COMMISSION 27 OF THE I.A.U.
INFORMATION BULLETIN ON VARIABLE STARS

Number 3495

Konkoly Observatory
Budapest
20 July 1990

HU ISSN 0374 - 0676

APSIDAL MOTION OF AS CAMELOPARDALIS

AS Cam (BD+69°325, HD 35311, V_{max}= +8.^{m}6) is a detached eclipsing binary consisting of two components of spectral types B8V and B9.5V in an eccentric orbit (e=0.135) and with orbital period equal to 3.43 days.

The spectroscopic orbit of this system was determined by Hilditch (1972). The last photometric studies have been made by Khaliullin and Kozyreva (1983). The apsidal motion of AS Cam has been recently discussed by Maloney et al. (1989). The authors used all the published timings of primary and secondary minima from 1899 to 1986 and confirmed a significant discrepancy between the observed value of periastron motion U_{obs}= 2400±850 yr and the theoretical one predicted by classical and general relativistic effects of U_{theo}= 815±81 yr. The cause of this discrepancy remained an unsolved problem (Maloney et al. 1989).

We observed AS Cam during two nights in January and April 1990. The observations were carried out at Mt. Suhora Astronomical Observatory of the Cracow Pedagogical University using the 60-cm Cassegrain telescope with a double-beam photometer (Szymanski and Udalski 1989). BD+69°323 was chosen as the comparison star. Two heliocentric moments of minima were computed using the Kwee and van Woerden method:

HJD Min	Type	Filter
2447898.2528 ± 0.0002	II	V
47982.5118 ± 0.0004	I	B

In order to investigate the period changes of AS Cam we have collected all minima available in the literature. Minima observed in different filters but in the same epoch were averaged. The final list of minima of AS Cam used in the

present analysis is given in Table 1, where a weight (WGT) has been arbitrarily assigned to each minimum.

In the next step we have assumed that the period changes are due to apsidal motion of the system only. The moments of both primary and secondary minima can be expressed by the approximate formulae (Martynov 1971):

(1)

$$\text{HJD Min} = M_o + P\cdot E + \begin{cases} -A\cdot\cos(\dot{\omega}\cdot E + \omega_o) & \text{- for primary min. (E is integer)} \\ +A\cdot\cos(\dot{\omega}\cdot E + \omega_o) & \text{- for secondary min. (E is halfed)} \end{cases}$$

where: $A = P\cdot e\cdot(1 + \text{cosec}^2 i) / 2\cdot\pi$. In the equation (1) we omitted terms of the order of e^2 and higher because of the low eccentricity of the orbit of AS Cam as well as a small interval of the observations in relation to the apsidal motion period. The values of M_o, P, A, $\dot{\omega}$, ω_o were adjusted *simultaneously* for both primary and secondary minima by means of the least squares method. The following parameters were obtained:

(2)

$$\text{HJD Min} = 2440204^d.4062 \pm 10 + 3^d.4309691 \pm 7 \cdot E \mp 0^d.111 \pm 7 \cdot \cos(0^\circ.0037 \pm 18 \cdot E + 198^\circ \pm 10)$$

The theoretical O-C curves for obtained parameters along with the observed O-C computed according to the linear elements given in eq.(2) are plotted in Figure 1 where only points with non-zero weight were presented. From the relation $U=360^\circ P/\dot{\omega}$ we estimated the value of apsidal motion period to be $U_{obs}=920\pm470$ yr and from the value of A the eccentricity of the system (assuming $i=89^\circ$) to be $e = 0.10 \pm 0.01$. In fact, a real value of e can be different from the presented value due to omission of the last terms in eq. (1). Nevertheless, our estimation showed that this difference should not be greater than 10%. The obtained value of e is significantly lesser than those known from photometric investigations (e=0.17) by Khaliullin and Kozyreva (1983) and used by Maloney et al. (1989) in their analysis of apsidal motion of AS Cam and those determined spectroscopically (e=0.135) by Hilditch (1972). The

Table I

No	HJD-2400000.	TYPE	M	WGT	REF	No	HJD-2400000.	TYPE	M	WGT	REF
1	15120.678	I	ptg	0	1	36	32937.702	I	ptg	1	1
2	15770.643	II	ptg	1	1	37	36612.310	I	ptg	1	1
3	16166.718	I	ptg	0	1	38	39859.4902	II	pe	10	1
4	16359.309	I	$ptg	1	2	39	39890.3692	II	pe	10	1
5	16360.754	II	$ptg	1	2	40	39924.6814	II	pe	10	1
6	16456.772	II	ptg	0	1	41	40132.4604	I	pe	10	1
7	16537.619	I	ptg	1	1	42	40204.5137	I	pe	10	1
8	16775.745	II	ptg	0	1	43	40269.6996	I	pe	10	1
9	17259.639	II	ptg	1	1	44	40626.5223	I	pe	10	3
10	18284.810	I	ptg	0	1	45	40911.297	I	pe	10	4
11	18431.585	I	ptg	1	1	46	40957.393	II	pe	10	4
12	18592.837	I	ptg	1	1	47	40959.327	I	pe	10	4
13	18750.564	I	ptg	1	1	48	40988.276	II	pe	10	4
14	20226.021	I	$ptg	1	2	49	40990.202	I	pe	10	4
15	20227.459	II	$ptg	1	2	50	40995.138	II	pe	10	4
16	20901.706	I	ptg	0	1	51	41007.3600	I	pe	10	3
17	21577.777	I	ptg	1	1	52	41547.5278	II	pe	10	5
18	22380.615	I	ptg	1	1	53	41578.4065	II	pe	10	5
19	22920.719	II	ptg	1	1	54	41580.3334	I	pe	10	5
20	23042.746	I	ptg	1	1	55	42460.4200	I	:vis	0	6
21	24648.596	I	ptg	1	1	56	44939.2415	I	pe	10	7
22	24991.572	I	ptg	1	1	57	44940.7526	II	pe	10	7
23	26000.306	I	ptg	1	1	58	45002.514	II	pe	10	8
24	26238.450	II	ptg	1	1	59	46397.4085	I	pe	10	9
25	26303.770	II	ptg	1	1	60	46500.331	I	pe	10	6
26	26422.379	I	ptg	1	1	61	46771.3810	I	pe	10	10
27	26751.617	I	ptg	1	1	62	47138.4956	I	pe	10	11
28	26753.583	II	ptg	0	1	63	47270.3851	II	pe	10	6
29	26988.454	I	ptg	1	1	64	47443.8483	I	pe	10	12
30	27187.554	I	ptg	0	1	65	47465.9520	II	pe	10	12
31	28127.474	I	ptg	1	1	66	47553.6410	I	pe	10	13
32	29194.531	I	ptg	1	1	67	47893.314	I	pe	10	6
33	29204.819	I	ptg	1	1	68	47898.2528	II	pe	10	14
34	30381.870	I	ptg	0	1	69	47982.5118	I	pe	10	14
35	32275.546	I	ptg	1	1						

Notes: (:)-uncertain, ($)-normal minimum

(1) Hilditch (1969), (2) Maloney et al. (1989), (3) Battistini et al. (1974), (4) Padalia and Srivastava (1975), (5) Guinan et al. (1976), (6) B.B.S.A.G. observers, (7) Khaliullin and Kozyreva (1983), (8) Pohl et al. (1983), (9) B.A.A.V.S. observers, (10) Guinan et al. (1987), (11) B.A.V. observers, (12) Lines et al. (1989), (13) Couls (1989), (14) this paper

theoretical estimations of U_{theo} using our value of e=0.10 yield the period of apsidal motion equal to 900 ± 70yr. Our analysis shows no differences between theory and observations. The cause of the anomalies obtained in earlier determinations of apsidal rotation of AS Cam might be due to the incorrect

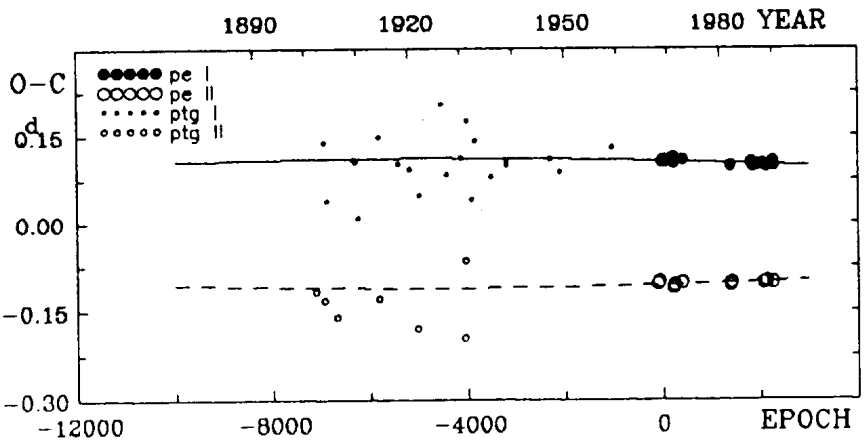

Figure 1

value of the orbital eccentricity of the system. It may be interesting to check our result by new spectroscopic and photometric observations.

This work has been partly supported by the Polish Academy of Sciences (grant CPBP 01.11).

J. KRZESIŃSKI, E. KUCZAWSKA, and G. PAJDOSZ
Institute of Physics, Pedagogical University,
Cracow, POLAND.

References:

Battistini,P., Bonifazi,A., and Guarnieri,A., 1974, I.B.V.S. No. 951.
Couls,C.J., 1989, I.B.V.S. No. 3369.
Guinan,E.F., Maloney,F.P., and Boyd,P.T., 1987, I.B.V.S. No. 3029.
Gulmen,O., Ibanoglu,C., Bozkurt,S., and Gudur,N., 1978, I.B.V.S. No. 1090.
Hilditch,R.W., 1969, Observatory 89, 143.
Hilditch,R.W., 1972, P.A.S.P. 84, 519.
Khaliullin,Kh.F., and Kozyreva,V.S., 1983, Ap.Sp.Sci. 94, 115.
Lines,H.C., Lines,R.D., Glownia,Z., and Guinan,E.F., 1989, P.A.S.P. 101, 925.
Maloney,F.P., Guinan,E.F., and Boyd,P.T., 1989, A.J. 98, 1800.
Martynov,D.Ya., 1971, in "Zatmennyje peremennyje zwezdy", ed. V.P. Zessewitch, Moscow, p.325.
Padalia,T.D., and Srivastava,R.K., 1975, Ap.Sp.Sci. 38, 87.
Pohl,E., Hamzaoglu,E., Gudur,N., and Ibanoglu,C., 1983, I.B.V.S. No. 2385.
Szymanski,M., and Udalski,A., 1989, Acta Astr. 39, 1.