V1504 CYG: OUTBURSTS

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ABSTRACT. The behavior of the dwarf nova V1504 Cyg during 2007 superoutburst and during several normal outbursts is considered. The binary during normal outbursts shows loop-like tracks on the V, V-R diagram, where prior the superoutburst the loop is steep and narrow while after the superoutburst the loop is mildly sloping and wider. The loop of the superoutburst resembles those of normal outbursts precedings the superoutburst. V1504 Cyg displays the early superhumps phenomenon during the ricing branch and first few days of the superoutburst.

Key words: Stars: binary: cataclysmic; stars: individual: V1504 Cyg

1. Introduction

V1504 Cyg is a SU UMa-type dwarf nova. The kind of this subclass of the cataclysmic variables is the presence of two types of outbursts (normal ones and superoutbursts) and orbital periods that are less then 2 h (Warner, 1995). In 1981 V.P. Tsesevich first pointed attention on this non-classified for that time variable star. Later on Raykov & Yuschenko (1988) suggested this star to be the SU UMa type nova, Nogami and Masuda (1997) confirmed this suggestion and found that superhump period is 0.07 day. As the dwarf nova, V1504 Cyg shows two type of the outbursts: the $\sim$ 3-day so-called normal outbursts and $\sim$ 14-day superoutbursts. Pavlenko and Dudka (2002) studied the outburst activity of V1504 Cyg and suggested the two types of the outbursts.

2. Observations and results

Observations of V1504 Cyg have been carried out with Cassegrain K-380 telescope in the Crimean astrophysical observatory in VR Johnson photometrical system in 2007, June – September during 31 nights, including superoutburst and two normal outbursts prior and after the superoutburst. The overall light curve is shown in Fig.1. It is seen that the normal outbursts

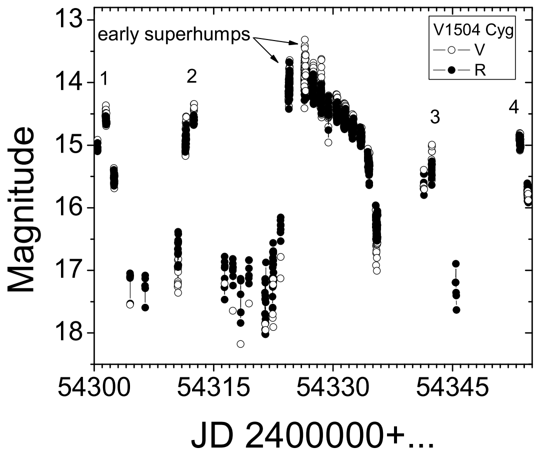

Figure 1: The long-term light curve of the V1504 Cyg. The open circles denote V data and the filled circles – R data. The normal outbursts are numbered.

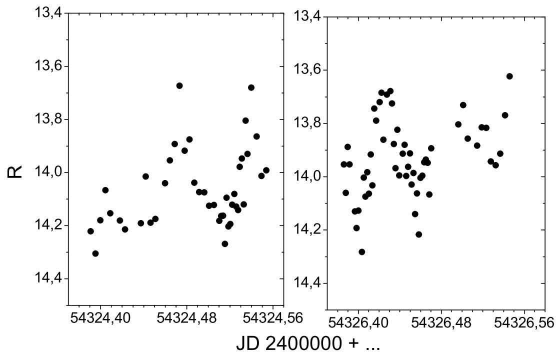

Figure 2: The nightly light curves displaying "early superhumps".

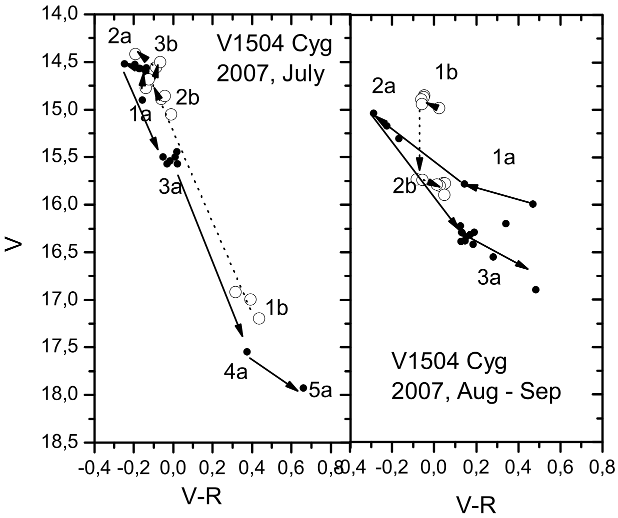

Figure 3: Left: The V, V-R dependence for the 1st (filled circles) and 2nd (open circles) normal outbursts. Right: the same for the 3nd and 4th normal outbursts.

have mean amplitude 3^m while the superoutburst – 3.5^m. The normal outbursts prior the superoutburst are brighter than those after superoutburst. All normal outbursts occured in 11 days. We do not discuss there the superhumps evolution during the course of the superoutburst, but note the appearence of the "early superhumps" on the ricing branch and during the first days of the superoutburst (Fig. 2). The amplitude of this light variations is variable and could reach 0.5^m, and the profile of the light curve is one-humped.

We constructed the magnitude – color diagrams separately for the normal outbursts before and after superoutburst and for the superoutburst itself (see Fig. 3). To supress the nightly magnitude and color variations, the data within time corresponded to the superhump cycle are averaged. It is seen that binary is bluer when brighter. In the outburst peak it shows the average $V - R \sim -0.2^m$. loop: the star is slightly bluer after passing the outburst peak. Contrary to this behavior, the 3d and 4th outbursts exibit more wide loop. At the same 16^m level the width of the first pair of loops is $\sim 0.1^m$, while those for the second pair – $\sim 0.4^m$. Also the first pair behaves steeper then the second one. The behavior of the superoutburst on the magnitude – color diagram resembles those of the 1st and 2nd normal outbursts (Fig. 4).

3. Discussion

We have revield that both the normal outbursts and superoutburst have practically the same blue color in maximum. During the outburst the accretion disk or accretion disk + hot belt + boundary layer could be the major contributors to the total light. The observing colors in maximum light correspond to the black-body temperature of order 50 000 K or higher. During the superoutbursts plateau duration the temperature of the hot radiation decreases up to 18 000 K – 19 000 K, and during the phase of rapid brightness decline decreases up to 10 000 K. If this radiation is produced by the accretion disk only, that means the disk is still in the hot stable state (Smak, 1984). In minimum the contributors to the total light are the accretion disk, hot spot on the disk, white dwarf and red dwarf. Just after the end of the superoutburst the mass of the accretion disk is the much smaller than prior the next superoutburst. One could expect that the normal outbursts behavior prior and after the superoutburst also may be different. Indeed, comparing the outbursts 1 and 2 with outbursts 3 and 4, one could see such difference. Before the superoutburst the narrow loop in Fig. 3 (left) corresponds to the "inside-out" propagation of the outburst, while after the superoutburst (Fig. 3, right) the instability is of the "outside – in" type (Smak, 1984).

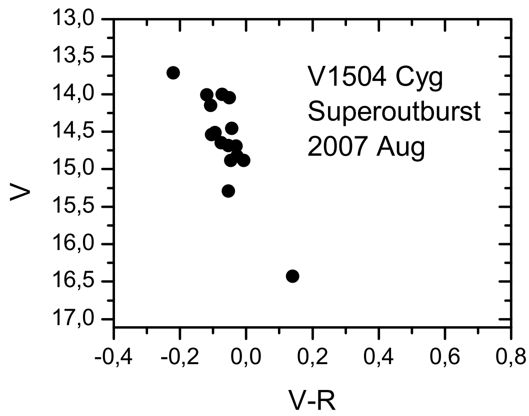

Figure 4: The V, V-R dependence for the superoutburst.

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References

Antoniuk O., Pavlenko E.: 2005, *ASP Conf. Ser.*, **330**, 379.
Nogami D., Masuda S.: 1997, *I.B.V.S.*, **4532**, 1.
Pavlenko E.P., Dudka O.I.: 2002, *Astrofizika*, **45**, 1.
Raykov A.A., Yushchenko A.V.: 1988, *Perem.Zvesdy*, **22**, 853.
Smak J.: 1984, *Acta Astronomica*, **34**, 161.
Warner, B.: 1995, *Cataclysmic variable stars*, Cambridge University Press.