PERIOD STUDY OF AL CAMELOPARDALIS

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Abstract. A detailed period study of the eclipsing binary system AL Cam is presented. A new period of $1^d.3283304$ has been given. Period fluctuations are apparent around the years 1931, 1934, 1948, and 1965. Large scatter present in the early part of the O–C diagrams does not allow us to estimate the actual value of period changes present in different portions of O–C diagrams.

1. Introduction

The eclipsing binary system AL Camelopardalis (= AL Cam = BD + 81°382 = BV38; $10^m.5$, A4V–A7V) was observed photographically by Strohmeier (1958), who gave its photographic light curve. Quester and Braune (1965) gave a visual minimum based on Braune's observations. Hilditch and Hill (1975) gave Strömgren indices of the system.

2. Epoch, Period, and New Period

Seventy-five minima have been collected from the literature. Out of which 25 minima are visual, while the remaining minima appear to be photographic. All are primary minima and there is complete absence of secondary minima. Out of these, 2 minima have not been considered in the discussion as they give unusual values of O–C (s), which differ from the regular trend of the period of the system. Epochs and periods of system, given by various authors, are given in Table I.

Using 73 minima, a new period of $1^d.3283304$ ($\pm 0^d.0000001$) has been obtained after trials, applying the method of least squares.

3. O–C Diagrams and Period Changes

No detailed period study of the eclipsing binary system AL Cam is available in the literature. Strohmeier (1958) and Quester and Braune (1965) gave minima of AL Cam. Strohmeier and Bauernfeind (1968) collected times of minima and fitted a period of the system. BBSAG observers have also given minima of AL Cam.

We have constructed two O–C diagrams (Figures 1 and 2) with the ephemerides:

$$\text{Primary Minimum} = \text{J.D. } 2\,416\,172.778 + 1^d.328343E \quad \text{(Strohmeier, 1958)}$$

and

$$\text{Primary Minimum} = \text{J.D. } 2\,416\,172.778 + 1^d.3283304E \quad \text{(present period)},$$

respectively.

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TABLE I

Epochs and periods of AL Cam

Sl. No.	Author	Epoch and period
1	Strohmeier (1958)	J.D. 2426411.511 + $1^d.328343E$
2	Quester and Braune (1965)	J.D. 2426411.523 + $1^d.32833335E$
3	Quester and Braune (1965)	J.D. 2439029.362 + − E
4	Srivastava (present work)	J.D. 2416172.778 + $1^d.3283304E$

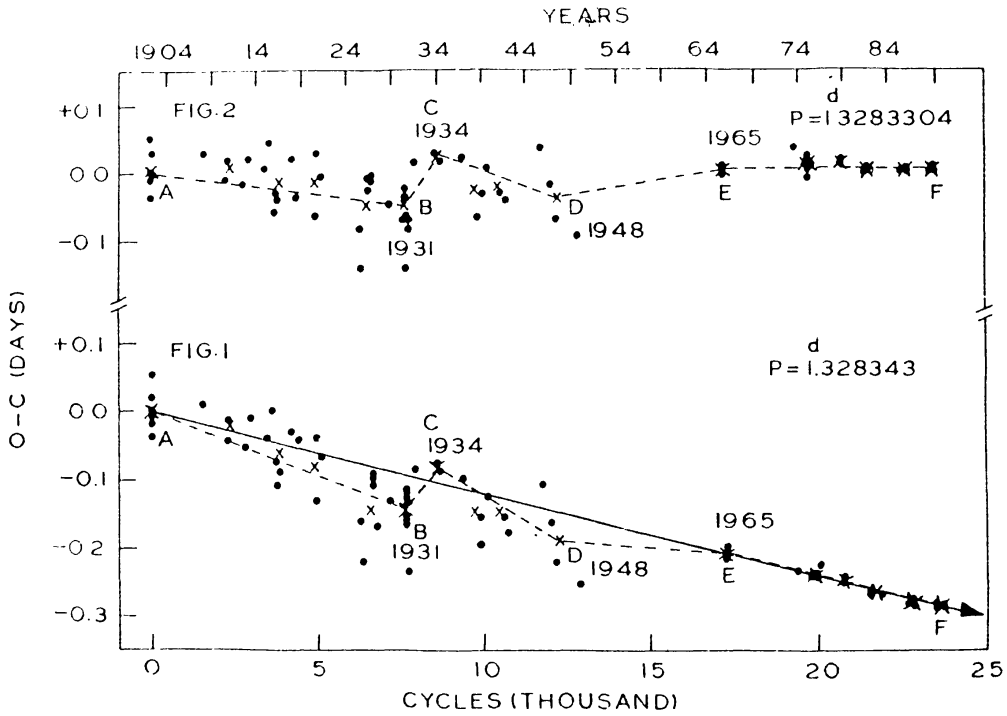

Fig. 1. O–C diagram based on $P = 1^d.328343$. The solid circles represent the primary minima and the crosses represent mean O–C values. The solid line with an arrow at one end shows the line passing through most of the mean O–C values, while the dashed lines represent the period fluctuations.

Fig. 2. O–C diagram based on $P = 1^d.3283304$. The solid circles indicate the primary minima, while the crosses indicate the mean O–C values. Dashed lines represent the period fluctuations.

The minima of AL Cam have been listed in Table II.

Figure 1 shows mostly negative O–C values and, thus, the period appears to be overestimated in the beginning by Strohmeier (1958).

There is large scatter in the O–C diagrams. In order to locate the epochs of period change, the minima have been grouped, according to their separability, as shown in Table II, and the means of O–C values have been shown as crosses in the figures. The O–C diagram (Figure 2) has been used to assess the period changes of AL Cam.

The O–C diagram (Figure 2) splits up into five portions between points A nd F, which

TABLE II

Minima of AL Cam

J.D.$_\odot$	Min.	Based on $P = 1^d.328343$				Based on $P = 1^d.3283304$				Reference
		Cycle	Mean of cycles	O–C	Mean of O–C values	Cycle	Mean of cycles	O–C	Mean of O–C values	
2416172.778	I	0		$0^d.000$		0		$0^d.000$		3
2416176.757	I	3		−0.306(?)		3		−0.306(?)		3
2416180.710	I	6		−0.038		6		−0.038		3
2416224.635	I	39	279	+0.052	$+0^d.001$	39	279	+0.052	$+0^d.005$	3
2416536.733	I	274		−0.011		274		−0.008		3
2416900.731	I	548		+0.021		548		+0.028		3
2417244.735	I	807		−0.016		807		−0.006		3
2418349.942	I	1639		+0.010		1639		+0.030		3
2419218.630	I	2293		−0.039		2293		−0.010		3
2419226.627	I	2299	2402	−0.012	+0.008	2299	2402	+0.008	0.000	3
2419102.711	I	2808		−0.054		2808		−0.019		3
2420121.926	I	2973		−0.016		2973		+0.022		3
2420755.522	I	3450		−0.039		3450		+0.004		3
2420990.678	I	3627		0.000		3627		+0.046		3
2421165.912	I	3759		−0.107		3759		−0.060		3
2421169.928	I	3762	3875	−0.076	−0.063	3762	3875	−0.029	−0.014	3
2421322.672	I	3877		−0.092		3877		−0.043		3
2421783.667	I	4224		−0.032		4224		+0.021		3
2422050.603	I	4225		−0.093		4225		−0.037		3
2422811.707	I	4498		−0.129		4498		−0.066		3
2422855.634	I	5031	4883	−0.038	−0.079	5031	4883	+0.026	−0.016	3
2422973.823	I	5120		−0.071		5120		−0.007		3
2424453.861	I	6296		−0.165		6296		−0.085		3
2424620.815	I	6360		−0.224		6360		−0.144		3
2424939.739	I	6600	6550	−0.103	−0.143	6600	6550	−0.020	−0.049	3
2424943.717	I	6603		−0.110		6603		−0.027		3
2424963.665	I	6618		−0.087		6618		−0.004		3
2425231.907	I	6820		−0.170		6820		−0.016		3
2425627.787	I	7118		−0.136		7118		−0.047		3
2426372.887	I	7679		−0.236		7679		−0.140		3
2426411.511	I	7708		−0.134		7708		−0.038		1
2426411.523	I	7708		−0.122		7708		−0.026		2
2426412.806	I	7709	7671	−0.168	−0.144	7709	7671	−0.071	−0.048	3
2426428.748	I	7721		−0.166		7721		−0.069		3
2426436.752	I	7727		−0.132		7727		−0.035		3
2426452.707	I	7739		−0.117		7738		−0.020		3
2426711.764	I	7934		−0.087		7934		+0.013		3
2427532.687	I	8552		−0.080		8552		+0.027		3
			8668		−0.086		8668		+0.023	
2427840.850	I	8784		−0.092		8784		+0.018		3

Table II (continued)

J.D.$_\odot$	Min.	Based on $P = 1^d.328343$				Based on $P = 1^d.3283304$				Reference
		Cycle	Mean of cycles	O–C	Mean of O–C values	Cycle	Mean of cycles	O–C	Mean of O–C values	
2428616.597	I	9368		$-0^d.098$		9368		$+0^d.020$		3
2429357.715	I	9926	9751	−0.195	−0.149	9926	9751	−0.071	−0.027	3
2429401.591	I	9959		−0.154		9959		−0.029		3
2429616.813	I	10121		−0.124		10121		+0.003		3
2430109.590	I	10492	10436	−0.162	−0.155	10492	10436	−0.030	−0.023	3
2430377.900	I	10694		−0.178		10694		−0.043		3
2431181.705	I	11299		−0.020(?)		11299		+0.122(?)		3
2431813.904	I	11775		−0.112		11775		+0.036		3
2432173.831	I	12046	12220	−0.116	−0.189	12046	12220	−0.015	−0.038	3
2432294.652	I	12137		−0.225		12137		−0.072		3
2433338.700	I	12923		−0.254		12923		−0.092		3
2439029.356	I	17207		−0.220		17207		−0.003		4
2439029.362	I	17207		−0.214		17207		+0.003		5
2439029.365	I	17207		−0.211		17207		+0.006		2
2439033.347	I	17210		−0.214		17210		+0.003		5
			17218		−0.214		17218		+0.003	
2439053.272	I	17225		−0.214		17225		+0.003		5
2439057.254	I	17228		−0.217		17228		0.000		5
2439057.259	I	17228		−0.212		17228		+0.005		4
2439057.263	I	17228		−0.208		17228		+0.009		6
2441853.394	I	19339		−0.239		19339		+0.034		7
2442403.324	I	19747		−0.243		19747		+0.006		8
2442408.641	I	19751		−0.239		19751		+0.009		9
			19758		−0.238		19758		+0.011	
2442460.444	I	19790		−0.242		19790		−0.007		10
2442460.450	I	19790		−0.236		19790		−0.013		11
2442913.420	I	20131		−0.230		20131		+0.023		12
2443702.437	I	20725		−0.249		20725		+0.011		13
			20727		−0.248		20727		+0.013	
2443706.425	I	20728		−0.246		20728		+0.014		13
2444625.390	I	21465		−0.270		21465		0.000		14
2444705.322	I	21480	21612	−0.263	−0.268	21480	21612	+0.007	+0.004	15
2445252.592	I	21892		−0.271		21892		+0.005		16
2446121.314	I	22546		−0.285		22546		−0.001		17
2446259.464	I	22650	22618	−0.283	−0.284	22650	22618	+0.003	+0.001	18
2446271.417	I	22659		−0.285		22659		0.000		18
2447262.354	I	23405		−0.291		23405		+0.003		19
2447307.518	I	23439	23505	−0.291	−0.290	23439	23505	+0.004	+0.005	20
2447614.367	I	23670		−0.289		23670		+0.008		21

? = Unusual value differing from normal period trend not included in the mean and not plotted in the figures.

References to Table II

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BBS = Bedeckungsveränderlichen Beobachter der Schweizerischen Astronomischen Gesellschaft, Bulletin.
IBVS = Information Bulletin on Variable Stars.
KLVB = Kleine Veröffentlichungen der Remeis-Sternwarte, Bamberg.
VBAM = Veröffentlichungen der Remeis-Sternwarte, Bamberg.

are shown by dashed lines. The reality of period change between points A to D is masked by the large scatter of O–C values. The portions DE and EF are, however, comparatively well-defined and appear to have ΔP of the order of 10^{-5} d and 10^{-7}, respectively. It is apparent that photographic minima show more scatter than the visual minima.

It is strange to note that neither the photoelectric observations are available for this system nor any secondary minimum has been given in the literature so far. Since no details about the nature of the system and about its evolution is available, thus, it is difficult to comment on the large scatter present in the O–C values of AL Cam. Irrespective of the large scatter, the O–C values, after grouping of minima, vary beyond the limit of usual observational errors of minima, and nearly to 2σ level. The period change around the year 1948 is considerable, however, the portion DE is scantily covered. After 1965, the period shows fair constancy.

4. Summary

Detailed period study of AL Cam shows that period changes of varying orders, are present, however, it is not fruitful to estimate the period changes in different portions of the O–C diagrams due to large scatter. The absence of analytical details and complete absence of secondary minima disallow us to search out the cause of considerable scatter present in the O–C values of the minima of the system. It is surprising that no secondary

minimum has been observed or reported so far in a period of nearly 85 years of its observations.

References

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