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PRESENTACIÓN MURAL

Triggered star formation in the CO shell G 126.1–0.8–14

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Abstract. G 126.1–0.8–14 is a molecular shell located in the Orion arm, at a distance of about 1 kpc. The HII region Sh2-187 is located over the border of this shell. Previous works show that Sh2-187 is a small ($\sim$ 9') and young ($\sim 2 \times 10^5$ yr) ionized region that shows signs of recent star formation in its surroundings. On the other hand, based on color criteria, we have found several infrared (MSX and IRAS) sources candidates of being young stellar objects (YSO) or ultracompact HII regions (UCHII) located projected onto the shell. In this work we present an analysis of the possible origin of G 126.1–0.8–14 and its possible roll in the formation of new stars.

Resumen. G 126.1–0.8–14 es una cáscara de gas molecular ubicada en el brazo de Orión, a aproximadamente 1 kpc de distancia. Sobre el borde de la cáscara se encuentra la región HII Sh2-187. Trabajos previos muestran que esta región es pequeña ($\sim$ 9') y jóven ($\sim 2 \times 10^5$ años), y presenta evidencia de formación estelar activa en sus alrededores. Por otro lado, a partir de un análisis de fuentes infrarrojas IRAS y MSX, hemos detectado que sobre la cáscara se localizan varias fuentes candidatas a objetos estelares jóvenes y regiones HII ultracompactas. En este trabajo presentamos un estudio de la cáscara de CO, su posible origen, y su rol como generadora de nuevas estrellas.

1. Introduction

The interstellar medium (ISM), far from being homogeneous, it is riddle with loops, shells and cavities. The origin of most of these structures is related to the action of massive stars, which, via their strong winds, high radiation fields, and supernova explosions, strongly perturb their surroundings. As a consequence of this interaction, shell-like expanding structures are created around these stars. As these structures evolve, gravitational instabilities can take place in the swept-up gas, which can fragment creating condense clumps that eventually may become new stars (Elmegreen & Lada 1977). In this work we present an analysis of a shell-like structure observed in the area of the HII region Sh2-187.

2. Results and discussion

2.1. Main parameters of the CO shell

An inspection of the ^{12}CO(1–0) emission distribution in the area of the HII region Sh2-187 shows that besides the cloud where the region is embedded (Joncas et al. 1992), Sh2-187, located at (l, b) = (126$.^\circ$68, –0$.^\circ$82), is seen projected onto the densest part of a well defined larger shell. Figure 1 shows the CO emission distribution in the velocity interval from –8.9 to –17.9 km/s. The data was taken from the Five College Radio Astronomical Observatory (FCRAO) CO Survey of the Outer Galaxy (Heyer et al. 1998), and have an angular resolution of 1′. We adopt for the region the distance given for Sh2-187 in the work presented by Russeil et al. (2007), D = 1440 ± 260 pc. The effective radius of the shell is 0$.^\circ$5, or 12.5 pc at the adopted distance. The systemic velocity of the structure, defined as the velocity where the shell is best defined, is $V_{\rm sys} = -13.8 \pm 0.8$ km s^{-1}. The expansion velocity, given by $V_{\rm exp} = \Delta v/2$, where Δv is the velocity interval covered by the structure, is $V_{\rm exp}$ =4.1 ± 0.8 km s^{-1}. The mass was estimated by integrating the CO line intensity as $W_{\rm CO} = \int$ T(CO)dv, where T(CO) is the average temperature of the molecular gas over the velocity interval considered. To calculate the H_2 column density, the relationship $X = N({\rm H_2})/W_{\rm CO}$ of 1.9 $\times 10^{20}$ cm^{-2}(K kms^{-1})$^{-1}$ (Grenier & Lebrun 1990) was considered. The molecular mass was derived from $M_{\rm shell}[M_\odot]$ =4.2 $\times 10^{-20} N(H_2)D^2A$, where D is the distance in pc and A is the area in stereoradians. We obtained $M_{\rm shell}[M_\odot]$ = (6.5 ± 3.1) $\times 10^4\, M_\odot$. The kinetic energy stored in the shell was estimated as $E_{\rm kin} = 0.5\ M_{\rm shell}\, V_{\rm exp}$ = (1.1 ± 0.7) $\times 10^{49}$ erg. A rough estimate for the age of G 126.1–0.8–14 was obtained using a simple model to describe the expansion of a shell created by a continuous injection of mechanical energy, $t_{\rm dyn}$= 0.6 $R/V_{\rm exp}$ (Weaver et al. 1977), which in this case yields t_{dyn} = (1.6 ± 0.5) $\times 10^6$ yr.

2.2. Origin of the structure.

The origin of the shell is unknown. To analyze if it was created by the action of massive stars, we search the available O star catalogues (Garmany 1983; Reed 2003; Maíz-Apellániz et al. 2004) looking for the massive star candidates. We have found eight stars in the catalog of Reed (2003), their location are indicated in Fig.2 and their main properties are presented in Table 1. The visual absorption A_v was estimated considering the hydrogen column density measured towards each star. The absolute magnitudes were obtained assuming a distance D = 1440 pc and the corresponding values of A_v. As can be inferred from Table 1, some of these stars could be O stars located at the adopted distance, and hence they could be responsible for the shell. However, it is important to mention that, given the poor spectral classification of the OB stars Reed's catalogue, to get an accurate spectral classification of these eight stars would be an important step. Another possibility for the origin of G 126.1–0.8–14 is a supernova explosion, which could have perturbed its surrounding molecular gas and create the observed CO shell. This scenario, as well as the presence of massive stars, is still in process of analysis.

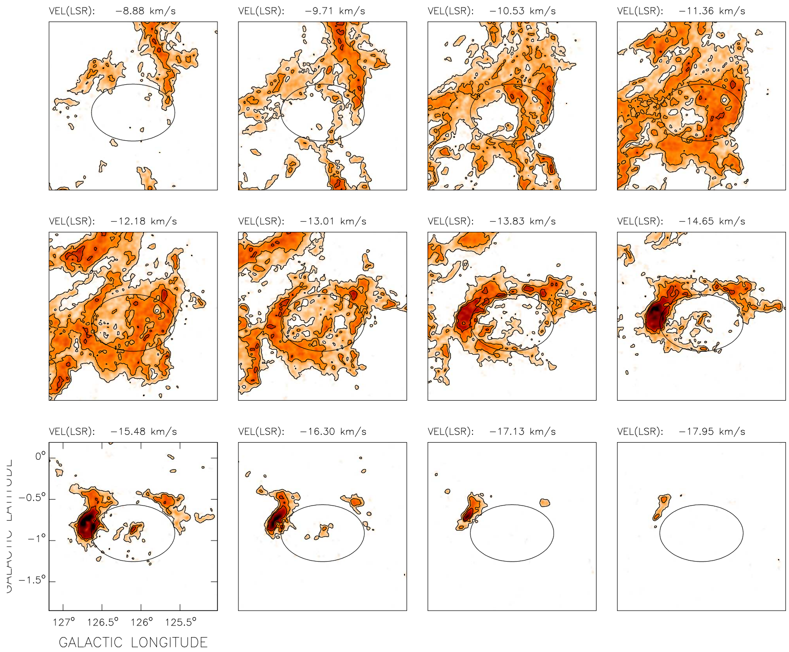

Figure 1. CO emission in the velocity range from –8.9 to –18 kms^{-1}. Contours are at 1, 3, and 5 K. The ellipse shows the position of G126.1–0.8–14.

	Identification	m_v	A_v	M_v (D = 1440 pc)
1	ALS 6520	8.86	2.5	–4.4
2	ALS 6511	10.31	3	–3.5
3	ALS 6544	9.07	2.6	–4.3
4	ALS 6542	9.29	3.7	–5.2
5	ALS 6498	10.26	5.1	–5.7
6	ALS 6549	11.12	3.7	–3.4
7	ALS 6515	9.99	3.3	–4.1
8	ALS 6555	10.9	3.3	–3.2

Table 1. Massive stars candidates of being responsible for the shell formation.

2.3. Triggered star formation

The most evident signature of recent star formation activity in the area is the presence of the young ($\sim 2 \times 10^5$ yr) HII region Sh2-187 located onto the densest part of the CO shell. This region was extensively studied by Joncas et al. (1992). In addition, applying color criteria to the IRAS and MSX catalogued point sources located projected onto the shell, we have found 5 infrared sources candidates of being ultra compact HII regions (UCHII) and 3 young stellar object candidates (YSOs). Their location are indicated in Fig. 2. The fact that towards the direction of these sources there is molecular gas observed only at the radial velocity where G 126.1–0.8–14 is detected suggests that they are at

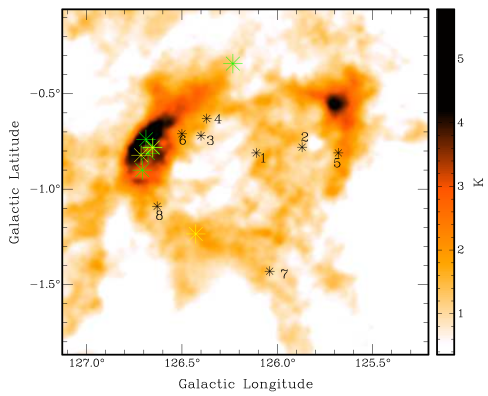

Figure 2. Averaged CO emission in the velocity range from –8.9 to –17.9 km/s. The massive stars candidates are indicated by black asteriscs. Green and yellow asteriscs indicate UCHII region and YSO candidates, respectively.

the same distance and hence embedded in the CO shell. As can be seen in Fig. 2, most of these sources are located in the area of Sh2-187, where, in addition, Bally & Lada (1983) detected a high-velocity molecular flow near the core of the molecular cloud and Lo & Burke (1973) and Henkel et al. (1986) observed a multicomponent H_2O maser, indicating that the Sh2-187 gas complex is still undergoing star formation.

3. Conclusions

In this work we present a new CO shell which clearly shows signatures of hosting active star formation. We have identified several young stellar objects projected towards the shell as well as several massive stars candidates of being responsible for its formation. A more detail analysis of all these sources is needed to better understand this object.

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