ABUNDANCES OF LIGHT METALS IN FIELD STARS WITH METALLICITY RANGE $-1.2 < [Fe/H] < +0.3$

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ABSTRACT. High resolution, high S:N spectra are used to determine the abundances of Fe, Ni, Ca, Al and Si in 25 field dwarfs with $-1.2 \leq [Fe/H] < +0.3$. We find overabundances for Al, Ca and Si in stars with $-1.2 < [Fe/H] < -0.5$ and solar [Ni/Fe] over the whole studied range.

1. INTRODUCTION

Detailed studies of abundances of light elements $8 < Z < 20$ in stars can provide a wealth of information about the chemical history of the Galaxy. These elements are synthesized in stars with different masses (Arnett, 1971; Woosley and Weaver, 1982) and their relative abundances and isotope ratios vary with the mean metallicity of the stars. An excellent review of the recent observational results is given by Lambert (1987).

2. OBSERVATIONS

The metallicity range $+0.3 > [Fe/H] > -0.6$ was observed with the ESO "CAT+CES+Reticon" combination, which gave $\lambda / \Delta\lambda \sim 10^5$, with S:N ~ 200 for stars with $m_V \sim 5$ in exposures of 1 hour. Reduction is described in Crivellari et al (1987). Stars with $-0.5 > [Fe/H] > -1.2$ were observed with the INT+IDS+CCD combination on La Palma giving $\lambda / \Delta\lambda \sim 2x10$ with S:N ~150 for $m_V = 8$ in exposures of 20 min. Reduction is described in Rebolo et al. (1987). Spectra come in 40 A (CES) and 125 A (IDS) ranges around the λ 6707 A Li doublet. Fig. 1 gives a sample CES spectrum for HD 209100, with S:N=180, indicating general spectral quality.

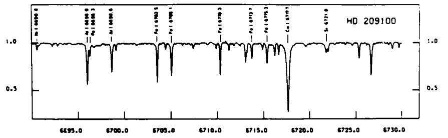

Fig. 1: Spectrum of HD 209100 in range λ6690 A - λ 6730 A with S:N ~ 180; an example of the material used for this work.

G. Cayrel de Strobel and M. Spite (eds.), The Impact of Very High S/N Spectroscopy on Stellar Physics, 421–424.
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https://doi.org/10.1017/S0074180900035385 Published online by Cambridge University Press

3. ANALYSIS

We derived abundances using spectral syntheses with Kurucz (1979) models for Teff >5500 K, or Gustafsson et al. (1975) models for Teff< 5500 K (all these have [Fe/H] >-0.6). Both curves of groth and direct matching of synthetic to observed spectra were used, with differences always <0.03 dex. The solar abundances using the model types on our own lunar spectrum never differ by more than 0.06 dex. Our Teff's were from b-y or R-I and V-K indices, calibrated by Carney (1983) or Olsen (1984) for the metal rich stars. Our log g's come from b-y, c_1 calibrations from the same authors. A microturbulence "default" of 1.5 km s^{-1} was used where not previously published. Log gf values were from Gurtovenko and Kostik (1981). The analysis is differential referring all abundances to our derived solar values. We estimate the errors in our ratios as ±0.1 dex in [Al/Fe], ±0.12 dex in [Ca/Fe] , ± 0.1 dex in [Si/Fe] and ±0.14 dex in [Ni/Fe].

In Fig. 2 we plot [Al/Fe] , [Si/Fe], [Ca/Fe] and [Ni/Fe] against [Fe/H].

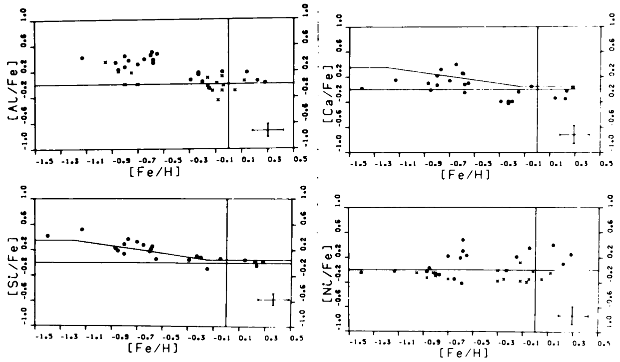

Fig. 2: Plots of [Al/Fe], [Si/Fe], [Ca/Fe] and [Ni/Fe] against metallicity [Fe/H]. For Si and Ca we include trend lines for α-elements from Lambert (1987). Key: • This work × Edvardsson et al . (1984).

4. DISCUSSION

The trends for [Si/Fe] and [Ca/Fe] illustrated here confirm the overabundances reported for α elements below [Fe/H] =-0.5, notably for [O/Fe] (Clegg et al., 1981; Edvardsson et al., 1984). This is broadly explicable by the earlier ejection of massive star products ($M > 10\ M_0$) via SNII, compared with those from lower mass stars. The decrease in slope of this tren with increasing Z, marginally confirmed here, may be due to the exact stellar mass range where each Z range originates.

Al is produced by C combustion, favoured by neutron excess and therefore by Pop I (Pardo et al., 1984). This would explain the [Al/Fe] deficiency at very low [Fe/H] , i.e. below [Fe/H] =-1 (François, 1986). Over excess

https://doi.org/10.1017/S0074180900035385 Published online by Cambridge University Press

for [Al/Fe] between [Fe/H] =-0.5 and -1.0 agreeing with Edvardsson et al. (1984) and Tomkin et al. (1985) is not presently explicable by galactic chemical evolution models.

Ni follows Fe right down to [Fe/H] =-1.5 as would be expected from a similar origin. Luck and Bond (1985) show an apparent overabundance at [Fe/H] =-1.8 but Gratton and Sneden (1987) have recently found [Ni/Fe] ~ 0 for [Fe/H] < -1.0 with no evidence for any abundance excess.

Abundance measurements in field stars show reasonable consistency from author to author with presently achievable high S:N, the principal sources of error are the use of models and model parameters.

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https://doi.org/10.1017/S0074180900035385 Published online by Cambridge University Press

DISCUSSION

HOLWEGER The dependence of [Al/H] or [Fe/H] derived assuming LTE may be different from that you will find when including NLTE effects. Departures from LTE, if present, are likely to be stronger in Al because of the lower ionization potential. These NLTE effects will depend on [Fe/H] because the ionizing UV field depends on metallicity.

ABIA Our Al lines have excitation potentials slightly higher than 3 e.v., so we expect departures from LTE are not very important.

GUSTAFSSON How strong are your Al lines ?

REBOLO The equivalent widths of our Al lines at 6696.03 Å and 6698.66 Å° are in no case higher than 80 mÅ. For instance in a star with [Fe/H] = −0.5 these lines have ≈ 40 mÅ and ≈ 20 mÅ respectively.

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