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First photometric study of the W UMa system GSC 1042-2191

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HIGHLIGHTS

- The first analysis of the light curve of the W UMa system GSC 1042–2191 were made.
- The orbital and physical parameters of the system were obtained.
- The system was found a low mass ratio, A-type over-contact binary with a fill out parameter of f 65.01%.

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ABSTRACT

We present new photometric observations covering eight minima times for the eclipsing binary GSC 1042-2191. The light curves in *BVRI* colors were analyzed by using WD-code for the system parameters. Eight minima times were obtained from the new observations. The system is found a low mass ratio ($q = 0.148$), A-type over-contact binary with a fill out parameter of $f = 65.01 \pm 12.18\%$. The preliminary absolute dimensions ($M_1 = 1.26 \pm 0.06$ M$_\odot$, $M_2 = 0.18 \pm 0.06$ M$_\odot$, $R_1 = 1.54 \pm 0.20$ R$_\odot$, $R_2 = 0.69 \pm 0.01$ R$_\odot$, $L_1 = 3.30 \pm 0.30$ L$_\odot$ and $L_2 = 0.59 \pm 0.20$ L$_\odot$) indicate the very much oversized and over-luminous secondary component, by assuming the present luminosity of the secondary is its main sequence luminosity, we predict the original mass is about 0.8 M$_\odot$, this means the present secondary could be transferred and/or lost 77% of its original mass and only its core is left.

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1. Introduction

GSC 1042-2191, TYC 1042-2191-1, 2MASS J19234908+0818254, HD 182314, SAO 124582, R.A. = $19^h23^m49^s.0854$, DEC = $+08^\circ18'25''.516$) belongs to the list of "New Eclipsing Binaries Found in the NSVS Database I" published by Otero et al. (2004). The photometric observations of the system show an eclipsing W UMa-type binary light curve. The orbital period of the system $P = 0^d.423796$ was obtained by Otero et al. (2004). The *V* magnitude of the binary in the Tycho Catalogue is about $9^m.31$ (Hog et al., 2000). There is no complete photometric and spectroscopic study of the system in the literature. In this paper, we present the results of the first photometric solution obtained from the first multi-band CCD light curves of GSC 1042-2191.

2. Photometric CCD observations

We observed GSC 1042-2191 three nights, on July 2, 6 and 10 in 2014. and three nights on July 11–13 in 2015 with the 40-cm Schmidt–Cassegrain telescope equipped with the Apogee Alta U47 CCD camera at Ulupinar Observatory (UPO) of Çanakkale Onsekiz Mart University (Turkey). This camera gives image scales of 0.65 arcseconds per pixel and provides an observed field of view (FOV) of 12 arcmin × 12 arcmin. Several bias, dark and flat frames were taken during the night of each observation to take into account pixel-to-pixel variations on the frame. Relevant data for eclipsing system and the adopted comparison stars are summarized in Table 1. The observational log of the system is listed in Table 2.

The reduction of the CCD frames has been made by C-MUNIPACK software (http://integral.sci.muni.cz/cmunipack). All frames have been calibrated by dark frame and flat-field corrections. Differential aperture photometry has been also performed in C-MUNIPACK. The new observations contributed eight times of minimum light in four filters. The minimum times determined by using the Kwee and van Woerden (1956) method are listed in Table 3. A linear least squares method appication to the minima times yielded the light elements of

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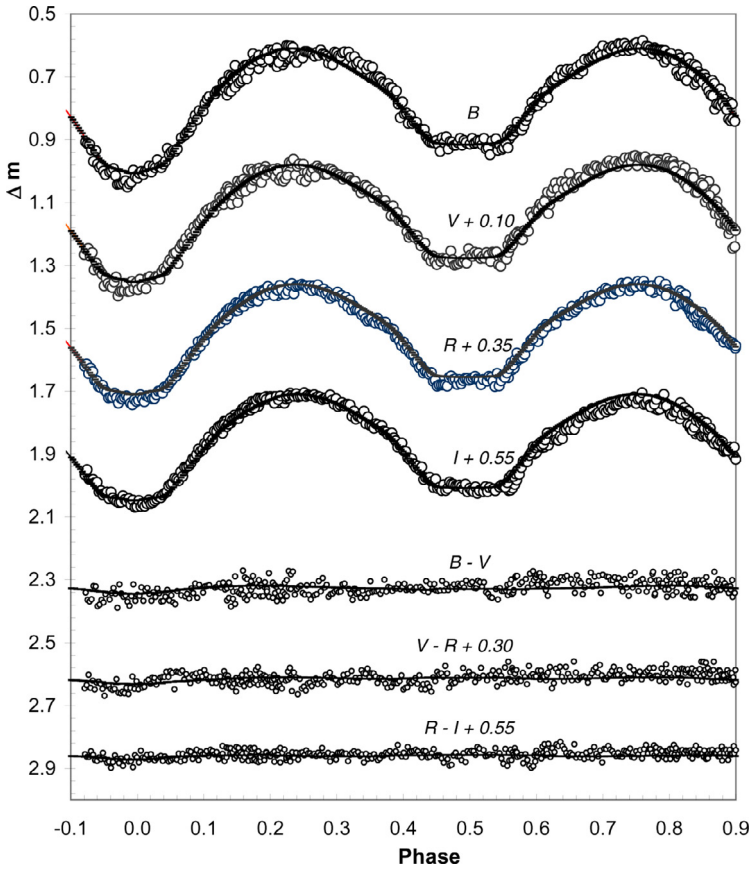

Fig. 1. The observational and theoretical light and color curves of GSC 1042-2191.

Table 1
The coordinates and *V* magnitudes of GSC 1042-2191 and two comparison stars.

Star	R.A. (2000)	DEC. (2000)	*V* (mag)
GSC 1042-2191	$19^h23^m49^s.0854$	$+08^\circ18'25''.516$	9.310 ± 0.020
C1= TYC 1042 2112	$19^h23^m56^s.0867$	$+08^\circ20'10''.698$	11.167 ± 0.116
C2= TYC 1042 2113	$19^h23^m34^s.8523$	$+08^\circ20'06''.646$	11.312 ± 0.122

the system as

$$HJD\ (Min\ I) = 2456841.3245(58) + 0^d.4238006(5) \times E. \quad (1)$$

which was used in phase calculation in forming the light and color curves. The *B*, *V*, *R* and *I* light curves and the *B*–*V*, *V*–*R* and *R*–*I* color curves are plotted in Fig. 1. The light curves in Fig. 1 show that the secondary eclipse is total; i.e, the eclipsing component in the secondary eclipse is larger and hotter component. It is clear in this case before analysis that the system is an A-type W UMa system. The variation of the color curves in Fig. 1. especially in *B*–*V* up to 0.1 magnitude indicate the temperature variation on the surfaces of the larger component. Since no spot effect is observable on the light curves such variations can be atributed to mass motions on or arround the larger primary component.

Table 3
New times of minima and residuals for GSC 1042-2191.

Hel.JD 2400000 (days)	Error (days)	Min.	Filter
56841.3276	±0.0004	I	*BVRI*
56841.5356	±0.0005	II	*BVRI*
56845.3502	±0.0006	II	*BVRI*
56845.5608	±0.0004	I	*BVRI*
56849.3763	±0.0006	II	*BVRI*
57215.5391	±0.0011	I	*BVRI*
57216.3875	±0.0005	I	*BVRI*
57217.4492	±0.0007	II	*BVRI*

3. Analysis of the light curves

The analysis of four light curves of GSC 1042-2191 were made by using the PHOEBE program (ver. 0.31, Prsa and Zwitter, 2005), based on the Wilson–Devinney (W–D) program (Wilson and Devinney, 1971). The program computes the light curves as a function of following main parameters: surface potentials ($\Omega_{1,2}$), mass ratio (q), luminosities of the components ($L_{1,2}$), orbital eccentricity (e), inclination (i), argument of periastron (ω), limb-darkening coefficients

Table 2
Observational log for photometric observations.

Star	Hel.JD 2450000	Filter	*N*	Sigma (*B*)	Sigma (*V*)	Sigma (*R*)	Sigma (*I*)
GSC 1042-2191	7215-7217	*BVRI*	410	0.012	0.012	0.011	0.010

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