PERIOD CHANGES IN THE RR LYRAE STAR IM AQUILAE

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Abstract

Maria Mitchell observations of the RR Lyrae (RRab) variable IM Aquilae confirm the size of the published decrease in period but show that a single, abrupt change must be rejected in favor of two changes or continuous change.

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The RR Lyrae star IM Aquilae, (α = 19^h 02^m 34^s, δ = -6° 54'.4 (1900); range photographic magnitude 13.6 - 15.0) is known to have a variable period. Tsesevich (1972) determined the star's elements to be $JD_{max.}$ (hel.) = 2428064.707 + 0.4569602 n until JD 2432772, and 2436423.332 + 0.4569487 n after this date.

We have used the Maria Mitchell Observatory plate collection in a two-part investigation of the period behavior of IM Aquilae. In the first part of the investigation, in 1979, estimates of brightness were made on the Nantucket plates for 1927 through 1979. Mean light curves were plotted, one to three per year, according to the published elements. The phases of the observed maxima were compared with maxima computed according to the second of the above sets of elements. In this comparison, a master mean light curve, on which a nominal maximum had been marked, was used to define the observed time of maximum. The resulting O-C values confirmed that the period had decreased, but showed that a single change at JD 2432772 is insufficient to describe the data. The simplest representation of the Maria Mitchell data from 1927-1979 is by the parabolic elements:

$$JD_{max.}(hel.) = 2439806.586 + 0.4569487\ n - 1.92\times10^{-10}\ n^2. \quad (1)$$

Equation (1) implies a continuous decrease in period at the rate of 6.9×10^{-5}% per year. The mean light curve in Figure 1 was drawn using these elements, and it confirms that parabolic elements provide a satisfactory representation of the variation. This representation is not unique. Another good representation uses Tsesevich's elements before JD 2431000 and again after JD 2436800 with an intermediate period between those dates, as listed in Table I.

The second part of our investigation, in 1981, was a test of these alternative representations. The years 1980 and 1981 were added, and also a group of early plates (1918-1926), which were poorer in quality but which extended the time-base. Plates from 1927 through 1935 were independently estimated by a second observer to strengthen the O-C values for these years, when many of the photographs were of relatively poor quality. New mean light curves for a year at a time were plotted, using the mean of the two observers' estimates and rejecting plates considered below par by either observer. The resulting O-C values are plotted in Figure 2. The thin lines are Tsesevich's elements. The heavier, dashed line segment is the middle set of elements from Table I, and the curve is the parabola of equation (1). The three straight segments are now seen to provide the superior representation.

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REFERENCE

Tsesevich, V. P. 1972, Astron. Circ. USSR, 736.

TABLE I Three-Segment Ephemeris of IM Aquilae

Julian Date (2440000 +)	JD Max. (hel.)	Period	Change	Change
-31000	2428064.707	$0^d.4569602$		
31000-36800	2432767.711	0.4569521	$-0^d.0000081$	-0.0018 %
36800-	2436423.332	0.4569487	-0.0000034	-0.0007 %

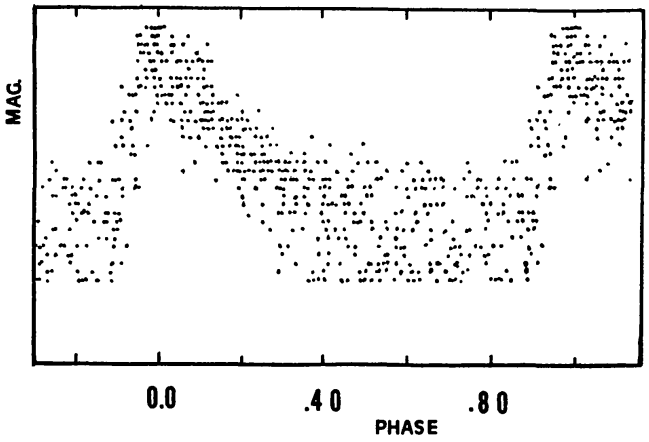

Figure 1. Mean light curve of IM Aquilae. Brightness estimates are on an arbitrary scale. The phase is given in fractions of the period.

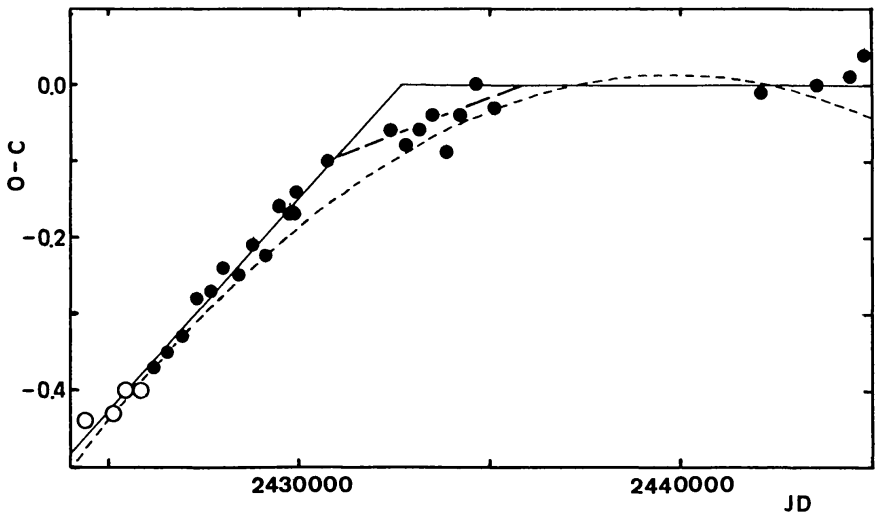

Figure 2. O-C (in units of the period) as a function of time. Open circles indicate lower weight. Predictions according to linear and parabolic elements are shown as the line segments and parabola, respectively.