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Depletions And Extinction Curves For Lines Of Sight Through The Outer Edges Of Truly Dense Molecular Clouds

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Observations of a few moderately reddened (0.3 < E(B-V) < 0.6) lines of sight through the outer edges of truly dense molecular clouds, not only show the overall depletions in these clouds to be as much as 0.5 (dex) greater than in comparably reddened diffuse clouds, but reveal a possible tendency for certain species to deplete preferentially (Joseph *et al.* 1986). For example, the Cr/Fe and the Mn/Fe abundance ratios both appear to be substantially less (~0.6 dex) for lines of sight with large abundances (log N $\gtrsim$ 13.0) of cyanogen (CN). Chromium and manganese may be good discriminators between the condensation (Field 1974) and the accretion (Snow 1975) models, since both elements are expected to deplete less rapidly than Fe in the condensation model and more rapidly than iron in the accretion model. Similarly, depletions of certain species in the densest portions of the molecular lines of sight (inferred from abundances of neutral atoms) appear to be enhanced by more than 1.0 (dex) over those found for the entire sightline (Joseph *et al.* in prep.). Since the lines of sight observed so far are believed (on the bases of CN data) to have large spatial densities, the observed depletion pattern for these sightlines may represent the best observational evidence of dust-gas interactions, leading to density-dependent depletion.

Manganese is perhaps the best indicator of this new depletion mechanism, even though the three absorption lines of Mn II used in this study have similar wavelengths and oscillator strengths and usually are all close to being saturated. Mn is depleted only slightly (typically 0.8 in the log less than iron) in both diffuse interstellar clouds (Jenkins *et al.* 1986) and in the less dense regions of the ρ Ophiuchi Dense Cloud (Snow and Jenkins 1980). On the other hand, the depletion of manganese is systematically closer to the values found for iron in molecular lines of sight and in sightlines well into the Ophiuchi cloud. The depletion of Mn actually is measured to be larger than Fe in the line of sight to HD 21483, having the largest amount of CN (log N = 13.5) in the present study.

The above results suggest that the preferential depletion of certain species should be readily observable in diffuse clouds, if each species accretes with its own time constant and if dust-gas interaction is a dominant depletion mechanism. Although numerous authors have cited a correlation between spatial densities and the amount of overall depletion as evidence of interstellar accretion, a careful examination of the element-to-element depletion from one line of sight to another contradicts this claim (e.g. Snow and Jenkins 1980, Joseph, Snow and Morrow 1985). In addition, with one exception, Snow (1984) found abundance ratios in the dense cores of diffuse clouds to be similar to the cloud as a whole. If density enhancements do exist and if density-dependent depletion occurs in the diffuse interstellar medium, then differences in the depletion ratio of various elements should be observed between high and low density diffuse clouds as well as between the cloud cores and the whole sightline as they are for the molecular lines of sight observed by Joseph *et al.*

Most of these molecular lines of sight exhibit anomalously high far-UV extinction with weak to normal strength 2200 A bumps superimposed on the underlying extinction. In contrast, shock models (Seab and Shull 1983) predict the extinction to be stronger than normal in both the far UV and the 2200 A spectral regions. The type of extinction curve observed in the molecular clouds is predicted from a simple model of grain accretion where modest amounts of new material have been mantled onto a standard (Mathis, Rumpl, Nordsieck 1977) grain size distribution (Joseph *et al.* 1986). While, calculations show that an accretion of an additional 20% by mass onto the grains should be sufficient to produce these extinction curve anomalies, only volatile elements still have sufficient gaseous phase abundance to be able to alter the grain size distribution. Ice mantling is possible, however, since it is observed frequently for lines of sight well into dense molecular clouds (Joyce and Simon 1982) and thick mantles have been inferred for a similar nearby line of sight to HD 29647 (Goebel 1983).

It is worth emphasizing that these results should be considered to be tentative until additional molecular lines of sight can be observed at high spectral resolution. Each line of sight requires large amount of observing time in order to obtain the multiple spectral images necessary to provide a sufficient signal-to-noise ratio.

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