COMMISSION 27 OF THE I. A. U.
INFORMATION BULLETIN ON VARIABLE STARS
Number 3494

Konkoly Observatory
Budapest
20 July 1990
HU ISSN 0374 - 0676

APSIDAL MOTION OF IQ PERSEI

IQ Persei (BD+47°920, HD 24909) is a bright (V_{max} = +7^m.7) eclipsing system consisting of two main sequence stars (B8+A6) with a slightly eccentric orbit (e = 0.075) and an orbital period of 1.74 days. The very accurate orbital and stellar properties of the system have been recently determined by Lacy and Frueh (1985) on the basis of new photometric and spectroscopic observations. The results of their studies yield among other things a value for the observed apsidal motion period of U_{obs}=140±30 yr.

Because Lacy's and Frueh's calculations of apsidal rotation were based only on two different epochs (about 13 years apart) of available data, we have decided to include IQ Per to our observational program to verify the value of apsidal motion of the system.

The apsidal motion of an eclipsing binary is well measured from the times of primary and secondary minima. We made photoelectric observations of minima of IQ Per during the period 1988-1990. They were observed using 60-cm Cassegrain telescope of the Mt. Suhora Observatory of the Cracow Pedagogical University. The observations were carried out using a one-channel photometer (Pajdosz and Zola 1989) in 1988 and a double-beam photometer (Szymanski and Udalski 1989) in years 1989-1990. Both BD+47°918 and BD+47°923 have been served as a comparison stars. Heliocentric times of minima (listed below) were determined using well known Kwee and van Woerden (KW) and graphical tracing-paper (TP) methods.

Year	HJD Min	Type	Filter	Notes
1988	2447268.366 ±0.001	I	V	(TP)
	47268.367 ±0.002	I	B	(TP)
1989	47783.5866±0.0006	II	V	(KW) normal
	47783.5867±0.0009	II	B	(KW) normal
1990	47948.3595±0.0010	I	B	(TP)
	47975.3810±0.0009	II	B	(KW)

In order to investigate the period behaviour of IQ Per 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 IQ Per used in the present analysis is given in Table 1, where a weight (WGT) has been arbitrarily assigned to each minimum.

If we assume that the period changes are due to apsidal motion of the system only and because of low eccentricity of the orbit of IQ Per, we can express the moments of primary and secondary minima by the approximate formulae (Martynov 1971):

$$\text{HJD Min} = M_o + P\cdot E + \begin{cases} -A\cdot\cos(\dot{\omega}\cdot E + \omega_o) & \text{- for primary min. (E is integer)} \\ +A\cdot\cos(\dot{\omega}\cdot E + \omega_o) & \text{- for secondary min. (E is halfed)} \end{cases} \quad (1)$$

where: $A = P\cdot e\cdot(1 + \mathrm{cosec}^2 i) / 2\cdot\pi$. According to this equation we computed the values of M_o, P, A, $\dot{\omega}$, ω_o using the least squares method, were sinusoidal curve (1) was *s i m u l t a n e o u s l y* fitted to both primary and secondary minima. The result is as follows :

$$\text{HJD Min}=2444290.3640 + 1^d.7435619\cdot E \mp 0^d.042\cdot\cos(0^\circ.0145\cdot E + 63^\circ.6) \quad (2)$$
$$\pm 4 \qquad \pm 2 \qquad \pm 2 \qquad \pm 12 \qquad \pm 2.0$$

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 shown in Figure 1. From the relation $U=360^\circ P/\dot{\omega}$ we estimated the value of apsidal motion period to be $U_{obs}=119\pm9$ yr and from the value of A the eccentricity of the system (assuming $i=89^\circ.3$) to be $e=0.076\pm0.004$. The value of e is in a good agreement with the value known from spectroscopic observations (given at the top of this paper). The theoretical estimations of U_{theo} using masses and radii published by Lacy and Frueh (1985) and the apsidal coefficients $k_1 = 0.0056$ and $k_2=0.0047$ (Hejlesen 1987) yield the value 103±10 yr.

Table I

No	HJD-2400000.	TYPE	M	WGT	REF	No	HJD-2400000.	TYPE	M	WGT	REF
1	33513.396	I	:vis	1	1	37	43399.385	I	vis	1	4
2	33546.500	I	vis	1	1	38	43460.407	I	vis	1	4
3	33900.449	I	vis	1	1	39	43481.306	I	vis	1	1
4	39859.933	I	pe	10	2	40	43512.716	I	vis	1	4
5	39866.911	I	pe	10	2	41	43596.399	I	vis	1	4
6	39873.885	I	pe	10	2	42	43772.503	I	vis	1	4
7	40222.597	I	pe	10	2	43	43936.371	I	vis	1	3
8	40223.5424	II	+‡pe	10	2	44	43957.335	I	vis	1	3
9	40555.618	I	pe	10	2	45	44140.405	I	:vis	1	4
10	40630.592	I	pe	10	2	46	44166.563	I	vis	1	4
11	40637.567	I	pe	10	2	47	44290.3461	I	pe	10	5
12	40644.541	I	pe	10	2	48	44637.303	I	vis	1	4
13	41040.332	I	:vis	1	1	49	44853.5193	I	pe	10	1
14	41230.389	I	vis	1	1	50	44925.907	II	+pe	10	6
15	41244.338	I	:vis	1	1	51	44926.749	I	pe	10	6
16	41249.567	I	vis	1	1	52	45622.425	I	vis	1	4
17	41373.358	I	vis	1	1	53	45636.401	I	vis	1	4
18	41603.504	I	vis	1	1	54	45983.359	I	vis	1	4
19	41673.266	I	vis	1	3	55	46112.3767	I	pe	10	4
20	41699.391	I	vis	1	3	56	46405.293	I	vis	1	1
21	41753.455	I	:vis	1	3	57	46717.391	I	vis	1	1
22	41781.354	I	vis	1	1	58	46731.348	I	vis	1	1
23	41971.394	I	vis	1	3	59	46764.486	I	vis	1	1
24	42060.338	I	vis	1	1	60	47029.490	I	vis	1	1
25	42074.275	I	vis	1	3	61	47057.388	I	:vis	1	1
26	42262.576	I	vis	1	3	62	47064.348	I	vis	1	1
27	42283.498	I	vis	1	1	63	47102.7277	I	pe	10	7
28	42283.513	I	vis	1	1	64	47151.551	I	vis	1	1
29	42414.250	I	vis	1	1	65	47207.328	I	vis	1	1
30	42433.447	I	vis	1	4	66	47207.334	I	:vis	1	1
31	42461.318	I	vis	1	3	67	47207.345	I	vis	1	1
32	42461.334	I	vis	1	4	68	47268.3665	I	pe	10	8
33	42740.304	I	vis	1	3	69	47783.5867	II	‡pe	10	8
34	42787.390	I	vis	1	3	70	47948.3595	I	pe	10	8
35	43141.351	I	vis	1	4	71	47975.3810	II	pe	10	8
36	43174.462	I	pe	10	1						

Notes: (:)-uncertain, (‡)-normal minimum, (+)-derived from original observations

(1) B.A.V. observers, (2) Hall et al. (1970), (3) B.B.S.A.G. observers,
(4) B.A.A.V.S.S. observers, (5) Pohl et al. (1982), (6) Lacy and Frueh (1985),
(7) Caton et al. (1989), (8) this paper

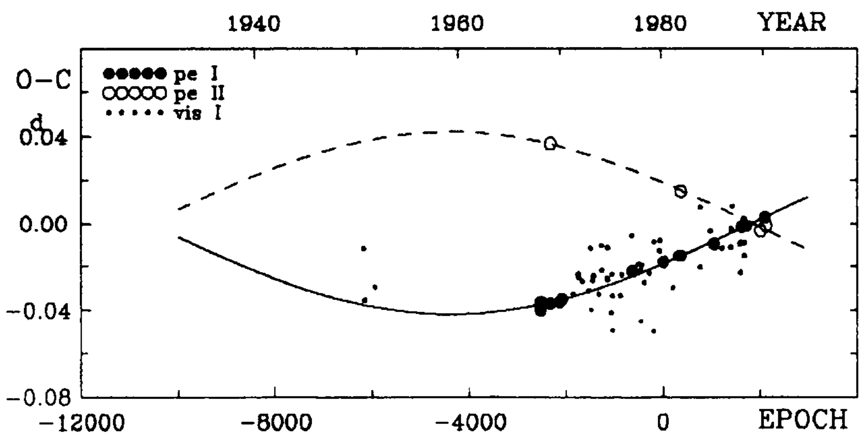

Figure 1

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

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