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DIFFERENTIAL PHOTOMETRY OF 2MASS J09440940-5617117[1]

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Cataclysmic variables (CVs) are binary stars consisting of a white dwarf accreting matter from a low mass companion via Roche-lobe overflow. 2MASS J09440940-5617117 was identified as a cataclysmic variable by Pretorius & Knigge (2008) using the SuperCOSMOS Hα survey (Parker et al. 2005). They performed time-resolved spectroscopy from which a probable orbital period of 0.1877(2) d was estimated. The spectrum shows emission lines of the Balmer series and Helium with strong HeIIλ 4686. They have also presented photometry, which does not cover the entire orbital period. Both photometry and spectroscopy indicate an eclipsing system. By the observational characteristics of this system, Pretorius & Knigge (2008) tentatively suggest a SW Sex classification.

We obtained optical photometry of 2MASS J09440940-5617117 in 2008 at Observatório do Pico dos Dias (OPD) operated by the Laboratório Nacional de Astrofísica in Brazil. The data were obtained with the 0.6-m Boller & Chivens telescope at OPD in three nights. The CCD arrays used are 1024 x 1024 pixels back-illuminated SITe devices. Table 1 presents a log of the observations. Figure 1 shows the observed field-of-view around 2MASS J09440940-5617117 .

We have used IRAF to correct for bias and flat-field and to perform differential photometry. To illustrate the photometric quality, we present in Figure 2 the light curve obtained on March 03, 2008 for 2MASS J09440940-5617117 and for a comparison star. In this light curve we see differences in the egress of eclipses. The reference star used is USNOB 8593-02515-1, for which the R_C magnitude was estimated in 11.55 ± 0.15, based on the USNO magnitudes of 593 stars in the same field-of-view.

The data set contains four eclipses, allowing us to determine an ephemeris for the eclipses in the system. We have included the data from Pretorius & Knigge (2008) to improve the orbital period estimate. Three different methods were used to estimate the period: Phase Dispersion Minimization, String-Length and Discrete Fourier Transform. The best ephemeris for the times of mid-eclipse is:

$$T_{mid-eclipse}(HJD) = 2\,454\,516.703\,9\ (3) + 0.187\,934\,0\ (5)\ E\ . \qquad (1)$$

The uncertainty in the period was obtained from the spread of the values given by the three different methods. It is a conservative value since this error is twice as large as the

[1]BASED ON OBSERVATIONS MADE AT THE OBSERVATÓRIO DO PICO DOS DIAS, BRAZIL, OPERATED BY THE LABORATÓRIO NACIONAL DE ASTROFíSICA.

one estimated using the expression of Gilliland & Fisher (1985) considering the noise. Our period estimate is consistent with the previous suggestion of Pretorius & Knigge (2008). Figure 3 shows the photometric data plotted in phase with our ephemeris.

The eclipse width ($\Delta\phi$) of 2MASS J09440940-5617117 is 0.112 ± 0.003 orbital cycles. It was calculated considering the phases of minimum and maximum derivative of the mean light curve, indicated by the dotted lines in Figure 4.

In a CV with a geometrically thin disk, the eclipse width and the mass ratio (q=M_2/M_1) can be used to estimate the inclination (i) of the system, as shown by Horne (1985). From the orbital period, we have obtained an estimate of the mass of the secondary star (see Table 2) using the table presented by Knigge (2006). Considering a wide range of white dwarf masses, 0.35-0.77 $M_\odot$, we have constructed a diagram of orbital inclination versus mass ratio, which is shown in Figure 5. For the estimated eclipse width, the lower limit to the mass ratio of the system is 0.66, while the upper limit can be found considering the limit of stable mass transfer (q < 5/6) and corresponds to 0.83. Considering these limits, the orbital inclination range is 84-90°. We remark that these results rely on the assumption that the disk is geometrically thin and that its center of light coincides with the white dwarf. This assumption fails if the accretion disk of 2MASS J09440940-5617117 is geometrically thick and suffers self-occultation – as it seems to occur in some SW Sex stars (Knigge et al. 2000).

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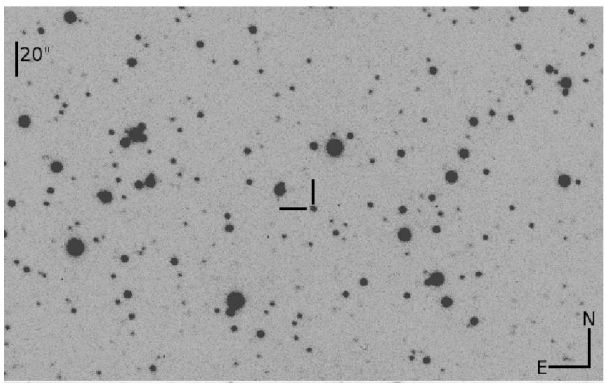

Figure 1. Finding chart for 2MASS J09440940-5617117 in the R_c band.

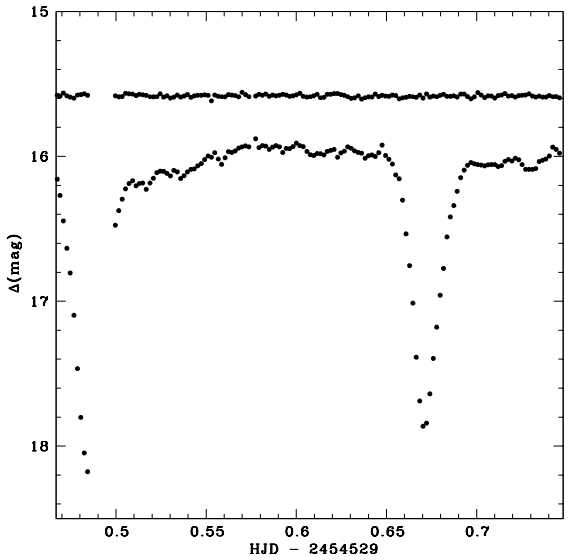

Figure 2. Optical light curve in the R_c band of 2MASS J09440940-5617117 on March 03, 2008. The light curve of a comparison star is also presented.

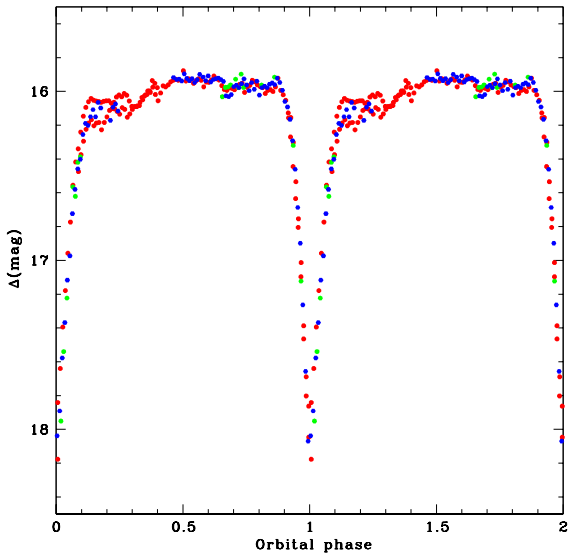

Figure 3. Phase diagram of 2MASS J09440940-5617117 in the R_c band on March 03, 2008 (red), on February 19, 2008 (blue) and on February 18, 2008 (green).

Table 1: Log of observations

Date	Telescope	Filter	Exposure time (s)	Number of images
2008 Feb 18	OPD/0.6m	R_C	120	19
2008 Feb 19	OPD/0.6m	R_C	120	74
2008 Mar 03	OPD/0.6m	R_C	120	140

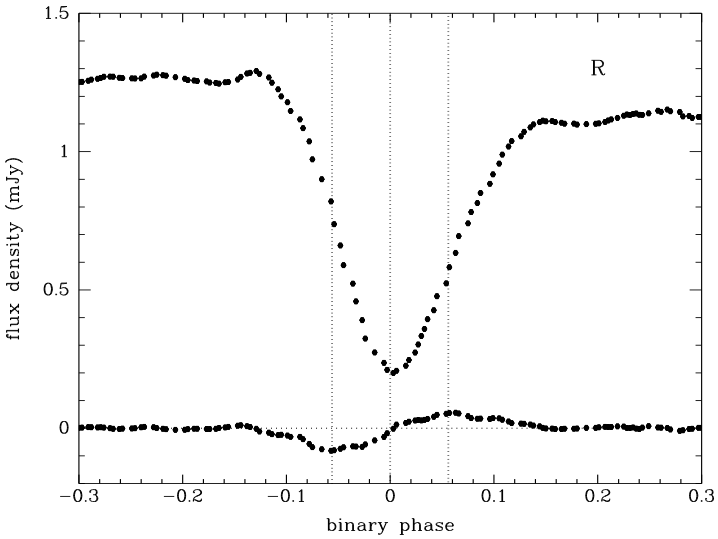

Figure 4. Mean eclipse profile and its derivative. The dotted lines indicate the center of the eclipse and the phases of minimum and maximum of the derivative.

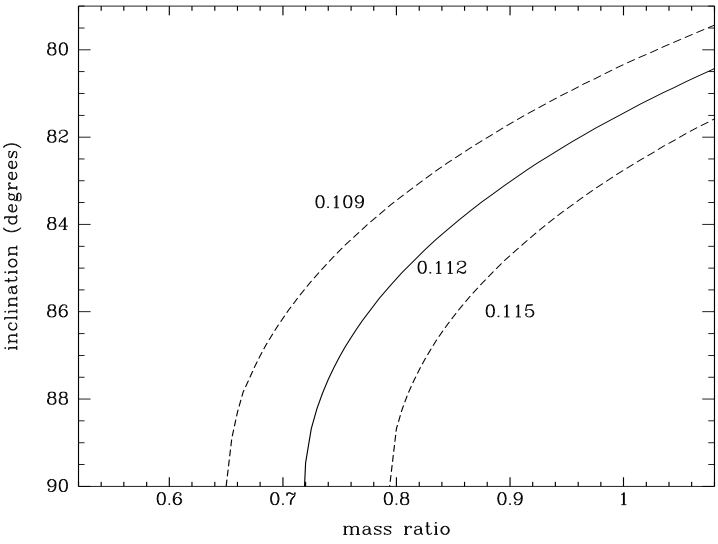

Figure 5. Orbital inclination versus mass ratio for an eclipse width of 0.112 ± 0.003 orbital cycles.

Table 2: Parameters of 2MASS J09440940-5617117

Parameter		Comments
P_{orb}	0.1879340(5) d	this work
$\Delta\phi$	0.112 ± 0.003	this work
q	0.66-0.83	this work
i	84-90°	this work
M_2	0.4 $M_\odot$	donor sequence - Knigge (2006)