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CARBON MONOXIDE IN THE ORION NEBULA

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ABSTRACT

We have found intense 2.6-mm line radiation from nine galactic sources which we attribute to carbon monoxide.

We have detected intense line radiation from the direction of the Orion Nebula at a frequency of 115, 267.2 MHz (in the "local standard of rest" system) which we attribute to the transition $J = 1$ to $J = 0$ in carbon monoxide. The observed spectrum is dominated by a single line with a peak antenna temperature of about 40° K and a width of 2.4 MHz (6.2 km sec^{-1}).[1] A spectrum measured with 2-MHz resolution is shown in Figure 1. This feature is most intense in a direction about 1′.2 northwest of the center of the continuum source, which corresponds closely to the direction of the OH emission, the IR star, and the IR nebula (cf. Fig. 2*b* of Schraml and Mezger 1969). A series of spectra taken at 1′ intervals of right ascension (approximately the beam width of the antenna) at a declination of −5°24′21″ (1950) clearly show line features out to at least 25′ in each direction from the center. About one-twentieth of the peak antenna temperature was observed at these limits. The angular distribution is strongly peaked to the center, is asymmetrical, and decreases smoothly but not monotonically from the center (Fig. 2). The center frequency of the line changes only slightly with angle, while the width of the line generally decreases away from the center of the source. The full angular width at half-maximum is 5′.5. In contrast to this, the map of Ori A made in the 1.95-cm continuum by Schraml and Mezger (1969) shows a width at one-twentieth of the peak temperature of only 10′ and a half-power width of 4′ with a monotonic decrease from the center of the source.

The frequency of the transition $J = 1$ to $J = 0$ in $^{12}C^{16}O$ is given as 115, 271.201 MHz in the NBS tables (Cord, Lojko, and Peterson 1968). Our observed center frequency thus corresponds to a velocity of 10.5 km sec^{-1} with respect to the "local standard of rest" with a full width at half-maximum of 6.2 km sec^{-1}. This may be compared with OH velocities reported in the range −8 to +24 km sec^{-1} (Palmer and Zuckerman 1967), H_2O velocities from −8 to +18 km sec^{-1} (Knowles, Mayer, and Sullivan 1969), and a 109*α* recombination-line peak at −2.6 km sec^{-1} (Mezger and Höglund 1967).

Preliminary measurements of a number of other galactic sources have shown the same spectral line in the direction of W3, Sgr A, Sgr B2, M17, W43, W44, W49, and W51. In each of these sources, the velocities of the most intense CO feature generally correspond well with published velocities in other lines.

This work was done with a specially constructed line receiver mounted on the NRAO 36′ paraboloid. Schottky barrier diodes developed by C. A. Burrus of Bell Laboratories were used in Sharpless wafer units both in the signal mixer and in a harmonic mixer used to control the frequency of the local oscillator klystron. Calibration noise was provided

[1] These numbers come from a measurement using the National Radio Astronomy Observatory (operated by Associated Universities, Inc., under contract with the National Science Foundation) fifty-channel spectral-line receiver (nominal 100-kHz resolution). The remainder of our measurements were made with the NRAO forty-channel receiver (2-MHz measured resolution).

by an avalanche diode mounted in a wave guide. Details of these devices will be published elsewhere. The low-noise 1390-MHz IF preamplifier and forty-channel line receiver were provided by NRAO.

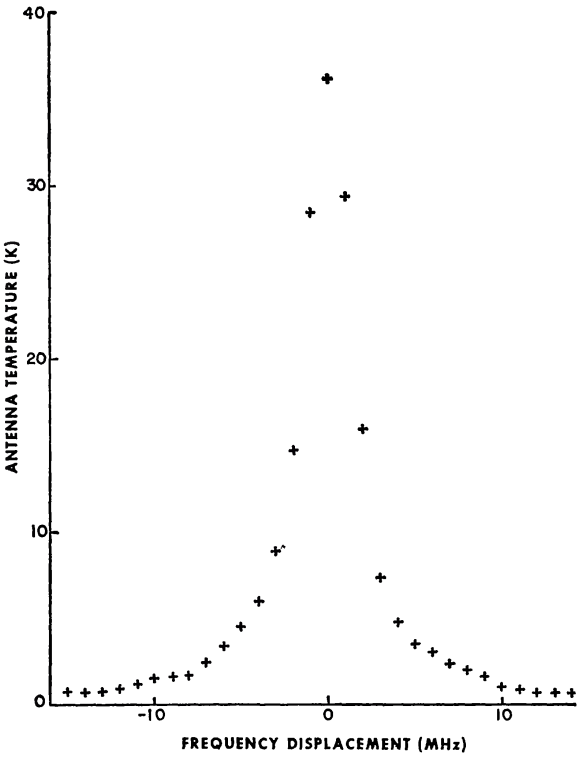

FIG. 1

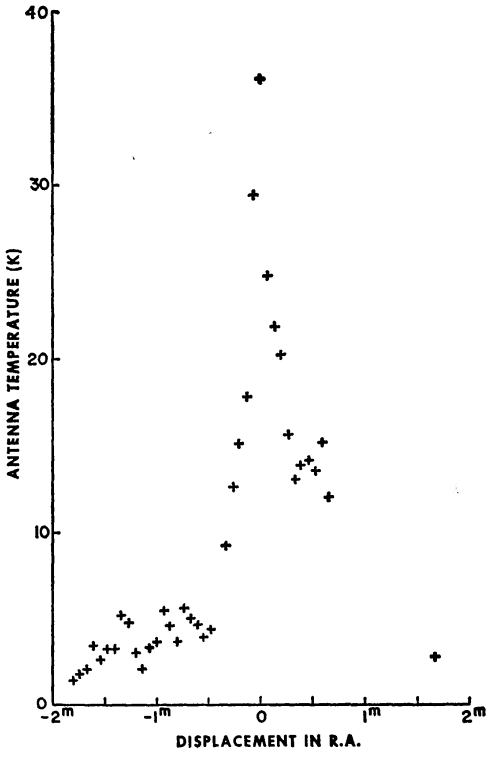

FIG. 2

FIG. 1.—Spectrum of CO radiation in the Orion Nebula made with the NRAO forty-channel line receiver. The center frequency is 115, 267.2 MHz.

FIG. 2.—Distribution in right ascension of the peak antenna temperature of CO radiation at a declination of −5°24′21″.

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We wish to acknowledge stimulating discussions with P. Thaddeus and P. Solomon which led us to undertake the study of molecules in this part of the spectrum.

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