V894 CYGNI: ANALYSIS AND INTERPRETATION OF VARIABILITY

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Abstract

New elements for a constant period, as well as for a possible changing period, are given for the RR Lyrae (ab) star V894 Cygni. Linear elements are:

$$JD_{(max)} = \underset{\pm 0.0011}{2445640.561} + \underset{\pm 0.00000008}{0.57138542}\ E. \quad (1)$$

Parabolic elements are:

$$JD_{(max)} = \underset{\pm 0.004}{2445640.566} + \underset{\pm 0.00000072}{0.57138667}\ E + \underset{\pm 2.0 \times 10^{-11}}{5.7 \times 10^{-11}}\ E^2. \quad (2)$$

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G. S. Tsarevsky (1961) studied V894 Cygni from 1950 to 1960 and labelled it an RRab variable with the elements:

$$JD_{(max)} = 2436997.198 + 0.571403\ E. \quad (3)$$

He also suggested the possibility that the star exhibited the Blazhko Effect.

Nantucket plates taken and stored at the Maria Mitchell Observatory (MMO) from 1928 to 1985 were individually examined in order to test these elements. A finding chart for the variable is presented in Figure 1. Photographic magnitudes for the surrounding sequence of comparison stars were determined using the "flyspanker" technique (Stock and Williams 1962; Dinerstein 1973). A group of stars in Groningen-Palomar Field 4A, located on the same plates, was used as comparison, as its stellar magnitudes had been published (Wehinger and Hidajat 1973).

It was found that V894 Cyg varied in brightness from photographic magnitude 12.2 to 13.9, differing systematically from Tsarevsky's stated range of 11.9 to 13.4, due to the use of different comparison sequences. More importantly, the study also found that the period disagrees with that reported by Tsarevsky.

The magnitudes of V894 Cyg were organized into groups of years (on the average of three years per group). Light curves were drawn up using Tsarevsky's elements and MMO software. Each observed curve was compared to an adopted mean curve on which a nominal maximum had been marked, to produce a first approximation to the value O-C. An O-C diagram was then plotted. This diagram was examined in turn by a program which uses the least squares method to determine the best fit of a line and a parabola to a set of points. The result of this preliminary analysis yielded the elements:

$$C_1 = \underset{\pm 0.0018}{2435580.757} + \underset{\pm 0.00000016}{0.57138462}\ E_1. \quad (4)$$

Note that the period agrees with Tsarevsky's figure when rounded to the fourth decimal place, but not beyond that.

The procedure was repeated with phases calculated from the new elements, resulting in the O-C diagram in Figure 2. The points on this O-C diagram are probably better fitted by a parabola, whose elements are:

$$C_2 = \underset{\pm 0.004}{2445640.566} + \underset{\pm 0.00000072}{0.57138667}\ E_2 + \underset{\pm 2.0 \times 10^{-11}}{5.7 \times 10^{-11}}\ E_2^2. \qquad (5)$$

Indeed, the F-test (Pringle 1975), which assesses the statistical significance of such a curve, favored a parabola with a 99% probability. However, when examined closely, the points can be interpreted as comprising two straight lines. One section, starting at JD 2426165 and ending around JD 2429700, could actually be a cubic, so varied are the points. However, it is more likely a straight line with a great deal of scatter. There simply are not enough points to make a sound judgement; Occam's Razor seems to be the only recourse from which a decision can be reached. In any case, the other line can be easily perceived by examining only the points beyond JD 2429700; they essentially describe a straight line of positive slope (Figure 3). A least squares analysis of this group yields the elements:

$$JD_{(max)} = \underset{\pm 0.0011}{2445640.561} + \underset{\pm 0.00000008}{0.57138542}\ E. \qquad (6)$$

In short, these are the elements which offer the best clue to make predictions on future activity of V894 Cyg.

Finally, to check for Blazhko effect, several groups of data were run through a Fourier search program written by Dr. E. Belserene, Director of MMO. After the fundamental period (0.57139 day) was extracted, the most promising secondary period found in the residuals was 0.4000 day. If two terms of the Fourier series were extracted, however, to account for the fact that the light curve is not a simple sine wave, the 0.4000-day period was no longer seen in the residuals. In the terminology of Fourier analysis it was an "alias" of the first harmonic. The fundamental frequency is almost exactly 1.75 cycles per day. The first harmonic is 3.50. This frequency appears in the residuals but the period search was not extended to such high frequencies. The alias that was seen differs by one cycle per day. The reciprocal of 3.50 - 1.00 cycles per day, is 0.40 day, as found by the program. No other period was consistently found in the residuals, so this method did not turn out to be a way to study the Blazhko effect, and no conclusion was reached as to its presence in this star.

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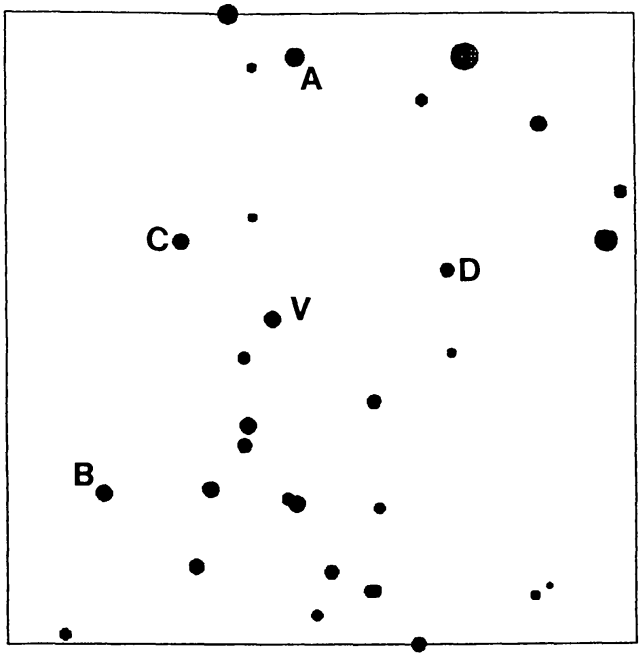

Figure 1. Finding chart, roughly 15' by 15', and comparison sequence for V894 Cyg: RA = $19^h\ 31^m\ 28^s$, Dec. = $+46^o\ 07'$ (1950). Photographic (B) magnitudes for comparison stars are: A = 12.1, B = 13.0, C = 13.3, D = 14.1.

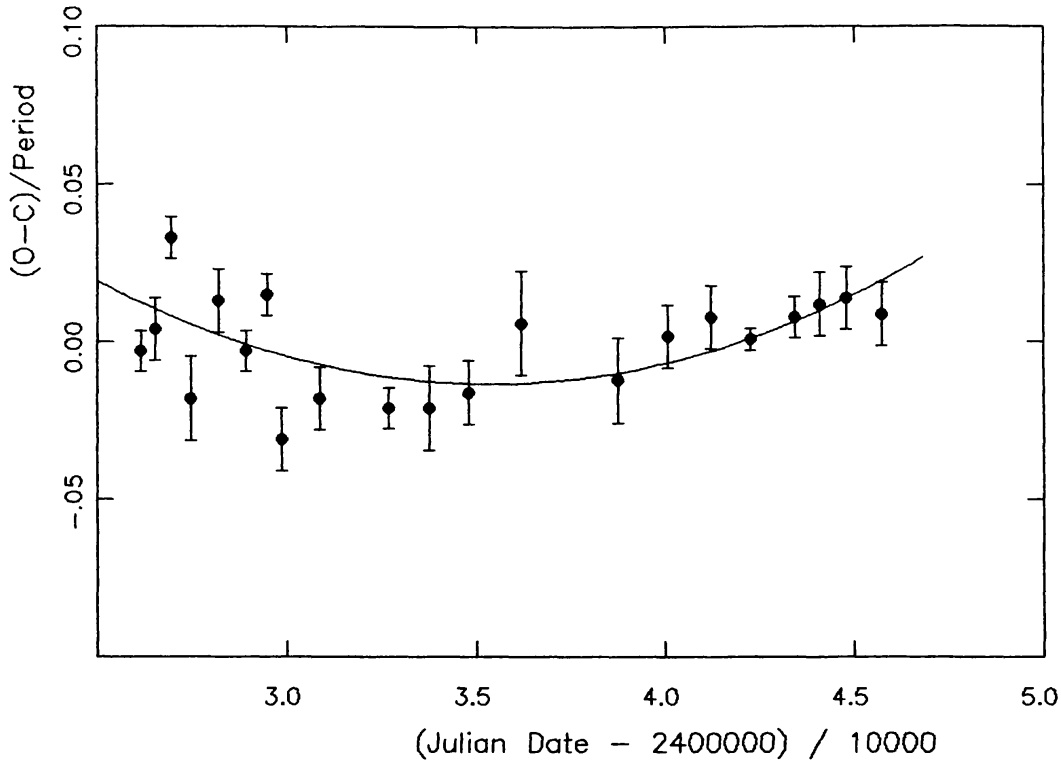

Figure 2. Complete O-C diagram for V894 Cyg, where C is defined in equation (2), and the value O-C is in fractions of a period. A parabola is shown as the best fit.

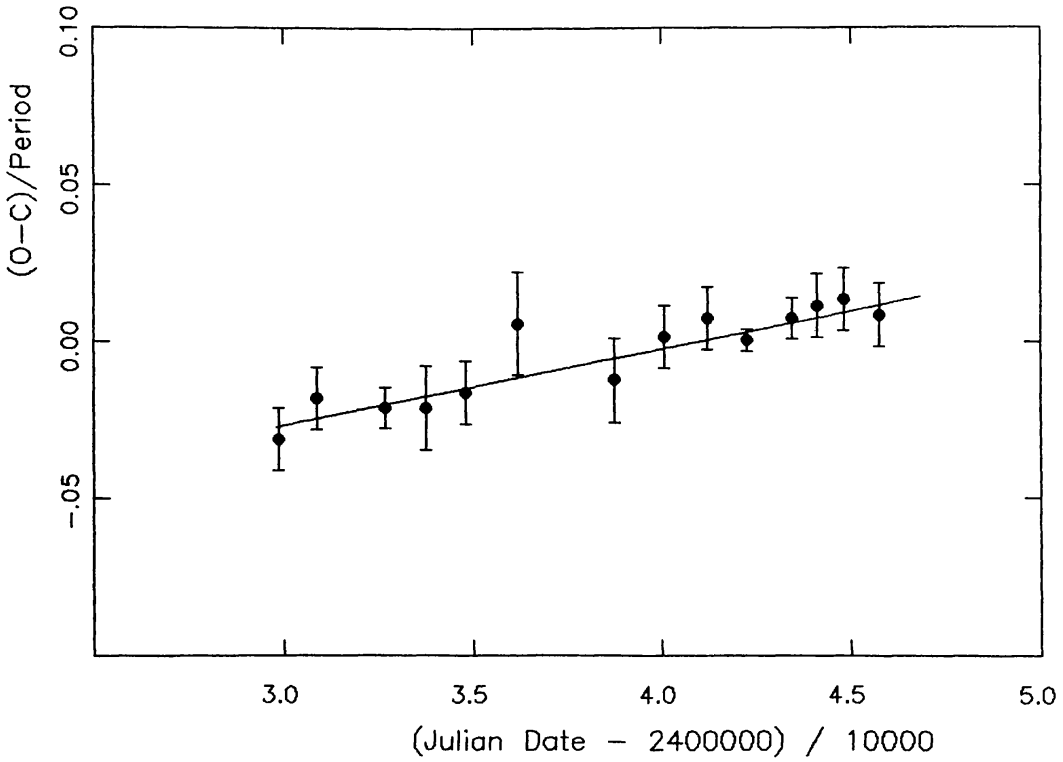

Figure 3. O-C diagram for V894 Cyg from JD 2429700 to the present, where C is defined in equation (2), and the value O-C is in fractions of a period. A straight line is shown as the best fit.