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Molecular study of two cores of intermediate/low mass in OMC1S

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Abstract. We present preliminary results of the spectral line survey of the intermediate- and low-mass cores ORI 139−409 and ORI 134−411 located in the Orion Molecular Cloud South (OMC1S). The sources were observed with the Submillimeter Array (SMA), the resulting spectra shows a very rich content of molecular transitions detected above 4σ. Complex molecules like Methyl Cyanide (CH_3CN), Methanol (CH_3OH), Methyl Formate ($HCOOCH_3$), Ethyl Cyanide (C_2H_5CN) and other simple ones such as Isocyanic Acid (HNCO), Sulfur Monoxide (SO) and Formaldehyde ($H_2\,^{13}CO$) were found. We estimated the physical parameters of the observed cores using the superset XCLASS. We did not find significant differences in rotational temperatures, column densities and molecular line content between the hot molecular cores, which could indicate a similar evolutionary status.

Key words. ISM: individual objects (OMC1S, Orion South), ISM: lines and bands, ISM: molecules, techniques: imaging spectroscopy

1. Introduction

One of the earliest stages of the high-mass (masses $\geq$ 8 $M_\odot$) star formation regime are the so-called Hot Molecular Cores (HMC) (Kurtz et al. 2000), and correspond to small ($<$ 0.05pc), hot ($\gtrsim$ 100K) and dense ($\gtrsim 10^7$ cm^{-3}) objects. One of the main characteristics of the HMC are their very rich molecular emission, especially from Complex Organic Molecules, COMs (Kurtz et al. 2000; Cesaroni 2005; Hernández-Hernández et al. 2014). Whilst COMs have also been found in low mass (hot corinos) and inter-mediate mass (Cazaux et al. 2003; Ceccarelli 2004; Fuente et al. 2005, 2009), some differences in the chemical species have been identified between the high and low mass regimes. In this work we study the molecular contents of ORI 139-409 and ORI 134-411: these sources are two intermediate/low mass hot cores, ($\geq$ 4 $M_\odot$ for ORI 139-409 and $\geq$ 0.5 $M_\odot$ for ORI 134-411), located in the southern part of the Orion Molecular Cloud (OMC) at a distance of 388 pc Kounkel et al. (2017).These HMCs are part of a multiple system of compact millimeter sources (see figure 1). The aim is to contribute to the understanding of the still poorly explored formation processes of Be/Ae stars and the bridge they represent between the high and low mass regimes.

2. Data collection and analysis

Observations have already been described in Zapata et al. (2007) and we repeat here some of the information for easier reference. The

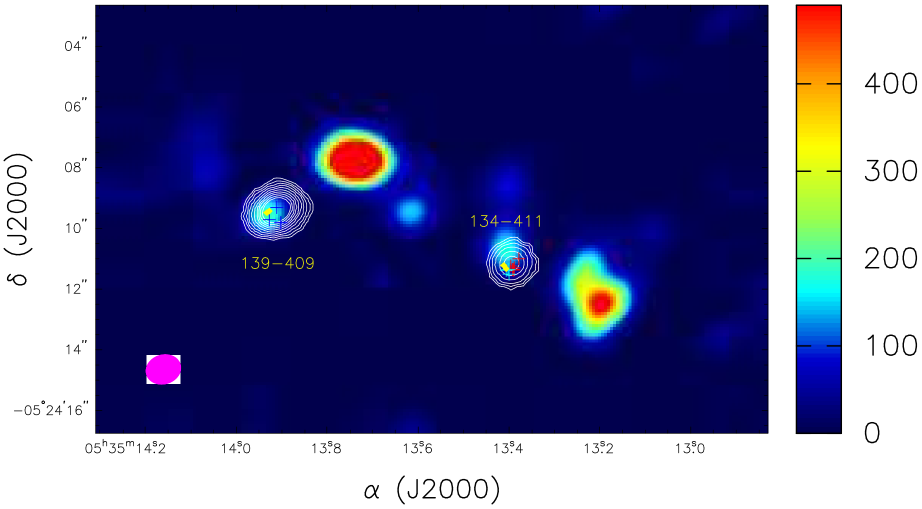

Fig. 1. SMA 1.3 mm continuum map of the southern region of the OMC1s overlaying on the $CH_3CN[12_4 - 11_4]$ integrated molecular emission of the hot molecular cores ORI 139−409 and ORI 134−411 (white contours). The synthesized beam is shown in the bottom left corner of the image. The complete description of the image is presented in Zapata et al. (2007).

data were obtained with the SMA in September 2004 when the array was in his extended configuration. The receivers were tuned at a frequency of 230.534 GHz in the upper side band (USB) and 220.534 GHz in the lower side band (LSB). The primary beam at this frequency is 55". The initial data reduction was made using the IDL superset MIR[1], the ROBUST parameter were set to 0. The calibrated data were imaged and analyzed using the MIRIAD (Sault et al. 1995) and KARMA (Gooch 1996) packages. The resulting synthesized beam was $1.13'' \times 0.93''$ with a P.A. =−73°.

3. Preliminary results

Figure 2 shows the beam averaged collected spectra extracted from ORI 139-409 in the LSB. The observed spectrum is depicted in black and in red is the best theoretical spectrum obtained with XCLASS, labelling the identified molecules. Features above 4σ threshold, represented with the blue horizontal line, are labeled. Together with the USB in both sources we detected as many as 37 molecular transition lines from 15 species, with most features in common in both sources. All lines present in the spectra of ORI 134-411 are also present in ORI 139-409. This probably suggests that a similar evolutionary status could describe both hot molecular cores. We identified four COMs: CH_3CN, CH_3OH, $HCOOCH_3$, C_2H_5CN in both sources. We have a tentative identification of the feature at 229.85045 GHz in ORI 139-409 with the complex molecule a'GG'g-$CH_2OHCH_2CH_2OH$, We are in the process of double checking identified lines, basically by verifying the potential presence of other features on the basis of the best fit parameters provided by XCLASS. As an example, the best fit physical parameters, such as rotational temperature and column densities for molecular species with three or more transitions in the observed frequency interval are listed in Table 1. Full details of this work are presented in Orozco-Aguilera et al. (submitted to The Astrophysical Journal).

[1] The MIR cookbook by C. Qi can be found at `http://cfa-www.harvard.edu/~cqi/mircook.html`

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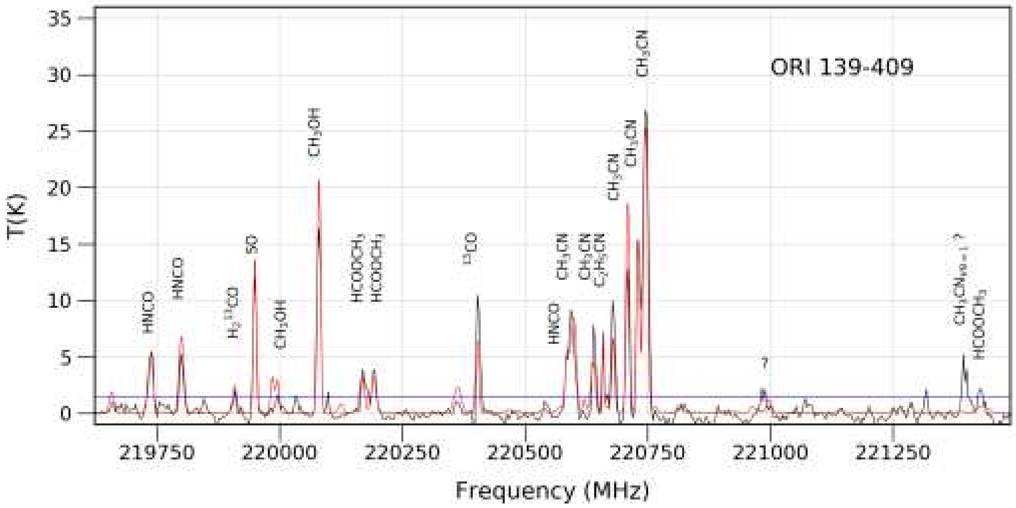

Fig. 2. SMA spectra from ORI 139−409 (black lines) in the LSB. The Blue line shows the 4σ threshold used to claim a detection. In red, we show the synthetic spectra computed with XCLASS.

Table 1. XCLASS best fit parameters for the Hot Cores ORI 139-409 and ORI 134-411. For the methanol line, we did different fitting for the lines in LSB and USB.

Molecule	ORI 139-409			ORI 134-411		
	T[K]	N[cm^{-2}]	N/NH$_2$	T[K]	N[cm^{-2}]	N/NH$_2$
HNCO	210	1.0 x 10^{16}	7.0×10^{-9}	170	3.7 x 10^{15}	2.0×10^{-9}
CH_3OH_{USB}	250	7.0 x 10^{17}	5.0×10^{-7}	266	3.5 x 10^{17}	2.0×10^{-7}
$HCOOCH_3$	34	1.1 x 10^{17}	1.0×10^{-8}	120	6.2 x 10^{16}	2.0×10^{-8}
CH_3CN	90	5.1 x 10^{15}	3.0×10^{-9}	315	2.4 x 10^{15}	1.0×10^{-9}
CH_3OH_{LSB}	170	3.8 x 10^{17}	3.0×10^{-7}	173	3.4 x 10^{17}	2.0×10^{-7}

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