Journal of Physics: Conference Series **172** (2009) 012044 doi:10.1088/1742-6596/172/1/012044

V455 And — a life before the outburst

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Abstract. V455 And (= HS 2331+3905) is a WZ Sge-type cataclysmic variable which shows a double-humped profile in its orbital light curve. It is also one of the few ZZ Cet pulsators among cataclysmic variables (CVs). In quiescence V455 And shows several types of variability in accordance with Araujo-Betancor et al. (2005). We present the results of observations of V455 And during the autumn seasons of the years 2004-2006, just before the superoutburst in 2007.

1. Introduction

The WZ Sge-type binary systems are a subclass of dwarf nova cataclysmic variables — consisting of a red dwarf and a white dwarf — that have the orbital periods close to the period minimum (80–90 min). The outbursts of WZ Sge-stars are very rare and more powerful than the usual dwarf nova outbursts. One of the WZ Sge-features is a double-humped orbital light curve in quiescence. At present about 20 of such systems are known. Usually they are discovered during their outbursts because their brightness in quiescence is very weak and their photometric characteristics are very similar to normal dwarf novae.

HS2331+3905 was discovered (Gänsicke et al., 2007) in the Hamburg Quasar Survey. The results of the observations during three years and the main characteristics of the star were described in the paper by Araujo-Betancor et al. (2005) "HS 2331+3905: The cataclysmic variable that has it all". In this paper they defined HS2331+3905 as a cataclysmic variable with a very wide spectra of variability: orbital (81.08 min) and superhump periods (83.38 min), non-radial pulsations of the white dwarf (5–6 min) and a coherent signal at 1.12 min. The spectroscopic period was about 3.5 hour. Besides, HS 2331+3905 is "the brightest CV white dwarf pulsator" (Gänsicke et al., 2007). Araujo-Betancor et al. (2005) proposed a possible superoutburst of HS2331+3905 as a WZ Sge-type binary. And such outburst (precisely, the superoutburst) happened in September, 2007. After the beginning of superoutburst it was named V455 And (Samus et al., 2007). Thus, V455 And was classified as WZ Sge-type system long before its outburst. Here we present the result of our observations obtained before the 2007 superoutburst.

2. Observations

At first we studied the photo-plates of the Moscow archive. The limit of these Moscow plates is about of 12–13 magnitude. There were 43 plates from 1907 till 1957. We did not see any outbursts on them. Due to the fact that the 2007 superoutburst was about 8.5 mag, any superoutburst had to be visible on these plates. The Julian Dates of plates are given in Table 1

(JD 2400000+). We carried out our observations of V455 And at the Crimean Laboratory of Sternberg Institute and at the Crimean Astrophysical Observatory in the autumn seasons of 2004 to 2007 with the 38-, 50-, 60-cm and 1.25-m telescopes. Below we present the results of our observations during the quiescence state of this system, before the 2007 superoutburst.

Table 1. Julian dates of archive plates (JD 2400000+).

JD	JD	JD	JD	JD
16708,44	17861.23	18925.30	29284.16	35718.45
16730,41	17939.17	18929.44	29285.45	35721.46
16880,21	18219.34	28043.44	29286.19	35723.49
17469,45	18241.21	28082.38	29287.15	35724.42
17587,21	18267.26	28753.42	29310.18	35724.44
17794,40	18564.41	28805.34	29318.21	36084.47
17826,39	18568.36	29147.49	35718.45	36185.17
17849,31	18598.23	29167.40	35718.45	
17860.23	18600,21	29172.42	35718.48	

3. The orbital light curves

The aggregate light curves of V455 And in V- and R-bands for 2004–2006 are given in Figs. 1 and 2. The average brightness of the system is practically constant during the period 2004–2006. This average brightness is about 16.0 mag in R-band and 16.4 mag in V-band. In Figs. 3 and 4 the mean phase-folded light curves in the R- and V-bands are presented. The double-hump structure of the light curves is clearly seen. Similar light curves are characteristic of WZ Sge-type stars and reflect the spiral structure of the accretion disc around the white dwarf. Gänsicke et al. (2007) proposed that the very complicated form of the warped accretion disc of V455 And is responsible for the different variabilities of this system. The period analysis of the data of 2006 showed the strongest peak at 17.76 d^{-1}, corresponding to the orbital period $0.^d0563$, while Araujo-Betancor et al. (2005) found the stronger peak at 35.52 d^{-1} corresponding to half of the period.

It can be noticed that sometimes the broad minimum (which is the deepest) occurs at phase 0.5, and the sharp minimum happens at phase near 0.0. However, sometimes the minimum at phase 0.0 is deeper. The double-humped light curve fitting to the ephemeris of Araujo-Betancor et al. (2005) allow to consider this modulation as the orbital one. The mean 2005–2006 R-light curve is more noisy than the mean 2004–2006 V-curve. This is due to the circumstances under which the observations in 2005 were obtained — the bulk of R-data was obtained with the smallest telescope. Concerning the individual light curves, an example in the B-band is shown in Fig. 5. Practically, the average 2006 B-light curve (Fig. 6) was obtained during three November nights of 2006. Note as well that the shape of both light curves (corresponding to years 2005 and 2006) is different. In particular, the humps switched their places and the minimum at phase 0.5 became smoother. In contradiction with the dwarf nova light curves where the usual orbital hump before the eclipse is generated by "a hot spot" on the accretion disk, the light curves of WZ Sge-stars in quiescence have a more complicated form. The disc in these systems has a complex structure and the pulsation (for example, V455 And, SDSS 0804) and the rotation of the white dwarf (WZ Sge, V455 And) can change the light curves.

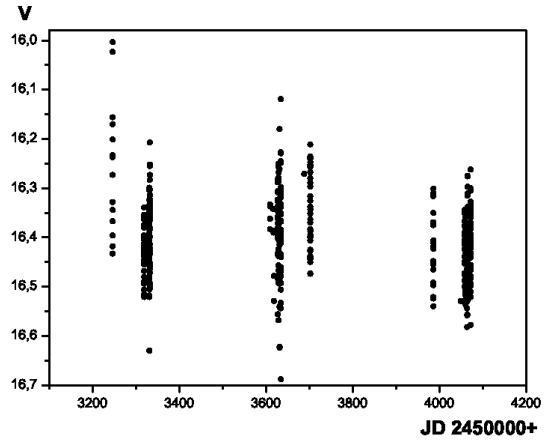

Figure 1. The aggregate light curve of V455 And during the years 2004–2006 in V-band.

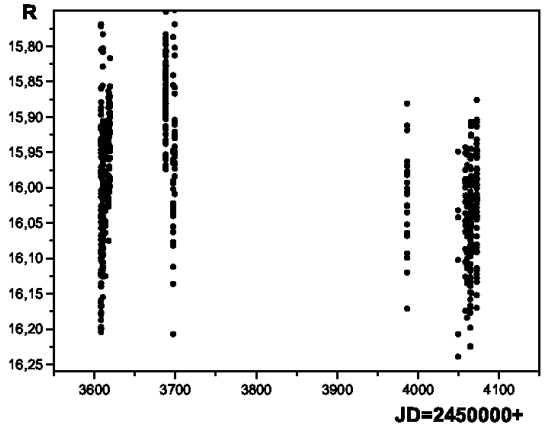

Figure 2. The aggregate light curve of V455 And during the years 2005–2006 in R-band.

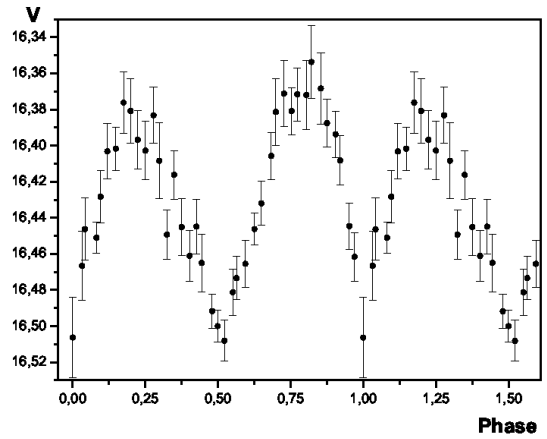

Figure 3. The mean V-orbital light curve of 2004–2006 years.

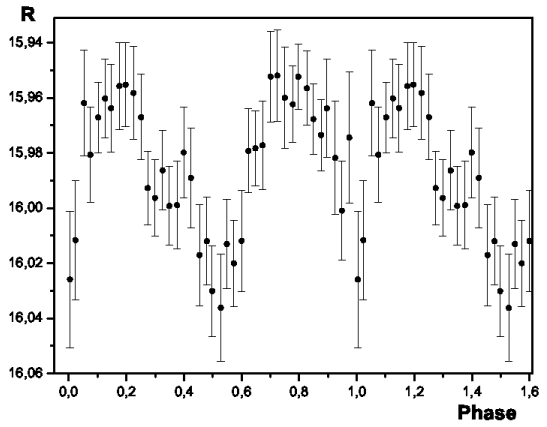

Figure 4. The mean R-orbital light curves of 2005–2006 years.

The search of white dwarf pulsations in binary systems is difficult because of hasting some quasi-periodical signals due to the orbital and rotational motions, the instabilities in the accretion stream and in the disc. As Gänsicke (2007) emphasized there were many additional signals. We found one of the signals at a frequency near 260 d^{-1} corresponding to the period about 5 min (Araujo-Betancor et al., 2005) which was proposed to be caused by non-radial pulsations of the white dwarf.

4. Discussion

In this paper we have exemplified only a small part of the light curves we have obtained. The orbital light curves of V455 And have a typically double-humped profile which is one of the WZ

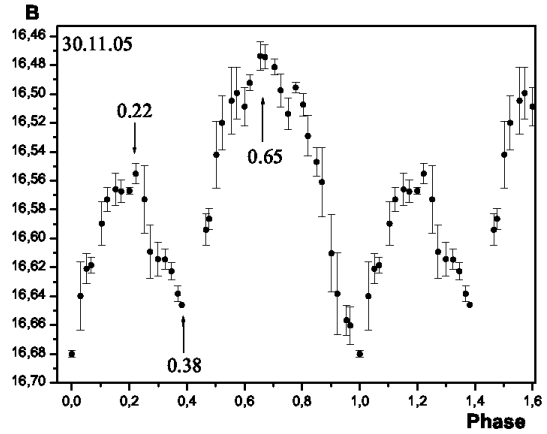

Figure 5. The orbital light curve for the 13th of November, B-band.

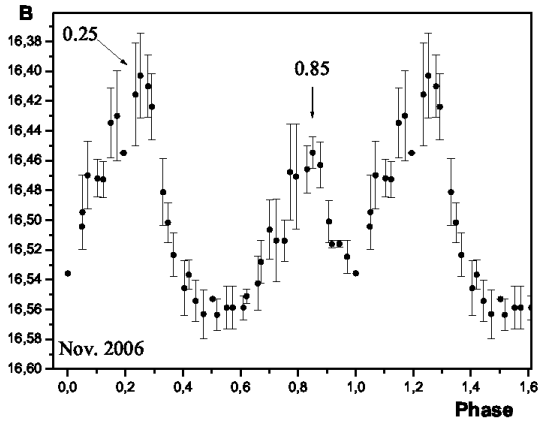

Figure 6. The mean orbital light curve in B-band, 2006, November.

Sge-type features, but sometimes each hump can split in two humps. The light curves of another WZ Sge-type star SDSS J080434.20+510349.2 show the same behaviour (Pavlenko et al., 2007; Pavlenko, 2008). The variable and sometimes multi-humped orbital modulation point at the complex and variable structure of accretion disc. However, we noticed no relevant changes in the light curves of V455 And nine months before the 2007 superoutburst.

Due to their brightness, V455 And and WZ Sge (as a prototype) are the only systems which were observed before their superoutbursts. The observations of the WZ Sge-type CVs during the superoutbursts and in quiescence are very important for elucidating the physics of accretion discs and the nature of both stellar components — a red and a white dwarf. One of the aspects of interest is the existence of non-radial pulsations of the white dwarf before and after the superoutburst because it is connected with the temperature of the white dwarf and the influence of the outburst on it. The second is rotation of the white dwarf. At least, there are two known spinning white dwarfs — WZ Sge and V455 And. And one more question still remains to be answered: are these systems intermediate polars or not? And, is it possible that the most of WZ Sge-type stars are intermediate polars?

Acknowledgments

This work was partially supported by the grants of Russian president NSh-1685.2008.2 and RFBR 06–02–16411. We are also grateful to the SOC and LOC for the hospitality during the conference.

References

Araujo-Betancor S Gänsicke B T Hagen J-H et al 2005 *A&A* **430** 629
Gänsicke B T 2007 *ASP Conf. Ser.* **372** Eds.: Ralf Napiwotzki and Matthew R Burleigh (San Francisco) 597
Pavlenko E P 2008 (this volume)
Pavlenko E P et al. 2007 *ASP Conf. Ser.* **372** Eds.: Ralf Napiwotzki and Matthew R Burleigh (San Francisco) 511
Samus N N Broens E Diepvens A et al. 2007 *IAUC* **8868**