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SPECTROSCOPIC STUDY OF THE GIANT AM STAR HD157740

D. KOLEV, V. KOLEVA
Rozhen National Astronomical Observatory
P.O. BOX 136, 4700 Smolyan,
Bulgaria

1. INTRODUCTION

HD157740 (=HR6481=SA0102905) was suspected to be a *peculiar star* through its behaviour in the Geneva photometric system (Hauck & North, 1982). Recently Kolev (1990) published the main parameters of the star and gave some arguments supporting its "mild" Am-nature. Here we present some results of our research in the chemical composition and the evolutionary status of HD157740 in comparison with the well known mild Am star 68 Tau whose stellar parameters - T_e = 9300 K, *lg g* = 3.75 (Lyubimkov & Savanov, 1983) in practice coincide with those for HD157740 (T_e = 9350 K, *lg g* = 3.80).

2. OBSERVATIONS AND DATA PROCESSING

Four IIaO-plates in the range 3500-4900 ÅÅ were obtained with the coude-spectrograph of the 2 m telescope at Rozhen during 1982-89. The resolution is about 0.18 Å and the maximum signal-to-noise ratio (S/N) for a single plate is ~20. The spectrograms were digitized using Rozhen's Joyce-Loebl MDM6 microdensitometer with 20μ-slit and 10μ-step. The data were processed on PC/AT using the ReWiA-1.4 software (Borkowski, 1988). Each spectrum was processed separately up to the normalization to "by-eye" pointed and spline-fitted continuum level. Then we coadded and averaged the data to obtain a summary spectrum. All further procedures were made over this unfiltered, S/N ~ 40 spectrum.

3. LINE IDENTIFICATION AND PARAMETERS

The spectrum was linearized and spread around λ_c = 4200 Å with a step of 0.05 Å Because of the severe line overlapping in the spectrum of HD157740 the overwhelming majority of the identified lines are derived by separation of complex unresolved blends. The following criteria were applied during this procedure: a) Gaussian fit for the line shape; b) wavelength - coincidence box of +1 or +2 steps for single lines and blend components, respectively; c) constancy of the value L=FWHM/λ for every line and component in a blend (this criterion was confirmed by our tests on the spectrum atlases of Sirius (Kurucz & Furenlid, 1979) and Deneb (Leedjarv & Iliev, 1989)); d) best fit of the observed shape of a certain spectral feature.

The line identification was implemented using Moore's RMT and the identification and W_λ lists for 68 Tau published by Wright et al. (1964) and Smith (1972). Total of 596 lines was measured in the range 3845-4865 ÅÅ of HD157740 spectrum. The unblended lines are only 72. From 6 single and well sketched lines we obtained a value L=(2.035±0. 143)$\cdot 10^{-4}$ and, taking into account our instrumental resolution, we reestimated the value Vsini = 36 ± 3 km/s.

The equivalent widths W_λ were measured by ReWiA 1.4 using the area of the fitting gaussians. Our error analysis showed that, mainly due to uncertainties in the continuum determination, the typical errors in W_λ are: ~50 % for W_λ~20 mÅ, ~30 % for W_λ ~ 25-50 mÅ and -10 % for W_λ ~ 150-200 mÅ.

In the spectrum of HD157740 we identified practically all lines usually found in an Am star spectrum and took for every species the mean of the values *w* = W_λ (157740).W_λ (68 Tau). There is an enhancement of the intensity of the iron peak element lines in HD157740 ($\bar{w}$ ~ 1.5). Some species (MgII, SiII, AII, AIII, SrII and EuII) show the same line intensity as in 68 Tau. CaI (6 lines) has $\bar{w}$ =1.6 and CaII K shows *w* = 1.3. A number of species (ZrII, CeII, ZnII, NdII) with few lines have $\bar{w}$ > 2. The situation with Sc needs some more comments. There are many ScII lines, but they all are strongly blended (e.g., the weak line SeII (14) 4384.81 Å lies in the center of a giant 10-component blend with strong Fe-lines). Therefore it is very difficult to estimate the true intensities of the SeII lines. It is known that Sc is underabundant in the Am stars and the relation W_λ (ScII4320)/W_λ (SrII4215) < 0.65 is used as a criterion to classify a certain Am star candidate. The line SeII (15) 4320.74 Å in HD157740 is blended with the strong line TiII (41) 4320.96 Å and the blend lies in the wing of H_γ where the local continuum is about 15 % below the main level. The criterion ratio mentioned above has for both stars coinciding values 0.34 - 0.35 and the criterion is satisfied. But it is more reliable that this fact is rather due to the enhanced intensity of SrII line.

4. ATMOSPHERIC ABUNDANCES

We used the program code by Piskunov (Ryabchikova & Piskunov, 1988) to compute curves-of-growth based on Kurucz's (1979) LTE model with T_e= 9350 and lgg = 3.8. Comparing the theoretical curves for species with a great number of lines (FeI,II and TiII) with the empirical ones for HD157740 and 68 Tau, we obtain a microturbulence parameter v_t = 3.5 km/s for both stars. Fig. 1 illustrates the procedure of determination of the abundances presented in Table 1. We use W_λ data for 68 Tau from Wright et al. (1964) and Smith (1972), gf-values from the sources, recommended by Adelman & Lanz (1988) and solar abundances from Grevesse (1984). In the last column of Table 1 the abundances obtained by Lyubimkov & Savanov (1983) are given. As can be seen, for the elements with good line statistics and with well established atomic data (Fe and Ti) our results for the reference star 68 Tau virtually coincide with those by Lyubimkov and Savanov (1983) (they use microturbulence parameter v_t=4.0 ± 0.5 km/s obtained by FeI and FeII lines too). We can not explain at present the significant divergences for SiII and, especially, for SrII. We only note that we use gf-values from Wiese et al. (1969) and damping constant from Brechot-Sahal (1968) for SiII lines and gf from Wiese & Martin (1980) for SrII. We must also note the embarrassing situation with CrII: it was found that none of the known gf-systems give satisfactory result for both stars, but the intensities of the cromium lines in HD157740 undoubtedly are greater than in 68 Tau - for CrI $\bar{w}$=1.39±0.33 (5 lines) and for CrII $\bar{w}$=1.35±0.36 (19 lines).

Table 1. Abundances for HD157740 and 68 Tau relative to the Sun

Spec.	[LgE1/H] HD157740	N	[LgE1/H] 68 Tau	N	[LgE1/H] 68 Tau
CaI	+0.38	6	+0.11	6	0.0
MgII	+0.10	1	+0.10	1	+0.10
TiII	+0.70	28	+0.33	28	+0.35
FeI	+0.53 }+0.50	92	+0.27 }+0.20	82	+0.20
FeII	+0.47	29	+0.14	27	
SrII	+1.61	2	+1.48	2	+0.90
SiII	+0.46	4	+0.4:	2	~0
ScII	-0.1:	8	-	-	-0.3

5. DISCUSSION

The peculiarity of the abundances of HD157740 is obvious, but it is possible to mark some differences in comparison with the classical MS Am stars. So, calcium seems to be even overabundant, while in the MS-Am this element is underabundant (see e.g. Gutrie, 1987). Further, it is quite possible for Sc, Si and Sr to be more abundant than in MS-Am.

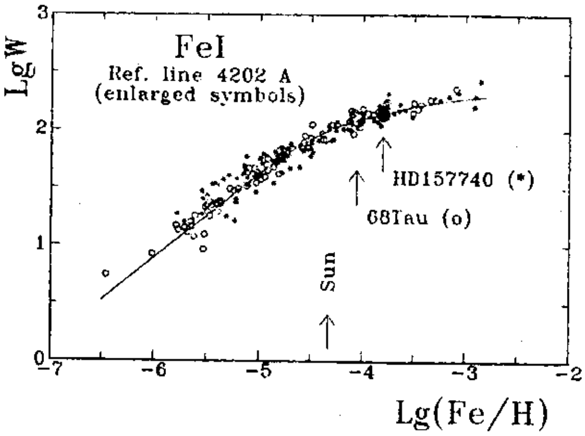

Fig. 1. Curve-of-growth for FeI lines in HD157740 and 68 Tau. Microturbulence parameter v_t = 3.5 km/s.

Maybe the explanation of these differences lies in the evolutionary status of HD157740 (and of 68 Tau as well). As it was found in the last decades, there exists a group of giant Am stars and the greater is their age, the smaller is the deficiency in Ca and Sc. They reach normal, or even overabundance (Berthet & Hauck, 1989; 1990). Thus, these Am-giants resemble the δ Del-stars. In the diagram lg T_e - M_v HD157740 (and 68 Tau as well) is disposed just near the sequence of the luminosity class III stars - it can be seen in Fig.2, where the ZAMS and the other luminosity classes are taken from Straizys & Kuriliene (1981). In the same Figure the locations of some "classical" and "mild" Am and δ Del-stars taken from Van't Veer-Menneret et al. (1985) are plotted as well. It is tempting to suggest the possibility HD157740 and 68 Tau to be members of a "hot branch" of the giant Am stars resembling the δ Del-stars. Moreover, a question arises, maybe it makes sense to combine both groups, the giant Am and the δ Del-stars, in a common group? Reverting to HD157740 it is very interesting what kind of peculiarity did the star show while beeing on the MS, when its spectral class must have been B8-A0 (T_e ~12000 -10000 K)?

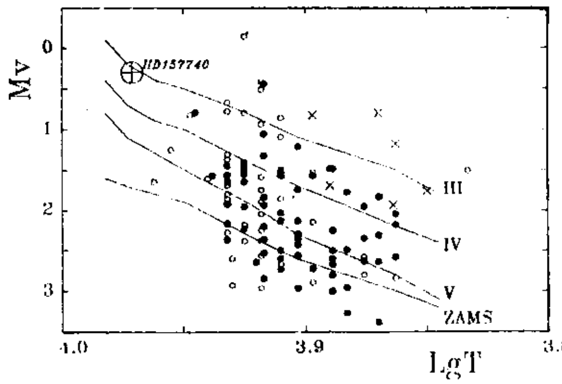

Fig. 2. Location of HD157740 together with other types of A stars on the M_v - Lg T_e diagram. The filled circles denote the classical Am, the open ones - the "mild" Am stars, and the crosses - the δ Del-stars according to Van't Veer-Menneret et al. (1985).

The example of HD157740 (and 68 Tau, as well) probably gives yet another argument supporting the suggestion that the separation processes in the quiet atmospheres of the slow rotating A stars during their evolution are responsible for the observed anomalies in the chemical composition of these atmospheres.

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