A REVISED PERIOD FOR V912 AQUILAE

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Abstract

V912 Aquilae, a classical Cepheid north of M11, was studied for period changes using plates of the Maria Mitchell Observatory. The revised elements are:

$$JD_{max} = 2431742.602 + 4.400371\ E + 3.26 \times 10^{-8}\ E^2.$$

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The fourth edition of the **General Catalogue of Variable Stars** (Kholopov et al. 1985) (GCVS) lists the following elements for V912 Aquilae, a classical Cepheid near M11:

$$JD_{max} = 2427245.478 + 4.40034\ E. \tag{1}$$

It also calls attention to a note saying that the shape of the light curve varies. The source of this note (Grigorevsky 1973) had little further to say on the subject; evidently the discovery was only a byproduct of the true purpose of the article, a computer program. In order to update the elements and look at the shape of the light curve, more than seventy years worth of plates belonging to the Maria Mitchell Observatory (MMO) were analyzed.

Since MMO possesses photographic plates of M11 covering the years from 1917 to 1988, there was a large amount of data to work with, more than 1000 plates, most of which contained V912 Aql. A finding chart for V912 Aql is presented in Figure 1.

After splitting this data set into twenty-four blocks, I plotted light curves of magnitude against phase calculated from equation (1). They turned out to have quite a bit of scatter in them, making it difficult to see just what their shape was. This scatter was tentatively attributed to the fact that the light curve is supposed to vary in shape. Since the dates of the plates were spread out over time, none of the light curves depicted just one complete cycle for the star but rather combinations of many. Thus it was impossible to view and compare separate cycles to determine whether or not they were different.

In an attempt to discover if perhaps there were any secondary periods superimposed on the first one, a Fourier analysis program was implemented to subtract out the 4.40034-day period and search for others, yet this, too, revealed nothing.

The light curves for 1941 through 1957 seemed slightly more consistent in shape than the others. Using their data, an average light curve was constructed and superimposed over each of the other light curves to find O-C's. If this average had not been used, the amount of scatter would have made it very difficult to see where on the other graphs the maxima were.

Next, an O-C diagram, plotting (O-C)/Period against Julian Date, was made for the full set of data, with C defined by the elements given in the GCVS; see Figure 2. The scatter evident in the light curves also showed up in the O-C's. The diagram should have revealed whether or not the catalogue period was correct; unfortunately that, too, was not easy to determine. (O-C)/P does increase with time, meaning that the actual average period has been slightly longer than 4.40034 days, the published period. However, no line, representing a constant period, or upward-curving parabola, representing a gradually increasing period, seems to fit the star data adequately.

Elements derived from the O-C diagram are:

(linear)

$$JD_{max} = \underset{\pm 0.018}{2431742.643} + \underset{\pm 0.000017}{4.400423}\,E; \tag{2}$$

(parabolic)

$$JD_{max} = \underset{\pm 0.018}{2431742.602} + \underset{\pm 0.000018}{4.400371}\,E + \underset{\pm 0.83 \times 10^{-8}}{3.26 \times 10^{-8}}\,E^2. \tag{3}$$

An F-test determined that the square term of the parabola is statistically significant; the probability that it is due to chance deviations from the line is 0.0008, which implies a period increase at an average rate of $5.4 \times 10^{-8} \pm 1.4 \times 10^{-8}$ day per year. There is a gap between 1958 and 1975, during which few or no plates were taken near M11. Before 1958 the diagram seemed to have a small positive slope and after 1975 a greater positive slope. I therefore tried to fit two separate lines to the data, one for each group, showing that perhaps some sudden change happened to the period during this gap, but this fit seemed no better than the single line.

In conclusion, although I was able to construct an O-C diagram for V912 Aql, I believe that more observations are necessary to determine whether or not the amount of scatter in its light curves and O-C diagrams is really due to a varying light curve. If so, the period we have for the star is not really a "period" at all, but simply a description of the star's average variations. It seems that this "period" has been increasing, yet even that could be a result of the varying light curves. Examination of future plates, especially plates taken over small intervals of time in order to record several complete cycles, could resolve these questions.

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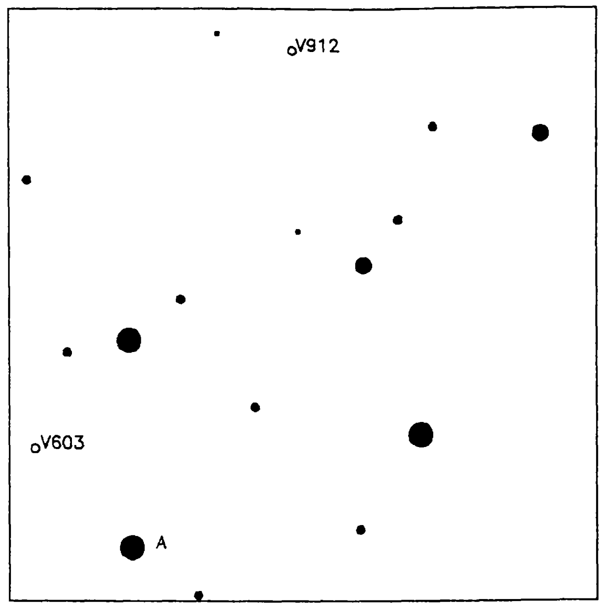

Figure 1. Finding chart for V912 Aquilae. The square is about 21 arcminutes to the side. Also in the field is V603 Aquilae. "A" is SAO 123936.

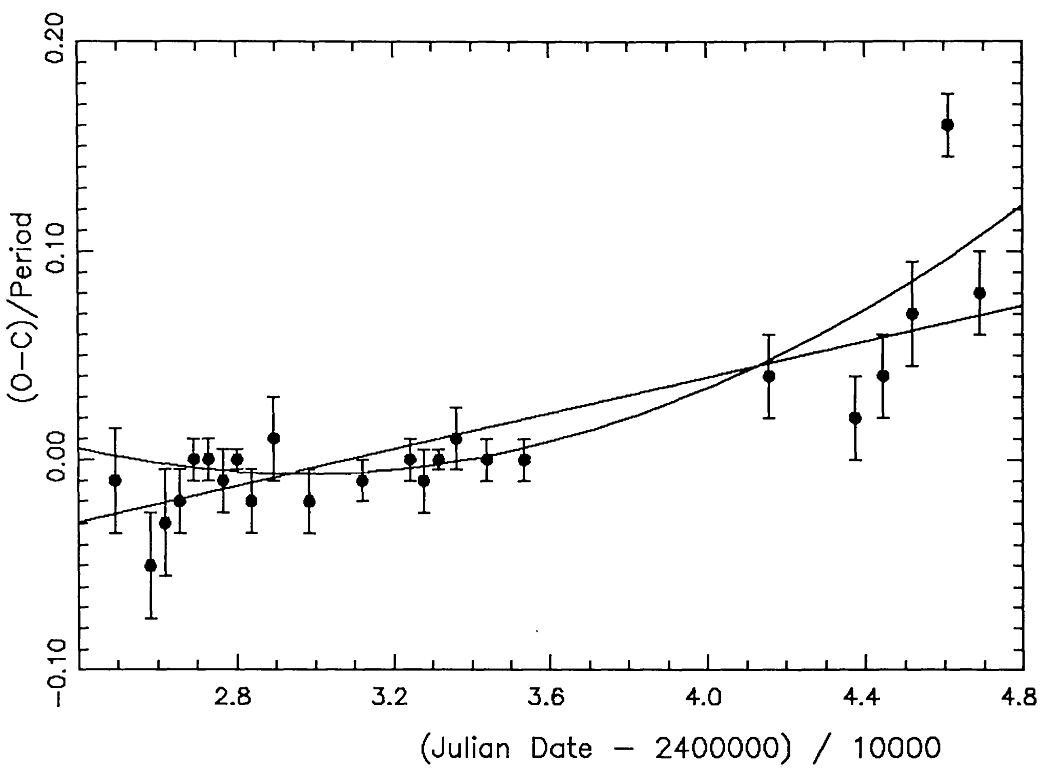

Figure 2. O-C diagram for V912 Aql, 1917-1988. Neither the line nor the parabola fit well. Derived elements are listed in equations (2) and (3).