INTERSTELLAR ABUNDANCE DETERMINATION USING IUE DATA

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INTRODUCTION

Analysis of the silicon interstellar abundances have been made for more heavily reddened lines-of-sight than were accessible to the Copernicus satellite. Silicon has rarely had accurate column densities determined from Copernicus data because the available lines all lie on the flat portion of the curve of growth for stars with $0.10 \lesssim E(B-V) \leq 0.35$. With IUE it is possible to reach color excesses of $E(B-V) \sim 0.5$-0.7, and in addition obtain data on the weak SiII line at 1808 Å, so that a wide range of oscillator strengths is available. The lower resolving power of the IUE, though, causes some difficulties in that several of the SiII lines are blended with strong lines of other species.

Data on the lines of sight analyzed so far have suggested that some of the absorption lines fall on the damped portion of the curve of growth, implying that silicon may not be as highly depleted as expected. The possibility cannot be ruled out at this time, however, that a curve of growth could be adopted with a higher b-value, so that none of the SiII lines are on the damped part, in which case substantial depletion would be inferred. The ambiguity is due in part to the recent discovery that some of the SiII lines have been assigned incorrect oscillator strength in the literature, and one line in particular (λ1526 Å) has an f-value which is too small. Work is currently under way by Shull and Snow using Copernicus to obtain correct values for these lines, which should then enable the correct determination of the silicon column density.

DATA REDUCTION

The column densities for silicon were determined from standard curve-of-growth analyses which exploit the relationship between absorption line equivalent widths and the column density of the absorbing particles. These results were then compared with column densities of HI, reduced according to the technique described by Bohlin (1975). The spectra used in this study are from recent observations by P. Conti, and are not subject to the Intensity Transfer Problems of earlier data. High-resolution IUE data were used in all cases.

The analysis was carried out on the interactive data system at the University of Colorado using a package of programs designed for interstellar abundance determinations (described in a separate paper, this Volume). The results discussed in this paper were obtained from the interstellar line spectra of the stars HD151804 (Spect. Class O9f, V=5.22, E(B-V)=0.41) and HD167659 (Spect. Class O8, V=7.39, E(B-V)=0.51), although the results were similar to those derived for a number of additional stars, to be described in a later paper.

The observed SiII lines used in the analysis have wavelengths at 1193, 1260, 1304, 1526, 1808 and 2334 Å, with the first two being of marginal use because they are blended with lines of Si and FeII respectively. When possible, an estimate of the contribution to the equivalent widths for each of the blended lines has been made from separate curve-of-growth analyses for CI and FeII. The SiII 2334 Å line, a forbidden intercombination line, is too weak in the current observations to produce a detectable absorption feature, and thus only provides an upper limit of its equivalent width. The remaining three lines consistently have small error bars associated with their equivalent widths and once the oscillator strengths are corrected should provide an unambiguous fit to a curve-of-growth.

The results of the analysis are as follows: The total hydrogen column density is 15.6E20 (Bohlin, et al., 1978) in the direction of HD151804 and is 25E20 in the direction of HD167659. Assuming that in each case some of the absorption lines do lie on the damped portion of the curve of growth, then the log of the silicon column densities are 16.8 for HD151804 and 16.7 for HD167659. Adopting the value of N/N_H=3.55E-05 as the solar abundance ratio of silicon, then depletion factors of 0.88 for HD151804 and of 1.79 for HD167659 are implied. These results however could be subject to change.

COMMENTS

The data indicates, although not conclusively, that silicon is probably more abundant than estimated from curve-of-growth analyses in which the SiII lines were assumed to follow the curve derived for other species. In an earlier case, (Snow, 1977), similar results were suggested. Likewise, de Boer (1979, 1980) has recently shown that oxygen may be typically more abundant than estimated from Copernicus data, where the OI lines all fell on the flat portion of the curve. Also, the absence of the SiII line at 1526 Å in most previous analyses probably caused systematic errors in the direction of decreased column density. In Morton's 1974 paper, Interstellar Absorption Lines in the Spectrum of Zeta Ophiuchi, the 1526 Å line was measured, but was inadvertently left off the graph. At any rate, detailed analyses for several lines-of-sight, to be published elsewhere, will be presented once the correct oscillator strengths are established.

REFERENCES

1. Bohlin, R.C.: Ap. J., 200, 402.

2. Joseph, C.L.: Analysis of IUE Spectra Using the Interactive Data Language. The Universe in Ultraviolet Wavelengths. NASA CP- , 19 (Paper of this Compilation).

3. Bohlin, R.C., Savage, B.D., and Drake, J.F.: Ap. J., 200, 402.

4. Snow, T.P.: Ap. J., 216 724.

5. de Boer, K.S.: Ap. J., 229, 132.

6. de Boer, K.S.: Ap. J., in press.