A COMPARISON BETWEEN THE RELATIVE HEAVY METAL ABUNDANCE OF THE EXTREME HALO FIELD STARS AND GIANT STARS OF GLOBULAR CLUSTERS

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Until very recently, estimates of the chemical composition at early epochs of the Galaxy were made through the analysis of halo field stars. Recently, however some medium dispersion studies of stars in globular clusters have appeared. It would be expected that both approaches would lead to identical results. However, a quick glance at the literature gives the opposite impression.

According to Dickens and Bell (1976) and Mallia (1977) the s process elements (barium, strontium) are, in some stars of some globular clusters, strongly enhanced (by a factor of more than thirty). This is attributed to mixing effects which occur at late stages of stellar evolution. Up to now, no barium line enhancement has been reported in Pop II field stars in spite of the fact that some of these stars have high luminosity (Fig. 1). In fact the enhancement of Ba has been observed in very few globular cluster stars, and it can be expected that the discrepancy will be removed when more Pop II field stars of high luminosity are observed.

A second point is that no over-deficiency of the same s elements has been reported in globular clusters. This over-deficiency, first discovered (but overestimated) by Wallerstein et al. (1963), has been reported several times in Pop II stars, but not in all of them (Koelbloed 1967). The barium over-deficiency, when it exists, is interpreted as a characteristic of the gas from which the star was made so it can give valuable information about the metal enrichment in the early stages of the Galaxy. We have investigated the occurrence of the barium over-deficiency among the Pop II stars by observing three new extreme halo field stars noted by Bond (1970) and Bidelman and MacConnell (1973). The analysis of these stars

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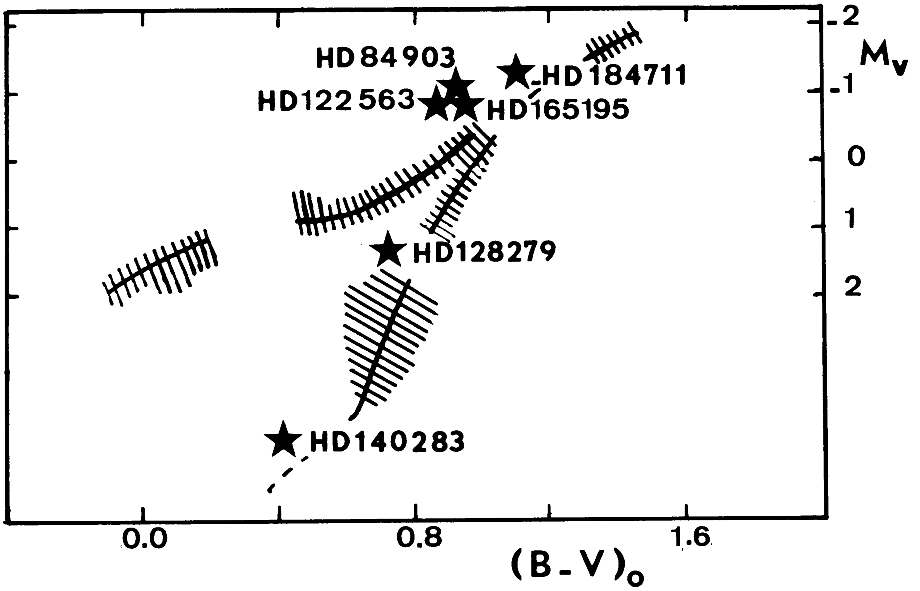

Fig. 1. Position of the analyzed field stars in the HR diagram, in relation with the NGC 6656 diagram.

shows that when the temperature is deduced from the (R-I) color index the overall metal abundance [M/H] is less than -2.3. In Fig. 2 the variation of the barium overdeficiency [Ba/Fe] is plotted as a function of [Fe/H] for these stars and for all the metal deficient stars selected in the literature with the condition [Fe/H] <-1.3. The overdeficiency of Ba appears only for [Fe/H] <-1.5, where [Ba/Fe] becomes a linear function of [Fe/H]. It is then easy to understand why the overdeficiency of Ba has not yet been observed in the globular clusters. The overall metal abundance of ω Cen is estimated as - 1.3 (Dickens and Bell 1976) or - 1.7 (Mallia 1977); in this case, an overdeficiency of Ba is unlikely. NGC 6397, with [M/H] = -2 (Mallia 1977) is the most deficient globular cluster studied and Fig. 2 predicts, in this case, an overdeficiency of Ba by a factor a little larger than two, which would imply a decrease of less than thirty percent of the equivalent width of the 4554 Å line of barium. Such a small decrease seems well below the observational errors.

It would be very interesting to observe in detail a few stars in globular clusters with very low iron content in order to check if the barium overdeficiency appears as would be expected if the halo field stars like the globular clusters, are remnants of the earliest phases of Galaxy formation.

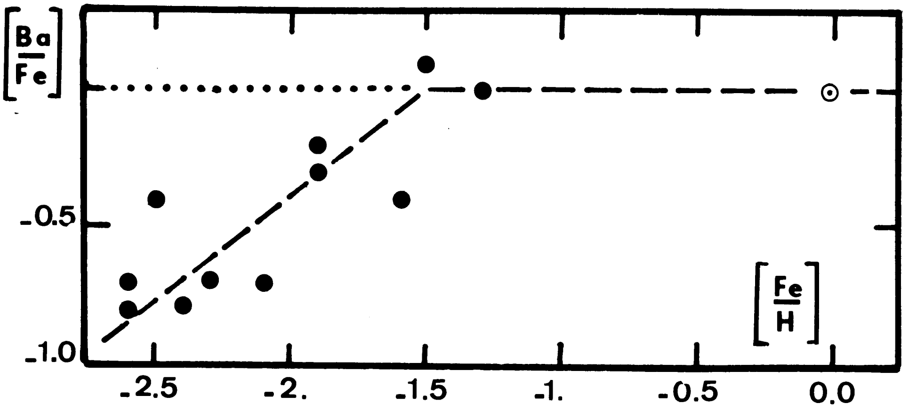

Fig. 2. The overdeficiency of Ba is a function of iron abundance and vanishes at about [Fe/H] = -1.5.

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DISCUSSION

CAYREL de STROBEL (TO KRAFT): How many clusters are known having a metal deficiency greater than [Fe/H] = -2.5?

KRAFT: As far as I know, there is nothing worse than -2.2.

SPITE: At -2.2, it is possible to measure the deficiency of barium if we have a high dispersion spectrum.

CAYREL de STROBEL (TO KRAFT): What is the distance modulus of that cluster?

KRAFT: It is M92, for which (m-M) = $14^m.2$. Are there any cases known with lower [Fe/H] in the southern hemisphere?

NORRIS: No, I don't know of any.

DICKENS: Several years ago we did a curve-of-growth analysis of one of the bright stars in NGC 6397 and got -2.0.

WALLERSTEIN: If I recall correctly Helfer, Greenstein, and I in 1959 found a substantial (about 0.5 in the log) deficiency of barium and other heavy s-process elements in a star in M92 for which we found [Fe/H] to be about -2.3. This was based on a curve-of-growth analysis of 18 Å/mm blue spectrograms.

SPITE: This is a reason to think that the barium abundance in globular clusters has the same behavior that in the field stars. More observations would be needed to reach a definite conclusion.

GREENSTEIN: I do not believe that the older analyses are capable of determining a metal deficiency to a factor of two. The modern techniques of model atmospheres and synthetic spectra are needed. For resonance lines of an ion the boundary temperature is decisive.

SPITE: The abundances presented here for all the field stars are determined through the use of model atmospheres. More details will be found in the paper submitted to Astronomy and Astrophysics.

KRAFT: There's also this question of star counts. ω Cen is a very rich cluster. If you take the ratio of barium stars to the total number of giants in ω Cen and apply it to a metal-poor cluster, would you expect to see any barium stars?

DICKENS: I don't know. Perhaps Norris could comment.

NORRIS: I wouldn't like to comment at this point. Zinn and I are completing a survey of CN and CH stars in ω Cen. The Ba II anomaly appears to exist in many stars, but I can't give a percentage.