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HD 30085: A NEW PT-HG RICH LATE B-TYPE STAR

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Abstract. Using high dispersion high quality spectra of HD 30085 obtained with the echelle spectrograph SOPHIE at Observatoire de Haute Provence, we show that this star, hitherto classified as a A0IV superficially normal star, is actually a Chemically Peculiar star of the HgMn type. Spectrum synthesis reveals large overabundances of Mn, Sr, Y, Zr , Pt and Hg which are characteristic of HgMn stars. We therefore propose that this interesting object be reclassified as a B8 HgMn star.

Keywords: stars: individual, stars: Chemically Peculiar

1 Introduction

HD 30085, currently assigned an A0IV spectral type, is one of the slowly rotating A stars studied in Royer et al. (2014). The incentive of this recent work has been to reclassify the 47 early A stars in the northern hemisphere brighter than V=7.0 mag with low apparent projected velocities (less than 60 km s^{-1}). A first abundance analysis of high resolution well exposed spectra of these objects has sorted out the sample into 17 chemically normal stars (ie. whose abundances do not depart more than ± 0.20 dex from solar values), 12 spectroscopic binaries and 13 Chemically Peculiar stars (CP) among which 5 are new CP stars whose status still needs to be specified fully (Si rich Bp stars, HgMn stars or new Am star ?). HD 30085 is one of these new CP star. We present here new abundance determinations for HD 30085 which allow us to propose that this star is a new HgMn late B star.

2 Observations and reduction

HD 30085 has been observed twice at Observatoire de Haute Provence (OHP) using SOPHIE in its high resolution mode (R=75000) in February 2012 and December 2013. Three 15 minutes were obtained in February 2012 with a signal-to-noise ratio of about 220 and coadded into a mean spectrum. One single 20 minutes exposure was obtained in December 2013 with a signal-to-noise ratio of about 300.

3 Reassigning a proper spectral type to HD 30085

The following spectral regions have been used to readdress the spectral type of HD 30085. First, the red wing of H_ϵ from 3980 Å up to 4000 Å harbours the Hg II line at 3984 Å and several Zr II and Y II lines likely to be strengthened in a late B-type star of the HgMn type (figure 1). Second, the region from 4125 Å to 4145 Å contains the Si II Multiplet II doublet and the Mn II line at 4136.92 Å(figure 1). The seven lines used are collected in table 1 with their identifications and preliminary abundances (see next section). Their positions are marked by vertical lines in both figures (after a correction for a radial velocity of about 10 km s^{-1}).

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Classification lines			
Wavelengths (Å)	Identification	Multiplet	Abundance
3982.44	Y II		200 ⊙
3983.87	Hg II	M 2	32000 ⊙
3990.96	Zr II		100 ⊙
3998.82	Zr II		100 ⊙
4128.07	Si II	M 2	2.5 ⊙
4130.88	Si II	M 2	2.5 ⊙
4136.92	Mn II		30 ⊙

Table 1. Preliminary abundances based on the seven lines used in this work.

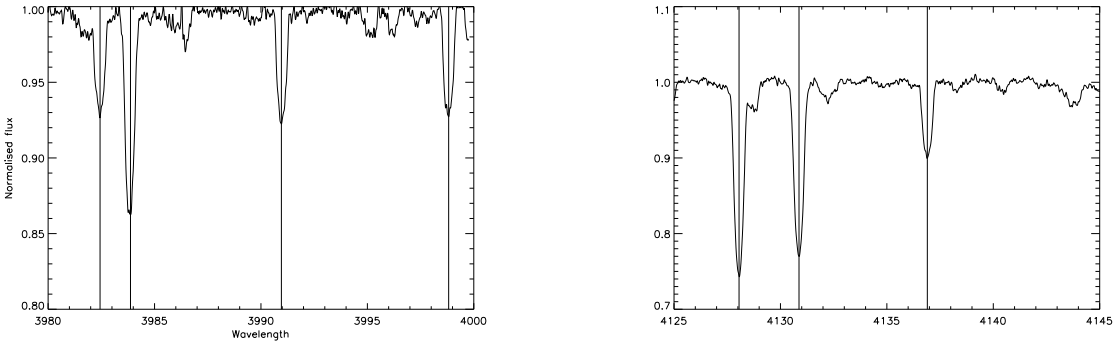

Fig. 1. Left: Hg II spectral line region (left). **R**ight: Si II Multiplet 2 spectral region.

4 Abundance determinations

4.1 Model atmospheres and spectrum synthesis

The effective temperature Teff and surface gravity log g of HD 30085 were first evaluated using Napiwotzky et al's (1993) UVBYBETA calibration of Stromgren's photometry in terms of effective temperature and surface gravity. A plane parallel model atmosphere assuming radiative equilibrium and hydrostatic equilibrium has been first computed using the ATLAS9 code (Kurucz, 1992), specifically the linux version using the new ODFs maintained by F. Castelli on her website. The linelist was built starting from Kurucz's (1992) gfhyperall.dat file * which includes hyperfine splitting levels. This first linelist was then upgraded using the NIST Atomic Spectra Database † and the VALD database operated at Uppsala University (Kupka et al., 2000) ‡.

A grid of synthetic spectra was computed with SYNSPEC48 (Hubeny & Lanz, 1992) to model the Si II, Mn II, Zr II and Hg II lines. The unknown abundance $[\frac{X}{H}]$ was varied until minimisation of the chi-square between the observed and synthetic spectrum.

4.2 Evidence for a Platinum excess

While modeling the Fe II lines in the 4500 Å- 4600Å region, we noticed a 2% feature at about 4514.15 Å which had no counterpart in our linelist. We have identified this feature as one of the strongest Pt II line expected at 4514.17 Å listed in VALD. No other line can reproduce the observed 2% line depth at this wavelength. Other lines of Pt II were also identified at shorter wavelengths to confirm the presence of platinum in HD 30085. In figure 2, the observed Pt II line profile at 4514.17 Å (solid line) is compared to three synthetic spectra (dashed lines) computed for 3 overabundances of platinum (2500, 3500 and 5000 ⊙). We also checked that a model

*http://kurucz.harvard.edu/linelists/
†http://physics.nist.gov/cgi-bin/AtData/linesform
‡http://vald.astro.uu.se/ vald/php/vald.php

computed for a solar platinum abundance yields no absorption at all at 4514.17 Å. From the 4514.17 Å line only, a provisional excess of platinum is derived to be about 3500 ± 1000.
The Hg overabundance is derived from the 3983.87 Å line of multiplet 2 including the hyperfine structure of various isotopes of Hg in a similar manner to Castelli & Hubrig (2004) modelling of HD 175640. The abundance that best fits the observed line profile is about 32000 ⊙. The abundance of Mn from the 4136.92 Å line is about 30 ⊙ and that of Zr derived from the 2 lines in Table 1 is about 100 ⊙. The Yttrium abundances from various Y II lines is about 200 ⊙.

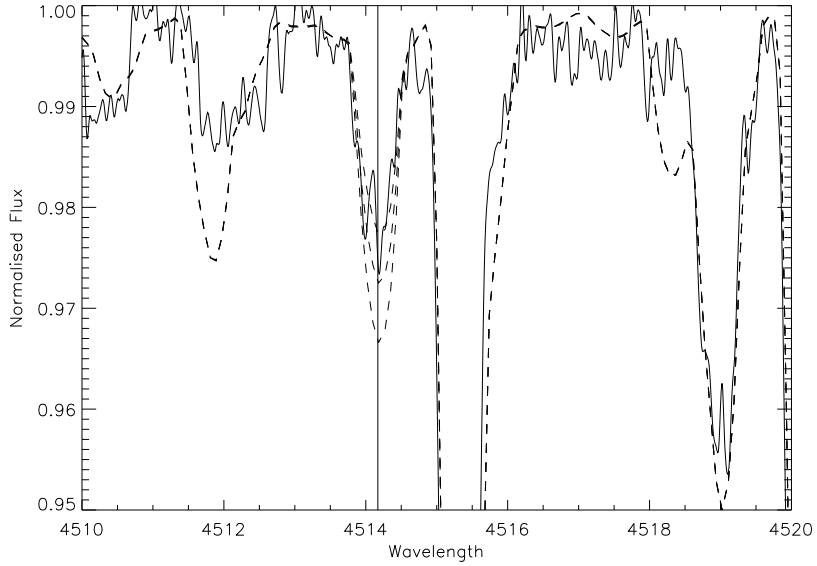

Fig. 2. Detection of the Pt II 4514.17 Å line (observed: thick line, models: dashed lines)

5 Conclusions

Whereas it was up to now classified as a normal early A star, our analysis of HD 30085 shows that it is actually a hotter star with peculiar abundances. Its effective temperature and surface gravity correspond to that of a B8V main sequence star. The overabundances in Mn, Sr, Y, Zr, Pt and Hg are characteristic of an HgMn star. It displays large overabundances of the Sr, Y and Zr triad which is however inverted compared to the solar system triad. The synthesis of the Hg II and Pt II lines reveals large overabundances of Pt and Hg (about 3500 and 32000 ⊙ respectively). We are currently performing a detailed abundance analysis of HD 30085 to complement the preliminary abundances presented here.

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