A line-confusion limited millimeter survey of ORION KL

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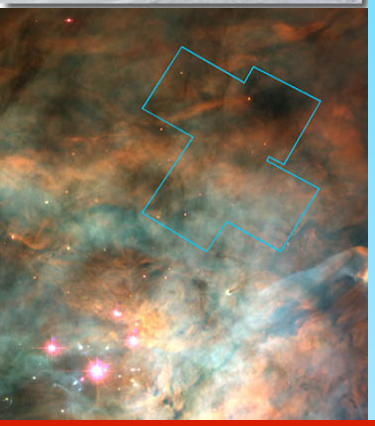
ORION KL as seen in the millimeter

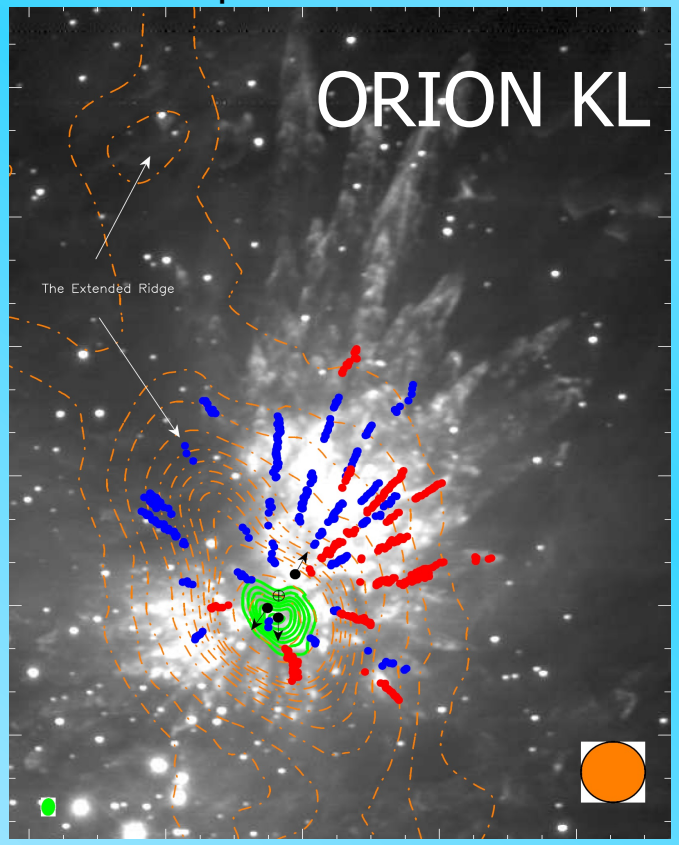
IRAM 30 M
Very high sensitivity



Orion Nebula (HST)
Closest high mass star forming region

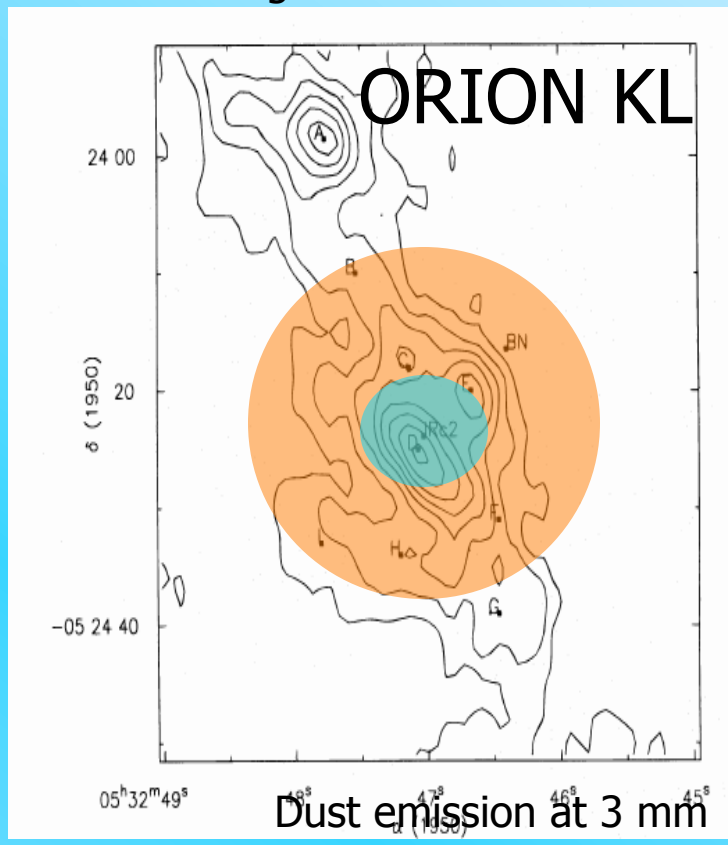
414 pc (Menten et al.)

Zapata et al. 2011



White: H_2; **blue**/**red**: CO; **green**: CH_3CN; **orange**: 850 μm; **black**: runaway stars

Wright et al. 1996



Dust emission at 3 mm

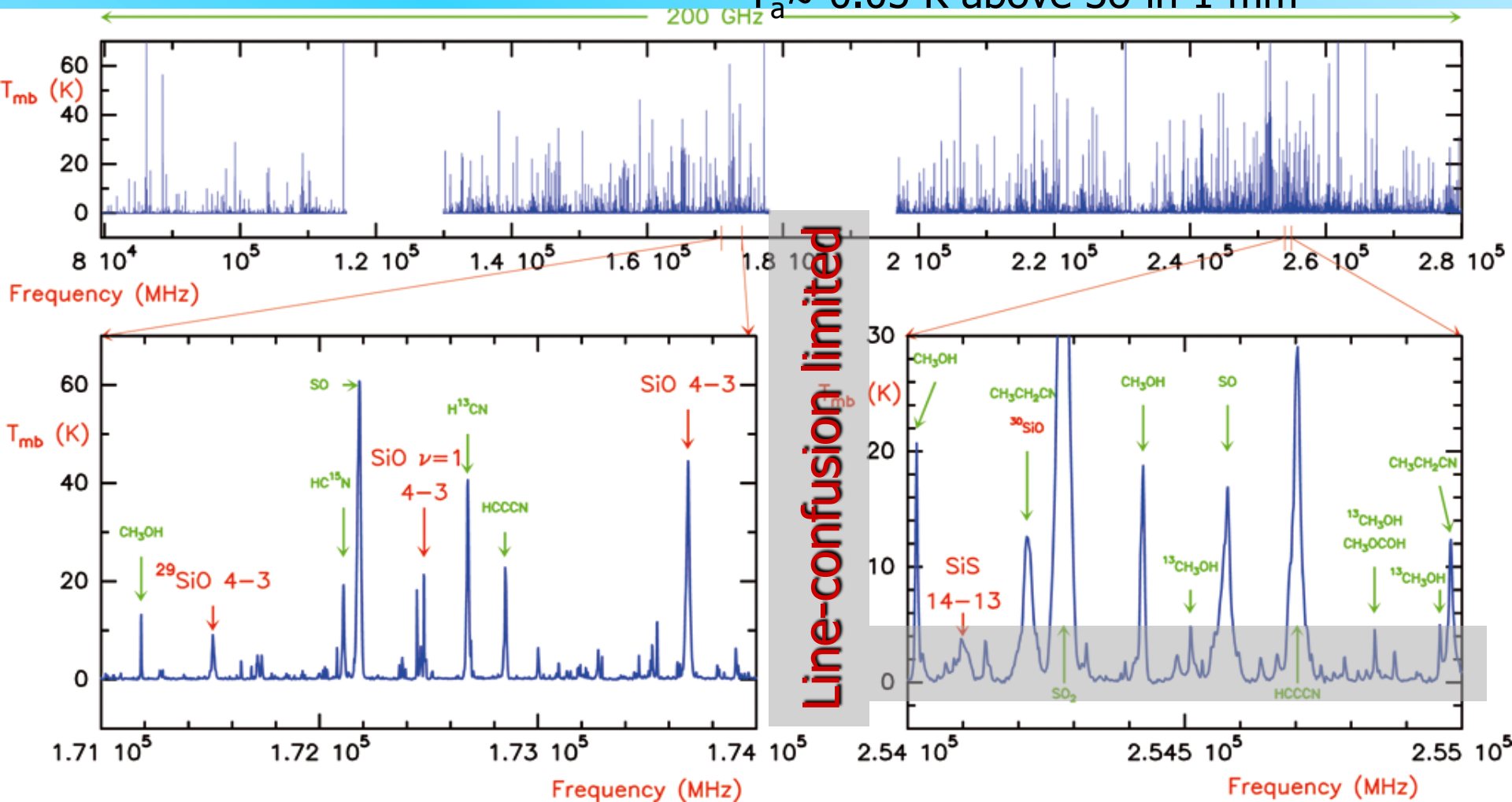
30″ HPBW at 80 GHz → 1250 AU

9″ HPBW at 280 GHz → 375 AU

THE DATA:

More than 15 000 spectral features

1 and 1.25 MHz of spectral resolution
Fully single-side band reduced
60 hours for 168 GHz reaching:
$T_a \approx 0.02$ K above 3σ in 3 mm and 2 mm
$T_a \approx 0.05$ K above 3σ in 1 mm



Diferent v_{LSR} and Δv depending on the molecule due to the complexity of the region. At least four components overlap in the beam:

- Extended ridge:

$v_{LSR} \sim 9$ km s^{-1}, $\Delta v \sim 5$ km s^{-1}
T ~ 60 K, n(H_2) ~ 10^5 cm^{-3}
CN, CO, CS, NO, SO, CCH, C_3H_2
CH_3CCH, HCO^+, HCS^+, HCN, HNC, HC_3N

- Compact ridge:

$v_{LSR} \sim 7$-8 km s^{-1}, $\Delta v \sim 3$-5 km s^{-1}
T ~ 150 K, n(H_2) ~ 10^6 cm^{-3}
OCS, HDO, H_2 CO, H_2 CS, HCOOH,
CH_3CHO, CH_3CN, H_2CCO, CH_3OH

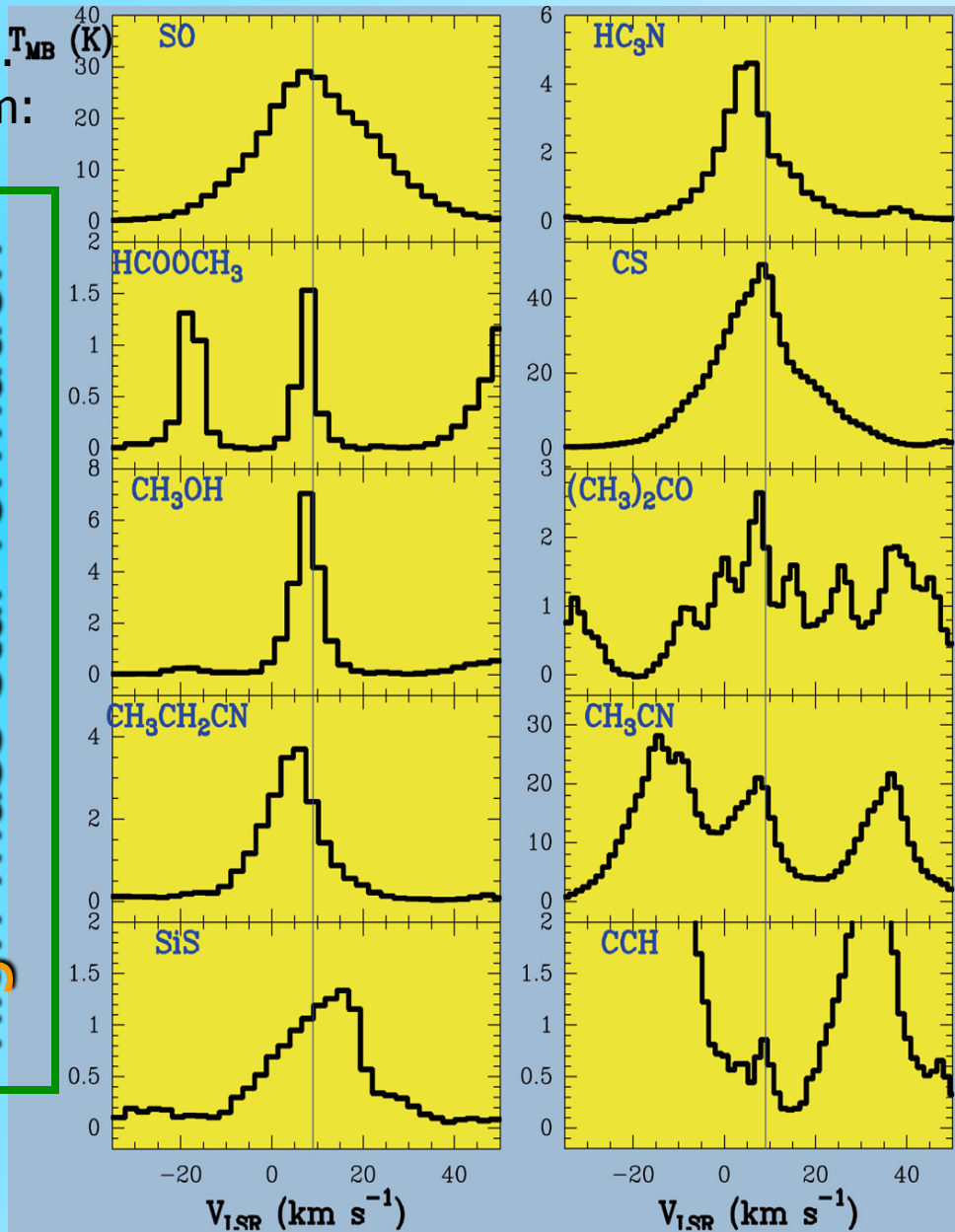
- Plateau:

$v_{LSR} \sim 6$-10 km s^{-1}, $\Delta v \sim 25$-30 km s^{-1}
T ~ 150 K, n(H_2) ~ 10^6 cm^{-3}
CO, CS, SiO, SO, SO_2, OCS, H_2S,
HDO, H_2CO, HCN, HC_3N

- Hot core:

$v_{LSR} \sim 3$-5 km s^{-1}, $\Delta v \sim 10$-15 km s^{-1}
T ~ 250 K, n(H_2) ~ 10^8 cm^{-3}
CO, HDO, H_2CO, HNCO, HCN, HC_3N,
CH_3CN, C_2H_3CN, C_2H_5CN

Components related with high mass star formation



GOALS

- Looking for new molecular species.

- Characterizing the isotopologues and vibrational states of well known molecules. Reducing the number of U lines in millimeter and sub-millimeter spectra → **ALMA, Herschel**

- The fully description of the molecular emission and chemical composition of Orion KL → **input in chemical and star formation models.**

- Constraining the physical parameters of the region due to the large number of transitions available of the same molecule in three different spectral windows → **input in chemical and star formation models.**

- Predicting the source spectra in other frequency ranges → **ALMA, Herschel**

TWO WAYS:

New results and detections thanks to the new frequencies provided by spectroscopy laboratories (Lille, Valladolid)

Alicia López's talk

Ethyl cyanide (CH_3CH_2CN)
Vinyl cyanide (CH_2CHCN)
Methyl Formate ($HCOOCH_3$)
Formamide (NH_2CHO)
Phenol (c-C_6H_5OH)

New results and detections from the data analysis dividing our work in the study of different families of molecules

Gisela B. Esplugues' talk

-CS bearing molecules
Si bearing molecules
SO, SO_2
HCN, HNC, HCO
CH_3CN
HC_3N, HC_5N
(CH_3CH_2CN, CH_2CHCN)

RESULTS

1.- 16 new detections in the ISM, reducing in 2000 the number of U lines→ Improving the molecular databases and the line identification process for ALMA and Herschel data.

2.- New detections in warm clouds such us C_3S → New inputs in chemical models.

3.- Description of new components in Orion KL (15.5 and 20.5 km/s) → Characterization of new interactions between gas, dust, and stars in this complex region.

4.- 2D maps (Marcelino et al.) → Structure of the region.
30m + HIFI → Temperature and density gradients of the Orion KL components.

ETHYL CYANIDE:
Demyk et al. A&A 466, 255–259 (2007)
Margulès et al. A&A 493, 565–569 (2009)
Daly et al. (submitted to ApJ)

METHYL FORMATE:
Carvajal et al. A&A 500, 1109–1118 (2009)
Margulès et al. ApJ, 714:1120–1132, (2010)
Tercero et al. A&A 538, A119 (2012)

FORMAMIDE:
Motiyenko et al. A&A 548, A71 (2012)

PHENOL:
Kolesniková et al. (In preparation)

VYNIL CYANIDE:
López et al. (In preparation)

CS bearing molecules:
Tercero et al. A&A 517, A96 (2010)

Si bearing molecules:
Tercero et al. A&A 528, A26 (2011)

SO and SO_2 species:
Esplugues et al. (submitted to A&A)

HC_3N, HC_5N species:
Esplugues et al. (In preparation)

CH_3CN species:
Bell et al. (submitted to A&A)

HCN, HNC, HCO^+ species:
Marcelino et al. (In preparation)

THANK YOU FOR LISTENING