CK COMAE BERENICES AND ITS VARIABLE COMPARISON STAR

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Abstract

CK Comae Berenices, of class RRab, was studied on plates of the Maria Mitchell Observatory (MMO). The period of this star has changed four times during the interval 1964-1986. Also, comparison star "e" as defined by a 1966 Lick Observatory survey was found to be variable.

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During the summer of 1987, CK Comae Berenices was investigated on Nantucket plates taken between 1964 and 1986. This RR Lyrae star had been studied by Kinman *et al.* (1966) and by Butler *et al.* (1979) at Lick Observatory, and by Gilmore (1979) at the Maria Mitchell Observatory (MMO). It is variable #8 in the Lick survey. Gilmore and I used the comparison stars given in that survey with the exception of star "e" which has been suspected of variability. I examined star "e" and confirmed its variability.

In preparation for extending Gilmore's study of the long-term period behavior of CK Com, seasonal light curves were plotted with phases calculated from the most recent of the published linear elements. These light curves showed considerable scatter. Scatter was reduced when the light curve for each season was plotted according to the appropriate period as determined for that year from a Fourier period search.

To examine period changes in more detail, I used a version of O-C analysis, frequently employed at MMO, that is similar to a method described by Coutts Clement and Sawyer Hogg (1977). First, one combines the light curves of a number of years in order to get a complete, representative light curve. From this, one creates a phase-averaged light curve. David Wilner had developed a program for phase-averaging at MMO in 1986. This program creates a certain number of vertical bins of uniform size. All points in each bin are averaged to make a single mean point. In addition, a given number of bins on either side of each bin can have their points averaged with the central bin. The effect is a smooth picture of the light curve.

A maximum is then chosen and marked on the light curve. The smoothed curve is superimposed on the light curves of individual years and shifted in phase until it matches as closely as possible. The adopted maximum is transferred to each individual light curve and the error in the computed phase of this observed maximum is determined subjectively from the uncertainty in choosing the best match.

To achieve high precision in the period changes, it seemed wise to mark the maximum in a way consistent with Gilmore's work on CK Com. She had defined a "standard maximum" 0.1 cycle before the average of the times of rise and descent. Unpublished data at MMO show that the specific phases that she called "rise" and "descent" are the times when the star passes through photographic magnitude 15.0. In my analysis, I was able to define the time of maximum in exactly the same way.

For each of the years since Gilmore's study, 1980 through 1986, I was able to choose a representative date of maximum in agreement with this definition. Figure 1 gives the observed phase of this standard maximum minus the phase computed according to:

$$JD_{(\text{Standard Max.})} = 2441822.576 + 0.694003\ E. \qquad (1)$$

The error bars are the subjective estimate of the uncertainty in matching the standard light curve to the annual curves. The first three line segments on the graph and the data before JD 2444051 are from Gilmore's work. A reasonable fit to the data is given by the four line segments drawn on the graph, and the corresponding elements listed in Table I. The first three are from Gilmore (1979). From JD 2444051 to 2444733, the data are too sparse to give an accurate estimate of the period, but the O-C diagram suggests a value at least 0.6941 day. In addition to this complicated period behavior, CK Com exhibits changes in the amplitude and shape of its light curve, evidenced by scatter in the folded light curves.

I also estimated magnitudes for star "e" of the Lick Observatory sequence for CK Com on some 300 plates taken from 1964 to 1986. The variability of "e" is confirmed, with an amplitude of about 0.6 mag. This much change could be seen in as few as 3 hours. Computer period searches failed to find a period. Perhaps the star is not periodic or perhaps the variation includes more than one period. Another possibility is that the exposure times, often one hour, are too long. The magnitude range is about 15.2 to 15.8 photographic.

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TABLE I

Period Elements for CK Comae Berenices

Interval (JD)	JD (Standard Max.)
2437370 to 2440130	2437370.71 + 0.6940159 E
2440130 to 2441630	2441630.35 + 0.6939080 E
2441630 to 2444051	2441630.35 + 0.6939962 E
2444733 to 2446616	2445674.27 + 0.6938976 E

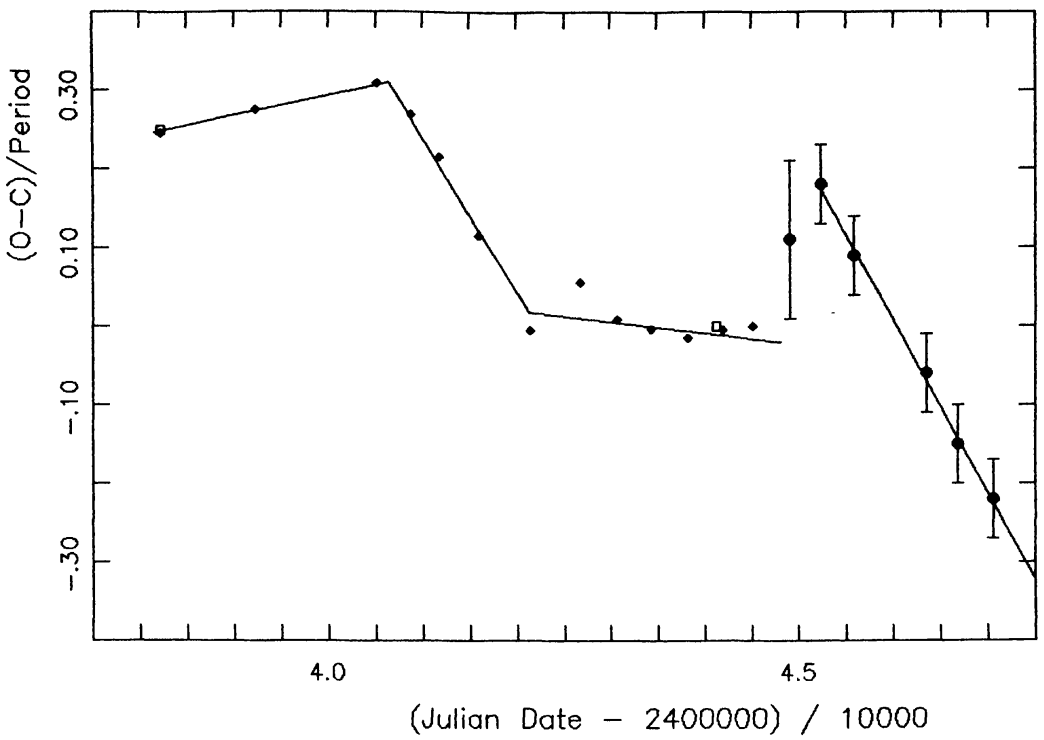

Figure 1. O-C diagram for CK Comae Berenices, giving the observed phase of the standard maximum minus the phase computed according to Equation (1).