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First photometric analyses of five contact ASAS binaries

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HIGHLIGHTS

- We present the analyses of ASAS light curves of five contact binaries.
- The light and the absolute parameters are derived.
- Evolutionary statuses of the systems are discussed.

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(ASAS 025115−2525.4
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ASAS 125340−5010.6)

ABSTRACT

We present the first light curve solutions of five binary systems selected from All Sky Automated Survey (ASAS) Catalog of Variable Stars. The light curves of the systems are analyzed and the light parameters are derived. The estimated absolute parameters of the components and the degree of contact values for all targets are also calculated. We compared our results to other known contact binaries by emphasizing the locations of the components on the mass–radius and the H–R diagram. The evolutionary statuses of the systems are also discussed. Results of our analyses confirm that the systems are contact binaries.

1. Introduction

The ASAS (Pojmanski, 1997) project aims the categorization of the stars which show light variations in time. The project includes four devices that were divided equally into two sections; two telescopes are placed in LCO, Chile in 2000 whilst the other two were positioned on Haleakala, Hawaii in 2006. All these ranged over wide field devices which were outfitted with the filters *V* and *I*. More than 400,000 frameworks have been collected since the start of the project. Approximately three quarters of the sky have been observed and more than 50,000 variables have been discovered among 15,000,000 stars. Nearly 80% of them were recently discovered ones. The ASAS-3 Variable Stars Catalog consists more than 10,000 eclipsing binaries including contact, semi-detached and detached types.

W UMa-type systems must be taken into consideration to be low temperature contact binaries with components of F,G,K spectral type. Hilditch et al. (1988, 1989) and many other researchers indicate that W UMa-type stars of A-type are more evolved than W-type according to their mass–radius and color–luminosity diagrams. The common convective envelope which reaches both inner and outer critical Roche surfaces surrounds W UMa-type binaries that are originated from two stars in contact (Mochnacki, 1981). The massive component of a typical W UMa-type system is a main sequence star that is fairly close to zero age main sequence; however, the radius of the component with lower mass is larger than a star with the same mass in zero age main sequence. We chose our targets which are categorized as eclipsing contact systems in ASAS database. There is no detailed information and investigation on selected targets in the literature. Table 1 lists some properties of the systems given in the ASAS database.

In the next section, we elaborate on the first light curve solutions of the selected targets. We give the concluding remarks and discuss the evolutionary statuses in the last section.

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Table 1
Properties of the systems taken from the ASAS Catalog database. *V* and *B–V* values are given in magnitudes. *B–V* values are calculated by using the magnitudes given by SIMBAD Astronomical Database.

ASAS No.	RA	DEC	Period (days)	*V*	*B–V*
025115−2525.4	$02^h51^m15^s$	−25°25′24″	0.55927	10.14	0.28
035020−8017.4	$03^h50^m20^s$	−80°17′24″	0.62241	11.94	0.63
035803+0620.5	$03^h58^m03^s$	06°20′30″	0.82511	11.75	0.56
040633−4729.4	$04^h06^m33^s$	−47°29′24″	0.40637	11.38	0.46
125340−5010.6	$12^h53^m40^s$	−50°10′36″	0.404664	9.42	0.50

Table 2
Results of the light curve analysis. Formal error estimates are given in parenthesis.

Parameter	025115−2525.4	035020−8017.4	035803+0620.5
q	0.107(2)	0.232(5)	0.120(2)
i (°)	74.4(2)	78.6(4)	71.4(8)
T_1 (K)	7400	5790	6044
T_2 (K)	6570(40)	5675(42)	5594(69)
$\Omega_1 = \Omega_2$	1.974(6)	2.26(2)	1.944(2)
$\overline{r_1}$	0.575(3)	0.526(8)	0.597(2)
$\overline{r_2}$	0.209(16)	0.278(17)	0.264(45)
$\frac{L_1}{L_1+L_2}$	0.920(4)	0.79(1)	0.89(1)
f (%)	9	34	96
T_0 (HJD-2450000)	2453.8722(96)	3071.5450(158)	2933.7760(291)
P (d)	0.559267(2)	0.622401(3)	0.825134(8)

2. Light curve analyses

The light curves of the systems were collected from the web page of ASAS Catalog of Variable Stars[1]. They were analyzed by using the PHOEBE software (Prša and Zwitter, 2005) which uses the Wilson–Devinney code (Wilson and Devinney, 1971). The appropriate mode of the program for contact binaries was chosen for the solution. During the solution; mass ratio q, inclination i, temperature of secondary component T_2, surface potential $\Omega_1 = \Omega_2$, luminosity of the primary component L_1, time of minimum light T_0 and the orbital period P were set as free parameters. Albedo values A_1 and A_2 were adopted from Ruciński (1969). Gravity darkening coefficients g_1 and g_2 were taken from van Hamme (1993). Since there is no detailed study in the literature, the effective temperature values of the primary components were estimated from Cox (2000) according to their *B–V* values which are calculated by using the magnitudes given by SIMBAD Astronomical Database (Table 1).

The light curve analyses indicated that our five targets are contact binaries as estimated by ASAS catalog. ASAS 040633−4729.4 is the system having the components with very close effective temperature values. ASAS 025115−2525.4 has the smallest degree of contact, $f = 9\%$ while ASAS 035803+0620.5 having the largest one, 96%. We found that the system with the largest mass–ratio value, 0.275, is ASAS 12534−5010.6 among our targets. The evident flat-bottomed shape of the minima of ASAS 025115−2525.4 refer to total eclipses during the primary and the secondary minima. The situation rises from the large difference between the radii of the components.

The resulting parameters are listed in Tables 2 and 3. The agreements of our solutions with the observational data are presented in Figs. 1 and 2. The data points which shows large deviation from the general trend were mainly graded as C and D in the catalog. These points were referred as worst/useless in the header of the data files. Therefore, we did not include them in our solution although D points are shown in the figures.

[1] http://www.astrouw.edu.pl/asas/

Table 3
Same as Table 2 but for ASAS 040633−4729.4 and ASAS 125340−5010.6.

Parameter	040633−4729.4	125340−5010.6
q	0.136(2)	0.275(5)
i (°)	75.6(2)	74.7(5)
T_1 (K)	6556	6350
T_2 (K)	6554(44)	6270(30)
$\Omega_1 = \Omega_2$	2.036(9)	2.36(1)
$\overline{r_1}$	0.566(4)	0.510(5)
$\overline{r_2}$	0.237(13)	0.290(11)
$\frac{L_1}{L_1+L_2}$	0.868(8)	0.77(1)
f (%)	32	27
T_0 (HJD-2450000)	4941.4942(80)	1980.7005(54)
P (d)	0.406365(1)	0.404664(1)

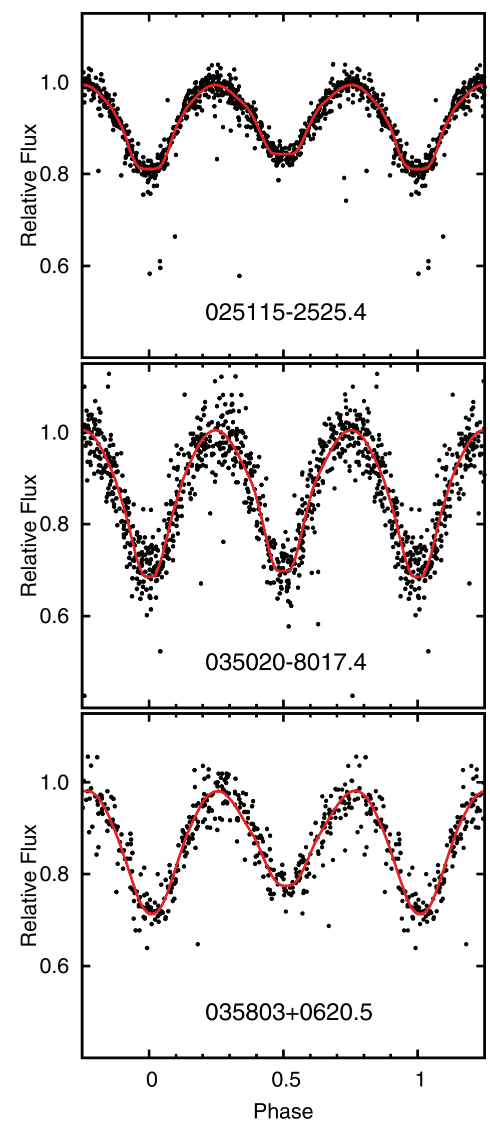

Fig. 1. The calculated (lines) and the observational (dots) light curves of ASAS 025115−2525.4,ASAS 035020−8017.4 and ASAS 035803+0620.5.

3. Discussion and conclusions

The analyses of ASAS light curve of five binary system were presented in this study. These analyses are the first analyses of these system in the literature. We derived the light parameters (Tables 2 and 3) and the estimated absolute parameters (Tables 4 and 5) of the systems. The calibration between mass and spectral type for