Search For SB2 Systems Among Selected Am Binaries

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Abstract

We report on the detection of secondary spectrum signatures in five spectroscopic binary systems: HD434, HD861, HD108642, HD178449, and HD216608. High signal-to-noise high-resolution spectroscopic observations have been carried out at Bulgarian NAO Rozhen in the frame of an extended project concerned mainly with Am stars in binary systems. We found out that our knowledge about early type binaries has serious gaps. This is true especially when it is based on older photographic techniques only. We reach the conclusion that photographic data involving longer orbital periods (where the orbital Doppler shifts are less or comparable to the rotational broadening of the spectral lines) and early type stars (that have only few and broad lines) should be revisited or at least used with caution. We demonstrate on the five systems above how CCD observations made with even 2-m class telescopes can discover the binary nature or secondary spectra in many currently unresolved SB1 systems. Important astrophysical information such as atmospheric parameters and mass ratios is used to unravel the previous misinterpretation of the data leading often to spurious orbits.

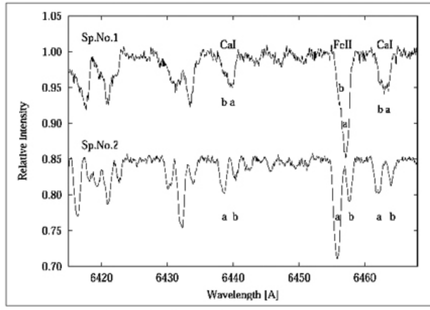
1. The Background

It is well-know fact that Am stars are found very often in binary systems (North et al. 1997; Debernardi et al. 2000). That is why they offer a unique possibility to study the role of tidal interactions on the stellar hydrodynamics and diffusion process in stellar atmospheres. We found indications (Budaj 1997; Iliev et al. 1998) that observed Am abundance pattern may depends on the orbital elements of a binary system. It is more pronounced in systems with higher eccentricities and possibly also at longer orbital periods. Some years ago we started an observational project concerned especially with Am stars in binary systems. Its main goal is to collect high quality spectroscopic data enough to fulfil the rigid requirements of spectrum synthesis procedures. Soon after the first observation we found that spectra of some target stars exhibit clear signs of the secondary components. Here we report on the resolving of new SB2 systems discovered among selected Am binaries.

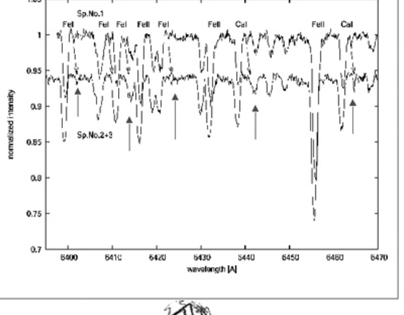
2. The Observations

Our spectroscopic observations were carried out with the 2-m RCC telescope of the Bulgarian National Astronomical Observatory Rozhen. Photometrics AT200 camera with a SITe S1003AB chip (1024 × 1024, 24 μm pixels) was used in the Third camera of the coudé spectrograph to provide spectra in two 100 Å wide spectral regions centered at 6440 Å and 6720 Å with a resolving power R = 32000. The typical S/N ratio reached is about 300. Standard IRAF procedures were used for bias subtraction, flat-fielding and wavelength calibration. Hot, fast rotating stars were used for telluric lines removal.

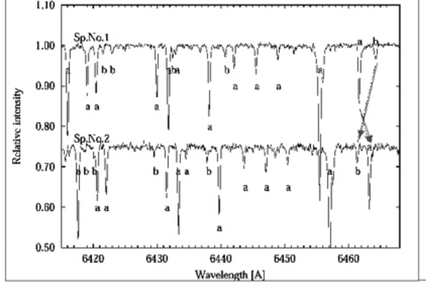
3. New SB2 Systems



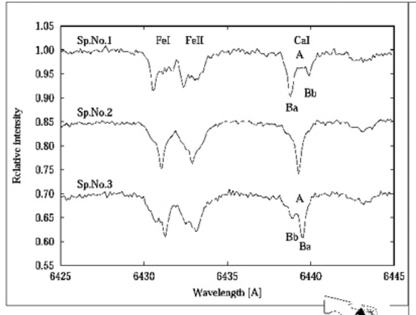
3.1. HD434 This star (HIP728, V=6.5 mag) is well-known SB1 system. Latest orbital elements are: P=34.26 days, e=0.475, K=24 km/s, γ=2.6 km/s. Our observations (Iliev et al. 2001; Budaj et al. 2003) revealed pronounced secondary spectrum. It is marked with "b" in the figure where you can trace the evolution due to orbital motion. We were able to derive the mass-ratio $M_1/M_2 = 1.19 \pm 0.06$, K and γ are different. The secondary produces heavy blends and previous orbit determination should be revisited.



3.2. HD861 This star (HIP1063, V=6.6 mag) is well-known SB1 as well. The orbital elements are: P=11.215 days, e=0.22, K=45 km/s, γ=–12.5 km/s. Consecutive spectra of HD861 (Budaj et al. 2004) are shown in the figure. While the strong lines of the primary are shifted to the left (blue), weak and sharp lines of the secondary moved to the right (red) as it is marked with arrows. To resolve the secondary S/N ratio of about 400 was needed. In this case high S/N is as important as high resolution. A rough estimation of the mass ratio gives value of about 2.

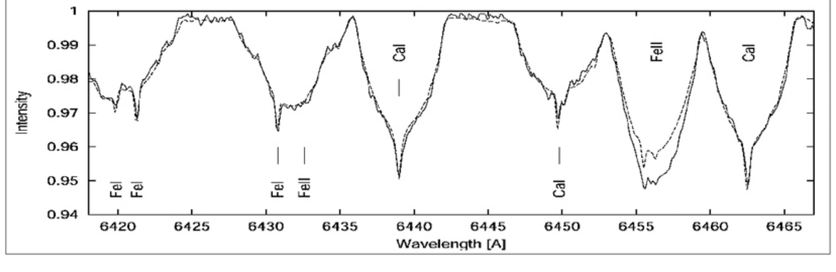


3.3. HD108642 The next star (HIP60880, V=6.5 mag) is SB1 system with P=11.215 days, e=0.0, K=41 km/s, γ=–0.7 km/s. Its SB2 nature was only suspected, indirect estimations (by-product of magnetic field polarimetric observations) give M_1/M_2=1.9. Slow rotation ($v\sin i$ < 5 km/s) of both components facilitates clear recognising of the secondary (Budaj et al. 2003). Our first direct determination of the mass-ratio shows that M_1/M_2=1.8. Due to orbital motion "a" and "b" line systems exchange places what is exhibited in the figure.



3.4. HD216608 This star (HIP113048, ADS 16345AB) is visual binary system. Component B (a F6V star) orbits the primary with a period of 105 years. There is also an optical companion C, faint 11-th magnitude star. Brightest member HD216608A is considered as SB1 system, it has Am characteristics, this is the reason to be included in our target list. Published orbital elements are: P=24.164 days, e=0.2, K=10 km/s. Spectroscopic observations reveal the triple structure of the line profiles. Precise analysis (Iliev et al. 2001) shows that sharp moving details both belong to the cool B component which seems to be newly found SB2 system. The two systems of lines are marked "Ba" and "Bb", while "A" stands for lines related obviously with hot A component. Heavy blends resolved partially here could affect all previous R.V. measurements in lower spectral resolution leading to false, counterfeit orbits. The very SB1 nature of HD216608A should be revisited as well.

3.5. HD178449 This star is 17 Lyr (HIP93917, V=5.2 mag). It is A component of ADS 12061, and SB1 system as well. B component is 9-th magnitude star 4" away from A. We have included HD178449 in our target list mainly to use it as reference object for the synthetic spectra procedures at high rotational velocities (130 km/s). The star itself turned out to be very interesting and we spent large amount of observing time to investigate the origin of sharp "noses" seen in the bottom of most lines (Budaj & Iliev 2003). Their nature is neither interstellar nor shell, they do not belong to B component. A comprehensive analysis including synthetic spectra calculations (dashed line) shows that weak details originate from a G-dwarf companion, which is apparently new discovered Ab component of the system. Small part of the spectrum of HD178449 with S/N ratio of about 1700 carefully aggregated for more than 11 hours of total exposure time is shown in the figure.



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