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On the orbital periods of the eclipsing binaries CM Lacertae, AB Andromedae and YY Eridani

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Abstract. A study of all the available photoelectric times of minima of CM Lac, AB And and YY Eri does not reveal any changes in their orbital periods.

Key words : eclipsing binaries—period changes

1. Introduction

Close eclipsing binaries exhibit regular variations in their orbital periods when reliable and accurate minimum-time data are used in the investigation. The probable cause for these variations in many systems is light-time effect of a multiple system (*cf.* Panchatsaram 1981 a, b; Panchatsaram & Abhyankar 1981a). However, it is also important to note those systems which have more or less constant orbital period over a time scale of a few decades. Among the 22 systems studied by us, only four systems CM Lac, Z Her, AB And and YY Eri seem to maintain nearly constant periods so far, at least from the times when they were first observed photoelectrically. It is however quite possible that changes will be revealed in course of time. The system Z Her was already discussed by us earlier (Panchatsaram & Abhyankar 1981b); a complete study by Plavec *et al.* (1961) of its orbital period including all types of minima has not revealed any change in its period. Here we will discuss the remaining three systems individually.

2. CM Lacertae

It is a detached system consisting of two normal main-sequence stars of spectral types A2 and A8, (Barnes *et al.* 1968). There are no conspicuous anomalies both in light and radial velocity curves. Therefore, the masses and radii of the components of this system can be more reliably determined (Popper 1968). All the published photoelectric times of minima have been collected and presented in Table 1. The minimum-time residuals have been computed through the light-elements given by Koch *et al.* (1963). A glance at the $O-C$ diagram shown in Figure 1 reveals that there has been no change in its period for at least 26 yr—an

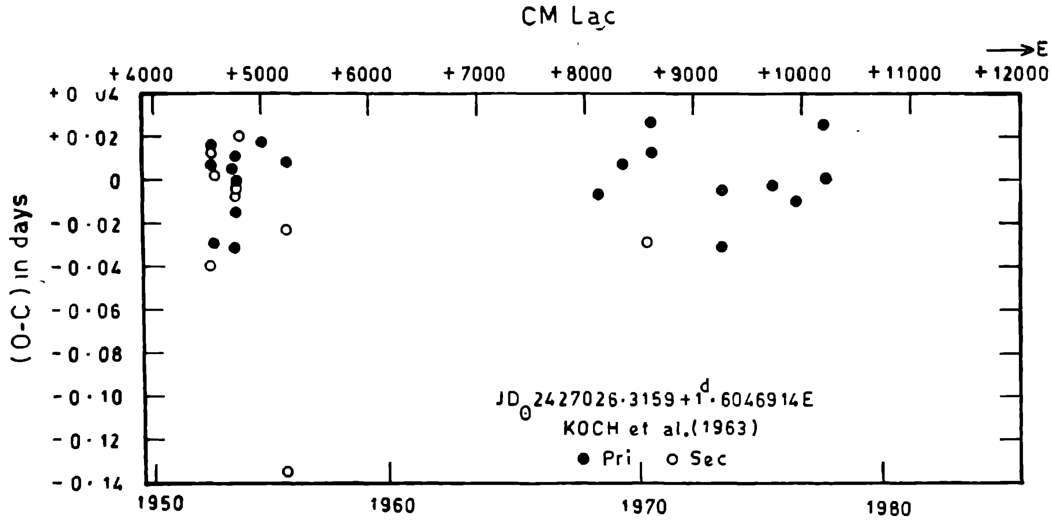

Figure 1.

Table 1. Photoelectric times of minima of CM Lac

Sl. No.	JD⊙		E	O − C	Notes
				d	
1.	243 4294.7615	II	+4530	−0.00409	1
2.	4315.6278	II	+4543	+0.00122	1
3.	4327.6626		+4550	+0.00083	1
4.	4343.7103		+4560	+0.00162	1
5.	4352.5348	II	+4566	+0.00032	1
6.	4356.5434		+4568	−0.00281	1
7.	4594.8425	II	+4717	−0.00038	2
8.	4606.8788		+4724	+0.00073	2
9.	4610.8892	II	+4727	−0.00053	2
10.	4643.7859		+4747	−0.00007	2
11.	4656.6221		+4755	−0.00140	1
12.	4660.635	II	+4758	−0.00023	2
13.	4664.6440		+4760	−0.00296	1
14.	4680.6950		+4770	+0.00113	1
15.	4729.6390	II	+4801	+0.00204	1
16.	5070.6358		+5013	+0.00192	1
17.	5419.6408	II	+5231	−0.01346	1
18.	5423 6670		+5233	+0.00101	1
19.	5440.5131	II	+5244	−0.00215	1
20.	244 0048.386		+8115	−0.00061	3
21.	0401.4195		+8335	+0.00079	3
22.	0787.3442	II	+8576	−0.00279	4
23.	0848.328		+8614	+0.00274	4
24.	0856.3501		+8619	+0.00138	4
25.	1893.7814		+9265	−0.00032	5
26.	1905.8139		+9273	−0.00300	5
27.	2636.7537		+9728	−0.00013	5
28.	2989.7850		+9948	−0.00094	5
29.	3360.4957		+10184	+0.00259	6
30.	3389.3542		+10197	+0.00010	6

Notes: 1. Alexander (1958) 2. Barnes *et al.* (1968) 3. Pohl and Kizilirmak (1970) 4. Kizilirmak and Pohl (1971) 5. Scarfe and Barlow (1978) 6. Ebersberger *et al.* (1978).

interval of time for which we have continuous photoelectric observations of minima. Further, the observed minima are represented with remarkable accuracy by the ephemeris given by Koch *et al.* (1963). One important feature in the $O-C$ diagram of CM Lac is that the scatter $\approx 0^{d}.006$ of points is not really negligible. Such a sizable spread of points in the $O-C$ diagram directs us to infer transient asymmetries in the minimum profiles, although no observer has reported on this phenomenon specifically. It may be noted however, that Alexander (1958) found some anomalies only in the outside eclipse light curves while Barnes *et al.* (1968) in *B* light curve alone.

3. AB Andromedae

Oosterhoff (1950) suggested a probable third component in the system AB And to explain the period changes he had found from an analysis of his photographic times of minima. It is generally agreed that the period of AB And is continuously increasing (Rigterink 1973, Landolt 1969). If the $O-C$ diagram is constructed using all types of minima one can find a secular increase of period. The photographic minimum points available in the early times exhibit virtually no marked scattering, whereas the later visual minima are not accurate. The spread of points around JD 243 7570 and JD 243 9800 is enormous amounting to $> 0^{d}.03$. Therefore, we restrict the discussion only to photoelectric minimum points. All the photoelectric times of minima and their residuals from the ephemeris of Quester (1967) are given in Table 2. The photoelectric $O-C$ diagram shown in Figure 2 exhibits a constancy of period for the last 23 years, except for a slight disturbance around JD 244 2053 ($E = +1800$). At that epoch there should have been a marked activity in the eclipse light curves resulting in abrupt discontinuity in the $O-C$ curve. Though the photoelectric points show a straight line segment for the small time interval considered here, it might be a part of the long term sinusoidal changes. However, this long term variation is expected to be subject to the subtle phenomena causing the discontinuity in the $O-C$ curve, of course, on a relatively much smaller scale. Quester's (1967) ephemeris so far represents all the photoelectric minima quite well.

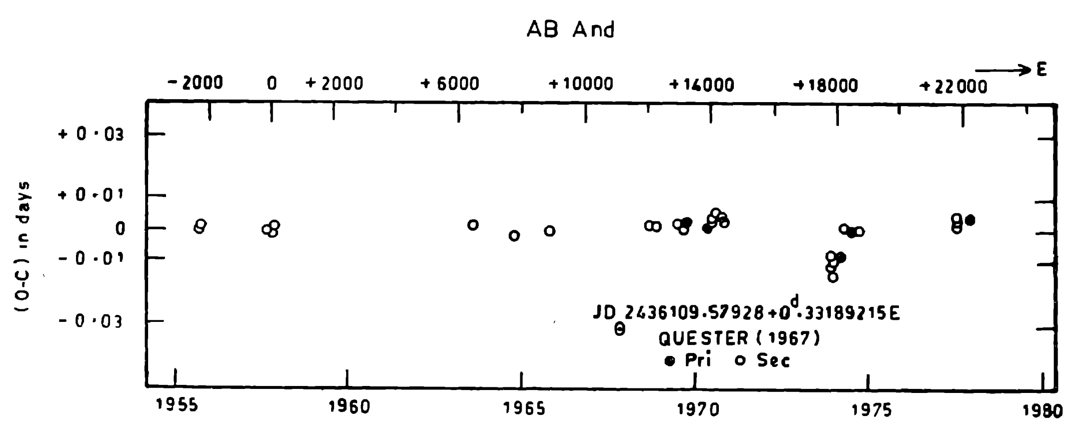

Figure 2.

Table 2. Photoelectric times of minima of AB And

Sl. No.	JD$_\odot$	E	$O-C$	Notes
			d	
1.	243 5370.4555	−2227	+0.00004	1
2.	5371.4515	−2227	+0.00036	1
3.	6109.5786	0	−0.00068	1
4.	6109.57835	0	−0.00093	2
5.	6124.6795	+45	−0.00087	1
6.	6124.68008 II	+45	−0.00029	2
7.	6132.6464 II	+70	+0.00062	1
8.	6132.64609 II	+70	+0.00031	2
9.	8288.453	+6565	+0.00176	3
10.	8672.449	+7722	−0.00146	4
11.	9051.305	+8863	−0.00035	4
12.	244 0128.79450	+12110	+0.00129	5
13.	0129.79008	+12113	+0.00119	5
14.	0131.78155	+12119	+0.00131	5
15.	0158.66477	+12200	+0.00126	5
16.	0158.83125 II	+12201	+0.00180	5
17.	0433.4725	+13028	+0.00229	6
18.	0474.294	+13151	+0.00106	6
19.	0833.4034	+14233	+0.00315	7
20.	0828.7568	+14219	+0.00304	8
21.	0828.9226 II	+14220	+0.00290	8
22.	0829.7525	+14222	+0.00307	8
23.	0829.9181 II	+14222	+0.00272	8
24.	0842.3655	+14260	+0.00416	9
25.	0846.3487	+14272	+0.00466	9
26.	0855.3094	+14299	+0.00427	9
27.	0883.6855 II	+14384	+0.00359	8
28.	0883.8511	+14385	+0.00325	8
29.	0885.6769 II	+14390	+0.00364	8
30.	0885.8427	+14391	+0.00349	8
31.	0886.6728 II	+14393	+0.00386	8
32.	0886.8382	+14394	+0.00332	8
33.	2043.3047	+17878	−0.00838	10
34.	2043.4649	+17879	−0.01412	10
35.	2045.2941	+17884	−0.01034	10
36.	2049.4433	+17897	−0.00978	10
37.	2053.4262	+17909	−0.00959	10
38.	2128.2694 II	+18135	−0.00807	10
39.	2258.3792 II	+18527	+0.00001	11
40.	2258.5451	+18527	−0.00004	11
41.	2265.3490 II	+18548	+0.00008	11
42.	2300.3636	+18653	+0.00005	11
43.	2300.5295 II	+18654	0	11
44.	3369.3904	+12874	+0.00224	12
45.	3370.3873	+21877	+0.00346	12
46.	3371.3827	+21880	+0.00318	12
47.	3373.3744	+21886	+0.00353	12
48.	3375.3653	+21892	+0.00307	12
49.	3481.4057 II	+22212	+0.00394	13

Notes : 1. Szafraniec (1962) 2. Binnendijk (1959) 3. Pohl and Kizilirmak (1964) 4. Pohl and Kizilirmak (1966) 5. Landolt (1969) 6. Pohl and Kizilirmak (1970) 7. Popovici (1971) 10. Tufekcioglu (1977a) 11. Popovici (1974) 12. Tufekcioglu (1977b) 13. Ebersberger *et al.* (1978).

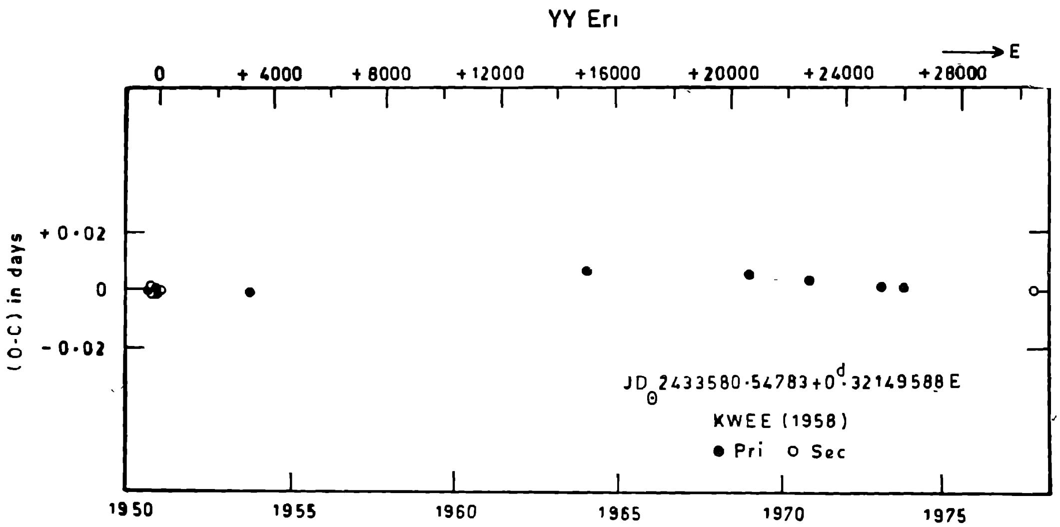

Figure 3.

4. YY Eridani

Both stars of this system are dwarfs and nearly of the same spectral type G5, G5. Kwee (1958) found that the period had increased since the time of older observations. It is unfortunate that we are able to get only a few photoelectric times of minima which have been listed in Table 3. The photoelectric $O-C$ diagram shown in Figure 3 is based on the 'still valid' light elements given by Kwee (1958). These

Table 3. Photoelectric times of minima of YY Eri

Sl. No.	JD⊙		E	O − C	Notes
1.	243 3574.6001	II	−19	−0.0006 d	1
2.	3580.5480		0	+0.00017	1
3.	3587.4606	II	+21	+0.00061	1
4.	3599.5163		+59	+0.00022	1
5.	3611.5724	II	+96	+0.00022	1
6.	3617.5197		+115	−0.00015	1
7.	3619.4487		+121	−0.00013	1
8.	3624.4318		+136	−0.00021	1
9.	3626.5215		+143	−0.00024	1
10.	3630.3800		+155	+0.00031	1
11.	3631.3438		+158	−0.00037	1
12.	3631.5050	II	+158	+0.00008	1
13.	3632.4692	II	+161	−0.00021	1
14.	3633.4337	II	+164	−0.00020	1
15.	4647.59263		+3319	−0.00002	2
16.	8413.281		+15032	+0.00711	3
17.	244 0201.4399		+20594	+0.00592	4
18.	0868.5418		+22669	+0.00387	5
19.	1680.3167		+25194	+0.00167	6
20.	1928.5125		+25966	+0.00265	6
21.	1928.5116		+25966	+0.00175	6
22.	3398.5500	II	+30538	+0.00024	7

Notes : 1. Cillie (1951) 2. Kwee (1958) 3. Pohl and Kizilirmak (1966) 4. Pohl and Kizilirmak (1970) 5. Kizilirmak and Pohl (1971) 6. Pohl and Kizilirmak (1974) 7. Ebersberger *et. al.* (1978).

meagre but accurate data do not show any change in the period in at least the last 20 years.

Finally it may be mentioned that regular photoelectric observations should be made for these systems to find any changes in their periods in future.

References

Alexander, R. S. (1958) *Astr. J.* **63**, 106.
Baglow, R. L. (1952) *Publ. David Dunlop Obs.* **2**, No. 1.
Barnes, R. C., Hall, D. S. & Hardie, R. H. (1968) *Publ. astr. Soc. Pacific* **80**, 69.
Binnendijk, L. (1959) *Astr. J.* **64**, 65.
Cillie, G. G. (1951) *Harvard Bull. No. 920.*
Ebersberger, J., Pohl, E. and Kizilirmak, A. (1978) *Inf. Bull. Var. Stars No. 1449.*
Kizilirmak, A. & Pohl. E. (1971) *Inf. Bull. Var. Satrs No. 530.*
Koch, R. H., Sobieski, S. & Wood, F. B. (1963) *Publ. Univ. Pa. Astr. Series. 9.*
Kwee, K. K. (1958) *Bull. Astr. Inst. Neth.* **14**, 131.
Landolt, A. U. (1969) *Astr. J.* **74**, 1078.
Oosterhoff, P. Th. (1950) *Bull. Astr. Inst. Neth.* **11**, 217.
Panchatsaram, T. (1981a) *Ap. Sp. Sci.* **77**, 179.
Panchatsaram, T. (1981b) *Bull. astr. Soc. India* **9**, 139.
Panchatsaram, T. & Abhyankar, K. D. (1981a) *J. Ap. Astr.*, **2**, 29.
Panchatsaram, T. & Abhyankar, K. D. (1981b) *Bull. astr. Soc. India*, **9**, 31.
Plavec, M., Smetanova, M. & Pekny, Z. (1961) *Bull. astr. Inst. Czech.* **12**, 117.
Pohl, E. & Kizilirmak, A. (1964) *Astr. Nachr.* **288**, 69.
Pohl, E. & Kizilirmak, A. (1966) *Astr. Nachr.* **289**, 191.
Pohl, E. & Kizilirmak, A. (1970) *Inf. Bull. Var. Stars No. 456.*
Pohl, E. & Kizilirmak, A. (1974) *Inf. Bull. Var. Stars No. 937.*
Popovici, C. (1971) *Inf. Bull. Var. Stars No. 508.*
Popovici, C. (1974) *Inf. Bull. Var. Stars No. 931.*
Popper, D. M. (1956) *Ap. J.* **124**, 196.
Popper, D. M. (1968) *Ap. J.* **154**, 191.
Quester, W. (1967) *Inf. Bull. Var. Stars No. 190.*
Rigterink, P. V. (1973) *Astr. Ap. Suppl.* **12**, 313.
Scarfe, C. D., Niehaus, R. J., Barlow, D. J. & Baldwin, B. W. (1973) *Inf. Bull. Var. Stars No. 844.*
Scarfe, C. D. & Barlow, D. J. (1978) *Inf. Bull. Var. Stars No. 1379.*
Szafraniec, R. (1962) *Acta Astr.* **12**, 181.
Tufekcioglu, Z. (1977a) *Inf. Bull. Var. Stars No. 1254.*
Tufekcioglu, Z. (1977b) *Inf. Bull. Var. Stars No. 1368.*