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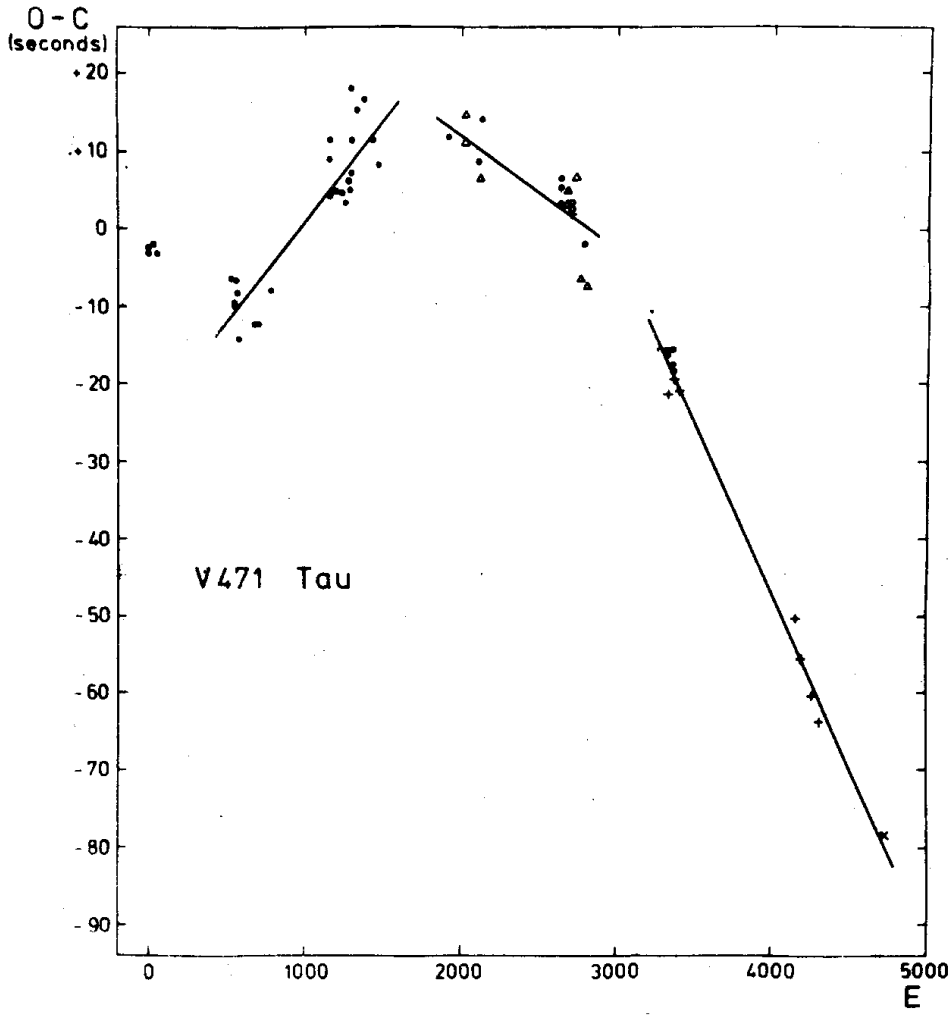
A DISCUSSION OF PERIOD CHANGES IN THE WHITE DWARF ECLIPSING BINARY SYSTEM V471 TAURI

Times of minimum have been obtained for the white dwarf eclipsing binary system V471 Tauri (BD+16°516) between 1973 and 1976. Seven eclipses were observed with the 76.1 cm telescope of the Rosemary Hill Observatory (RHO) and four with the No.4 40.6cm telescope of the Kitt Peak National Observatory (KPNO). The data are listed in Table 1 where the modified Julian Date (as defined by: MJD = JD - 2400000.5) of mid-eclipse is given as well as the O-C in seconds of time. The O-C's were computed from the light elements of Young and Lanning (1975) transformed to modified Julian Date: 40609.56490 + 0.52118346·E.

Plotted in Figure 1 are the O-C's from Table 1 (crosses) as well as those from Lohsen (1974) - open circles, Young and Lanning (1975) - dots, and Cester and Pucillo (1976) - triangles. The times of minima obtained by Ibanoglu (1976) have not been plotted because they were published to 0.001 day. Similarly, the average O-C has been plotted for the four new times obtained with the small telescope at KPNO.

It is apparent in Fig.1 that the period of V471 Tau has changed more than once since its discovery in 1969. Young and Lanning suggested that the changes were due to mass loss or mass transfer in the binary system. Herczeg (1975) objected on the grounds that the system is detached with no other evidence for mass flow. He suggested a light-time effect in an eccentric orbit around a third body. The trend of the recent O-C's in Figure 1 indicates that if there is a light-time orbit, its period is greater than the five years suggested by Herczeg. It should be noted that Herczeg's objection to mass flow may not be entirely valid: there are a number of binary systems in which large scale mass flow is suspected even though the systems are detached, e.g. the


O - C
(seconds)
+20
+10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
V471 Tau
0
1000
2000
3000
4000
5000
E

RS Canum Venaticorum systems.

From Figure 1 we see that since epoch 3500 the period has been relatively constant. It appears simplest to assume a period change at about epoch 1500 followed by a second change at about epoch 3000. (Apparently there was an earlier change just after the discovery of the system but there is too little information available for much discussion of this event.) We have fitted three straight lines to the available O-C's as indicated in Fig.1. The coefficients of these lines and the resulting linear light elements are given in Table 2. The third segment (C) should be useful for prediction of eclipses in the near future. For prediction of the first contact, 0.01699 day should be subtracted from the predicted time of mid-eclipse.

The O-C diagram consisting of linear segments would imply rather short time intervals when the period was changing separated by longer intervals of period constancy. Unfortunately, the time scales of the period changes can not be estimated from the available material because there are not enough timings at intervals when the linear segments join together. We can obtain the upper limit to such a time scale, however, assuming that the segment B is actually parabolic, implying a continuous period change between segments A and C. The time-scale (e-folding time) of the period change estimated in that way is 2×10^6 years. Such a time-scale, being comparable to the thermal time scale of the KOV component, suggests that this component (and its variable moment of inertia in particular) might cause the period changes observed in V471 Tauri.

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Table 1

Site	UT Date	t_{mid} (MJD)	Epoch	O-C (seconds)
RHO	30 Nov 73	42016.23908	2699	+ 1.9
RHO	26 Oct 74	42346.14794	3332	-21.5
RHO	2 Dec 74	42383.15197	3403	-21.1
RHO	22 Dec 75	42768.30621	4142	-50.2
RHO	11 Jan 76	42788.11112	4180	-55.5
RHO	17 Feb 76	42825.11509	4251	-60.4
RHO	11 Mar 76	42849.08949	4297	-63.7
KPNO	26 Oct 76	43077.3678	4735	-68
KPNO	27 Oct 76	43078.4100	4737	-82 -78.5
KPNO	28 Oct 76	43079.4523	4739	-88
KPNO	29 Oct 76	43080.4948	4741	-76

Table 2

Segment	Range in Epoch	Linear O-C Fit	Linear Light Elements (MJD)
A	500-1800	$-24^{s}.7+0^{s}.0259\times E$	$40609.56462+0.52118376\times E$
B	1800-3000	$+42.3-0.0151\times E$	$40609.56539+0.52118329\times E$
C	3000-5000	$+131.2-0.0445\times E$	$40609.56642+0.52118294\times E$

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