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PRESENTACIÓN ORAL

Molecular gas associated with IRAS 10361-5830

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Abstract. We investigate the molecular gas distribution associated with IRAS 10361-5830 located in the border of the HII region Gum 31 based on different molecular lines observed with the APEX telescope. We have found that an embedded massive star has created a compact HII region, a signpost of recent star formation activity.

Resumen. Analizamos la distribución del gas molecular asociado a IRAS 10361-5830 ubicada en el borde de la región HII Gum 31 en base a observaciones de diferentes líneas moleculares obtenidas con el telescopio APEX. Encontramos una región HII compacta originada en una estrella masiva todavía embebida en el gas denso, signo evidente de formación estelar reciente.

1. Introduction

Expanding HII regions usually appear surrounded by molecular and dust envelopes which are potential sites for the formation of new stars, mainly through the *Radiatively Driven Implossion* (RDI, see Lefloch & Lazareff 1994) and the *collect and collapse* processes (Elmegreen & Lada 1977). The last one proposes the fragmentation of the dense molecular envelopes in clumps, which in turn may collapse and form new stars, as the result of the expansion of the ionized region and many studies have revealed the presence of Young Stellar Objects (YSOs) along the dense envelope (see Deharveng et al. 2003; Pomarès et al. 2009 and references therein). The HII region Gum 31, located at 3.0±0.5 kpc in the Carina region, is one of these cases. ^{12}CO(1-0) data taken with the NANTEN telescope **(angular resolution = 2.′7)** have revealed the presence of an almost complete molecular shell detected in the **velocity** interval –27 to –14 km s^{-1}, encircling the ionized region. Many candidate YSOs are found to be located towards this envelope (Cappa et al. 2008).

We report the results of a high angular resolution sensitive molecular line study towards the infrared source IRAS 10361-5830 catalogued as a candidate YSO based on photometric criteria (Cappa et al. 2008), and projected onto the molecular envelope of Gum 31. Our aim is to investigate the characteristics of its associated molecular material and the evolutionary stage of the IR source.

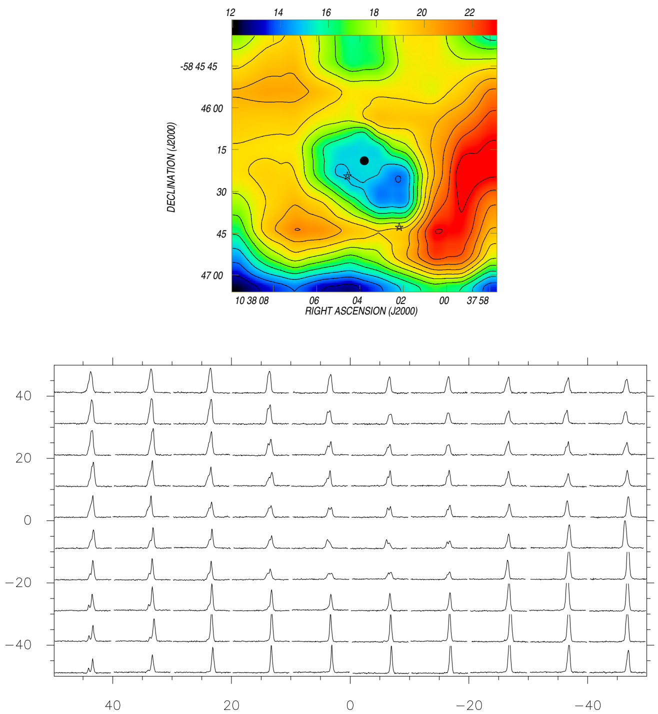

Figure 1. *Upper panel:* Main-beam brightness-temperature T_{mb} of the ^{12}CO(3-2) line averaged within the velocity interval [–28,–20] km s^{-1}. The grayscale goes from 13 to 25 K. Contours correspond to 14 to 24 K in steps of 1K ($3\sigma = 0.21$ K). **The filled circle marks the position of the IRAS source, while the two stars indicate the location of the two MSX YSO candidates.** *Bottom panel:* ^{13}CO(3-2) spectra showing T_{mb} vs. LSR velocity obtained towards the surveyed region. The (0,0) position coincides with the center of the IRAS source.

2. Data

To accomplish this study we mapped at 10″ spacing the molecular emission in the ^{12}CO(3-2), ^{13}CO(3-2), and C^{18}O(3-2) lines using the Atacama Pathfinder EXperiment (APEX), located in the north of Chile, in a region of 1′.5 in size centered at the IRAS source position. One pointing observation of the HCO^{+}(4-3) and CS(7-6) lines towards the catalogued position of the IRAS source were also obtained. The data have an angular resolution of about 20″ and a velocity resolution of 0.3 km s^{-1}.

Complementary radio continuum data at 843 MHz from SUMMS (Mauch et al. 2003), at 8 μm (IRAC-GLIMPSE,Benjamin et al. 2003) and 24μm (MIPSGAL, Carey et al. 2005) were used for comparison and analysis.

3. Main results and conclusions

^{12}CO(3-2) emission was detected in the velocity interval from –28 to –20 km s^{-1} within the observed region. The upper panel of Fig. 1 displays the main-beam brightness-temperature T_{mb} averaged in this velocity interval. The line emission distribution exhibits a low molecular emission central region of about $14''$ in radius (0.21 pc at 3.0 kpc) coincident with the IRAS position, surrounded by a molecular shell of stronger emission of about $29''$ in radius (0.42 pc at 3.0 kpc).

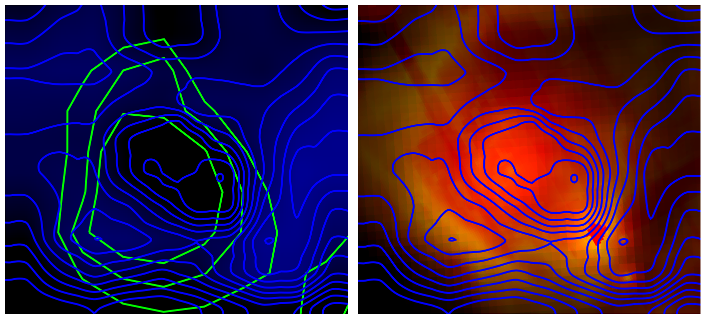

Figure 2. *Left panel:* Radio continuum emission at 843 MHz (green contours) with the ^{12}CO emission (colorscale and contours). *Right panel:* Composite image showing the emission at 8 μm (in yellow) and 24 μm (in red), and the same ^{12}CO contours of the left panel.

The filled circle marks the position of the IRAS source, which is located near the center of the low emission region, and the other two symbols, the position of the MSX sources G286.3747-00.2630 and G286.3773-00.2563, classified as compact HII region (CHII) and massive young stellar object (MYSO), respectively (see Cappa et al. 2008). The former MSX source appears projected near the center of the low molecular emission region, while the second one is seen near its borders. **The** IRAS source is probably resolved in the two MSX sources, bearing in mind the difference in angular resolution.

The observed ^{13}CO(3-2) spectra are shown in the bottom panel of Fig. 1. The spectra at the center exhibit two maxima with a separation of a few km s^{-1}. The brighter component is centered at –22.6 km s^{-1}, coincident with the systemic velocity of the molecular envelope, while the fainter one is centered at –25 km s^{-1}. On the contrary, the outer regions show only one bright velocity component at –22.6 km s^{-1}. The existence of a molecular envelope, along with the presence of two components in the central region is compatible with **expansion**. In this interpretation, the faint component would correspond to the approaching cap of the expanding shell.

Figure 2 includes two composite images. The one on the left shows the ^{12}CO emission in color scale **and light blue contours** and the radio continuum emission at 843 MHz in **green** contours. The presence of radio continuum emission inside the molecular envelope indicates the existence of ionized gas. This ionized gas, along with warm dust, are also observed in the **right** panel, where the 24 μm emission is shown in **red**. This panel also shows the 8 μm emission (in yellow), due to polycyclic aromatic hydrocarbons (PAHs), indicative of a photodissociation region located at the interfase between the ionized and molecular materials.

The upper panel of Fig. 3 illustrates the HCO$^+$ line emission observed towards the IRAS source position. The profile **shows** emission centered at –22.6 km s^{-1}. This velocity is compatible with the velocity of the dense gas

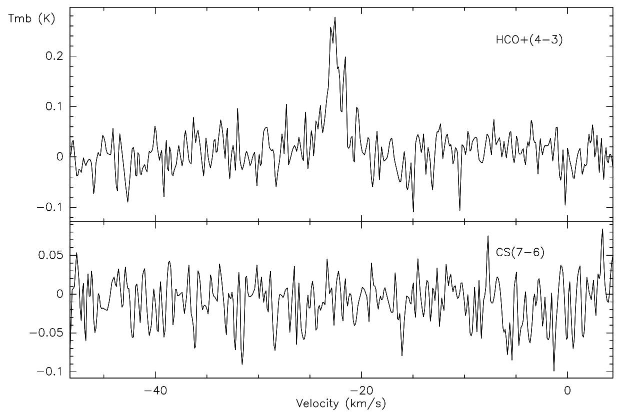

Figure 3. HCO$^+$(4-3) (upper panel) and CS(7-6) (bottom panel) spectra observed towards the center of the IRAS source. Intensities are expressed as main-beam brightness-temperatures.

linked to Gum 31. Finally, no CS emission has been detected, as revealed in the bottom panel. The lack of detection of CS line emission may imply that the gas density is lower than 10^7 cm^{-3} (Plume et al. 1997), suggesting that the densest molecular gas has been dispersed.

We estimate a mean H_2 column density $N_{H2} \simeq 1.24{\times}10^{22}$ cm^{-2} in the envelope, from the ^{13}CO(2-1) line using LTE and an abundance $N_{H2}/^{13}CO = 5{\times}10^5$ (Dickman 1978). The total mass obtained adopting a relative Helium abundance of 25% by mass and the original ambient density estimated by distributing the molecular mass within the volume of a sphere of 0.64 pc in radius (the outer radius of the molecular shell) are 115 M$_\odot$ and $1.5{\times}10^3$ cm^{-3}, respectively.

The high original ambient density of the region along with the distribution of the ionized gas, warm dust, PAHs, and molecular emissions strongly indicates that IRAS 10361-5830 is a compact HII region. Further studies are neccessary to disclose the ionizing star.

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