# ANALYSIS OF AC COMAE BERENICES

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**Abstract**

New elements for AC Comae Berenices, an RRab star, are based on data taken from MMO plates from 1965 to 1990:

$$JD_{max} = 2443883.819 + 0.5908939\ E - 3.7 \times 10^{-10}\ E^2.$$

These elements also satisfy published data from 1963 to 1966. The photographic range is 14.4 - 16.0, using updated magnitude measures for the local comparison sequence.

As of 1968 AC Comae Berenices, then called S 7776 Com, was found to have the following elements, according to Meinunger and Wenzel (1968):

$$JD_{max} = 2438472.390 + 0.590915\ E. \tag{1}$$

The period, 0.590915 day, is typical of an RR Lyrae variable of the type RRab. They determined the photographic range as 12.8 - 14.0. The *General Catalogue of Variable Stars* (Kholopov *et al.* 1985)(GCVS) changed the range to 13.6-15.1 B. Then in 1986 Leam Cika began to reevaluate AC Com's elements using data taken from plates at the Maria Mitchell Observatory (MMO). The photographic range determined at this time by Cika was 1.9 magnitudes, ranging from 15.25 to 16.15, based on provisional magnitudes for a local sequence. He suggested revised elements:

$$JD_{max} = 2440301.763 + 0.5908965\ E. \tag{2}$$

My research reported in this paper is aimed at updating these elements as well as eliminating some of the uncertainty in the estimated magnitudes of the local comparison stars.

Magnitude estimates were made from about 300 photographic plates taken at the Maria Mitchell Observatory, by comparison with Cika's local sequence. I established new magnitudes for these comparison stars. This was done using an iris photometer to compare the relative size and density of the photographic image of the comparison stars to those of TON1542, a standard sequence located nearby whose magnitudes had been determined photoelectrically (Angione 1971). Figure 1 identifies the variable and the sequence stars. The new photographic sequence magnitudes, from iris photometry of seven plates, are b = 13.82, c = 14.56, d = 15.11, e = 15.86, f = 16.12. Mean errors of these average magnitudes, based on plate-to-plate differences, are $\pm 0.08$ to $\pm 0.14$ magnitude.

The data from the years 1965 to 1990 were broken down into twelve sets of two year groups in order to test Cika's equation (2). Light curves for these sets were then plotted as magnitude versus phase calculated from the equation:

$$(JD - E)/P = N + F. \tag{3}$$

JD is the Julian date of the observed data point; E is the given epoch that is being tested; P is the given period being tested. The quotient is written as an integer, N, plus a fraction, F, which is the phase. The light curves show that AC Com varies between magnitudes 14.4 and 16.0, using the new magnitudes for the sequence stars. Figure 2 is the light curve for 1975-1980.

The way to analyze how the period is changing over time is to use the elements to calculate when the maxima in its cycle would have occurred, and then compare these calculated maxima to the actual times of maxima as determined from the light curves. The difference is O-C (Observed - Calculated). These deviations were found by comparing the individual light curves to a representative composite curve showing a typical cycle in the variation of AC Com. The amount the maximum is shifted away from phase zero is the O-C measurement. It is given as (O-C)/P, the time interval as a fraction of the period. A plot of these values against JD gives a visual picture of how the deviations are changing with time (Figure 3).

A least squares analysis can then provide a best fit line or parabola to indicate a more accurate period and epoch. My analysis of the MMO data implied new parabolic elements:

$$JD_{max} = \underset{\pm 0.003}{2443883.819} + \underset{\pm 0.0000005}{0.5908939}\,E - \underset{\pm 1.3 \times 10^{-10}}{3.7 \times 10^{-10}}\,E^2. \qquad (4)$$

The corresponding rate of change in the period is -0.77 $\pm$ 0.28 cycle in 106 years. The rate is nearly three times as large as its mean error. There is a 98% confidence level that the rate is different from zero and not simply due to errors in the observed values of O-C (Pringle 1974).

The open circle in Figure 3 is the average of 13 maxima from 1963.15 to 1966.20 (Meinunger and Wenzel 1968). It fits rather nicely on this established parabola. However, a large part of the curvature seems to be due to the final set of data. If the parabola is calculated with the final point left out the rate becomes smaller, -0.63 $\pm$ 0.24 in 106 years. The difference is not very large because the last point, which has a large error bar, had been given low weight in the least-squares solution. I think it will be important to see if future data substantiate or contradict the downward trend.

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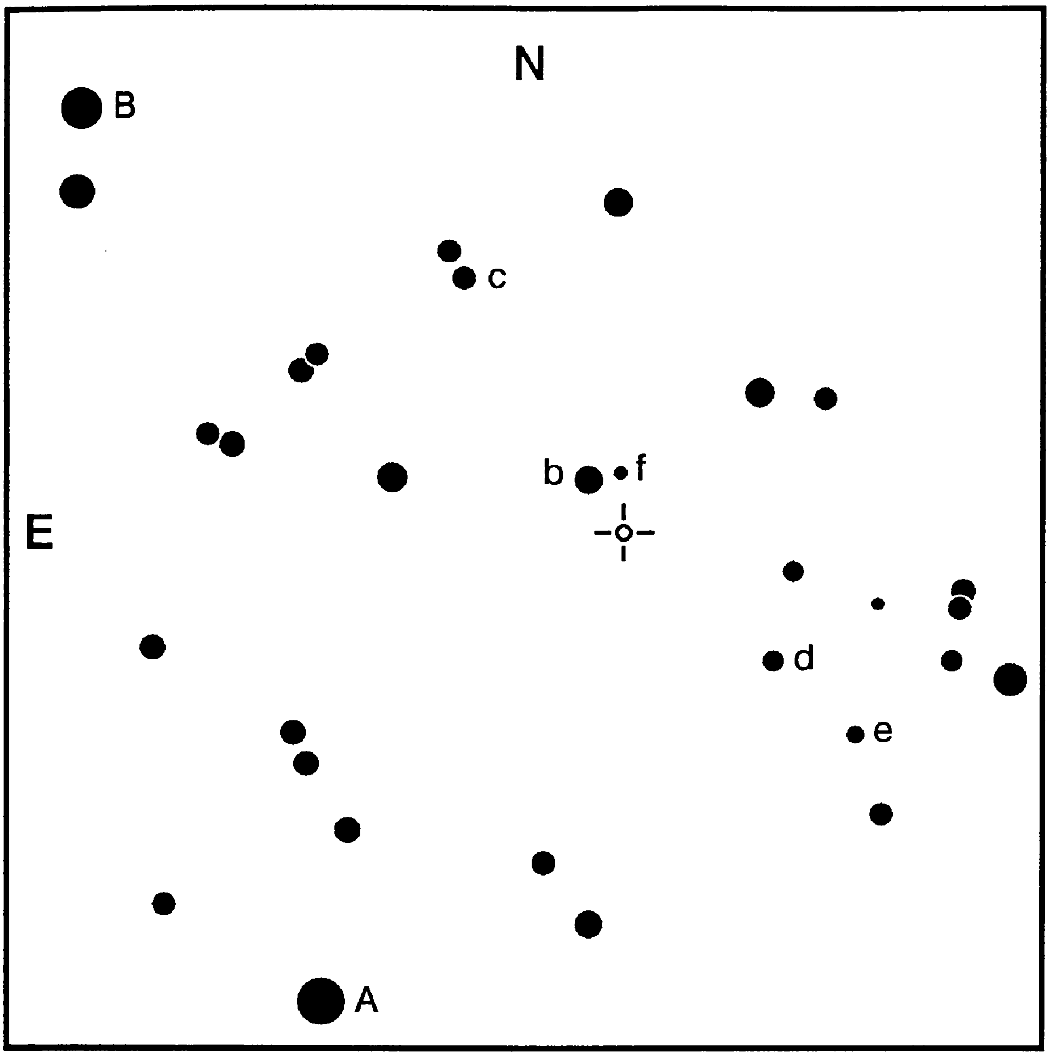


Figure 1. Finding chart, 40 x 40 arc minutes, for AC Com and local sequence stars. The variable is marked V; A and B are SAO 82267 and SAO 82272, respectively.

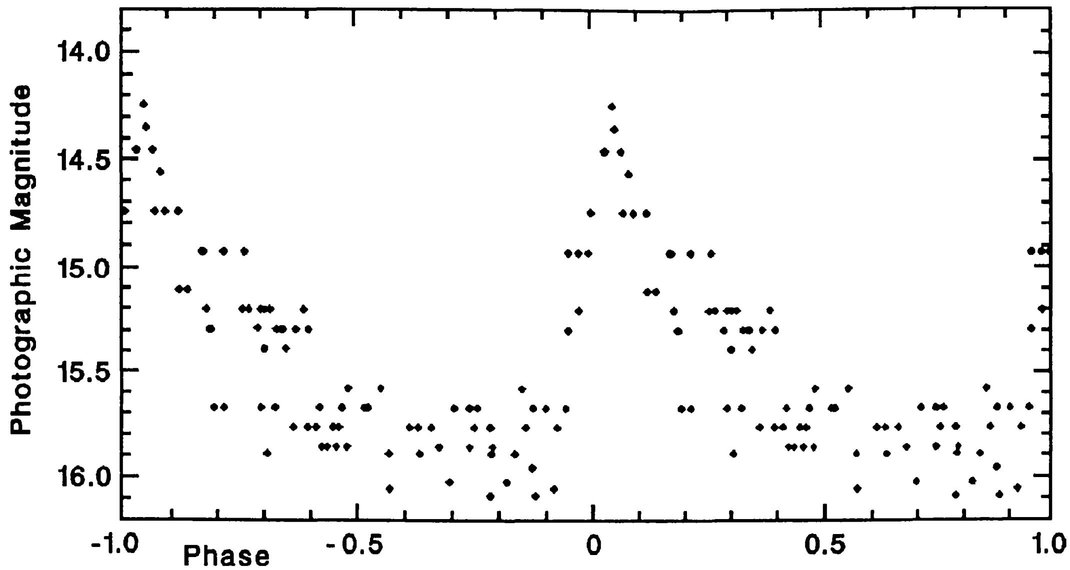


Figure 2. Typical light curve for AC Com. This one is for data taken from MMO plates from 1975 to 1980.

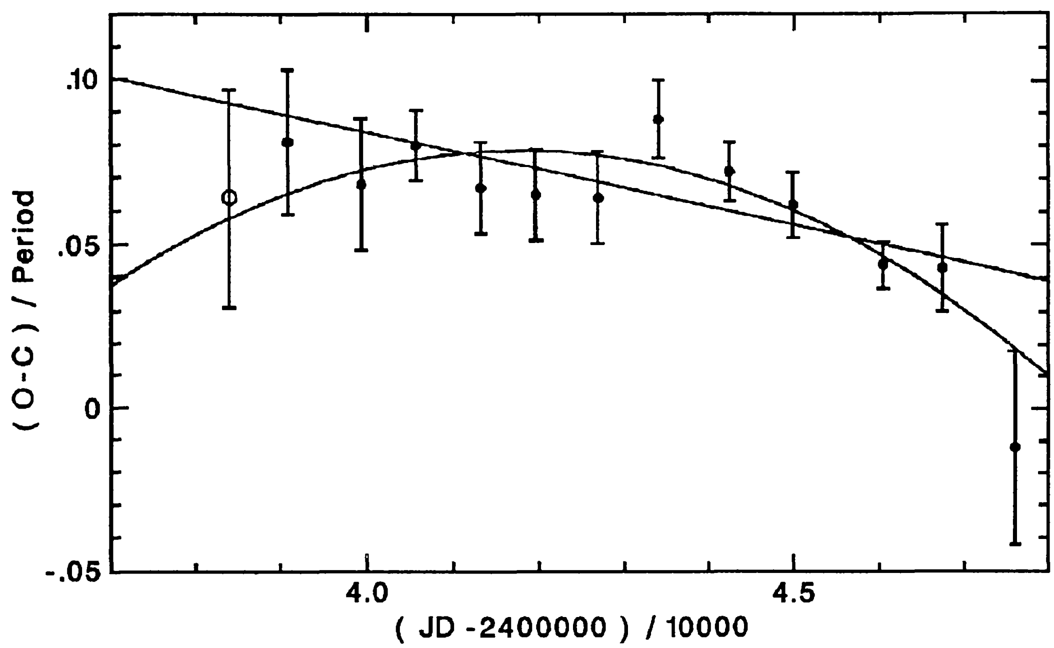


Figure 3. O-C diagram for AC Com. The filled circles represent 1965-1990 data taken from MMO plates, analyzed here at the Maria Mitchell Observatory. The open circle represents 1963-1966 data by Meinunger and Wenzel. The curve is a least squares parabola based on the MMO data.