IUE OBSERVATIONS OF BLUE HALO HIGH LUMINOSITY STARS*

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ABSTRACT

Two high luminosity population II blue stars of high galactic latitude, BD+33°2642 and HD 137569 have been observed at high resolution. The stellar spectra show the effect of mass loss in BD+33°2642 and abnormally weak metallic lines in HD 137569. The interstellar lines in the direction of BD+33°2642, which lies at a height $z \gtrsim 6.2$ kpc from the galactic plane, are split into two components. No high ionization stages are found at the low velocity component; nor can they be detected in the higher velocity clouds, because of mixing with the corresponding stellar/circumstellar lines.

INTRODUCTION

Various classes and subclasses of blue halo stars of population II and old disk population have recently been described and discussed (ref.s 1 and 2). Three large groups, which include all subclasses, are generally recognized to be important: the horizontal branch (HB) stars, the subdwarfs, the high luminosity (HL) population II-B stars. This last group is formed of stars which lie several magnitudes above the HB stars. Bernard 29, in the globular cluster M 13, BD+33°2642 and HD 137569 are commonly thought to belong to the HL-population II-B-star group.

Here we report on the high resolution IUE observations of BD+33°2642 and HD 137569. The spectrum of BD+33°2642 (only SWP observations, exposure time 4.7 hours) will be discussed more extensively since it presents the effects of mass-loss in the high-

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ly ionized resonance lines of C IV, Si III and Si IV, and intriguing evidence for the presence of high ionization stages in the interstellar lines. The basic data for the two stars are presented in Table 1.

THE STELLAR SPECTRA

The main results emerging from a study of BD+33°2642 made by Stalio and Franco (ref. 6) are:

1) the effective temperature, on the basis of the spectral energy distribution, is found to be about 18000 K, lower than the temperature determined from the line spectrum (ref. 4) by about 5000 K. Discrepancies between temperatures determined from the continuum and line spectrum are also found in population I early-type supergiants (see e.g. ref. 7) but seem not to be so great. They are generally ascribed to the different depths of formation of the two spectra,

2) the carbon spectrum appears less ionized than in τ Sco, whose UV spectrum has been used for comparison. This result is probably due to combined effects of a lower effective temperature and lower carbon abundance,

3) the photospheric turbulence is small: it has been calculated to be 2.3 km s^{-1} from a curve of growth of Fe III lines. This value is in agreement with the visual data, but in conflict with the observations of population I stars having similar effective temperature and gravity (ref. 8),

4) the star has a stellar wind revealed by the displaced lines of C IV, Si III and Si IV (figure 1). The terminal velocity is estimated to be −520 km s^{-1} from the steep blue edge of the Si III resonance profile. A lower limit for the mass-loss is calculated to be 4.7×10^{-8} $M_\odot$ yr^{-1}.

HD 137569, on the contrary, does not show clear evidence for mass flux: the most prominent features in the UV, the resonance lines of C II, have large symmetrical wings. The remaining spectrum consists of abnormally weak metallic lines of Mg II, Si III and Fe III, multiplet 34. The ultraviolet flux distribution is that of a B3 supergiant with no reddening. The anomalous B-V colour index, and the variable radial velocities reported in ref. 5, support the idea that the star is part of a binary system.

THE INTERSTELLAR SPECTRA

If we consider both stars as having low mass (ref. 2) typical of population II objects, their height from the galactic plane is 6.2 kpc for BD+33°2642 and 0.8 kpc for HD 137569. By virtue of its distance, BD+33°2642 can provide information on the high ionization galactic halo gas. The interstellar spectrum is split into two components at about -35 and -105 km s^{-1}. All measurable lines are presented in table 2. High ionization stages, C IV and Si IV, seem to be present (figure 1) at the stellar velocity, thus suggesting that they might come from gas formed around the star.

The interstellar spectrum is very well measurable in HD 137569 due to the weakness of stellar lines. All usually observed interstellar lines are present at about zero velocity. There might be evidence of weak Si IV components at 0 and -100 km s^{-1}.

CONCLUSIONS

We have studied two stars of the group of HL-population II-B objects, whose cinematical and evolutionary situation is rather controversial. BD+33°2642 is likely to be a population II object, similar to the globular cluster giant Bernard 29; it has a large amount of mass loss for its low mass, and, besides abundances, presents differences with population I stars of the same spectral class in the size of the photospheric turbulent motions, which are smaller, and in the amount of discrepancies between the effective temperature determined from the continuum and line spectrum. HD 137569 has a simpler UV spectrum than BD+33°2642: it shows abnormally weak metallic lines and no evidences of high ionization stages and mass flux, unlike all known early type stars of low gravity.

For both stars the reddening, as deduced from the interstellar bump at 2175 Å, is low. The radial velocities of the interstellar gas in the line of sight of BD+33°2642 are at -35 and -105 km s^{-1}; no high ionization stages are found in the low velocity cloud; nor can they be detected in the higher velocity cloud, because of mixing with the corresponding stellar/circumstellar lines.

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TABLE 1 : The Basic Data.

	BD+33°2642	HD 137569	
Spectral Type	B2	B5	ref. 3
V	10.8	7.86	ref. 3
B-V	-0.14	0.24	ref. 3
l''	52°	21°	
b''	+51°	+52°	
Radial Velocity	-95 km s^{-1}	variable; -30 km s^{-1} in our spectrum	
T_{eff}	22900 °K (ref.4)	12000 °K	ref. 5
log g	2.3 (ref.4)	2.3	ref. 5
M_V	-3.9	-2.6	based on masses of 0.66 $M_{\odot}$

TABLE 2 : Radial velocities of the interstellar lines on the wavelength scale of the star rest frame, BD+33°2642.

Ion	λ (A)	Vel (km s^{-1})	Vel (km s^{-1})	Ion	λ (A)	Vel (km s^{-1})	Vel (km s^{-1})
C I	1656.928	-	-103	Si II	1260.418	-42	-101
	1657.380	-	-113		1264.730	-	-103
	1657.907	-	-118		1265.023	-	-102
	1328.833	-20	-110		1304.369	-40	- 98
	1277.240	-29	-		1526.719	-33	- 72
C II	1334.530	-20	-110		1533.445	-	-112
	1335.700	-23	-102	Si III	1206.510	-	- 90*
C IV	1548.202	-	- 87*	Si IV	1393.755	-	- 90*
	1550.774	-	- 81*		1402.769	-	- 85*
N I	1199.549	-15;-55	-	S II	1250.586	-35	-106
	1200.224	-34	-		1253.812	-29	-100
	1200.711	-5;-43	-		1259.520	-30	-102
O I	1302.170	-36	- 98	Fe II	1608.456	-28	- 84
Mg I	2026.405	-	- 82	Ni II	1741.560	-31	-117:
A III	1670.786	-41	- 95		1751.920	-22	-
Al III	1854.720	-	-106*		1773.960	-42	-
	1862.795	-	-102*	Zn II	2026.097	-27	-105
Si II	1193.284	-36	- 87				
	1194.497	-	- 90				

* also photospheric contributions

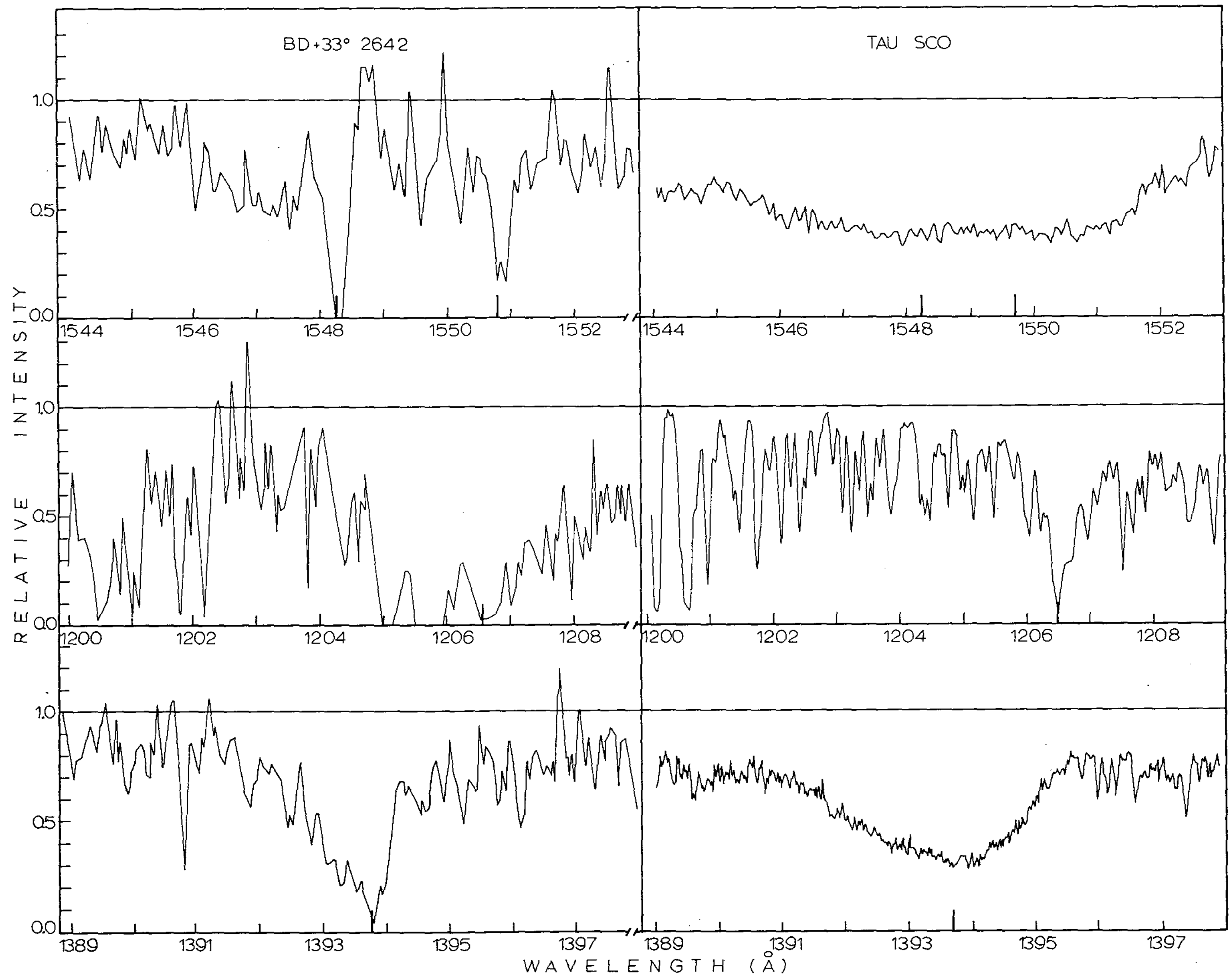

Fig. 1. Resonance line profiles of the C IV doublet (top), of Si III 1206.52 (middle) and of Si IV 1393.73 (bottom) compared with the same lines observed in Sco (ref. 9).