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PRELIMINARY RESULTS ON THE MOLECULAR EMISSION FROM THE T TAURI CIRCUMSTELLAR DISK

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ABSTRACT We report the initial results of a study of the chemical composition of the T Tauri circumstellar disk. The excitation and distribution of CS and HCO^+ are discussed. These two molecules behave quite differently in the YSO environment.

OBSERVATIONS

Although there has been a substantial amount of work on the physical structure of circumstellar disks, very little is known about their chemical composition. We have therefore started a program to obtain single–dish and interferometer observations of a number of YSO's with associated circumstellar disks. We report here the preliminary results for two molecules, CS and HCO^+, in the T Tauri circumstellar region.

Observations of CS in the J=2→1 line and of HCO^+ in the J=1→0 were carried out with the Owens Valley Millimeter Array (OVRO). Complementary single–dish observations of higher excitation lines were obtained with the CSO and the IRAM 30m telescope. We show in Figure 1 spectra of several HCO^+ and CS lines observed with different spatial resolution.

The excitation of HCO^+

At least two components are needed to explain the HCO^+ lines. The ratio of the J=3→2 to J=4→3 lines requires a density of at least $1 \cdot 10^6$ cm^{-3}. Combined with single–dish $C^{18}O$ J=2→1 observations, we estimate the HCO^+ fractional abundance to be $1 \cdot 10^{-9}$. The HCO^+ lines probably arise in a warm region ($\approx$ 100K), from which the J=1→0 line is expected to be slightly *weaker* than the higher excitation lines. An additional colder, less dense component is therefore required to explain the strong J=1→0 emission.

The single dish spectra already show that HCO^+ traces some kind of activity; the wings in the high excitation lines seem to indicate either outflow or rotation. This is also observed in the line profile seen with the interferometer, since its width resembles that of the higher excitation lines. The wings can be detected out to a velocity of $\pm$7.5 km s^{-1} from line center, appear to be unresolved and coincide almost exactly with the stellar position in the interferometer maps. In contrast, the integrated HCO^+ emission peaks offset from the star. If the wings were caused by Keplerian rotation around a 1 $M_\odot$ body seen almost face on, we would be forced to conclude that the HCO^+ arises as close as several AU to the star, which is quite unlikely. It is more plausible that this

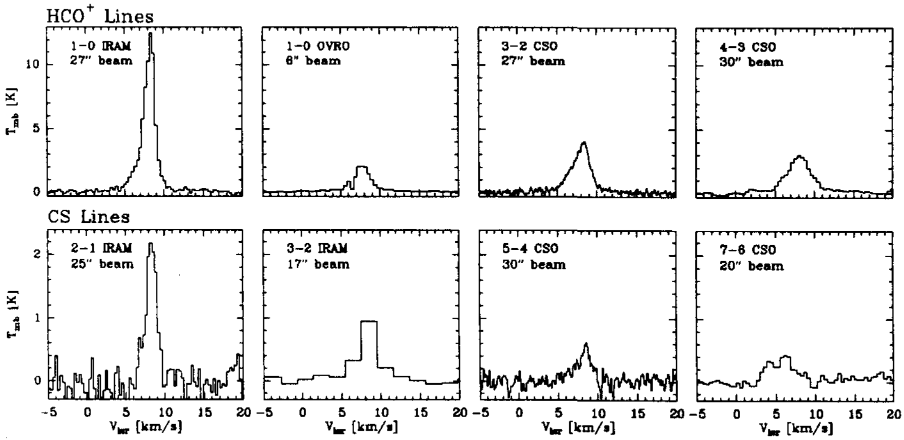

FIGURE I HCO$^+$ and CS spectra. The Owens Valley beam only partly resolves the HCO$^+$ J=1→0 line, but almost completely resolves the CS J=2→1 line.

HCO$^+$ results from the interaction of the fast stellar wind with the surrounding molecular material.

The CS distribution

CS was detected in the T Tauri region in a number of transitions. We model the J=7→6 and J=5→4 lines with the same warm dense region as found for HCO$^+$. The derived column density is $3 \cdot 10^{12}$ cm^{-2}. Most of the J=2→1 emission has to come from a region with different physical conditions. We identify this again with a cold (< 30 K) surrounding cloud.

The CS fractional abundance is estimated to be $\approx 1 \cdot 10^{-10}$, which is low compared with the abundance of $\approx 1 \cdot 10^{-8}$ found in the rest of the Taurus cloud. Furthermore, the interferometer data show that there is very little compact CS emission in the direction of T Tauri. A combined OVRO and IRAM 30m map clearly shows the CS peak emission to be offset from the position of the continuum source. These results lead to the conclusion that CS in T Tauri has a low abundance close to the star.

CONCLUSIONS

Warm HCO$^+$ seems to be prominent in the T Tauri circumstellar region, especially near the inner disk where the densities are high. It clearly traces activity close to the star. Furthermore we show that CS is most likely depleted in the T Tauri circumstellar disk, similar to our findings for HL Tauri (Blake et al. 1992). This seems to be a general difference between T Tauri stars and embedded objects (Ohashi et al. 1991), and may be explained as condensation of CS and other polar molecules onto grains.

Blake, G.A., van Dishoeck, E.F., Sargent, A. 1992, *Ap J* **391** L99
Ohashi, N., Kawabe, R., Hayashi, M., Ishiguro, M., 1991, *AJ* **102** 2055