ANOTHER LOOK AT THE PERIOD OF HS AQUILAE

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Abstract

An examination of the Mira variable HS Aquilae using recent Maria Mitchell Observatory plates reveals that the period has become shorter than the 267-day period given by Harwood in 1962. A constantly decreasing period is favored over an abrupt change. The rate of change is approximately -0.17 ± 0.01 day per year.

Kristin Thompson (1981) examined the period of HS Aquliae, a Mira star, to test the 267-day period determined by Margaret Harwood (1962). Thompson's data, derived from Maria Mitchell Observatory (MMO) plates, revealed a change in period, but because of an interval of several years when no plates were taken of this field, she could not determine if the period had increased or decreased. Using the most recent MMO plates for the years 1980-1990, I found that the period had decreased.

An O-C diagram, Figure 1, was produced using Thompson's elements to calculate maxima:

$$JD_{max} = 2428010 + 263.8\ E. \qquad (1)$$

From the light curve of the recent data I identified dates when the variable was increasing in brightness, was at maximum brightness, was fading, or was bright enough to be seen but at uncertain phase. Points other than maxima were included on the O-C diagram because of the scarcity of data available from photographic plates of this faint, long period variable. Including increasing and decreasing branches on the diagram gives an approximation of where unseen maxima would lie. A maximum comes above, i.e., later than, a point indicating increasing brightness, and it comes below, or earlier than, a point of decreasing brightness.

When the most recent results were added to Thompson's it was clear the period had decreased. Thompson was prevented from reaching this conclusion because the number of cycles in the 1956-1967 gap was uncertain. Plotting the group of recent data in the upper right of Figure 1 corresponds to having it start at 45 cycles past the epoch, with 30 cycles in the interim years. If this held, it would imply a period slightly longer than Harwood's (1962) 267-day period. The same data points plotted in the lower right, starting at 46 cycles past epoch, correspond to 31 cycles elapsing in the interim years. A smoother transition is made between earlier and later data if there are 31 cycles in the interim years rather than 30. This most probably implies that sometime within the gap years the period became shorter than 263.8 days.

Due to the absence of data, we do not know how the shortening of the period occurred. The change may have been abrupt, corresponding to the meeting of two or more straight line segments, or the period may have been changing continuously, denoted by a higher degree polynomial. Both possibilities were explored. The method of least squares was used to fit line segments and a parabola to the O-C points for maxima. The new elements indicated by the lines on Figure 1 are the following:

for JD 2424000 to 2434900, $JD_{max} = \underset{\pm 5}{2428003} + \underset{\pm 0.3}{266.5}\,E;$ (2)

for JD 2441220 to 2447765, $JD_{max} = \underset{\pm 4}{2445397} + \underset{\pm 0.5}{260.5}\,E.$ (3)

The amount by which the data points deviate from the lines gives a mean error of $\pm$10.0 days. If the function truly describes the behavior of the star, mean error is the uncertainty with which the date of a cycle's maximum is chosen. With the parabola shown in Figure 1, the mean error is reduced to $\pm$9.0 days. The parabola gives a slightly better approximation, yielding these elements:

$$JD_{max} = \underset{\pm 4}{2428006} + \underset{\pm 0.8}{267.5}\,E - \underset{\pm 0.004}{0.060}\,E^2. \quad (4)$$

In conclusion, the period of HS Aql is more likely changing at a nearly constant rate rather than decreasing suddenly and maintaining a constant period. The rate of change is -0.17 $\pm$ 0.01 day per year. If data could be located for the intervening years, a hypothesis for how the period of HS Aql changes could be made with more certainty.

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References

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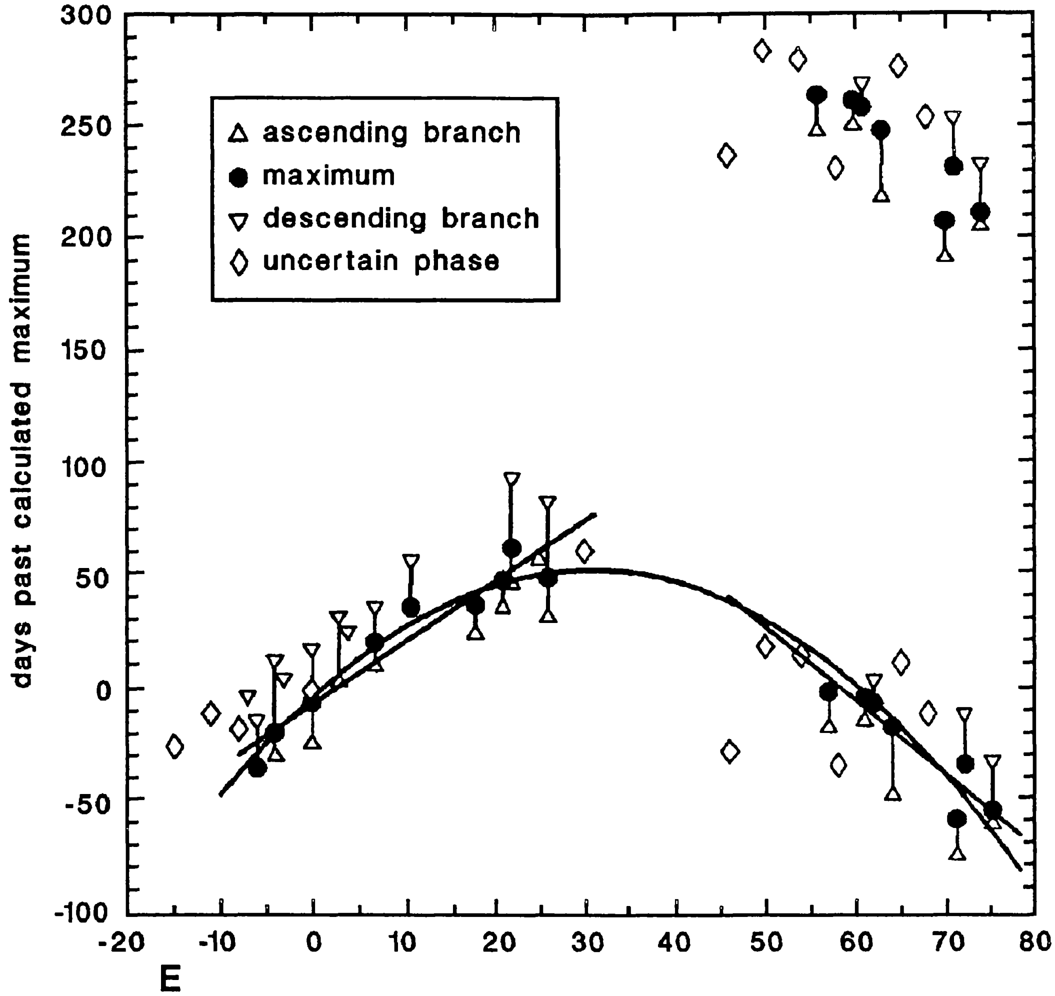

Figure 1. O-C diagram for HS Aquilae, computed from equation (1). The least-squares line segments and parabola correspond to the elements in equations (2), (3), and (4). See text for explanation of data plotted in upper right corner.