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ON THE ORBITAL PERIOD BEHAVIOUR OF THE CONTACT BINARY BO Canum Venaticorum

Selim O. SELAM and Berahitdin ALBAYRAK

Ankara University, Faculty of Science, Dept. of Astronomy and Space Sciences, TR-06100 Tandoğan, Ankara, TURKEY

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ABSTRACT

Times of minima of the contact binary BO Canum Venaticorum (BO CVn) were collected from the literature and two new times of secondary minima were determined from the new observations obtained at the Ankara University Observatory. An (O-C) analysis based on the all available times of minima yields a constant orbital period over the last 14 years instead of a period increase mentioned in the recent literature. We commend the future observations of BO CVn to solve the period problem of the system.

1. INTRODUCTION

BO CVn (=BD+41° 2447 = SAO 044828, m_V=9.73, sp:A5) was discovered to be a variable star by Oja [1], who published the first light curve and determined the orbital period of the system. He also classified the system as a W UMa-type contact binary. Subsequent times of minima have been published by Hübscher et al. ([2], [3], [4] and[5]), Agerer & Hübscher ([6], [7], [8] and [9]), Albayrak et al. ([10], [11] and [12]), Albayrak [13] and Müyesseroğlu et al. [14]. Very recently, the first photometric solution of the system have been obtained by Albayrak et al. [11] based on their BV photometry in 1992. This solution revealed that BO CVn is a typical A-type W UMa system with q=0.205, f=0.18 and i=87.54°. Albayrak et al. [11] were also performed an (O-C) analysis for all times of minima of the system available until April 2000. They fitted a quadratic function to the (O-C) variation which the data cover the interval between April 1989 - April 2000 and obtained the following quadratic ephemeris:

$$\mathrm{MinI} = \mathrm{HJD}\ 2446895.46145 + 0^{d}.517457547 \times E + 3.034 \times 10^{-10} \times E^2 \quad (1)$$
$$\pm 0.00199 \qquad \pm 0.000000970 \qquad \pm 0.954$$

They are suggested that the coefficient of the squared term of this ephemeris yields a slow but secular increase in the orbital period of the system by dP/dt = 0.037 sec/yr. They also attributed this period change to a conservative mass transfer from the less massive to the more massive component and estimated the mass transfer rate as

$\Delta M=1.57 \times 10^{-10}$ M⊙/yr. Note that the highest known rates of similar long-term period increases among the W UMa-type systems are 0.027 sec/yr for V839 Oph [15], 0.031 sec/yr for UZ Leo [16] and 0.053 sec/yr for XY Boo [17]. Therefore we decided to monitor the behaviour of the orbital period of BO CVn in terms of minima observations.

2. THE (O-C) ANALYSIS

Covering the period of last 3 years, there are 5 additional times of minima available to us since the (O-C) analysis work by Albayrak et al. [11]; one primary and one secondary minima by Albayrak et al. [12], one secondary minimum by Müyesseroğlu et al. [14] and finally 2 newly determined secondary minima in this study. The observations were carried out at the Ankara University Observatory in BV filters using the 30 cm Maksutov telescope equipped with a SSP-5A photoelectric photometer. The differential observations were reduced outsite the atmosphere in the usual way, and heliocentric corrections were applied to the observing times. The times of 2 new minima from these observations were calculated using the well known method of Kwee & van Woerden [18]. The values of these minima times were very recently published [19] among the other times of minima of some eclipsing binaries of our Minima Monitoring Programme. The complete list of all available times of minima of BO CVn are given in Table 1 and consists of 36 timings which are all the results of photoelectric observations covering a period of 14 years.

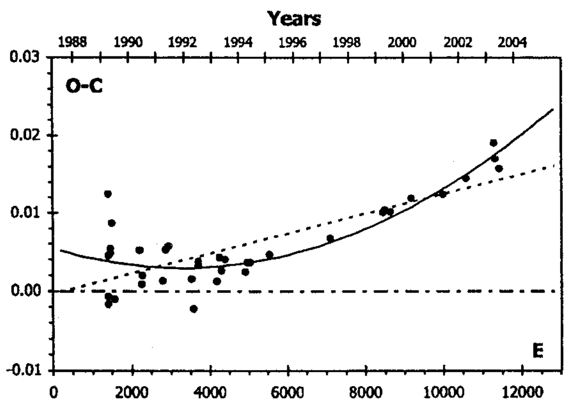

Figure 1. The O-C diagram of BO CVn. Dot-dashed line: linear ephemeris (Eq. (2)), dotted line: linear ephemeris (Eq. (3)), solid curve: quadratic ephemeris (Eq. (4)).

The (O-C) diagram for all available times of minima in Fig.1 were constructed using the linear ephemeris

$$\text{MinI} = \text{HJD } 2446895.455 + 0.5174597 \times E \quad (2)$$

Table 1. List of all available times of minima of BO CVn

Min (HJD) 2400000+	Error	Type	Filter	E	$(O-C_1)$	$(O-C_2)$	Ref.
47624.5540	-	I	V	1409.0	-0.0017	-0.0032	[4]
47624.5550	-	I	B	1409.0	-0.0007	-0.0022	[4]
47626.6300	-	I	B	1413.0	+0.0044	+0.0030	[4]
47626.6380	-	I	V	1413.0	+0.0124	+0.0110	[4]
47651.4684	-	I	V	1461.0	+0.0048	+0.0033	[2]
47651.4690	-	I	B	1461.0	+0.0054	+0.0039	[2]
47673.4643	0.0022	II	BV	1503.5	+0.0086	+0.0071	[10]
47709.4180	0.0010	I	BV	1573.0	-0.0011	-0.0028	[10]
48036.4588	0.0015	I	BV	2205.0	+0.0052	+0.0027	[10]
48065.4322	0.0011	I	BV	2261.0	+0.0008	-0.0017	[10]
48071.3841	0.0017	II	BV	2272.5	+0.0019	-0.0006	[10]
48341.4974	0.0023	II	BV	2794.5	+0.0013	-0.0020	[10]
48383.4156	0.0026	II	BV	2875.5	+0.0052	+0.0019	[13]
48419.3795	0.0024	I	BV	2945.0	+0.0057	+0.0023	[10]
48724.4178	0.0006	II	BV	3534.5	+0.0015	-0.0027	[3]
48748.4759	0.0014	I	BV	3581.0	-0.0023	-0.0065	[11]
48811.3528	0.0012	II	BV	3702.5	+0.0033	-0.0011	[11]
48812.3882	0.0025	II	BV	3704.5	+0.0037	-0.0007	[11]
49056.3679	0.0007	I	BV	4176.0	+0.0012	-0.0038	[4]
49091.5582	0.0005	I	BV	4244.0	+0.0042	-0.0009	[11]
49117.4295	0.0011	I	BV	4294.0	+0.0026	-0.0026	[11]
49167.3658	0.0011	II	BV	4390.5	+0.0040	-0.0013	[11]
49439.5480	0.0014	II	BV	4916.5	+0.0024	-0.0036	[5]
49465.4222	0.0004	II	BV	4966.5	+0.0036	-0.0024	[5]
49503.4555	0.0001	I	BV	5040.0	+0.0036	-0.0025	[5]
49763.4800	0.0003	II	BV	5542.5	+0.0046	-0.0021	[6]
50570.4605	0.0004	I	BV	7102.0	+0.0067	-0.0021	[7]
51271.3630	0.0040	II	BV	8456.5	+0.0101	-0.0005	[8]
51295.4252	0.0004	I	BV	8503.0	+0.0104	-0.0002	[8]
51362.4360	0.0005	II	BV	8632.5	+0.0101	-0.0006	[9]
51645.4882	0.0003	II	BV	9179.5	+0.0119	+0.0004	[9]
52070.3231	0.0002	II	UBV	10000.5	+0.0124	-0.0001	[12]
52375.3677	0.0002	I	UBV	10590.0	+0.0145	+0.0012	[12]
52740.4401	0.0011	II	UBV	11295.5	+0.0191	+0.0049	[14]
52757.5142	0.0002	II	BV	11328.5	+0.0170	+0.0028	[19]
52813.3986	0.0052	II	BV	11436.5	+0.0157	+0.0014	[19]

which was given by Oja [1]. The (O-C) residuals from that ephemeris are listed in Table 1 as $(O-C_1)$. A new linear ephemeris was determined by linear approximation to all data:

$$\begin{aligned} \mathrm{MinI} = \mathrm{HJD}\ 2446895.4546 &+ 0^d.51746099 \times E \qquad (3) \\ \pm 0.0010 \quad &\pm 0.00000017 \end{aligned}$$

and the corresponding residuals are listed in Table 1 as $(O\text{-}C_2)$. Since period variation was suspected, a quadratic ephemeris was also computed using all minima as:

$$\text{MinI} = \text{HJD } 2446895.4604 + 0^d.51745820 \times E + 2.3 \times 10^{-10} \times E^2 \quad (4)$$
$$\pm 0.0016 \quad \pm 0.00000067 \quad \pm 0.5$$

This quadratic ephemeris would yield a rate of period variation of dP/dt = 0.028 sec/yr which is lower than that of the estimate by Albayrak et al. [11].

3. CONCLUSION

The sum of squared-residuals are 4.0×10^{-4} d^2 and 2.6×10^{-4} d^2 for the linear and the quadratic fits obtained in this study, respectively. Note that these two values are in the same order and not significantly (statistically) different from each other. Taken into account this, and the fact that the change in the amount of the rate of period variation dP/dt just adding 3 years of data to Albayrak et al.'s [11] list of minima, we can state that it is too early to say that the period of BO CVn is changing. Indeed we can say that the period has been constant over the last 14 years. This situation temporarily invalidates any interpretation in terms of mass exchange between the components as well. However, an exceptable amount of period change in the future cannot be excluded due to the observed quadratic trend in the (O-C) diagram. To solve the question about the orbital period of BO CVn further accurate times of minima are needed.

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