Bulgarian Academy of Sciences. Българска академия на науките

Astrophysical Investigations, 6. Астрофизически изследвания, 6
Sofia. 1991. София

Photometric characteristics of KR Aur as an anti dwarf-nova

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The possibility of detecting the changes in mass transfer rate in stars of the KR Aur type by patrol observations of the flickering is discussed. Electrophotometric observations of the flickering of KR Aur in maximum brightness are presented.

Key words: anti-dwarf novae, photometric observations, short-time variations.

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I. Introduction

The variable KR Aur, discovered in 1960, has shown a photometric behaviour which led Popova (1965) to propose that this is a variable of new type. KR Aur was the star for which for the first time in astronomical literature the term "anti-nova" has been used (Popova, 1975).

Almost 30 years have passed since the discovery of the variability of KR Aur, but it still attracts the interest of astronomers. It is possible to speak already for a group of cataclysmic variables similar to KR Aur. There are about 10 stars in this group. At the Fifth Annual Workshop on Cataclysmic Variables and Related Objects at the University of Texas, Bond (1980) has proposed the designation "anti dwarf-novae" for this newly recognised subclass of nova-like variables. Opposite to "novae" these variables spend most of the time in maximum light with rapid variations — this is their normal state, but occasionally fade by 5-6 magnitudes to low state of minimum light for some months or even years. This photometric behaviour has not yet a definitive explanation.

At normal state these objects have spectra close to that of dwarf-novae at maximum light. In a low state their spectra resemble those of dwarf novae in minimum (Shafter, 1983). The spectroscopic observations of KR Aur have shown that it is a close binary system, near pole-on oriented, with orbital period of 3,907 h and components white dwarf and red dwarf with masses of 0,7 and 0,48 solar masses respectivelly (Shafter, 1983).

II. Observations

Systematic observations of rapid and long-term light variations of KR Aur were initiated by the authors at the Rozen National Astronomical Observatory. In

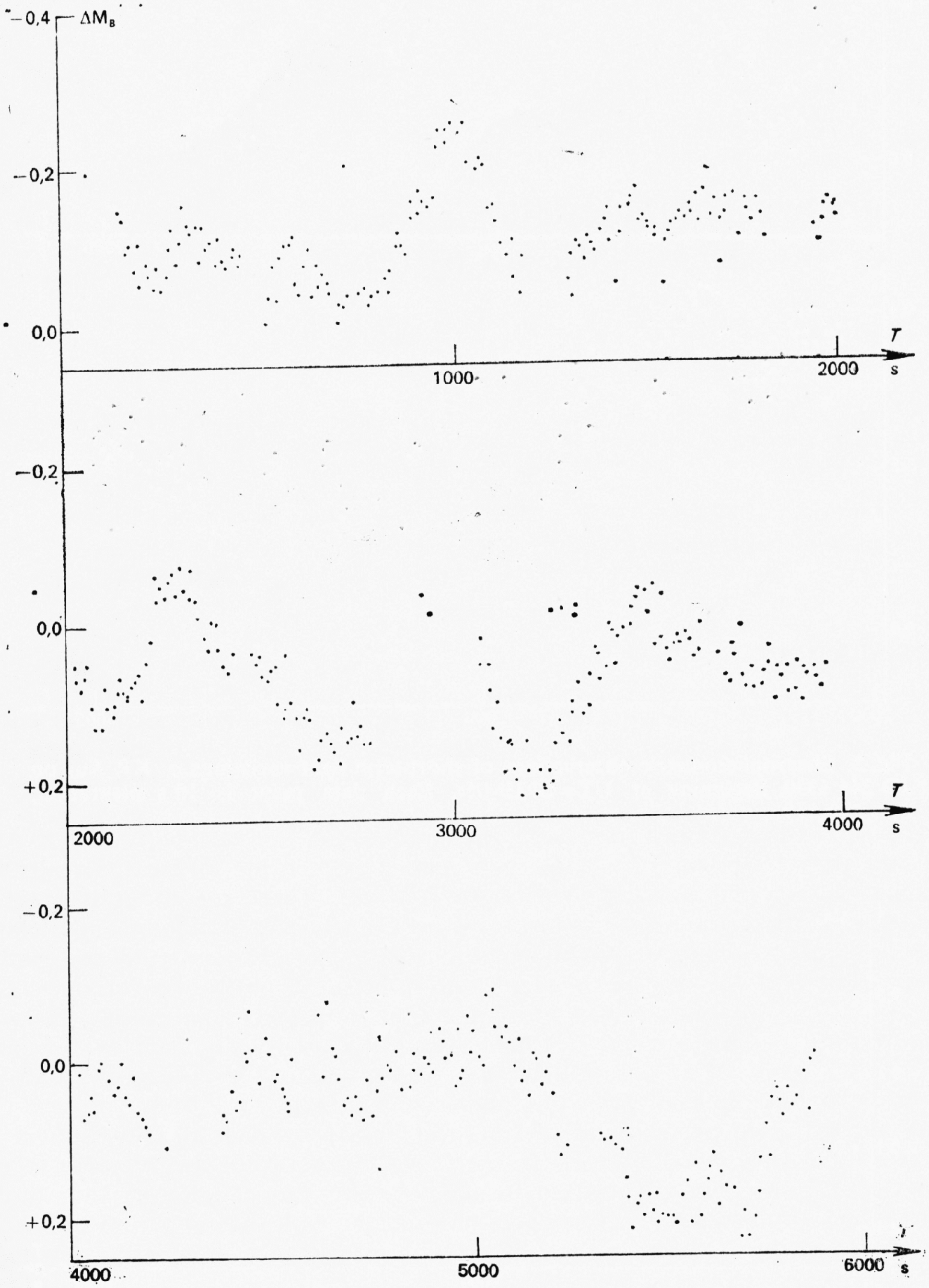

Fig. 1. Electrophotometric observations of short-time light variations of KR Aur on JD 244 6325. Beginning at UT=$0^h36^m50^s$. Each data point is 10 s integration, $\sigma = \pm 0^m,022$

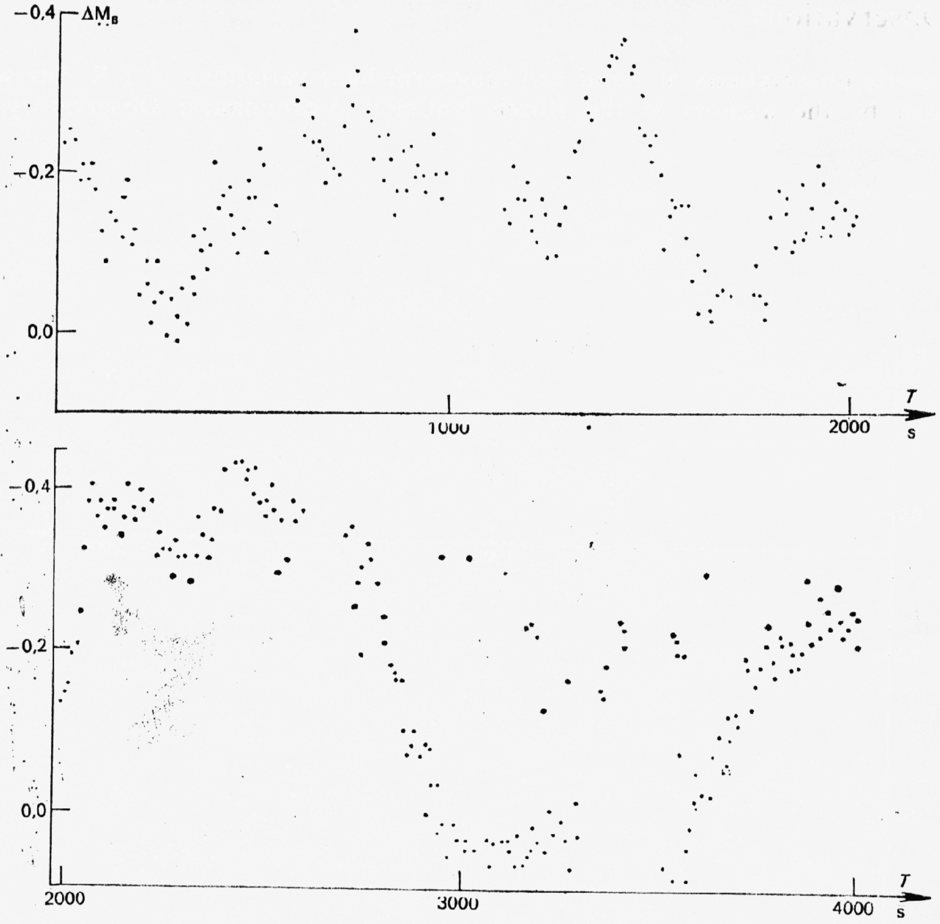

Fig. 2. Electrophotometric observations of short-term light variations of KR Aur on JD 244 6330. Beginning at UT=$0^h33^m05^s$. Each data point is 10 s integration, $\sigma=\pm 0^m,019$

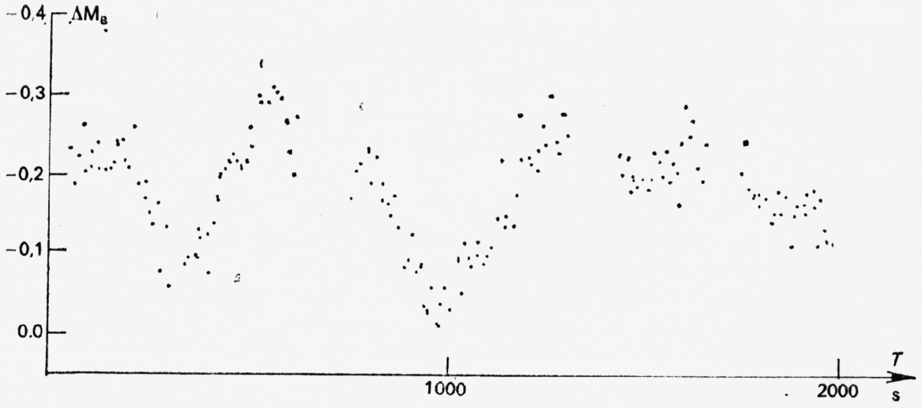

Fig. 3. Electrophotometric observations of short-term light variations of KR Aur on JD 244 6331. Beginning at UT=$0^h05^m44^s$. Each data point is 10 s integration, $\sigma=\pm 0^m,024$

this paper, the electrophotometric patrol observations in three nights 17, 22 and 23 September 1985, carried out to study the short-time variations in maximum light are presented. The photometric data were acquired using the electrophotometer with photon counting technique described by Panov et al. (1982) attached to 60 cm Cassegrain reflector. The observations were made in filters BG12+GG13 with an integration time of 10 s. The relative brightness in instrumental "b" magnitudes was obtained. As standard star the Popova's (1965) comparison star "c" was used. During each observing run of KR Aur the star "c" was measured every ten minutes and also just prior to the beginning and after the end of the observations. The standard deviations obtained on the ground of this data are $\pm 0^{m},022$, $\pm 0^{m},019$ and $\pm 0^{m},024$ for the nights of 17, 22 and 23 Sept. 1985, respectivelly.

Fig. 1 shows the light variations of KR Aur during time interval of $1^{h}33^{m}15^{s}$ — from UT $0^{h}36^{m}50^{s}$ till $2^{h}10^{m}05^{s}$ on 1985 Sept. 17 (JD 244 6325). The results from observing run on 1985 Sept. 22 (JD 244 6330) in the course of $1^{h}42^{m}06^{s}$ — from $0^{h}33^{m}05^{s}$ till $2^{h}15^{m}11^{s}$ are presented in Fig. 2. Fig. 3 shows the relative brightness of KR Aur during the time interval of $1^{h}36^{m}16^{s}$ — from $0^{h}05^{m}44^{s}$ till $1^{h}42^{m}00^{s}$ on 1985 Sept. 23 (JD 244 6331).

III. Discussion

The observed light curve has large-amplitude: 0,2-0,3, sometimes up to 0,5 magnitude rapid variations in a time scale of about some tens of seconds or some minutes. Taking into consideration the mean standard deviation 0,02 mag, obtained by observations of the check star, the reality of the existence of rapid variations of the brightness of KR Aur is beyond doubt. They are of the same order as the rapid variations (short-time variations, flickering) observed by Robinson et al. (1981) for MV Lyr at maximum light. In 1985 KR Aur was also in maximum. The observations in the three mentioned nights — 17, 22 and 23 September — one prior each patrol run and two after its end and photographic observations in these nights gave a mean value for $B \approx 13^{m},6$. The observed flickering in this time intervals indicate the existence of mass transfer in maximum light of KR Aur.

Robinson et al. (1981) found that in MV Lyr in minimum light the flickering disappears. There are no observations with good time resolution of KRAur in minimum light. It is worthwhile to note, however, that the evaluation of rate of mass transfer based on the value of α in the low $F_{\lambda} \sim \lambda^{-\alpha}$ of energy distribution in the continuum of the spectrum (Williams and Ferguson, 1982) shows a reduction by a factor of ten of the rate of mass transfer with the drop by about two magnitudes in luminocity. So, from the spectra obtained by Popova and Vitrichenko (1978) in maximum light of KR Aur ($\sim 13^{m}, 5$), $\alpha \approx 2$ and the mass transfer should be $10^{-9} M_{\odot}/yr$. From the spectrum taken at magnitude $15^{m}, 5$, $\alpha = 1,4$ and the rate of mass transfer is respectivelly $10^{-10} M_{\odot}/yr$ (Shafter, 1983).

These results are in agreement with the mechanism proposed by Robinson et al. (1981) to explain the "period gap" in binaries between 2 and 3 hours and the long-term light variations of systems with orbital period near "period gap". Analysing the observations of MV Lyr they concluded that fading of luminosity is caused by a total cessation of mass transfer from late-type star to the white dwarf of the system. They argue, that cataclysmic variables evolve through the period gap between 2 and 3 hours, but due to ceasing of mass transfer while in the gap they become almost undetectable. According to the theories of the evolution of cataclysmic variables (Rappoport et al., 1982), (Paczynski and Sienkiewich, 1981), most systems with orbital periods between 3 and 4 hours are inevitably driven into the gap due to the effects of gravitational radiation.

Since Robinson et al. (1981) consider the systems with periods close to the period gap unstable, it would be possible for them to fall into the state with diminishing or cessing mass transfer for certain months or years. The accretion disk will disappear and a drop of light will be observed. Really, the orbital periods of the variables showing low states are clustered around both edges of the gap: KR Aur — 3^h54^m. LX Ser —3^h48^m, VZ Scl — 3^h20^m, TT Ari — 3^h18^m, MV Lyr — 3^h12^m, AM Her —3^h06^m, AN UMa — 1^h55^m, VV Pup — 1^h30^m.

It has to be noted that Robinson's mechanism is not fully consistent with more than 20 binary systems with orbital periods near the period gap, but does not show long-term changes. It can not be excluded that through systematic observations such changes will be discovered.

An alternative explanation was suggested by Warner (1983). His idea is that close binary systems which show low states are in fact either polars or intermediate polars and that the low state phenomenon is a feature of these two groups. But it also has to be noted that, up to the present, for many polars and intermediate polars low states have been observed. It is known, however, that most of those objects were discovered not long ago and their photometric curves are not studied in detail.

Further systematic photometric, spectral and polarimetric observations of similar objects are of great importance.

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