C_2H AND HC_3N IN INTERSTELLAR CLOUDS

Alwyn Wootten
Owens Valley Radio Observatory, Caltech
Dept. of Astronomy, University of Texas
G.P. Bozyan, D.B. Garrett, R.B. Loren, R.L. Snell,
P. Vanden Bout
Dept. of Astronomy, University of Texas

A survey for the molecules C_2H and HC_3N in a variety of interstellar clouds has been completed. Both molecules are very widespread, in cold dark clouds as well as in hot clouds. C_2H emission has been mapped in L1534. In cold clouds the fractional abundance $X(C_2H)$ is found to be $2\text{-}6\times10^{-9}$. The ratio of abundances $X(C_2H)/X(HC_3N)$ falls in the range 6-10, consistent with some gas-phase reaction schemes for these molecules.

C_2H has not previously been detected in cold dark clouds. Since HC_3N has been detected in abundance in a number of clouds, and since both molecules are thought to derive from the same precursor molecule $C_2H_2^+$ in gas-phase chemistry, we have surveyed a number of clouds for C_2H and HC_3N emission. As a result, both molecules have been found in a variety of clouds: cold dark clouds, clouds near Herbig-Haro objects, and in complexes near HII regions.

The C_2H line was sufficiently strong to permit detailed mapping in L1534, L43, and M17SW. These maps show that C_2H emission is strongly correlated with emission from other molecules excited in dense regions.

In L1534 the C_2H map displays a distinct maximum near the peak HC_5N emission found by Little et al. (1978). An additional peak which does not correspond to an HC_5N emission peak has been found to the northwest. This additional peak has also been found in absorption at 2 cm by formaldehyde.

The column density of C_2H is in general similar to that of HCO^+ or H_2CO. The ratio of collisional to radiative timescales is also similar for these molecules. Therefore C_2H emission probably arises in regions similar to those producing HCO^+ and H_2CO emission. This conclusion is strengthened by the similarity of the maps of these species. We have therefore used a large velocity gradient (LVG) code to determine the abundance of C_2H, $X(C_2H)$, following the procedure detailed in Wootten et al. (1978). We find $X(C_2H) \sim 2\text{-}6\times10^{-9}$ in cold dark clouds, (L63, L134N, L1534, L1529) but is probably much lower, $X(C_2H) \sim 10^{-10}$, in

B. H. Andrew (ed.), Interstellar Molecules, 81–82.

https://doi.org/10.1017/S007418090007220X Published online by Cambridge University Press

denser, warmer clouds (M17SW, ρ Oph, NGC2264). Using a similar analysis for the J=5-4 line of HC_3N allows us to estimate the abundance ratio $X(C_2H)/X(HC_3N) \sim 6-10$ for most clouds. In M17SW the ratio appears to be 37.

In a simple chemical reaction scheme, C_2H is created by electron recombination on $C_2H_2^+$ and destroyed by reaction with oxygen. HC_3N is created by reaction of $C_2H_2^+$ and HCN, followed by electron recombination; it is destroyed by reactions with C^+ or He^+. The abundance ratio $X(C_2H)/X(HC_3N) \sim 10$ is consistent with this scheme.

The abundance of C_2H appears to be somewhat higher in the Taurus cloud L1534 than in two otherwise similar clouds L134N and L63. Langer (1976) demonstrated that the CO abundance in a chemically evolving cloud reaches equilibrium only after fairly lengthy timescales; and that before it attains equilibrium the excess of free carbon in the cloud can lead to elevated C_2H abundances. Perhaps equilibrium in carbon chemistry has not yet been reached in the clouds with highest abundances of C_2H.

REFERENCES

Langer, W.D.: 1976, Astrophys. J. 206, 699.
Little, L.T., Riley, P.W., MacDonald, G.H., and Matheson, D.N.: 1978, M.N.R.A.S. 183, 805.
Wootten, A., Evans, N.J., Snell, R., and Vanden Bout, P.: 1978, Astrophys. J. (Letters) 225, L143.

https://doi.org/10.1017/S007418090007220X Published online by Cambridge University Press