# THE ABUNDANCE OF INTERSTELLAR SULPHUR AND ZINC IN HIGH DENSITY SIGHT-LINES

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On the basis of early absorption line studies of individual lines of sight with the Copernicus satellite, chlorine, sulphur and zinc were classed together as elements which showed little or no depletion, relative to hydrogen, in the interstellar medium. The abundances of other less volatile elements, such as Fe and Mg were found to vary widely from one sight-line to another with gas-phase abundances in some cases being orders of magnitude below their solar counterparts. This depletion of elements from the interstellar gas is attributed to the existence of interstellar dust grains which contain a substantial fraction of the total mass of certain elements. Elements which show little or no depletion from the gas-phase are useful as tracers of metallicity or, alternatively, as a means of estimating hydrogen column densities, since their gas-phase abundances represent their true abundances in the interstellar medium. Recent work based on data from Copernicus and IUE has shown that in general depletion correlates well with the mean volume density of hydrogen, $\bar{n}(H)$, along a sight-line, while correlations with hydrogen column density, N(H), are generally much weaker (Harris et al, 1984). Indeed, the large-scale survey of Harris and Bromage (1984) has revealed, contrary to expectation, that even the volatile element chlorine is depleted by factors of 5 or more in certain sight-lines and the depletion increases markedly with increasing $\bar{n}(H)$. The conclusion of Blake et al (1985) that the under-abundance of HCl in the Orion Molecular Cloud implies that Cl is depleted by up to a factor of 30 in this dense region is in excellent agreement with the density dependent behaviour of Cl depletion in diffuse clouds discovered by Harris and Bromage. Spitzer (1985) has shown that an idealized model of interstellar gas distribution consisting of a warm, uniformly distributed component and two types of cloud component offers a direct explanation for the "preference" of elements to deplete according to $\bar{n}(H)$.

Here we report on detailed studies of the depletion/ density behaviour of two other volatile elements which were previously considered to be virtually undepleted, S and Zn, using equivalent width data from both Copernicus and IUE observations. The results provide further evidence that the established dependence of depletion on $\bar{n}(H)$ extends to volatile elements and show that their use as tracers of metallicity, or for estimating hydrogen column densities, may lead to large errors in sight-lines through dense regions (with $\bar{n}(H) \gtrsim 10\ cm^{-3}$). It now appears that such elements may take part in the surface chemistry of grains and be important constituents of grain mantle material, although they probably do not contribute significantly to the

bulk mass of grains. Due to the very similar atomic masses and ionization potentials of sulphur and phosphorous, the thermal velocity distributions of the singly ionized species of these elements in interstellar clouds should be very similar. However, a comparison of Doppler widths (b-values) derived for SII and PII in the same sight-lines from the Bohlin et al (1983) Copernicus equivalent width measurements has revealed an unexpected systematic discrepancy of a factor of ~ 1.7. This discrepancy indicates that the normally adopted oscillator strengths of the PII $\lambda\lambda$ 1153 and 1302 Å lines may require revision.

Full details of the work described here are given in Harris and Mas Hesse (1986 a,b).

References


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