OBSERVATIONS OF MOLECULES IN DIFFUSE CLOUDS

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We are actively engaged in observing and analysing molecules in diffuse clouds, in the directions of reddened stars (1). This paper presents some recent results: In the ultraviolet, using the IUE satellite, we have so far observed 60 stars in a continuing programme to study interstellar CO, with more than 30 detections of ^{12}CO and 10 of ^{13}CO; almost all of these are new detections (2). The results have been compared with microwave observations of CO in selected directions, and with our own and other optical observations of CH, CH^+ and CN.

A catalogue has been prepared (3), of all observations of interstellar molecules (at all wavelengths) in sight-lines towards reddened stars, normalizing to a uniform set of oscillator strengths. Correlation analyses are in progress, giving relations between molecular column densities. The degree of scatter of points shows the closeness of the relation between the species concerned. The slope in a log-log plot shows how the relation varies with cloud properties - with column density, that is with cloud size or volume density. Theoretical interstellar chemistry needs to explain these relations.

A comparison of CH with H_2 shows a very close relation between the two molecules, with a distribution that is negligibly different from a 45^o slope. This means that the chemistry of CH must be very closely linked to H_2, with a relative abundance that is independent of cloud dimensions. On the other hand, for CO and H_2, there is a good relation but not so close as for CH and the distribution is distinctly different from a 45^o slope - the relative abundance of CO is greater in denser and more extensive clouds. This result has implications not only for interstellar chemistry but also for the study of the galactic distribution of H_2.

In contrast with these, a plot of CH^+ against CH shows very considerable scatter. This is consistent with the well-known result (1) that the CH abundance is two orders of magnitude greater than equilibrium chemical models can explain, so that it is probably formed by processes largely unrelated to CH and other molecules observed, perhaps in shock fronts. Within the scatter, however, there is a general tendency for the column

M. S. Vardya and S. P. Tarafdar (eds.), Astrochemistry, 133–134.

densities of CH^+ and CH to increase together. This may well be no more than the general trend of all interstellar column densities to increase with distance, which produces apparent correlations between totally unrelated species. However, CH also is enhanced in shocks (4).

Data are still very sparse for certain molecules, particularly the optical species CN, C_2 and OH. Most recently, we have searched for CN using the 2.5 metre Isaac Newton Telescope on La Palma (5), obtaining very high signal-to-noise with the IPCS detector. Several detections were made, but the spectral resolution currently available there is not adequate for study of very weak interstellar lines.

We have examined our IUE spectra for other interstellar lines, and claim a detection of MgH^+ in two sight-lines (6). The detection is tentative because it is based on only one spectral line, but there clearly is an interstellar line at the predicted wavelength and no other identification can be suggested. We have also a possible detection of HCl in one sight-line.

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