# A molecular shell with star formation toward the supernova remnant G349.7+0.2

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# ABSTRACT

A field of  $\sim 38' \times 38'$  around the supernova remnant (SNR) G349.7+0.2 has been surveyed in the CO J=1-0 transition with the 12 Meter Telescope of the NRAO, using the On-The-Fly technique. The resolution of the observations is 54". We have found that this remnant is interacting with a small CO cloud which, in turn, is part of a much larger molecular complex, which we call the "Large CO Shell". The Large CO Shell has a diameter of about 100 pc, an  $H_2$  mass of  $9.3 \times 10^5 M_{\odot}$  and a density of 35 cm<sup>-3</sup>. We investigate the origin of this structure and suggest that an old supernova explosion ocurred about  $4 \times 10^6$  years ago, as a suitable hypothesis. Analyzing the interaction between G349.7+0.2 and the Large CO Shell, it is possible to determine that the shock front currently driven into the molecular gas is a non-dissociative shock (C-type), in agreement with the presence of OH 1720 MHz masers. The positional and kinematical coincidence among one of the CO clouds that constitute the Large CO Shell, an IRAS point-like source and an ultracompact H II region, indicate the presence of a recently formed star. We suggest that the formation of this star was triggered during the expansion of the Large CO Shell, and suggest the possibility that the same expansion also created the progenitor star of G349.7+0.2. The Large CO Shell would then be one of the few observational examples of supernova-induced star formation.

Subject headings: ISM: clouds — ISM: molecules — star formation — ISM: individual (G349.7+0.2) — supernova remnants

#### 1. Introduction:

The young, massive progenitor stars of Type II supernovae are born in large molecular complexes. Since half of the Galactic supernova remnants (SNR) are supposed to be of this type, it is expected that a similar number of SNRs be in physical contact with their parent clouds. This contention is partially supported by CO observations (Huang & Thaddeus 1986), which show a good positional correlation between large molecular complexes and SNRs. Thus, the interaction between SNRs and molecular clouds seems to be a common phenomenon in nature.

When a SN explodes near a molecular cloud, the expansion of the shock front into the cloud can accelerate relativistic particles, heat and compress the molecular gas, change its chemistry and produce turbulent mixing. Condensed clumps created by this mechanism may eventually end as new stars. However, very few cases provide direct evidence of SNR-molecular cloud interactions. Morphological signatures are often invoked to prove a physical association between an SNR and a molecular cloud (eg. Landecker et al. 1989, Reynoso et al. 1995, Dubner et al. 1999), but the most convincing evidence for shocked molecular gas are line broadenings (Frail & Mitchell 1998, Reach & Rho 1999) or spectral wings (Seta et al. 1998).

Another powerful tool indicative of SNR-molecular gas interaction is provided by the presence of OH 1720 MHz shock-excited masers. Within several OH 1720 MHz surveys (Frail et al. 1996, Green et al. 1997, Koralesky et al. 1998), in which around 150 Galactic SNRs have been observed, OH 1720 MHz masers have been detected toward nearly twenty of them. In a recent paper, Reynoso & Mangum (2001; hereafter Paper I) have surveyed the environs of three of these SNRs (G349.7+0.2, G16.7+0.1 and CTB 37A) in the CO J=1-0 transition, and found molecular clouds interacting with the shock fronts in all three cases. In this paper, we analyze the CO data in a large field around one of these remnants:

G349.7+0.2.

G349.7+0.2 is an incomplete clumpy shell, brighter to the south (Figure 1), with a diameter of 2'. Based on HI observations (Caswell et al. 1975), this remnant is located beyond the tangent point, at a positive systemic velocity greater that +6 km s<sup>-1</sup>, which places it also beyond the far side of the solar circle. Clark & Caswell (1976) suggest that the strong north-south emission ridge observed in radio continuum is not a filled center but represents a non-uniform distribution of emission in a shell, which would be evidence for a strong interaction with the interstellar medium (ISM) at an early stage. In Paper I, it was shown that the OH 1720 MHz masers detected by Frail et al. (1996) toward this remnant, appear encircling a molecular cloud of ~ 5.5 pc in diameter, located at the same systemic velocity of the masers. The extension of the area covered by our survey allowed the detection of a much larger, ring-like CO feature, that includes the small molecular cloud interacting with G349.7+0.2.

In this paper, we investigate the origin of this large structure and its connection with G349.7+0.2. In Section 2, we describe the observations. Section 3 presents the main results, which are discussed in Section 4. In Section 5, we summarize our conclusions.

# 2. Observations and data reduction:

Observations of the CO J=1–0 line (115.271204 GHz) were performed with the NRAO<sup>2</sup> 12 Meter Telescope located on Kitt Peak, Arizona, on 1998 June 12-18 and 27-30. The beam size at this frequency is 54''. The observational parameters are listed in Table 1, including the noise of the final images. Observations were made using the On-The-Fly (OTF)

<sup>2</sup>The National Radio Astronomy Observatory is a facility of the National Science Foundation operated under cooperative agreement by Associated Universities, Inc. technique, which allows efficient surveying of large areas. Three different spectrometers were employed: two filter bank spectrometers with 128 channels and resolutions of 1 MHz and 500 kHz, respectively, and a 768-channel autocorrelator with a resolution of 98 kHz. An absolute position-switching mode was used. The reference position was measured to be free of CO emission down to levels of less than about 0.5 K. Four maps, covering a square field of  $\sim 38' \times 38'$ , were obtained.

Since data at the 12 Meter Telescope are calibrated by default to the  $T_R^*$  scale, which is equivalent to the radiation temperature  $T_R$  for a source much larger than the main diffraction beam of the telescope, it is often necessary to apply corrections which refer to sources of different sizes. For sources with sizes in the range 20'' - 40'', the efficiency factor which converts  $T_R^*$  to  $T_R$  is 0.85 based on historic measurements of the planets Jupiter and Saturn.

The AIPS package was employed for data processing. Baselines were subtracted directly from the raw data with the task SDLSF. This task computes a first degree polynomial using a unique range of line-free channels in the whole area. Because of the proximity of G349.7+0.2 to the Galactic plane, it was extremely difficult to find a suitable range of line-free channels. We thus decided to give priority to the baseline removal in the regions closest to the remnants and OH 1720 MHz masers, with possible detriment to the rest. Maps were averaged for each source using the task WTSUM, with  $1/\sigma^2$  as weight, where  $\sigma$  is the noise image. Due to the very high noise of one of the original maps, only three of them were kept in the average.

# EDITOR: PLACE TABLE 1 HERE.

Frequency [GHz]:	115.27 (2.6 mm)		
Number of channels:	768	128	128
Spectral resolution [kHz]	98	500	1000
Spectral resolution $[\rm km \ s^{-1}]$	0.25	2.6	1.3
Angular resolution [arcsec]:	$53.6 \times 53.6$		
Surveyed area [arcmin]:	$\sim 38 \times 38$		
Observing mode :	absolute position switched		
	On-The-Fly (OTF)		
Central position $[RA (2000)]$	$17 \ 17 \ 59.90$		
[decl. (2000)]:	-37 26 9.0		
Reference position $[RA (2000)]$	17 03 59.23		
[decl. (2000)]:	-37 27 8.7		
Number of maps:	3		
Observing time [hours]:	4.1		
Central velocity (LSR) [km $s^{-1}$ ]:	-40		
rms [K]:	0.6	0.4	0.4

 Table 1.
 Observational Parameters

#### 3. Results:

Figure 2 displays the CO distribution in the range 12.6 to 21.2 km s<sup>-1</sup>. At  $v \sim +14.5$  km s<sup>-1</sup>, there appears a chain of clouds forming an arc-like feature opened to the northeast. At  $v \sim +16.5$  km s<sup>-1</sup>, this arc merges with the bulk of the CO emission at the northeast, outlining a circle that fades away at  $v \sim +20.5$  km s<sup>-1</sup>. The cloud interacting with G349.7+0.2 is part of this molecular complex. Figure 3 shows the CO emission integrated over the velocity interval +14.5 to +20.5 km s<sup>-1</sup>. The extended CO structure is remarked by a 700 × 770 arcsec ellipse that fits the brightest peaks. In what follows, we will refer to the large CO structure as the "Large CO Shell", and will identify individual smaller clouds within this structure with numbers.

One of the individual clouds, hereafter "cloud 1", has been reported in Paper I. Cloud 1 has a systemic velocity of +16.5 km s<sup>-1</sup>, and is positionally coincident with G349.7+0.2. Based on the presence of OH 1720 MHz shock-excited masers at the same position and velocity, as well as infrared emission from shock-heated dust arising from the same location, it was concluded that the SNR is interacting with this molecular cloud.

As in Paper I, masses are estimated by integrating  $N_{H_2}$  over the solid angle subtended by the CO emission feature. To calculate the H<sub>2</sub> column density, the relationship  $X = N(H_2)/W_{CO}$  is used, where  $W_{CO}$  is the integrated CO line intensity,  $W_{CO} = \int T_R(CO) dv$ , in K km s<sup>-1</sup>, and where we have divided our antenna-based T<sup>\*</sup><sub>R</sub> temperatures by the efficiency factor of 0.85 to place them on the T<sub>R</sub> scale appropriate for sources with sizes in the range 20" - 40".

Using a mean molecular weight per H<sub>2</sub> molecule of 2.72 m<sub>H</sub> (Allen 1973), the mass of a cloud can be expressed as:

$$M = 5.7 \times 10^{-21} X W_{CO} \theta^2 D^2 M_{\odot}, \tag{1}$$

where D is the distance in kpc, and  $\theta$  is the angular radius of the cloud in arcmin, computed as half the measured diameter deconvolved by the beam size. Assuming spherical volumes, the density can be estimated as:

$$n_{H_2} = \frac{4.1 \times 10^{-19} \, X \, W_{CO}}{D \, \theta} \, \text{cm}^{-3}.$$
 (2)

Based on the close agreement between the systemic velocities of cloud 1 and the Large CO Shell, the distance adopted for the whole molecular complex will be the kinematical distance to cloud 1, ~ 23 kpc, which corresponds to a Galactocentric distance of R = 14 kpc (Paper I). Therefore, the ratio X is assumed to be  $8 \times 10^{20}$  cm<sup>-2</sup> (K km s<sup>-1</sup>)<sup>-1</sup> (Digel, Bally & Thaddeus 1990). The derived parameters may be over estimated by a factor of 2 (see Paper I). The mass and H<sub>2</sub> density of the Large CO Shell can be roughly estimated to be about  $9.3 \times 10^5$  M<sub> $\odot$ </sub> and 35 cm<sup>-3</sup>, respectively. In this computation, an outer diameter of ~ 870 arcsec and an inner diameter of ~ 500 arcsec were assumed. At the distance assumed, the outer diameter of the Large CO Shell is ~ 100 pc. Although the density is somewhat low, both mass and size place this structure in the category of giant molecular clouds (Goldsmith 1987).

With the aim of exploring if star formation is taking place in the Large CO Shell, we have searched for protostellar candidates in the IRAS Point Source Catalogue that fulfill the following selection criteria: (1)  $S_{100} \ge 20$  Jy, (2)  $1.2 \le S_{100}/S_{60} \le 6.0$ , and (3)  $S_{60}/S_{25} \ge 1$ , where  $S_{\lambda}$  denotes the (uncorrected) IR-flux density in the wavelength  $\lambda \mu m$ . The first criterion selects only strong sources, while the second and third discriminate against cool stars, planetary nebula and cirrus clumps (Junkes, Fürst & Reich 1992). However, these selection criteria may include not only protostars but also dust heated in SNR shocks (Arendt 1989). Three IRAS sources are found in the field covered by the present survey (white stars in Fig. 3), two of them coincident with CO clumps: IRAS 17146-3723 at cloud 1, and IRAS 17147-3725 at a CO concentration centered approximately at RA= $17^h 18^m 10^s.0$ ,  $decl=-37^{\circ}28'25''$  (J2000), hereinafter named "cloud 2". The superposition of these two IR sources with CO maxima is very unlikely to be by chance, and their connection with the CO emission will be discussed in the next Section.

In Table 2 we summarize the parameters estimated for each CO structure. The parameters of cloud 1 have been also reported in Paper I. The second column quotes the approximate central position of the structures in equatorial coordinates referred to J2000. The third column lists the radii r after deconvolution with the beam size. For the Large CO Shell, only the outer radius is given. The fourth and fifth columns contain the systemic velocity  $v_{sys}$  and the FWHM velocity  $\Delta v$ , both in km s<sup>-1</sup>. The computed mass and H<sub>2</sub> densities are given in the last two columns.

# EDITOR: PLACE TABLE 2 HERE.

#### 4. Discussion:

# 4.1. The Large CO Shell and the SNR G349.7+0.2

There is compelling evidence that G349.7+0.2 is interacting with a molecular cloud. Moreover, our present results suggest that the SN event occurred inside the Large CO Shell, thus confirming the statement of Clark & Caswell (1976) that the expansion has been influenced by a dense environment. Nevertheless, it is unlikely that cloud 1 has interacted with the shock front in early stages, since stars are more probable to explode in the interclump gas than in dense clumps (Chevalier 1999).

The radio structure of G349.7+0.2 can be fitted by two overlapping rings, with one smaller and brighter than the other. This characteristic similar to many other SNRs, can be easily explained if the smaller ring corresponds to the side of the expanding shell

encountering the higher density (Manchester 1987). We therefore propose a scenario in which the SN shock front has expanded into a density gradient; the smaller half of the shell has expanded into higher density gas and is now running through cloud 1.

Assuming a distance of 23 kpc to G349.7+0.2, the radii of the large and small rings are  $R_l \sim 9$  pc and  $R_s \sim 6$  pc respectively. Based on Fig. 3, the small ring appears to be expanding into the Large CO Shell, while the large ring is expanding into a region of low density. If the energy was conserved during expansion, then  $nR^2/t^2 = const$ . (e.g. Dubner et al. 1992), and we can expect that the distances  $R_l$  and  $R_s$  travelled by the shock front during the lifetime of the remnant be related by  $(R_l/R_s)^2 = n_s/n_l$ , where n refers to the ambient medium into which each of the two rings is expanding. Replacing  $n_s$  by 35 cm<sup>-3</sup> (Table 2), we deduce that  $n_l = 15$  cm<sup>-3</sup>.

In an inhomogeneus medium, an SNR can be undergoing different evolutive stages in different places at the same time. Here, the expansion of the larger ring is analyzed. Cioffi, McKee & Bertschinger (1988) determined the radius of an SNR at the onset of the radiative phase as:

$$R_c = 14 \left( \frac{E_{51}^{2/7}}{n_0^{3/7} \xi_m^{1/7}} \right), \tag{3}$$

where  $\xi_m \simeq 1$  for solar abundances. Adopting a canonical value of  $E_0 = 10^{51}$  ergs, and assuming an ambient density of 15 cm<sup>-3</sup>, equation (3) yields  $R_c = 12$  pc. In spite of the uncertainties involved in this determination, it can be considered then that the radiative phase has not been achieved yet, and therefore the use of the Sedov equations is appropriate.

The equations that govern the expansion of an SNR in the Sedov phase are extracted from Cox (1972):

$$R_s = 13.6 t_4^{2/5} \left(\frac{E_{51}}{n_0}\right)^{1/5} \text{ pc}$$
(4)

$$V_s = 535 t_4^{-3/5} \left(\frac{E_{51}}{n_0}\right)^{1/5} \text{ km s}^{-1}$$
(5)

From equation (4), the age of the remnant is  $1.4 \times 10^4$  yrs, and thus the shock velocity is  $\sim 260 \text{ km s}^{-1}$ . Using once again the relationship  $(V_l/V_s)^2 = n_s/n_l$ , we find that the velocity of the shock front driven into the higher density gas of the Large CO Shell is  $V_s = 170 \text{ km s}^{-1}$  which, when entering cloud 1, can be slowed down to 33 km s<sup>-1</sup>. At velocities lower than  $\sim 50 \text{ km s}^{-1}$ , shocks are of C-type (Neufeld & Dalgarno 1989), thus this estimate is consistent with the theoretical prediction by Lockett, Gauthier & Elitzur (1999) that the conditions under which 1720 MHz OH maser emission is produced can exist only if shocks are of C-type.

#### 4.2. Star formation in the Large CO Shell

Based on the morphology, we suggest that the Large CO Shell is the remains of an expansive event. In what follows, we try to explain the origin of this structure. The hypothesis of a wind-driven bubble can be discarded since a literature search revealed no early-type stars or associations within the area subtended by the Large CO Shell. Therefore, as an alternative, we will investigate the hypothesis that the expansive event was a SN explosion. Assuming that the mass of the Large CO Shell was initially distributed uniformly in a sphere of radius 435" (~ 50 pc), then the original density was  $n_0 = 30 \text{ cm}^{-3}$ . Since the Large CO Shell extends over a velocity interval of about 6 km s<sup>-1</sup>, we adopt a velocity expansion of 3 km s<sup>-1</sup> as a working hypothesis. Taking into account that in the radiative phase, which is the last stage in the evolution of an SNR before dissipating in the ISM, the expansion law is  $R \propto t^{1/4}$ , an upper limit to the age of the shell can be obtained as  $t = R/4V \simeq 4 \times 10^6$  yrs. This age is sufficient for the formation of protostars. In the next paragraphs, the origin of the two IRAS sources found in coincidence with CO peaks will be discussed.

Because of its spectral characteristics, IRAS 17147-3725 is catalogued as an ultra-

compact (UC) H II region (Wood & Churchwell 1989). In Fig. 3, it can be seen that IRAS 17147-3725 is positionally coincident with a weak, unresolved radio continuum point source. This continuum source has a peak flux more than 20 times above  $\sigma$ , and has an integrated flux of  $S_{\nu} = 0.025$  Jy at 1.41 GHz. We propose that this source is the radio continuum counterpart of the UC-H II region IRAS 17147-3725.

Compact H II regions are created when ultraviolet emission from newly formed stars ionize the neighboring gas. Also, the surrounding dust is heated and reradiates the energy at infrared wavelengths. Therefore, the IRAS source 17147-3725 is very likely dust heated by a recently formed star. To trace the high density cores where high mass stars are born, Bronfman et al. (1996) observed UC-H II regions in the CS J=2-1 line, and found that IRAS 17147-3725 has a peak at +17.6 km s<sup>-1</sup>, which is in coincidence with the systemic velocities of cloud 2 and the Large CO Shell (Table 2).

The Lyman continuum (LyC) flux from the ionizing star in the UC-H II region can be derived from the radio continuum flux as:

$$N_{LyC} \simeq 7 \times 10^{46} \,\nu^{0.1} \,S_{\nu} \,D^2,\tag{6}$$

where  $\nu$  is given in GHz,  $S_{\nu}$  in Jy and D is the distance in kpc (Mezger, Smith & Churchwell 1974). A temperature of  $T_e = 10^4$  K and a ratio <sup>4</sup>He/H=0.1 have been assumed. The flux obtained,  $N_{LyC} \simeq 9.6 \times 10^{47}$  photons s<sup>-1</sup>, is consistent with an O9 - O9.5 ZAMS type star (Panagia 1973). On the other hand, following Helou, Soifer & Rowan-Robinson (1985), the luminosity of the IRAS point source can be estimated from the fluxes at 60  $\mu$ m and 100  $\mu$ m according to:

$$L_{FIR} = 4\pi D^2 FIR = 0.385 D^2 (2.58 S_{60} + S_{100}) L_{\odot} = 4.1 \times 10^5 L_{\odot}, \tag{7}$$

where FIR is the integrated flux from the band between 42  $\mu$ m and 122  $\mu$ m. We can compute, then, the parameter  $\Theta = L(IR)/(N_{LyC} E_{LyC} \alpha)$  that characterizes a compact H II region (Panagia 1974), where  $E_{LyC}$  is the energy of a single Lyman- $\alpha$  photon and  $\alpha$  is the ratio of the total luminosity of the star to the expected Lyman- $\alpha$  luminosity. For a O9.5 type star,  $\alpha = 13.2$  (Panagia 1973), thus  $\Theta \simeq 8$ . High values of  $\Theta$  ( $\Theta > 1$ ) indicate that the dust is still mixed with the ionized gas to an appreciable extent. The value obtained here implies therefore that this UC-H II region is a very young object.

Let us now discuss the origin of IRAS 17146-3723, the source coincident with cloud 1. Condensed molecular matter can form a protostar after the matter has cooled, which occurs in a period of the order of  $10^6$  years. Such a period is too long compared to the age of G349.7+0.2 deduced in Section 4.1, thus this IRAS source cannot be a protostar triggered by G349.7+0.2. We suggest, therefore, that the IR emission from this source arises from dust heated by the shock front of G349.7+0.2. The OH 1720 MHz masers detected by Frail et al. (1996) towards this remnant provides additional support to the presence of shocked interstellar gas.

The Large CO Shell shares some common characteristics with another SNR, G54.4-0.3, which is claimed to be a case of SN induced star formation: both present a CO shell slowly expanding at ~ 4 km s<sup>-1</sup>, in an ambient medium with density  $n_0 = 30 \text{ cm}^{-3}$ , and both have an IRAS source coincident with a compact H II region created by an O9 type star (Junkes et al. 1992). The main difference is that the CO shell of G54.4-0.3 coincides with a radio continuum shell, while available radio surveys show no continuum emission at the position of the Large CO Shell. According to the  $\Sigma$ -D relation of Case & Bhattacharya (1998), the surface brightness that should be observed is  $\Sigma \simeq 4 \times 10^{-22} \text{ W m}^{-2} \text{ Hz}^{-1} \text{ sr}^{-1}$ . Such a low surface brightness is probably missed by Galactic radio surveys (see Green 1991). Nevertheless, both the age derived above and the low expansion velocity, suggest that the shock has disappeared and the Large CO Shell is an SNR in the phase of dissipation. Besides, due to the old age of this remnant, there is no need for an alternative explanation for the origin of the star that created the UC-H II region IRAS 17147-3725. In the case of G54.4-0.3, instead, Junkes et al. (1992) need to include a stellar wind previous to the SN explosion to explain how the protostar detected as an IRAS point source was triggered, since the SNR was not old enough.

In summary, the scenario proposed here is that a SN exploded some  $\sim 4 \times 10^6$  years ago at approximately RA=17<sup>h</sup>18<sup>m</sup>22<sup>s</sup>.3, decl=-37°22′55″ (J2000), in a molecular cloud with density  $n_0 = 30$  cm<sup>-3</sup>. The SN shock wave triggered the formation of an O9 - O9.5 type star, currently detected as the IR source IRAS 17147-3725. It is possible that the progenitor star of G349.7+0.2 has also been triggered by the expansion of the Large CO Shell. The Large CO Shell, therefore, constitutes a new candidate for SN induced star formation. Even though the evidence is not conclusive, it is important to note that the case most strongly claimed to be SN induced star formation, is based on the spatial coincidence between the association CMa R1 and an optical ring which, together with an HI expanding shell, is interpreted as an old SNR (Herbst & Assousa 1977). However, the hypothetical SNR could never be confirmed.

#### 5. Conclusions:

The surroundings of the SNR G349.7+0.2 have been investigated in the CO J=1-0 transition. Our observations allowed us to determine the density distribution of the ISM into which this remnant is expanding. A large, ring-like structure has been detected, which we called "the Large CO Shell". It was found that "cloud 1", the CO cloud interacting with G349.7+0.2 (Paper I), is part of the Large CO Shell. We suggest that this molecular shell is the remnant of an old supernova explosion, now in the phase of dissipation.

We analyzed the interaction between G349.7+0.2 and the Large CO Shell, and

concluded that the age of the former is about  $1.4 \times 10^4$  years. The shock driven by G349.7+0.2 into cloud 1 was confirmed to be of C-type, in agreement with the conditions requiered for OH 1720 MHz masers to exist (Lockett et al. 1999).

Three IRAS point like sources with spectral characteristics typical of protostars were found in the Large CO Shell. One of them, IRAS 17146-3727, is a clump of dust heated by the shock front (Paper I). Another one, IRAS 17147-3725, is located at the position of a CO peak, and coincides with an UC-H II region, probably produced by an O9-9.5 type star.

In summary, we propose that the explosion of a star, about  $4 \times 10^6$  years ago, in a medium with density 30 cm<sup>-3</sup>, pushed the surrounding gas forming what we see now as the Large CO Shell and triggered, during its expansion, the birth of an O9 - O9.5 type star detected as the IR source IRAS 17147-3725. It is possible that the formation of the progenitor star of G349.7+0.2 was also induced in the same way. High sensitivity radio-continuum observations are needed to investigate whether the Large CO Shell has a counterpart in synchrotron emission and to measure the strength and orientation of magnetic fields in this direction. This information is crucial in determining a SN origin for this structure.

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Table 2. Observed and derived parameters for CO structures associated with G349.7+0.2

structure	central coordinates RA, decl. (J2000)	r (arcsec)	$v_{sys}$ (km s <sup>-1</sup> )	$\Delta v$ (km s <sup>-1</sup> )	${ m M}$ $({ m M}_{\odot})$	$n_{H_2}$ $(\mathrm{cm}^{-3})$
Cloud 1	17 18 0.0, -37 26 36	24	+16.5	4.0	$1.2 \times 10^4$	1080
Cloud 2	17 18 10.0, -37 28 25	33	+17.3	4.5	$2.2 \times 10^4$	790
Large CO Shell	17 18 22.3, -37 22 55	435	+17.5	6.3	$9.3 \times 10^{5}$	35

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# 6. Figure captions

Fig. 1.— A radio continuum image of G349.7+0.2 at 1.4 GHz obtained with the VLA, kindly provided by C. Salter. The grayscale is indicated in mJy/beam on top of the image, while the contours are expressed as a percentage of the peak flux density (0.48 Jy/beam) at 1, 2, 3, 5, 10, 20, 30, 40, 50, 60, 70, 80, 90, and 99%. For better contrast, white contours are used over dark shadows. White crosses indicate the position of the OH 1720 MHz masers detected by Frail et al. (1996). The beam, indicated in the bottom left corner, is  $19''.4 \times 4''.5$ , P.A.= $-22^{\circ}$ .

Fig. 2.— CO emission between 12.6 and 21.2 km s<sup>-1</sup>. The greyscale is in Kelvins, and is shown on top of the images. The beam size,  $54'' \times 54''$ , is shown in the bottom right corner of the first frame. The velocity of each frame is indicated in the top right corner. All velocities are referred to the LSR.

Fig. 3.— CO emission integrated between +14.5 and +20.5 km s<sup>-1</sup>. The greyscale is in K km s<sup>-1</sup>, and is shown on top of the image. The original image was convolved to a  $60'' \times 60''$  beam, plotted in the bottom right corner. An ellipse is fitted to the CO peaks. The white stars indicate the position of three IRAS point sources, discussed in the text. A few representative contours of the continuum emission from G349.7+0.2 are included as grey solid lines. The  $3\sigma$  noise level is 6.5 K km s<sup>-1</sup>.

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