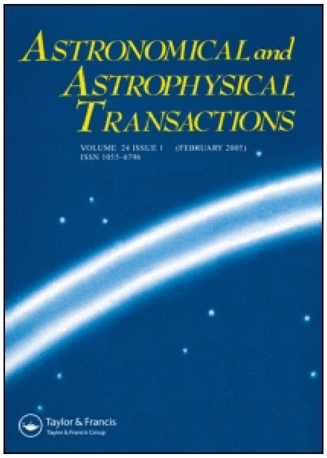

Astronomical & Astrophysical Transactions
The Journal of the Eurasian Astronomical Society
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713453505

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Online Publication Date: 01 February 2003
To cite this Article: Sobolev, A. M., Salii, S. V., Ellingsen, S. P., Zinchenko, I. I., Johansson, L. E. B. and Sutton, E. C. (2003) 'MOLECULAR RADIO EMISSION FROM THE G34.26+0.15/34.24+0.13 COMPLEX', Astronomical & Astrophysical Transactions, 22:1, 7 - 10
To link to this article: DOI: 10.1080/1055679031000091779
URL: http://dx.doi.org/10.1080/1055679031000091779

Astronomical and Astrophysical Transactions,
2003, Vol. 22(1), pp. 7–10

MOLECULAR RADIO EMISSION FROM THE G34.26 + 0.15/34.24 + 0.13 COMPLEX

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(Received 5 April 2002)

We report molecular line observations of the G34.26 + 0.15/34.24 + 0.13 complex, which contains a bright molecular core and a proto-B-star. ATCA observations show that both objects are closely associated with 6.7 GHz class II methanol masers. Methanol line series at 96, 157 and 241 GHz towards the protostar position were observed at SEST. Modelling of the methanol data shows that the molecular core embedding protostar is not greatly influenced by the outflow from the young stellar object. Molecular line mapping at Onsala reveals the presence of a cavity and two compact clumps to the southeast of the bright molecular core. The protostar is situated at the edge of one compact clump. It is very likely that the material outflowing from the protostar freely escapes towards the cavity. Comparison of the line profiles of different molecules shows substantial chemical inhomogeneity within the region.

Keywords: Star-forming regions; ISM:individual (G34.3); Molecules; Radio line:ISM

The G34.26 + 0.15/34.24 + 0.13 complex contains the bright compact molecular core G34.26 + 0.15 (Carral and Welch, 1992) and the recently found proto-B-star G34.24 + 0.13MM (Hunter *et al.*, 1998). These two objects are located at peaks in the sub-millimetre continuum emission and are separated in the sky by about 84 seconds of arc. Observations of the entire complex show considerable evidence of induced star formation, including shocks, UCH II regions and methanol, OH and H_2O masers.

Observations with the ATCA interferometer in 1998 show that both the proto-B-star object and the G34.26 + 0.15 core have 6.7 GHz class II methanol maser sites in their immediate vicinities (see also single-dish observations by Caswell *et al.* (1995) and preliminary results obtained by Sobolev *et al.* (1998)). The velocities of the maser features at the proto-B-star position ranged from 55 to 62 $\mathrm{km\,s^{-1}}$ while the G34.26 + 0.15 maser spectrum contained only one component at 57.5 $\mathrm{km\,s^{-1}}$. EVN interferometry performed by Yi *et al.* (2001) showed that the structure of the maser cluster at G34.24 + 0.13MM resembles that of an outflow.

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ISSN 1055-6796 print; ISSN 1476-3540 online
DOI: 10.1080/1055679031000091779

In October 1999 SEST was used to make observations of the methanol line series at 96, 157 and 241 GHz towards the proto-B-star G34.24 + 0.13MM. The lines are rather weak, with the line ratios indicating that the temperature is rather low for the protostar's immediate vicinity. The best LVG fit for our methanol data is given in Table I. The values of the model parameters show that the bulk of the molecular material around G34.24 + 0.13MM is not greatly affected by shock waves.

In April 2001, Onsala 20 m was used to map the G34.26 + 0.15/34.24 + 0.13 complex in the CS(2–1) and HCO^+(1–0) lines. Both maps show the compact molecular core G34.26 + 0.15 and reveal the presence of a cavity and two compact clumps. A map of the CS(2–1) line emission is shown in Figure 1. It is interesting that the edge of the cavity is delineated by the crescent-shaped H II region G34.26 + 0.2D. Another important finding is that the G34.24 + 0.13MM proto-B-star is situated at the boundary between the cavity and one of the compact clumps. The spatial and velocity correlations indicate that the 6.7 GHz methanol masers trace an outflow which arises at the boundary of the dense clump or within the clump. These new observations support the hypothesis that the G34.24 + 0.13MM object represents an example of a very early stage of formation of a massive star and show that it lies at the edge of a dense clump. It is possible that a UCH II region has not formed around this young stellar object because outflowing material can freely escape towards the cavity.

In addition, the HCN (1–0), $H^{13}CN$(1–0) and $C^{34}S$(2–1) lines were observed at Onsala towards the G34.24 + 0.13MM object, the centres of the compact clumps, and the cavity. The CS spectra are single peaked with $V_{lsr} \approx 57\,km\,s^{-1}$ and a full width at half-maximum (FWHM) of about $3\,km\,s^{-1}$ (Fig. 2). The spectra of HCN(1–0) hyperfine components are double peaked (Fig. 2). One of the peaks has $V_{lsr} \approx 57\,km\,s^{-1}$ and a FWHM of about $2\,km\,s^{-1}$. These values coincide with parameters of the $C^{34}S$(2–1) line. It is interesting that the second HCN spectral peak has $V_{lsr} \approx 55\,km\,s^{-1}$, which coincides with that of the strongest maser feature in the vicinity of the protostar. The lower V_{lsr} component is present in the HCO^+(1–0) spectra as well.

TABLE I Beam-averaged Brightness Temperature of CH_3OH Lines Observed towards the Proto-B-Star Position and Results of LVG modeling ($T_k = 35.0$ K; $N_{CH_3OH}/\Delta V = 2.37 \times 10^9\,s\,cm^{-3}$; $n_H = 2.37 \times 10^5\,cm^{-3}$; filling factor $\phi = 0.07$). The Superscript b Denotes that Corresponding Lines are Blended. Uncertainties in the Brightness Temperatures Correspond to 1σ. Upper Limits Correspond to 3σ.

Frequency (GHz)	*Transition*	T_B^{abs} *(K)*	T_B^{mod} *(K)*
86.902 95	7_2–6_3 A^+	0.03 ± 0.02	0.00
96.739 36	2_{-1}–1_{-1} E	0.33 ± 0.03	0.38
96.741 38	2_0–1_0 A^+	0.53 ± 0.03	0.41
96.744 55	2_0–1_0 E	0.18 ± 0.03	0.19
96.755 51	2_1–1_1 E	0.06 ± 0.03	0.03
156.488 86	8_0–8_{-1} E	<0.06	0.01
156.602 41	2_1–3_0 A^+	0.10 ± 0.02	0.03
156.828 53	7_0–7_{-1} E	<0.06	0.02
157.048 62	6_0–6_{-1} E	0.06 ± 0.02	0.04
157.179 01	5_0–5_{-1} E	0.09 ± 0.02	0.08
157.246 05	4_0–4_{-1} E	0.10 ± 0.02	0.11
241.700 21	5_0–4_0 E	0.13 ± 0.02	0.14
241.767 22	5_{-1}–4_{-1} E	0.33 ± 0.02	0.27
241.791 43	5_0–4_0 A^+	0.33 ± 0.02	0.39
241.852 35	5_{-3}–4_{-3} E	<0.05	0.00
241.879 07	5_1–4_1 E	<0.05	0.03
241.887 70	5_2–4_2 A^+	<0.05	0.00
241.904 11	5_2–4_2 E	$0.13^b \pm 0.02$	0.03
241.904 40	5_{-2}–4_{-2} E	$0.13^b \pm 0.02$	0.03

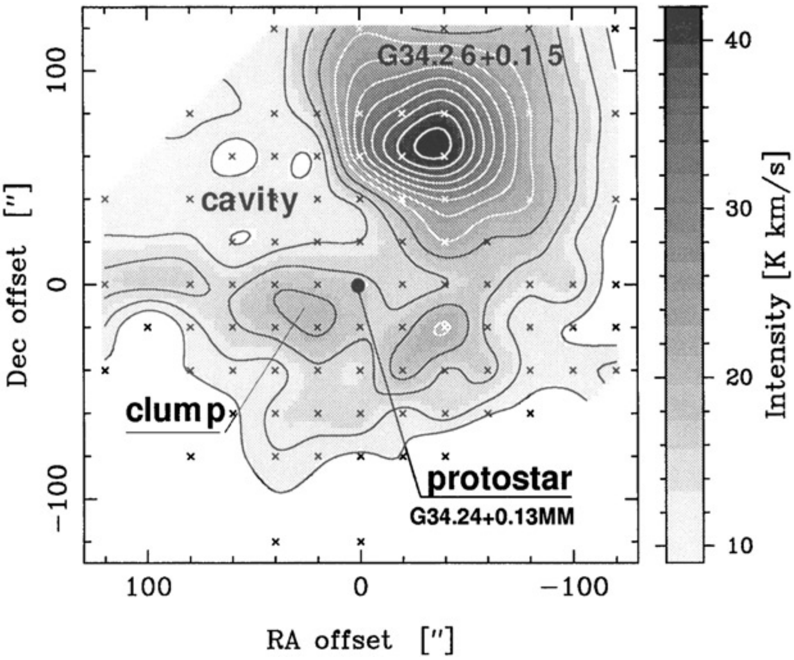

FIGURE 1 Map of the CS (2–1) line emission integrated from 52 to 62 km s^{-1}: X, observational points. The reference position corresponds to α_{1950} = 18:50:49.0, δ_{1950} = +01:09:57.

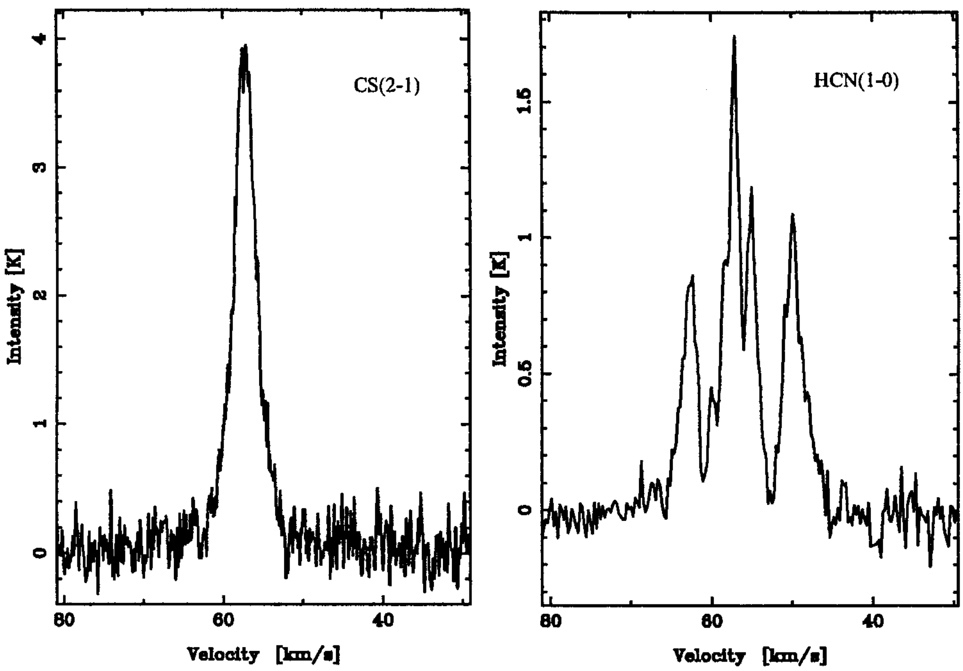

FIGURE 2 Spectra of CS (2–1) and HCN(1–0) lines toward the proto-B-star G34.24 + 0.13MM.

Initial analysis of data obtained with the BIMA interferometer shows that spatial distributions of N_2H^+ and methanol are greatly different from those of CS, HCN and HCO^+. So, there are several clear indications of substantial chemical inhomogeneities in the region.

Acknowledgements

The study was supported by INTAS grant 99-1667 and National Science Foundation grant AST 99-81363.

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