PERIOD REVISIONS FOR SEVEN ECLIPSING BINARY STARS

Gerard Samolyk
9504 W. Barnard Ave.
Greenfield, WI 53228

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Abstract

Recently published AAVSO times of minima of seven eclipsing binary stars indicate a discrepancy when compared to the elements listed in the fourth edition of the *General Catalogue of Variable Stars*. New elements for AD And, BD And, WZ Cep, CC Com, SW Lac, Z Per, and W UMi have been calculated.

1. Introduction

While compiling *Observed Minima Timings of Eclipsing Binary Stars No. 3* (Baldwin and Samolyk 1996), the orbital periods of a number of stars were found to be discordant when compared to the fourth edition of the *General Catalogue of Variable Stars* (GCVS) (Kholopov *et al.* 1985). Seven of these stars were evaluated for this paper.

New elements were calculated using a linear regression method in cases where the period appeared constant for a given interval. A second-order solution was also calculated for cases in which the period appeared to be undergoing continuous change. The O-C plots in Figures 1–7 are based on the elements from GCVS, with the exception of SW Lac, for which the elements from Rudnicki *et al.* (1989) are used. The new elements are shown as dashed lines. Error estimates are included for each set of newly calculated elements. In every case, only the primary eclipses are considered.

2. AD And

No period change is evident in the AAVSO data; however, the period for AD And is shorter than that listed in the GCVS. When running the regression that produced equation (1), the two CCD times of minima were given a weight of 20.

$$\begin{aligned} JD_{min} = \;& 2443045.856 + 0.98619023\,E \\ & \pm 0.008 \pm 0.00000038 \end{aligned} \qquad (1)$$

3. BD And

The period of BD And is longer than the GCVS period. Equation (2) is the best linear fit to these data.

$$\begin{aligned} JD_{min} = \;& 2443045.599 + 0.4629033\,E \\ & \pm 0.008 \pm 0.0000003 \end{aligned} \qquad (2)$$

4. WZ Cep

Equation (3) is the best fit to the observations of WZ Cep. The period of this star is shorter than the GCVS period; however, no change in period is evident in the AAVSO data.

$$JD_{min} = \underset{\pm 0.008}{2443275.712} + \underset{\pm 0.00000037}{0.41744533}\ E \qquad (3)$$

5. CC Com

The period of CC Com has been continuously decreasing during the observed interval. Equation (4) best describes the behavior of this star during this time. The linear elements in equation (5) are being used for predicting eclipses in the near future.

$$JD_{min} = \underset{\pm 0.002}{2443190.918} + \underset{\pm 0.00000035}{0.22068600}\ E + \underset{\pm\ 1.04 \times 10^{-11}}{(-1.72 \times 10^{-11}\ E^2)} \qquad (4)$$

$$JD_{min} = \underset{\pm 0.005}{2446144.688} + \underset{\pm 0.00000019}{0.22068517}\ E \qquad (5)$$

6. SW Lac

The period of SW Lac has changed several times during the past 30 years. Five linear segments have been isolated, and a set of elements has been calculated for each. For the interval before JD 2440800, equation (6) represents the best fit.

$$JD_{min} = \underset{\pm 0.005}{2438967.743} + \underset{\pm 0.00000060}{0.32072658}\ E \qquad (6)$$

A decrease in the period occurred near JD 2440800. Equation (7) fits the observed times of minima for the next three observing seasons.

$$JD_{min} = \underset{\pm 0.003}{2440813.682} + \underset{\pm 0.00000051}{0.32071717}\ E \qquad (7)$$

Another slight decrease in the period occurred around JD 2441900. After this date the observed times of minima fit equation (8).

$$JD_{min} = \underset{\pm 0.005}{2441980.609} + \underset{\pm 0.00000046}{0.32071466}\ E \qquad (8)$$

From JD 2443100 to 2448500, the period of SW Lac remained stable. The elements published in Rudnicki *et al.* (1989), and given in equation (9), well describe the behavior of this star during this time interval.

$$JD_{min} = 2445275.3467 + 0.32072018\ E \qquad (9)$$

Another decrease in the period of SW Lac occurred near JD 2448500. Equation (10) best describes the current behavior of SW Lac, and will be used to predict future eclipses until the next change in period is observed.

$$JD_{min} = \underset{\pm 0.005}{2448545.569} + \underset{\pm 0.0000008}{0.3207153}\ E \qquad (10)$$

7. Z Per

The period of Z Per has been decreasing since the first AAVSO observations were made of this star in 1967. Equation (11) provides a quadratic fit for these observed times of minima. Equation (12) gives the linear elements currently used for the AAVSO ephemeris.

$$JD_{min} = \begin{array}{l} 2439769.728 + 3.0563360\,E + (-1.69 \times 10^{-8}\,E^2) \\ \pm 0.003 \pm 0.0000042 \quad \pm \quad 0.12 \times 10^{-8} \end{array} \qquad (11)$$

$$JD_{min} = \begin{array}{l} 2448232.596 + 3.056234\,E \\ \pm 0.003 \pm 0.000007 \end{array} \qquad (12)$$

8. W UMi

W UMi also appears to have a continuously decreasing period, as shown in equation (13). A linear fit for the most recent observations is given in equation (14).

$$JD_{min} = \begin{array}{l} 2436082.653 + 1.7011584\,E + (-1.34 \times 10^{-9}\,E^2) \\ \pm 0.006 \pm 0.0000030 \quad \pm \quad 0.37 \times 10^{-9} \end{array} \qquad (13)$$

$$JD_{min} = \begin{array}{l} 2443778.669 + 1.70114162\,E \\ \pm 0.009 \pm 0.0000026 \end{array} \qquad (14)$$

References

Baldwin, M. E., and Samolyk, G. 1996, *Observed Minima Timings of Eclipsing Binaries No. 3*, AAVSO, Cambridge, MA.

Kholopov, P. N., *et al.* 1985, *General Catalogue of Variable Stars*, 4th Ed., Moscow.

Rudnicki, K., *et al.* 1989, *Rocznik Astron. Obs. Krakowskiego, Suppl. Ann. Cracoviense*, No. 60, Krakow.

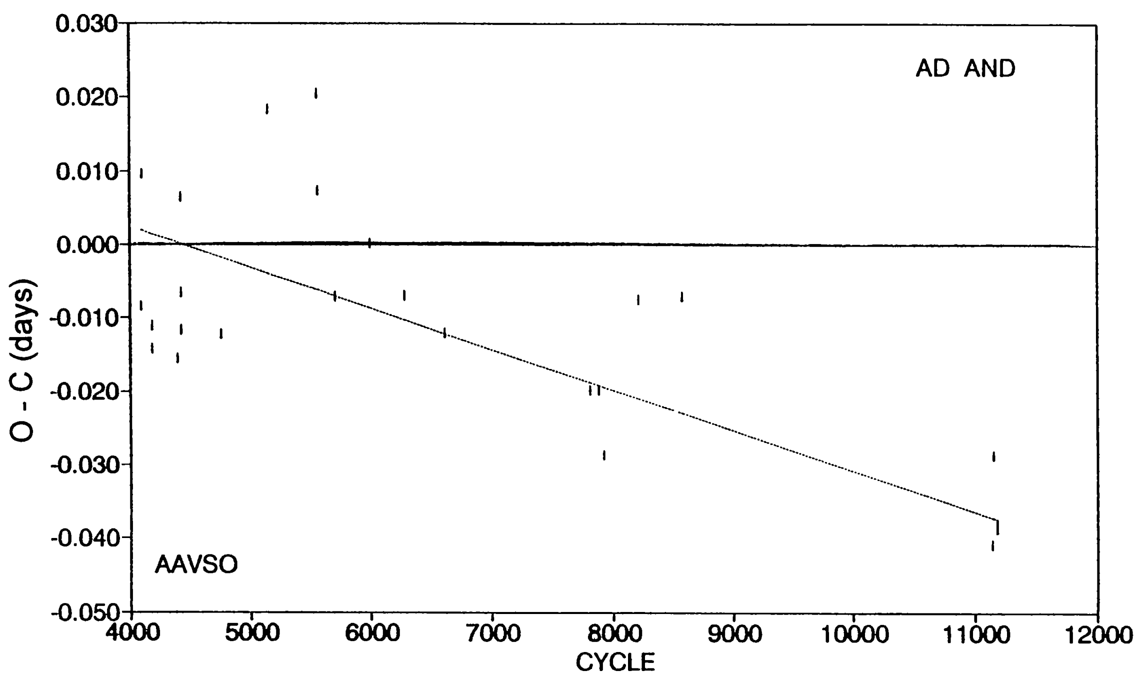

Figure 1. O-C plot of AD And based on the GCVS elements. The dashed line represents equation (1).

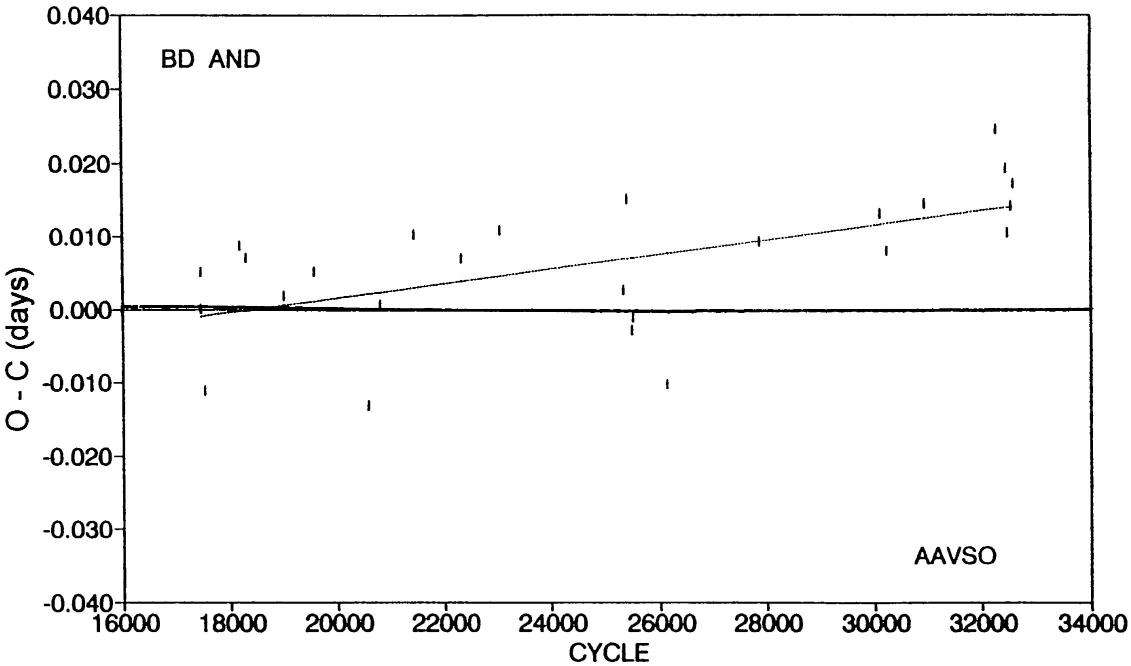

Figure 2. O-C plot of BD And based on the GCVS elements. The dashed line represents equation (2).

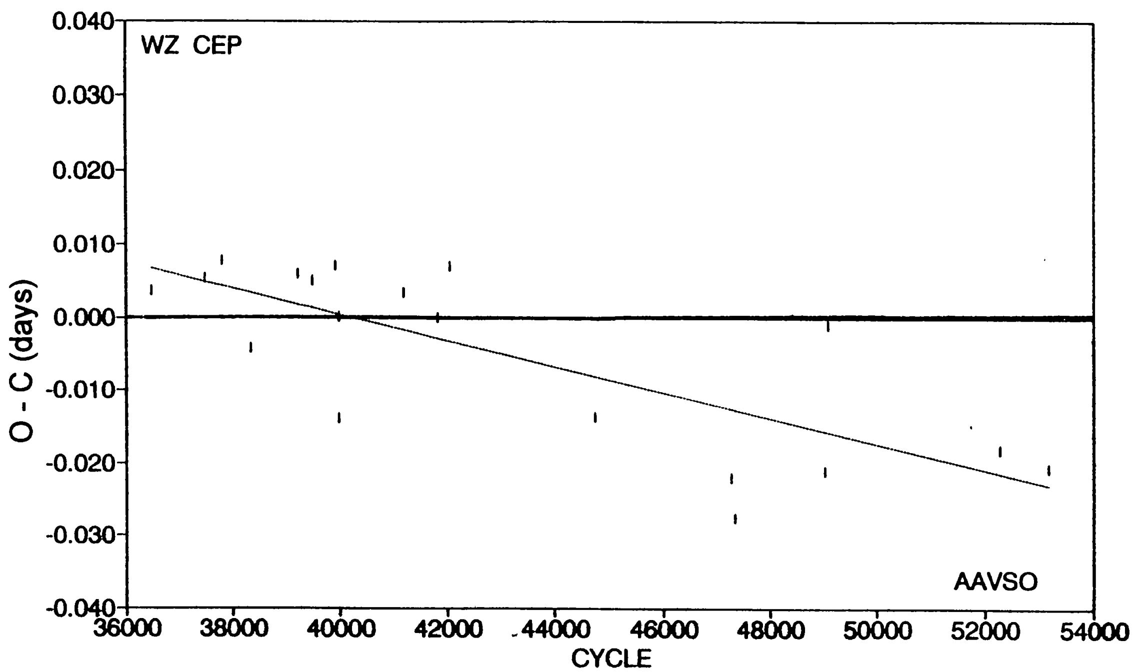

Figure 3. O-C plot of WZ Cep based on the GCVS elements. The dashed line represents equation (3).

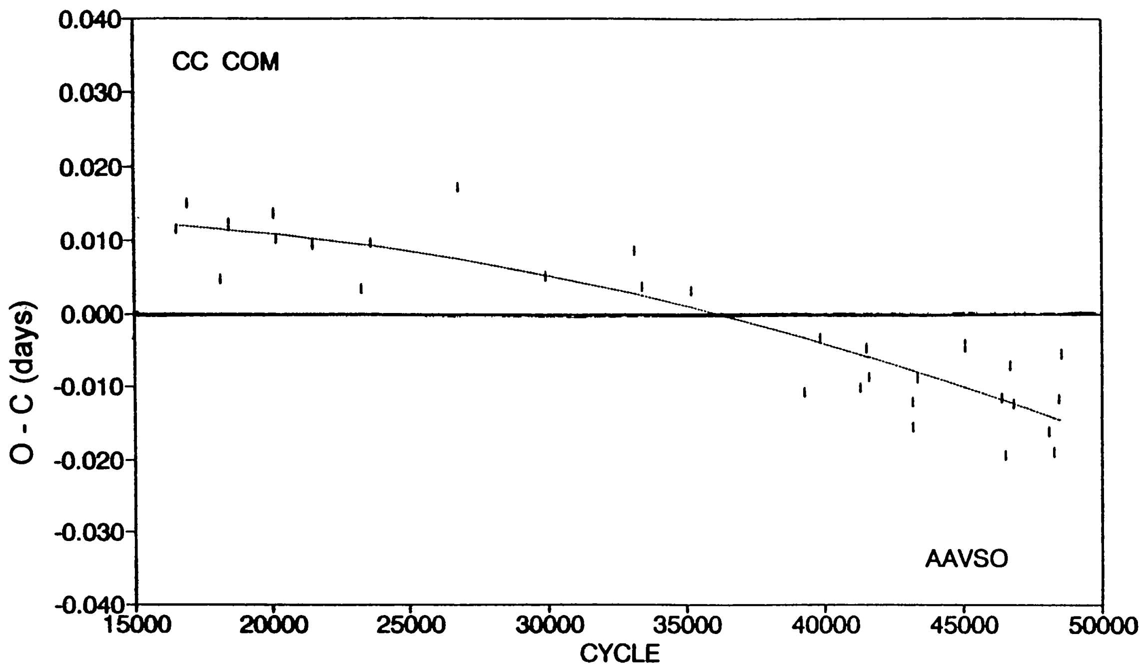

Figure 4. O-C plot of CC Com based on the GCVS elements. The dashed curve represents equation (4).

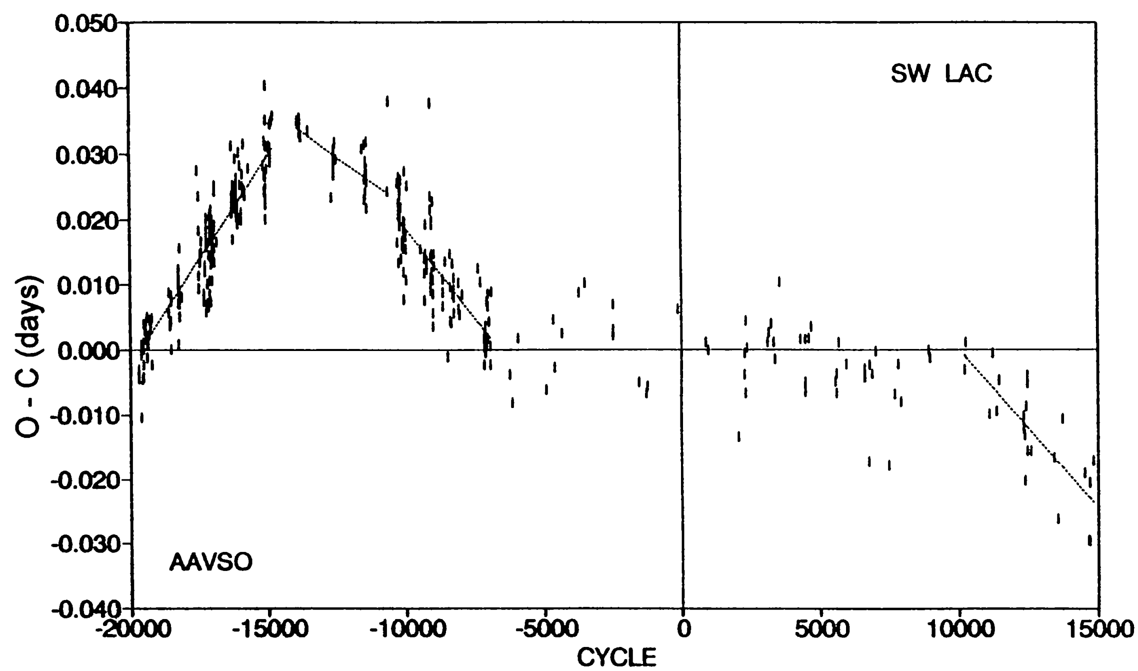

Figure 5. O-C plot of SW Lac based on the Rudnicki *et al.* (1989) elements (equation (9)). The dashed lines represent (left to right) equations (6), (7), (8), and (10).

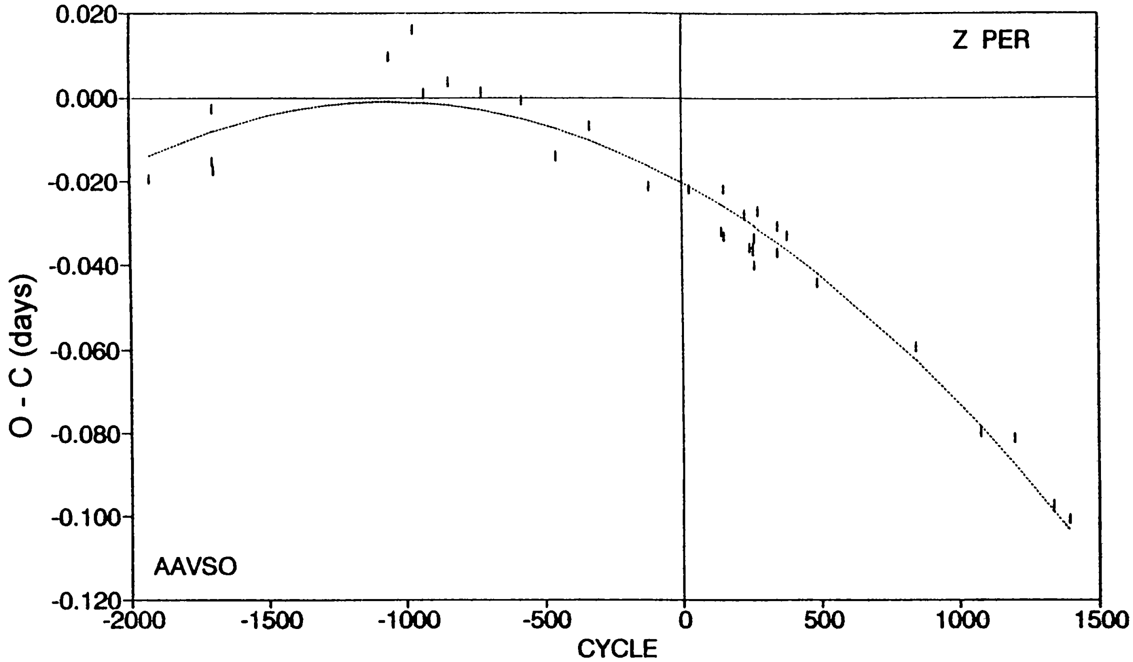

Figure 6. O-C plot of Z Per based on the GCVS elements. The dashed curve represents equation (11).

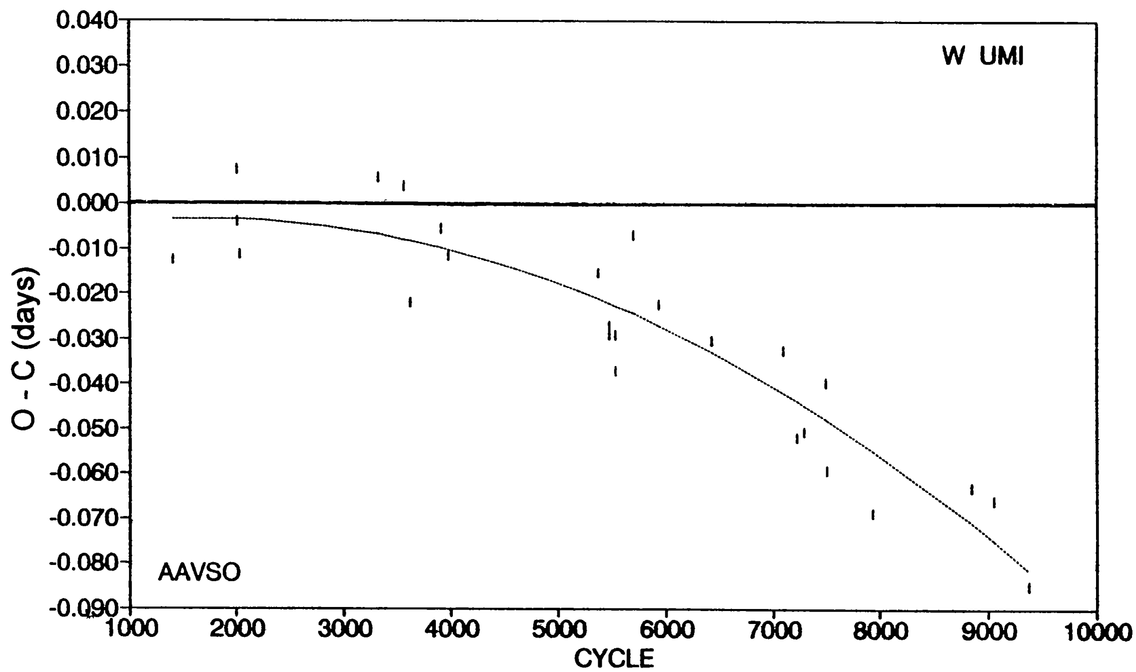

Figure 7. O-C plot of W UMi based on the GCVS elements. The dashed curve represents equation (13).