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Flickering in KR Aurigae – CCD Observations

S. Boeva, **A. Antov**, **R.S. Bachev**

Institute of Astronomy, Bulg. Acad. Sci., Sofia 1784, Bulgaria

Abstract.

We present CCD photometric observations for the cataclysmic variable star KR Aurigae carried out at Belogradchik Astronomical Observatory and at National Astronomical Observatory – Rozhen, Bulgaria. We studied the fast variability (flickering) of the system in different states of the brightness and in different filters.

1 Introduction

The cataclysmic variable KR Aur was discovered by M.Popova in 1960. The system consists of a white dwarf and a red dwarf which transferring mass trough accretion disc. It is a typical member of VY Scl class stars. They are called "anti-dwarf novae" too, because in the predominant part of the time they are in the bright state with a high mass transfer rate and rarely their brightness drops to states with a weak or totally ceased mass transfer rate. In the literature only two stars are known with a deep minimum having lasted for several years – KR Aur and MV Lyr. In the case of KR Aur, the latest one continued from 1994 to 2001 and the brightness varied from 15^m to 19^m in V while normal magnitude is about 13.

The brightness of all cataclysmic variables is changing fast in all states and in all colours – it fluctuates about some mean value with amplitude of a few tenths of magnitude. This phenomenon is known as flickering. It exists in different time scales – from seconds to hours. The changes of brightness could be quasi-periodic – they continued for a few cycles.

In this work we studied the flickering behavior of KR Aur during its deep minimum and after rising of luminosity of the star and we made a comparison with similar stars.

2 Observations

Our observations covered the period from 1999 when the star was in the low state (about $18^m - 19^m$ in V band) to 2006 when it was in the high one. The observations were obtained at the Astronomical Observatory - Belogradchik with

60 cm Cassegrain telescope with SBIG ST8 and at the National Astronomical Observatory – Rozhen with 2 m RCC telescope equipped with Photometrics AT 200 CCD cameras trough U, B, V, R_c and I_c bands. We have used data from 17 light curves with durations from 0.5 to 8.5 hours (on average 1 h). The exposure times were between 10 and 150 s. The accuracy of measurements depended on the brightness, the telescope and the filters used and it varied from $0.^m02$ in the high state to $0.^m35$.

3 Results

The goals of our research were to detect flickering in the low state and to compare it with the high state flickering. Our data indicated presence of flickering in 4 out of 5 cases at minimum light of KR Aur. In the last case the accuracy of the measurements was about $0.^m35$ and we can't confirm or discard the existence of flickering. Even if we made photometric estimates only two values obtained at interval of several minutes could differ with a few tenths of magnitude.

The similar systems TT Ari and MV Lyr in low states commonly presented lack of variations of the brightness with amplitude more than $0.^m1$. This can be regarded as a consequence of decreased mass transfer rate. On rare occasions they had a strong flickering with amplitude of about 1 and more magnitude [2, 3, 5]. The authors supposed that in both systems some residual disk remained or mass transfer from secondary never stopped completely. In compliance with this, our previous works are indicative of presence of active processes in the system, because the energy distribution at minimum light was changing considerable.

The flickering at minimum (Figure 1) and at maximum light (Figure 2) is not identical. Oscillations with shorter periods laying on longer variations are

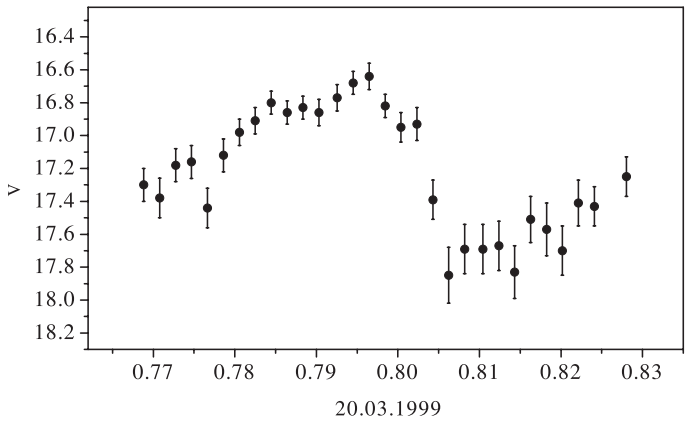

Figure 1. Light curve of KR Aur in the low state – 20.03.1999 in V band.

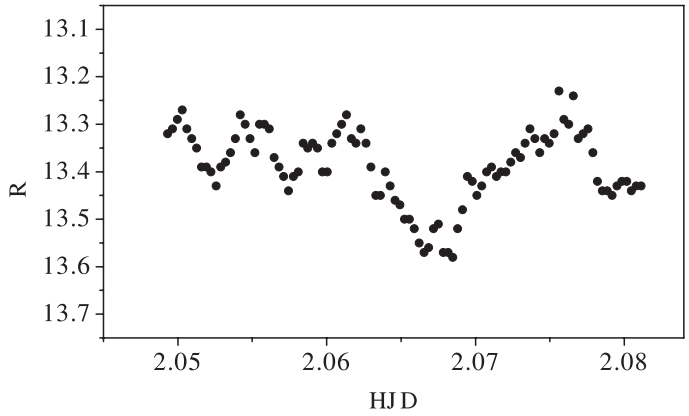

Figure 2. Light curve of KR Aur in the high state – 22.12.2003 in R band.

present in the light curves in the high state. However the amplitude of oscillations depends on the magnitude – in all bands it is higher at low brightness of the star (Figure 3). There is a good linear approximation between amplitude and V magnitude. The absolute flux in all bands was changing from 10–20 percents in the high state to 2–3 times in the low one. We consider that the high amplitudes in the low state could be a result of some different source from the one in the high state.

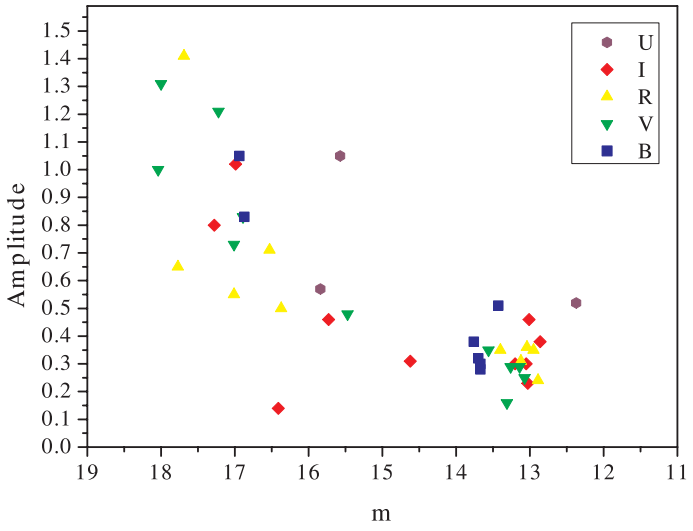

Figure 3. Dependence of the amplitude of the flickering on the magnitude in U, B, V, R_c and I_c.

KR Aur has only a spectroscopic period determined from Shafter [4] – 3 h 54 min, but has not any known photometric one. We tried to register long-periodic oscillations with periods comparable to the orbital period of the system. There are data in the literature for quasi-periodic oscillations with periods ranging from a few hundred to 3–5 thousand seconds. The preliminary results from Lomb – Scargle analysis show very often presence of periods of 10–15 min. These kinds of modulations are registered from many authors for KR Aur [1, 6]. We carried out long lasting observations in January 2006 (about 8 h 30 min with some interruptions and others of 5 h) searching for long-term periods in the light curve of the star. In our data periods of 3 h 26 min and 3 h 58 min in two consecutive days are presented. The difference of approximately 30 min shows that these periods are quasi-periodic oscillations. The above mentioned values are too close to the spectroscopic period of KR Aur but they can't be explained with any action of the accretion disc. Perhaps long periods are related to the secondary, the stream or the transition of matter in the system.

4 Conclusions

We have found that KR Aur presents flickering more often than other similar systems in the low state and the amplitude is proportional to magnitude in all bands. Quasi-periodic oscillations were detected with periods close to the spectroscopic one. The detailed analysis will give us more information about this interesting system.

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