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Elemental abundance analysis of single and binary late-B stars using sub-meter class telescopes: HR 342, HR 769, HR 1284, and HR 8705

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Abstract. We test the capabilities of 0.4 m telescopes equipped with an échelle spectrograph to derive fundamental parameters and elemental abundances of four late-B type stars: HR 342, HR 769, HR 1284, and HR 8705. The medium resolution ($R \sim 14\,000$) spectra covering the wavelength range of 4380-7350 Å of the four stars have been obtained using the 40-cm-telescope in Ankara University Kreiken Observatory (AUKR). Using spectrum synthesis, we were able to derive the abundances of eleven chemical elements. We find that these stars do not show remarkable departures from the solar abundances, except for HR 8705 and the primary component of HR 1284, which exhibit slight under-abundances of a few elements, i.e., O, Mg, Al, Si, and Fe. We also find that HR 1284 is probably a newly recognized spectroscopic binary star. In order to model the spectrum of this object, one of us (TK) has developed a new graphic interface which allows us to synthesize the composite spectrum of binary stars.

Key words: chemical abundance analysis – chemically peculiar stars – early type stars – stars: individual: HR 342, HR 769, HR 1284, HR 8705

1. Introduction

The atmospheres of chemically peculiar (CP) late-B stars are useful laboratories to test the theory of atomic diffusion. We have recently started a project aiming at observing and analysing high resolution spectra of about 100 slowly rotating late-B stars in order to find new CP stars. In order to decide which objects should be monitored at a higher resolution with larger telescopes, we are currently observing these objects using a 40-cm telescope equiped with a medium resolution échelle spectrograph. We present here the abundance analysis of HR 342, HR 769, HR 1284, and HR 8705 and the detection of a new binary object (HR 1284). We also present a new interface which allows us to synthesize the spectrum of detached SB2 binaries.

2. Observations and analysis

The targets have been observed using the Shelyak eShel spectrograph mounted on the 40-cm telescope in Ankara University Kreiken Observatory (AUKR) in 2017. The spectra span the spectral range 4380-7350 Å with a medium resolution, i.e., $R \sim 14000$. The atmospheric parameters were initially estimated from Johnson (BV) magnitudes with the calibrations of Flower (1996) and then refined by modelling H_β lines. The fundamental parameters of the stars were also estimated from a $\log g$–$T_{\rm eff}$ diagram (Fig. 1) and are collected in Table 1.

The model atmospheres were calculated using ATLAS12 (Kurucz, 2005) and the synthetic spectra were computed using SYNSPEC49/SYNPLOT (Hubeny & Lanz, 1995). The linelist was first constructed from R. Kurucz's gfall.dat and then updated by using VALD, NIST, and recent publications. We iteratively adjusted the synthetic spectra to the observed spectra until the best fit was achieved in order to derive the elemental abundances.

During the analysis, we have found that HR 1284 (HD 26171) is most likely a newly recognized SB2 star, where the lines of the secondary component are barely visible. One of us (TK) modified SYNPLOT into a new interface (called SYNPLOTBIN) to model the composite spectrum of this binary star. The observed spectrum is compared to the composite synthetic spectrum together with the synthetic spectra of each component in Fig. 2. In the lower panel of Fig. 2, Mg I triplet around 5175 Å, Fe I line at 5328.038 Å, and Na I doublet around 5890 Å belonging to the secondary component are distinguishable in the observed composite spectra of the system.

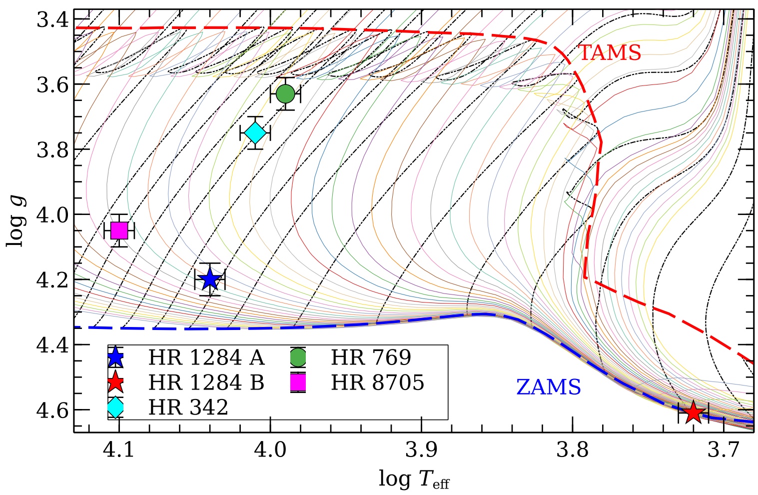

Figure 1. Stars on the theoretical $\log g$–$\log T_{\rm eff}$ diagram (tracks taken from Bressan et al. 2012).

Table 1. Fundamental parameters of the targets

Star	Sp.T.	$T_{\rm eff}$ (K)	$\log g$ (cgs.)	M ($M_\odot$)	Age (Myr)
HR 342	B9.5V	10250 ± 250	3.75 ± 0.05	3.00 ± 0.10	325 ± 20
HR 769	B9.5V	9800 ± 200	3.63 ± 0.05	3.05 ± 0.10	340 ± 20
HR 1284 A	B9.5V	11000 ± 300	4.20 ± 0.05	2.67 ± 0.10	200 ± 20
HR 1284 B	K1V	5200 ± 300	4.61	0.90 ± 0.02	200 ± 20
HR 8705	B8V	12500 ± 500	4.05 ± 0.05	3.40 ± 0.10	158 ± 20

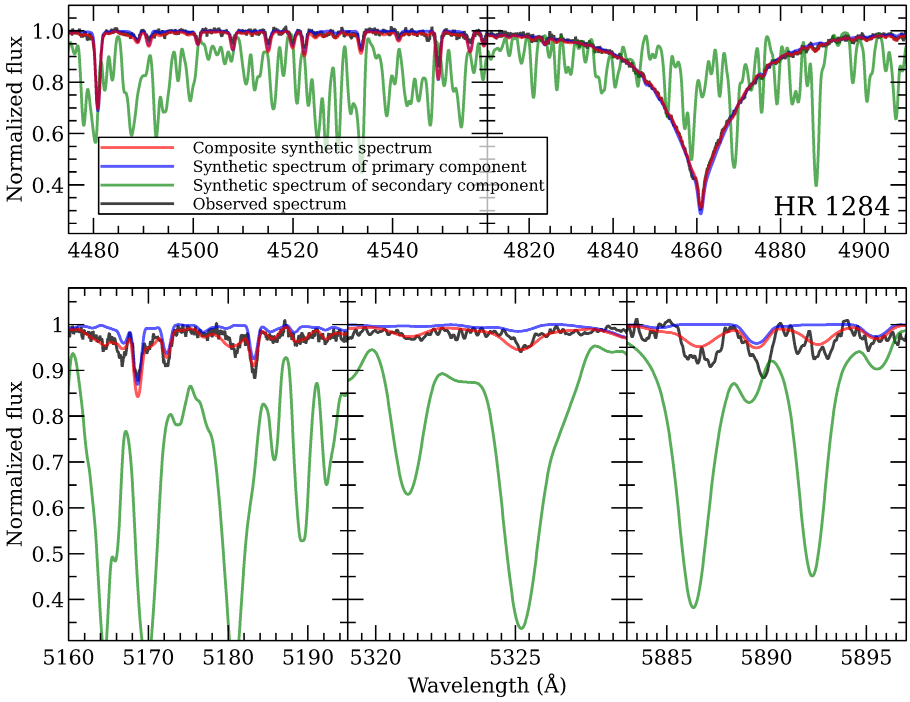

Figure 2. Observed spectra of HR 1284 and synthesized spectra for its components.

3. Results and conclusion

We have derived the abundances of 11 elements for four bright stars with uncertainties ranging from ±0.10 and ±0.25 dex (Fig 3, right). The chemical patterns of the stars do not depart significantly from the solar composition except for HR 8705 and the primary component of HR 1284, which exhibit slight under-

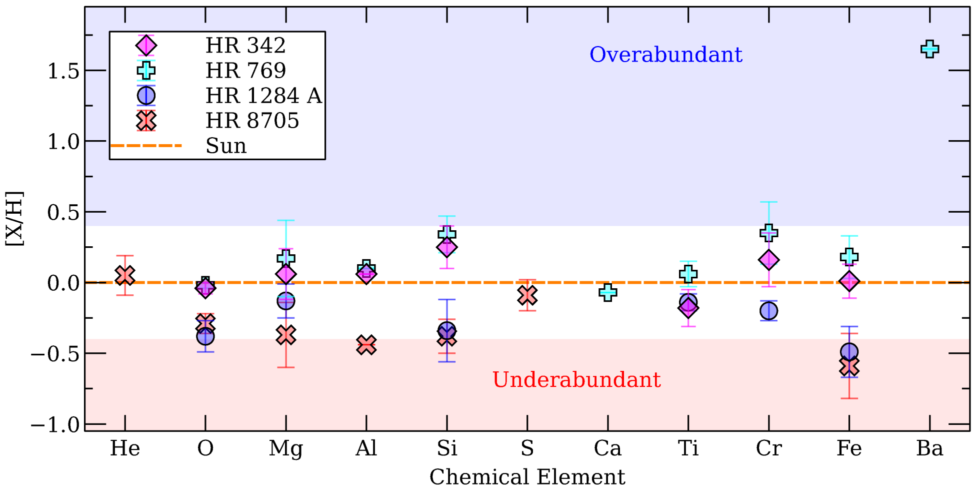

Figure 3. Abundance pattern of the target stars.

abundances of a few elements, such as O, Mg, Al, Si, and Fe. We could detect a very shallow Ne I 6402 Å line only in the spectra of HR 8705, indicating a slight enhancement of Neon. Higher resolution spectra of these two stars, obtained using larger telescopes, will help clarify their natures.

This demonstrates the usefulness of small telescopes equipped with medium resolution spectrographs to derive abundances for certain chemical elements and sort out putative candidates for CP stars to be observed afterwards at higher resolution with meter class telescopes.

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