

New ephemeris of two W Uma-type binaries: BQ Ari and V1370 Tau

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Abstract

The new light curve and ephemeris of two eclipsing binary systems BQ Ari and V1370 Tau are presented. The observation was made with CCD through C filter, and we used the Czech astronomical society's database to extract raw data, to obtain the time of minimums we used Table Curve software and then calculate O-C with the new ephemeris.

Keywords: Variable star, W UMa, Photometry

Introduction

We study on BQ Ari (00646-00946) and V1370 Tau (01305-01430) are two W UMa-type eclipsing binary. The W UMa-type is very significant to the study about the formation and dynamical evolution of contact binary (Haghi, 2015). The periods of this group of variable stars are typically short and range between 0.25 days to around 1.0 days. Each of the components in the binary is of nearly the same spectral type, from around middle A to early K, with the bulk concentrated in middle F through early G.

W UMa has exhibited some slight period changes since its discovery in 1903. One theory to describe this phenomenon is mass transfer between the components of the system, which is viewed to change the period on the basis of angular momentum redistribution (Rucinski 1993).

The visual magnitude of BQ Ari changes from 10.28 to 10.55 and for V1370 Tau is 10.9 to 11.31 magnitude. Both of these binary systems have a short period; for BQ Ari is 0.282336 day and for V1370 is 0.295523 day (<https://www.aavso.org/vsx/index.php?>). The spectral type of these stars are unclear.

In this paper, the new light curve and ephemeris are presented. The data which used had inserted into the variable star section of Czech astronomical society's database (<http://var2.astro.cz>). We used these data to obtain the time of minimums, then calculate O-C with the new ephemeris for each star.

Observation

The observations for BQ Ari were made on 16 and 17 October 2017 at Broumov NMO station and for V1370 Tau were made on 15 and 16 November 2017 at Víglaš station. These data were observed by CCD photometry through the filter clear. The information of stars and observations is given in Table 1.

Table 1. Information of observers and instruments

Star	Star Coordination (j2000)	Observer	Instrument	Coordinates
BQ Ari	02 48 40.726 +13 44 48.02	Školník V	Tamron LNS 44/300 + Canon 600D	024840.7+134448
V1370 Tau	05 32 48.779 +19 02 3.69	Nosál P	NWT 150/600 + Canon 20D + MPCC mk.III	053248.8+190204

These data transforming from JD to HJD and changing to phase, based on the last ephemeris (Anton Paschke, 2011) the new light curves are presented in Figures 1 and 2.

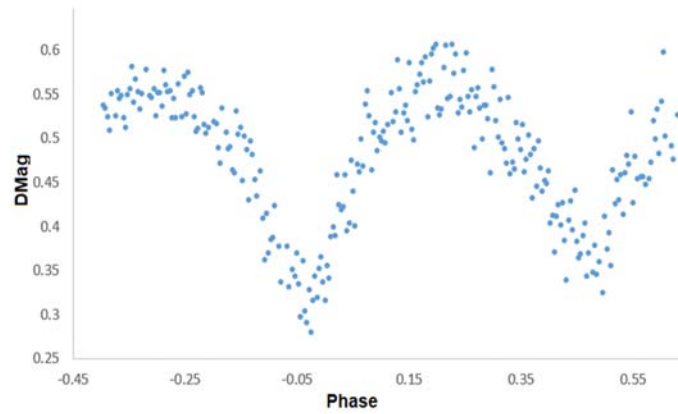


Figure 1. The light curve of BQ Ari

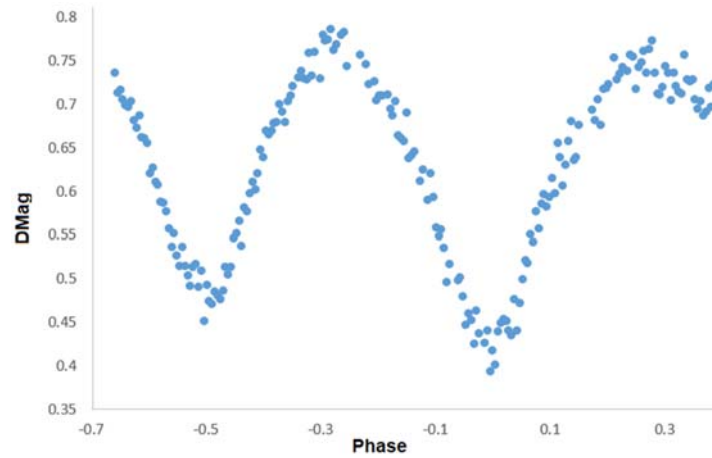


Figure 2. The light curve of V1370 Tau

Times of minimum

To determine the exact time of minimums through filter clear, the data were imported into the Table Curve software. Then by fitting a Gaussian curve, we get the minimum. The results are given in Table 2.

Table 2. The new Times of minimum in Clear filter

Star	MIN I (HJD)	MIN II (HJD)
BQ Ari	2458043.453995±0.00062529	2458043.596128±0.00095971
V1370 Tau	2458073.547877±0.00054767	2458073.402151±0.00045486

To calculate the new period, at first we should calculate Epoch for each new minimum, so we have used equation (1). In this equation, P (Period) and T₀ (ToM) is related to previous ephemeris (Table 3) and T is the new Time of Minimum. The results of this equation present in table 4.

$$T = P \times E + T_0 \quad (1)$$

Table 3. Previous ephemeris of BQ Ari and V1370 Tau

Star	ToM	Period	Reference
BQ Ari	2451382.9000 (HJD)	0.2823	(Paschke, 2011)
V1370 Tau	2456664.23601 (HJD)	0.2955	Bob Nelson's Database

Table 4. New Epoch and ToM for BQ Ari and V1370 Tau

Star	Epoch	ToM	Type
BQ Ari	23590.96107	58043.45400	I
	23591.46449	58043.59613	II
V1370 Tau	22352.59270	58073.54788	I
	22352.09958	58073.40215	II

To obtain a new period, we use the gradient of the diagram. The diagram contains previous ephemeris and calculations. They are given in Tables 5 and 6. The diagrams are presented in Figure 3. Also, the new period is given in Table 7 for each star.

Table 5. Previous calculation of BQ Ari

Epoch	ToM	Type	O-C	Reference
0	51382.902	-	0	GCVS 4
12104	54800.2853	I	-0.011644	IBVS 5918
14913	55593.361	I	-0.017768	OEJV 0142
15880	55866.378	I	-0.01968	BAVM 225
18349	56563.4596	I	-0.025664	IBVS 6118
18349.5	56563.6016	I	-0.024832	IBVS 6118
18384.5	56573.48279	II	-0.025402	IBVS 6114
18385	56573.62509	I	-0.02427	IBVS 6114
19572.5	56908.8959	II	-0.02746	JAVSO..42..426

Table 6. Previous calculation of V1370 Tau

Epoch	ToM	Type	O-C	Reference
0	51467.79345	-	0	IBVS 5570
14804.5	55842.85	-	-0.04627088	IBVS 6018
15179.5	55953.6685	II	-0.04972088	IBVS 6029
15192	55957.3634	I	-0.04888588	IBVS 6084
16431.5	56323.6548	II	-0.06097128	IBVS 6063
17346	56593.90371	-	-0.069858199	IBVS 6092
17584.5	56664.38308	I	-0.07324688	OEJV 0168

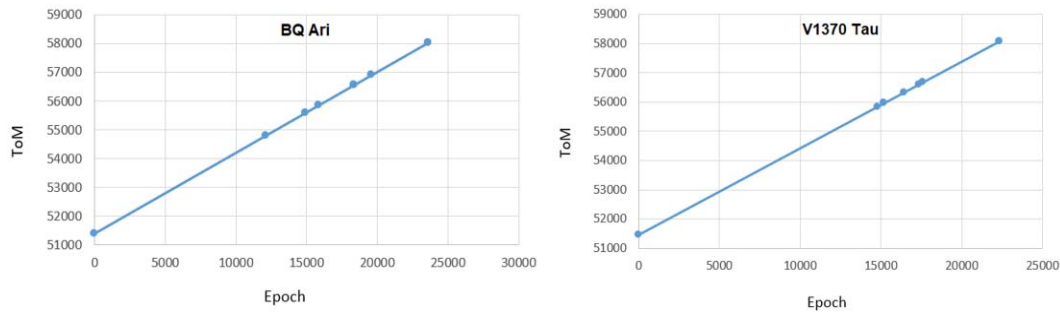


Figure 3. Diagram of BQ Ari and V1370 Tau

Table 7. The new period of stars

Star	Period (d)
BQ Ari	0.2823
V1370 Tau	0.2955

Finally, to calculating O-C we used equation 2 (Zahabi, 2014) and the result is given in Table 8.

$$O-C = (E - E') \times P_0 \quad (2)$$

Table 8. O-C of each minimum

Star	O-C	MIN
BQ Ari	0.010990	I
	0.010024	II
V1370 Tau	0.001873	I
	-0.000159	II

Conclusion

This paper's goal is to present a new light curve and ephemeris of two W Uma-type eclipsing binaries BQ Ari and V1370 Tau. The ephemeris is calculated in the following order for each star:

$$BQ \text{ Ari MIN I (HJD)} = 2458043.453995 (\pm 0.00062529) + 0.2823 \quad (3)$$

$$V1370 \text{ Tau MIN I (HJD)} = 2458073.547877 (\pm 0.00054767) + 0.2955 \quad (4)$$

O-C parameter is calculated based on Equation 2 and the result shown in Table 8.

Acknowledgment

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References

- A. Haghi, et al., 2015, Journal of Occultation and Eclipse (JOE), p14-29.
- Rucinski, 1993, Contact Binaries of the W UMa Type, The Realm of Interacting Binary Stars, doi: https://doi.org/10.1007/978-94-011-2416-4_8
- Anton Paschke, 2011, A list of minima and maxima timing, Open European journal on variable stars.
- S. Zahabi, A. Karbassi, A. Hasanzadeh, 2014, A study of period changes and light curve analysis of SW Lac, JOE 1.