New spectral observations of the EBS star UU Cas

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(Poster contribution)

Abstract. High-resolution (R = 30 000) spectroscopy of the Eclipsing Binary System UU Cas obtained with the Coude spectrograph of the 2m telescope of the Bulgarian NAO is presented. The observations cover three spectral regions: the one centred on λ=4520 Å, the other one centred on λ=4720 Å and the region around H_β. In each region detailed line identification and radial velocity measurements were performed. The new data together with those published by Markov et al. [2009] are used to obtain a better solution of the RV curve and to get some insight into the nature of the system.

Key words: spectroscopy: eclipsing binary stars:

Нови спектрални наблюдения на затъмнително променливото звезда UU Cas

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Представени са нови спектрални наблюдения на UU Cas, получени с куде спектрографа аташиран към 2м телескоп в НАО. Наблюденията покриват три спектрални области: едната област е центрирана в λ=4520 Å, втората - в λ=4720 Å и третата около H_β . Във всяка една от тези области сме извършили детайлно отъждествяване на наблюдаваните спектралните линии и сме измерили техните радиални скорости. Новите радиални скорости са използвани за доуточняване параметрите на кривата на лъчевите скорости на системата.

1 Introduction

UU Cas is a β Lyr-type eclipsing binary system (EBS). The photometric behaviour of the system is well established (e.g., Kumsiashvili [2009], Polushina [2002]) but spectroscopic observations are scarce - the only ones known being those of Sanford [1934]. Motivated by the missing spectroscopy, a long-term monitoring campaign of UU Cas was initiated in the fall of 2008 using the Coude spectrograph at the 2-m telescope of the Bulgarian National Astronomical Observatory. First results, comprising line identification and radial velocity measurements in two spectral regions, the one centred on λ=5700Å and the other one around H_α, were presented in Markov et al. [2009]. A first approximation of the radial velocity (RV) curve of the system was also provided.

In this contribution we describe the new observations of UU Cas collected since October, 2009 at the Bulgarian NAO and briefly comment on some preliminary results.

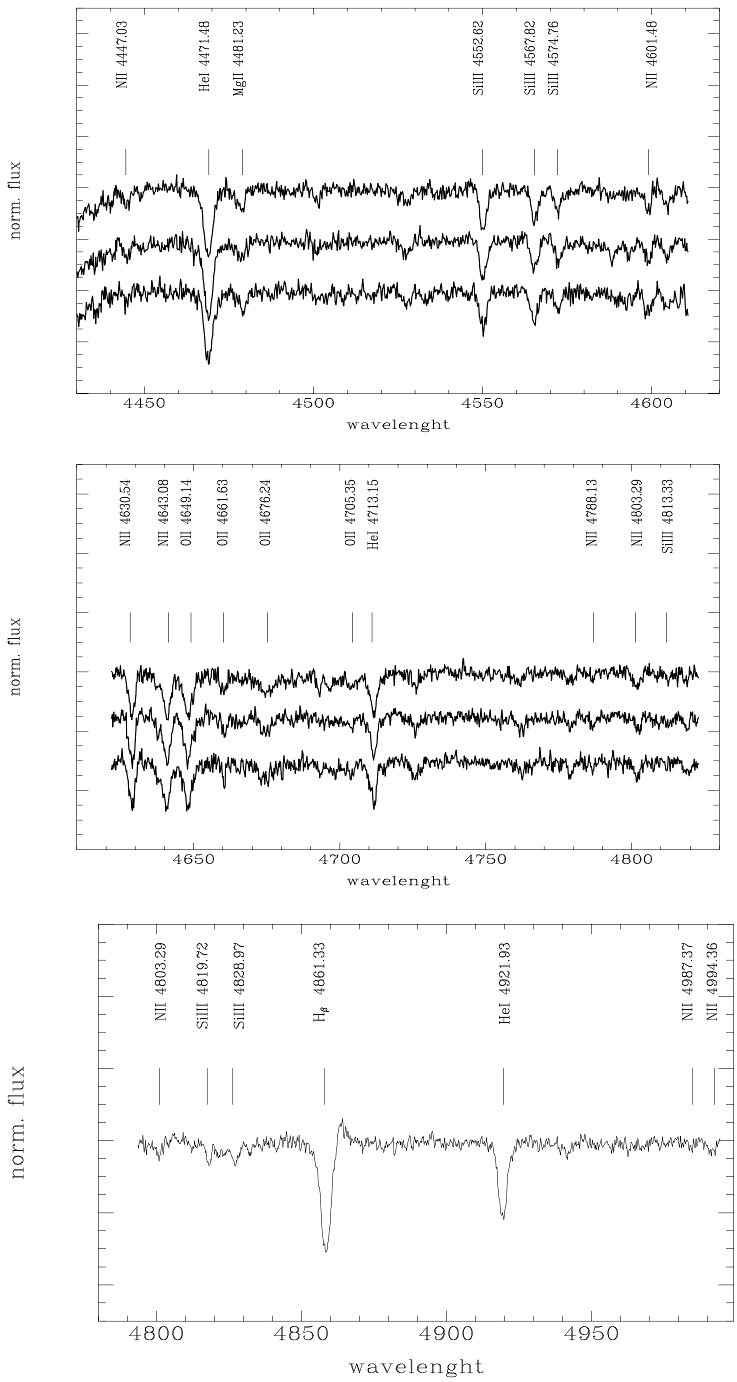

Fig. 1. UU Cas observations in three spectral windows centered on λ=4520 Å(top panel), λ=4720 Å(midle panel) and on H_β (bottom panel). The spectra shown in the top and middle panels are taken within 2 hours. In each plot the identified spectral features are marked with vertical lines and labeled with the corresponding atomic transition.

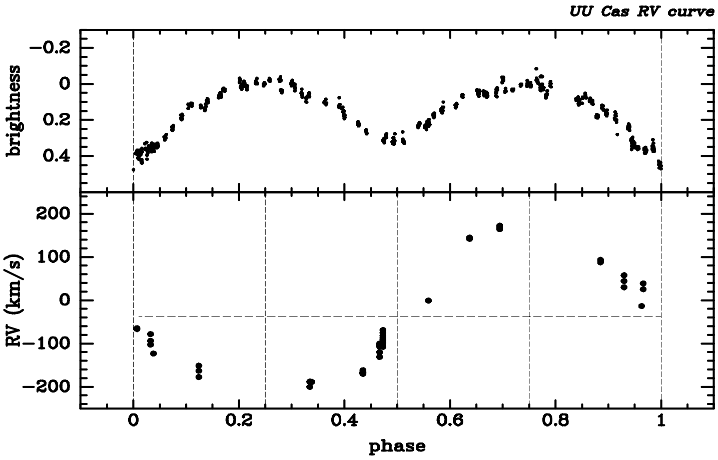

Fig. 2. *Top panel*: The UU Cas light curve in the B-band as derived by Kumsiashvili et al. [2009]. *Bottom panel*: The updated radial velocity curve of UU Cas. The new data-points correspond to phases 0.44, 0.46, 0.47 and 0.56.

2 Follow-up observations of UU Cas

The new observations have been taken with the same equipment as described by Markov et al. [2009]. In addition to the two spectral regions already observed, three new, centered on λ=4520 Å, λ=4720 Å and around H_β, were obtained. In each spectral region, several consecutive exposures (within 2 hours) were taken to ensure sufficient S/N for line identification and radial velocity measurements.

3 Results

The spectra collected in each of the three newly observed regions are illustrated in Figure 1. Apart from several transitions in HeI, numerous lines of SiIII, NII, OII and MgII have been identified. H_β shows a P Cygni-type profile indicative of line-formation in an extended envelope with a velocity gradient inside.

At our resolution and S/N ratio, the identified metal lines do not show signatures of line splitting. At the corresponding phase, the velocities of the lines, averaged within each of the three metal ions, are well sinchronized with the RV curve presented in Markov et al. [2009] (Fig. 2, bottom panel). This finding suggests that metal lines sofar identified have been formed in the same region, most likely the photosphere of the primary. Using sine approximation to the updated RV curve we got an estimate of the system velocity of UU Cas of $-45\pm$ 12.5 km sec^{-1}. Further refinements of this estimate might be expected due to incomplete phase coverage (Important data-points around phase 0.25 and 0.75 are still missing.).

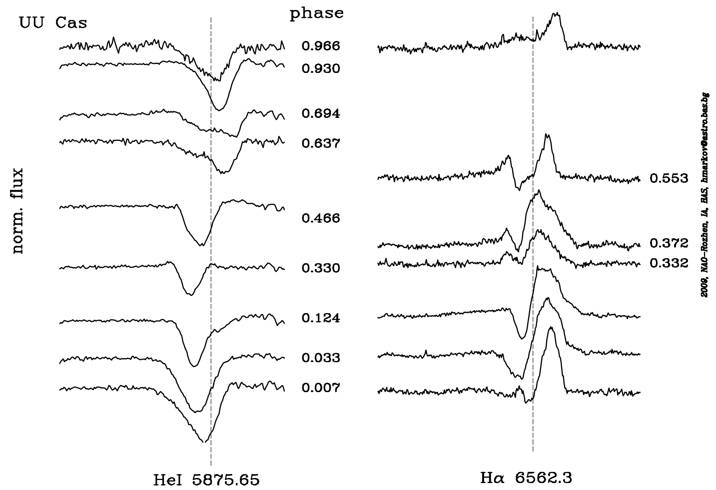

Fig. 3. Profile variations observed in He I 5876 Å and H_α ordered by phase.

The set of He I λ5875 and H_α profiles collected since the beginning of the UU Cas monitoring campain in December 2008 is shown in Fig. 3. An interesting point in the phase development of He I λ5875 is the clear line-splinting around phases 0.64-0.69 and 0.12. To get some inside into the origin of the splitting, we measured the radial velocities of the deeper He I λ5875 component and compared them with the RV curve determined by the metal lines. The obtained results are shown in Figure 4, where the He I λ5875 velocities are marked by asterisks. Two things become appearant from this plot: first, the He I λ5875 and metal line velocities are well synchronized suggesting the dynamical behaviour of the former is dominated by the primary and second, at a given phase the He I λ5875 velocity is systematically "bluer" that that of metal lines suggesting presence of a velocity gradient in the region of line-formation. Taken together these findings imply the primary is most likely a massive B1/B2-type star with extended envelope, as also suggested by Polushina [2002] on base of photometric analysis.

Concerning the second absorption component of He I λ5875 seen at phases 0.64-0.69 and 0.12, our interpretation, at least at present, is that this component is likely formed in a region related to the secondary. Another evidence in support of our hypothesis about the contribution of the secondary into the He I λ5875 line formation is the fact that at phases 0.01 and 0.03, i.e. when the primary is, at least partly hidden, by the secondary, this line shows strongest absorption while the opposit must take place.

The phase behaviour of H_α is shown in Figure 3. The profile of this line is rather complex showing simultaneous presense of emission and absorp-

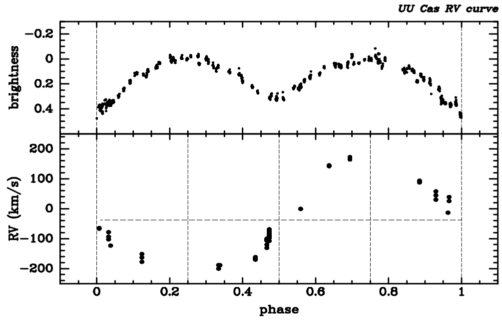

Fig. 4. The UU Cas RV curves derived from different chemical species. Black points refer to V_r from metal lines (Si, N, Mg, Fe, Na); asterisks mark the velocities of the stronger He I λ5875 absorption component; squares denote V_r of the stronger emission peak of H_α .

tion components. The profile morphology is highly variable changing from a P Cygni-type to a double-peaked (disk-like) emission with a red component being stronger than the blue one. The available data do not allow any statement about the origin of the different components to be drawn.

4 Summary

In this contribution we present new spectroscopy of UU Cas collected since October 2009 and outline some preliminary results. In particular, we extend the spectral coverage by observing new wavelength regions, identify new spectral lines and add new points to the RV curve thus achieving better coverage by phase. Also, we obtain new observations in the regions around He I λ5875 and H_α which together with the previous ones allow us to better understand the origin of the complex structure of these lines.

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Fig. 6. Prof. Vladimir Schkodrov at the Closeing Dinner of the Conferenvce