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Photometry of some more neglected bright cataclysmic variables and candidates☆

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HIGHLIGHTS

- Variations on time scales of hundredths of days occur in KT Eri but are not strictly periodic.
- A 0.1952 d modulation in KT Eri may be orbital in nature (subject to confirmation).
- A previous claimed 15.4 m period in CTCV 2056-3014 is probably spurious; thus the star is not an IP.
- Flickering in V504 Cen and CTCV 2056-3014 is among the strongest observed in CVs.
- Ret 1 (=P831-57) does not flicker but shows variations suggesting a long orbital period.

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ABSTRACT

As part of an effort to better characterize bright cataclysmic variables (CVs) and related systems which have received little attention in the past light curves of four systems (V504 Cen, KT Eri, Ret 1 and CTCV 2056-3014) are analyzed. For some of these stars no time resolved photometry has been published previously. While flickering is observed in all systems except Ret 1, it is particularly strong in V504 Cen and CTCV 2056-3014. In the latter star, a previously observed 15.4 m period, leading to its tentative classification as an intermediate polar, is probably spurious. Variations on time scales of hundredths of days observed in the pre-outburst light curve of the classical nova KT Eri continue after the outburst but appear not to be strictly periodic. Furthermore, the long term post-outburst light curve exhibits modulations with quasi-periods of quite different length. Thus, these variations cannot be due to aspect related variations in a system with a giant component similar to some recurrent novae. Instead, the system possibly exhibits variations with a period of 0.1952 d which may be orbital. However, any such conclusion still requires confirmation. The absence of flickering in Ret 1 indicates that the system probably does not contain an accretion disk. Instead, the observation of slow variations supports a previous suspicion of low amplitude variability with a period >12 h.

1. Introduction

Cataclysmic variables (CVs) are binary stars where a Roche-lobe filling late-type component (the secondary) transfers matter via an accretion disk to a white dwarf primary. It may be surprising that even after decades of intense studies of CVs there are still an appreciable number of known or suspected systems, bright enough to be easily observed with comparatively small telescopes, which have not been studied sufficiently for basic parameters to be known with certainty. In some cases even their very class membership still requires confirmation.

Therefore, I started a small observing project aimed at a better understanding of these stars. Previous results have been published in a series of papers by Bruch (2016, 2017a, 2017b, 2017c), Bruch and Diaz (2017) and Bruch and Monard (2017). Here, I present time resolved photometry of some more of these neglected systems. In most cases no such observations have been published before. I also retrieved data from publicly accessible archives which for some of the systems permit to draw valuable conclusions.

The main targets of this study are KT Eri, an old nova with cyclic brightness variations on the time scale of hundredth of days during quiescence, V504 Cen, a novalike variable which was recently identified to occasionally exhibit low states and thus belongs to the VY Scl subclass, and CTCV 2056-3014 which was classified as a candidate intermediate polar. Additionally, I briefly discuss a limited amount of observations of the CV candidate Ret 1 (= P83l-57).

In Section 2 the observations and data reduction techniques are briefly presented. Sections 3 – 6 then deal with the individual ob-

☆ Based on observations taken at the Observatório do Pico dos Dias / LNA.

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Table 1
Journal of observations.

Name	Date	Start (UT)	End (UT)	*V*
V504 Cen	2014 Apr 01	5:17	6:59	13.8
	2014 Apr 29	0:03	7:17	14.1
	2014 Apr 29/30	23:15	6:33	14.3
KT Eri	2014 Oct 23	2:23	6:17	14.8
	2014 Oct 24	5:56	7:45	14.8
Ret 1	2016 Aug 09	4:56	8:50	14.2
	2016 Set 06	7:24	7:31	14.1
	2016 Set 07	4:55	5:26	14.1
	2016 Set 08	5:08	5:40	14.1
	2016 Set 09	5:26	8:27	14.1
CTCV 2056-3014	2015 Jun 09	7:52	8:47	17.2
	2015 Jun 10	5:30	8:55	17.4
	2015 Jun 11	6:04	8:54	17.6
	2016 Set 07/08	21:58	3:38	17.0
	2016 Set 08/09	21:37	2:29	17.1

jects of this study. Finally, a short summary in Section 7 concludes this paper.

2. Observations and data reductions

All observations were obtained at the 0.6-m Zeiss and the 0.6-m Boller & Chivens telescopes of the Observatório do Pico dos Dias (OPD), operated by the Laboratório Nacional de Astrofísica, Brazil. Time series imaging of the field around the target stars was performed using cameras of type Andor iKon-L936-B and iKon-L936-EX2 equipped with back illuminated, visually optimized CCDs. A summary of the observations is given in Table 1. Some light curves contain gaps caused by intermittent clouds or technical reasons. In order to resolve the expected rapid flickering variations typical for CVs the integration times were kept short. Together with the small readout times of the detectors this resulted in a time resolution of the order of 5 s. In order to maximize the count rates in these short time intervals no filters were used. Therefore, it was not possible to calibrate the stellar magnitudes. Instead, the brightness is expressed as the magnitude difference between the target and a nearby comparison star, the constancy of which was verified through the observation of several check stars. A rough estimate of the effective wavelength of the white light band pass, assuming a mean atmospheric extinction curve, a flat transmission curve for the telescope, and a detector efficiency curve as provided by the manufacturer, yields $\lambda_{\rm eff} \approx 5530$ Å, very close to the effective wavelength of the Johnson *V* band (Allen, 1973) 5500 Å;. Therefore, using *V* magnitudes of the comparison stars as provided by Zacharias et al. (2013), it is possible to calculate approximate mean nightly visual magnitudes of the target stars. The reliability of these is attested by the excellent agreement with archival long-term light curves as demonstrated in the case of KT Eri in Fig. 1 (Section 3.1) where the yellow dot, which represents the magnitude of KT Eri during the observing nights discussed here, falls right on the long term visual light curve retrieved form the archives of the American Association of Variable Star Observers (AAVSO), Association Française des Observateurs d'Etoiles Variables (AFOEV), and British Astronomical Association, Variable Star Section (BAAVSS). The average nightly magnitude of the observed stars is included in Table 1. A list of the comparison stars for each target, taken from the UCAC4 catalogue Zacharias et al. (2013), together with their *V* magnitudes is given in Table 2.

Basic data reduction (biasing, flat-fielding) was performed using IRAF. For the construction of light curves aperture photometry routines implemented in the MIRA software system Bruch (1993) were employed. The same system was used for all further data reductions and calculations. Throughout this paper time is expressed in UT. Timing analysis of the data employing Fourier techniques was done using the Lomb-Scargle algorithm (Lomb, 1976; Scargle, 1982; Horne and Baliunas, 1986). The terms "power spectrum" and "Lomb-Scargle periodogram" are used synonymously for the resulting graphs.

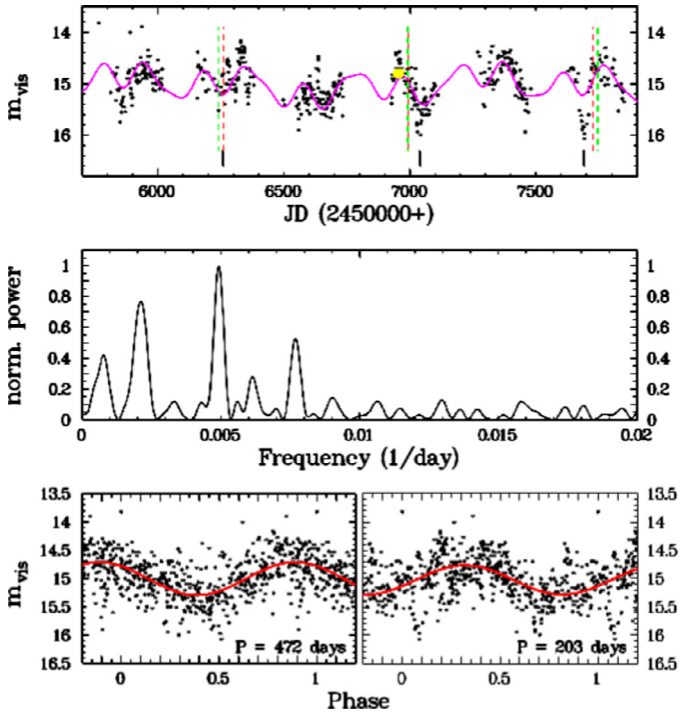

Fig. 1. *Upper frame:* Post-outburst lightcurve of KT Eri (combined data from AAVSO, AFOEV and BAAVSS archives). The black tickmarks indicate epochs of supposed periodic minima. The broken red and green vertical lines indicate the predicted minimum epochs based on a linear least squares fit to the minimum epochs observed by Munari and Dallaporte (2014) and the last two minima marked in the figure (for details, see text). The magenta curve is a four component least squares sine fit with periods fixed to the inverse of the frequencies of the four highest peaks in the Lomb-Scargle periodogram shown in the middle frame. The yellow dot marks the epoch and mean magnitude of the time resolved observations discussed in Section 3.2. *Middle frame:* Lomb-Scargle periodogram of the light curve in the upper frame. *Lower frames:* The light curve folded on the period 472 days (left) and 203 days (right), corresponding to the two highest peaks in the Lomb-Scargle periodogram. The phase zero point is arbitrary. The red curves represent least squares sine fits. (For the interpretation of the reference to colour in this figure legend, the reader is referred to the web version of this article.)

Table 2
Comparison stars.

Target star	Comparison star (UCAC4)	*V*
V504 Cen	249-063231	11.995
KT Eri	400-006830	12.869
Ret 1	131-003250	13.031
CTCV 2056-3014	299-343578	13.453

3. KT Eri

KT Eri is a well-known classical nova detected in 2009 by Itagaki (2009). While the outburst has been extensively documented by many observers, the quiescent state has received less attention. In particular, photometry with high time resolution has never been published. This is the motivation to include the star in the present study.