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

L.T. Little[1], G.H. Macdonald[2], P.W. Riley[2] and D.N. Matheson[3]
[1]DERAD, Observatoire de Meudon, 92190 Meudon, France
[2]Electronics Laboratory, University of Kent at Canterbury, UK
[3]SRC Appleton Laboratory, Chilbolton Observ., Stockbridge, UK

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.

B. H. Andrew (ed.), Interstellar Molecules, 67–68.

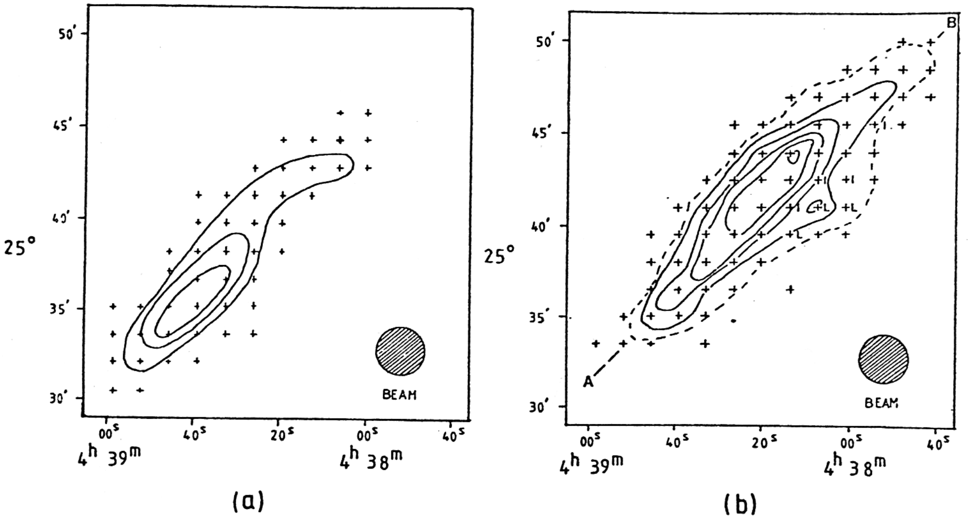

Figure 1. Contours of peak antenna temperature in the lines (a) J = 9→8 HC_5N (resolution 0.30 km/s) (b) (1,1) NH_3 (resolution 0.43 km/s). Positions lettered I have LSR velocities between 5.4 and 5.7 km/s; those lettered L have velocities between 5.2 and 5.4 km/s, and represent evidence for a second weak component on the W flank. Otherwise 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.

REFERENCES

Broten, N.W., Oka, T., Avery, L.W., MacLeod, J.M., and Kroto, H.W.: 1978, Astrophys. J. (Letters) 223, pp. L105-L107.
Little, L.T., Riley, P.W., Macdonald, G.H., and Matheson, D.N.: 1978, Mon. Not. R. astr. Soc. 183, pp. 805-811.
Rydbeck, O.E.H., Sume, A., Hjalmarson, A., Elldér, J., Rönnäng, B.O., and Kollberg, E.: 1977, Astrophys. J. (Letters) 215, pp. L35-L40.
Smith, D., and Adams, N.G.: 1977, Astrophys. J. 217, pp. 741-748.
Walmsley, C.M., Winnewisser, G., and Toelle, F.: 1980, Astron. Astrophys., in press.

https://doi.org/10.1017/S0074180900072168 Published online by Cambridge University Press