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OH Observations of the Dust Complex Lynds 1630 and of NGC 2024

W. M. Goss
Kapteyn Astronomical Institute, Groningen, and Raman Research Institute, Bangalore*

A. Winnberg
Max-Planck-Institut für Radioastronomie, Bonn

L. E. B. Johansson
Onsala Space Observatory

A. Fournier
Kapteyn Astronomical Institute, Groningen

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Summary. Approximately 12 square degrees of the dust cloud Lynds 1630 east and north of the H II region NGC 2024 (W 12) have been mapped in the 1667 MHz line of OH. The counterpart of the narrow absorption line in the direction of W 12 is only seen at positions north and south of W 12. This component can be identified with a dense cold OH cloud which may be physically associated with the H II region. The broad OH emission line seen near W 12 can be traced east and north of W 12 and reaches a maximum near the reflection nebulae NGC 2068–71. The velocity field of the OH associated with L 1630 is essentially constant while the velocity dispersion is quite variable. The minimum is reached near NGC 2068–71 in agreement with the H I results of Sancisi. OH emission associated with the large globule Lynds 1622 has also been detected. Observations of CH at five positions near NGC 2068–71 show emission lines in good agreement with the OH properties.

Key words: interstellar molecules — OH emission — dust clouds — CH emission

Introduction

The dust cloud Lynds 1630 (Lynds, 1962) east and north of ζ Orionis has been discussed by Asklöf (1930), Bok and Cordwell (1971) and Isobe (1973). The average photographic extinction is $2–4^m$ and the size $\sim 4° \times 1^1/_2°$. OH absorption in this region was first found by Goss (1968) in the spectrum of the H II region NGC 2024 (W 12) and has been discussed in detail by Manchester and Gordon (1971, hereafter MG). Extensive CO observations of this cloud have been reported by Tucker *et al.* (1973) and by Milman *et al.* (1975a). Recently, Strom *et al.* (1975) have found several luminous stars in L 1630 with ages as young as a few times 10^5 years.

The objectives of the present study can be summarized as follows: (i) detailed observations of the OH emission and absorption near NGC 2024 in order to determine the optical depth and excitation temperature of the OH in front of the H II region; (ii) an investigation of the relation of this OH to the more wide-spread OH associated with L 1630; (iii) a comparison with optical extinction in order to find any possible correlation between OH and dust; (iv) a comparison between the OH observations and observations in the 21-cm line and in the CO and CH lines; (v) a discussion of OH emission from the globule L 1622.

The OH observations near the reflection nebula NGC 2071 have been summarized previously by Johansson *et al.* (1974); the type I maser source OH 205.1–14.1 as well as the peculiar OH emission associated with the dust cloud were discussed by these authors. In particular the 1720 MHz line of OH from the dust cloud appears in absorption against the 2.7 K isotropic background.

OH Observations

The observations were made in three observing periods: August 1972, December 1972 and September 1973 using the 25-m telescope of the Onsala Space Observatory, Sweden (Rydbeck and Kollberg, 1968). The system temperature varied between 20 and 35 K with a travelling wave maser (Kollberg, 1973). The aperture efficiency was 0.52 and the beam efficiency 0.64. One

* Presently at Division of Radiophysics, C.S.I.R.O., Sydney.

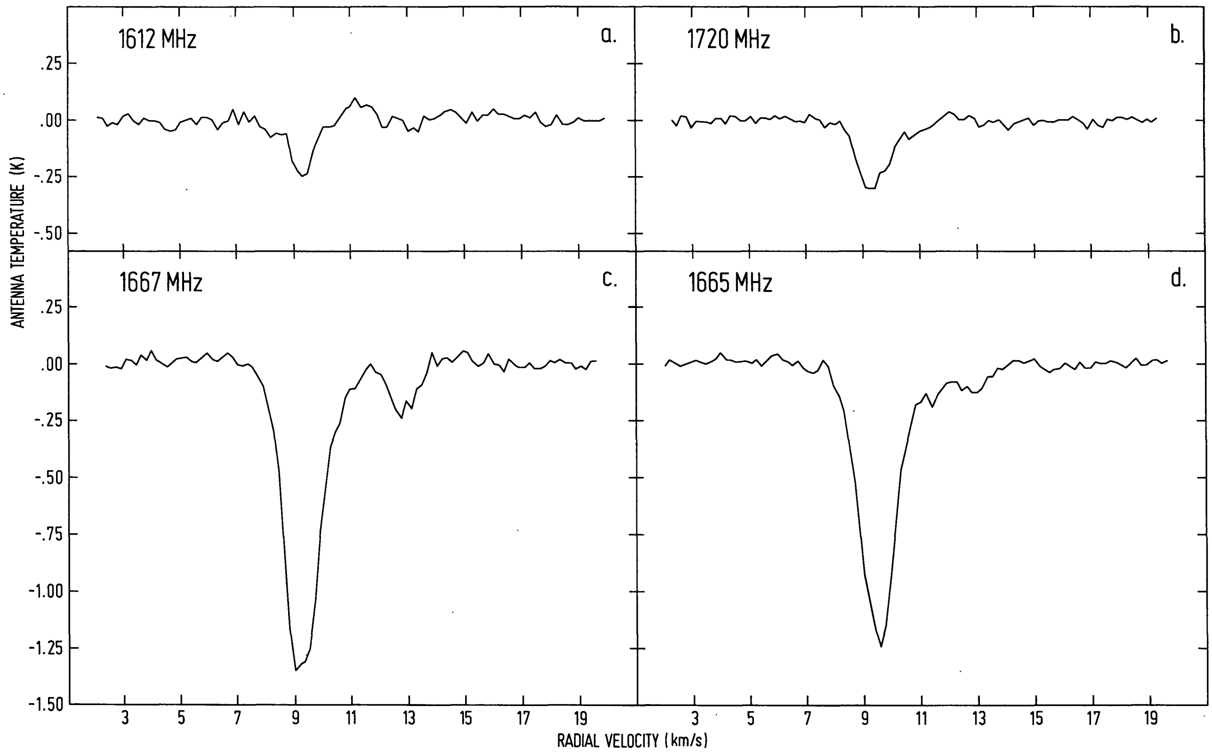

Fig. 1. OH spectra in the direction of W 12 obtained at Onsala. Antenna temperature is plotted versus LSR velocity. The filter resolution is 1 kHz (0.18 km/s at 1665 MHz)

Kelvin antenna temperature corresponded to 10 f.u.[1]) for a point source. The HPBW was 27′×31′. At 1667 MHz typical integration times were 90 min per profile with an r.m.s. noise of 0.005 K antenna temperature. Spectra with 1 and 10 kHz resolution were recorded simultaneously. At a few positions the 1665 MHz line was observed and the satellite lines at 1612 and 1720 MHz were investigated only in the direction of W 12 and OH 205.1–14.1 (Johansson *et al.*, 1974).

The observations were initiated near W 12 and were continued in all directions where the line was stronger than 0.02 K antenna temperature. Profiles were obtained at 84 positions including W 12 and OH 205.1–14.1. The initial survey was spaced at 30′ (about one beam width); where the antenna temperatures were >0.1 K, subsequent observations were made at intermediate points.

OH Near W12

The strong OH absorption lines near W 12 have been well studied. MG detected emission lines 20′ north and south of the continuum source. From a comparison of the emission and absorption lines the excitation temperatures of the OH transitions were calculated.

In Fig. 1 we show the profiles obtained in the direction of W 12 with 1 kHz resolution (0.18 km/s at 1666 MHz). The antenna temperature of the continuum is 5.8 K. From a comparison of the previous absorption data published by Goss (1968), Manchester *et al.* (1970), Turner and Verschuur (1970) and MG with the present data, we conclude that the antenna temperature scale at 1665 and 1667 MHz of MG contains a calibration error of 1.5±0.1. The continuum temperature and the 1612 and 1720 MHz data published by MG, however, are consistent with the present work and the previous data. Many of the conclusions of MG remain unchanged since several of the quantities are derived from ratios of the main lines.

The results of gaussian fitting of the absorption profiles are given in Table 1 (T_A is the peak antenna temperature). The difference in line shape between the 1665 and 1667 MHz main components (at 9.49 and 9.30 km/s, respectively) is not large enough to warrant more than one gaussian component per line. The velocities are based on the rest frequencies: 1612.231, 1665.401, 1667.358 and 1720.527 MHz. With this choice the velocity of the 1665 MHz line at ~9 km/s is 0.2 km/s higher than that of the 1667 MHz line. One possible interpretation is that the 1665 MHz rest frequency should be decreased by 1 kHz to 1665.400 MHz. Manchester and Gordon (1970) adopt this point of view whereas Turner (1973) suggests that the W 12 1665 MHz line may be contaminated by emission. Application of the rest frequencies given by ter Meulen and Dymanus (1972) makes the differencies

[1]) 1 f.u. = 1 flux unit = 10^{-26} W m^{-2} Hz^{-1}.

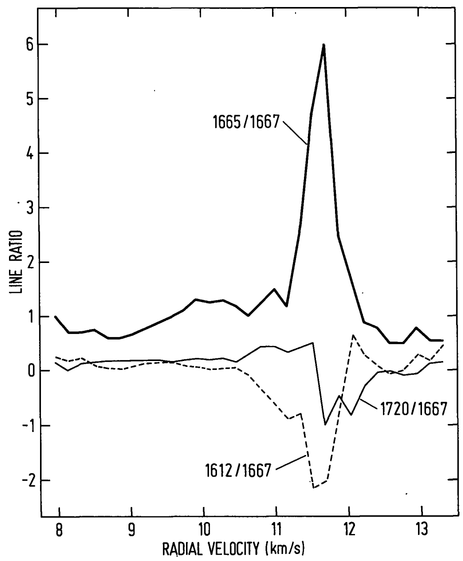

Fig. 2. Line ratios as a function of radial velocity for OH absorption lines in W 12. Frequency resolution is 1 kHz. The heavy solid line is T_{1665}/T_{1667}, the thin solid line T_{1720}/T_{1667} and the dashed line T_{1612}/T_{1667}. Telescope positioned at R.A. (1950) = $05^h39^m10^s$, Dec. (1950) = $-01°55'.5$

between the line velocities even larger. Aperture synthesis observations could possibly solve this problem.

In Fig. 2 we show the relative line strengths T_{1612}/T_{1667}, T_{1665}/T_{1667} and T_{1720}/T_{1667} as a function of radial velocity from 8 to 13.25 km/s (cf. MG Fig. 2). As MG first pointed out, there are large departures from LTE at velocities above 10 km/s. The 1612 MHz line goes into emission at $\sim$10.5 km/s and the 1720 MHz line may possibly go into emission at $\sim$11.7 km/s.

In Fig. 3 we show line profiles at neighbouring positions. W 12 N (Fig. 3a and b) is 30′ north of W 12, W 12 E (Fig. 3d) is 30′ east, while W 12 N, E (Fig. 3c) is 30′ north and 30′ east. No emission was detected 30′ to the west with a peak-to-peak limit of 0.025 K antenna temperature. A broad component ($\Delta V_{1/2}$ $\sim$8–9 km/s) which is also seen in the spectra presented by MG is apparent in these emission profiles. Only at W 12 N is the narrow counterpart of the absorption line clearly visible. Figure 4 shows this line with 1 kHz resolution. There is only a suggestion of this line at 1665 MHz (Fig. 3b); the 1665 MHz profile is dominated by a line at $\sim$3 km/s. In the direction 30′ south of W 12 (W 12 S) the broad emission component is present with an antenna temperature of $\sim$0.06 K. The narrow component appears in absorption but this is probably due to a response to W 12 itself caused by a slightly asymmetric main lobe. MG find that the narrow component is present with a radial velocity of $\sim$11 km/s at 20′ south of W 12. This line has an intensity which is about one half the intensity of the corresponding line seen 20′ north of W 12.

Following MG we can solve for the excitation temperatures at 1667 and 1665 MHz by a comparison of the emission and absorption lines. The major assumption is that the OH cloud has the same properties at both positions. Clearly this may be a doubtful assumption since the narrow component is only seen north and south of W 12. To apply this method we have assumed that the excitation temperature is not a function of velocity and that the narrow line at W 12 N (V = 8.3 km/s) can be compared with the absorption line at 9.3 km/s. For 1667 MHz we find that $T_{OH} - T_{BB} = 1.0 \pm 0.3$ K, where T_{OH} is the excitation temperature and T_{BB} is the

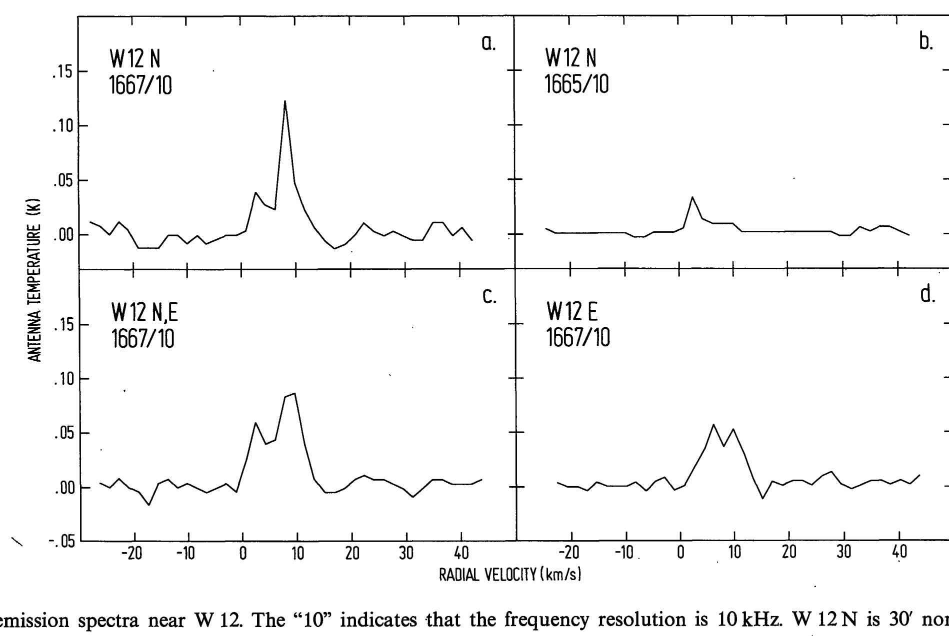

Fig. 3. OH emission spectra near W 12. The "10" indicates that the frequency resolution is 10 kHz. W 12 N is 30′ north of W 12, W 12 E is 30′ east and W 12 E, N is 30′ east and 30′ north

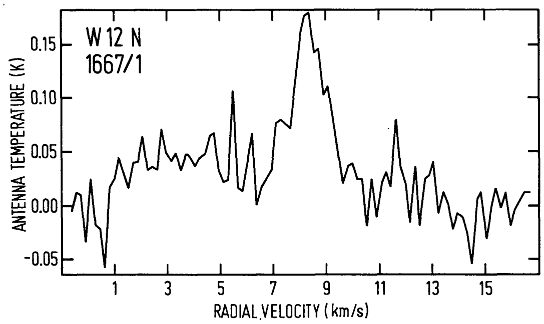

Fig. 4. The 1667 MHz spectrum 30′ north of W 12 with 1 kHz frequency resolution

isotropic background plus a small contribution due to the galactic background. Following Johansson *et al.* (1974) we take $T_{BB}=3.2$ K. For 1665 MHz $T_{OH}-T_{BB}=0.0\pm0.3$ K. These values differ slightly from MG due to the calibration error mentioned above.

Using the line ratio method (Goss, 1968) we determined the following optical depths: τ (1667) = 1.8 and τ (1665) = 1.3. The resultant column density is 1.8×10^{15} cm^{-2}. These values are in agreement with MG to within the errors. In addition the filling factor, *R*, is 0.32.

Broad Component near W12

It is easy to separate the broad and narrow components near W 12 since spectra with 1 and 10 kHz resolution are available for all positions. At most positions the lines are so broad that they cannot be detected on the unsmoothed 1 kHz spectra. The broad component emission can be identified with the L 1630 dark cloud to be discussed below. In Table 1 we give the parameters of the broad component for W 12 N, W 12 S and W 12 E. In addition, 10 kHz spectra at 1665 and 1667 MHz in the direction of W 12 show this emission line. (This is not evident in the 1 kHz spectra of Fig. 1.) At this position the line is possibly contaminated by the strong absorption near 9 km/s. The peak intensity is ~0.04 K at 1667 MHz and ~0.03 K at 1665 MHz, while the peak velocity is 4–5 km/s, and the width 3–4 km/s. The presence of emission implies that the excitation temperature of this OH component is ≧12 K (the brightness temperature of W 12).

The broad component appears to be closely correlated with the optical extinction near W 12. As an example the line is not detected to the west of W 12 (see above) where the extinction is lower.

The profiles obtained at two positions (W 12 E and W 12 N, E in Fig. 3) show some indication of a lower velocity component at $V\sim4$ km/s. This is not seen at nearby positions; about 1°.5 away (R.A. (1950) = $05^h45^m09^s$, Dec. (1950) = −00°55′ and R.A. (1950) = $05^h47^m09^s$, Dec. (1950) = −00°55′), there is again a suggestion of a double line with the lower velocity component at ~5 km/s.

OH Emission from L 1630

In Fig. 5 we show a contour map of the antenna temperature at 1667 MHz superposed on a portion of the Palomar Sky Atlas (red sensitive plate). The H II region NGC 2024 is partially hidden by the over-exposed image of ζ Orionis; the bright reflection nebulae to the north-east are NGC 2068–71. The type I OH source OH 205.1–14.1 (Johansson *et al.*, 1974) just north of NGC 2071 is also indicated. The diffuse

Table 1. Data for W 12 from gaussian fitting

Name	Line (MHz)	Filter (kHz)	V (km/s)	$\Delta V_{1/2}$ [a] (km/s)	T_A (K)	Area [b] (K · kHz)
W 12	1612	1	9.3 ±0.1	1.0 ±0.2	−0.24±0.03	1.4±0.2
		1	11.2 ±0.1	1.1 ±0.2	0.07±0.02	—
W 12	1665	1	9.49±0.03	1.52±0.08	−1.20±0.05	10.8±0.3
		1	11.4 ±0.2	1.3 ±0.2	−0.16±0.03	1.2±0.2
		1	12.7 ±0.3	1.5 ±0.2	−0.14±0.02	1.2±0.2
W 12	1667	1	9.30±0.03	1.44±0.08	−1.38±0.06	11.8±0.4
		1	13.05±0.06	1.22±0.08	−0.21±0.03	1.5±0.2
W 12	1720	1	9.3 ±0.1	1.2 ±0.2	−0.31±0.02	2.3±0.2
		1	10.7 ±0.1	0.8 ±0.2	−0.06±0.02	0.3±0.1
W 12 N	1665	10	2.9 ±1.0	1.8 ±0.5	0.03±0.01	—
		10	~8	~4	≦0.015	—
W 12 N	1667	10	6.4 ±2.0[c]	9.6 ±3.0	0.03±0.01	—
		1	8.3 ±0.2[d]	1.6 ±0.4	0.16±0.03	—
W 12 S	1667	10	8.0 ±0.6[c]	7.0 ±0.8	0.06±0.02	—
W 12 E	1667	10	7.7 ±0.6[c]	7.6 ±1.3	0.05±0.01	—

[a]) Full width at half maximum.
[b]) For absorption lines.
[c]) Broad component only.
[d]) Narrow component only.

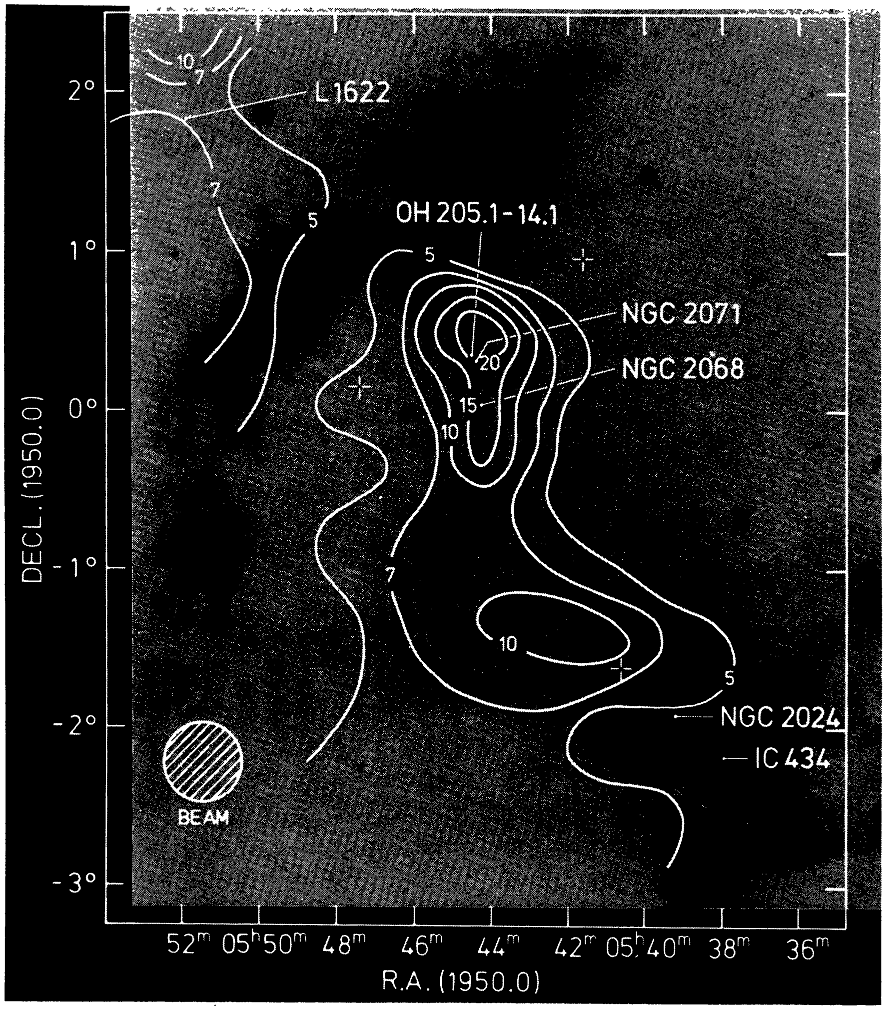

Fig. 5. The L 1630 dark cloud. Antenna temperature (multiplied by 100) at the 1667 MHz OH line superimposed on the red photograph of the Palomar Sky Atlas (copyright National Geographic Society-Hale Observatories)

shape of L 1630 is roughly delineated by the 0.05 K contour. In Fig. 6 we show an overlay of the velocity half-widths, $\Delta V_{1/2}$.

The OH velocities are quite constant throughout L 1630 with no evidence for a large scale systematic pattern. As is the case for CO (Tucker *et al.*, 1973), there is no evidence for rotation. The mean velocity of 7 km/s close to declination $\sim 2°$ rises to 9–10 km/s near NGC 2068–71. The line widths over much of the cloud are quite large as compared to the more typical line widths of 1–2 km/s usually associated with dust clouds (cf. Turner, 1973). The variation in $\int T_A dV$ over the cloud is qualitatively similar to that of T_A. However, the extremes of the variation are somewhat smaller. To some extent the line widths are inversely correlated with T_A. This effect is typified by the smaller $\Delta V_{1/2}$ at the maximum in T_A near NGC 2068–71. For the positions with $T_A > 0.1$ K, the mean $\Delta V_{1/2}$ is 3.5 km/s. For those with $T_A < 0.1$ K, the mean $\Delta V_{1/2}$ is 6.5 km/s. There is an additional correlation between V and $\Delta V_{1/2}$ which is present if the higher velocities (9–10 km/s) at the maximum near NGC 2068–71 are neglected. Lower velocity positions tend to have large line widths. A precise explanation of this is lacking. Sancisi (private communication) has suggested that these variations could be due to the presence of two distinct components. The lower velocity component would have larger line width and lower intensity, while the higher velocity component would be more intense and have a smaller width. Unfortunately such a clear cut separation is only obvious near W 12.

The high excitation temperature (>12 K near W 12) plus the large line width (3–6 km/s) make this OH cloud quite unusual. The CO observations near W 12 by Tucker *et al.* (1973) and Milman *et al.* (1975a) also imply CO excitation temperatures of ~ 20 K. It is therefore possible that the cloud is being heated by internal energy sources, e.g. the T Tau stars.

Sancisi (1970) has pointed out that the H I distribution has a maximum intensity in an elongated region with NGC 2068–71 near the centre. The equivalent widths of the H I profiles reach a minimum of ~ 13 km/s near

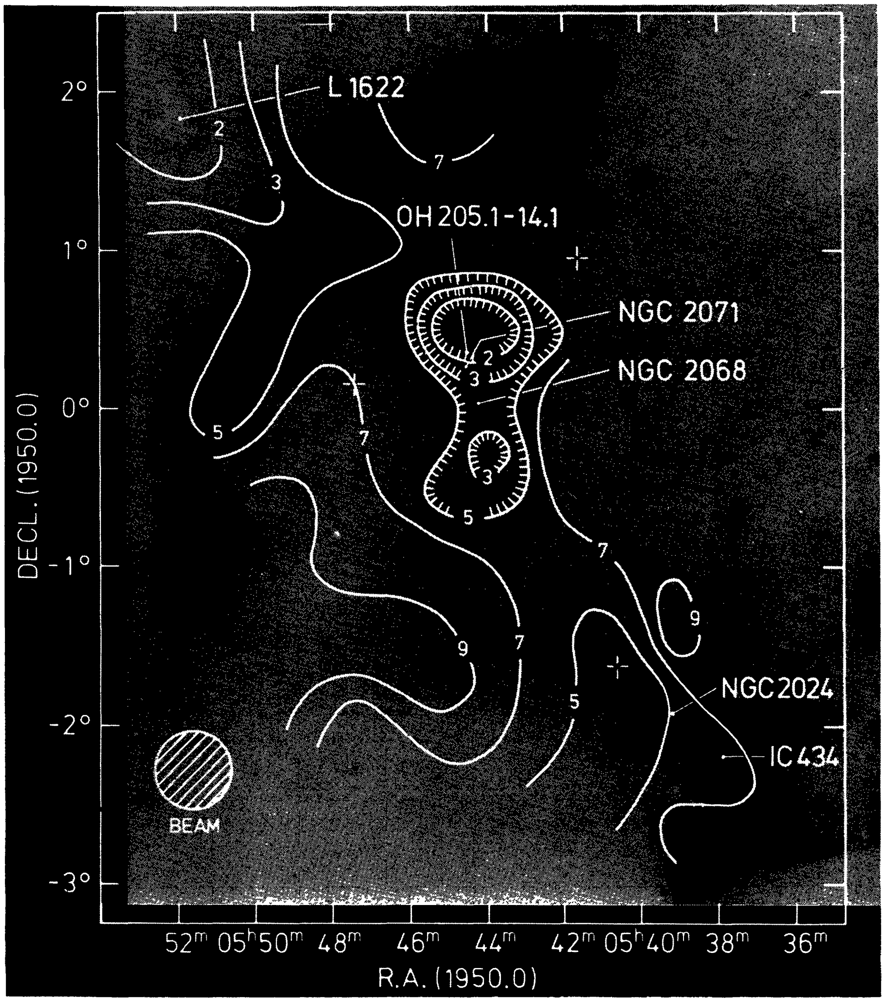

Fig. 6. Same as Fig. 5 but with velocity half width (km/s) of the 1667 MHz line of OH

the reflection nebulae. Both of these properties are qualitatively similar to the OH properties shown in Figs. 5 and 6. Sancisi has also drawn attention to the remarkable correspondence between H I features (maximum intensity and minimum equivalent widths) and the position of a group of T Tau stars found by Herbig and Kuhi (1963). The T Tau distribution shows a striking similarity to the OH distribution (T_A) in Fig. 5.

Following Sancisi *et al.* (1974) we have tried to correlate the OH properties (T_A, N_{OH}) with the extinction. From star counts, Asklöf (1930) has estimated the photographic extinction to be $\sim 2\overset{m}{.}4$. The galaxy counts of Shane and Wirtanen (1967) indicate that the extinction is $>2\overset{m}{.}5$. Lynds (1962) finds that the maximum extinction is $\sim 4^m$. We estimated the distribution of extinction, Δm, using the star counts made by Isobe (1973). He has counted stars on the Sky Survey using a grid of $26' \times 26'$, which is quite close to our HPBW. To convert to magnitudes of extinction we used the method described by Bok (1956) and Bok and Cordwell (1971) which involves using the van Rhijn luminosity tables [tabulation of $\log N(m)$ versus $l^{\rm I}, b^{\rm I}$ where $N(m)$ is the number of stars/degrees^2 of magnitude m or brighter]. The $\Delta \log N(m)$ versus m for this region is quite close to that derived by Bok (1956) for the dark cloud in Ophiuchus. The comparison region (Δm assumed to be zero) is taken at R.A. (1950) $= 05^h41^m02^s$ and Dec. (1950) $= +00°59'$ where the star counts have a maximum.

The derived extinction has a maximum of $\sim 2.5^m$ near R.A. (1950) $= 05^h41^m55^s$, Dec. (1950) $= -01°37'$ north-east of W 12. Over a $26' \times 26'$ grid the extinction is $\sim 2^m$ near NGC 2068–71. However, references to the Sky Atlas and large scale photographs (Strom *et al.*, 1974) indicate that there are regions with much larger extinction on a smaller scale. From a near IR survey of the region Strom *et al.* (1974) have found small areas with 10–15^m of visual extinction.

The degree of correlation found between T_A (1667) and Δm is much poorer than that found by Sancisi *et al.* (1974) for the Perseus OB 2 dark cloud. The correlation is decidedly improved if the points within ~30′ of W 12 are neglected. (Probably the inaccuracies in the star counts near the bright stars ξ and ζ Orionis contribute to the poorer correlation in this area.) In this case the relation found is $T_A(1667) \approx (0.06 \pm 0.02)\, \Delta m$ Kelvin. In the Perseus OB 2 cloud the coefficient is ~0.05.

Comparison with CO Observations of L 1630

Tucker *et al.* (1973) have mapped a part of L 1630 in the 2.6-mm CO line with an angular resolution of 2′.6. These authors suggest that the total mass of the cloud is in the range 10^4 to $10^5\, M_\odot$ of which one half or more is H_2.

The CO velocities are in good agreement (to ±1 km/s) with those of OH and show no pronounced changes across the cloud. If we only consider the OH positions with $T_A > 0.1$ K the mean radial velocity of the OH lines is 9.3 km/s as compared to 9.6 km/s for the ^{12}CO lines and 9.8 km/s for the ^{13}CO lines. For the same group of OH lines the mean $\Delta V_{1/2}$ is 3.5 km/s as compared to 3.1 km/s for the ^{13}CO lines (less affected by saturation). It is striking that the column densities of CO are 10^3–10^4 times greater than those of OH. The CO cloud appears to be smaller than the OH cloud; this probably reflects the poorer observational limits for CO as compared to OH.

Recently, Milman *et al.* (1975a) observed two small parts of L 1630 (mainly the areas around NGC 2068–71 and NGC 2023) in the ^{12}CO and ^{13}CO lines at $\lambda = 2.6$ mm. Again the CO velocities are in good agreement with those of OH and show a remarkable constancy over the regions observed.

OH Observations of Lynds 1622

The opaque dust cloud Lynds 1622 (Lynds, 1962) lies about 2°.4 north-east of NGC 2068 and 1°.2 north of a portion of Barnard's Loop. The extinction is $\sim 6^m$ at the centre of this 22′ × 16′ globule. An absorption line of H_2CO has been detected by Dieter (1973). The line has the following properties: $V = 1.3$ km/s, $\Delta V_{1/2} = 0.5$ km/s and $N_{H_2CO} = 6 \times 10^{13}$ cm^{-2}, if the excitation temperature is 2 K. Milman *et al.* (1975b) have also detected 2.6-mm CO lines from L 1622. For the ^{12}CO line they measure $V = 2.2$ and 12.0 km/s, $\Delta V_{1/2} = 2.2$ and 2.0 km/s, respectively; and for ^{13}CO they obtain $V = 1.6$ km/s and $\Delta V_{1/2} = 2.0$ km/s. Assuming the terrestrial value $n(^{12}CO)/n(^{13}CO) = 89$, that CO is thermalized, and that the ^{12}CO line is optically thick they obtain a projected density for the low-velocity line of $N_{CO} = 1 \times 10^{17}$ cm^{-2}.

In Fig. 7 we show two OH line profiles in the direction of L 1622. The "off-source" profile is the average of 4 profiles at positions 30′ north, south, east and west of L 1622. The OH associated with L 1630 is obvious at all positions as shown in Table 2; T_A varies by a factor of three over the four surrounding positions. On the globule itself an OH line is seen which corresponds to the H_2CO line. Thus this globule has a distinctly different velocity and is probably physically separated from L 1630. From the 1665 to 1667 MHz ratio for the 1 km/s line it appears that the optical depth for this component is small. Furthermore if we assume that $T_{OH} \gg T_{BB}$ we can calculate the projected densities if beam dilution is taken into account (the OH is assumed to uniformly fill the 22′ × 16′ globule). The calculated projected density of OH is 8×10^{13} cm^{-2} which is slightly greater than that of H_2CO. If T_{OH} is close to T_{BB} then this is a lower limit (Knapp and Kerr, 1973).

Knapp (1974) has looked for H I self absorption from this globule; no evidence for a line was found. In Fig. 8 we show H I line profiles made with the 100-m telescope of the Max-Planck-Institut für Radioastronomie in Effelsberg. The "on" profile (Fig. 8a) shows what could be considered a self-absorption feature of ~10 km/s which may correspond to L 1630. However, the gradient of the emission line over the area around the globule is so large that it prevents any quantitative

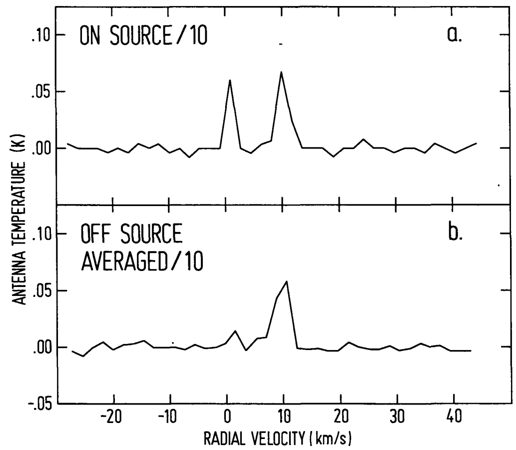

Fig. 7. Two OH profiles at 1667 MHz near the large globule Lynds 1622. Frequency resolution is 10 kHz. "On source" is in the direction of the globule at R.A. (1950) = 05h51m49s, Dec. (1950) = +01°47′. "Off source" is the average of four profiles 30′ north, south, east and west of the globule

Table 2. OH Observations of L 1622

Name	Line (MHz)	Filter (kHz)	Velocity, V (km/s)	$\Delta V_{1/2}$ (km/s)	T_A (K)
L 1622	1667	1	0.8±0.3	0.9±0.3	0.08±0.02
		1	10.1±0.3	1.8±0.6	0.07±0.02
L 1622	1665	10	~ 0.8		<0.03
		10	10.6±1.0	2.0±0.5	0.07±0.03
L 1622 E	1667	10	9.9±0.4	1.8±0.8	0.06±0.02
L 1622 W	1667	10	9.3±0.6	3.2±1.0	0.04±0.02
L 1622 N	1667	10	9.9±0.2	1.5±0.5	0.13±0.04
L 1622 S	1667	10	9.9±0.4	1.5±0.7	0.08±0.03

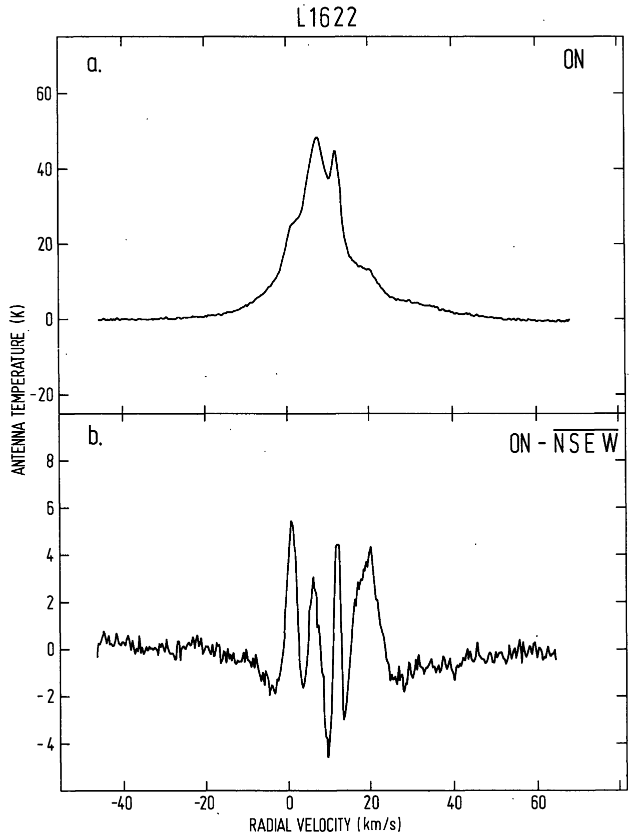

Fig. 8a and b. H I profiles near Lynds 1622 taken with the 100-m telescope at Effelsberg. Figure 8a is the profile in the direction of the globule. Figure 8b is the "on" profile minus an "expected" profile formed by averaging four profiles obtaines 40′ to the north, south, east and west of the globule. Frequency resolution is 2 kHz (0.4 km/s)

mapping of this possible absorption component. The "absorption" profile (Fig. 8b) ("on" minus the average of four comparison profiles observed 40′ north, south, east and west of L 1622) shows no features >10 K at either ~10 km/s (L 1630) or at ~1 km/s (L 1622).

CH Observations near NGC 2071

The CH observations were made in March 1974 with the Onsala 25-m telescope. At the frequency of the $^2\Pi_{1/2}$, $J=1/2$, $F=1\rightarrow1$ transition (3335.481 MHz) the HPBW is 15′. The CH emission was measured at five positions north-east of NGC 2071. The data are summarized in Table 3 and the profile obtained at R.A. (1950) = $05^h45^m00^s$, Dec. (1950) = +00°35′ is shown in Fig. 9. For comparison purposes the parameters of the OH line from this area are also listed in Table 3. The velocities and half-widths of the two molecular species are in good agreement.

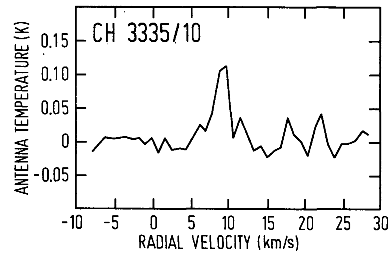

Fig. 9. CH spectrum at the $^2\Pi_{1/2}$, $J=1/2$, $F=1\rightarrow1$ transition at 3335.481 MHz. The position is 23′ north-east of NGC 2071 [R.A. (1950) = $05^h45^m00^s$, Dec. (1950) = +00°35′]. Frequency resolution is 10 kHz (0.9 km/s)

Conclusions

a) In agreement with MG the excitation temperature of the 1667 MHz line near W 12 is within ~1 K of the background temperature. The excitation temperature of the 1665 MHz line is even lower.
b) The narrow absorption line in W 12 is probably physically associated with the H II region since the emission counterpart is only seen adjacent to the source. The broad emission line associated with the dark cloud L 1630 is also seen near W 12 but disappears to the west where the extinction is lower. The excitation temperature of the OH giving rise to this line is ≧12 K near W 12. Hence the OH excitation temperature may be similar to that of CO (~20 K).
c) The distribution of OH in L 1630 has an essentially constant radial velocity but a quite varying velocity half-width. The intensity has a maximum and the velocity half-width a minimum near NGC 2068 in agreement with H I observations (Sancisi, 1970). There is a weak correlation of T_A (1667) and optical extinction

Table 3. CH and OH data near NGC 2071

Line	Filter (kHz)	R.A. (1950)	Decl. (1950)	Velocity, V (km/s)	$\Delta V_{1/2}$ (km/s)	T_A (K)
CH	10	$05^h45^m00^s$	+00°35′	9.3±0.1	1.6±0.2	0.10 ±0.02
CH	10	05 46 00	+00 35	9.3±0.2	2.0±0.5	0.06 ±0.01
CH	10	05 47 00	+00 35	8.9±0.5	3.6±0.6	0.05 ±0.02
CH	10	05 46 00	+00 50	8.5±0.8	4.5±1.0	0.045±0.02
CH	10	05 46 00	+00 20	9.3±0.8	4.9±0.8	0.06 ±0.02
OH	10	05 44 33	+00 42	9.0±0.3	2.4±0.6	0.11 ±0.03
OH	1	05 44 33	+00 27	9.1±0.1	2.1±0.2	0.22 ±0.03
OH	10	05 45 33	+00 42	9.2±0.3	3.1±0.5	0.10 ±0.02
OH	1	05 45 33	+00 27	9.2±0.1	1.8±0.3	0.15 ±0.03

as derived from star counts. In general the velocity half-width is 3–6 km/s and is much larger than previously found in dark clouds. On a scale of 30′ these broad lines are not made up of many unresolved sharp features since all observations were made with 0.18 and 1.8 km/s velocity resolutions. The OH properties agree with the CO properties as determined by Tucker *et al.* (1973).

d) The OH observations of the large globule L 1622 show a double profile. The low velocity component is associated with the globule while the high velocity component arises from L 1630.

e) The radial velocity and half-power width of CH lines near NGC 2071 are in good agreement with those of the OH lines.

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W. M. Goss
CSIRO, Division of Radiophysics
P.O. Box 76
Epping, N.S.W., 2121, Australia

A. Winnberg
Max-Planck-Institut für Radioastronomie
D-5300 Bonn 1
Auf dem Hügel 69
Federal Republic of Germany

L. E. B. Johansson
Onsala Space Observatory
S-43034 Onsala, Sweden

A. Fournier
Kapteyn Astronomical Institute
University of Groningen
P.O. Box 800
NL-8002 Groningen, The Netherlands