IMPROVED PHOTOMETRIC CHARACTERISTICS OF THE NEWLY DISCOVERED EW-TYPE SYSTEM GSC 04370-00206

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ABSTRACT. We present results of two-color photometric study of the newly discovered EW–type eclipsing binary star GSC 04370-00206 in the field of the intermediate polar MU Cam. CCD V,R observations were obtained in the Astronomical Observatories in Hlohovec, Baja and Kolonica in 2007-2009. Improved photometric elements for the primary minimum were determined: Min.BJD=2454805.75635+0.44264511(27)E. The range of the brightness variations is 13.79-14.13 (V) and 13.07-13.44 (R). The accuracy of the period determination is by a factor of $\sim 7,000$ times better than the one published by the discoverers based on only one night of observations. We report on the night-to-night variability of the shape of the light curve which is interpreted by a presence of spots in the atmosphere of one or both components (O'Connel effect).

Key words: stars: variables, eclipsing binaries

During monitoring of the intermediate polar MU Cam = 1RXS J062518.2+733433 in frame of the international campaign "Inter-Longitude Astronomy" (see Andronov et al. (2010) for recent highlights on variable stars of different types), Kim et al. (2005) discovered a new EW-type star GSC 04270-00206 and estimated the orbital period of $P_{orb} = 0.^{\rm d}4421 \pm 0.^{\rm m}0018$ and an initial epoch of 2454805.75635.

The observations were obtained in 2007-2009 using 60cm Zeiss Cassegrain in Hlohovec, Slovakia; the 50cm reflector in Baja, Hungary and the 1m VNT ("Vihorlat National Telescope") in Kolonica, Slovakia. The V (14 nights, 66 hours, $n = 1011$) and R (16 nights, 72 hours, $n = 1163$) filters were used for observations. The photometric data were reduced the using C-Munipack software package (Motl, 2007). The calibration of the comparison stars was discussed by Kim et al. (2005) based on Henden (2004). The time series analysis was carried out using the MCV program (Andronov and Baklanov, 2004). The periodograms for observations in both filters were computed using the sine fit, then the period was doubled and re-analyzed using the best fit trigonometric polynomial (TP) fit of statistically optimal order s (see Andronov (1994, 2003) for a description). The range of the brightness variations is $13.^{\rm m}792$-$14.^{\rm m}169$ (V) and $13.^{\rm m}067$-$13.^{\rm m}444$ (R) based on this fit. For both filters, we obtained $s = 4$. Finally, the initial epoch for the primary minimum is Min.BJD=2454805.75635 by Kim et al. (2005) and the a weighted mean for the period of $P = 0.^{\rm d}44264511(27)$.

The accuracy of our period determination is by a factor of $\sim 7,000$ times better than the one published by the discoverers based on only one night of observations.

Our improved light elements were confirmed by Chinarova et al. (2010) based on two nights of observations.

From original light curves, we have determined timings of the primary and secondary minima. They are listed in Table 1, as well as the corresponding brightness. For the determination of the characteristics of extrema, we have used the "asymptotic parabola" (AP) method by Marsakova and Andronov (1996). As the majority of minima were covered in two colors (VR), we also computed the color index and the weighted mean minimum timings (also listed in Table 1). Unexpectedly, it was found to be the same for either primary ($V-R = 0.^{\rm m}758(6)$), or secondary ($V-R = 0.^{\rm m}755(6)$) minima. The mean values (integrated over a period) are $V = 13.^{\rm m}948(1)$ and $R = 13.^{\rm m}213(2)$), respectively. This corresponds to the mean color index $V - R = 0.^{\rm m}735(2)$, only slightly "hotter" than at minima.

Phase curves are shown in Fig. 1. There are systematic changes from night to night. So we may suggest that there is a variability of brightness of star which can be interpreted as the O'Connel's effect, i.e. the presence of the migrating spots in the atmosphere.

Table 1: Characteristics of minima.

HJD 24.....	mag	Min	
54308.44674±0.00097	14.199± 0.019	2	*V*
54309.55169±0.00063	14.207± 0.022	1	
54312.43015±0.00068	14.167± 0.012	2	
54314.41964±0.00044	14.240± 0.007	1	
54315.53010±0.00086	14.160± 0.014	2	
55069.57531±0.00192	14.115± 0.053	1	
55094.58453±0.00049	14.225± 0.006	2	
55220.51604±0.00039	14.200± 0.006	1	
55304.39825±0.00053	14.148± 0.007	2	
54308.44544±0.00068	13.441± 0.008	2	*R*
54309.55017±0.00137	13.457± 0.029	1	
54312.43004±0.00114	13.303± 0.010	2	
54314.42057±0.00085	13.504± 0.009	1	
54315.53097±0.00140	13.457± 0.023	2	
55094.58345±0.00036	13.491± 0.006	2	
55220.51562±0.00034	13.434± 0.004	1	
55304.39859±0.00077	13.397± 0.010	2	
54308.44587±0.00056	0.757± 0.021	2	$V-R$
54309.55142±0.00057	0.750± 0.037	1	
54312.43012±0.00058	0.865± 0.016	2	
54314.41984±0.00039	0.736± 0.011	1	
54315.53034±0.00073	0.703± 0.027	2	
55094.58383±0.00029	0.734± 0.008	2	
55220.51580±0.00026	0.767± 0.007	1	
55304.39836±0.00044	0.751± 0.012	2	

Systematic changes of brightness from one minimum to another at the trigonomeric polynomial are significant only in the R filter and are negligible in V.

The $(V-R)$ color variations are rather strange. The largest value of V-R corresponding to smallest temperature occurs unexpectedly at the phase 0.5 of the secondary minimum, whereas the largest color temperature is observed at phase 0.9, i.e 0.1 prior to the main minimum, practically at the middle of the descending branch. This differs from expectations for deformed stars, for which a double-hump wave is observed with a temperature maximum at phases of 0.25 and 0.75.

To check results of fitting of complete light curves using the TP fit, we also computed mean characteristics using the AP fit: $R_1 - R_2 = 13.^{\rm m}448 - 13.^{\rm m}439 = 0.^{\rm m}0090(15)$, and, in the V filter: $V_1 - V_2 = 14.^{\rm m}215 - 14.^{\rm m}190 = 0.^{\rm m}0252(15)$. This differs from results from the TP fit. One of possible explanations may be due to significant variability of the shapes of the individual light curves discussed above: the AP fit characterizes only parts of minima covered by observations (either descending, or ascending branch of the light curve), whereas the TP fit uses all the nights and phases. Thus systematic night-to-night variations may strongly affect mean values of estimated parameters.

This interesting object is recommended for further observations.

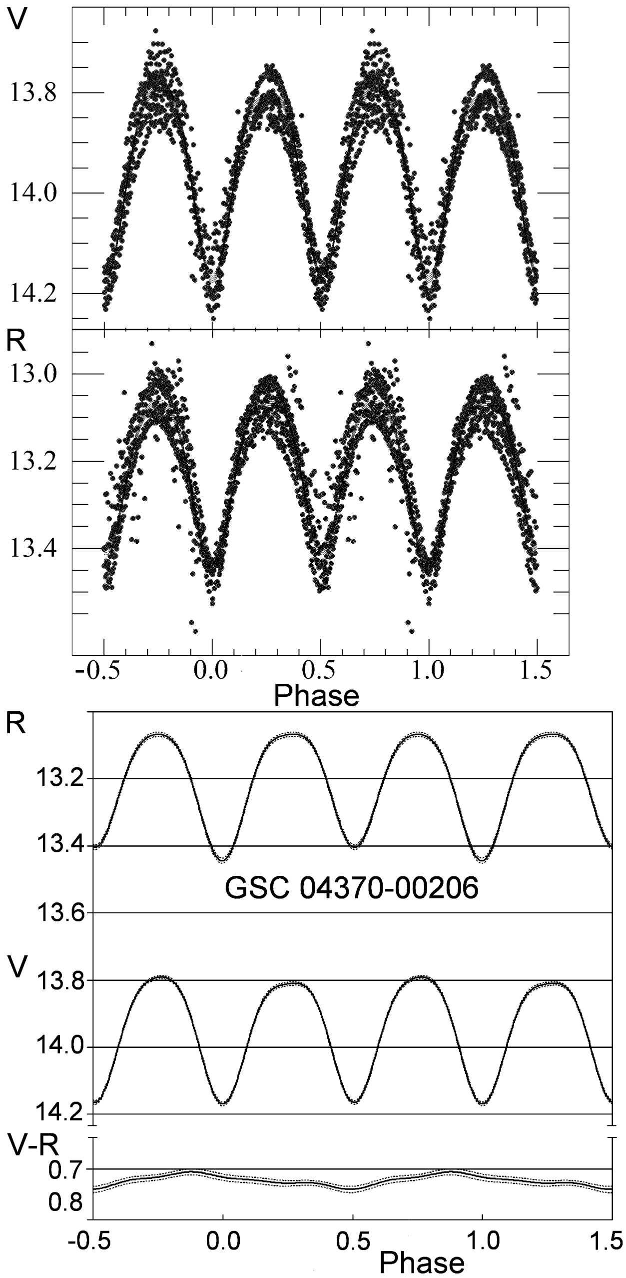

Figure 1: Phase light curves of GSC 04370-00206 (up) and 4-th order trigonometric polynomial fits (bottom).

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