SEARCH FOR CO IN ATOMIC HYDROGEN CLOUDS

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The relationship between dense molecular clouds and diffuse clouds, as well as the mechanisms connected with the formation of molecules in diffuse clouds, may be studied using HI 21-cm line observations and molecular line observations in the same directions. For this purpose we previously studied the OH 18-cm main lines (Kazès et al., 1977) and the 2.6-mm CO lines (Crovisier and Kazès, 1977) in directions where strong 21-cm absorption features had been detected in the Nancay survey (Crovisier et al., 1978). Liszt and Burton (1979) also measured CO lines toward 19 directions observed in the Arecibo 21-cm emission/absorption survey (Dickey et al., 1978). This paper presents preliminary results of a more comprehensive search for ^{12}CO in directions previously studied in the Nancay survey.

The observations were made at 2.6 mm with the NRAO 11-m millimetre-wave radio telescope on Kitt Peak (the National Radio Astronomy Observatory is operated by Associated Universities, Inc., under contract with the National Science Foundation). Each direction was observed for 20 minutes with 0.26 and 0.65 km/s velocity resolutions and a position-switching technique (detection limit: $T_A^* = 0.5$ K). Seventy-six directions were investigated, mainly at low and intermediate galactic latitudes toward extragalactic sources showing strong 21-cm absorption in the Nancay survey. The CO line was detected in 22 HI clouds, out of which 16 were new detections.

All the detected CO features correspond in velocity to HI absorption features. However, the antenna temperatures of the detected lines are neither correlated with the corresponding HI optical depths, nor with the HI column densities at the same velocities (see Figure 1). This result does not confirm the strong correlation claimed by Liszt and Burton (1979).

The present investigation shows that in approximately 1/4 of the lines of sight, physical conditions are such that HI to H_2 conversion has occurred in appreciable quantities to allow the formation and hence the detection of CO. The overwhelming presence of HI in a line of sight may result in a blend of several features corresponding to different clouds. The deduced spin temperatures (90 K on the average) are the harmonic means

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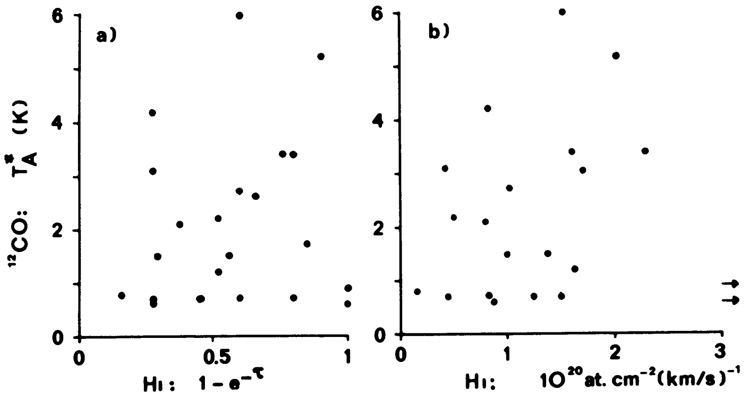

Figure 1. The equivalent antenna temperature of the CO detected spectral features as a function of a) the HI 21-cm absorption, b) the HI column density per unit velocity, at the CO velocity.

of the real spin temperatures along the line of sight. Therefore, the detectable molecular emission cannot be directly related to the deduced spin temperature, but it is plausible that the CO is formed in a restricted, cold and well-shielded region of the line of sight. The relatively low detection rate obtained from our fairly large sample tends to support the scarcity of these privileged regions.

CO velocities do not coincide with the central velocities of the HI absorption features: the velocity difference has a dispersion of $[(V_{CO} - V_{HI})^2]^{\frac{1}{2}} \sim 1.6$ km/s. While this value is comparable to that of the internal velocity dispersion of the HI features (σ_V = FWHM/2.35 $\sim$ 1.6 km/s), the CO lines are significantly narrower ($\sigma_V \sim 0.7$ km/s). This result adds weight to the argument that the detected CO is associated with only a small fraction of the HI in the line of sight. A more comprehensive study of the distribution of molecules in diffuse clouds would need mapping in both molecular and HI lines.

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