Discovery of new Chemically Peculiar late B-type stars: the case of HD 67044

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Introduction

HD 67044 currently assigned an B8 spectral type is one of the slowly rotating B stars situated in the northern hemisphere which we are currently observing. The selection criteria for this sample of stars are a declination higher than -15^o, spectral class B8 or B9, luminosity class V or IV and V magnitude brighter than 7.85. Most of the stars of this B8-9 sample have just recently been observed in December 2014. The incentive of this work is to perform a careful abundance analysis study of high resolution high $\frac{S}{N}$ ratio spectra of these objects and sort them out into chemically normal stars (ie. whose abundances do not depart more than $\pm$ 0.15 dex from solar), new spectroscopic binaries and new chemically peculiar B stars(CPs) which had remained unoticed so far. HD 67044 is one of these new CP stars. We present here new abundance determinations for HD 67044 which allow us to propose that this star is a new CP late B star. Monier et al. (2015) have recently published the discovery of 4 new HgMn stars (3 from this late-B stars sample and one from a sample of 47 early A types stars verifying the same criteria). Royer et al (2014) have published the analysis of the sample of 47 early A stars having low apparent projected velocities in the northern hemisphere up to V=6.65 mag. A careful abundance analysis of high resolution high $\frac{S}{N}$ ratio spectra of these objects has sorted out the sample into 17 chemically normal stars, 12 spectroscopic binaries and 13 Chemically Peculiar stars (CPs) among which 5 are new CP stars whose status still needs to be specified fully (Si rich Bp stars, HgMn star or Am star ?).

Observations and Reduction

HD 67044 has been observed once at Observatoire de Haute Provence using the High Resolution (R =75000) mode of SOPHIE in December 2014. A 15 (?) minutes exposures was secured in December 2014 with a $\frac{S}{N}$ ratio of about ***.

Conclusions

HD 67044 has overabundances in which are characteristic of an SiCrEu star. We thus propose that **it should be reclassified as a late Chemically Peculiar B star of the SiCrEu type. It displays a mild overabundance of Silicon and large overabundances of Titanium, Chromium, Yttrium, Zirconium and Europium which range from 10 $\odot$ to about 200 $\odot$**

References

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The nature of the new CP star HD 67044

Several spectral regions have been used to readdress the spectral type of HD 67044. The star being a late B-type dwarf, the chemical peculiarity could be either i) of the HgMn type, ii) or of the Si type or iii) of the SrCrEu type, or iv) a hybrid of the last two. We therefore investigated several spectral regions containing strong resonance or low excitation lines of Hg, Mn, Si, Sr, Cr and Eu. First, the red wing of H_ϵ harbors the Hg II λ 3984 Å line and several Zr II and Y II lines likely to be strenghtened in late B star of the Hg-Mn type. The region from 4125 Å to 4145 Å contains the classification Si II doublet (M 2), the Mn II line at 4136 Å and the Sr II resonance line at 4129.72 Å likely to be strengthened respectively in a Bp Si star, in a star enriched in Mn and a SrCrEu Bp star. The regions 4070-4080 Å, 4210-4220 Å and 4300-4310 Å contain the resonance lines of Sr II at 4077.71 Å and 4215.52 Å and the low-excitation line at 4305.44 Å. The 4200-4210 Å region contains the Eu II resonance line at 4205.04 Å. The 4550-4560 Å region contains the strongest expected Cr II line at 4558.65 Å.

Laboratory wavelength (Å)	Identification	Multiplet number	Abundance
3982.44	Y II		200 $\odot$
3983.87	Hg II	M 2	not detected
3990.96	Zr II		70 $\odot$
3998.82	Zr II		70 $\odot$
4077.71	Sr II		1 $\odot$
4128.07	Si II	M 2	2-3 $\odot$
4130.88	Si II	M 2	2-3 $\odot$
4136.92	Mn II		about $\odot$
4205.04	Eu II		70 $\odot$
4215.52	Sr II		1 $\odot$
4305.44	Sr II		1 $\odot$
4558.65	Cr II	M 1	10 $\odot$

Table 1: Classification lines and determined abundances for HD 67044

Model atmospheres and spectrum synthesis calculation

The effective temperature and surface gravity of HD 67044 were first evaluated using $B-V=-0.04$ and the effective temperature calibration versus $B-V$ in Doazan & Underhill (****). This yields T_{eff} = 10200 K in good agreement with Huang et al (2010) who derived T_{eff} = 10519K ad $\log g$ = 3.72 which we have adopted for the surface gravity. A plane parallel model atmosphere assuming radiative equilibrium and hydrostatic equilibrium has first been computed using the ATLAS9 code (Kurucz,1992). The linelist was built from Kurucz's (1992) gfhyperall.dat file which includes hyperfine splitting levels. A grid of synthetic spectra was computed with SYNSPEC48 (Hubeny & Lanz, 1992) to model the Si II, Ti II, Cr II, Mn II, Fe II, Y II, Zr II and Eu II lines. Computations were iterated varying the unknown abundance $[\frac{X}{H}]$ until minimisation of the chi-square between the observed and synthetic spectrum. Figure 1 displays the synthesis of 3 lines: Y II 3982.44 Å, Zr II 3990.96 Å and Zr II 3998.82 Å. The observed line profiles, rectified to the red wing of H_ϵ are compared to the synthetic spectrum proving the best fit to the oberved one. The model is computed for an overabundance of Yttrium of 200 $\odot$ and of Zirconium of 70 $\odot$ (solid line: observed normalised spectrum, dashed lines: synthetic spectrum).

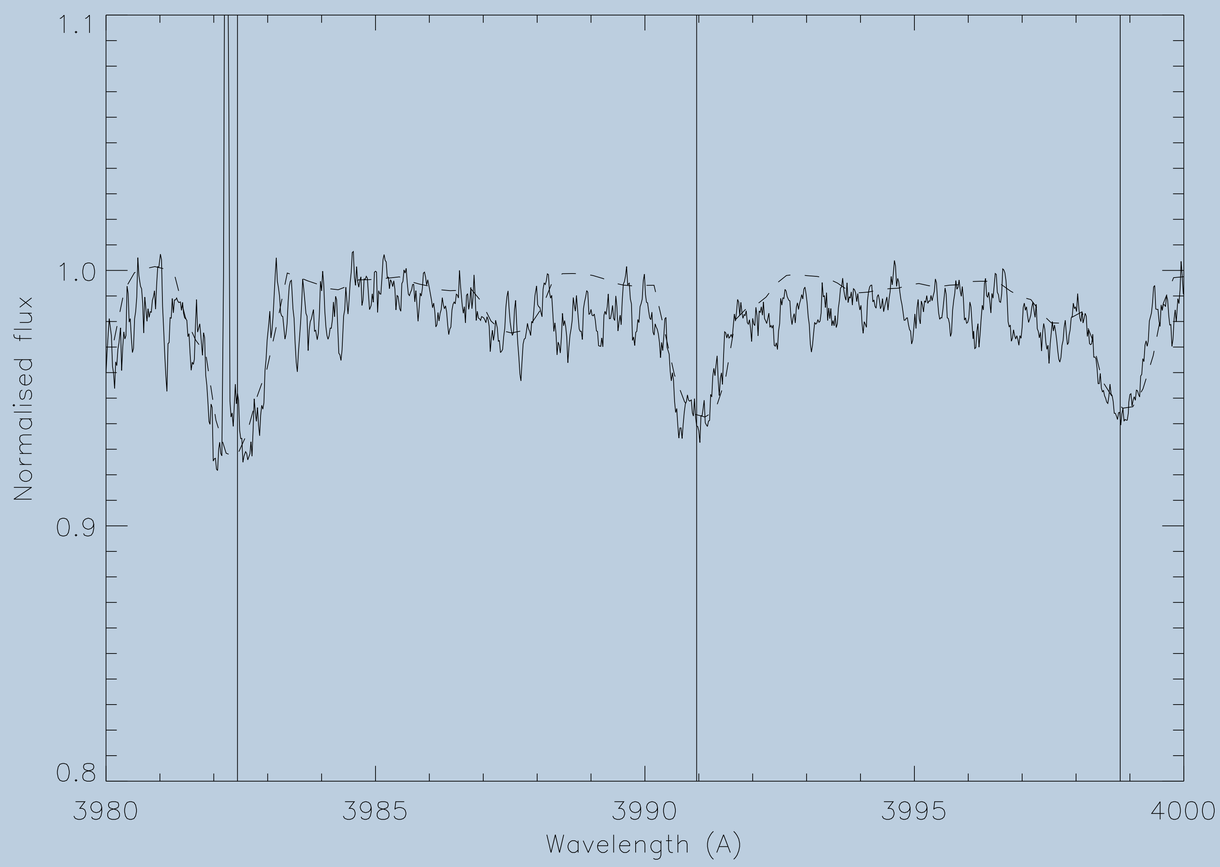

Figure 1: Y II and Zr II lines in the red wing of H_ϵ (observed: solid line, model: dashed line)