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Stratified abundance analysis of CP star HD 103498

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Abstract. Chemically peculiar stars look spectroscopically and photometrically different from their "normal" analogs. It is therefore difficult to accurately determine atmospheric parameters of these stars and special methods are needed for the consistent analysis of their atmospheres. The main aim of the present work is to analyse atmospheric abundance and stratification of chemical elements in the atmosphere of the chemically peculiar star HD 103498.

Keywords : chemically peculiar, atmospheres, HD 103498

1. Introduction

Chemically peculiar stars are unusual in chemical composition in comparison to that of normal stars and this family of stars resides on the upper main sequence and they contribute about 15%-20% of early B to late F-type stars. This group of stars hold the strong abundance anomalies in their atmospheres such as non-uniform horizonal and vertical distributions of chemical elements and/or surface magnetic fields of different intensity. HD 103498 (65UMaD, HR 4561) is a characteristic example of the co-called CP group of spectral type A with weak magnetic field.

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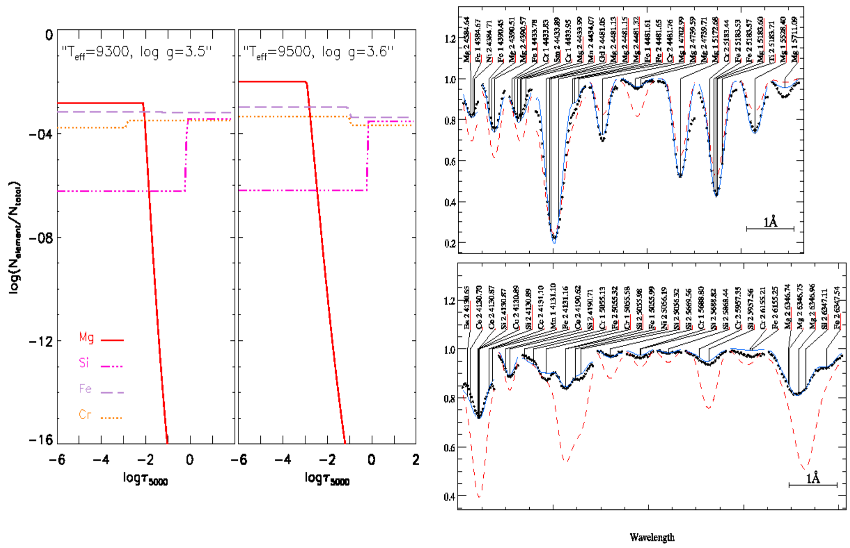

Figure 1. Left vertical columns represent stratification of Mg and Si in atmosphere of HD 103498 derived using two models with T_{eff} = 9300 K and T_{eff} = 9500 K and different optimization settings for the step-like stratification profile. Right horizontal columns denote a comparison between the observed and predicted profiles of Mg (top panel) and Si (bottom panel).

2. Observations, data reduction and analysis

This star was observed on Feb 2, 2009 using the 2.56m Nordic Optical Telescope (NOT), La Palma, Spain, equipped with the FIber-fed Echelle Spectrograph. The standard steps of échelle spectra reduction were performed using the 'REDUCE' package of *Piskunov & Valenti (2002).*

3. Analysis tools and methodology

To perform model atmosphere calculation we used LLmodels stellar model atmosphere code (*Shulyak et al., 2004*), VALD database (*Kupka et al. 1999; Piskunov et al.1995*) was used as a source of atomic lines data, SYNTH3 *(Kochukhov, 2007)* was used in all synthetic spectrum calculations, classical abundance analysis is performed using updated version (*Tsymbal, 1996*) of WIDTH9 code (*Kurucz, 1975*), NLTE effects on MgI/MgII ions were analysed using the DETAIL, SURFACE codes (*Butler, 1984; Giddings, 1981*). To study the stratification of chemical elements in the atmosphere of the star we used the DDAFit script which is an automatic procedure to find chemical abundance gradients from the observed spectra (Kochukhov, 2007). The model atmosphere construction and stratified abundance analysis both are strongly coupled

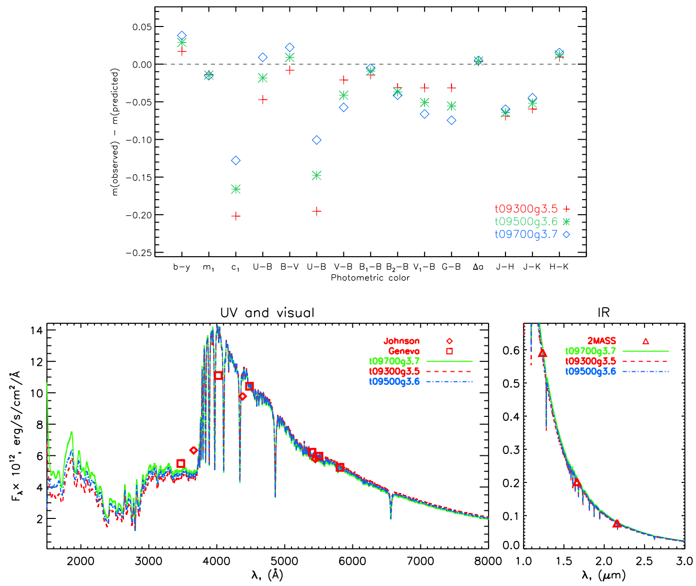

Figure 2. Top panel: Difference between observed and predicted colors of different photometric systems. Theoretical colors were reddened applying $E(B-V) = 0.06$. Bottom panels: Comparison between observed photometric parameters calibrated in absolute units and theoretical fluxes convolved with FWHM=5 Å Gaussian. Theoretical fluxes were reddened applying $E(B-V) = 0.06$.

together, therefore it is necessary to use the iterative procedure as in *Pandey et al. (2011)*.

- Two model atmospheres (T_{eff}=9300K, log g = 3.5 and T_{eff}=9500K, log g = 3.6) computed with individual and stratified abundances provide reasonable fit simultaneously to spectroscopic and photometric indicators.
- The abundance analysis demonstrates strong overabundance of Fe and Cr relative to the Sun.
- This star is Cr-Fe rich, but these two elements do not show any signature of noticeable stratification in its atmosphere.
- Mg has a large abundance gradient in the atmosphere of this star with accumulation of Mg ions in the uppermost atmospheric layers but distribution of Si demonstrates opposite behaviour. It indicates that Mg is pushed up by radiative forces more efficiently than Si.
- From the HIPPARCOS parallax of $\pi = 3.37 \pm 0.56$ mas (*van Leeuwen 2007*) the distance to the star is $d = 297$ pc, which results in redenning value of $E(B-V) = 0.06$. Comparing observed photometry in Strömgren, Geneva, 2MASS, and Johnson filters transformed to physical units with model fluxes

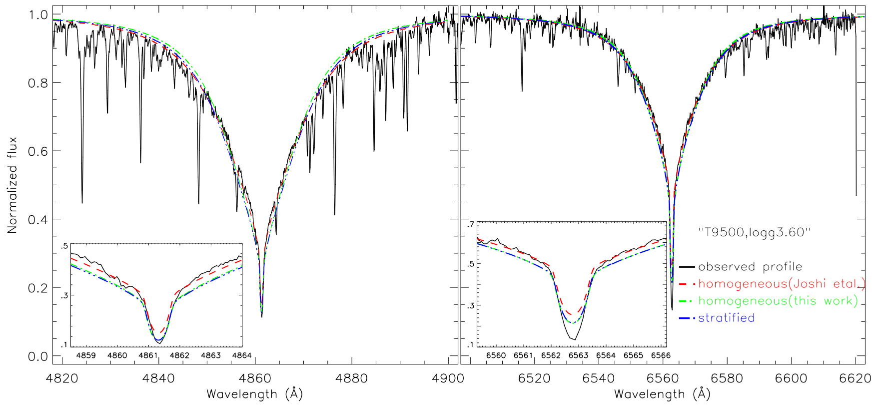

Figure 3. Comparison between the observed Hβ (left panel) and Hα (right panel) line profiles and synthetic profiles calculated with homogeneous and stratified abundances, both with the final adopted $T_{\rm eff}$ = 9500 K, log g = 3.6 model. The inset shows the zoomed part of the profiles around the core of line.

we estimated the radius of HD 103498 to be R = 4.56 ± 0.77 $R_\odot$ for T_{eff} = 9300 K, log g = 3.5 model and R = 4.39 ± 0.75 $R_\odot$ for T_{eff} = 9500 K, log g = 3.6 model respectively.

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