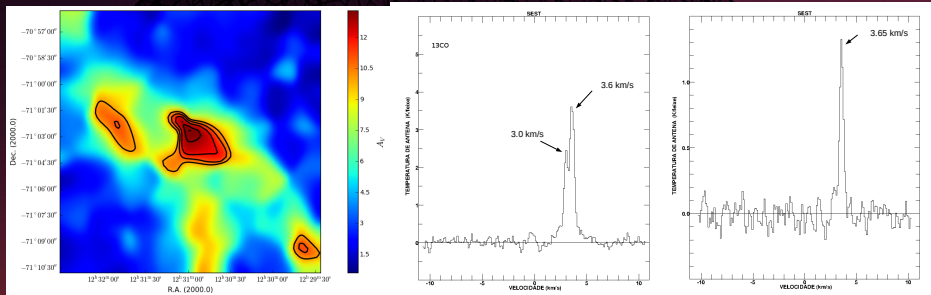
Table : Condensations observed in Musca through spectral lines

Condensation	$\alpha_{J2000.0}$ (h:m:s)	$\delta_{(J2000.0)}$ ( $^{\circ}$ : ' : ")	Observed molecule
Mu4	12 24 30.00	-71 50 19.0	$^{13}\text{CO}$ , $\text{C}^{18}\text{O}$
Mu5	12 25 35.60	-71 42 35.0	$^{13}\text{CO}$ , $\text{C}^{18}\text{O}$
Mu6	12 26 15.00	-71 26 36.0	$\text{NH}_3$
Mu8	12 29 36.56	-71 10 39.0	$^{13}\text{CO}$ , $\text{C}^{18}\text{O}$
Mu9	12 30 49.00	-71 10 36.0	$\text{NH}_3$
Mu10	12 31 01.98	-71 03 04.3	$^{13}\text{CO}$ , $\text{C}^{18}\text{O}$
Mu11	12 31 41.00	-71 01 42.0	$\text{NH}_3$
Mu13	12 35 06.00	-70 40 48.0	$^{13}\text{CO}$ , $\text{C}^{18}\text{O}$ , $\text{NH}_3$

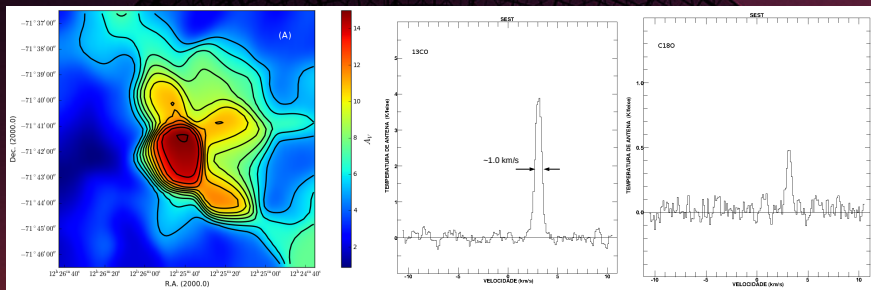


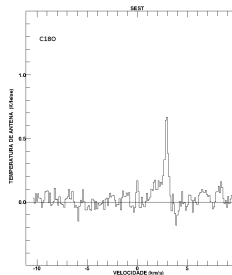
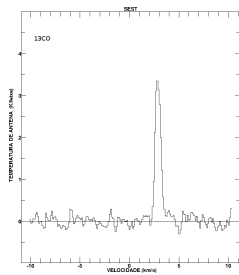
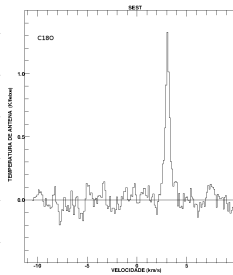
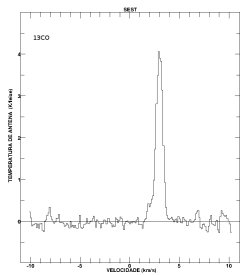
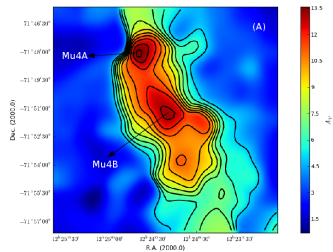












## Radial velocity

- $V_c = 2.9\text{--}4.0 \text{ km s}^{-1} \rightarrow 0.2 \text{ km s}^{-1} \text{ pc}^{-1}$

## Line widths

- $\Delta V (^{13}\text{CO}) = 0.75 \pm 0.16 \text{ km s}^{-1}$
- $\Delta V (\text{C}^{18}\text{O}) = 0.56 \pm 0.12 \text{ km s}^{-1}$
- $\Delta V (\text{NH}_3) = 0.63 \pm 0.31 \text{ km s}^{-1}$  (smoothed)

Note: all lines widths are dominated by nonthermal motions

Velocity dispersion of  $^{13}\text{CO}$ 

- Mu13:  $0.41 \text{ km s}^{-1}$
- Mu10:  $0.26 \text{ km s}^{-1}$
- Mu4 and Mu5:  $0.05 \text{ km s}^{-1}$

## Dynamics

- $\sigma_{\text{NT}}/\sigma_{\text{T}}: 2 \text{ to } 4 \rightarrow \text{transonic regime}$

- Optical depth

- ①  $\tau_{C^{18}O}$ : 0.08-0.35
- ②  $\tau_{^{13}CO}$ : 0.4-1.9

- Temperature

- ① From CO: 8-15 K;
- ② From NH<sub>3</sub> (Mu13):  $T_{exc} = 8$  K;  
 $T_K = 12 \rightarrow \eta_f < 1$

- Density:

- ①  $N(H_2) \rightarrow 3.4 \pm 0.4 \times 10^{21} \text{ cm}^{-2}$
- ②  $n(H_2) \rightarrow 2.6 \pm 0.7 \times 10^3 \text{ cm}^{-3}$  (from CO lines)
- ③  $n(H_2) \rightarrow 1.4 \times 10^4 \text{ cm}^{-3}$  (from NH<sub>3</sub> lines in Mu13)

- Masses:

- ①  $M(H_2) \rightarrow 6-35 M_{\odot}$ ;  $M_V \rightarrow 5-24 M_{\odot}$ ;  $M_J \rightarrow 6-14 M_{\odot}$   
 $\alpha_{vir} = M_V / M(H_2) \lesssim 1 \rightarrow$  virialized (Mu4, Mu5 and Mu10)  
 $M(H_2) > M_J \rightarrow$  can fragment<sup>1</sup> (Mu4, Mu5 and M10)

<sup>1</sup>Zhang et al., 2014



A large satellite dish antenna is shown from a low angle, looking up. The dish is a complex grid of metal mesh, and its central feed horn is illuminated from below, creating a bright, glowing effect. The background is a gradient of colors from a sunset or sunrise, transitioning from a deep purple at the top to a bright orange at the bottom. The text "Thank you!" is centered over the dish in a large, white, sans-serif font.

**Thank you!**