OPTICAL OBSERVATION STUDY OF W UMA ECLIPSING BINARY SYSTEM DF CVN USING ASAS, KWS, AND SUPERWASP ARCHIVES

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Abstract. This study aims to determine the physical and geometrical parameters of the eclipsing binary system DF CVn, and compare three automated sky survey archives (All Sky Automated Survey (ASAS), Kamogata-Kiso-Kyoto Wide-field Survey (KWS), and Super Wide Angle Search for Planets (SuperWASP) for stellar optical observation. The BVR light curves of our system (DF CVn) were obtained on May 2009 from Kottamia Astronomical Observatory (KAO), Egypt, and the V light curves were obtained from the ASAS, KWS, and SuperWASP archives. The asymmetric V light curves were modeled by a dark spot on a more massive component. Furthermore, 103 new times of minima were determined from the SuperWASP observations. Using PHOEBE software, the light curves were analyzed to determine the geometric and photometric parameters of the system. Our results indicate that DF CVn is an A subtype of the UMa eclipsing binary (weak contact), with a mass ratio q =0.357, and its inclination $i = 72.58^o$. From the O-C curve of the minima times, we found that the orbital period changes $(\Delta P/P) = -4.5836X10^{-11}$.

Key words: Stars – Variable stars – V* DF CVn, Eclipsing binary – W UMa binary system .

1. INTRODUCTION

The eclipsing binary system DF CVn (TYCHO2 3021.2642.1 = GSC 03021-02642 = NSV 5904) was discovered as a variable star by Weber (1963) during a photographic survey of selected areas of the northern hemisphere. The system was documented as NSV 5904 in the New Catalogue of Suspected Variable Stars (Kholopov, 1982). Visual observations of the system were obtained by members of the European amateur association, GEOS, which confirmed that the variability of the system is similar to a W-Ursae Majoris (UMa) type eclipsing binary. From visual observations, Vandenbroere (1999) confirmed the light variability with an apparent period of 0.16345^d. However, Vandenbroere *et al.*(2001) doubled this period to 0.326890^d. Photoelectric measurements were performed at the Jungfraujoch station in a collaboration between GEOS and the Geneva Observatory (Vandenbroere *et al.*, 2001), where the light curves of nine points for the B and V filter were obtained during two nights in December 1998. Vandenbroere *et al.*(2001) obtained more than 200 unfil-

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tered CCD images using a TI245C camera mounted on a 0.2-m Newtonian reflector. They derived light minima four times and determined the new ephemeris as follows: HJD (Min I) = 2450571.219 + 0.326890 E. Acerbi *et al.*(2005) published the first V-filtered light curve based on CCD observations using a CCD camera (Kodak KAF 40) mounted on a 0.2-m Schmidt–Cassegrain telescope for seven nights during the interval from JD=2453107 to JD=2453145. They found that the system DF CVn is a contact A subtype of the W UMa eclipsing binary, with a photometric mass ratio of q = 0.347 and that the primary (deeper) minimum occurs when the hotter and more massive companion star is eclipsed by its cooler and less massive companion. Dai *et al.*(2011) indicated that DF CVn is a W-type weak-contact binary, with a mass ratio of q = 0.28 and an over-contact degree of f = 20 $\%$. From Dai *et al.*'s (2011) paper, it is unclear whether a third body exists in the system, and thus, whether the light curves presented address this cyclic variation in the times of minima. Therefore, the third body may be a low-mass dwarf. In this case, the third body is difficult to detect due to its extremely low luminosity. If the unseen tertiary component exists, then DF CVn is a triple star. This may further confirm the hypothesis that most contact binary stars exist in multiple systems (D'Angelo *et al.*, 2006; Pribulla and Rucinski, 2006; Rucinski *et al.*, 2007). Kozai oscillation (Kozai, 1962), alternatively, a combination of Kozai cycles and tidal friction (Fabrycky and Tremaine, 2007) in an additional body of this type may remove angular momentum from the central system. Essam *et al.*(2010) conducted a preliminary photometric analysis using Binary Maker 3 (BM3) to determine orbital and physical parameters with new BVR photometric observations. Acerbi *et al.*(2005) assumed (from $(B-V)=0.78$) that the primary component of the system DF CVn is a G8V spectral type. Dai *et al.*(2011) observed low-amplitude changes in the light curves on a short timescale of approximately half a month and attributed this to dark spot activity.

2. OBSERVATIONS AND DATA REDUCTION

Photometric observations of the eclipsing binary system DF CVn were obtained using two methods. The first involved obtaining B, V, R observations over five nights (15th, 16th, 17th, 18th, and 21st of May 2009) using the 1.88 reflector telescope at the Kottamia Astronomical Observatory (KAO), Egypt, The differential photometric observations of DF CVn were performed with GSC 3021–2613 and GSC 3021–2617 as the comparison and check stars, respectively. All times were correlated according to the Heliocentric Julian Date (HJD). Standard data reduction processes (dark and bias removal and flat-field correction) and aperture photometry were applied using the free data reduction software MuniWin (http://c-munipack.sourceforge.net/). We obtained differential instrumental magnitudes (Δb,

Δv, and Δr) and constructed the light curves of the DF CVn system (see Essam *et al.*, 2010). The second method involved observations from the archives of the All Sky Automated Survey (ASAS, https://asas-sn.osu.edu/), Kamogata-Kiso-Kyoto Wide-field Survey (KWS, http://kws.cetus-net.org/ maehara/VSdata.py?object), and Super Wide Angle Search for Planets (SuperWASP, https://wasp.cerit-sc.cz/search) databases. The ASAS observations were conducted at the Las Campanas Observatory, Chile. The database contains V-filter light curves of over 50,000 variable stars with declinations below $+28^o$. We used all the V-band photometric data starting from 2456606.141 to 2458500.014 (HJD). We collected and used photometric data from the KWS (f.l. = 105-mm lens + SBIG ST-8xME CCD camera) database starting from 2455551.370 to 2458519.302 (HJD). The V-band fluxes of the object gradually increased from approximately December 13, 2014, and reached 9.6 mag in the V-band and 8.2 mag in the Ic-band on January 02, 2015. Finally, the SuperWASP photometric data spanning more than 7 years from September 14, 2006 (2453128.383 HJD) to December 6, 2013 (54251.539 HJD) was also collected. The SuperWASP data reduction pipeline is described in detail by Pollacco *et al.*(2006). The epoch of the V filter primary minimum derived by Dvorak (2009) and the period derived by Acerbi *et al.*(2005) were used to construct the following ephemeris:

$$HJD(MinI) = 2454503.756 + 0.3268956E \tag{1}$$

We applied this ephemeris to the phases of our collected observations from SuperWASP, ASA, and KWS archives to produce the V-band light curves that are illustrated in Fig.1.

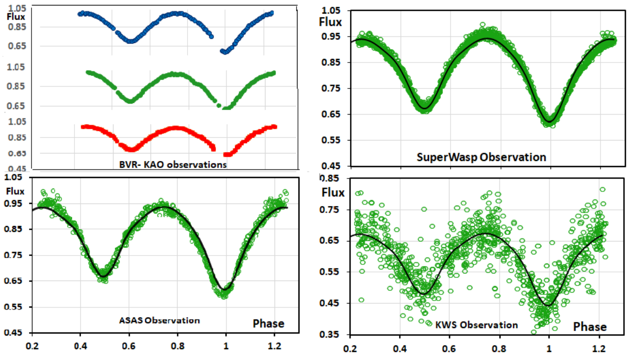

Fig. 1 – DF CVn observations and synthetic light curve (solid line) from SuperWASP, ASA, and KWS archives in addition to KAO observations in BVR-color

3. TIMES OF PHOTOMETRIC MINIMA

A total of 103 new DF CVn minima times (58 primaries and 45 secondaries) were derived from the SuperWASP and KAO observations. The observed minima times (Obs. Min.) were determined using the software package AVE (Barbera, 1996), which employs the method of Kwee and Woerden (1956). We used the O-C gateway ephemeris to determine the time of minimum:

$$HJD(MinI) = 2451694.414 + 0.3268955E \tag{2}$$

Table 1 represents these times of minima, where E represents integer cycle number; Type represents the type of minimum (primary or secondary).

4. PHOTOMETRIC ORBITAL PERIOD CHANGES

We employed the times of minima in Table 1 together with the available published CCD times of minima in the O-C gateway website: (http://astro.sci.muni.cz /variables/ocgatebeginning). They started from 2451305.738 to 2458548.4294 HJD and were used with the linear ephemeris in Eq. (2) to calculate the values of (O-C), and then construct the (O-C) curve as shown in Fig. 2 (left panel). From the (O-C) curve in Fig. 2, we can study the orbital period changes of the system DF CVn. The least-squares fitting method for quadratic terms (see Fig. 2, left panel) produced the following equation:

$$(O-C) = -0.0014(\pm 0.0004) + 4.5653(\pm 0.8981) * 10^{-7}E \\ -2.2918(\pm 0.4457) * 10^{-11}E^2 \tag{3}$$

Notably, the period continuously varied for the long-time observations. The corresponding residuals are shown in the right panel of Fig. 2. The coefficient of the square term in Eq. (3) was used to determine the rate of period change ($\Delta P/P = -4.5836 * 10^{-11}$). The new parabolic elements of the system DF CVn were used to determine the new ephemeris as follows:

$$HJD(MinI) = 2451693.1949 + 0.32690440E - 2.2918 * 10^{-11} * E^2 \tag{4}$$

From the residuals diagram in Fig. 2 (right panel), we note that the period reveals complex changes, and a possible cyclic oscillation is discovered to superpose the secular decrease that can be explained either by the magnetic activity cycles of the components or the presence of a third body

Table 1

Times of minima for the system DF CVn derived from SuperWASP and KAO observations

T(min)	**Err.**	**E**	**O-C**	**T(Min.)**	**Err.**	**E**	**O-C**
3128.5035	0.0003	4387	−0.0011	4232.4320	0.0001	7764	0.0014
3129.4851	0.0009	4390	−0.0002	4233.4117	0.0002	7767	0.0004
3130.4663	0.0004	4393	0.0003	4234.3921	0.0003	7770	0.0001
3132.4274	0.0006	4399	0.0001	4249.4310	0.0002	7816	0.0018
3141.5811	0.0003	4427	0.0006	4250.4118	0.0002	7819	0.0019
3160.5367	0.0004	4485	−0.0037	4251.3921	0.0002	7822	0.0015
3161.5171	0.0002	4488	−0.0040	3132.5910	0.0002	4399.5	0.0001
3162.5008	0.0001	4491	−0.0010	3137.4923	0.0002	4414.5	−0.0020
3165.4429	0.0003	4500	−0.0009	3138.4732	0.0002	4417.5	−0.0018
3166.4239	0.0001	4503	−0.0006	3139.4540	0.0001	4420.5	−0.0017
3181.4608	0.0002	4549	−0.0009	3141.4167	0.0003	4426.5	−0.0004
3199.4390	0.0008	4604	−0.0019	3153.5098	0.0005	4463.5	−0.0024
3200.4210	0.0006	4607	−0.0006	3154.4906	0.0004	4466.5	−0.0023
3201.3999	0.0009	4610	−0.0024	3155.4720	0.0002	4469.5	−0.0016
4115.7320	0.0009	7407	0.0030	3156.4526	0.0002	4472.5	−0.0016
4118.6737	0.0008	7416	0.0027	3157.4336	0.0002	4475.5	−0.0013
4120.6343	0.0007	7422	0.0019	3158.4137	0.0005	4478.5	−0.0019
4135.6695	0.0003	7468	−0.0001	3159.3936	0.0006	4481.5	−0.0027
4139.5913	0.0006	7480	−0.0010	3170.5078	0.0028	4515.5	−0.0029
4149.7280	0.0003	7511	0.0019	3171.4890	0.0002	4518.5	−0.0024
4150.7086	0.0001	7514	0.0018	3172.4696	0.0003	4521.5	−0.0025
4152.6705	0.0002	7520	0.0024	3172.4701	0.0002	4521.5	−0.0020
4153.6499	0.0004	7523	0.0011	3173.4510	0.0002	4524.5	−0.0018
4154.6312	0.0001	7526	0.0017	3173.4524	0.0004	4524.5	−0.0004
4155.6148	0.0006	7529	0.0046	3174.4314	0.0003	4527.5	−0.0021
4157.5718	0.0006	7535	0.0002	3189.4708	0.0003	4573.5	0.0001
4158.5564	0.0003	7538	0.0042	3190.4490	0.0014	4576.5	−0.0024
4159.5327	0.0002	7541	−0.0002	4140.7378	0.0007	7483.5	0.0013
4163.7827	0.0007	7554	0.0001	4143.6790	0.0017	7492.5	0.0004
4165.7437	0.0002	7560	−0.0002	4146.6230	0.0002	7501.5	0.0024
4166.7242	0.0003	7563	−0.0004	4149.5669	0.0013	7510.5	0.0042
4167.7046	0.0003	7566	−0.0007	4155.7738	0.0004	7529.5	0.0002
4169.6656	0.0005	7572	−0.0011	4161.6602	0.0012	7547.5	0.0024
4171.6265	0.0005	7578	−0.0016	4162.6401	0.0003	7550.5	0.0016
4194.5136	0.0012	7648	0.0029	4163.6205	0.0023	7553.5	0.0013
4195.4930	0.0002	7651	0.0016	4189.4470	0.0003	7632.5	0.0031
4204.6421	0.0013	7679	−0.0024	4194.6760	0.0003	7648.5	0.0018
4206.6079	0.0002	7685	0.0020	4195.6570	0.0004	7651.5	0.0021
4208.5701	0.0002	7691	0.0028	4202.5226	0.0002	7672.5	0.0029
4210.5302	0.0004	7697	0.0016	4203.5038	0.0006	7675.5	0.0034
4212.4916	0.0003	7703	0.0016	4204.4840	0.0003	7678.5	0.0029
4213.4731	0.0002	7706	0.0024	4205.4647	0.0003	7681.5	0.0029
4214.4537	0.0002	7709	0.0023	4206.4417	0.0002	7684.5	−0.0008
4215.4312	0.0002	7712	−0.0009	4208.4066	0.0002	7690.5	0.0027
4216.4147	0.0001	7715	0.0020	4214.6196	0.0022	7709.5	0.0047
4217.3953	0.0003	7718	0.0018	4219.5220	0.0004	7724.5	0.0037
4218.3765	0.0002	7721	0.0024	4220.5020	0.0006	7727.5	0.0030
4222.6226	0.0004	7734	−0.0012	4221.4817	0.0005	7730.5	0.0020
4225.5677	0.0003	7743	0.0019	4223.4440	0.0004	7736.5	0.0030
4227.5288	0.0004	7749	0.0016	4224.4244	0.0002	7739.5	0.0026
4228.5093	0.0001	7752	0.0014	4225.4050	0.0001	7742.5	0.0026
4231.4507	0.0003	7761	0.0008				

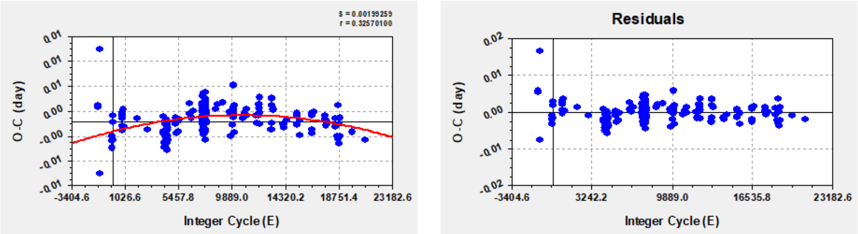

Fig. 2 – Solid red line in the left panel represents the quadratic fitting terms in Eq. (3), while the right panel represents the corresponding residuals of the quadratic fitting of the system DF CVn.

5. PHOTOMETRIC DATA ANALYSIS OF THE SYSTEM DF CVN

To determine the physical and geometrical parameters of the DF CVn system, we used PHOEBE software (Andrej Prsa, version 0.31a), which comprises two programs: synthetic light curve (LC) and differential correction (DC). The model has been described and quantified in documentation from PHOEBE 1.0. (http://phoebe-project.org/1.0/download), based on Wilson and Devinney (1971), Wilson (1979, and 1990), and Wilson and van Hamme (2003). The analyses were performed for the available V light curves (Fig. 1). The light curves of this system appear to exhibit a typical O'Connell effect (O'Connell, 1951). Different solutions, with and without spot/s on the components, were tested. We started the solution with the exponent of gravity darkening, g1 = g2 = 0.32 considered by Lucy (1967), and a bolometric albedo, A1 = A2 = 0.5 considered by Rucinski (1969), for convective envelope stars being assumed. The values of the bolometric limb darkening, Xbol1 and Xbol2, and the monochromatic limb darkening, X1 and X2, were taken from Van Hamme's tables (1993). The over-contact mode in the PHOEBE software was adopted for the LC solution. Initially, some parameters were assumed, *e.g.*, the orbital inclination i, mass ratio (q), and surface temperature of the hot component star (T1). The other parameters, *e.g.*, the surface temperature of the cold component star (T2) and surface potential of the two components,$\Omega 1$ =$\Omega 2$, had to be adjusted and employed in the second part (DC) in PHOEBE. The relative brightness of star 2 was calculated using the stellar atmosphere model. Since no spectroscopic radial velocity measurements were available for the selected binary used in this study, q was determined using the extensive q-search method from the light curve modeling, as discussed in Deb *et al.*(2010), to determine the most probable mass ratio for both systems. With this technique, test solutions were computed at a series of assumed mass ratios (q), with the values ranging from 0.10 to 1.0 in steps of 0.01. Each of the test solutions was computed in the model of the contact binary. For each assumed q, a fit solution was obtained, and the resulting sum of the squared deviations for each value of q was plotted. The value of q corresponding to the minima of the sum of the squared deviations was taken as the initial mass ratios in the modeling. Fig. 3 shows that the minimum occurs at a value around q = 0.347. The derived physical and geometrical parameters are listed in Table 2 with their standard deviations. In Table 2, we compare our results with selected previous work.

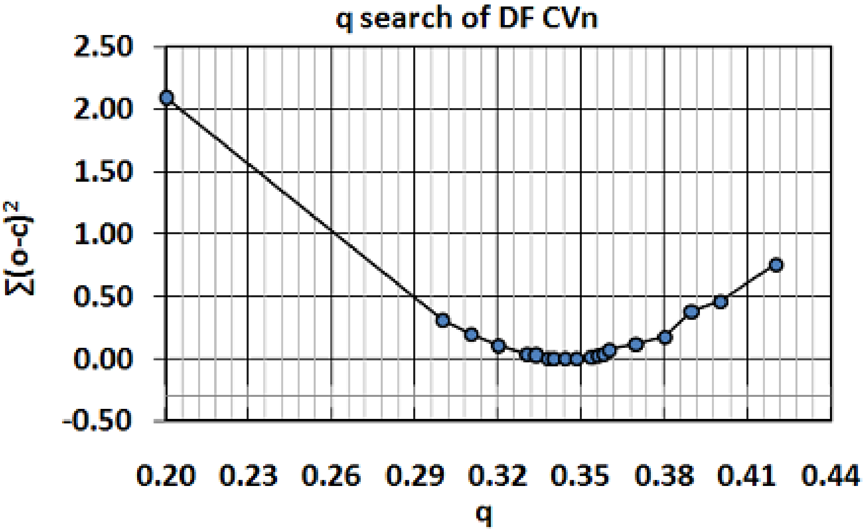

Fig. 3 – q-Search diagram for the DF CVn system

The final fit of the observations is shown in Fig. 1, for the SuperWASP, ASA, and KWS archives.The results show that star 1 should be the more massive and hotter component, while star 2 should be less massive and cooler. The physical and geometrical parameters listed in Table 2 were used with the Binary Maker 3 program (BM3) (Bradstreet, 2005) to present the Roche geometry of the system, as shown in Fig. 4, which shows the degree of contact. The same physical and geometrical parameters were employed with BM3 to display the system configurations at different phases (0.05, 0.20, 0.45, and 0.85), as shown in Fig. 5. The properties of the DF CVn system in Table 2 were compared with the properties of the A and W subtypes of the W-UMa binaries (Rucinski, 1973). Through the degree of contact, radii, temperature difference between the components, and transit primary minimum (Binnedijk, 1970), we found that DF CVn is likely to be an A subtype of the W UMa eclipsing binary stars.

Table 2

Physical and Geometrical Geometric parameters of the DF CVn system

Parameter	**Acerbi, F.,2005**	**Essam** *et al.*, **2010**	**Dai, H.F., 2011**	**Pres. Work**
$Wavelength,\lambda$	5500	5480	5500	5500
$Inclination,I$	72.863 ± 0.064	75	68.55 ± 0.17	72.578 ± 0.139
$SurfaceTemp.,T1$	5337	5330	5520	5200 ± 17.163
$SurfaceTemp.,T2$	4902 ± 2	4980	4812 ± 6	4950 ± 15.804
$SurfacePot.,\Omega1=\Omega2$	2.5495 ± 0.0015	2.5465	2.3963 ± 0.0013	2.6033 ± 0.0021
$MassRatio,q$	0.3475 ± 0.0007	0.3665	0.284 ± 0.001	0.3572 ± 0.00092
$Fill-outParm.,f1,f2$	0.091 ± 0.01	0.27	0.194 ± 0.1	0.192
$GravityExp.,g1$	0.320	0.32	0.320	0.619 ± 0.023
$GravityExp.,g2$	0.320	1.00	0.320	1.00 (fixed)
$Reflection,A1$	0.50	0.50	0.50	0.229 ± 0.039
$Reflection,A2$	0.50	1.00	0.50	1.00 (fixed)
$AngularRot.,F1=F2$	1.00	1.00	1.00	1.00 (fixed)
$LimpDarkening,X1$	0.399	0.673	0.786	0.694
$LimpDarkening,X2$	0.399	0.729	0.795	0.733
$L1/(L1+L2)$	0.7563 ± 0.0008	0.7987	0.6210 ± 0.0017	0.7714 ± 0.0128
$L2/(L1+L2)=1-L1$	0.2320 ± 0.0008	0.2013	0.379	0.2286 (fixed)
$r1(back)$	0.5088 ± 0.0014	0.50849	0.5326 ± 0.0049	0.494 ± 0.0032
$r2(back)$	0.3252 ± 0.0025	0.32554	0.3163 ± 0.0071	0.313 ± 0.0043
$r1(side)$	0.4812 ± 0.0011	0.48088	0.5054 ± 0.0039	0.469 ± 0.0041
$r2(side)$	0.2890 ± 0.0014	0.28934	0.2771 ± 0.0039	0.282 ± 0.0043
$r1(pole)$	0.4484 ± 0.0008	0.44811	0.4675 ± 0.0028	0.439 ± 0.0030
$r2(pole)$	0.2768 ± 0.0011	0.27710	0.2651 ± 0.0033	0.271 ± 0.0036
$Spotofstar1$ $Co-latitude$	111 ± 2.2	90	90	90 (fixed)
$Longitude$	60.3 ± 2.8	15	270.4 ± 1.8	15 ± 1.30
$SpotRadius$	9.68 ± 0.78	15	14.9 ± 1.2	20 ± 1.40
$Temp.Factor$	0.5021 ± 0.005	0.51	0.93 ± 0.08	0.900 ± 0.012
$Sumofresidual$	0.28516	0.1129		0.0733

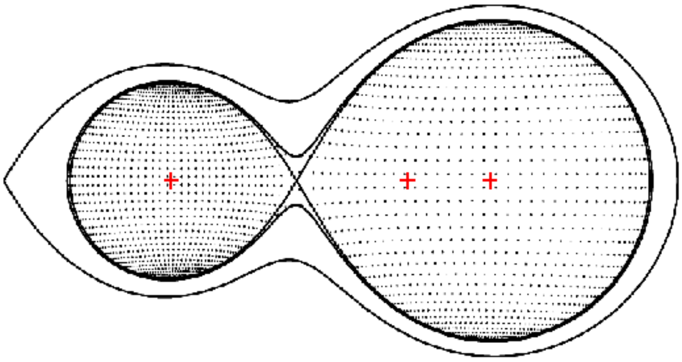

Fig. 4 – Roche geometry of DF CVn in the V-band with a fill-out ratio of approximately 11%

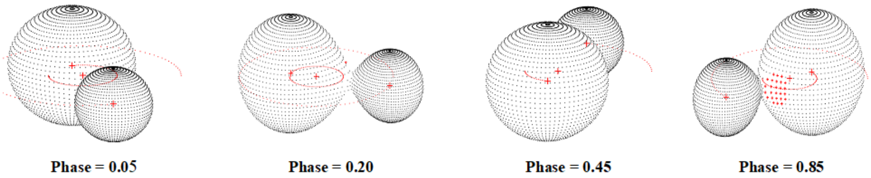

Fig. 5 – Shape of DF CVn at phases 0.05, 0.20, 0.45, and 0.85 in the V-band.

6. ABSOLUTE PARAMETERS AND EVOLUTIONARY STATE OF THE SYSTEM DF CVN

6.1. ABSOLUTE PARAMETERS

Spectroscopic observations are one of the important sources for estimating physical parameters. At present, there is no spectroscopic determination of the orbital elements available; thus, For the system DF CVn, the absolute parameters of the DF CVn system cannot be determined directly. Therefore, we have used simple approximation formulae (Harmanac, 1988), which relate the effective temperature to other basic physical parameters (mass, radius, luminosity, and bolometric magnitude). Comparing our results with the empirical laws from Gazeas (2009), based on light curve solutions and values of the Gaia measured distances of the system (Bailer-Jones *et al.*2018), we determined the absolute parameters for the DF CVn system. Referring to Ivanov *et al.*(2010) and the empirical formula from Gazeas (2008) the mass of the primary was estimated to be Mp=0.906±0.016 $M_\odot$.Using the mass ratio and orbital period, the separation between components and the mass of the secondary are estimated to be α =1.046±0.05$R_\odot$ and Ms=0.340±0.006$M_\odot$, respectively. Other absolute parameters for DF CVn are Rp =1.028±0.05$R_\odot$, Rs =0.6199±0.04$R_\odot$, Lp =0.725±0.052$L_\odot$, and Ls =0.462±0.07$L_\odot$, and the absolute magnitude of the system is (Mv) =4.383±0.082.

6.2. EVOLUTIONARY STATE

To compare several marginal contact binaries and review the evolutionary status of DF CVn, the absolute physical parameters of the components of the system were plotted as M-L, M-R, and H-R diagrams (Fig. 6). Using the evolutionary tracks for the non-rotating model, as computed by Mowlavi *et al.*(2012) for both zero-age main sequence stars (ZAMS) and terminal-age main sequence stars (TAMS) with a metallicity of Z = 0.014 (solar metallicity), we plot the components of DF CVn in Fig. 6.

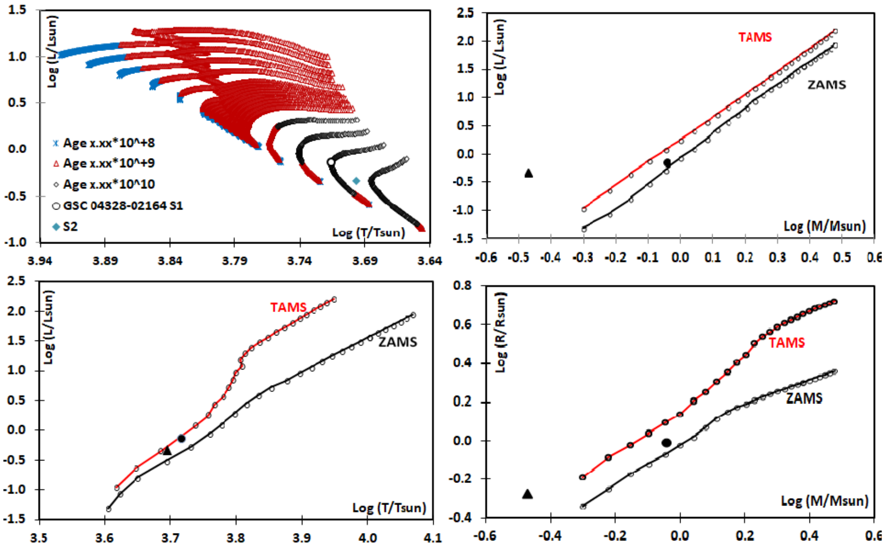

Fig. 6 – A binary system (DF CVn) as shown from evolutionary tracks in the HR diagram at Zinit = 0.014.

It is clear that components of our system follow the general pattern of the A-subtype systems and seem to be in good agreement with the A-type W UMa systems on the log M-logL plane. We observed that the primary is above the ZAMS for all relations, but the secondary has evolved far from the TAMS as shown in the M-L Relation. We calculated values for their masses using this formula and the effective temperatures of the system derived above. The results indicate that our system will be a weak-contact binary with unfilled Roche lobes, and therefore, not likely to be exchanging mass. We are naming it the primary as it is hotter and more luminous, which was originally the more massive star (q<1) and has not subsequently transferred matter to the secondary star to the extent that the situation has reversed.

7. CONCLUSIONS AND FUTURE WORK

The eclipsing binary system DF CVn exhibits a slight light variation from one maximum to the other, which is known as the O'Connell effect (O'Connell, 1951), presented in Fig. 1. This effect can be explained by the star spot hypothesis on the components of W UMa systems that indicate high surface activity due to their rotation and convective envelopes.
-We concluded that the SuperWASP archive is best suited for the photometric optical observations of the short-period eclipsing binaries.
-From the solution of the V light curves of DF CVn, using PHOEBE software, we conclude that the system is a weak-contact binary system with its degree of contact approximately that of an A-type W-UMa variable star, with a mass ratio of q = 0.3479 ± 0.0009. The light curve suggests the presence of a spot on the primary component, when the larger, more massive star is eclipsed by its smaller, less massive companion. -From the detected potential, the size of the Roche lobes depends on the system's separation as well as on the mass ratio of the two stars. Thus, if both stars have the same mass, they would possess Roche lobes of the same size. Beyond the equipotential surface that includes L1, a region exists where a test mass would feel the influence of both stars.
According to the Stefan-Boltzmann law, the equator region appears darker, and the emitted flux is smaller than at the poles: F(P) = Fpole(g(P)gpole)g, where g(P) is the gravity at a point P and g is the gravity darkening exponent.
- A total of 103 new DF CVn times of minima (58 primaries and 45 secondaries) were derived from the photometry analysis conducted for this research, and a new linear ephemeris was determined, as shown in Eq. (2).
-The V-band solutions provide the parameters that in principle are in agreement with those derived by Acerbi *et al.*(2005).
- We found that our results compare with the empirical laws of Gazeas (2009)
-From the O-C result, we estimate the rate of period change $\Delta P/P = -4.5836\mathrm{x}10^{-11}$. Additionally, from the O-C curve, either a third body or magnetic activity cycles of the components may exist. For this reason, further multi-wavelength and radial velocity observations of DF CVn are required to determine the absolute parameters.

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