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Orbital solution and evolutionary state for the eclipsing binary 1SWASP J080150.03+471433.8

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HIGHLIGHTS

- The primary component is more massive and hotter than the secondary.
- The primary component showes a good fit with the M-R and M-L relations.
- There is an energy transfer from primary to secondary through the common convective envelope.

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ABSTRACT

We present an orbital solution study for the newly discovered system 1SWASP J080150.03+471433.8 by means of new CCD observations in VRI bands. Our observations were carried out on 25 Feb. 2013 using the Kottamia optical telescope at NRIAG, Egypt. 12. New times of minima were estimated and the observed light curves were analysed using the Wilson–Devinney code. The accepted orbital solution reveals that the primary component of is more massive and hotter than the secondary one by about 30 K. The system is an over-contact one with fillout ratio ~29% and is located at a distance of about 195 Pc. The evolutionary status of the system is investigated by means of stellar models and empirical data.

1. Introduction

The study of short period eclipsing binaries is important for understanding the nature and evolution of low-mass stars and to allow investigation of the cause of the period cut-off (Norton et al., 2011). The system 1SWASP J080150.03+471,433.8 (we will further use the short name SWAP08) is one of 53 short period eclipsing binary stars identified by Super WASP project (Norton et al., 2011). The identified list of stars includes 48 new objects with periods < $0.^{d}23$. The system SWAP08 was classified as a short period W UMa star ($p = 0.^{d}21751$) with $V_{max} = 13.40$ mag, while the depth of the primary and secondary minima are 0.66 and 0.64 mag respectively. The first photometric observations were obtained for the system after its discovering by Terrill and Gross (2014) during their reclassification for 143 new W UMa systems identified by Lohr et al. (2013) in the SuperWasp data. They measured complete light curves in the B, V, and I_c bands and established the first photometric solution for the system.

A photometric study of the eclipsing binary SWAP08 was our goal using new VRI CCD observations. The present paper is a continuation of the series concerning the photometric analysis of the newly discovered eclipsing binaries, Elkhateeb and Nouh (2016), Elkhateeb et al. (2015), Elkhateeb and Nouh (2015) and Elkhateeb et al. (2014a, 2014b).

Section 2 is devoted to the observations. In Section 3, a light-curve analysis of the system is given. Section 4 deals with the duscussion and conclusion.

2. Observations

New CCD observations were carried out in the VRI bands on 25 February 2013 using a 2Kx2K CCD camera attached to the 1.8 m Kottamia optical telescope. Differential photometry was performed with respect to GSC 3408-0,1475 and GSC 3408-00,253, as comparison and check stars, respectively.

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Table 1
VRI observational data of the eclipsing binary SWASP08.

JD	ΔV	Error	Phase	JD	ΔR	Error	Phase	JD	ΔI	Error	Phase
2456714.2443	0.0883	0.0034	0.2605	2456714.2466	−0.3634	0.0028	0.2501	2456714.2478	−0.8387	0.0029	0.2444
2456714.2491	0.0829	0.0034	0.2384	2456714.2514	−0.3573	0.0028	0.2280	2456714.2526	−0.8261	0.0029	0.2223
2456714.2542	0.1059	0.0031	0.2152	2456714.2604	−0.3050	0.0029	0.1866	2456714.2616	−0.7824	0.0030	0.1810
2456714.2629	0.1628	0.0036	0.1751	2456714.2652	−0.2747	0.0029	0.1646	2456714.2664	−0.7462	0.0030	0.1589
2456714.2678	0.2087	0.0036	0.1526	2456714.2701	−0.2279	0.0030	0.1422	2456714.2713	−0.7007	0.0029	0.1365
2456714.2726	0.2765	0.0036	0.1304	2456714.2749	−0.1580	0.0029	0.1200	2456714.2761	−0.6292	0.0030	0.1144
2456714.2778	0.3628	0.0037	0.1065	2456714.2801	−0.0669	0.0032	0.0961	2456714.2812	−0.5372	0.0035	0.0909
2456714.2823	0.4644	0.0040	0.0860	2456714.2892	0.1783	0.0034	0.0544	2456714.2857	−0.4198	0.0036	0.0702
2456714.2869	0.6029	0.0042	0.0649	2456714.2936	0.2955	0.0036	0.0340	2456714.2903	−0.2937	0.0037	0.0493
2456714.2913	0.7346	0.0047	0.0445	2456714.2980	0.3145	0.0037	0.0137	2456714.2947	−0.1962	0.0038	0.0289
2456714.2958	0.8024	0.0051	0.0241	2456714.3069	0.1700	0.0035	0.9727	2456714.2992	−0.1905	0.0039	0.0085
2456714.3002	0.7976	0.0050	0.0036	2456714.3115	0.0311	0.0034	0.9516	2456714.3036	−0.2324	0.0038	0.9881
2456714.3137	0.4296	0.0040	0.9417	2456714.3160	−0.0778	0.0032	0.9313	2456714.3081	−0.3523	0.0037	0.9675
2456714.3181	0.3413	0.0038	0.9213	2456714.3204	−0.1580	0.0032	0.9109	2456714.3171	−0.5745	0.0035	0.9262
2456714.3270	0.2096	0.0039	0.8806	2456714.3248	−0.2068	0.0031	0.8904	2456714.3215	−0.6470	0.0035	0.9058
2456714.3315	0.1786	0.0037	0.8600	2456714.3293	−0.2559	0.0032	0.8701	2456714.3259	−0.7080	0.0035	0.8854
2456714.3359	0.1462	0.0037	0.8394	2456714.3337	−0.2919	0.0031	0.8495	2456714.3304	−0.7461	0.0035	0.8649
2456714.3407	0.1144	0.0036	0.8174	2456714.3382	−0.3176	0.0032	0.8289	2456714.3348	−0.7778	0.0035	0.8444
2456714.3451	0.0963	0.0035	0.7971	2456714.3430	−0.3434	0.0031	0.8070	2456714.3393	−0.8059	0.0035	0.8238
2456714.3496	0.0916	0.0036	0.7766	2456714.3474	−0.3529	0.0031	0.7866	2456714.3441	−0.8210	0.0033	0.8019
2456714.3541	0.0990	0.0033	0.7561	2456714.3519	−0.3574	0.0029	0.7661	2456714.3485	−0.8372	0.0034	0.7814
2456714.3585	0.1043	0.0034	0.7355	2456714.3563	−0.3559	0.0029	0.7457	2456714.3530	−0.8349	0.0033	0.7609
2456714.3630	0.1206	0.0036	0.7150	2456714.3608	−0.3333	0.0031	0.7250	2456714.3574	−0.8259	0.0033	0.7405
2456714.3674	0.1520	0.0037	0.6946	2456714.3653	−0.3127	0.0031	0.7045	2456714.3619	−0.8141	0.0034	0.7199
2456714.3720	0.1801	0.0038	0.6738	2456714.3697	−0.2797	0.0033	0.6840	2456714.3664	−0.7859	0.0035	0.6995
2456714.3764	0.2160	0.0039	0.6534	2456714.3742	−0.2606	0.0033	0.6634	2456714.3709	−0.7655	0.0035	0.6787
2456714.3809	0.2712	0.0045	0.6327	2456714.3787	−0.2042	0.0034	0.6428	2456714.3753	−0.7243	0.0037	0.6583
2456714.3854	0.3371	0.0038	0.6122	2456714.3876	−0.0765	0.0031	0.6018	2456714.3798	−0.6876	0.0037	0.6376
2456714.3898	0.4549	0.0037	0.5918	2456714.3921	0.0313	0.0032	0.5811	2456714.3887	−0.5462	0.0034	0.5966
2456714.3943	0.5748	0.0040	0.5712	2456714.3966	0.1647	0.0033	0.5607	2456714.3932	−0.4354	0.0035	0.5760
2456714.3987	0.6996	0.0041	0.5508	2456714.4010	0.2744	0.0034	0.5404	2456714.3977	−0.3090	0.0035	0.5557
2456714.4031	0.7477	0.0043	0.5304	2456714.4055	0.2913	0.0034	0.5198	2456714.4021	−0.2307	0.0036	0.5353
2456714.4076	0.7493	0.0042	0.5098	2456714.4099	0.2871	0.0034	0.4993	2456714.4110	−0.2289	0.0036	0.4943
2456714.4121	0.7171	0.0041	0.4894	2456714.4143	0.2247	0.0033	0.4789	2456714.4199	−0.4413	0.0034	0.4532
2456714.4165	0.6098	0.0038	0.4690	2456714.4188	0.0902	0.0032	0.4584	2456714.4245	−0.5544	0.0035	0.4323
2456714.4211	0.4765	0.0037	0.4479	2456714.4234	−0.0264	0.0031	0.4375	2456714.4289	−0.6406	0.0033	0.4119
2456714.4300	0.2782	0.0034	0.4069	2456714.4323	−0.2055	0.0030	0.3964	2456714.4330	−0.7036	0.0033	0.3913
2456714.4345	0.2246	0.0034	0.3864	2456714.4367	−0.2302	0.0030	0.3760	2456714.4379	−0.7415	0.0033	0.3708
2456714.4389	0.1863	0.0035	0.3660	2456714.4412	−0.2700	0.0030	0.3555	2456714.4423	−0.7672	0.0033	0.3504
2456714.4433	0.1571	0.0034	0.3456	2456714.4456	−0.3039	0.0030	0.3350	2456714.4467	−0.7943	0.0033	0.3300
2456714.4478	0.1324	0.0034	0.3251	2456714.4501	−0.3348	0.0030	0.3146	2456714.4512	−0.8234	0.0034	0.3095
2456714.4523	0.1083	0.0032	0.3046	2456714.4586	−0.3543	0.0030	0.2755	2456714.4597	−0.8391	0.0034	0.2705
2456714.4607	0.0863	0.0034	0.2656	2456714.4630	−0.3704	0.0030	0.2551	2456714.4641	−0.8260	0.0034	0.2500
2456714.4652	0.0988	0.0035	0.2451	2456714.4675	−0.3523	0.0030	0.2347	2456714.4686	−0.8280	0.0034	0.2296
2456714.4740	0.1302	0.0036	0.2045	2456714.4763	−0.3150	0.0032	0.1941	2456714.4774	−0.8009	0.0037	0.1889
2456714.4785	0.1567	0.0038	0.1840	2456714.4807	−0.2904	0.0032	0.1737	2456714.4819	−0.7681	0.0039	0.1685
2456714.4829	0.1880	0.0038	0.1636	2456714.4852	−0.2578	0.0033	0.1533	2456714.4863	−0.7304	0.0036	0.1482
2456714.4873	0.2388	0.0040	0.1433	2456714.4903	−0.1900	0.0035	0.1299	2456714.4926	−0.6337	0.0038	0.1190
2456714.4937	0.3336	0.0042	0.1142	2456714.4960	−0.1019	0.0035	0.1037	2456714.4971	−0.5608	0.0038	0.0987

Table 2
Light curve parameters for the eclipsing binary SWASP08.

Filter	D_{max}	D_{min}	A_p	A_s
V	0.0088 ± 0.0004	0.0546 ± 0.0022	0.7195 ± 0.0294	0.6649 ± 0.0271
R	0.0130 ± 0.0005	0.0232 ± 0.0010	0.6849 ± 0.0280	0.6617 ± 0.0270
I	0.0019 ± 0.0001	0.0402 ± 0.0016	0.6486 ± 0.0265	0.6089 ± 0.0249

A total of 147 measurements were obtained. The corresponding phases of the observed data were calculated using the ephemeris adopted from our observations as:

$$\text{Min I} = 2456714.3010 + 0.217513^{*}E \quad (1)$$

Table 1 lists the magnitude difference (the variable minus the comparison star) in VRI, together with the corresponding Julian date and phase, and these measurements are displayed in Fig. 1. The parameters describing the observed light curves **D_{max} = (Max I – MaxII) and D_{min} = (Min I – Min II)** have been measured and listed in Table 2 together with the depth of the primary **(A_p = (Min I – Max I))** and the secondary (As = (Min II – Max I)) minima in the VRI bands. Using the method of Kwee and Van Woerden (1956) a total of 12 new times of primary and secondary minima (six minima estimated from our observations and another six from Terrill and Gross (2014) light curves) were derived by means of the software Minima V2.3 (Nelson 2002) and are listed in Table 2.

3. Photometric analysis

As the light curves of the system, SWAP08 showed deep potentially complete (total/annular), eclipses, it was selected by Terrell and Gross (2014) for B, V, and I_c observations. They carried out a first photometric study and a set of light curve parameters were