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New CCD photometry of the eclipsing binary system V1067 Her

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HIGHLIGHTS

- New CCD photometric analyses of the W UMa type binary V1067 Her were performed.
- The spectral type of the two components was found to be K2 and K4.
- The system was found to be as A-subtype with fill-out factor of about 16%.
- The evolution status was performed according to ZAMS and TAMS tracks.
- The (O-C) residual diagram method and period variation was illustrated.

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ABSTRACT

We present a new set of CCD photometric observations for the short period eclipsing binary 1SWASP J1743 (= V1067 Her). We have determined the available times of light minima and two new linear and quadratic ephemerides have been obtained. The photometric solutions for the system have been performed using Wilson and Devinney Code. The 3D and fill out configuration revealed that V1067 Her is an over contact W UMa binary with relatively low fill-out factor of about 16%.

We investigated the period variation for the system. It showed a strong evidence of period changes by using the (*O-C*) residual diagram method and we have concluded long-term orbital period decrease rate $dP/dt= -3.0 \times 10^{-7}$ d/yr, corresponding to a time scale 8.6×10^{5} yr. Such period decrease in the A-type W UMa systems is usually interpreted to be due to mass transfer from the more to the less massive component.

1. Introduction

Studying variable stars and particularly eclipsing binaries is a key role to understanding the physical parameter and evolution status of many other stars, it was estimated that over 80% of all stars may be members of binary systems (Smith, 1995). The system V1067 Her (1SWASP 174,310.98 + 432,709.6, 2MASS J17431097 + 4,327,094, GSC 03100–01616, α 2000 = 17 h 43 m 10.97 s; $\delta 2000 = +43^\circ\ 27'\ 09.4''$) was identified for the first time by ROTSE1 as ROTSE1 174,311.02 + 432,709.0. Blättler and Deithelm, 2000 determined its period of $0.^{d}258109$. Recently the system was investigated by the SuperWASP photometric survey and listed as short period eclipsing binary candidate with period = $0.^{d}22853$ and a visual magnitude Vmag .= 13.3 (Norton et al., 2011).

More recently Loher et al. 2012 represented a more detailed investigation for the period changes in three stars of SuperWASP at the near short period limit, V1067 Her was one of them. In their study they indicated that the period of V1067 Her decreases with rate of –0.0546 sec/year. They also derived a new period for the system equal to 22,300.517 sec = $0.^{d}2581$ and considered it as the optimum period for the whole observations. This paper is distributed as the following, in Section 2, the observations and data reduction have been presented, while in Section 3 we presented the calculated times of minima and discussed the period variations. Section 4 has dealing with the light curve analysis and modeling. Finally the evolution status for the system, the results and conclusion has been summarized in Sections 5 and 6, respectively.

2. Observations and data reduction

In the present work we obtained new CCD photometric observations for the eclipsing binary system V1067 Her in V, R, and I band filters through two nights, 20th June and 19th Aug 2014.

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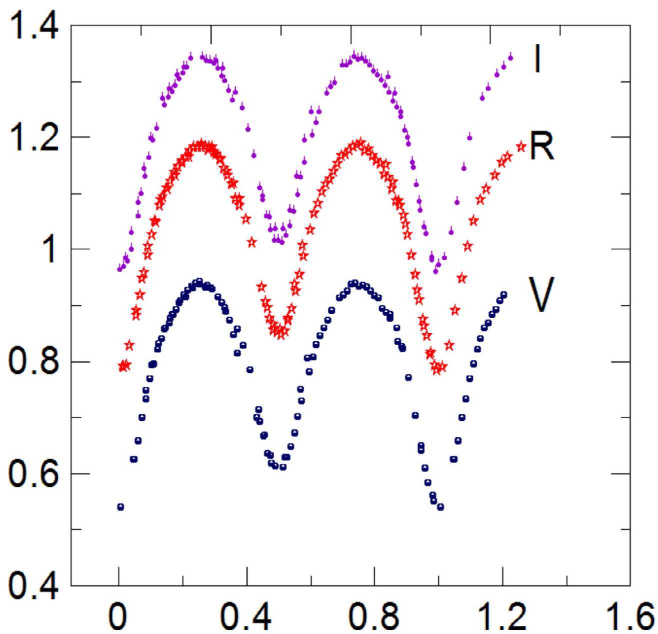

Fig. 1. The phase diagram observed of V1067 Her in the V, R and I filters.

The observations were carried out using EEV CCD 42–40 CCD camera with format 2048 × 2048 pixels, cooled by liquid nitrogen to −120°C and mounted in the Newtonian focus of the 1.88 m reflector telescope oftheKottamia Astronomical Observatory (KAO). We here represent the first observations for the system V1067 Herin the R and I filters. Differential photometry was performed with respect to GSC0310-01067 and GSC 0100–0,1797, as a comparison (C) and check (CK) stars, respectively.

All times were corrected to Heliocentric Julian Date (HJD). Table 1 of the Appendix list the differences in magnitude between the variable and the comparison stars together with the corresponding HJD in the V, R and I filters, respectively. Fig. 1. represents the phase diagram of V1067 Her in V, R and I filters.

3. Time of minima and period variations

The variability of V1067 Her has been discovered by Akerlof et al. 2000 through the ROTSE1 CCD survey. (Blättler 2000) has followed up the system observationally with an unfiltered CCD camera and obtained eight times of minima. Blättler and Diethelm 2000 have observed a complete light curve. They also deduced the following light elements, by applying a linear fit of two normal minima of the ROTSE1 data together with Blättler's eight minima time, as:

$$\mathrm{HJD(Min\ I)} = 2451746^{d}.4139(6) + 0^{d}.2581094(25) \times E \quad (1)$$

Norton et al. 2011 have presented light curves and periods of 53 short period eclipsing binary stars (with periods less than or equal approximately 0.23 d) identified by SuperWASP. They have determined the periods of these stars by a written period searching code which depends on two special techniques (cf., Lehto 1997 and Norton et al., 2011). They determined a shorter period for V1067 Her as 0.22583 day. Later on, Lohr, et al. 2012 have determined the period by the three-step custom-written IDL procedure described in their paper to find half the period and then studied the period variation for the system via the *O–C* method. They deduced the following approximate eclipse time for V1067 Her as: $2454997^{d}.688926 + 0^{d}.258108\ E - 4.5 \times 10^{-10}\ E^2$ in which the period is longer than that obtained by Norton et al. 2011. They also suggested a period decrease of about −0.0546 s/yr = -6.32×10^{-7} day/year, and referred such decrease to be due to mass transfer from the primary to the secondary component, possibly accompanied by unstable mass and angular momentum loss from the system.

Due to more new observed time of minima are now determined, we aimed to discuss the period variability of V1067 Her and to give a new ephemeris by using the well-known *O–C* method. Hence, we have collected all the available time of minima from the literature together with our two new minima time. They are all 36 minima (17 primary and 19 secondary) listed in Table 2. The table is self-explanatory where the *O–C* residuals were calculated by using Eq. (1).We have constructed the *O-C* diagram as seen in Fig. 2. Due to all minima used in the present analysis are photometrically observed; then we needn't a weighted fitting method.

To predict timing of new minima, the last 10 minima times have been linearly fitted and used to obtain the new light elements:

$$\mathrm{HJD(Min.I)} = 2451746^{d}.44746 + 0^{d}.258106748E \quad (2)$$

with SD = 0.002 day, r = 0.963, and residual sum of squares = 3.977×10^{-5}. We have also applied the quadratic least squares fit to all the data points (except the minima time 2,453,992.363, marked as a triangle, for its high deviation from the general trend of the diagram, as shown in Fig. 3), and obtained

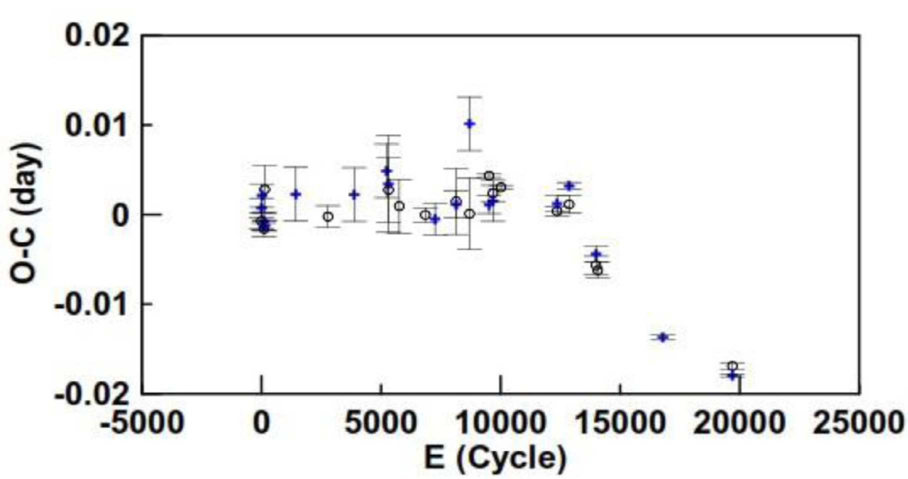

Fig. 2. The *(O–C)* residual diagram of V1067 Her. The open circles for primary, the crosses for secondary minima. Error bars due to minima times determination.