HIGH-RESOLUTION SPECTROSCOPY AT ROZHEN: HUNT FOR SB2 MARKS IN THE SPECTRA OF Am BINARIES

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Metallic-line A stars (or well-known Am stars) constitute a subgroup of chemically peculiar stars on the upper main sequence. Abnormally strong metallic and unusually weak Ca and Sc lines are typical for their spectra. Observed peculiarities are due apparently to slow selective diffusion driven mainly by the fine-tuned balance between radiation pressure and gravity. The diffusion operates first below the deepest HeII convection zone until it disappears because of He settling and then proceeds much higher and more effectively below the H+HeI convection zone. Rotation was found to play a key role in this process as it induces large scale mixing which can disturb the microscopic diffusion process. Recent sophisticated calculations indicate clearly that a rotational velocity less than about 90 km/s is required for diffusion to prevail and Am phenomenon to occur. There are also indications that Am peculiarity may depend on the orbital elements of a binary system [1, 2]. It is more pronounced in systems with higher eccentricities and possibly also at longer orbital periods. Since Am stars are found very often in binary systems (see discussions in [3, 4]) they offer an unique possibility to study the importance of tidal interactions on the stellar hydrodynamics and diffusion process.

Some years ago we started an extended multilateral observational project concerned especially with Am stars in binary systems. Its main aim is to collect spectroscopic data of high quality enough to fulfil the rigorous requirements of the spectrum synthesis procedures. First of all, this means S/N ratio of 300, 400 and more. Soon after the first observations we realised

that results go far beyond the scope of the project – some of the spectra exhibited clear signs of secondary components. Later on we were able to register the evolution due to orbital motion as well. Resolving SB1 systems became the second aim of our project. Here we report on the new SB2 systems found among selected Am binaries. The fact that we discovered SB2 signatures in 5 out of 28 stars simply shows that high resolution CCD spectroscopy of slow rotating binary stars offers really new opportunity to shed more light on their orbits, physical parameters and evolution.

Our spectroscopic observations were carried out with the 2-m RCC telescope of the Bulgarian National Astronomical Observatory in the frame of our observational program on Am-stars in binary systems. Photometrics AT200 camera with a SITe SI003AB 1024 x 1024 CCD chip, (24 microns pixels) was used in the Third camera of the coude spectrograph to provide spectra in two different spectral regions 100 angstroms wide and centered on 6440 angstroms and 6720 angstroms with resolving power R = 32000. The typical S/N ratio is about 300. Wavelength calibration has the r.m.s. error of 0.005 angstroms IRAF standard procedures have been used for bias subtracting, flat-fielding and wavelength calibration. Telluric lines have been removed using spectra of hot, fast rotating stars.

About thirty Am binaries were selected: 1) to be brighter than 7-th magnitude in V; 2) to have declination > +10 deg.; 3) to have orbital periods between 10 and 180 days. This assures a full range of original eccentricities that did not undergo circularization during the evolution on the main-sequence. We put no constraint on the rotational velocity and included one more broad line normal star for testing the analysis on highly rotating stars.

Only the main results with figures are reviewed here, for much more information we address the reader to the original papers where they are published.

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, gamma=2.6 km/s. Our observations [5, 6] revealed pronounced secondary spectrum. It is shown with “b” in the Figure 1.

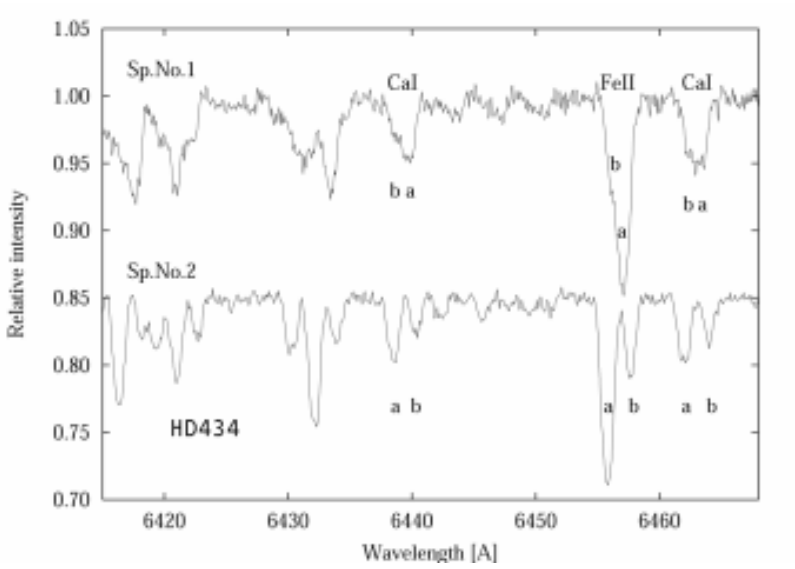

Fig.1

HD861. This star (HIP1063, V=6.6 mag) is well known SB1 system again, it is close and bright. The orbital elements are P=11.215 days, e=0.22, K=45 km/s, gamma=-12.5 km/s. Two successive spectra of this star [7] are shown in the Figure 2. While the strong lines of the primary “a” are shifted to the blue, weak but sharp lines of the secondary “b” moved to the red, as it is marked with arrows. To resolve the secondary signal-to-noise ratio of about 300 is reached. In this case high signal-to-noise ratio is as important as the high resolution.

HD108642. The next star in our sample (HIP60880, V=6.4 mag.) is SB1 system with P=11.784 days, e=0.0, K=41 km/s, gamma=-0.7 km/s. Its SB2 nature was only suspected. Slow rotation of both components facilitates the resolution of the secondary [6]. Our observations are presented in the Figure 3. Both systems of lines are well separated and recognized. As a result of the orbital motion “a” and “b” lines exchange their places.

HD216608. Fourth in a row, this star (HIP113048, ADS 16345 AB) is a visual binary system. Component B (a F6V star) orbits the primary with a period of 105 years. There is also an optical C companion, faint star of 11- th magnitude. Brightest member HD216608 A is a SB1 binary system,

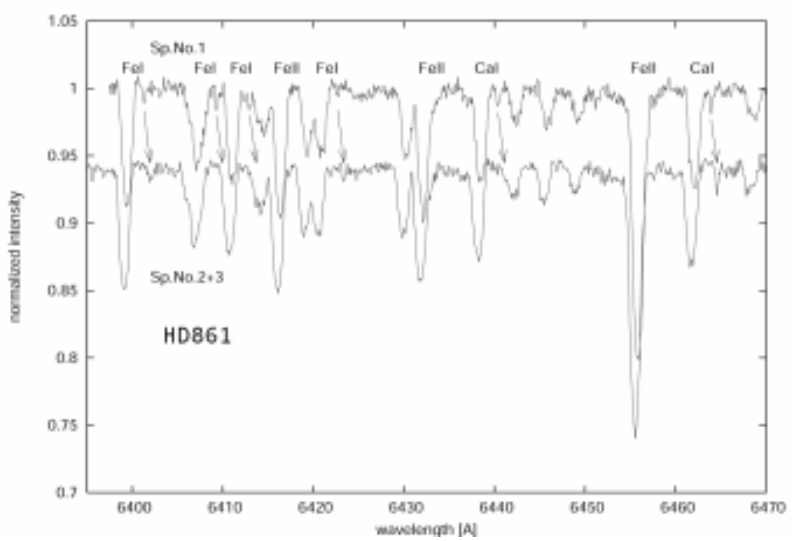

Fig.2

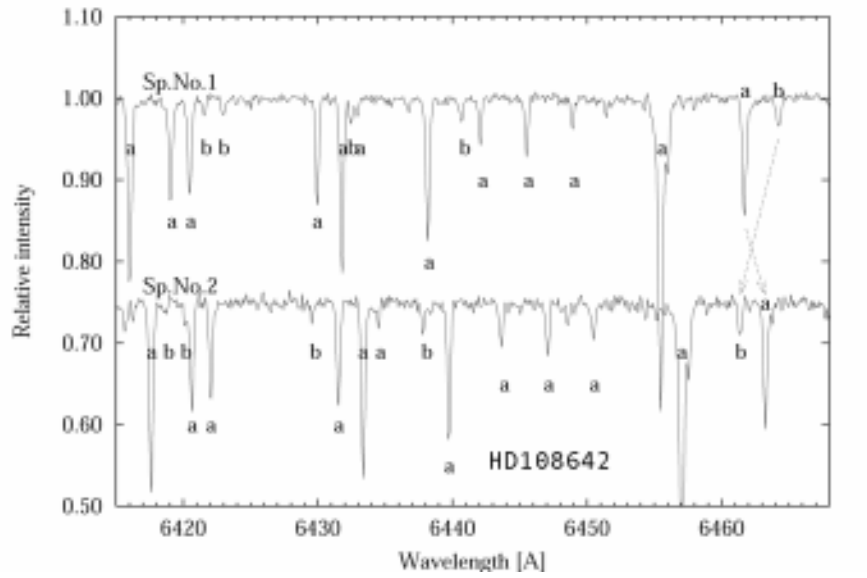

Fig.3

it is an Am star and thus, was our main target to study. Orbital elements are: P=24.164 days, e=0.2, K=10 km/s. Results of our spectroscopic observations [8] are shown in the Figure 4.

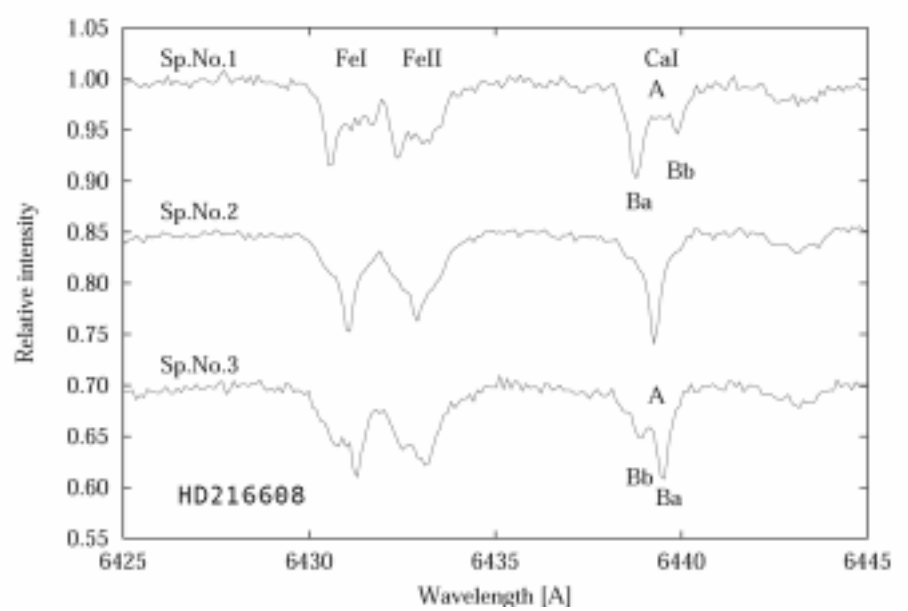

Fig. 4

HD178449. The star (17 Lyr, HIP93917) was included in our target list in order to use it as reference object for synthetic spectra procedures at high rotational velocities. This object is known SB1 system, it turned out to be very interesting and we spent large amount of observing time to solve the case [9]. Small portion of its spectrum is shown below in the Figure 5.

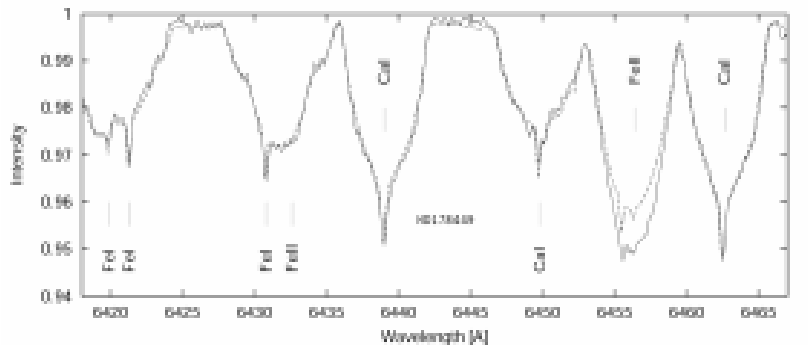

Fig. 5

The comprehensive investigation including sophisticated synthetic spectra calculations (presented with dashed line in Figure 5) shows that weak sharp “noses” belong to the newly discovered Ab component of this

system. To reject their interstellar or shell origin observations with signal-to-noise level of about 1700 were carefully collected and matured for more than 10 hours of accumulated exposure time.

Review shown here illustrates once again that the coude-spectrograph in operation at Rozhen is efficient and convenient for studying the spectroscopic binary systems. Some of our previous results in this field [10, 11, 12] could be used as reference what kind of spectroscopic investigations can be successfully carried out at NAO Rozhen.

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