FORMALDEHYDE IN L1551, L134 AND THE GALACTIC CENTRE

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The formaldehyde molecule is an excellent probe of physical conditions inside interstellar clouds. We illustrate this by presenting results of our recent series of observations using the MPIfR Effelsberg 100-m radio telescope for the 6-cm transition, the NRAO Green Bank 43-m radio telescope for the 2-cm transition and the NRAO Kitt Peak 11-m mm-wave telescope for the 2-mm transition.

L1551 AND L134

We have mapped the L1551 dark cloud in these three lines (see fig. 1), and a hyperfine analysis (as described by Sandqvist and Lindroos 1976) has been applied to the 6-cm absorption profiles. As a separate approach to the study of this cloud we have constructed a model, fitting the predicted line intensities to the observed intensities in all three lines with the use of a Monte Carlo procedure (Bernes 1978, 1979) for solving the radiative transfer equation. Both analyses indicate decreasing 6-cm excitation temperature towards the centre of the cloud, demanding a corresponding rise in the kinetic temperature. According to the model the kinetic temperature increases from 11 K in the cloud periphery to 20 K in the central regions and the hydrogen number density increases from 10^3 cm^{-3} to slightly above 10^4 cm^{-3} in the centre. Column densities calculated from the hyperfine analysis show a marked increase towards an embedded 2.2 μ infrared object (source no. 5, Strom et al. 1976). A high-density region at this point has been included in the model, which here indicates a hydrogen number density of 4-5 10^4 cm^{-3} but no increase of the kinetic temperature.

A 2-cm H_2CO absorption profile of high quality (fig. 2) has been obtained towards L134. The hyperfine analysis of this profile yielded an excitation temperature of 2.0 K, a total optical depth of 1.0 and a velocity dispersion of 0.12 km s^{-1} for the 2-cm absorption line. These results are found to be inconsistent with our upper limit to the 2-mm line intensity and an earlier 6-cm hyperfine analysis by Downes et al. (1976).

B. H. Andrew (ed.), Interstellar Molecules, 103–107.

A detailed presentation of the above results for L1551 and L134, as well as an analysis of formaldehyde observations of L1317(S187) and NGC 7023 will be published in the near future in Astronomy and Astrophysics.

THE SGR A +40 KM s^{-1} MOLECULAR CLOUD

The +40 km s^{-1} feature in the galactic centre has been studied in detail in the absorption lines of H I, OH and H_2CO (6-cm) seen towards Sgr A (Sandqvist 1970, 1974). Through a series of lunar occultations, observed with the NRAO 43-m radio telescope, the continuum source Sgr A was resolved into several components, now generally known as Sgr A East and Sgr A West. Furthermore, the +40 km s^{-1} cloud was also resolved into several components, with major features having velocities of +50 and +25 km s^{-1}. There is some evidence of a general velocity gradient across the complex. It is noteworthy that the OH observations show a concentration of molecules directly towards Sgr A West that is smaller than in some of the surrounding regions. This effect was also noted in the aperture-synthesis observations of 6-cm H_2CO line absorption in the Sgr A complex by Whiteoak et al. (1974); their interpretation was that the molecular region is mainly behind the continuum sources. On the other hand, Liszt et al. (1975) found that there is a decrease of CO emission line intensity towards Sgr A West and hence that the H_2CO absorption results do not necessarily imply that the molecular region is on the far side of the galactic nucleus. The HCN emission line results of Fukui et al. (1977), which have a 2' resolution, show a minor decrease of intensity in the direction of Sgr A West, and these authors place the molecular region on the far side of the nucleus.

In the analysis of the occultation and aperture-synthesis absorption data mentioned above, it was assumed that all the continuum sources lay behind the molecular region. If this assumption is abandoned, and a re-analysis is performed and a comparison made with 2-mm H_2CO line emission, it may be possible to determine the relative positions of the continuum and the molecular regions; while the absorption line data are affected by the relative arrangement of these regions, the emission line data are not. With this in mind, we have begun mapping a region around Sgr A in the 2-mm H_2CO line, and here we present some of the preliminary observations.

The mapping observations so far obtained are presented in fig. 3, where the top small numeral in each square gives the maximum T_A-value (K) for each 2-mm profile, and the large numerals represent $\int_{line} T_A\, dV$ (K km s^{-1}). The bottom small numerals give the approximate radial velocity V(km s^{-1}) of the T_A^*-peak. The map, consisting of grid points with 1' spacing, is centered on the position of Sgr A West at $\alpha(1950.0)= 17^h42^m29\overset{s}{.}3$, $\delta(1950.0)= -28^\circ59'18''$ (the reference "off"-point in the position-switching observing mode was $\alpha(1950.0)=17^h41^m29\overset{s}{.}3$, $\delta(1950.0)= -28^\circ59'18''$). The 2-mm H_2CO numbers are superimposed on a map of the OH distribution (solid contours) and the 18 cm continuum (dashed contours) as obtained by lunar occultation observations (Sandqvist 1974). The OH

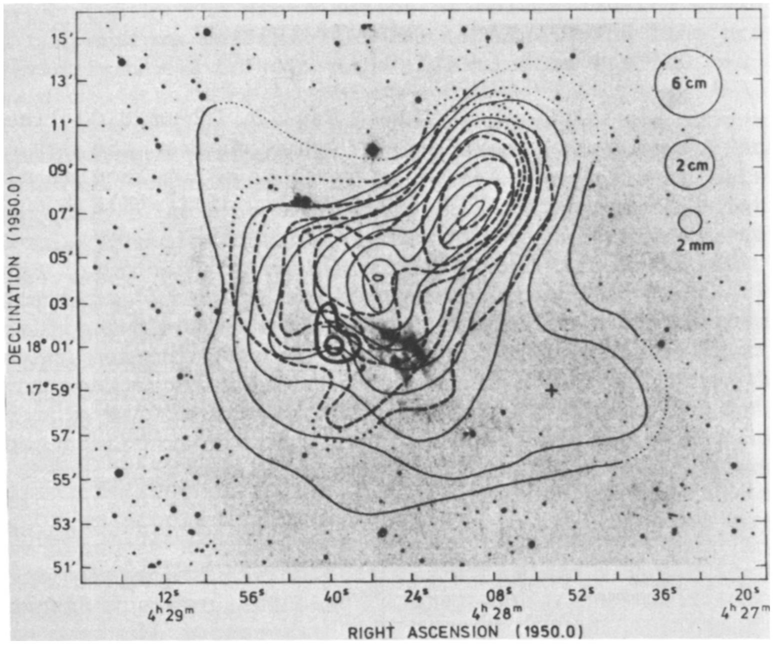

Fig. 1. The dark cloud L1551. H_2CO contours of 6-cm (thin solid lines) and 2-cm (dashed lines) brightness temperatures, and 2-mm (heavy solid line) T_A^*, superimposed on the red print of the National Geographic Society-Palomar Sky Atlas. The crosses mark positions of five 2.2 μ infrared sources (Strom et al. 1976). The large nebulosity is S239. The 6- and 2-cm and the 2-mm beams are shown in the upper right hand corner. Contour intervals are -0.1, -0.03 and +0.2 K for the 6-cm, 2-cm and 2-mm lines, respectively, with the outermost contour having values of -0.2, -0.9 and +0.4 K, respectively.

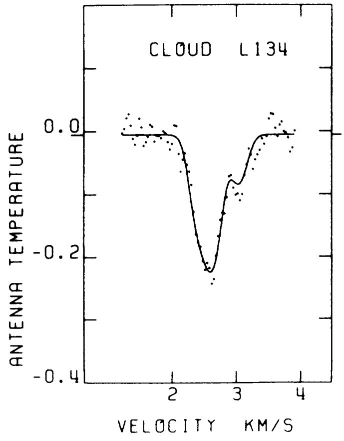

Fig. 2. A 2-cm H_2CO absorption profile (dots) observed towards L134 ($\alpha(1950.0)=15^h50^m54^s$, $\delta(1950.0)=-04^o31'00''$). The velocity resolution is 0.08 km s^{-1}, and the integration time was 8 hours. The beamwidth was 2'.1 and the beam efficiency 0.5. The profile determined from a hyperfine analysis is shown as a solid line.

https://doi.org/10.1017/S0074180900072296 Published online by Cambridge University Press

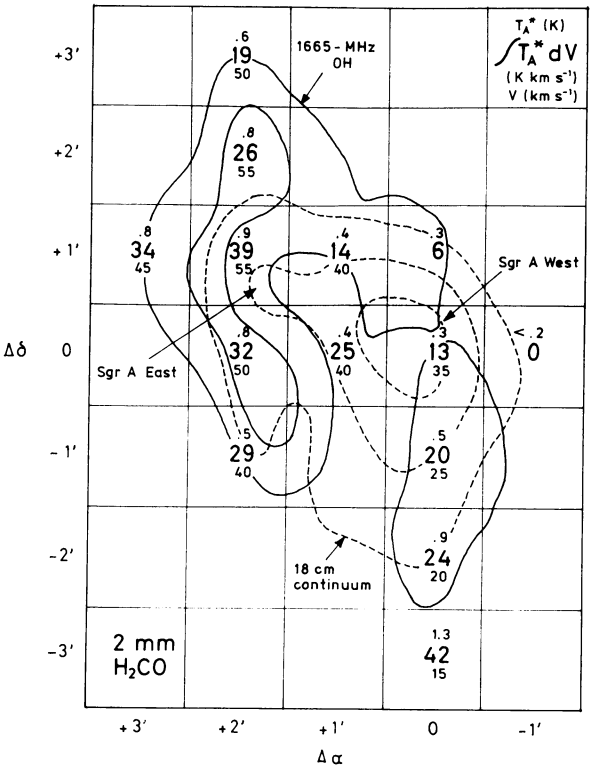

Fig. 3. 2-mm H_2CO line emission from the Sgr A +40 km s^{-1} molecular cloud. Values of T_A^* (K), $\int_{line} T_A^*\,dV$ (K km s^{-1}) and V(km s^{-1}) are given at each observed point. The origin is at $\alpha(1950.0)= 17^h42^m29^s\!.3$, $\delta(1950.0)= -28^o59'18''$. The solid line contours represent the OH distribution and the dashed contours the 18-cm continuum (Sandqvist 1974).

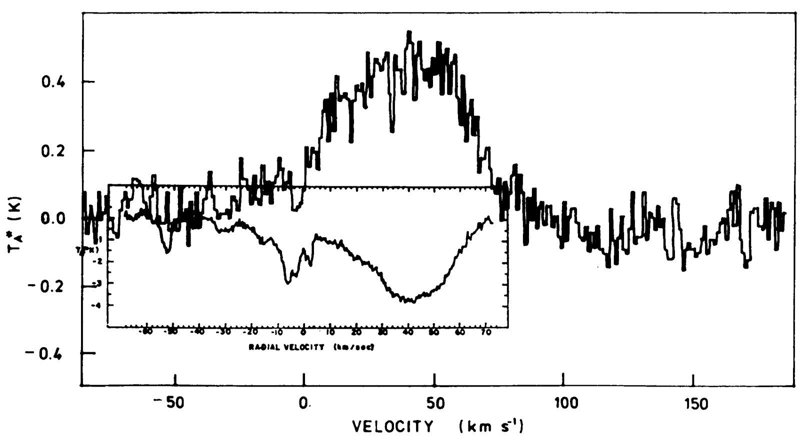

Fig. 4. The averaged profile of all the 2-mm H_2CO observations in fig. 3. The velocity resolution is 1.1 km s^{-1}. A 6-cm H_2CO absorption profile (Sandqvist 1970) observed towards Sgr A with a velocity resolution of 0.5 km s^{-1} is inserted for the sake of comparison.

is represented by the distribution of column density divided by excitation temperature for the 1665-MHz OH line. The line profile has been integrated from -42 to +102 km s^{-1}, excluding the -30 and 0 km s^{-1} features.

The averaged profile of all the 2-mm H_2CO observations in fig. 3 is shown in fig. 4, and can be thought of as having been obtained with an approximately 3' x 6' beam. There is a remarkable similarity between this 2-mm H_2CO emission profile and the 6-cm H_2CO absorption line profile observed towards Sgr A with a beamwidth of 6'.6 (Sandqvist 1970, reproduced in fig. 4), which may be an indication that most of the continuum sources lie behind the molecular region. The general velocity gradient across the molecular complex, discovered through the lunar occultation observations, appears to be confirmed by the 2-mm observations. The decrease in H_2CO column density towards Sgr A West (as indicated by the decrease of the integrated 2-mm values in fig. 3) still leaves it undecided whether the molecular region is on the near or far side of the galactic nucleus. It is hoped that the complete mapping of this region and the above-mentioned analysis may resolve this problem.

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