PERIOD CHANGES IN DF HYDRAE

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(Received 13 August, 1990)

Abstract. The period study of the eclipsing binary DF Hya, based on up-to-date minima has been presented. The least-squares method has been applied to obtain a new period, which comes out to be $0^d.3306017$. Period changes are found around the years 1949, 1974, and 1982. Appreciable period changes are apparent around 1949 and 1974, the strongest being around 1974. The period changes (ΔP) range from 0.46×10^{-6} d to 0.46×10^{-5} d, the average being 1.89×10^{-6} d. Such period changes are usual for a contact system, like DF Hya. Our results do not show increase in the time interval 1959–1985 as suggested by Zhang *et al.* (1989).

1. Introduction

The history of DF Hya is not clearly given in the literature. However, the oldest reference available to us is that of Hoffmeister (1934). He gave the magnitudes of DF Hya from photographic observations. Ashbrook (1952) observed the system visually. Tsesevich (1954a, b) also observed the system probably visually. These references are not available to us. Whitney (1959) gave the period of DF Hya. Koch and Koch (1962) gave photographic epoch of the system. Hoffmann (1983) and Zhang *et al.* (1989) observed the system photoelectrically.

2. Epoch, Period, and New Period

Ashbrook (1952), Tsesevich (1954a, b), Whitney (1959), Koch and Koch (1962), Diethelm (1974), Hoffmann (1983), and Zhang *et al.* (1989) gave the epochs of the system. Whitney (1959), Hoffmann (1983), Kholopov (1985), and Zhang *et al.* (1989) gave the new periods of DF Hya. The epochs and periods, given by various authors, have been listed in Table I.

TABLE I

Epochs and periods of DF Hya

Sl. No.	Author	Epoch and period
1	Srivastava (present work)	J.D. 2430677.048 + $0^d.3306017E$
2	cf. Kholopov (1985)	J.D. 2431138.231 + $0^d.3305978E$
3	Whitney (1959)	J.D. 2431138.231 + $0^d.3305990E$
4	Ashbrook (1952)	J.D. 2433009.418 + –
5	Brancewicz and Dworak (1980)	– + $0^d.330589E$
6	Zhang *et al.* (1989)	J.D. 2445021.5009 + $0^d.33060443E$
7	Zhang *et al.* (1989)	J.D. 2445021.5051 + $0^d.33060169E$ + $7^d.5 \times 10^{-11}E^2$
8	Hoffmann (1983)	J.D. 2445021.5060 + $0^d.3302005E$

Astrophysics and Space Science **181**: 15–20, 1991.

In all, 21 minima have been collected from the literature. Out of these 8 minima are photoelectric, 5 are visual while the remaining minima are probably photographic. Out of these 21 minima, 5 are secondary minima and remaining minima are primary.

From these minima, a new period has been derived, employing the method of least squares, which comes out to be $0^d.3306017 (\pm 0^d.0000005)$, which is not significantly different than the one given by Zhang *et al.* (1989).

3. O–C Diagrams and Period Changes

All the available times of minima, observed in the time-interval 1942–1985, have been collected and listed in Table II. The O–C diagrams (Figures 1(a) and 1(b)) have been constructed from the ephemeris

$$\text{Primary Minimum} = \text{J.D. } 2430677.048 + 0^d.3305990E\,, \quad \text{(Whitney, 1959)}$$

and

$$\text{Primary Minimum} = \text{J.D. } 2430677.048 + 0^d.3306017E\,, \quad \text{(present period)}$$

respectively.

The period changes have been assessed from the O–C diagram (Figure 1(b)). This O–C diagram splits up into 4 portions (*AB*, *BC*, *CD*, *DE*). The dashed trends indicate that the period changes are apparent around the years 1949, 1974, and 1982. The amount of period changes (ΔP) in different portions of the O–C diagram range from 0.46×10^{-6} d to 0.46×10^{-5} d. The stronger period changes are visible around 1949 and 1974. The average period change (ΔP) being 1.89×10^{-6} d, which is not unusual for a contact system, DF Hya (Brancewicz and Dworak, 1980). The derived period changes have been listed in Table III.

Two increasing and two decreasing trends are apparent in the O–C diagrams. Although, the portions *BC* and *CD* are scantily covered, yet points, *B*, *C*, and *D* are significant as not less than 3 points lie around these points.

Zhang *et al.* (1989) had stated that the accumulated effect of the O–C (S) showed that th eperiod of DF Hya was increasing in the years 1959–1985. This statement is not true in the light of present findings, wherein the period has shown decreasing tendency around the year 1949. Actually, Zhang *et al.* (1989) had overlooked 3 minima given by Diethelm (1974), which bridge the large gap between 1949 and 1985. These minima have changed the picture of period trends.

4. Summary

Up-to-date minima of DF Hya have been compiled and a detailed period study of DF Hya has been initiated. Appreciable period changes are found in different portions of the O–C diagram, the average being 1.89×10^{-6} d. This amount of average period change is usual for a contact system like DF Hya.

TABLE II

Minima of DF Hya

J.D.$_\odot$	Min.	Type of obs.	Based on $P = 0^d.3305990$				Based on $P = 0^d.3306017$				Reference
			Cycle	Mean of cycles	O–C	Mean of O–C values	Cycle	Mean of cycles	O–C	Mean of O–C values	
2430677.048	I	pg	0		$0^d.000$		0		$0^d.000$		6
2431138.231	I	v	1395		−0.003		1395		−0.006		5
				1496		$-0^d.005$		1496		$-0^d.009$	
2431204.677	I	pg	1596		−0.007		1596		−0.011		6
2431497.927	I	pg	2483		+0.002		2483		−0.005		6
				3148		−0.003		3148		−0.011	
2431937.615	I	pg	3813		−0.007		3813		−0.017		6
2432675.856	I	pg	6046		+0.006		6046		−0.010		6
2433009.418	I	pg	7055	7095	−0.006	−0.004	7055	7095	−0.025	−0.023	1
2433382.658	I	pg	8184		−0.012		8184		−0.034		6
2434847.708	II	pg	12615.5		−0.011		12615.5		−0.045		4
				13213		−0.012		13213		−0.047	
2435242.608	I	pg	13810		−0.012		13810		−0.049		6
2442089.281	I	v	34520		−0.044		34520		−0.138		2
2442109.447	I	v	34581	34584	−0.045	−0.048	34581	34584	−0.138	−0.142	2
2442132.412	II	v	34650.5		−0.056		34650.5		−0.150		2
2445021.3400	II	pe	43388.5		+0.1063		43388.5		−0.0198		3
2.445021.5009	I	pe	43389		+0.0929		43389		−0.0242		7
				43389		+0.0986		43389		−0.0208	
2445021.5051	I	pe	43389		+0.0971		43389		−0.0200		7
2445021.5060	I	pe	43389		+0.0980		43389		−0.01917		3

Table II (continued)

J.D.$_\odot$	Min.	Type of obs.	Based on $P = 0^d.3305990$				Based on $P = 0^d.3306017$				Reference
			Cycle	Mean of cycles	O–C	Mean of O–C values	Cycle	Mean of cycles	O–C	Mean of O–C values	
2446115.1385	I	466697		$+0^d.109$		46697		$-0^d.0170$			7
2446115.3043	II	46697.5		$+0.1095$		46697.5		-0.0165			7
			46700		$+0.1098$		46700		-0.0162		
2446117.1235	I	46703		$+0.1105$		46703		-0.0156			7
2446117.2886	II	46703.5		$+0.1103$		46703.5		-0.0158			7

References to Table II

1. Ashbrook, J.: 1952, *Astron. J.* **57**, No. 1198, 63.
2. Diethelm, R.: 1974, *Bedeck. Veränderl. Beob. Schweiz. Gesell. Bull.* **14**, 1.
3. Hoffmann, M.: 1983, *Inf. Bull. Var. Stars*, No. 2344.
4. Tsesevich, V. P.: 1954a, *Astron. Circ.* (*Kasan*) **40**.
5. Tsesevich, V. P.: 1954b, *Odessa Izv.* **4**(2), 101.
6. Whitney, B. S.: 1959, *Astron. J.* **64**, 258.
7. Zhang, Y., Liu-Qi., Yang, Y., Wang, Bi, and Zhang, Z.: 1989, *Inf. Bull. Var. Stars*, No. 3349.

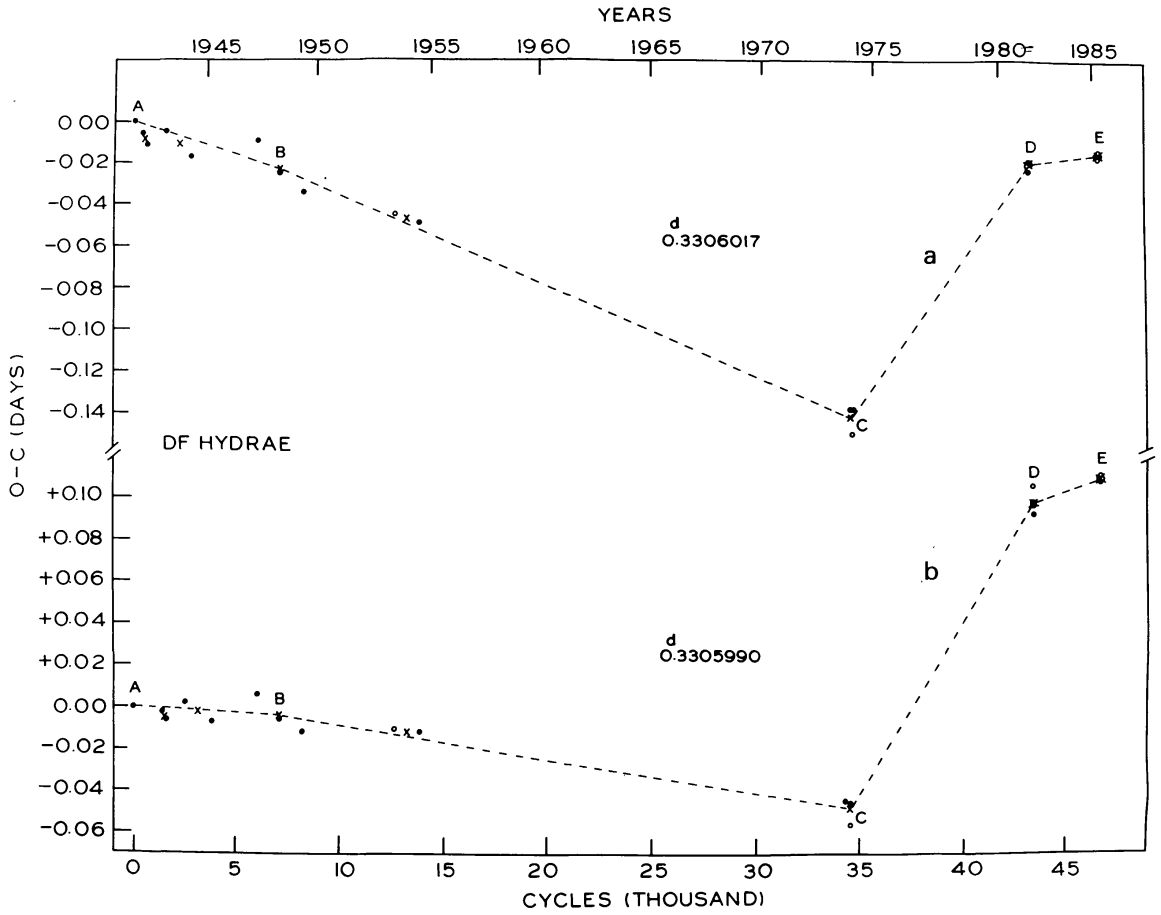

Fig. 1. O–C diagrams based on $P = 0^d.3305990$ (a) and $P = 0^d.3306017$ (b). Filled and open circles indicate primary and secondary minima, respectively, while the crosses represent the mean O–C values. Dashed lines represent the period trends.

Our results differ from those given by Zhang *et al.* (1989) in the sense that the period does not appear to be increasing in 1959 as suggested by Zhang *et al.* (1989), instead it is decreasing.

TABLE III

Changes in period of DF Hya

Portion	Interval of cycles	$\Delta P/P$	Total change in period ΔP (days)	Period trend
AB	0– 7095	3.24×10^{-6}	1.07×10^{-6}	*D*
BC	7095–34584	4.33×10^{-6}	1.43×10^{-6}	*D*
CD	34584–43389	1.38×10^{-5}	0.46×10^{-5}	*I*
DE	43389–46700	1.39×10^{-6}	0.46×10^{-6}	*I*
	Mean	5.69×10^{-6}	1.89×10^{-6}	

D = decrease, *I* = increase.

References

Ashbrook, J.: 1952, *Astron. J.* **57**, No. 1198, 63.
Brancewicz, H. K. and Dworak, T. Z.: 1980, *Acta Astron.* **30**, No. 4, 501.
Diethelm, R.: 1974, *Bedeck. Veränderl. Beob. d. Schweiz. Astron. Gesell. Bull.* **14**, 1.
Hoffmann, M.: 1983, *Inf. Bull. Var. Stars*, No. 2344.
Hoffmeister, C.: 1934, *Astron. Nachr.* **253**, No. 6058, 195.
Kholopov, P. N.: 1985, *General Catalogue of Variable Stars*, p. 122.
Koch, J. C. and Koch, R. H.: 1962, *Astron. J.* **67**, 462.
Tsesevich, V. P.: 1954a, *Astron. Circ. (Kasan)* **40**.
Tsesevich, V. P.: 1954b, *Odessa Izv.* **4**(2), 101.
Whitney, B. S.: 1959, *Astron. J.* **64**, 258.
Zhang, Y., Liu-Qi, Yang, Y., Wang, Bi, and Zhang, Z.: 1989, *Inf. Bull. Var. Stars*, No. 3349.