THE RELATIVE DISTRIBUTION OF AMMONIA AND CYANOBUTADIYNE EMISSION IN HEILES 2 DUST CLOUD

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A map of the NH_3 (1,1) emission in Heiles 2 dust cloud, observed with 2.2 arc min. resolution, is presented and compared with that of the $J = 9 \rightarrow 8$ transition of HC_5N. Although the distribution of both molecules lies on a ridge, there is a marked anti-correlation in the observed antenna temperatures of the two molecules along it. This appears to be best explained as a variation in the relative abundances of the two molecules along the ridge by a factor 8-20 in a distance of 10^{18} cm.

Interest has focused on the dark dust cloud Heiles 2 since the discovery within it of numerous cyanopolyynes $HC_{2n}CN$ (e.g. Broten et al. 1978). Using the SRC Appleton Laboratory 25m radio telescope ($\eta_B \approx 0.37$) we have mapped Heiles 2 in the $J = 9 \rightarrow 8$ transition of HC_5N at 24 GHz (Little et al. 1978) and also in the NH_3 (1,1) transition at 23.7 GHz first detected there by Rydbeck et al. 1977 (see figure 1).

Although the emission from both molecules lies along a ridge, there is an interesting anti-correlation between the two along it. It is hard to explain this as a subtle excitation effect; a genuine variation in chemical abundance seems more likely.

At the NH_3 peak the optical depth in the NH_3 (1,1) line was found to be $\tau = 1.5 \pm 0.25$ from the main/hyperfine component ratio. Comparing this value with $\tau = 0.4 \pm 0.2$ deduced by Rydbeck et al. at the HC_5N peak shows that the increase in NH_3 antenna temperature going from the HC_5N peak to the NH_3 peak is accompanied by increase in τ. From the measured dimensions of the NH_3 source, the observed antenna temperature, and τ, the excitation temperature of the NH_3 and hence the density of colliding particles (hydrogen molecules) may be deduced, assuming a kinetic temperature 10K. Results in the range $n_{H_2} \sim (1 \text{ to } 5) \times 10^4$ cm^{-3} are obtained. This molecular hydrogen density may then be used to determine the excitation conditions for HC_5N. The result of this procedure is to suggest that, moving along the Heiles 2 ridge from NW to SE, a decrease in NH_3 column density is accompanied by an actual increase in that of HC_5N, with a relative variation by a factor of 8 to 20.
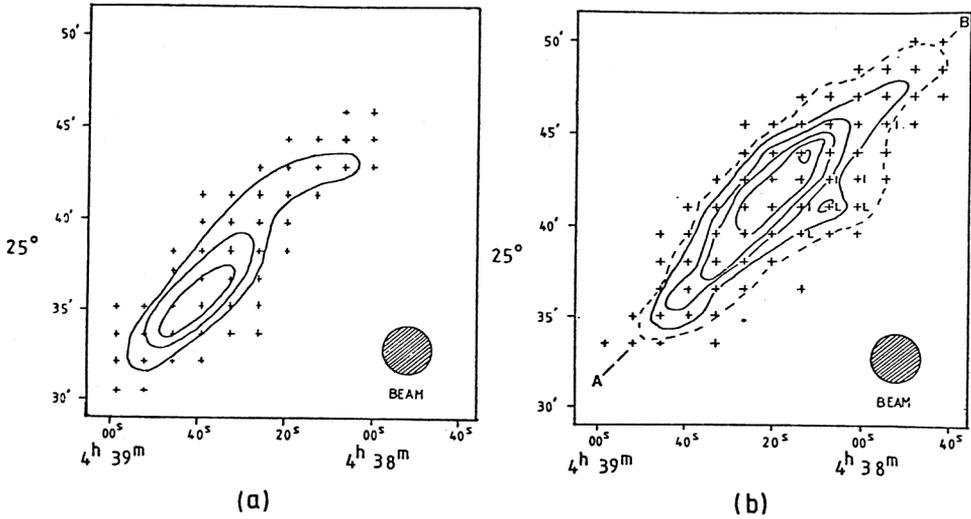
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Figure 1. Contours of peak antenna temperature in the lines
(a) $J = 9 \rightarrow 8$ HC_5N (resolution 0.30 km/s) (b) (1,1) NH_3 (resolution 0.43
km/s). Positions lettered I have LSR velocities between 5.4 and 5.7
km/s; those lettered L have velocities between 5.2 and 5.4 km/s, and
represent evidence for a second weak component on the W flank. Other-
wise LSR velocities do not differ significantly from 5.8-5.9 km/s. The
line widths suggest Doppler broadening $\sim$0.4 km s^{-1}. For the HC_5N map
the contour interval is 0.2K (lowest contour 0.3K). For the NH_3 map the
contour interval is 0.15K (broken contour 0.2K).

        The explanation for this behaviour is unknown. In ion-molecule
schemes for interstellar chemistry (e.g. Smith & Adams 1978) CN and HCN
are produced from NH_3 by reaction with ions such as C^+, CH_3^+, and it is
conceivable that the polyynes are formed from these molecules via reactions
with $C_2H_3^+$, $C_4H_3^+$ etc. (Walmsley et al. 1980). An abundance variation of
some of these ions could lead to an increase in [HC_5N] while at the same
time decreasing [NH_3]. Variation of the cosmic ray and u.v. ionization
rate with position in the cloud might produce such an effect.

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