Revealing the nature of HD157087

Khalack V.

Département de Physique et d'Astronomie, Université de Moncton, Moncton, Canada

Viktor.Khalack@umoncton.ca

Abstract

The new spectropolarimetric data obtained recently for HD157087 with ESPaDOnS at the CFHT are analysed to verify the nature of this object. The modified ZEEMAN2 code in a semi-automatic mode is used to analyse several hundreds of line profiles in a single run. It provides information on abundance distribution for each chemical element at the different atmospheric layers through estimation of the contribution of blends to the studied line profiles. The abundance analysis reveals evidences of a significant abundance increase towards the deeper atmospheric layesr for several chemical elements. Togethere with the found enhanced abundance of Ca and Sc this fact contradicts the classification of HD157087 as a marginal Am star.

Introduction

In convective stellar atmosphere of Am stars turbulent motions rapidly decrease any abundance inhomogeneities leading to a more or less uniform abundance at different optical depths (Michaud 1983). Am stars are usually rich in heavy elements and show some deficit of Ca and Sc (Preston 1974). If HD157087 is indeed an Am star the abundance of chemical species can be different from the solar one (Yüce et al. 2011), but should be uniformly distributed in its stellar atmosphere.

The new ESPaDOnS spectra of HD157087 are thoroughly analyzed with the aim to determine abundance of chemical elements employing the T_{eff}, log(g) and metallicity derived for this stars with the help of FITSB2 code (Napiwotzki et al. 2004) from the best fit of Balmer line profiles. The obtained value of effective temperature is consistent with the results for T_{eff} derived from the c_1 (Napiwotzki et al. 1993) and $(B-V)_0$ (Netopil et al. 2008) photometric temperature calibrations (see Table 1).

Table 1. Fundamental stellar parameters of HD157087

Object	Photometric calibrations		Fit of Balmer line profiles			
	T_{eff} [c_1], K	T_{eff} [$(B-V)_0$], K	T_{eff}, K	log(g)	[M/H]	χ^2 / ν
HD157087	8897±51	8930±165	8882±100	3.57±0.10	0.0±0.1	0.5758

Abundance analysis

The modified version of ZEEMAN2 code (Khalack et al. 2017; Landstreet 1988) is used to automatically treat a list of a hundreds line profiles in a consecutive mode. From the simulation of a selected line profile we can derive radial velocity and Vsin(i) and abundance (at particular layer of stellar atmosphere, where the line optical depth is τ_l=1) for different chemical elements that contribute to this profile (see Fig. 1). Combination of the results obtained from analysis of all selected line profiles allows one to study a vertical stratification of element's abundance with the atmospheric depths (see Fig. 2) and to derive average abundance for different chemical species (see Table 2).

Table 2. Comparison of averages abundances for several ions in HD157087

Ion	Feb. 10		Feb. 15		Yüce et al. (2011)	
	[X/H]	N	[X/H]	N	[X/H]	N
He I	-0.08±0.13	4	-0.15±0.09	7		
C I	-0.33±0.08	26	-0.25±0.08	19	-0.14±0.13	3
Mg II	-0.20±0.06	9	-0.22±0.07	9	-0.07±0.23	4
Ca I	+0.22±0.08	38	+0.12±0.07	29	-0.12±0.16	8
Ca II	+0.12±0.10	15	-0.01±0.06	10		
Sc I	+0.90±0.23	7	+1.78±0.19	13		
Sc II	+0.00±0.09	17	+0.74±0.26	9	-0.35±0.19	9
Ti II	+0.39±0.06	109	+0.34±0.06	96	-0.14±0.20	51
Fe II	+0.41±0.05	252	+0.38±0.05	195	+0.15±0.20	73
Cr II	+0.53±0.07	131	+0.47±0.07	108	+0.10±0.21	40
Mn II	+0.63±0.10	55	+0.52±0.09	55	+0.29±0.21	14

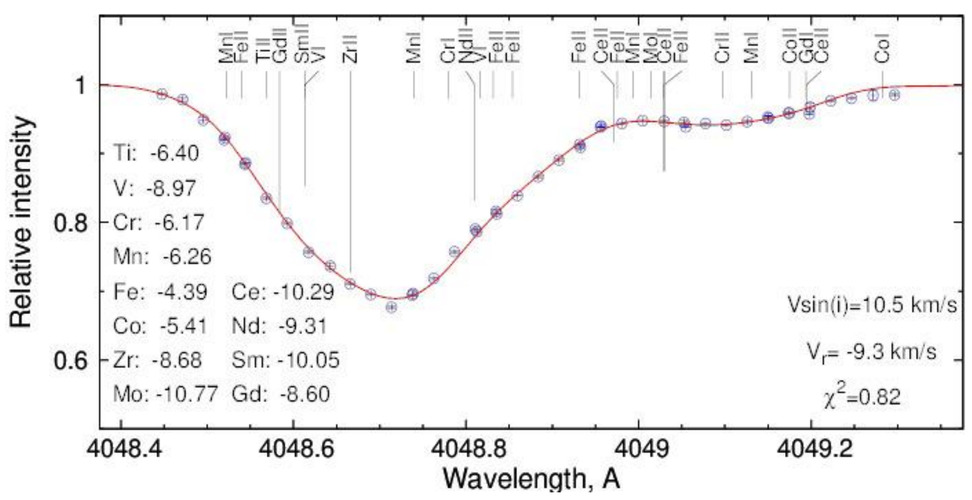

Figure 1. The observed spectrum of HD157087 (open circles) is well fitted by synthetic spectrum (solid line).

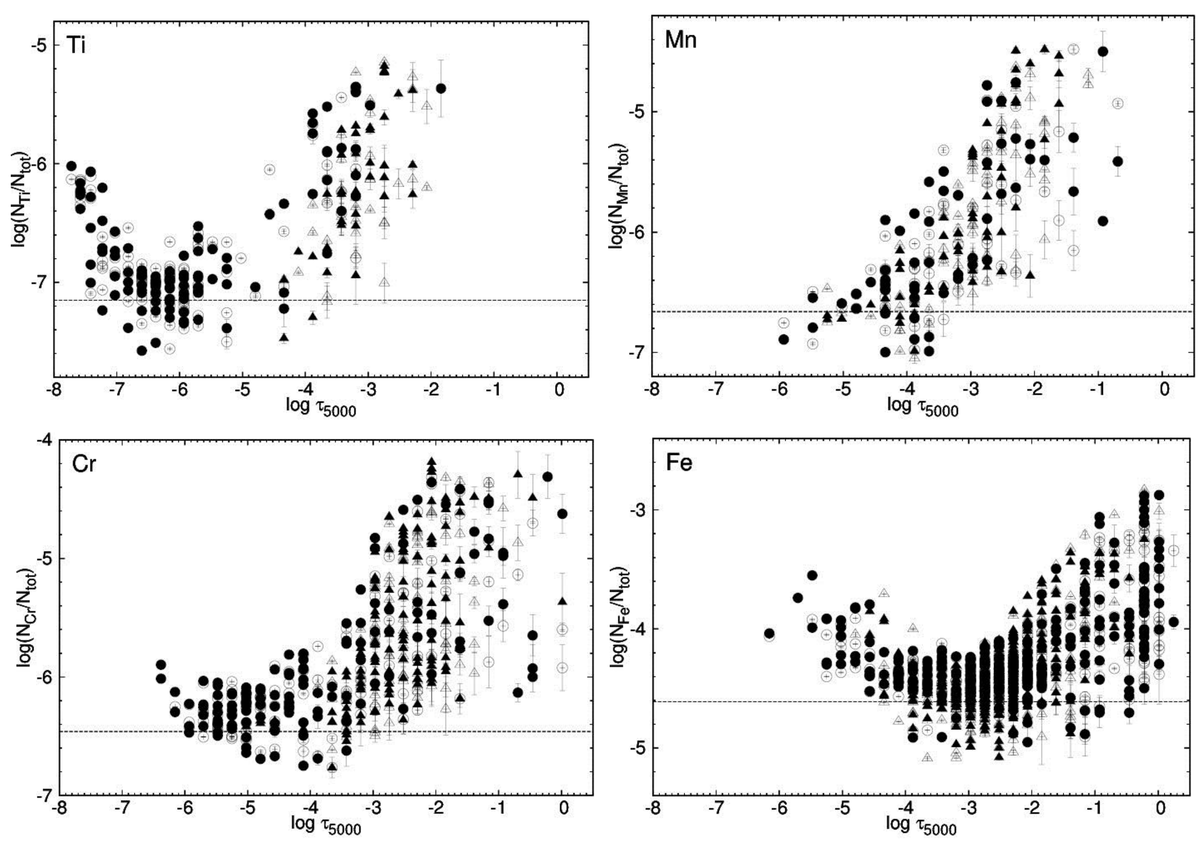

Figure 2. Distribution of Ti, Mn, Cr and Fr abundance with optical depth in HD157087 based on the results obtained for neutral (triangles) and once ionized (circles) ions. Open and filled symbols present the results obtained from the analysis of two different spectra.

Conclusions

The abundance analysis of HD157087 spectra has revealed that:

- Ca has solar abundance, while the abundance of Sc appears to be enhanced by +1 dex (see Tab.2);
- average abundances of certain chemical species are variable during long periods of time(see Tab.2);
- Cr, Mn, Co, Ni and Zr show significant trends of abundance increase with atmospheric depths (see Fig.2);
- abundance of Ti and Fe reaches its minimum around $\log(\tau_{5000})$= -7 dex and -3 dex respectively, and increases towards the stellar surface and towards the deeper atmospheric layers (see Fig.2);

These facts indicate that HD157087 is not an Am star or a marginal Am star.

- HD157087 is know to be an astrometric binary system (Macarov & Kaplan 2005) with a period higher than 6 years.
- Preliminary periodic analysis of radial velocity variations results in detection of short periodic (several days) and long periodic (several years) changes in Vr (Khalack 2018).

HD157087 is member of a binary system or probably even member of a triple system.

References

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