

## REVISED ELEMENTS FOR DT CYGNI

KATHERINE L. RHODE  
 Maria Mitchell Observatory  
 Nantucket, MA 02554

Received 12 December 1989

## Abstract

Recent observations of the s-Cepheid DT Cygni and published data were used to revise the elements for this star. An interpretation of the period changes of DT Cygni suggested by Szabados is not supported. Another interpretation of the period behavior is proposed.

\* \* \* \* \*

DT Cygni was included in a group of bright s-Cepheids observed for the Maria Mitchell Observatory (MMO) by the Automatic Photometric Telescope (APT) in Arizona. Details concerning the nature of s-Cepheids, as well as the manner in which data were obtained from the APT, are included in a paper about the s-Cepheid SU Cassiopeiae (Rhode 1989).

The APT observations of DT Cyg were obtained from the first quarter of 1987 through the second quarter of 1989. The comparison star was HD 202314,  $V = 6.17$ , and the check star was HD 202109,  $B = 4.19$ . Folded light curves were plotted in  $B$  and  $V$  using these data and elements from the **General Catalogue of Variable Stars** (Kholopov *et al* 1985) (GCVS). Figure 1 shows the  $V$  curve. The elements used are:

$$JD_{\max} = 2444046.969 + 2.499215 E. \quad (1)$$

Maximum on these light curves was found to be at phase  $-0.06$ , indicating that equation (1) is no longer applicable.

Because Szabados (1977) had made an extensive study of DT Cyg's period since its discovery, his published elements were used when making an O-C diagram. They are:

$$JD_{\max} = 2441737.793 + 2.499082 E. \quad (2)$$

Observations of DT Cyg were made and published after 1977 by Moffett (1984) and Guetter (1984), so three points were available to add to Szabados' O-C diagram. They are listed in Table I. Figure 2 shows Szabados' O-C diagram with the new points added.

O-C points were assigned error bars according to the weight assigned each of them by Szabados. The error bars are proportional to the square root of the weights of the points. Szabados gave visual and photographic observations weights of either 0.5 or 1, and photoelectric observations weights of either 2 or 3. In addition, Szabados gave zero weight to one point on his plot; it is indicated in Figure 2 by an open circle. The O-C points added to Szabados' diagram, namely the photoelectric observations made by Moffett, Guetter, and the APT, were all assigned a weight of 3.

There is an inconsistency in Szabados' Table 11, which lists O-C values he calculated from values of Observed Maximum JD (O) published in previous papers. The O value listed in the table from a paper by Svolopoulos (1960) is inconsistent with the corresponding O-C value. I examined the paper by Svolopoulos, and confirmed that the O value Szabados listed (2436099.527) is correct, but that the O-C should be  $-0.337$  instead of  $-0.437$ . This correction changes Szabados' O-C

diagram considerably; a line segment on his plot fitted to points with JD's between 2435259 and 2436099 should have a positive slope, rather than the zero slope which is shown.

Szabados had concluded from his O-C diagram that during long intervals (2000 to 4000 days) the elements of DT Cyg are constant, while during intermediate intervals the moments of maxima undergo phase shifts of 0.21 to 0.23 day or their multiples, while the period remains unchanged. Taking into account the corrected O-C value from Svolopoulos and the three points added to Szabados' O-C diagram since 1977, a new interpretation of the behavior of the period is proposed. The updated O-C diagram is well accommodated by three line segments, computed by least-squares and showing two changes in period after JD 2424375. The first and last segments have near zero slope, whereas the middle segment has a positive slope.

So, rather than supporting Szabados' assertion that DT Cyg's period is constant but subject to phase shifts, the O-C diagram in Figure 2 indicates a period behavior more like that of the s-Cepheid SZ Tauri, which also has what Szabados terms a "stepwise" O-C diagram. Like SZ Tau (Trammell 1987), DT Cyg shows a series of constant periods. The new elements implied by the first line segment, applicable between JD 2424000 and 2429000, are:

$$JD_{\max} = 2426005.004 + 2.499108 E. \quad (3)$$

$$\pm 0.018 \quad \pm 0.000030$$

New elements implied by the second line segment, applicable between JD 2432000 and 2439000, are:

$$JD_{\max} = 2437046.697 + 2.499280 E. \quad (4)$$

$$\pm 0.021 \quad \pm 0.000030$$

New elements implied by the third line segment, applicable between JD 2441000 and 2448300, are:

$$JD_{\max} = 2444374.335 + 2.499087 E. \quad (5)$$

$$\pm 0.023 \quad \pm 0.000029$$

The periods in equations (3) and (5) are close enough to suggest that the period possibly returned to its previous value.

This project was supported by the National Science Foundation grant AST-8619885, and the acquisition of the photoelectric data was made possible by funding from the Theodore Dunham, Jr. Grant for Research in Astronomy. I wish to thank Joyce Rey of the Harvard-Smithsonian Center for Astrophysics library, for accessing the SIMBAD data retrieval system to obtain bibliographical references on DT Cyg. This research was conducted under the guidance of Dr. Emilia P. Belserene, to whom I am grateful for her patience and encouragement.

**TABLE I**

O-C Values for DT Cyg Since 1977

<u>Observed Maximum</u> (JD)	<u>O-C</u> (days)	<u>Source</u>
2443652.143	0.053	Moffett (1984)
2445646.305	-0.052	Guetter (1984)
2447343.284	0.050	present paper

## REFERENCES

- Guetter, H. H. and Hewitt, A. V. 1984, *Inf. Bull. Var. Stars*, No. 2499.  
 Kholopov, P. N. *et al.* 1985, *General Catalogue of Variable Stars*,  
 Fourth Edition, Moscow.  
 Moffett, T. J. and Barnes, T. G. 1984, *Astrophys. Journ. Suppl.* 55,  
 389.  
 Rhode, K. L. 1989, *Journ. Amer. Assoc. Var. Star Obs.* 18, 119.  
 Svolopoulos, S. 1960, *Astron. Journ.* 65, 473.  
 Szabados, L. 1977, *Budapest Mitt.*, No. 70.  
 Trammell, S. 1987, *Journ. Amer. Assoc. Var. Star Obs.* 16, 104.

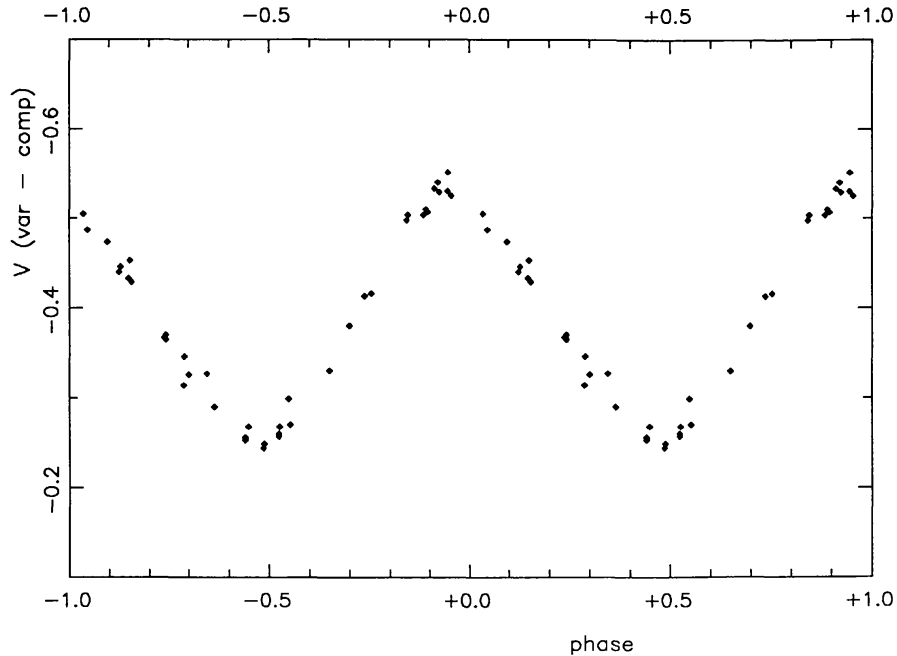


Figure 1. The  $V$  light curve of DT Cygni from JD 2446938 through 2447702. Phase is calculated from equation (1).

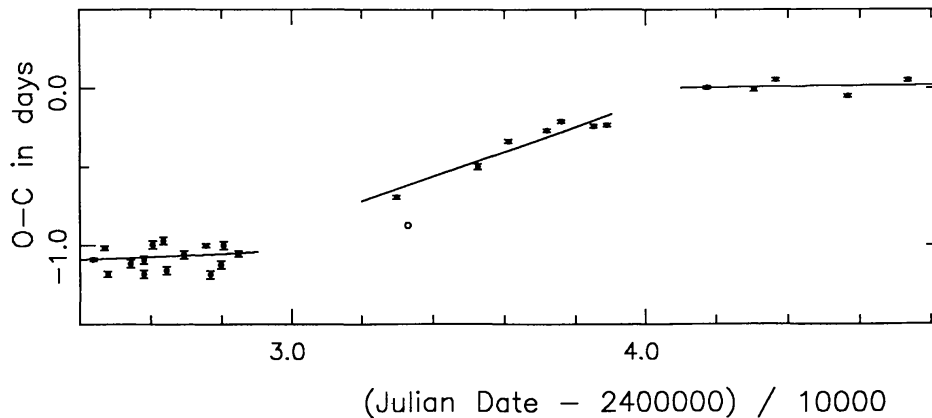


Figure 2. O-C in days plotted against Julian Date for DT Cyg.  $C = 2441737.793 + 2.499082 E$ . The line segments represent the elements in equations (3), (4), and (5). The open point was assigned zero weight by Szabados.