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THE CHANGING PERIOD OF DL CASSIOPEIAE

DL Cas is an eight day classical Cepheid in the open cluster NGC 129. It had been suspected by Gunther (1953, Astr. Nachr., 281, 267) of having a changing period because various authors in the past had obtained slightly different periods, ranging between 7.99988 and 8.0012 days. The star has now been investigated on Harvard plates of the AC series taken with a 1.5-inch Cooke lens (scale 600"/mm) between 1898 and 1953. Dr. E.B.Newell and two of his graduate students, who had been investigating other aspects of the cluster, took part in the observations:

Hoffleit	1160 estimates
Newell	124
S. Danford	182
H. Falk	321
TOTAL	1 787

The star, 9.17 - 10.6 mag (pg), is greatly overexposed on many of the plates and is also frequently affected by overlapping images of a nearby star, resulting in appreciable magnitude scattering in the derived light curves. Phases were first computed on the basis of a close approximate period, and mean light curves were then derived for successive intervals of 1000 days. Corrections to the period were then ascertained from the deviations of the various mean curves from one-another. Within a 1000-day interval a change in the fifth place of the period is scarcely significant. The one constant period, 8.00026 days, that best represents the observations was independently determined and is very close to the period given in the recent General Catalogue of Variable Stars, 8.00027 days. However, the dispersion of the observations at the steepest part of the ascending light curve appears excessive. The deviations from the mean show progressive, non-linear changes in phase. Several trial changing periods were therefore derived. These improved the dispersion, but the nature of the correction term was not sufficiently definitive.

Almost twenty years have elapsed since the last of the Harvard patrol plates on this region. Subsequently, in 1957 and 1959, two excellent photoelectric light curves were obtained by Arp, Sandage and Stephens (1959, Astrophys. J., 130, 80) and Oosterhoff (1960, Bull. Astr.Inst. Nether., 15, 199), respectively. While their phases did not deviate greatly from the predicted values, they did suggest the need for more recent observations. Hence my summer student assistants at the Maria Mitchell Observatory and I obtained 28 additional short exposure plates with the 7.5-inch Cooke triplet in the summer of 1971. These new observations definitely confirm that the period is not constant.

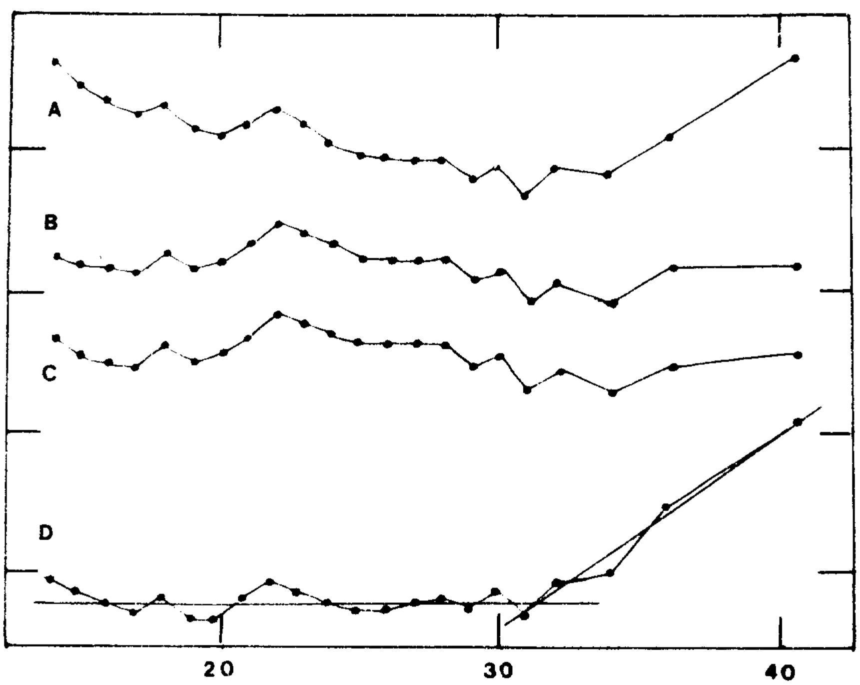

Figure 1. Deviations of phase of steepest ascent as function of J.D. Ordinate markers at intervals of 0.1 period. Abscissae, (JD-2400000)/1000

In Figure 1 and Table I the deviations of the individual 1000-day mean curves for each 1000-day interval from their common mean are represented for several of the more promising solutions. The top curve is for the basic constant reciprocal period of 0.124996. Next, a parabola and a cosine curve were fitted to the deviations.

TABLE I. Dispersion in Ascending Phase
for Various Reciprocal Trial Periods

	1/Period	Phase	Correction	σ	n	JD Interval*
A	0.124996	0		$\pm$0.025	22	14–41
B	0.124996		$-4.10^{-10}(JD-2427000)^2$	.012	22	14–41
C	0.124996		$+0.04 \cos 0^\circ.01(JD-2427000)$	.012	22	14–41
D	0.125000	0		.031	22	14–41
E	0.125000	0		.008	18	14–31
	0.124987	0		.007	5	31–41

*(JD–2400,000/1000)

The Table shows the dispersion at the phase of steepest ascent, computed as $\sigma = \pm\sqrt{\Sigma(\varphi_a - \varphi_o)^2/n}$ where φ_a is the observed mean phase of ascent in any particular 1000-day interval, and φ_o is the overall mean of these phases; n is the number of 1000-day intervals represented.

The parabolic term (B) and the cosine term (C) provide practically identical improvement. This is possible because the observations span less than half a cycle of the assumed cosine curve. In the final curve in Figure 1, and lines E of the Table, it is seen that an abrupt change in period after JD 2431000 (ca 1945) represents the present observations satisfactorily. The reciprocal period prior to that time was 0.125000, and later, 0.124987, corresponding, respectively, to periods of 8.00000 and 8.00083 days. The resulting light curves are shown in Figure 2, where the dots represent means from the Harvard plates in successive 1000-day intervals, the open circles represent single observations by Arp *et al* and by Oosterhoff, and the crosses the individual Maria Mitchell Observatory plates.

It is curious to note that the periods obtained are so close to exactly eight days that even over a 50-year interval the points show significant gaps in the light curve at every one eighth of the period for observations made at a single location.

Scattered previously published observations (cited by Gunther, 1953), although on possibly different magnitude-systems, are not in contradiction to the present results. The Harvard estimates, handicapped as they are by large observational uncertainties, seem to suggest that the star may also undergo slow variations in amplitude or magnitude at maximum. Photoeledtric observations of DL Cas over the next decade would be needed to confirm or refute this suspicion.

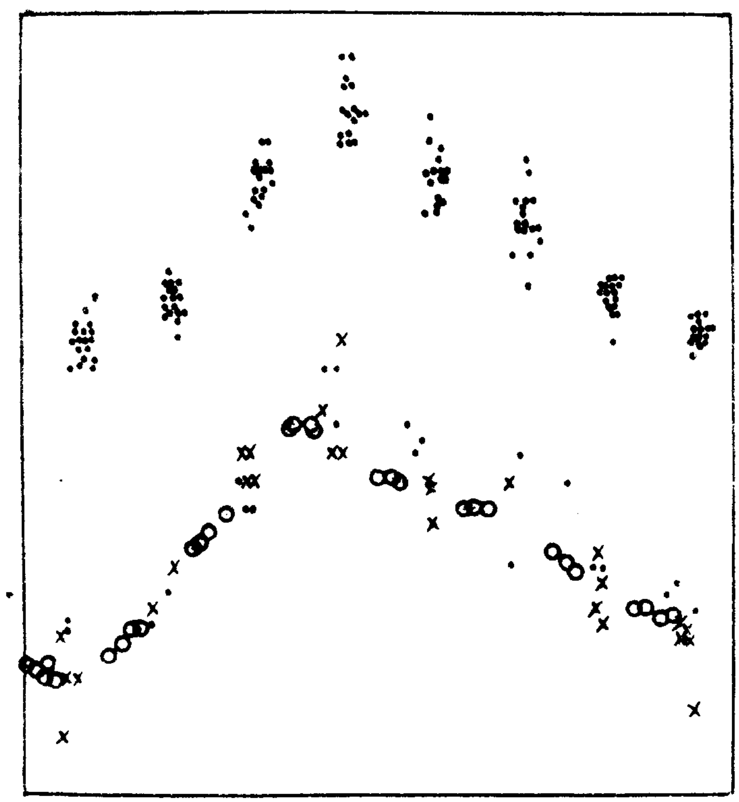

Figure 2. Upper diagram: the Harvard observations prior to JD 2431000 represented by reciprocal period 0.125000. Lower diagram: the later observations represented by 0.124987.

I wish to thank Dr. Newell for instigating this investigation, and the National Science Foundation for the grant to the Maria Mitchell Observatory, Nantucket, Massachusetts, which was used in part to obtain the 1971 observations and complete the numerical analysis of all of the observations.

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