COMMISSIONS 27 AND 42 OF THE IAU
INFORMATION BULLETIN ON VARIABLE STARS

Number 5423

Konkoly Observatory
Budapest
5 June 2003

HU ISSN 0374 – 0676

DIRECT MASS RATIO DETERMINATION IN THE SB2 SYSTEMS HD 108642 AND HD 434

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The star HD 108642 (HR 4750, SAO 82326, HIP 60880, BD $+27^\circ$ 2138) is a well known SB1 type binary. Abt & Levato (1977) classified the spectrum as Am(A2/A7/F0) from hydrogen, metallic and CaII-K lines, respectively. HIPPARCOS introduced the trigonometric parallax (9.76 ± 0.79) mass and $V = 6.52$ mag (ESA, 1997). Abt & Morrell (1995) measured projected rotational velocity and obtained $v \sin i = 13$ km s^{-1}. Their measurements were rescaled by Royer et al. (2002) who obtained $v \sin i = 21$ km s^{-1}. Landstreet (1998) derived $v \sin i < 4.5$ km s^{-1}. The orbit was determined and improved by Harper (1926, 1935). More recently Abt & Willmarth (1999) derived new orbital elements: $P = (11.7843 \pm 0.0004)$ d, $e = 0$, $\gamma = -0.7$ km s^{-1}, $K = 41.14$ km s^{-1} which are in a good agreement with the Harper's results. Boesgaard (1987), using spectroscopic observations in the region of about 6700 Å, first noted the presence of a secondary spectrum and estimated the flux ratio value $L1/L2 = 7.7$. Recently, Shorlin et al. (2002) as a by-product of their magnetic field measurements derived from polarimetric least-squares deconvolution profiles $M1/M2 = 1.9 \pm 0.1$, $L1/L2 = 15$, $\gamma = (-2 \pm 2)$ km s^{-1}.

The star HD 434 (HIP 728, BD+ 27° 3, SAO 73772, $V = 6.47$mag) is also well known as an SB1 system. Latest orbital elements are those of Sreedhar Rao & Abhyankar (1992): $P = 34.25999$ d, $e = 0.475 \pm 0.034$, $\gamma = (2.6 \pm 0.6)$ km s^{-1}, $K = (24.1 \pm 0.9)$ km s^{-1}. Recently, Iliev et al. (2001a) discovered a very pronounced secondary spectrum (see the references therein). Here we present new observations of this fresh SB2 system.

Our spectroscopic observations were carried out with the 2m RCC telescope of the Bulgarian National Astronomical Observatory in the frame of our observational program on Am-stars in binary systems. The Photometrics AT200 camera with a SITe SI003AB 1024×1024 CCD chip, (24 μm pixels) was used in the Third camera of the coudé spectrograph to provide spectra in the 6400–6500 Å region with R = 32000. A typical S/N ratio is about 300. IRAF standard procedures have been used for the bias subtracting, flat-fielding and wavelength calibration. Telluric lines have been removed using spectra of hot, fast rotating stars. The wavelength calibration has the r.m.s. error of 0.005 Å. EQWREC2 code of Budaj & Komžík (2000) was used for continuum rectification and radial velocity measurements. The log of observations is listed in Table 1.

Small portions of our spectra in the vicinity of CaI 6439 which is most illustrative are depicted in the Figures 1 and 2. It is apparent that there are two systems of lines travelling and crossing in the spectra of both stars. For the mass ratio and gamma velocity of HD 108642 we obtained: $M1/M2 = 1.824 \pm 0.011$, $\gamma = -0.4$ km s^{-1}. Our gamma velocity is in a very good agreement with the value determined recently by Abt & Willmarth (1999) who measured only the radial velocities of the primary. This confirms and improves the results of Shorlin et al. (2002). For HD 434 we obtained: $M1/M2 = 1.19 \pm 0.06$, $\gamma = +12.0$ km s^{-1}. Moreover, we are able to put a serious constraint on the K value of the primary which is $K > 30.8$ km s^{-1}! Note that this K value and gamma velocity are not in agreement with the value determined by Sreedhar Rao & Abhyankar (1992). This underlines the statement of Iliev et al. (2001a) that the secondary spectrum causes so heavy blends that the previous orbit determinations must be revisited. Hube & Gulliver (1985) e.g. obtained preliminary and different orbital elements: $P = 34.26014$ d, $e = 0.405 \pm 0.033$, $\gamma = (6.9 \pm 0.7)$ km s^{-1}, $K = (35.5 \pm 1.7)$ km s^{-1} which were confirmed later by Margoni et al. (1992). They better satisfy our constraints on K value but their gamma velocity is still rather low.

Table 1: List of observations and the results: Date, HJD of the exposure beginning, effective exposure time in seconds, radial velocities of both components in km s^{-1}, the $M1/M2$ ratios and the γ velocities in km s^{-1}.

Sp. No.	Date	HJD (2450000+)	Eff. exp.	RV_a	RV_b	$M1/M2$	γ
HD 108642							
1	8.3.2001	1977.493	5400	−41.9	+74.5	1.824 ± 0.011	− 0.4
2	13.3.2003	2713.457	5410	+31.6	−58.2		
HD 434							
1	28.8.2002	2515.475	5410	+34.7	−17.0	1.19 ± 0.06	+ 12.0
2	21.10.2002	2569.348	4370	−26.9	+58.3		

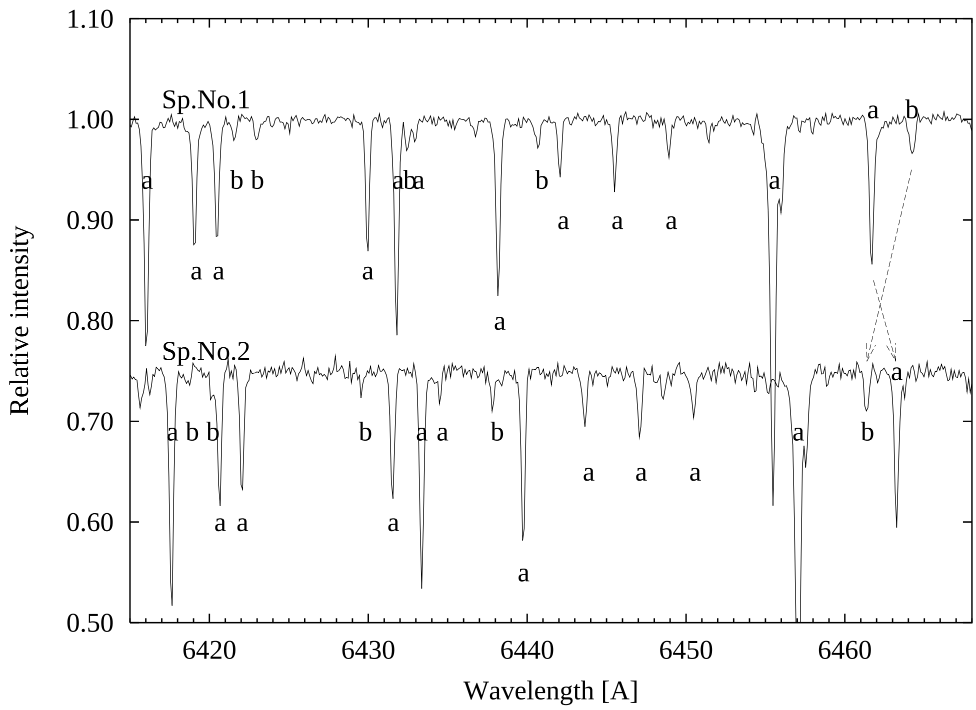

Figure 1. Two spectra of HD 108642 shifted by -0.25 in relative intensity and where a – denotes the lines of the primary and b – the secondary star.

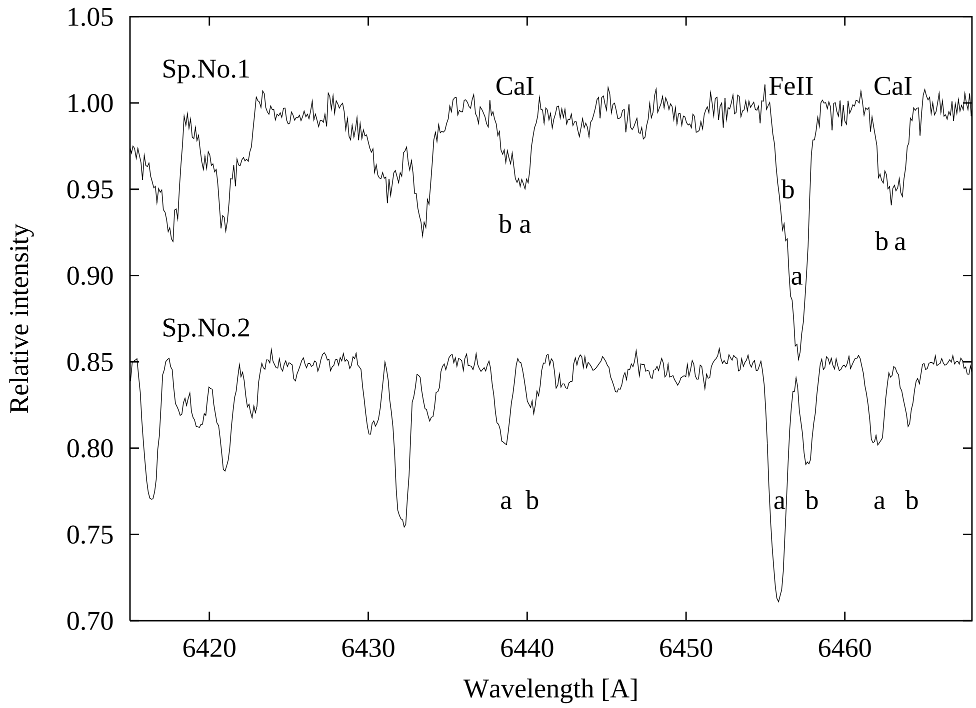

Figure 2. Two spectra of HD 434 shifted by -0.15 in relative intensity. Notation as in Fig. 1.

The $M1/M2$ ratios and absolute radial velocities listed in Table 1 above are not necessarily self consistent. It is because only one unblended line (Can 6439) was used for absolute radial velocity measurements while more lines could be used for relative radial velocity changes and the $M1/M2$ determination. The Gaussian decomposition procedure of a few good lines was used to measure the relative radial velocities in the case of Sp. No.1. of HD 434 as the lines of the primary and secondary slightly overlap, otherwise, center of mass method was used. The estimated 1σ precision of our radial velocity measurements is about 1 km s^{-1}. The estimated 1σ error of $M1/M2$ values is more or less formal error estimated from only 2 spectra. The true error may be slightly higher. This paper again illustrates that new CCD observations of many so far unresolved SB1 systems are highly desirable as they may lead to a discovery of secondary spectra and a subsequent direct mass ratio determination in even bright and well studied SB1 cases as demonstrated e.g. by Iliev et al. (2001a, 2001b) and Ryabchikova (1998).

This work was partially supported by the VEGA grant No. 3014 and by the APVT-51-000802 project.

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