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OXYGEN IN HALO GIANTS

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ABSTRACT: High resolution CCD spectra were obtained in the region λλ6290-6330 A containing the |OI| λ6300.3 A line for a sample of halo giants. Synthetic spectra were computed to derive their oxygen abundances. A mean value [O/Fe] ≃ +0.35 is obtained.

I. Introduction

The oxygen-to-iron ratio in the halo stars is a boundary condition of major importance in contexts such as (1) the chemical evolution of the Galaxy, and (2) the mass distribution of the (first) stars preceding the halo stars, a subject connected to theories of star formation at low metallicities.

Oxygen overabundances in the halo have been found by different authors - see Sneden (1985) for a review - the available data showing however a non-negligible scatter.

In the present work, the oxygen abundance was derived for a sample of 17 halo giants, where a relatively low scatter is found.

II. Observations and theoretical spectra

The spectra were obtained at the 1.4 m Coudé Auxiliary Telescope , using the Coudé Echelle Spectrometer (CES) and a 1024x512 element RCA CCD detector, at the European Southern Observatory (ESO), La Silla, Chile.

The list of stars, selected essentially from Bond (1980) is presented in table I.

The synthetic spectra calculations (cf. Barbuy, 1981), include a molecular dissociative equilibrium, where carbon and oxygen are compounds of several molecules. In particular, the oxygen association in CO molecules affects non-negligibly the strength of atomic oxygen lines in cool giants.

The derivation of stellar parameters is based on photometric indices and measured equivalent widths, as well as on detailed analyses

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given in the literature. The model atmospheres employed are interpolated in the grids by Bell et al (1976) .

III. Results

The iron-to-hydrogen ratio adopted and the resulting oxygen-to-iron ratios are given in table I.

The [O/Fe] ratios as a function of metallicity [Fe/H] are shown in figure 1, where data for disk stars by Nissen et al (1985) are also plotted.

HD n°	[Fe/H]	[O/Fe]	HD n°	[Fe/H]	[O/Fe]
2796	-2.4	+0.4	103036	-1.7	+0.7
6268	-2.5	+0.25	122956	-1.9	+0.25
21581	-1.65	+0.25	165195	-2.1	+0.4
26297	-1.4	+0.25	184711	-2.3	+0.3
23798	-2.2	+0.35	187111	-2.0	+0.4
29574	-1.4	+0.5	204543	-1.63	+0.3
36702	-2.0	+0.3	206739	-1.6	+0.25
44007	-1.7	+0.35	222434	-1.9	+0.35
83212	-1.5	+0.4			

Table I - Program stars, metallicities adopted and oxygen-to-iron ratios obtained.

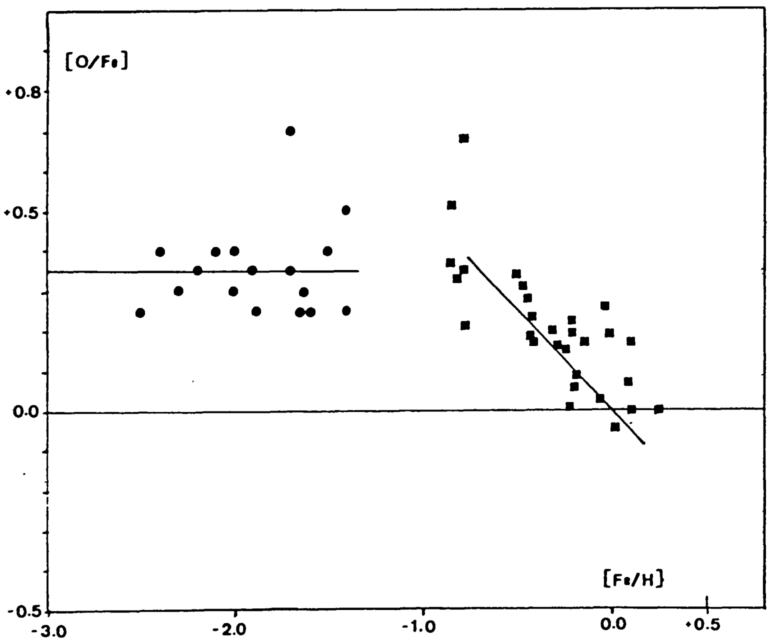

Figure 1 - Oxygen-to-iron ratio versus iron to hydrogen ratios for: ●: typical halo stars (present work), ■ : typical disk stars (Nissen et al, 1985).

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IV. Discussion

In the present work, a constant [O/Fe] ratio is found for typical halo stars in the metallicity range $-2.5 < [Fe/H] < -1.4$. A mean value $[O/Fe] \simeq +0.35$ is obtained, showing an overabundance lower than the previously reported values of +0.6 dex (e.g., Clegg et al, 1981).

This set of data combined to results for typical disk stars by Nissen et al (1985) are consistent with the following scenario for the chemical enrichment in oxygen and iron in the Galaxy:

The O/Fe ratio in halo stars represents the signature of nucleosynthesis in massive stars, where oxygen is produced in excess with respect to iron, relative to the solar value (Arnett, 1978). The oxygen excesses increase with stellar mass and it could be expected that [O/Fe] would show a slight decrease from the more metal-poor to the intermediately metal-poor halo stars, corresponding to a gradual enrichment by stars of decreasing mass and longer timescales of evolution, among the massive stars: this decrease is not seen in the present determinations.

The enrichment in iron is provided by the intermediate (and low) mass stars ($M < 9\ M_{\odot}$), and their effect starts to be seen at metallicities around $[Fe/H] \simeq -1.0$. The gradual enrichment in iron causes a progressive decreases of the O/Fe ratio in the disk, which is clearly seen from the data by Nissen et al (1985).

A next important step to be done is a study of O/Fe for a sample of intermediate metallicity stars, characterized by kinematics and metallicities ($-1.2 < [Fe/H] < -0.8$) of the old disk and thick disk populations.

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DISCUSSION

R. CAYREL We are in one of the rare cases, with the 6300 [OI], where one has not to worry about departure from LTE because 99% of O happens to be in the ground level of OI. Could you do the same type of analysis with subdwarfs near the turn off instead of giants ?

BARBUY It is a forbidden line forming preferentially in low density media, and appearing therefore stronger in giants. It practically disappears for gravities log g $\geq$ 3.5.
For subdwarfs the OI triplet at λ7771-5 Å is convenient (showing however pronounced non-LTE effects).

JUDGE A general comment about Oxygen in the UV region in cool giants. Space telescope should enable the detection of the OI λ1300 chromospheric emission lines in Pop. II giants which IUE has shown to be so strong in population I giant stars. The enhanced relative abundance of OI reported here and elsewhere during this Symposium in Population II stars should have observable effects in UV spectra. Eventually these lines may provide valuable constraints on the heating of chromospheres, related to the subphotospheric convection zone structure, as a function of metallicity.

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