

THE PERIOD BEHAVIOR OF
THREE RR LYRAE VARIABLES IN COMA BERENICES

DIANE GILMORE
Maria Mitchell Observatory
Nantucket, MA 02554

Abstract

Three stars from a Lick RR Lyrae star survey were studied on plates of the Maria Mitchell Observatory. The periods of two stars, DV and CD Com, were revised. The period of the other, CK Com, was found to have had two changes during the interval 1964-1979.

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1. Introduction

During the summer of 1979, three RR Lyrae variables in Coma Berenices were investigated on some 200 Nantucket plates exposed between 1964 and 1979. All three stars had previously been studied at Lick Observatory by Kinman *et al.* (1965) and by Butler *et al.* (1979). All times quoted in these studies are heliocentric.

2. DV Comae Berenices

The first star studied was DV Comae (variable #26 in the Lick survey). Using the period published in the earlier Lick paper (0.54084), seasonal light-curves were plotted and phases of maxima determined. Next, the phase difference (cycles) between observed and computed maxima given by J.D. (Max.) = 2437736.549 + 0^d.54084 E was plotted against Julian Date for each season. Analysis of this plot led to equation (1):

$$\text{J.D. (Max.)} = 2443279.665 + 0^{\text{d}}.5408432 \text{ E.} \quad (1)$$

A repetition of this process using eq. (1) produced Figure 1. The line, obtained from a least squares solution, represents the final elements:

$$\text{J.D. (Max.)} = 2437700.314 + 0^{\text{d}}.5408441 \text{ E.} \quad (2) \\ \pm 0^{\text{d}}.000006 \text{ (m.e.)}$$

The two crosses on Figure 1 represent O-C values obtained by fitting a mean light-curve to observations given in the Lick papers. A line drawn through them would give a period near 0^d.540842, which is about 2×10^{-6} days longer than the original Lick period, but 4×10^{-6} days longer than the revised period given by Butler *et al.* (1978). It seems reasonable to suppose that in the revision the correction was applied with the wrong sign.

3. CK Comae Berenices

The second star studied was CK Comae (variable #8 in the Lick survey). Seasonal light-curves plotted according to a linear ephemeris showed considerable scatter. A preliminary plot of the phase differences prepared as for DV Comae appeared to be best fit by three line segments. Scatter was reduced when the light-curve for each season was plotted according to the appropriate period indicated by the plot. These light-curves still show variable magnitude of maximum, beyond reasonable limits of observational error, possibly due to the Blazhko effect. However, an attempt to find a period for

the effect was unsuccessful.

The phase of maximum varies with the amplitude, occurring earlier when the amplitude is high, as Detre (1962) has noted. The ascending and descending branches were observed to vary less in phase, so for the subsequent analysis, a "standard maximum" was chosen, .100 cycle before the average of the times of rise and descent. Actual maxima occur as much as .135 or as little as .085 cycle before this average time.

Figure 2 gives the observed phase of this standard maximum minus the phase computed according to

$$\text{J.D. (Standard Max.)} = 2441822.576 + 0.^{\text{d}}.6940033 \text{ E} . \quad (3)$$

These elements were chosen as representative of the more recent observations. The three equations that fit the observations best are:

$$\text{for J.D. 2437370 to 40130, J.D. (Std.Max.)} = 2437370.71 + 0.^{\text{d}}.6940159 \text{ E}; \quad (4)$$

$$\text{for J.D. 2440130 to 41630, " } = 2441630.35 + 0.^{\text{d}}.6939080 \text{ E}; \quad (5)$$

$$\text{for J.D. 2441630 to 44051, " } = 2441630.35 + 0.^{\text{d}}.6939962 \text{ E}. \quad (6)$$

The square points on Figure 2 correspond to O-C residuals obtained by fitting a mean light-curve to each of the two sets of Lick observations.

Figure 3 is the composite light-curve for CK Comae calculated in accordance with eqns. (4), (5), and (6). Its scatter at maximum is the result of the amplitude differences that were mentioned above.

4. CD Comae Berenices

The third star studied was CD Comae (variable #5 in the Lick survey). Its period was listed in the later Lick paper as $0.^{\text{d}}.592018$, with the comment that it could give phases in error by 4 or 5 cycles in the interval between the two sets of Lick observations (J.D. 2437370 - 7436 and 2443630 - 3637). Light curves based on the Lick period show an unusually large scatter. Spurious periods related to the Lick period were tested, but none seemed to explain all observations. So, a range of periods from .2 to 1 day was tested with the aid of a computer program based on the period search method of Lafler and Kinman (1965). One period, $0.^{\text{d}}.589$, was found to be promising. A preliminary O-C plot was prepared using the elements:

$$\text{J.D. (Max.)} = 2437370.313 + 0.^{\text{d}}.589 \text{ E}, \quad (7)$$

where 2437370.313 is the published epoch. Analysis of the plot suggested trial periods of either $0.^{\text{d}}.5896$ or the related period $0.^{\text{d}}.5887$ (differing by one cycle per year). Testing proved the longer period to be superior. Figure 4 was plotted with the aid of the following,

$$\text{J.D. (Max.)} = 2437370.313 + 0.^{\text{d}}.5896066 \text{ E}. \quad (8)$$

A final least-squares analysis resulted in these new elements for CD Comae:

$$\begin{aligned} \text{J.D. (Max.)} &= 2437300.307 + 0.^{\text{d}}.5896066 \text{ E} \quad (9) \\ &\pm 0.0000011 \text{ (m.e.)} \end{aligned}$$

This new period causes differences with the Lick revised period, not of 4 or 5 cycles, but of about 43 cycles over the 17 years that bridge

the Lick observations.

On Figure 4, O-C values obtained by fitting a mean light-curve to the Lick observations are indicated by triangles.

5. Acknowledgements

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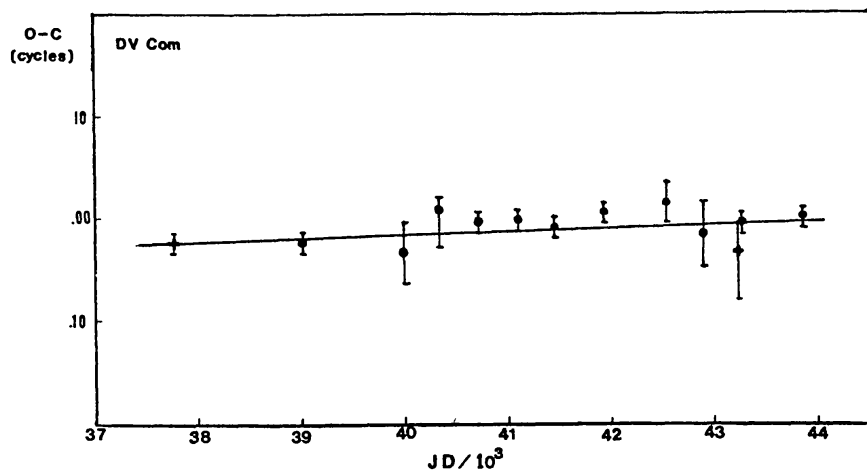


Figure 1. O-C diagram of DV Comae Berenices.

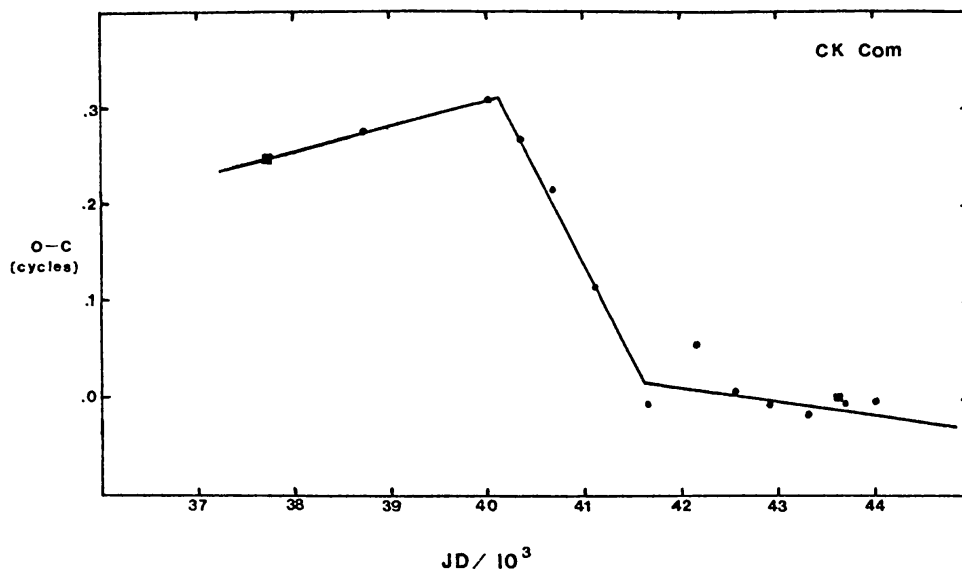


Figure 2. O-C diagram of CK Comae Berenices.

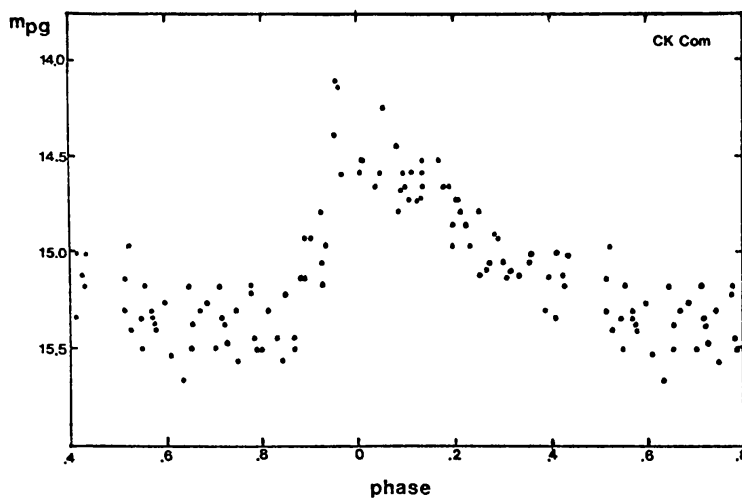


Figure 3. Mean light curve of CK Comae Berenices.

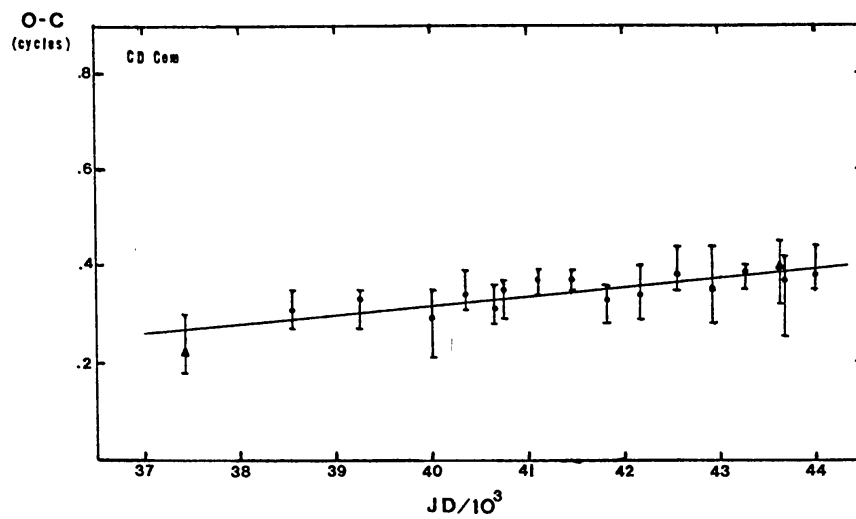


Figure 4. O-C diagram of CD Comae Berenices.