CONSTANCY OF PERIOD IN TX CETI

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Abstract. A slightly improved period ($P = 0\overset{d}{.}7408401$) of the eclipsing binary system TX Ceti has been given, which is based on all available times of minima. The O–C diagrams based on the period given in PPEN (1980) and based on the new period, have been given. The period of TX Ceti shows fair constancy between the time interval 1928 to 1988. The present O–C diagrams do not confirm, either the presence of a third body or the presence of mass transfer as suggested earlier.

1. Introduction

The variability of the eclipsing binary TX Ceti (TX Cet = BD − 1°263 = = 261.1934 = P 2524) was detected by Hoffmeister (1934). The system was later observed by Piotrowski (cf. Szafraniec, 1959), Tsesevich (1954), Szczepanowska (1955), Kordylewski (cf. Duerbeck and Ammann, 1978), and BBSAG observers. Duerbeck and Ammann (1978) secured first photoelectric observations and analysed the system. Karimie and Duerbeck (1985) and Li and Leung (1987) also analysed the system using Duerbeck and Ammann's (1978) observations. In order to see the controversies regarding the presence of a third-body and mass transfer, detailed period study of TX Cet has been attempted in this paper for the first time.

2. Epoch, Period, and New Period

The epochs and period of the eclipsing binary system TX Cet have been given by various authors, which are given in Table I. Besides Hoffmeister (1934), Piotrowski (cf. Szafraniec, 1959), Tsesevich (1954), Szczepanowska (1953, 1955), Kordylewski (1959), Kordylewski (cf. Duerbeck and Ammann, 1978), Kurochkin (cf. Banachiewicz, 1973), Kreiner and Winiarski (1978), and BBSAG observers gave times of minima, which are given in Table II. We have collected 40 minima of TX Cet from the literature.

TABLE I

Epoch and period of TX Ceti

Sl. No.	Author	Epoch and period
1	Tsesevich (1954)	2431020.270 + $0\overset{d}{.}74084$
2	Kurochkin (1970)	2439415.489 + $0\overset{d}{.}74084$
3	Duerbeck and Ammann (1978)	2443082.6343 + $0\overset{d}{.}74084025$
4	Srivastava (present work)	2425502.499 + $0\overset{d}{.}7408401$

TABLE II

Minima of TX Ceti

J.D.⊙	Min.	Based on $P = 0\overset{d}{.}74084$				Based on $P = 0\overset{d}{.}7408401$				Reference
		Cycle	Mean of cycles	O–C	Mean of O–C values	Cycle	Mean of cycles	O–C	Mean of O–C values	
2425502.499	I	0		$0\overset{d}{.}000$		0		$0\overset{d}{.}000$		1
2426631.533	I	1524		−0.006		1524		−0.006		1
			1767		$-0\overset{d}{.}003$		1767		$-0\overset{d}{.}004$	
2426991.587	I	2010		0.000		2010		−0.001		1
2428833.302	I	4496		−0.014		4496		−0.014		2
2428834.454	II	4497.5		+0.028		4497.5		+0.027		2
			4499		−0.005		4499		−0.005	
2428836.256	I	4500		−0.023		4500		−0.023		2
2428839.232	I	4504		−0.010		4504		−0.011		2
2430968.42	I	7378		+0.003		7378		−0.011		3
2430997.30	I	7417		−0.009		7417		−0.010		3
2431000.272	I	7421		−0.001		7421		−0.001		3
2431020.270	I	7448		−0.005		7448		−0.005		4
2431020.271	I	7448	7459	−0.004	−0.001	7448	7459	−0.006	−0.003	4
2431023.238	I	7452		−0.001		7452		−0.001		3
2431058.07	I	7499		+0.012		7499		+0.011		3
2431080.282	I	7529		−0.001		7529		−0.002		3
2431089.170	I	7541		−0.003		7541		−0.004		3
2433.561.083	II	10877.5		+0.007		10877.5		+0.006		5
			10878		+0.002		10878		+0.001	
2433561.353	I	10878		−0.004		10878		−0.005		6
2436453.5927	I	14782		−0.0023		14782		−0.0043		7
2436453.593	I	14782	14782	−0.002	0.000	14782	14782	−0.004	−0.002	8
2436453.598	I	14782		+0.003		14782		+0.001		8
2437306.288	I	15933		−0.014		15933		−0.016		8
2439415.489	I	18780		+0.015		18780		+0.013		9
			19054		+0.008		19054		+0.006	
2439821.455	I	19328		+0.001		19328		−0.001		10
2443082.6343	I	23730		+0.0023		23730		+0.0003		11
2444486.514	I	25625		−0.010		25625		−0.012		12
2444555.428	I	25718		+0.006		25718		+0.004		12
			25713		+0.001		25713		0.000	

Table II (continued)

J.D.⊙	Min.	Based on $P = 0^d.74084$				Based on $P = 0^d.7408401$				Reference
		Cycle	Mean of cycles	O–C	Mean of O–C values	Cycle	Mean of cycles	O–C	Mean of O–C values	
2444567.293	I	25734		$+0^d.018$		25734		$+0^d.015$		12
2444598.399	I	25776		−0.009		25776		+0.006		13
2444895.464	I	26177		−0.003		26177		−0.006		14
2444987.326	I	26301	26261	−0.005	$-0^d.004$	26301	26261	−0.008	$-0^d.007$	15
2444990.291	I	26305		−0.004		26305		−0.006		15
2445252.554	I	26659		+0.002		26659		−0.001		16
2445255.524	I	26663		+0.009		26663		+0.006		16
2445296.258	I	26718	26723	−0.004	−0.002	26718	26723	−0.006	−0.005	17
2445336.257	I	26772		−0.010		26772		−0.013		17
2445359.226	I	26803		−0.007		26803		−0.010		17
2445673.348	I	27227		−0.001		27227		−0.004		18
2446762.402	I	28697		+0.018		28697		+0.015		19
2447471.363	I	29654		−0.005		29654		−0.008		20

References to Table II

1. Hoffmeister, C.: 1934, *AN* **253**, 195.
2. Piotrowski (cf. Szafraniec, R.: 1959, *AAPS* **3**, 259).
3. Tsesevich, W.: 1954, *Oddessa Izv.* **4**, 209.
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15. Locher, K.: 1982, *BBS* **58**, 3.
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17. Germann, R.: 1983, *BBS* **64**, 3.
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1. AAc = *Acta Astronomica c.*
2. AC = *Astronomical Circular.*
3. AAP = *Astronomy and Astrophysics (Supplement Series).*
4. AN = *Astronomische Nachrichten.*
5. BBS = *Bedeckungs Veränderlichen Beobachter der Schweizerischen Astronomischen Gesellschaft Bulletin.*
6. IBVS = *Information Bulletin on Variable Stars.*
7. Oddessa Izv. = *Oddesa Izvestia.*
8. SAC = *Rocznik Astronomiczny Obserwatorium Krakowskiego.*

By use of these minima, a new period of TX Cet has been obtained after trials, employing the method of least squares, which comes out to be $P = 0\overset{d}{.}7408401$ ($\pm 0\overset{d}{.}0000001$), which is not significantly different from the periods given earlier.

3. O–C Diagrams and Period Behaviour

In all, forty minima were available in the literature, which were observed in the time interval 1928 to 1988. Out of these only two minima are secondary, while the remaining minima are primary. Also, except the only photoelectric minima, given by Duerbeck and Ammann (1978), others are either photographic or visual.

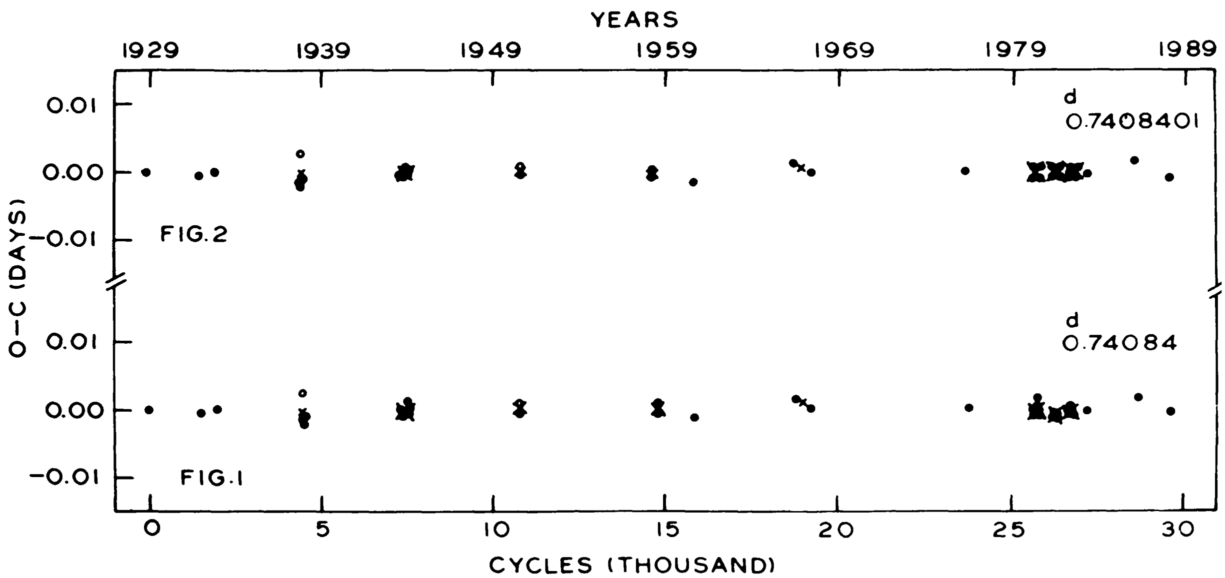

Fig. 1. O–C diagram based on the initial epoch and $P = 0\overset{d}{.}74084$. The solid and open circles represent primary and secondary minima, respectively, while the crosses represent mean O–C values.

Fig. 2. O–C diagram based on the initial epoch and $P = 0\overset{d}{.}7408401$. The solid and open circles represent primary and secondary minima, respectively, while the crosses represent mean O–C values.

Two O–C diagrams (Figures 1 and 2) have been constructed based on the following ephemeris:

$$\text{Primary minimum} = \text{J.D. } 2425\,502.499 + 0\overset{d}{.}74084E\,, \quad \text{(earlier period)}$$

and

$$\text{Primary minimum} = \text{J.D. } 2425\,502.499 + 0\overset{d}{.}7408401E\,, \quad \text{(present period)}$$

respectively.

Both O–C diagrams show that period of TX Cet is almost constant since its earliest determination.

4. Earlier Investigations

Duerbeck and Ammann (1978) first analysed the system using their photoelectric observations. They could not find a satisfactory solution using the Russell and Merrill (1952) method, thus they incorporated a third light of 40% to account for the small light losses during the minima. They also attempted a solution using synthetic light curve technique method, developed by Hill and Hutchings, and assuming that TX Cet consists of two strongly distorted Main-Sequence stars, which were, however, not in contact. They could not find an exact fit of the light curves, thus they incorporated some other assumptions.

Karimie and Duerbeck (1985) further analysed the system TX Cet using Duerbeck and Ammann's (1978) observations and applying synthetic technique method given by Wilson and Devinney. They stated that both components of TX Cet had nearly filled their critical volumina, and TX Cet has reached the terminal age Main Sequence. They have shown that they are almost in contact phase.

Li and Leung (1987) have again analysed the observations of Duerbeck and Ammann (1978) with the Wilson and Devinney model. They found that TX Cet either did not possess a third body at all or else the third light was marginally detectable. They also found that TX Cet was a semi-detached system with lower mass component filling its Roche-lobe. It is believed that TX Cet may be evolving from an evolved configuration. They stated that there was no doubt that the lower mass component had evolved, and was the mass looser. TX Cet may be in post-evolved contact phase, where the gainer is now absorbing mass slowly and starting detached from its Roche surface. Thus, the mass-transfer process is present in TX Cet.

All the above analyses are controversial about the presence of a third light and, the last two indicate that TX Cet is a semi-detached system, and both the components are in near contact phase. Also, that slow mass transfer process is possessed by the system.

It is strange that the present O–C diagrams show no evidence of any sinusoidal variation, i.e., no indication of the presence of a third body. Also, these diagrams show no evidence of any period change, thus there is no indication of detectable mass transfer, while even in the post-Main-Sequence evolution there should have been some signs of mass transfer. This situation is amounting to a paradox. It is strange to note that from the same photoelectric observations different results have been published in the literature.

Although the present O–C diagrams do not speak about any period change, yet badly needed photoelectric minima may reveal some more mysteries of TX Cet in future.

5. Conclusions

Detailed period study of TX Cet has been presented for the first time. The period shows no evidence of its change, however, it is strange for a semi-detached or for a nearly contact system. There is also no evidence of any third light being present in the system. The photoelectric minima are badly needed for TX Cet.

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