A REVISION OF THE VARIABLE PERIOD OF IM AQUILAE

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Abstract

Previously published elements for the RR Lyrae variable IM Aquilae are revised with the addition of observations from the Maria Mitchell Observatory plate collection from 1981 through 1990. The following parabolic elements provide a good approximation of the decreasing period:

$$JD_{max} = 2439806.597 + 0.45694896\ E - 1.91 \times 10^{-10}\ E^2.$$

The RR Lyrae star IM Aquilae, $19^h\ 05^m\ 15^s$, $-06^\circ\ 49'.9$ (1950), 13.6-15.0 photographic, has been previously studied for its variations in period. Heliocentric elements published by Tsesevich (1972) before JD 2432772 are:

$$Max(JD_{hel.}) = 2428064.707 + 0.4569602\ E. \quad (1)$$

After this date heliocentric elements are:

$$Max(JD_{hel.}) = 2436423.332 + 0.4569487\ E. \quad (2)$$

Lada and Belserene (1981) revised these elements, favoring a three-part representation of the variable's period which uses the elements in equation (1) until JD 2431000 and after JD 2436800, with a segment between those dates given by:

$$Max(JD_{hel.}) = 2431767.711 + 0.4569521\ E. \quad (3)$$

They also offered an alternate representation with the parabolic elements:

$$Max(JD_{hel.}) = 2439806.586 + 0.4569487\ E - 1.92 \times 10^{-10}\ E^2. \quad (4)$$

In order to test these various representations of IM Aql's period, plates in the Maria Mitchell Observatory collection were inspected to extend Lada and Belserene's 1918-1981 time-base to 1990. Estimates of the variable's brightness were made for the years 1981 through 1990, and folded light curves for each set of two years' estimates were plotted with heliocentric phases calculated according to equation (2).

O-C values for the folded light curves were calculated with a non-linear least squares method, which minimizes the sum of the squares of the residuals in magnitude, when a mean light curve is compared to a given folded light curve (Belserene 1986). A mean light curve for the period 1981-1990 was used to define the shape of the light curve and the observed time of maximum. The phases of observed maxima were compared to the maxima calculated by equation (2) to produce the O-C data.

Resulting O-C values are shown in Figure 1, plotted against JD, along with 1918-1980 data from Lada and Belserene. Darkened circles are values from Lada and Belserene; squares are recent data. The previously published O-C value for 1981 was replaced by a revised value since the few observed magnitudes for that year had not

been sufficient to produce a reliable O-C value. Estimated magnitudes were re-evaluated for 1981 and grouped with the following years' data to produce the O-C value shown at JD 2444980.

The O-C values published by Lada and Belserene had been produced with a mean light curve different from that which was used for the 1981-1990 data, and the light curves had been compared without the aid of a computer. To check for systematic differences between the old and new methods, O-C values for 1968-1980 were recalculated by the new method. These values are shown as open circles in Figure 1. The differences in the O-C values for the three reviewed data points are indicative of the uncertainties involved in calculating O-C. Since the differences are not systematic, however, the 1918-1980 results were not revised. It is recommended that future revisions of the period of IM Aql unify the method for the O-C calculations for the entire time-base.

A least squares fit to the O-C data produced the parabolic elements:

$$\begin{aligned} \text{Max}(JD_{\text{hel.}}) = {} & 2439806.597 + 0.45694896\,E - 1.91 \times 10^{-10} E^2. \qquad (5) \\ & \pm 0.003 \quad \pm 0.00000018 \quad \pm 0.09 \times 10^{-10} \end{aligned}$$

Equation (5) implies a steady decrease in the period at a rate of $-3.05 \times 10^{-7} \pm 0.15 \times 10^{-7}$ days per year. The parabola is shown on Figure 1 as the solid curve; the dotted lines are Lada and Belserene's three-segment linear representation. Although a parabola was rejected by Lada and Belserene in favor of the three-part linear representation, the least squares parabola is now believed to be an effective approximation of the rate of decrease in the period of the variable. The mean error of a single O-C value is 0.02 in units of the period based on deviations from the least squares parabola; this error is typical in O-C values found at the Maria Mitchell Observatory and seems to verify the validity of the parabola. A lack of data from 1956 through 1967 prevents a conclusive adoption of the parabolic elements; four straight segments, corresponding to three abrupt changes in period, could also provide a valid representation of the available data.

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References

Belserene, E. P. 1986, *J. Amer. Assoc. Var. Star Obs.*, **15**, 243.
Lada, E. L., and Belserene, E. P. 1981, *J. Amer. Assoc. Var. Star Obs.*, **10**, 81.
Tsesevich, V. P. 1972, *Astron. Circ.*, USSR, 736.

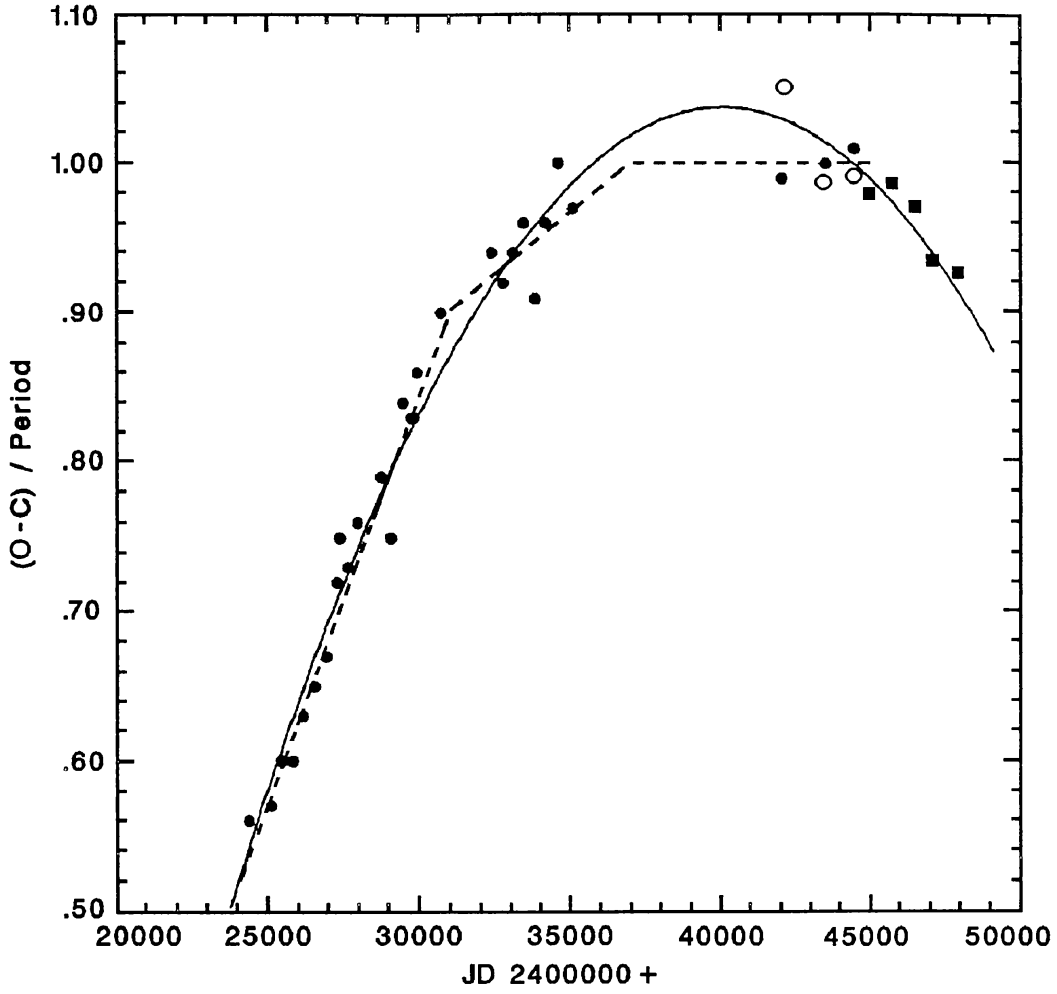

Figure 1. O-C in fractions of a period versus Julian Date for IM Aquilae, 1918-1990. Darkened circles are from Lada and Belserene (1981); squares are author's values. Open circles are O-C values found by the author's method applied to the brightness data used by Lada and Belserene. The curve is the least-squares parabola; dotted lines are a three-part representation given by Lada and Belserene.