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STAR FORMING REGIONS TOWARDS STELLAR WIND BUBBLES: RCW 52 AND RCW 78

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RESUMEN

Hemos llevado a cabo observaciones de la emisión en el continuo infrarrojo en 870 μm y de la línea molecular ^{13}CO(2-1) hacia regiones de formación estelar en las burbujas interestelares RCW 52 and RCW 78 utilizando el telescopio APEX. Las observaciones moleculares revelaron los densos grumos en los que están embebidos los candidatos a objetos estelares jóvenes, mientras que las observaciones de continuo en el infrarrojo nos permitieron detectar el polvo frío asociado.

ABSTRACT

We carried out observations of the continuum emission at 870 μm and the ^{13}CO(2-1) line towards star forming regions in the stellar wind bubbles RCW 52 and RCW 78 using the APEX telescope. The molecular observations revealed the dense clumps in which the young stellar object candidates are enshrouded, while the IR continuum emission allowed to find the associated cold dust.

Key Words: ISM: bubbles — ISM: individual (RCW 52, RCW 78) — stars: formation

1. INTRODUCTION

Similarly to the expanding envelopes around HII regions, the dense shells surrounding stellar wind bubbles are potential sites for the formation of new stars (Zavagno et al. 2007; Deharveng et al. 2008) through the *Collect and collapse* and the *RDI* processes.

With the aim of detecting the cold dust and the molecular clumps linked to regions of active stellar formation in the dense envelopes around the ring nebulae RCW 52 and RCW 78, we carried out observations of the continuum emission at 870 μm and the ^{13}CO(2-1) line.

2. OBSERVATIONS

The data at 870 μm (345 GHz) were obtained with the Atacama Pathfinder Experiment (APEX), located in the north of Chile, in a region of $12' \times 12'$ in size towards RCW 52 and of $8' \times 8'$ in size towards RCW 78, using the LABOCA bolometer array (Siringo et al. 2009). The data have an r.m.s. noise of 15 mJy beam^{-1} and an angular resolution of $18''.2$.

The APEX-1 SHFI instrument was used to perform the ^{13}CO(2-1) observations at 220.4 GHz. The data were obtained with an angular resolution of $30''$, a velocity resolution of 0.33 km s^{-1}, and an r.m.s. noise of 0.1 K.

3. THE RING NEBULA RCW 52

RCW 52 is a partial ring of $6'$ in size linked to LSS 1887 (O7V), a member of the Car OB1 association located at 2.5 kpc. The optical appearance of the nebula suggests the action of the stellar winds of the massive star onto its local interestellar medium. The velocity of the ionized gas is -18 km s^{-1}. The fact that RCW 52 is bordered by MSX-Band A emission along with the existence of molecular gas with velocities of ≈ -20 km s^{-1} linked to the nebula (Cappa et al. 2005) indicates the presence of photodissociation regions.

Figure 1 displays an overlay of the DSS-R image of the nebula in grayscale and the emission at 870 μm in contours. The dust emission is clumpy. Some of the dust clumps coincide with young stellar object (YSO) candidates and with the PDR.

The dust clumps match in position with ^{13}CO(2-1) emission within the range $[-23, -13]$ km s^{-1}, indicating that both the molecular and dust clumps are linked to the nebula.

Adopting dust color temperatures in the range 20–30 K, a gas-to-dust ratio of 100, and a dust opacity at 870 μm of 1.8 cm^2 g^{-1} (Deharveng et al. 2009), the total mass is 150–300 $M_\odot$.

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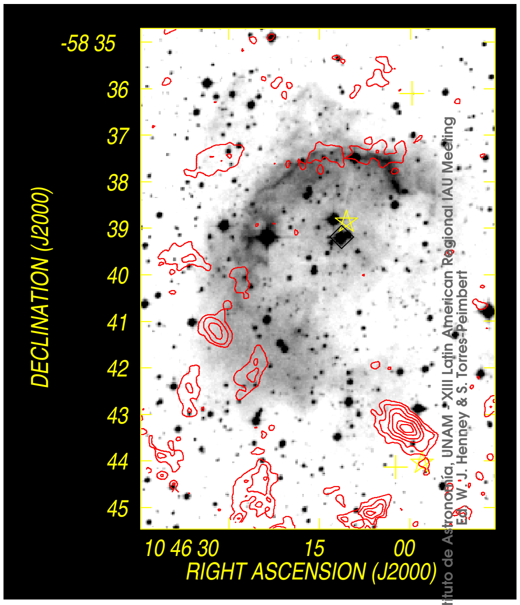

Fig. 1. Overlay of the DSS-R image of RCW 52 in grayscale and the continuum emission at 870 μm in contours. Contours ranges from 20 to 50 mJy beam^{-1}. The star, the square, and the crosses mark the position of IRAS, MSX, and 2MASS YSO candidates, respectively.

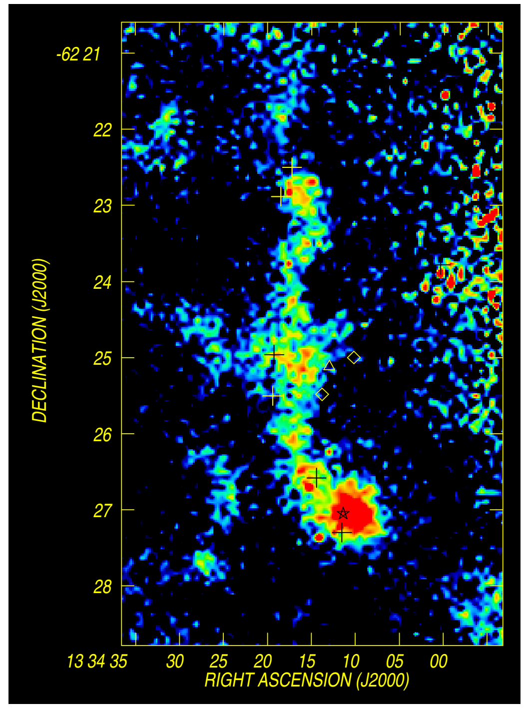

Fig. 2. Continuum emission at 870 μm corresponding to one of the star forming regions in RCW 78. Colorscale ranges from 20 to 130 mJy beam^{-1}. The star, the squares and the triangle, and the crosses mark the position of IRAS, MSX, and 2MASS YSO candidates, respectively.

4. THE RING NEBULA RCW 78

The nebula, of about 35′ in size, is bright to the W and faint to the E. It is associated with WR 55 (HD117688, WN7) at 5 kpc. The velocity of the ionized gas is in the range $[-53, -38]$ km s^{-1} (Chu & Treffers 1981), while the molecular gas component has velocities in the range $[-57, -32]$ km s^{-1} (from NANTEN and SEST data, Cappa et al. 2009). Most of the molecular gas is linked to the W part of the nebula.

Two areas of active stellar formation are present in the southern part. Figure 2 displays the emission at 870 μm corresponding to one of these areas. The dust emission is elongated, with the YSO candidate IRAS 13307-6211 projected onto the brightest emission region, coincident with the IRAC emission at 8 μm. The molecular counterpart of this region, as shown by the ^{13}CO(2-1) observations, has velocities in the interval $[-55, -51]$ km s^{-1}, suggesting that the star forming region is in the approaching section of the expanding shell that surrounds RCW 78. This nebula, as well as RCW 52, shows moderate stellar formation. The total mass estimated for the clumps is 65–130 $M_\odot$.

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