COMMISSIONS 27 AND 42 OF THE IAU
INFORMATION BULLETIN ON VARIABLE STARS
Number 3900

Konkoly Observatory
Budapest
21 June 1993
HU ISSN 0324 - 0676

TIMES OF MINIMUM LIGHT FOR 35 ECLIPSES OF 21 APSIDAL MOTION BINARIES

We report here on the continuation of a program of observing eclipsing binary systems suggested by Gimenez and Delgado (1980), and by Gimenez (1985), as candidates for possible detection of general-relativistic apsidal motion. Additional systems were observed from the table of Hegedüs (1988). This paper tabulates results since the last publication by Caton et al. (1989). The observations were made with the same equipment described in that paper.

The observations for a given eclipse were made through the V filter only, to maximize the number of data points. The observations have not been transformed to the Johnson system, since they were only intended for timing analysis. The observations are available from the IAU Archives, file number 248.

The times of minimum light and standard errors given in Table I were calculated using the method of Kwee and van Woerden (1956), using a program written by Ghedini (1982). This algorithm has been shown by Caton (1989) to give the most accurate estimation of time of conjunction for asymmetric light curves. The values of O−C were computed using the epoch and period in the fourth edition of the General Catalog of Variable Stars (Kholopov, 1985-87). The value of each O−C is listed to a precision usually limited by the precision of the published epoch.

Table I

System	Type of Eclipse	Heliocentric (−2400000)	O−C (days)	Comparison Star
BW Boo	Primary	48341.66516 ±0.00020	−0.0109	BD+37°2551
UW Boo	Primary	48362.65544 ±0.00029	+0.0074	BD+47°2135
AS Cam	Primary	48191.80069 ±0.00028	−0.01443	BD+69°0323
	Secondary	48601.60190 ±0.00025		"
PV Cas	Secondary	48208.65307 ±0.00013		BD+58°2555
	Primary	48237.54912 ±0.00093	−0.0054	"

Table I (cont.)

System	Type of Eclipse	Heliocentric (−2400000)	O−C (days)	Comparison Star
PV Cas	Primary	48538.61836 ±0.00058	−0.0169	BD+58°2555
V459 Cas	Primary	48209.67110 ±0.00009	−0.072	BD+60°0178
EK Cep	Primary	47840.60313 ±0.00049	+0.0051	BD+68°1239
	Primary	48234.67627 ±0.00012	+0.0047	"
CW Cep	Primary	48197.65350 ±0.00017	−0.0250	BD+62°2162
V1143 Cyg	Primary	48019.73800 ±0.00011	−0.0057	BD+54°2187
Y Cyg	Primary	48528.73157 ±0.00043	+0.1363	BD+34°4190
HS Her	Primary	48744.77194 ±0.00031	−0.0073	BD+24°3538
	Secondary	49105.81612 ±0.00025		
DI Her	Primary	48816.65450 ±0.00043	+0.0021	BD+24°3567
u Her	Secondary	48746.74837 ±0.00019		BD+32°2896
	Secondary	48022.72852 ±0.00092		BD+32°2896
TX Leo	Primary	49037.78855 ±0.00009	+0.0421	BD+10°2166
XX Leo	Primary	48352.70823 ±0.00018	See note	BD+14°2198
	Primary	48690.66135 ±0.00039		"
	Secondary	48705.71009 ±0.00049		"
	Secondary	48741.64571 ±0.00019		"
RR Lyn	Primary	48936.69194 ±0.00026	−0.0107	BD+56°1136
U Oph	Primary	48765.75180 ±0.00015	+0.0068	BD+02°3283
FT Ori	Secondary	47840.80454 ±0.00017		BD+21°1161

Table I cont.

System	Type of Eclipse	Heliocentric (−2400000)	O−C (days)	Comparison Star
FT Ori	Primary	48279.59924 ±0.00020	+0.00252	BD+21°1161
	Primary	48282.75125 ±0.00047	+0.00412	"
AG Per	Primary	48195.71090 ±0.00019	+0.026	BD+33°776
	Secondary	48196.81694 ±0.00131		"
	Secondary	47843.81937 ±0.00125		"
IQ Per	Primary	48183.74166 ±0.00028	+0.0035	BD+47°923
	Secondary	48196.81612 ±0.00142		"
TX UMa	Primary	48324.90636 ±0.00017	+0.0822	BD+46°1658
DR Vul	Primary	48536.69947 ±0.00078	+0.118	BD+26°3827

Notes

(1) The primary for AS Cam has a residual of −0.0156 days, and the secondary has a residual of −0.0098 when computed from the light elements of Maloney et al. (1989), continuing the slow migration to negative residuals that they noted.

(2) The times of minimum for the primaries of PV Cas are in reasonable agreement with the ephemerides of Gimenez and Margrave (1982), with (O−C)s of +0.0014 and −0.0004 days for JD 48237 and 48538, respectively. These are within the formal errors shown in Table I. The secondary's O−C from Gimenez and Margrave's prediction is −0.0013 days. We note that this is an order of magnitude larger than the formal error, the latter being determined from over a hundred measurements taken over 4.5 hours with good observing conditions (the V extinction coefficient, determined from the comparison star, was 0.12 mag/air mass with a standard error of 0.006). The mean difference in magnitude between the comparison and check star (BD +58°2561) for 24 measurements during the event was 0.088 ±0.009 magnitudes.

(3) In observing XX Leo it was found that the light elements in the General Catalog lead to an eclipse prediction off by about a half a cycle. We were able to observe enough events to determine that the current period is 0.9711296 days.

(4) Sharp-eyed readers will note two virtually simultaneous events observed on JD 2449196 – AG Per and IQ Per. On that night both events were observed by taking two variable measurements, bracketed by comparisons and skies, alternately on one system and the other. This reduced the number of data points but appears to not have greatly affected the result. The error, for 29 points was half the error for JD 2447843, which had

over a hundred measurements. However, the seeing conditions on that night, with (check star minus comparison) residuals of 0.008 magnitudes, were apparently not as good as on the two-event night, which had residuals of 0.004 magnitudes. On both nights the check star, BD +32°0714, was measured to be 0.223 magnitudes fainter than the comparison.

(5) The residual for TX UMa is −0.202 days when computed from the linear formula used by Todoran and Roman (1992), placing it a little above the last and lowest point in their O−C diagram (their Figure 1).

We would like to thank Mr. R. L. Hawkins and Mr. John Gullett for helping with some of the observations. We gratefully acknowledge the assistance of the staff at the U.S. Naval Observatory Library, in providing reference material. This research has made use of the Simbad database, operated at CDS, Strasbourg, France.

DANIEL B. CATON
WANDA C. BURNS
Dark Sky Observatory
Department of Physics
and Astronomy
Appalachian State University
Boone, North Carolina 28608 U.S.A.

References:

Caton, D. B., 1989, *Bull. A. A. S.*, **21**, No.1, 714
Caton, D. B., Hawkins, R. L., and Burns, W. C. 1989, *Inf. Bull. Var. Stars*, No. 3408
Ghedini, S., 1982, *Software for Photometric Astronomy*, Willman-Bell, Richmond, VA, p. 46
Gimenez, A., 1985, *Astrophys.J.* **297**, 405.
Gimenez, A. and Delgado, A., 1980, *Inf. Bull. Var. Stars*, No. 1815
Gimenez, A. and Margrave, T., 1982, *Astron. J.*, **87**, 1233
Hegedüs, T., 1988, *Bull. Inf. Centre Donnees Stellaires*, **35**, 15
Kholopov, P. N., editor 1985-87, *General Catalog of Variable Stars*, Fourth Edition, Nauka Publishing, Moscow
Kwee, K. and van Woerden, H., 1956, *B.A.N.*, **12**, 327
Maloney, F.P., Guinan, E.F., and Mukherjee, J., 1991, *Astron. J.*, **102**, 256
Todoran, I. and Roman, R., 1992, *Inf. Bull. Var. Stars*, No. 3819