

# Radial velocities of six early-type evolved stars

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**Abstract.** Measurements of radial velocities of six early-type evolved stars of luminosity class III-I are presented. Although the sample consists of stars with suspected variable radial velocity, our data do not indicate the variability.

**Key words:** evolved stars – spectroscopy

## 1. Introduction

Among early-type stars, many spectroscopic binaries are known; however, they are common only among main-sequence stars, and rare among evolved stars of luminosity class III-I. Knowledge of more binaries with an evolved component would be helpful for tests of stellar evolution, statistics of binaries as well as for other purposes.

There are also many stars with suspected variable velocity (see e.g. Abt and Biggs, 1972) among the early-type stars, evolved stars included. In order to find more binaries with an evolved component we started a study of several brighter stars with these characteristics using the 2-m telescope in Ondřejov some time ago.

## 2. Observations and measurements of the spectra

The stars discussed here are listed in Tab. 1. The spectra were taken in the coude spectrograph of the 2-m telescope with a dispersion of 1.7 nm/mm (camera  $f=350$  mm) or 0.85 nm/mm (camera  $f=700$  mm) in the ultraviolet/blue region on Kodak 103aO or IIaO plates. Since 1981 the plates were sensitized either in the N<sub>2</sub> or H<sub>2</sub> atmosphere. Three plates were taken at the Rozhen Observatory (Bulgaria) with a similar instrument giving a dispersion of 0.9 nm/mm. Some of the columns of Tab. 1 are explained at the end of this chapter.

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**Table 1.** List of observed stars

HD No.	Spect. type	No. of plates	Rad. Vel.	m.e.	Ext. err. (E)	Int. err. (I)	E/I
7902	B6 Ib	5	-32.3	$\pm 3.3$	$\pm 2.367$	$\pm 8.85$	0.27
28446	B1 III	18	- 7.7	$\pm 14.5$	$\pm 13.996$	$\pm 27.866$	0.50
42087	B2.5 Ib	9	+14.3	$\pm 2.7$	$\pm 3.979$	$\pm 7.731$	0.51
187983	A1 Iab	5	-4.4	$\pm 0.9$	$\pm 4.058$	$\pm 6.06$	0.67
195592	O9.5 Ia	8	-32.7	$\pm 3.7$	$\pm 9.278$	$\pm 8.852$	1.048
208501	B8 Ib	9	-20.9	$\pm 2.8$	$\pm 7.252$	$\pm 7.549$	0.96

+ HD 42087: 2 Rozhen plates; HD 208501: 1 Rozhen plate

The spectra were measured with a digitizer constructed and located at the Ondřejov Observatory; the measurements were reduced using the SPEFO code written by J.Horn et al. (1993) at the Ondřejov Observatory. This code allows the digitized spectrum to be transformed, to be filtered and rectified; the velocity is measured using the reflected image of the line profile. If the spectral lines were narrow, the Abbe comparator of the Astronomical Institute of the Charles University was also used to measure the plates (HD 42087, 208501). There were no systematic differences between the two sets of data; the results given in Tabs 1 and 2 are those from the digitizer.

The results for the individual plates are given in Tab. 2. The table is self-explanatory; velocities obtained from H, He and metallic lines are shown separately.

We expected better accuracy in the radial velocities. It appears that the plate noise combined with the large width of most lines is responsible for the scatter of the velocities. The small width of our spectra (0.2 and 0.3 mm for 1.7 nm/mm and 0.85 nm/mm plates, respectively) was probably a drawback.

The mean velocities for each star are contained in Tab. 1. Since the number of our plates is rather small, our results do not justify any sophisticated statistical treatment. Instead, we used the method suggested by Abt and Levy (1978) of discriminating between constant and variable velocities. In Tab. 1 we calculated the ratio of external to internal errors. When this ratio is less than 2 (in the case of broad-line spectra), variability cannot be claimed. This is the case of all our stars.

### 3. Discussion

HD 7902: This star was suspected of variable radial velocity by Petrie and Pearce (1958), with 3 measured velocities from -47.0 to -20.8 km/s; two velocities published by Hayford (1932) also fall within this range. The star is listed as the suspected variable star NSV 466 with brightness changes of about 0.1 mag.

HD 28446 (1 Cam): Frost et al. (1926) note: probably SB, and give 3 velocities in the range from -14.6 to +48.9 km/s. Plaskett and Pearce (1931) claim

Table 2. List of measured spectrograms

JD	nm/mm	Exp.	Emul.	RV H	No.	RV He	No.	RV other	No.	RV Ca	No.
<b>-2 440 000</b>											
<b>HD 7902</b>											
4499.548	1.7	86	103aO	-40.2	7	-24.9	4	-41.3	4	-34.2	2
4849.585	1.7	62	IaO	-35.5	13	-33.9	4	-30.2	2	-31.6	2
5193.576	1.7	100	IaO	-39.9	11	-30.0	2	-33.2	4	-34.9	1
5201.513	1.7	144	IaO	-35.9	15	-41.1	2	-14.6	1	-36.3	1
5211.555	1.7	44	IaO	-34.3	12	-21.5	2	-28.1	7	-30.3	2
<b>HD 28446</b>											
4469.556	0.8	70	103aO	-14.2	3					-2.2	1
4485.502	0.8	68	103aO	-12.6	4					1.6	1
4490.540	1.7	34	IaO	-9.3	2					3.4	1
4499.592	1.7	24	103aO	-35.5	4	-2.8	2			4.1	1
4516.574	1.7	28	103aO	-22.8	4	-4.3	2			6.0	1
4518.614	1.7	38	103aO	+12.8	2	+34.9	1			0.8	1
4519.587	1.7	76	IaO	-13.2	4	-5.7	2			14.3	1
4523.592	1.7	60	103aO	-14.6	4					3.8	1
4849.615	1.7	16	IaO	+16.3	3					-1.1	1
4851.552	1.7	14	IaO	-29.2	4					-6.3	1
4982.405	1.7	26	IaO	-13.4	4	-19.7	1			-6.5	1
5006.245	1.7	27	IaO	-7.8	4					-2.2	1
5008.252	1.7	19	IaO	+28.6	3	-22.2	2			-10.6	1
5010.232	1.7	20	IaO	-10.0	4	-60.1	2			-2.0	1
5011.230	1.7	20	IaO	+3.1	3					-8.5	1
5013.472	1.7	82	IaO	+13.2	4	-31.6	2			-17.3	1
5201.583	1.7	54	IaO	-6.0	4	+19.1	2			-1.1	1
5211.583	1.7	18	IaO	-2.1	4	-10.2	2			-13.5	1
<b>HD 42087</b>											
4499.642	1.7	16	103aO	+13.4	10	+13.7	3	+11.2	3	+7.4	2
4516.663	1.7	23	103aO	+16.1	12	+23.8	3	+13.4	4	+10.7	1
4518.648	1.7	40	103aO	+11.1	6	+14.8	2	+13.4	5	+12.6	2
4574.518	1.7	88	103aO	+12.6	4	+17.9	4	+15.3	6	+12.2	2
4575.450	1.7	50	103aO	+4.6	8	+7.6	5	+13.9	5	+11.2	2
4982.444	1.7	38	IaO	+9.8	5	+16.0	5	+13.3	6	+10.8	2
5011.306	0.8	176	IaO	+9.2	5	+17.1	11	+12.0	4	+13.9	2
5275.619	0.9	31	IaO	+15.9	8	+19.6	9	+17.1	7	+11.6	2
5341.488	0.9	80	IaO	+17.3	9	+21.1	12	+16.8	5	+15.1	2
<b>HD 187983</b>											
4499.335	1.7	20	103aO	-15.5	5			-0.7	5	-9.9	1
4767.504	0.8	84	IaO	-0.9	5			-1.0	37	+0.9	1
4849.422	0.8	100	IaO	-1.8	5			-0.4	36	-4.4	2
5119.572	1.7	24	IaO	-0.9	5			+2.5	19	-8.4	2
5196.347	1.7	40	IaO	-7.6	5			-2.9	29	-8.5	1
<b>HD 195592</b>											
4499.417	1.7	92	103aO	-41.8	4	-45.5	2			-7.8	1
4516.449	1.7	300	103aO	-46.4	2	-23.4	2			-16.4	1
4767.415	1.7	46	IaO	-16.7	3	-33.9	2			-18.3	1
4797.533	0.8	131	IaO			-20.1	2			-6.8	2
4851.451	1.7	166	IaO	-50.0	1	-42.1	2			-18.7	1
5120.453	1.7	110	IaO			-30.0	2			-7.0	1
5164.495	1.7	112	IaO	-38.3	1	-19.1	2			-12.8	1
5200.474	1.7	240	IaO	-31.0	3	-37.3	2			-18.0	1
<b>HD 208501</b>											
4518.487	0.8	306	103aO	-23.1	4	-15.8	1	-21.1	1	-13.1	1
4575.273	0.8	174	103aO	-20.6	4	-19.7	6	-19.0	7	-9.4	2
4952.308	0.8	306	IaO	-36.8	9	-15.7	7	-18.5	7	-17.2	2
4982.258	1.7	130	IaO	-23.9	12	-18.5	3	-25.7	5	-17.1	1
5119.544	1.7	30	IaO	-24.7	4	-15.0	2	-29.6	2	-23.2	1
5166.449	1.7	52	IaO	-35.7	3	-18.2	3	-22.7	1	-21.7	1
5190.476	1.7	79	IaO	-19.9	5	-15.4	3	-18.4	3	-17.4	2
5196.476	1.7	42	IaO	-28.7	6	-17.4	1	-29.1	3	-18.3	1
5276.379	0.9	10	IaO	-12.8	3	-8.7	3	-11.6	3		

that this star is a double-lined binary and give velocities of both components with differences up to 280 km/s for 8 of their 17 plates. In our spectra there are also cases where the lines seem to be split (nearly all plates), but the magnitude of the splitting is always comparable to the noise frequency so that we do not consider it real. It would be worthwhile to use a modern detector to prove the nature of the lines of this bright star. The period analysis of our data (using Deeming's (1975) algorithm) revealed the best period to be 1.313 days, which can hardly reflect the orbital motion in the binary system.

HD 42087 (3 Gem): Plaskett and Pearce (1931) noted the variability of the radial velocity. Their claim is, however, based on only one plate (-25 km/s) deviating from 7 others (range +11.3 to 30.1 km/s).

HD 187983 (HR 7573): only one radial velocity was published for this star (-4.7 km/s) by Harper (1937), so we included the star into our program to check the constancy or variability of its velocity.

HD 195592: Variability of radial velocity was claimed by Plaskett and Pearce (1931); 6 plates, range -50.0 to -2.8 km/s.

HD 208501 (13 Cep): Frost et al. (1926) note: probably SB, however, only one radial velocity (+41.0 km/s) deviates from 13 others (range -1.5 to -25.5 km/s).

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