Stars with discrepant $v \sin i$ as derived from the Ca II 3933 and Mg II 4481 Å lines. III. The stars with $v \sin i$ (3933) $<$ $v \sin i$ (4481)*

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Axial rotation of a star plays an important role in its evolution, physical conditions in its atmosphere and appearance of its spectrum. We analyzed CCD spectra of nine stars for which their projected rotational velocity derived from the Ca II line at 3933 Å was remarkably lower than that ones derived from the Mg II at 4481 Å. We derived effective temperatures and surface gravities using published $uvby\beta$ photometries, and computed synthetic spectra. Comparing observed line profiles of the two lines with computed ones we estimated values of $v \sin i$. One of the stars, HD 44783 is a Be-star which, besides narrow absorptions in the spectrum originatig in its circumstellar environment, has also lines of interstellar origin. We found an indication of a circustellar matter in the spectrum of HD 25 152. In the spectra of remaining seven stars narrow components at the line of Ca II at 3933 Å as well as narrow absorptions at the Na I at 5889.951 Å (D1) and 5895.924 Å (D2) lines are of interstellar origin. In HD 114376 two systems of interstellar components exist disclosing thus two different interstellar clouds towards the star. In the spectrum of HD 138527 signs of the light of a supposed companion contributing with 15% to the total light of the system, were detected.

I. INTRODUCTION

In previous two papers of this series (Zverko et. al [1] and Zverko et. al [2]) we dealt with multiple stars HD 2913 and HD 90569 that have $v \sin i$(Ca II-3933) $>$ $v \sin i$(Mg II-4481). We demonstrated that the former has a composite spectrum consisting from a B9.5V star and an early F-type main sequence star. The spectrum of the latter bears indications of duplicity, however, not confirmed so far. In this paper we investigate spectra of nine stars with $v \sin i$(Ca II-3933) $<$ $v \sin i$(Mg II-4481) which are listed in Table I.

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* Based on spectroscopic observations made at Rozhen NAO, SAO RAS, AV ČR Ondřejov, and ELODIE public archive

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TABLE I: List of stars.

HD	HR	Spectrum	$v\sin i$ [km s^{-1}]			RV	Notes
			Ca II [21]	Mg II [33]	this work	[km s^{-1}]	
25152	1234	A0V	50	250	127	−20var	$v\sin i = 68$ km s^{-1}
44783	2300	B8Vn	65	300	125-280	3var	Be- star
45563	2347	B9V ?SiSr	50	125	105	42	$v\sin i = 80$ km s^{-1}
53744	2669	B9V	160	350	250	−16var?	$v\sin i = 280$ km s^{-1}
113797	4943	B9V ?Pec	0	175	140	−13var	
114376	4967	B7III	0	125	120	−6var	ADS 8805BC, binary?
136849	5718	B9Vn	180	350	220	−7SB	$v\sin i = 260$ km s^{-1}
138527	5770	B9V	0	175	135	−18var	
188485	7601	A0III	95	150	115	−8var	

II. OBSERVATIONS, THE METHOD

We obtained CCD spectra at the National Astronomical Observatory, Rozhen, Bulgaria (NAO), and at the Special Astrophysical Observatory, Nizhnij Arkhyz, Russia (SAO). The NAO spectra were taken with the Photometrics AT200 CCD 1024×1024 camera at the 3rd optical camera of the coude spectrograph of the 2-m RCC telescope, with $R = 22\,000$. The Ca II region extends from 3898 to 3967 Å and the Mg II one from 4447 to 4550 Å. The IRAF[1] standard procedures were used for reducing the spectra. The SAO spectra were obtained with the 6-m BTA telescope either with the Nasmyth echelle spectrometer (NES) equipped with a 2048×2048 CCD camera [22] giving resolution $R = 43\,000$ and the spectral region $4226 - 5654$ Å, and the Main stellar spectrograph (MSS) equipped with a Zeeman analyser and a CCD2 2048×2048 camera giving $R = 15\,000$ and the spectral region $4453 - 4695$ Å. The ZEEMAN software package based on a set of ESO MIDAS routines [19] and the package REDUCE [20] were used to reduce the SAO spectra.

SYNSPEC code [15, 17] was used to compute synthetic spectra, detailed line profiles of the Ca II 3933 and Mg II 4481 lines, and to derive elemental abundaces by means of comparing with observed lines. LTE atmosphere models are interpolated from the grid of Castelli & Kurucz [18]. The VALD database was used for atomic line data [24, 26–28]. Effective temperature and surface gravity values were derived using the codes UVBYBETA [29] and TEFFLOGG [30] with the $uvby\beta$

[1] IRAF is distributed by the National Optical Astronomy Observatory, which is operated by the Association of Universities for Research in Astronomy (AURA), Inc., under cooperative agreement with the National Science Foundation.

data extracted from SIMBAD. Abundance corrections where mentioned, are relative to solar ones.

The remarkably low values of $v \sin i$ estimated by Palmer *et al.* [21] from the Ca II-3933 Å suggest a possible presence of an interstellar line. Therefore, where possible, we confronted these data with the "New 3D gas density maps of Na I and Ca II interstellar absorption within 300 pc" elaborated by Welsh *et al.* [32].

Radial velocity were determined by means of CCF ([3]), using synthetic spectra as a template.

III. ANALYSIS

A. HD 25152

HD 25152 (HR 1234, HIP 18769, V = 6.41, A0V). More values of the projected rotational velocity can be found in the literature. Palmer *et al.* [21] give $v \sin i = 50$ km s^{-1} for the Ca II 3933 Å–line, Wolff & Preston (1978) [33] have $v \sin i = 250$ km s^{-1} for the Mg II 4481 Å–line, and Dworetsky [7] gives $v \sin i = 100$ km s^{-1}. Hube [16] determined 7 values of radial velocity ranging from RV= -20 to $+4$ km s^{-1}. Belikov [6] gives RV= -20.4 km s^{-1}.

Spectra of HD 25152 available are listed in Table II, where also observables mesured in this work are introduced as follow: equivalent widths and FWHM of the narrow (interstellar, affix "int" is used) line in columns 5 and 6 respectively, radial velocities derived from the interstellar and star's component in columns 7 and 8 respectively.

TABLE II: List of spectra of HD 25152 and measured observables.

Spectrum	HJD 2450000+	Region	S/N	EWint mÅ	FWHMint Å	RVint km s^{-1}	RVstar km s^{-1}
MSS 5051	5075.5770	Mg II 4481	600			-9.0 ± 0.4	
NAO hmed2	4844.3134	Mg II 4481	255				-24.9 ± 0.6
NAO caed2	4844.3473	Ca II 3933	125	27	0.37	0.2 ± 0.6	-23.5 ± 1.5
NAO nadew2	5788.5671	Na I D1 5889	180	94	0.25	10.5 ± 0.1	-0.2 ± 8
		Na I D2 5895		83	0.24		
NAO nadew3	5789.5684	Na I D1 5889	260	96	0.24	10.1 ± 0.3	0.0 ± 12
		Na I D2 5895		87	0.23		

From two sets of $uvby\beta$ indices introduced in SIMBAD we calculated $T_{\rm eff} = 10\,530$ and $10\,640$ K, and $\log g = 3.94$. Formal errors which folows from the UVBYBETA and TEFFLOG routines amounts to $\approx$ tens of Kelvins, while real errors reach to a few hundreds of Kelvins at this temperature region.

The model atmosphere was interpolated to $T_{\rm eff} = 10\,580$ K, $\log g = 3.94$. The theoretical spectrum was computed with microturbulence $\xi = 0$ $\mathrm{km\,s^{-1}}$ and solar abundances, except for helium, magnesium and calcium, which were mildly corrected by factors of 0.9, 1.5 and 0.45 respectively. A section of the spectrum in the Mg II 4481 Å region is shown on Figure 1a, where a comparison of the MSS spectrum with the synthetic one is displayed.

The line widths fit best with the value of the projected rotational velocity $v \sin i = 127$ $\mathrm{km\,s^{-1}}$ as it is documented in a high resolution on Figure 1b, c. The all observed spectra in Figure 1 are shifted by a value of the corresponding star's radial velocity which is given in the last column of Table II.

The NAO spectrum for the region of the Ca II-line has significantly lower ratio, $S/N = 125$ in comparison with the other ones. Despite this, a narrow absorption feature is clearly visible longward of the centre of the wide Ca II-line. The narrow one has FWHM = 0.37 Å indicating low projected rotational velocity, and the equivalent width EW = 27 mÅ, measured below the wide line profile. Radial velocity of this feature is ≈ 0 $\mathrm{km\,s^{-1}}$. The parallax according to HIPPARCOS is 8.74 mas, while SIMBAD intriduces 8.25 mas, what corresponds to the distance 114 to 121 pc. The BS Catalog gives 123 pc, and notes *Sirius group; UMa stream.* Also Belikov [6] includes this star in the Per OB2 star complex. So the narrow absorption may be of interstellar origin. Welsh *et al.* [32] give EW= 34 mÅ for the interstellar component in the spectrum of a nearest HD 24760 which is 165 pc distant. Other four stars HD 22780, HD 23180, HD 24131 and HD 24912 found within 5^o from HD 25152 have interstellar components with equivalent widths ranging from 26 to 119 mÅ and correlated with distances from 248 to 543 pc.

The spectrum around the Na I D1 and D2 lines is shown on Figure 1d. The synthetic spectrum rotated to $v \sin i = 127$ $\mathrm{km\,s^{-1}}$ fits well the helium line at 5875.6 Å. The star's radial velocity estimated using this line equals to zero. The radial velocity of the narrow doublet however, is RV ≈ 10 $\mathrm{km\,s^{-1}}$. The FWHM values for the deep narrow lines are ≈ 0.24 Å, comparable with the resolution of the observed spectrum 0.27 Å. The average values of the equivalent widths are EW(D1) = 95 mÅ and EW(D2)= 85 mÅ. Two out of the four stars mentioned in the previous paragraph, HD 22780 and HD 24131, have equivalent widths given for both Na I D1 and D2 lines, 130 and 81 mÅ and 245 and 155 mÅ respectively. The stars are at distances 248 and 317 pc while HD 25152 is 120 pc distant.

Despite the equivalent widths of the Ca II and Na I lines in HD 25152 correspond with strengths of interstellar lines of stars occuring in near directions and comparable distances, the different radial velocities of the narrow Ca II and Na I lines in the spectrum of HD 25152, suggest a different origin of the Ca II and Na I lines.

Paunzen et al. [23] mentioned two different criteria how to distiguish between the interstellar and circumstellar origin. According to the first of them, ratio EW(D1)/EW(D) = 2 points to an optically thin, i. e. interstellar environment, while the ratio near unity represents a circumstellar disk. For HD 25152 EW(D1)/EW(D) $\approx$ 1.1 which rather points to the circumstellar origin of the doublet. For the two stars from the Welsh et al.[32] mentioned above, the ratio amounts to 1.6.

The second criterion uses ratio EW(Ca II)/EW(Na I D1+D2). If the ratio is much larger than unity, the lines are of a circumstellar origin. For HD 25152 W(Ca II)/EW(Na I D1+D2) $\approx$ 0.15. For HD 22780 the ratio is 0.12, and for HD 24131 it is 0.18. According to this criterion the lines in these three stars are not of a circumstellar origin.

Isobe et al. [8] measured equivalent width equal 0.2 Å of the diffuse interstellar band at 4430 Å in the spectrum of this star.

Heiles [12] measured stellar polarization 0.2%, which suggests occurence of interstellar matter in the vicinity of HD 25152.

Whatever the origin of the narrow lines in the spectrum of HD 25152 is, the presence of the narrow Ca II line is misleading which result in an underestimation of the value of the projected rotational velocity, as the narrow feature creates a higher contrast against the continuum background in the photographic spectrum than the wide stellar line.

B. HD 44783

HD 44783 (HR 2300, HIP 30448, V=6.2, B8Vn). Palmer et al. [21] gives $v \sin i$ = 65 km s^{-1} from Ca II 3933 Å, Wolff & Preston [33] from the Mg II 4481 Å estimated $v \sin i$ = 300 km s^{-1}. Hoffleit & Warren [14] moreover, introduce variable radial velocity, "RV= 3var" km s^{-1}.

Spectra at our disposal and their essentials are listed in Table III. The ELODIE spectrum displaying wavelengths from 4000 to 6800 Å as well as the NAO spectrum comprising Hβ line discloses profiles of Balmer lines typical for a Be-star. As an example we display a profile of Hβ on Figure 2a.

Frémat et al. [10], based on the same ELODIE spectrum which is now publicly accsessible, determined $v \sin i = 226 \pm 50$ km s^{-1}, $T_{\rm eff} = 11\,000 \pm 1000$ K, $\log g = 3.05 \pm 0.15$, and spectral type B9 III. Simbad lists three sets of *uvby* indexes and four values of the β index. All these quantities

TABLE III: List of spectra of HD 44783.

Spectrum	HJD 2450000+	Lines	S/N	EWint mÅ	FWHMint mÅ	RV km s^{-1}	Remark
Elodie	1896.4386	Hα,Hβ	120			9.2 ± 1.5	central absorption
		Hγ,Hδ				9.1 ± 1.5	central core
		Mg II region				9.3 ± 0.5	$v \sin i = 250$ km s^{-1}
		Na I D1/D2				30.4 ± 1.0	broad lines
		Na I D1/D2		34/14	0.17/0.15	13.5 ± 0.1	narrow lines
NAO nadfa1	5941.3579	Na ID1,D2	140			16.5 ± 3.1	broad lines
		Na ID1,D2	140	33/17	0.35/0.33	17.2 ± 0.2	narrow lines
NES	5281.2781	Hβ	144			45.9 ± 1.5	central absorption
		D1,D2	148			51.0 ± 4.1	broad lines
		D1,D2	148	31/16	0.21/0.17	50.1 ± 0.21	narrow lines

are, however, strongly influenced by emmisions in the spectrum as in the case of Hβ line, which spoils the β index, or a distorted profile of Hδ line, which is encompassed by the v filter entering in to the parameters m_1 and c_1, that are crucial in the procedure used while determining effective temperature and gravity. This brings uncertainity in determination of the atmospheric parameters that is reflected also in the large errors of the values derived by Frémat et al. [10]. To analyze the spectrum of HD 44783 in details is beyond the scope of this work. Now we know that a narrow absorption at the Ca II 3933-line could take away Palmer et al. [21] when estimated the value of $v \sin i$. We can contribute with additional values of radial velocity. For this purpose we computed a synthetic spectrum using a model atmosphere with $T_{\rm eff} = 11\,000$ K and $\log g = 3.0$. To reach a suitable fit for lines used we increased microturbulence to 5 km s^{-1}, and corrected abundances by factors of 10 and 3 for sodium and magnesium respectively. On Figure 2b we show a section of the spectrum in the region of the sodium D1 and D2 lines. These two star's lines are well fitted with the value $v \sin i = 125$ km s^{-1} which is, however, only a half of that accepted above. The profile of the He I line at 5875 Å, however, needs a value $v \sin i = 280$ km s^{-1} for which the profile is also depicted in the Figure 2b. Similar discrepance is apparent at the region of the Mg II 4481 Å line (in ELODIE spectrum), where for lines of Fe II the lower value is suitable, while for the lines of magnesium 4481 Å and helium at 4471 Å lines rather $v \sin i = 250$ km s^{-1} is better. The lower value would also be better for the blend of the lines of He I, Fe II and Sc II around 4923 Å, as shown on Figure 2a. These our observations are concordant with the scatter of ± 50 km s^{-1} estimated by

Frémat at al. [10]. The inconsistent values of $v \sin i$ derived using various spectral lines reflect the complex structure of the veiled system and related ways of the formation of spectral lines. Not only central emisions reverse central parts of Hα and Hβ, hints also exist of a central emision in the profiles of the He I 5875 Å on the spectrum NAO (see Figure 2b) and Mg II 4481 Å. While for weak metalic lines the lover value $v \sin i = 125$ km s^{-1} commonly complies, outer wings of Hδ and Hγ lines would need $v \sin i > 300$ km s^{-1}. Such inconsistencies however, results also in a similar uncertainity of measurement of radial velocity values. In Table III we bring the values of radial velocity determined using various means. The values for the Balmer lines are for the central absorption peaks formed in the circumstellar matter. These values were estimated by CCF comparing the corresponding observed core with a triangle of a size and shape of the core of the line an placed at the laboratory wavelength of the line. The value in the Mg II region with a number of weak metalic photospheric lines was derived by CCF using a synthetic spectrum. Despite the two types of the lines have a different origin, their radial velocity values are equall, RV$\approx$ 9.2 km s^{-1}, suggesting the circumstellar formation, where the narrow absorptions origin, does not expand. The broad Na I D1, D2 lines, that are supposed to be of a photospheric origin, have a remarkable different radial velocity RV$\approx$ 30km s^{-1} in the ELODIE spectrum. The narrow D1, D2 lines were compared with a part of a synthetic spectrum containing the two sodium line only. The radial velocity of the narrow pair, 13.5 km s^{-1}, does not correspond to either of the previous determinations. The plenty of teluric lines in the ELODIE spectrum makes the measuring of parameters of the Na I D1, D2 lines harder. This is especially noticeable in the case of D2 (Figure 2b). The difference between the values of radial velocity for the broad and narrow pairs suggests that the narrow D1, D2 lines might be of interstellar origin. The two values of radial velocities derived from the broad and narrow components in the NAO spectra, 16.5 and 17.2 km s^{-1} respectively, are close, so other criterion for their origin must be considered to exclude a circumstellar origin of the narrow ones. We measured equivalent widths of these lines using a triangle method. For the ELODIE spectrum we estimated EW(D1)= 34 mÅ, EW(D2)= 14 mÅ, the ratio is 2.4. FWHM(D1)= 0.17 Å, FWHM(D2)= 0.15 Å (R=0.13 Å). This spectrum, however, is heavily contaminated with teluric lines that must be taken into account when measuring these parameters. For the NAO spectrum we estimated EW(D1)= 33 mÅ, EW(D2)= 17 mÅ, with the ratio 1.9, and FWHM(D1)= 0.35 Å, FWHM(D2)= 0.33 Å (R=0.27 Å). In the NES spectrum EW(D1)=31 Å, EW(D2)=16 mÅ giving the ratio 1.9, and FWHM(D1)=0.21 Å, FWHM(D2)=0.17 Å (R=0.14 Å). According to the criterion introduced by Paunzen et al. [23], EW(D1)/EW(D2)=2 if the lines are of interstellar origin, these lines are of the interstellar origin as the condition is fulfilled in the all three spectra.

The estimated FWHMs exceeds mildly the theoretical resolution of the sapectra, thus some contribution from circumstellar matter around this Be star cannot be excluded, as can be seen in the left part of the D1 line in the NAO spectrum (Figure 2b). Welsh et al. [32] give EW(D1)=88 mÅ for a near by angular distance and 313 pc distant HD 47839, and EW(D1)=116 mÅ, EW(D2)=73 mÅ for other near HD 43285, which is 228 pc distant. The distance of HD 44783 is 348 pc.

C. HD 45563

TABLE IV: List of spectra of HD 45563.

Spectrum	HJD 2450000+	Region	S/N	EWint mÅ	FWHMint Å	RVint km s^{-1}	RVstar kms^{-1}
NAO hemger1	5588.4400	Mg II 4481 Å	141				31.1 ± 0.6
NAO ca9ej1	5587.3905	Ca II 3933 Å	47	22	0.21	18.2 ± 0.6	30.8 ± 1.2
NAO nadfa1	5941.3743	Na I D1	126	25	0.25	21.7 ± 0.2	45.5 ± 2.7
		Na I D2		14	0.24		

HD 45563 (HR 2347, HIP 30798, V=6.48, B9V). Palmer et al. [21] give $v \sin i = 50$ km s^{-1} from the Ca II 3933-line, while Wolff & Preston [33] have $v \sin i = 125$ km s^{-1} from the Mg II 4481-line. Royer et al.[25] derived $v \sin i = 115$ km s^{-1}. Hoffleit & Warren [14] give $v \sin i = 80$ km s^{-1}, and RV= 42 km s^{-1}.

Using four sets of the *uvby* indexes listed in SIMBAD we derived $T_{\rm eff}$ from 10 840 K to 10 910 K, and $\log g$ from 4.08 to 4.14. The average values are $T_{\rm eff} = 10\,890$ K and $\log g = 4.10$. We computed a synthetic spectrum for these valeus and with the value of microturbulence $\xi = 0$ km s^{-1}. To reach a fit, abundances of helium, magnesium and calcium were corrected by factors of 1.2, 2.5 and 0.6 respectively. Then for the projected rotational velocity we obtain $v \sin i = 105$ km s^{-1}. The very good fit is displayed on Figure 3.

The radial velocities in the NaD region were determined by means of CCF. The star's value fits broad lines of He I 5875.6 Å, and D1 and D2. The value for the interstellar lines was derived using a section of a synthetic spectrum containing the narrow D1, D2 lines only.

The ratios of the equivalent widths EW(D1)/EW(D2 = 1.8 as well as EW(Ca)/EW(D1+D2) = 0.56 points to an interstellar origin of the narrow lines. Welsh et al. [32] introduce equivalent widths 26 mÅ and 13 mÅ for D1 and D2 in the spectrum of HD 45563, the values in an excellent agreement with our measurements, i. e. 25 mÅ and 14 mÅ for D1 and D2, respectively.

D. HD 53744

HD 53744 (HR 2669, HIP 34367, V=6.48, B9V). Palmer et al. [21] determined $v \sin i$ = 160 km s^{-1} from the Ca II 3933- line, and Wolf & Preston [33] give $v \sin i = 350$ km s^{-1} from the Mg II 4481-line. SIMBAD database lists two values of $v \sin i$ namely 297 and 250 km s^{-1}. Abt [13] give 250 km s^{-1}, and Zorec [11] 288 km s^{-1}. Hoffleit & Warren [14] notes possible variable radial velocity.

We have spectra from NAO as well as from SAO MSS and NES spetrographs, as they are listed in Table V.

TABLE V: List of spectra of HD 53744.

Spectrum	HJD 2450000+	Region	S/N	EWint mÅ	FWHMint Å	RVint km s^{-1}	RVstar kms^{-1}
MSS	5282.2736	Mg II 4481	400				-19.2 ± 2.1
NAO hemger1	5588.4400	Mg II 4481	140				-21.6 ± 3.0
NAO ca9ej1	5587.3905	Ca II 3933 (1)	47	19	27	-224.1 ± 0.6	-109 ± 10
NAO nadfa1	5941.3743	Na I D1	126	56	0.26	10.3 ± 0.1	-7.0 ± 7.6
		Na I D2		32	0.28		
NESl0325026	5281.3071	Na I D1	180	56	0.20	43.7 ± 0.1	-26.7 ± 1.4
		Na I D2		33	0.20		

Two indepedent sets of $uvby\beta$ listed in SIMBAD introduce identical indexes from which we derived $T_{\rm eff} = 11\,630\,{\rm K}, \log g = 3.56$. With this model atmosphere and zero miocroturbulence the value of magnesium abundance needs to be increased by a factor of 3.3 relatively to the solar value, and the abundance of helium mildly corrected by factor of 1.1. Then $v \sin i = 280$ km s^{-1}. The fits of the observed spectra with the calulated ones are displayed on Figure 4a, b. Remarkable is the absence (at most a weak indication can be admitted) of the He I at 5875 Å line in the NES spectrum. The depths as well as FWHMs of the lines D1 and D2 correspond to the higher resolution of the echelle spectrum. The remaining narrow absorptions are teluric lines. According to the criterion of Paunzen et al. [23] the ratio EW(D1)/EW(D2) ≈ 1.7, thus the D1 and D2 lines are of interstellar origin, which is not inconsistent with distance 289 pc according to the parallax introduced in the Vizier database.

The star's radial velocity of the NAO *nadfa*1 spectrum is derived from the He I line at 5875 Å. The star's radial velocity of the NES spectrum is derived from Hβ line. Confusing is the difference between the radial velocity values of D1, D2 lines measured on the two spectra, the NES and the NAO ones. If they are of the same origin, and there is no reason to assume anything else, as we show in the previous paragraph, their radial velocities should fit each other within the limits of accuracy. The teluric lines visible in the NES spetrum are at position corresponding to RV= 1.5 $\mathrm{km\,s^{-1}}$, which is compatible with the baricentric correction applied to the spectrum, RV= 1.8 $\mathrm{km\,s^{-1}}$, thus approving a correct scale of the wavelngth.

E. HD 113797

TABLE VI: List of spectra of HD 113797.

Spectrum	HJD 2450000+	Region	S/N	EWint mÅ	FWHMint Å	RVint km $\mathrm{s^{-1}}$	RVstar $\mathrm{kms^{-1}}$
MSS vo029bt	5281.4931	Mg II 4481 Å					-14.2 ± 0.5
NAO hemgee1	4925.3160	Mg II 4481 Å	341				-24.1 ± 0.8
NAO hemgeg5	4999.3602	Mg II 4481 Å	362				-18.6 ± 0.5
NAO hemgel3	5316.3669	Mg II 4481 Å	217				-17.5 ± 0.7
NAO ca9ee1	4925.3579	Ca II 3933 Å	184	10	0.18	-10.8 ± 0.9	-17.7 ± 1.3
NAO ca9eg5	4999.3148	Ca II 3933 Å	252	13	0.18	-9.8 ± 0.8	-17.2 ± 1.6
NAO nadew1	5787.2573	Na I D1	234	12	0.26	-8.6 ± 0.3	-21.3 ± 15.5
		Na I D2	234	5	0.24		

HD 113797 (14 CVn, HR 4943, HIP 63901, V=5.25, B9V). Palmer et al. [21] determined $v \sin i =$ 0 $\mathrm{km\,s^{-1}}$ from the Ca II 3933-line, and Wolf & Preston [33] give $v \sin i = 175$ $\mathrm{km\,s^{-1}}$ from the Mg II 4481-line. Hoffleit & Warren [14] give $v \sin i = 175$ $\mathrm{km\,s^{-1}}$. Data in SIMBAD summarizes three values of $v \sin i$ from 54 to 152 $\mathrm{km\,s^{-1}}$, introduces variable radial velocity from -22 to 8 $\mathrm{km\,s^{-1}}$, and light variability in V from 5.10 to 5.29 mag.

We derived $T_{\rm eff} = 11\,200$ K, $\log g = 4.16$ from two identical sets of $uvby\beta$ photometry listed in SIMBAD. A model atmosphere with these parameters was used for computing a synthetic spectrum. A value of microturbulence equal to zero was used as well as mildly corrected abundances of some chemical elements by factors as follow: helium 1.1, sodium 3, magnesium 2.2, calcium 0.6, titan and iron 1.2. This is well documented on Figure 5a, where the MSS spectrum is fitted with the theoretical one. The excellent fit with the accepted value of projected rotational velocity, $v \sin i = 140$ $\mathrm{km\,s^{-1}}$, is displayed on Figure 5b, where a section around the Mg II line in the NAO spectra is shown in an enlarged scale. A weak narrow absorption is clearly visible longward off the centre of the broad calcium Ca II line on Figure 5c, as well as narrow D1 and D2 lines on Figure 5d.

Our estimation of equivalent widths of Ca II and D1, D2 introduced in Table VI point to the interstellar origin of these lines as EW(D1)/EW(D2) = 2.4 and EW(Ca II)/EW(D1D2)≈ 0.7, which is comparable with those given by Welsh et al. [32] i. e., 1.86 and 0.7, derived from their values EW(D1)= 13 mÅ, EW(D1)= 7 mÅ, W(Ca)= 14 mÅ. They introduce 87 pc for the distance to this star, while according to the parallax in SIMBAD, the distance is 105 pc.

Also the similar vaules of radial velocities of the narrow components point to a common, interstellar, origin.

F. HD 114376

HD 114376 (15 CVn, HR 4967, HIP 64217, ADS 8805BC, V=6.28, B7III). Palmer et al. [21] determined $v \sin i = 0$ km s^{-1} from the Ca II 3933-line, and Wolf & Preston [33] give $v \sin i =$ 125 km s^{-1} from the Mg II 4481-line. In SIMBAD $v \sin i = 115$ km s^{-1}, and Hoffleit & Warren [14] give $v \sin i = 125$ km s^{-1}. HD 114376 is a multiple star with a visual component HR 4971 which is 284.4" distant, however, does not share a common proper motion. Hoffleit & Warren [14] note further *Binary? C, 11.2 at 1*", and list four values of radial velocity from -8.0 to +1.0 km s^{-1}.

Five sets of Strömgren photometries published in SIMBAD and Vizier carry to heteregeneous values of surface gravities. SIMBAD introduces three sets of $uvby\beta$ photometry. While the values of effective temperature range from 14 030 to 14 230 K, being thus in a good agreement, the surface gravity takes on values $\log g = 3.53$ and 3.54 (Vizier) and 3.77, 3.79 and 4.03 (SIMBAD). The averages are $T_{\rm eff} = 14\,100$ K, $\log g = 3.73$. In Table VII we list the observations and measured quantities. The best fit of the theoretical with observed spectra was reached for $v \sin i = 120$ km s^{-1}.

The spectrum shows several noticeable features. One points to the profile of He I line at 4471 Å. The line has an additional absorption in the violet half of the profile which could not be satisfactorily reproduced in the synthetic spectrum. This is well visible in the MSS spectrum as well as in the three NAO spectra, Figures 6a and 6b respectively.

Essential for HD 114376, however, is the occurence of the clearly separated double narrow absorptions or two systems (in Table VII, column 3, marked by (1),(2)) at D1 and D2 in the spectrum. The double narrow absorption is visible also in the Ca II 3933 line, albeit a bit blended. The separation of the two systems at D1 and D2 is 30 km s^{-1}, the estimated separation of the two systems at Ca II is ≈ 24 kms^{-1}. The radial velocities of the narrow lines were estimated using CCF.

A synthetic spectrum unwidened due to rotation was used for the NaD lines. A simple triangular profile of a FWHM= 0.2 Å for the vilet component, and FWHM= 0.4 Å for the red one was used in the case of the Ca II line.

According to the ratios EW(D1/D2)≈ 2.1, the both systems of the D1, D2 lines are of interstellar origin. Also according to the second criterion, EW(Ca)/EW(D1D2), the both systems are of interstellar origin, as the corresponing ratios are 0.54 and 0.14. Thus we observe two interstellar clouds in the direction to the distant HD 114376.

HD 114376 is 350 pc distant. Welsh et a. [32] do not list stars near HD 114376 at a comparable distance.

TABLE VII: List of spectra of HD 114376.

Spectrum	HJD 2450000+	Region	S/N	EWint mÅ	FWHMint Å	RVint km s^{-1}	RVstar kms^{-1}
MSS vo027bt	5281.4812	Mg II 4481 Å					-3.1 ± 1.7
NAO hemgee2	4926.4194	Mg II 4481 Å	262			-9.5 ± 0.3	
NAO hemgeg4	4998.3591	Mg II 4481 Å	266				-9.0 ± 0.3
NAO hemgek1	5262.4973	Mg II 4481 Å	136				-15.4 ± 0.5
NAO ca9ee2	4926.3793	Ca 3933 Å(1)	144	19	0.26	-33.2 ± 3.0	-9.5 ± 2.0
NAO ca9ee2		Ca II 3933 Å(2)		5	0.26	-8.7 ± 3.0	
NAO ca9eg4	4998.3206	Ca II 3933 Å	127	18	0.20	-33.8 ± 2.0	-9.2 ± 2.0
NAO ca9eg4		Ca II 3933 Å		5	0.20	-10.4 ± 2.0	
NAO nadew1	5787.2690	Na I D1/D2(1)	184	23/11	0.21/0.20	-35.4 ± 0.3	-14.5 ± 3.5
NAO nadew1		Na I D1/D2(2)			25/12	0.23/0.21	-5.3 ± 0.3

G. HD 136849

HD 136849 (50 Boo, HR 5718, HIP 75178, V= 5.37, B9Vn). Palmer et al. [21] determined $v \sin i = 180$ $\mathrm{km\,s^{-1}}$ from the Ca II 3933-line, and Wolf & Preston [33] give $v \sin i = 350$ $\mathrm{km\,s^{-1}}$ from the Mg II 4481-line. Hoffleit & Warren [14] give $v \sin i = 260$ $\mathrm{km\,s^{-1}}$. The star is a spectroscopic binary. Adams [4] discovered variable radial velocity of this star on three Mt.Wilson prism spectra. Frost et al. [5] give 5 values of radial velocity measured on Yerkes prism spectra and commented *"the lines are definitely double"* with the split of the lines corresponding to values

TABLE VIII: List of spectra of HD 136849.

Spectrum	HJD 2450000+	Region	S/N	EWint mÅ	FWHMint Å	RVint km s^{-1}	RVstar kms^{-1}
ELODIE	3149.4238	4200 – 6800 Å	299				$+0.8 \pm 0.2$
		Na I D1/D2		58/20	0.19/0.14	-12.8 ± 0.1	
NAO hemgee1	4925.4787	Mg II 4481 Å	278				-19.3 ± 1.1
NAO hemgeg2	4996.5018	Mg II 4481 Å	172				-4.3 ± 1.4
NAO hemgeg3	4997.4378	Mg II 4481 Å	340				-4.3 ± 1.0
NAO ca9ee1	4925.4472	Ca II 3933 Å	115	5	0.18	-19.7 ± 0.9	-26.5 ± 1.8
NAO ca9eg2	4996.5396	Ca II 3933 Å	86	4	0.10	-12.4 ± 1.5	-4.9 ± 2.6
NAO ca9eg3	4997.3956	Ca II 3933 Å	174	5	0.24	-6.7 ± 1.3	-8.2 ± 2.1
NAO ca9ew5	5791.3025	Ca II 3933 Å	126	6	0.22	-22.2 ± 0.9	-1.4 ± 2.3

-83.1 and +88.0 km s^{-1}. McAlister et al.[9] listed this binary among stars with negative results in speckle interferometry.

From the $uvby\beta$ photometry introduced in SIMBAD we derived $T_{\rm eff} = 10\,970$ K and $\log g = 4.25$. With micorurbulence equal to zero and abundances of manganese and calcium corrected by factors of 2.5 and 0.5 respectively, and the value of the projected rotational velocity $v \sin i = 220$ km s^{-1} we reached a best fit for the Mg II 4481 Å line in the ELODIE as well as in the NAO spectra, and for the Ca II 3933 Å line in the NAO spectra . This is well documented on Figures 7a and 7b.

Weak and narrow feature with FWHM from 0.10 to 0.22 Å near the centre of the Ca II 3933 Å line is visble on all the NAO Ca spectra. Their equivalent widths take on values from 4 to 6 mÅ. HD 136849 is 80 pc distant. A nearest HD 138749 which is 95 pc distant has EW(Ca)= 7 mÅ measured by Welsh et al. [32]. The values are consistent with the interstellar origin, however, their radial velocities do not confirm this as the values from -6.7 to -22.2 km s^{-1} indicate variability.

The values of the star's radial velocity derived with CCF are given in the last column of Table VIII. The value for the ELODIE spectrum is determined for a section 4460 – 4540 Å, the same region as is covered by the NAO Mg spectra, using theoretical spectrum as a template.

A discrepancy also exists between intensity of the Mg II 4481 Å line and intensities of weaker lines of Mg II at 4390, 4434, 4436.5, 4534.3, 4740 and 5264, that in comparison with 4481 Å have higher excitation potentials, and for which abundance reduced to 0.4 relative to solar value is more convenient.

Noticeable is the extended aborption in the violet part of the profile of the Ca II line in spectrum *ca9ee1* acquired on HJD 2 454 925.447, that might indicate, similarly as noted in previous paragraph, a composed spectrum of a spectroscopic binary. The *hemgee1* spectrum taken in the same date, however, bears no signs of such extension in the profile of the Mg II line, as documented on Figure 7a.

The origin of the narrow Ca II line and the D1 and D2 lines is interstellar as EW(D1)/EW(D2) 58/20 = 2.9 and EW(Ca)/EW(D1+D2) 5/78 = 0.06.

H. HD 138527

TABLE IX: List of spectra of HD 138527.

Spectrum	HJD 2450000+	Region	S/N	EWint mÅ	FWHMint Å	RVint km s^{-1}	RVstar kms^{-1}
NES l9512024	4964.3010	Mg II 4481 Å	160				-17.6 ± 0.6
NAO hemgeg4	4998.3980	Mg II 4481 Å	217				-18.0 ± 0.7
NAO hemgel1	5314.3419	Mg II 4481 Å	141				-23.4 ± 1.2
NAO ca9eg4	4998.4372	Ca II 3933 Å	110	4	0.14	$-22.5\pm$	-23.4 ± 1.7
NAO ca9el2	5314.3871	Ca II 3933 Å	59	5	0.14	$-17.6\pm$	-17.9 ± 2.0
NAO ca9ew4	5790.3176	Ca 3933 Å	60	6	0.18	$-23.1\pm$	-6.3 ± 2.8
NAO nadew1	5787.2832	Na I D1	233	57	0.21	-20.6 ± 0.1	-15.2±6.5
		Na I D2		39	0.23		

HD 138527 ($12\tau^2$ Ser, HR 5770, HIP 76069, V= 6.22, B9V). Palmer et al. [21] determined $v \sin i = 0$ km s^{-1} from the Ca II 3933-line, and Wolf & Preston [33] give $v \sin i = 175$ km s^{-1} from the Mg II 4481-line. Hoffleit & Warren [14] introduces variable radial velocity RV= -18 km s^{-1} and Stickland & Weatherby [31] give two values, -18.1 and -26.5 km s^{-1}, and further two values, -8 and -7.8 km s^{-1} are intoduced in Vizier. McAlister et al.[9] listed this binary among stars with negative results in speckle interferometry.

Three sets of the $uvby\beta$ photometry lead to values, whose average values are $T_{\rm eff}$ = 11 200 K and $\log g = 4.08$. For the atmosphere with these parameters and micrturbulence equall to zero we needed to reduce abundances of chemical elements whose spectral lines occur in the region of Mg II 4481 Å, i. e. helium, magnesium, titan and iron by factors 0.9, 0.55, 0.4 and 0.3 respectively. This reminds the feature known for the "weak-line" λ Boo-type stars. However, the relatively high effective temperature and the scattered values of radial velocity suggest rather a binary nature of the star. In such a case the light of a companion in the binary results in reducing of strengts of spectral lines, without reduction of abundances in order to reproduce the observed spectrum. We computed a synthetic spectrum with normal abundances and reduced it by a factor of 0.85, simulating thus the lihgt of a companion contributing by 15% to the total light of the binary. In a result we reached an excellent fit with the observed spectrum. This is shown on Figure 8a, where the reduced synthetic spectrum is marked as "synthetic2". The best fit is for $v \sin i = 135$ km s^{-1}. A section around Mg II 4481 Å in the NES spectrum is displayed on Figure 8b. With normal abundance of magnesium and $v \sin i = 135$ km s^{-1} the factor reducing the depth of the line is 0.8. Figure 8c displays the vicinity of the line of calcium at 3933 Å. The same $v \sin i$ and abundance of calcium reduced by a factor of 0.4 results in a best fit when the spectrum is reduced by a factor 0.85. It must be kept in mind, however, that while decreasing the value of abundance also the reduction factor of the light of the primary component must be decraesed (it means increasing the share of the "primary" in the total light of a binary). The ratio of lights of the binary componets must be fixated by other indicator, such as, e. g., by lines of various chemical elements in the case shown on Figure 8a. Distinctive are the weak narrow features close to the centre of the broad line Ca II 3933 Å. Figure 8d displays the region of the sodium line D1 and D2. The observed spectrum is poorly reproduced by the computed one in this case. While the accepted value of $v \sin i$ is convenient, the star's D1 and D2 lines are reproduced quite unsatisfactorily, as well as the observed profile of the He I line at 5875 Å, which is deeper and asymmetric. These observations might be possible signs of the binary component in this spectrum.

The ratio EW(D1)/EW(D2) ≈ 1.5, as well as EW(Ca)/EW(D1D2) 1 point to an interstellar origin of the sodium and the narrow calcium lines. Welsh et al. [32] measured EW(Ca) = 8 mÅ, in accordance with our measurements.

I. HD 188485

HD 188485, (HR 7601, HIP 97961, V= 5.52, A0III). Palmer et al. [21] determined $v \sin i =$ 95 km s^{-1} from the Ca II 3933-line, and Wolf & Preston [33] give $v \sin i = 150$ km s^{-1} from the Mg II 4481-line. Hoffleit &Warren [14] notes variable radial velocity and SIMBAD summarizes seven values ranging from -11.0 to -2.0 km s^{-1}.

From three sets of $uvby\beta$ indexes listed in Simbad we derived $T_{\rm eff} = 10\,580$ K, $\log g = 4.03$. Wu et al. [34] detrived $T_{\rm eff} = 10\,124 \pm 186$ K, $\log g = 3.93 \pm 0.08$. With zero microturbulence,

TABLE X: List of spectra of HD 188485.

Spectrum	HJD	Region	S/N	EWint	FWHMint	RVint	RVstar
	2450000+			mÅ	Å	km s^{-1}	kms^{-1}
NAO hemgen2	5407.3641	Mg II 4481 Å	180				-7.7 ± 0.6
NAO ca9en2	5407.3895	Ca 3933 Å	98	10	0.14	-25 ± 2.0	-13.5 ± 1.1
NES l9A04029	5109.3345	Na 5890 Å	150	34	0.16	-1.6 ± 0.5	-2.6 ± 17
				10	0.15	-1.6 ± 0.5	

helium is in deficit by a factor 0.6, magnesium must be increased by a factor 3 to reach a fit of the magnesium 4481 Å line, and also iron fits better here with a correction by a factor of 1.5. A comparison of the observed NAO with the synthetic spectrum in the Mg II region is shown on Figure 9a. In the calcium region magnesium, silicon and calcium has to be corrected by factors 0.8, 0.3 and 0.9 respectively. A close vicinity of the Ca II 3933 Å line is shown on Figure 9b, where besides the fit of the calcium line profile for $v \sin i = 115$ km s^{-1} also a weak narrow feature is visible near the centre of the star's line.

In the region of Na I D1, D2 lines sodium must be reduced to at least 0.2 of the solar abundance. The NES spectrum in this region is contaminated by teluric lines, but this does not prevent from reliable identification of narrow interstellar lines D1 and D2. Remarkable is the absence or at most a weak presence of star's D1, D2. In their expected positions some depresssion can be discernible, but this is rather due to blending with the teluric lines.

According to the criterion EW(D1)/EW(D2) = 3.4 as well as EW(Ca)/EW(D1D2) = 0.23, the lines are of interstellar origin. This star is 144 pc distant, EW(Ca)= 10 mÅ. Welsh et al. [32] for a near by angular distance HD 187811, distant 190 pc, give EW(Ca) = 14 mÅ. A flagrant is, however, the difference between the values of radial velocity derived from the narrow calcium line and the narrow pair D1 and D2.

The derived values of the star's radial velocity given in the last column of Table X are concordant with those introduced in SIMBAD. The large formal error of the value determined from the NES Na I section is due to the contamination of the spectrum by teluric lines, and a relevant error may be lesser. On Figure 9 the fit of the synthetic profile of the He I line at 5875 Å with the observed one using the derived value RV= -2.6 km s^{-1} is exccellent, while a shift close to ± 17 km s^{-1} marked by the vertical bars would result in a poor agreement.

IV. CONCLUSION

We investigated spectra of nine stars for which published projected rotational velocities derived from the line of Ca II at 3933 Å are remarkably lesser than those derived from the line of Mg II at 4481 Å. The list of the stars originated rather serendipitously in connection with other project, and do not represent any physical, kinematic or dynamic group. The difference between the corresponding widths of the lines is too large to bee due to any imperfection in the observation or reduction processes. An inspection of the spectra reveals narrow absorption features not only at the Ca II at 3933 Å line, but also at the region of the sodium doublet Na I D1, D2 around 5890 Å. We summarize basic results in Table XI where the criteria for the interstellar/circumstellar origin, i. e. ratios of equivalent widths of D1 to D2 and Ca II 3933 to D1 plus D2 respectively in columns 6 and 7 are given. With the exception of two stars, HD 25152 and HD 44783, in the remaining seven ones the narrow features at Ca II 3933 Å and Na I 5890 Å are undoubtedly of interstellar origin. The ratio EW(Ca)/EW(D1+D2) (colmn 7) much larger than unity points to a circumstelar origin of these lines, whichis not the case of these seven stars, as the ratio for them is lower or much lower than unity. The ratio EW(D1)/EW(D2) (column 6) near unity points to a circumstellar disk what, again, is not the case of any of these seven stars. HD 138527 has this ratio 1.5 what, albeit, is still well larger than unity, but the value may be influenced by a possible binary companion, as discussed in Subsection III H in detail. HD 44783 is a Be star with a circumstellar shell. Even though the ratio EW(D1)/EW(D2) for this star is ≥ 2, the profiles of the D1 and D2 lines suggest a possible occurence of a circumstellar component, Subsection III B. In the case HD 25152 the two criteria result in diverse finding. While the ratio EW(Ca)/EW(D1+D2)= 0.15 undoubtedly points to an interstellar origin, according to the ratio EW(D1)/EW(D2)= 1.1 these lines origin entirely in a circumstellar environment. As discussed in Subsection III A, this star is a member of a star complex which could leave some traces in its pectrum.

The entries in Table XI, columns 2, 3 and 4 witness that not only in spectra of distant stars near in low galactic latitudes, but also in relatively near-by (bright) stars, distant ≈ 100 pc, even in high galactic latitudes, as HD 113797, HD 136849 or HD 138527, interstellar lines can be expected.

In majority, all the stars in this sample are chemically normal. The abundance corrections amounting from factors of $\approx 3 - 0.3$ used to reach the best fits of the observed and theoretical spectra, do not exceed a usual scatter.

TABLE XI:

HD	Distance pc	l °	b °	Spectrum	D1/D2	Ca/D1D2	Origin
25152	120	160	-12	NAO Ca		0.15	interstellar
				NAO Na	1.1		circumstellar
44783	348	282	-2	NAO Na	1.9		Be star
				ELODIE	2.4		in'stel+c'stel?
				NES Na	1.9		interstellar
45563	160	208	-4	NAO Ca		0.56	interstellar
				NAO Na	1.8		interstellar
53744	290	189	+16	NAO Ca		0.22	interstellar
				NAO Na	1.7		interstellar
				NES Na	1.7		interstellar
113797	105	104	+80	NAO Ca		0.68	interstellar
				NAO Na	2.4		interstellar
114376	350	105	+78	NAO Ca (1)		0.56	interstellar
				NAO Ca (2)		0.22	interstellar
				NAO Na (1)	2.1		interstellar
				NAO Na (2)	2.1		interstellar
136849	80	52	+57	NAO Ca		0.06	interstellar
				ELODIE	2.9		interstellar
138527	140	24	+51	NAO Ca		0.05	interstellar
				NAO Na	1.5		interstellar
188485	144	62	-2	NAO Ca		0.23	interstellar
				NAO Na	3.4		interstellar

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facility.

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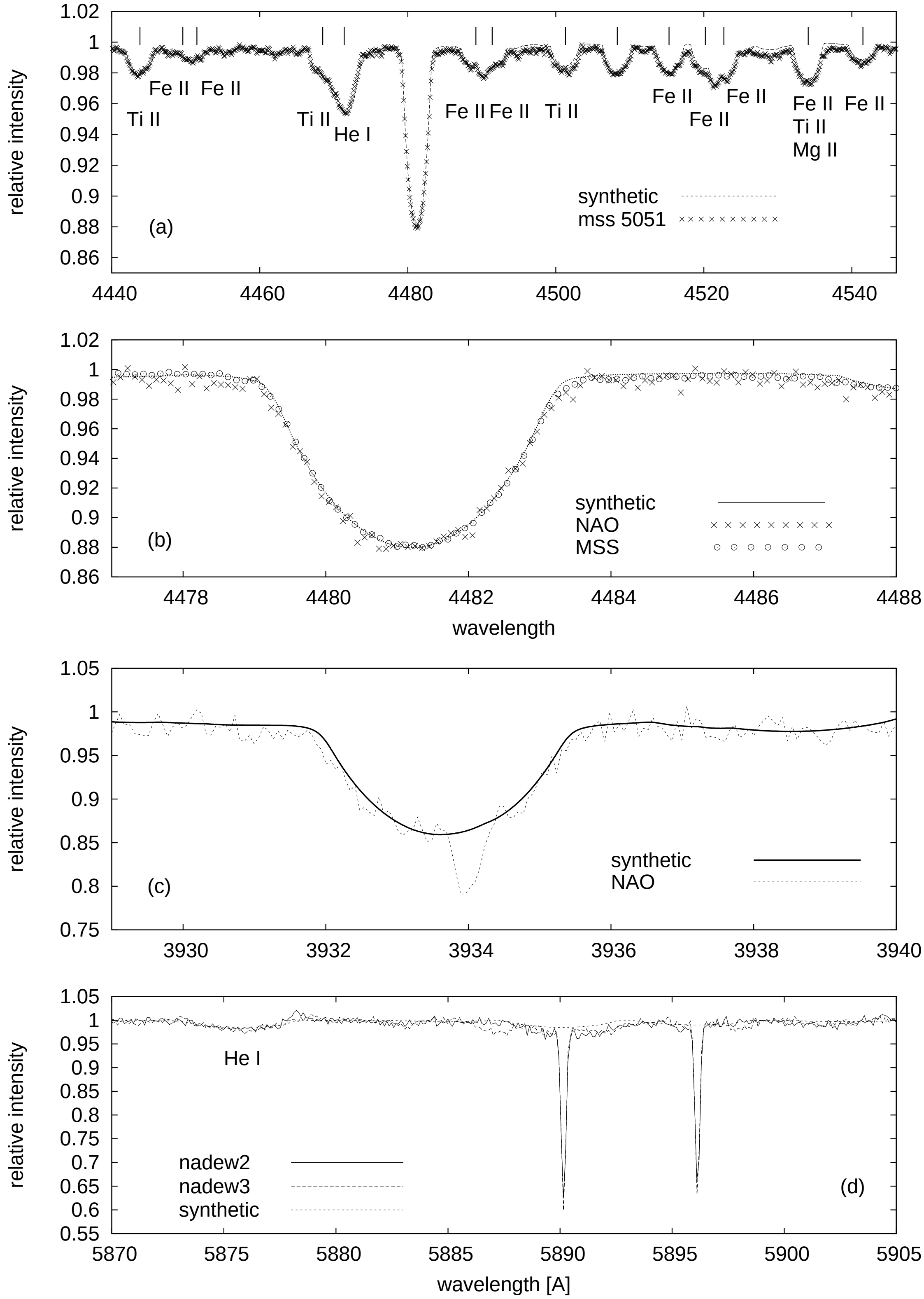

FIG. 1: Spectra of HD 25152, $v \sin i = 127$ km s^{-1}. The observed spectra are shifted in wavelength by corresponding values of the star's radial velocity in this as well as in all the following figures.

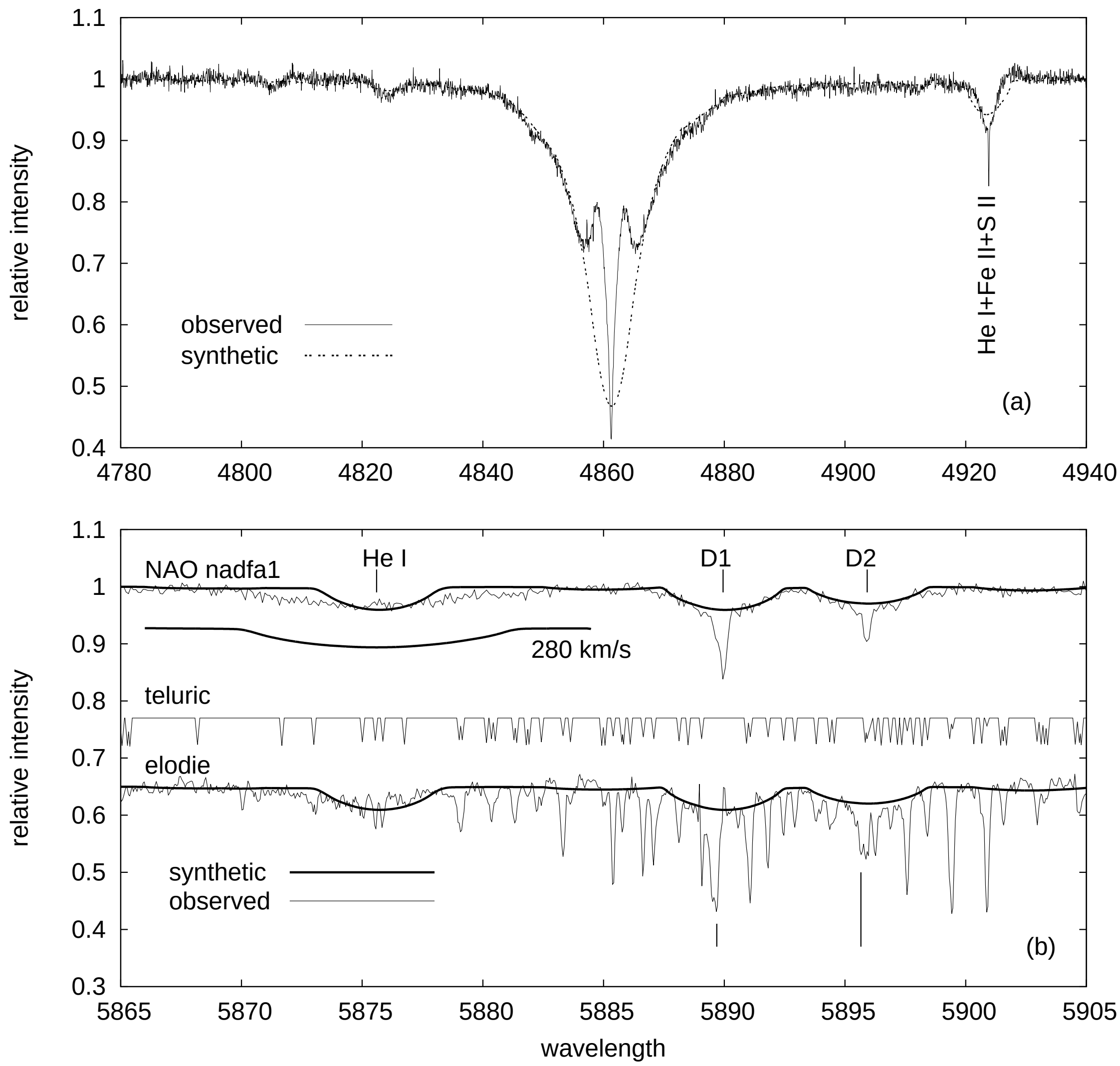

FIG. 2: a) A *shell* profile of the Balmer line Hβ of HD 44783, $v \sin i = 225$ km s^{-1} is applied. b) A section of the spectrum in the vicinity of the D1D2 lines. The teluric lines are depicted schematically to enable identification of lines in the ELODIE spectrum. In the upper part of panel (b) a profile of the He I 5875 line also a profile widened to 280 km s^{-1}.

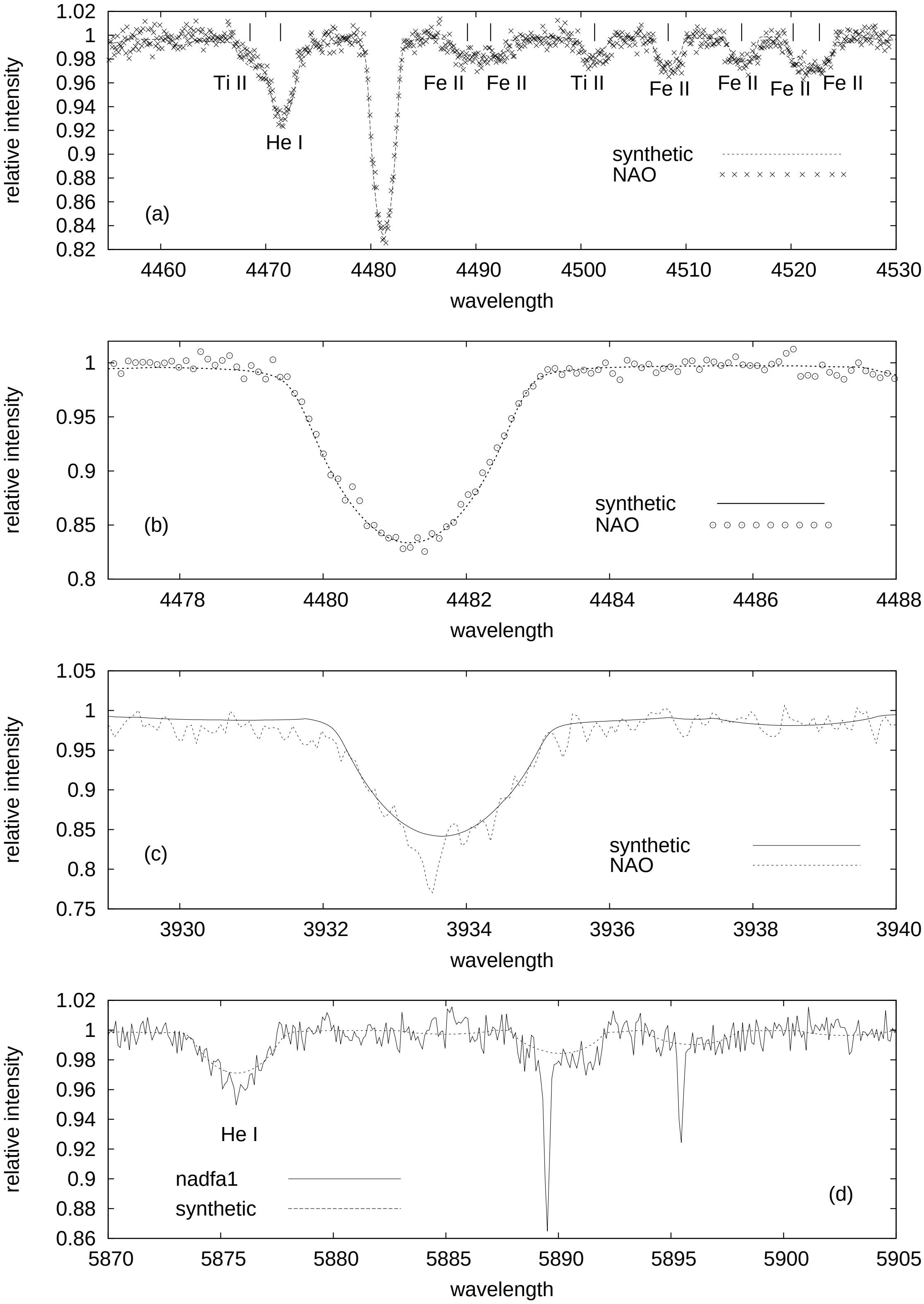

FIG. 3: Spectra of HD 45563, $v \sin i = 105$ km s^{-1}.

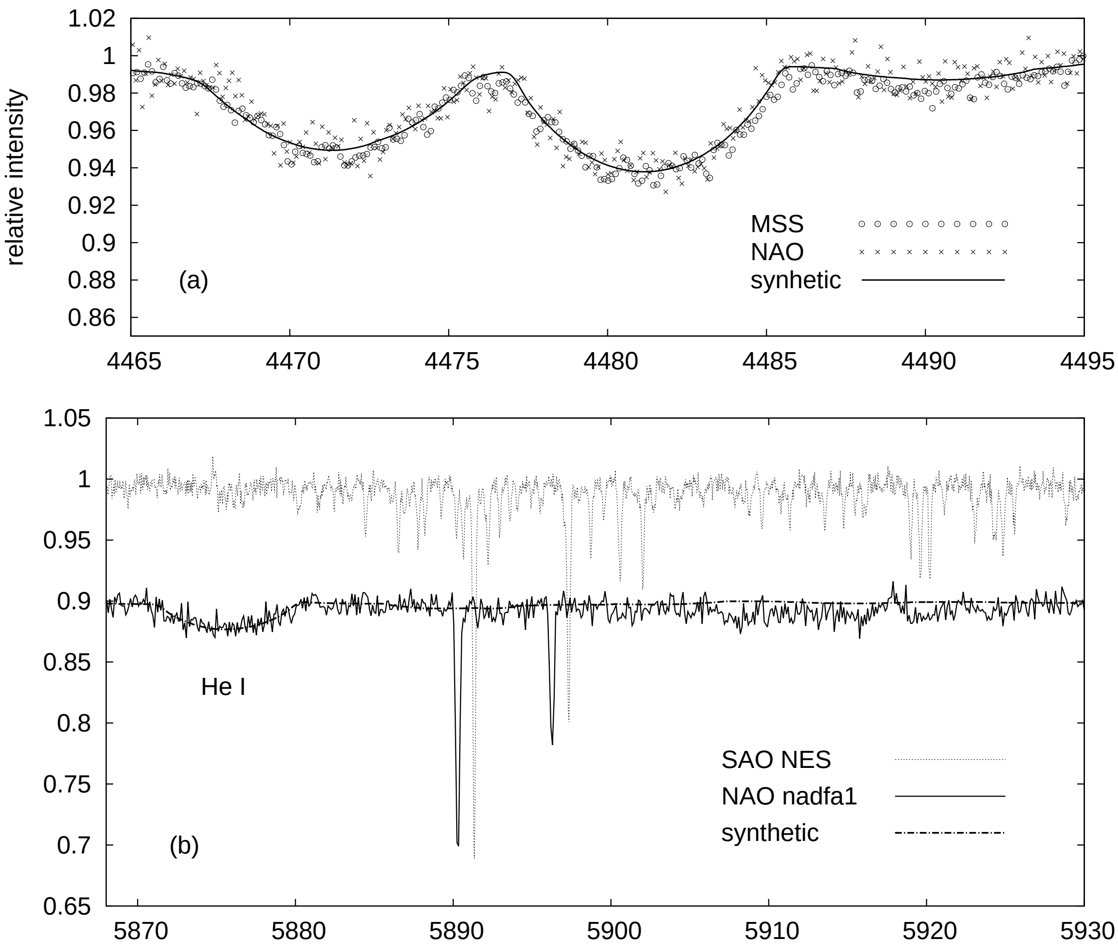

FIG. 4: HD 53744, $v \sin i = 280$ km s^{-1}. In panel (b) the spectra shifted in relative intesity for clarity.

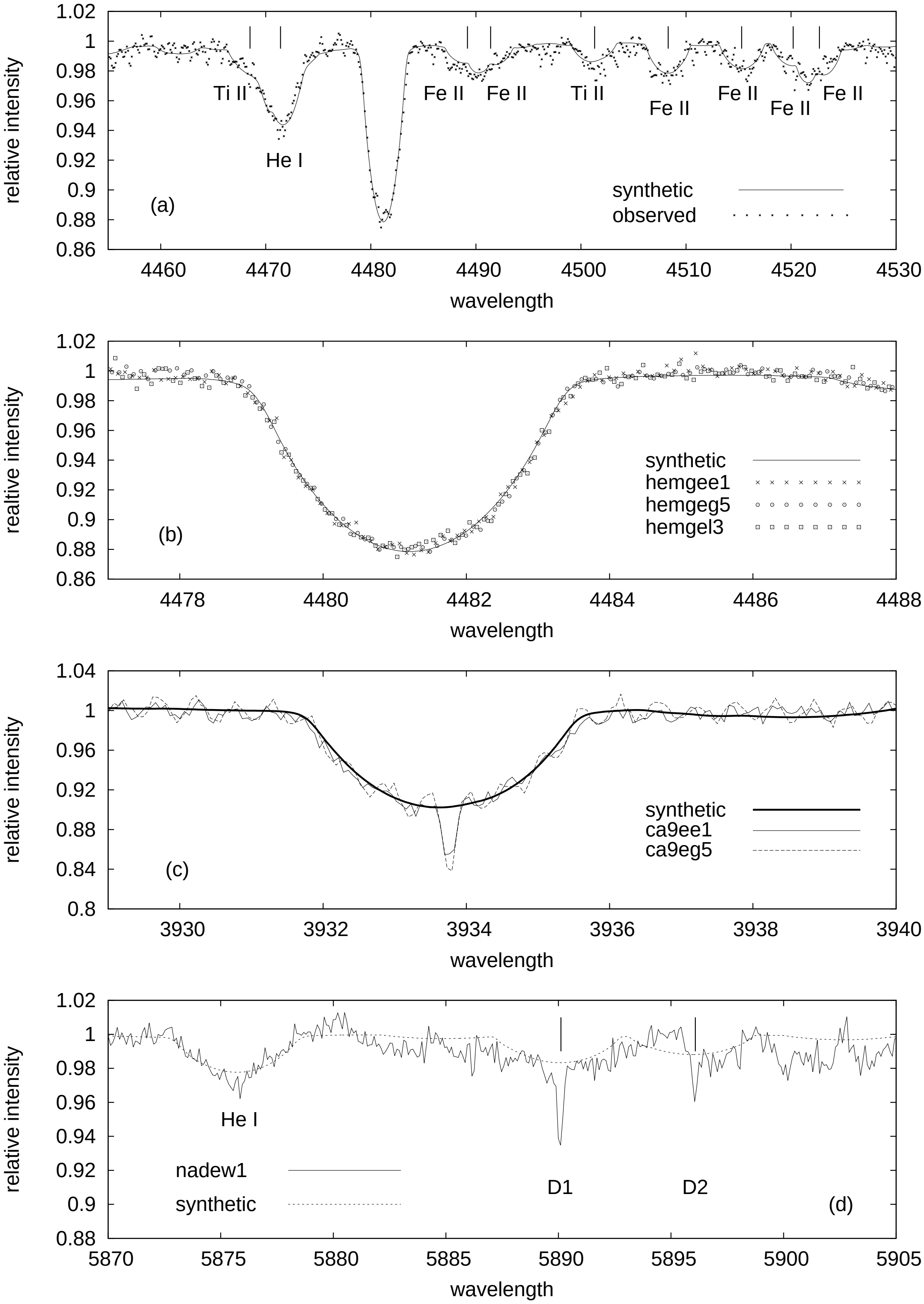

FIG. 5: Spectra of HD 113797, $v \sin i = 140\ \mathrm{km\,s^{-1}}$.

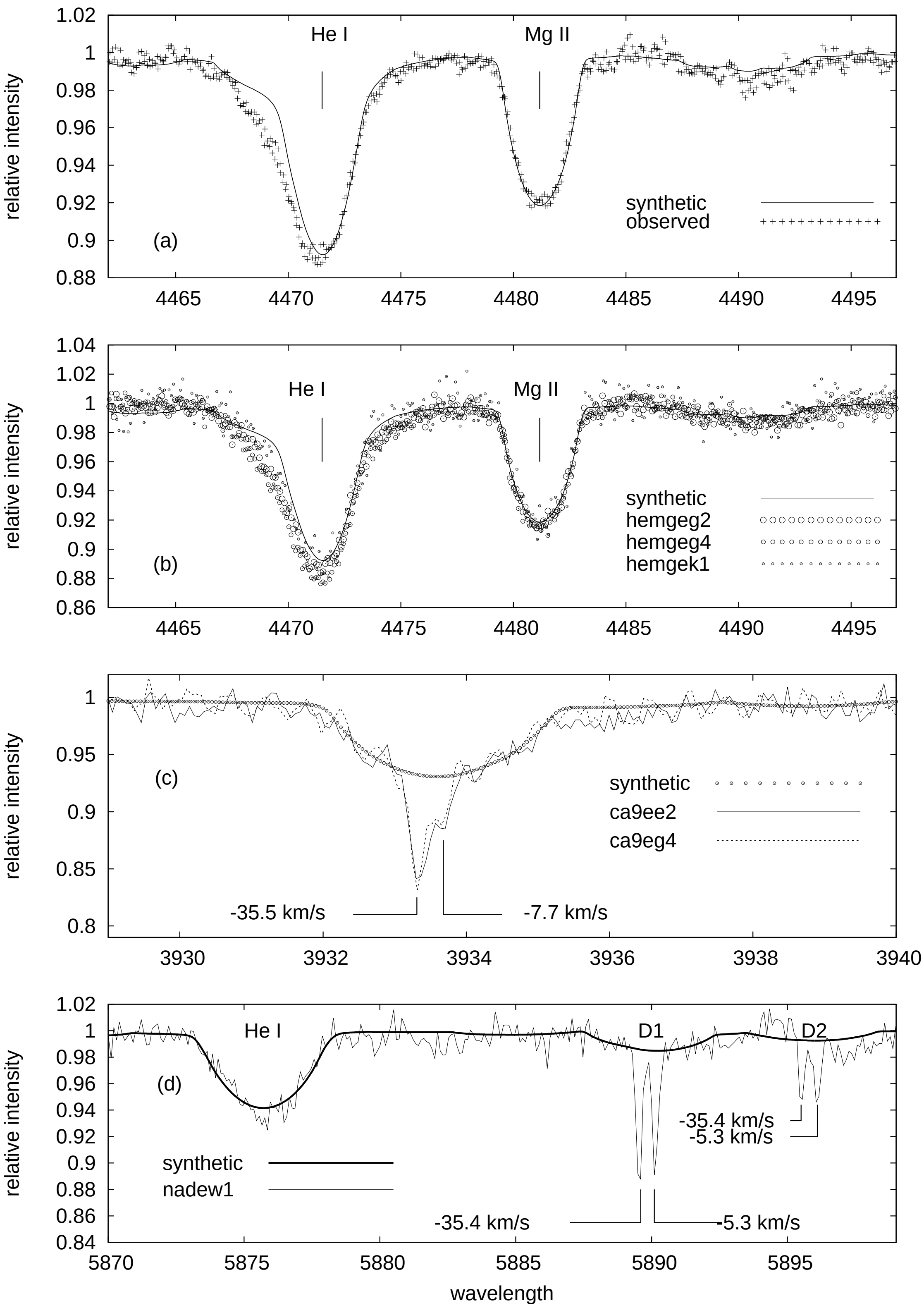

FIG. 6: Spectra of HD 114376, $v \sin i = 120\ \mathrm{km\,s^{-1}}$. Two systems of interstellar line are visible in panels (c) and (d).

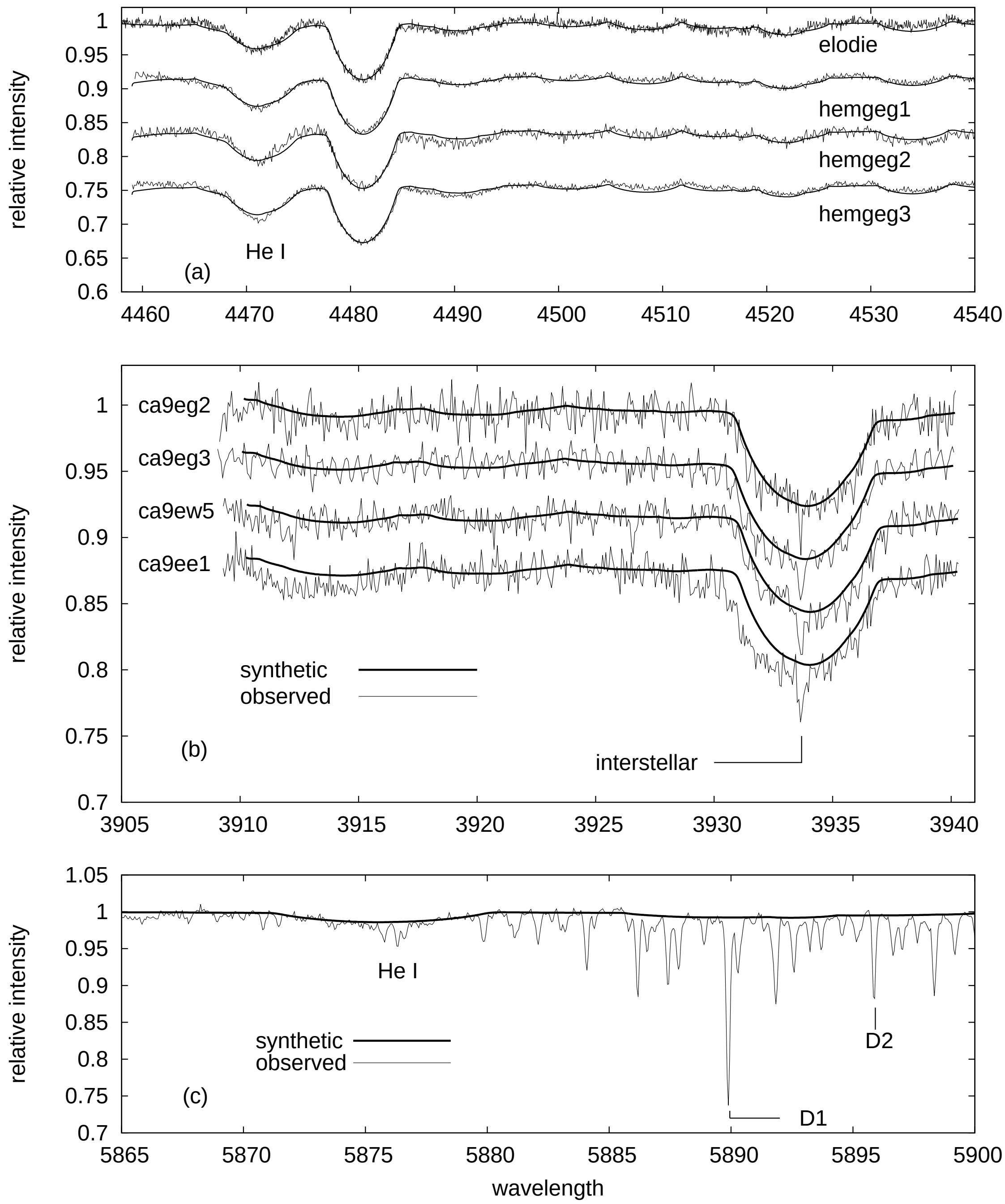

FIG. 7: Spectra of HD 136849, $v \sin i = 220 \text{ km s}^{-1}$. The observed as well as the corresponding synthetic spectra showing the Ca II region are aligned with the narrow (interstellar) features.

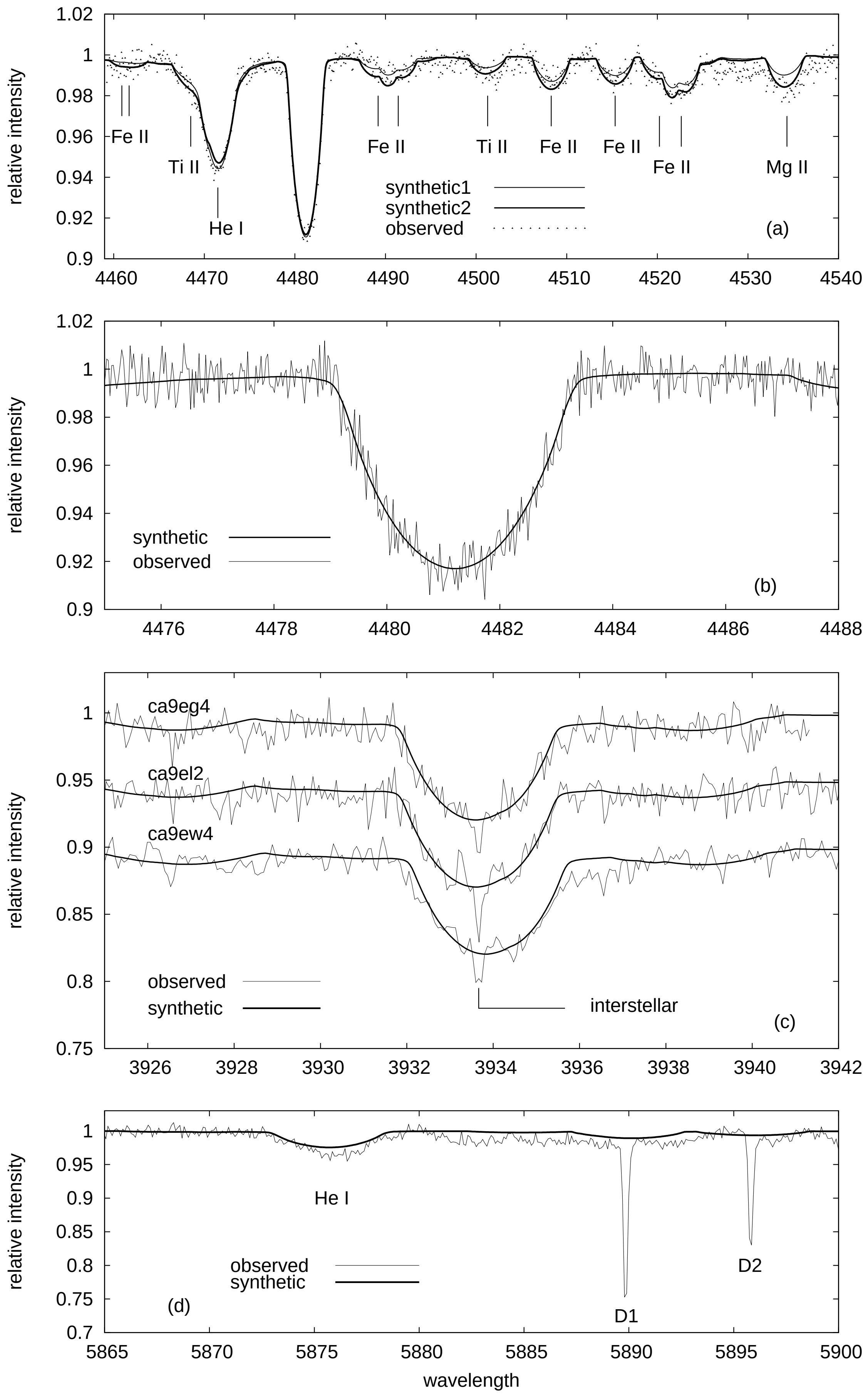

FIG. 8: Spectra of HD 138527, $v \sin i = 135$ km s^{-1}. In the panel (a) "synthetic1" shows a spectrum with reduced abundances, "synthetic2" shows one with normal abundances but reduced by a factor 0.85 in the realtive intensity. In panel (b) the observed spectra are aligned with the radial velocities of the narrow absorptions.

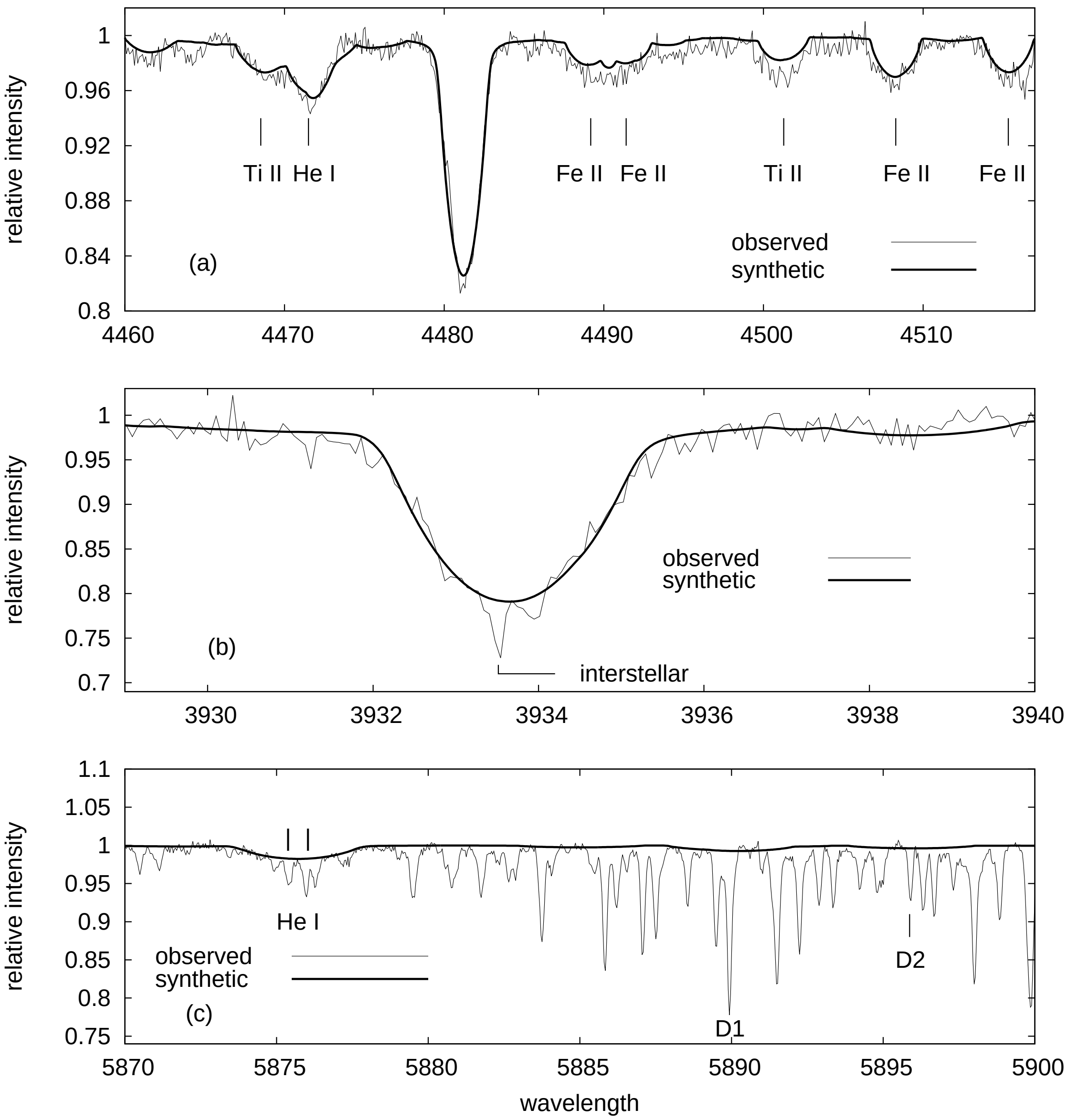

FIG. 9: Spectra of HD 188485, $v \sin i = 115\ \mathrm{km\,s^{-1}}$. The vertical bars in panel (c) denote maximum shift in wavelength for the formal error in radial elocity, $\pm 17\ \mathrm{km\,s^{-1}}$.