# A PERIOD UPDATE FOR FIVE ECLIPSING BINARY STARS - SS ARI, TY BOO, DF HYA, Z LEP, AND TY UMA

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**Abstract**

AAVSO observations of 5 eclipsing binary stars indicate a large discrepancy when compared with the elements from the 4th edition of the *General Catalogue of Variable Stars* (Kholopov *et al.* 1985). New periods for SS Ari, TY Boo, DF Hya, Z Lep, and TY UMa have been calculated.

When reducing AAVSO eclipsing binary data, all times of minima are compared with the elements published in the 4th edition of the *General Catalogue of Variable Stars* (GCVS). Often, stars need period corrections. In this paper, period updates are given for five stars that have been favorite targets of the Milwaukee Astronomical Society Observatory.

All observations were made visually with an arbitrary step sequence of comparison stars. One of these stars, Z Lep, appears to be type EA star with an amplitude of about 1.5 magnitudes. The remaining four stars, SS Ari, TY Boo, DF Hya, and TY UMa, are type EW with amplitudes of 0.5 to 0.7 magnitude. Although this is near the lower limit for visual observing, each of these stars are near good comparison stars and the observers have a high degree of confidence in their data.

All AAVSO times of minima for these stars are listed in Tables 1-5. The reduction was done using a computer-aided tracing paper program. The new elements were calculated using a linear regression on these minima, and are as follows:

1) SS Ari - Times of minima published in *Odessa Isvestia* (Kramer 1948) and *Variable Stars Bulletin* (Odynskaya 1949) are in close agreement with equation 2.

| | | | | | | |
|---|---|---|---|---|---|---|
| GCVS | $JD_{min}$ | = | 2439028.395 | + | 0.4059936 E | (1) |
| This paper | $JD_{min}$ | = | 2443045.719 | + | 0.40598632 E | (2) |

2) TY Boo -

| | | | | | | |
|---|---|---|---|---|---|---|
| GCVS | $JD_{min}$ | = | 2434480.425 | + | 0.3171477 E | (3) |
| This paper | $JD_{min}$ | = | 2443330.751 | + | 0.31715095 E | (4) |

3) DF Hya - Times of minima published in *Odessa Isvestia* (Tsesevich 1954) support equation 6, however, some scatter exists.

| | | | | | | |
|---|---|---|---|---|---|---|
| GCVS | $JD_{min}$ | = | 2431138.231 | + | 0.3305978 E | (5) |
| This paper | $JD_{min}$ | = | 2442787.777 | + | 0.33060521 E | (6) |

4) Z Lep - Two minima published in *Odessa Isvestia* (Tsesevich 1954) produce an O-C of about -2 hours. A small change in period has probably taken place since this time.

GCVS $JD_{min} = 2427424.311 + 0.993715\ E$ (7)
This paper $JD_{min} = 2443452.838 + 0.993703571\ E$ (8)

5) TY UMa - Using equation 10, the O-C values before cycle 0 are somewhat large. However, these data are not sufficient to determine if a period change occured near this time.

GCVS $JD_{min} = 2439532.4965 + 0.3545386\ E$ (9)
This paper $JD_{min} = 2444334.724 + 0.35454487\ E$ (10)

Table 1. New times of minima for SS Ari.

| *JD (min) Hel. 2400000+* | *Equation 1* | | *Equation 2* | | | |
|---|---|---|---|---|---|---|
| | *Cycle* | *O-C* | *Cycle* | *O-C* | *N* | *Observer* |
| 43045.715 | 9895 | 0.013 | 0 | -0.004 | 5 | G. Samolyk |
| 43045.709 | 9895 | 0.007 | 0 | -0.010 | 6 | G. Wedemayer |
| 43051.796 | 9910 | 0.004 | 15 | -0.013 | 11 | G. Wedemayer |
| 43066.819 | 9947 | 0.006 | 52 | -0.011 | 8 | G. Samolyk |
| 43096.867 | 10021 | 0.010 | 126 | -0.006 | 7 | C. Hesseltine |
| 43123.673 | 10087 | 0.021 | 192 | 0.005 | 10 | G. Samolyk |
| 43185.575 | 10239.5 | 0.009 | 344.5 | -0.006 | 10 | G. Wedemayer |
| 43751.744 | 11634 | 0.019 | 1739 | 0.015 | 9 | G. Samolyk |
| 43879.601 | 11949 | -0.012 | 2054 | -0.014 | 13 | G. Samolyk |
| 44463.831 | 13388 | -0.006 | 3493 | 0.002 | 10 | G. Hanson |
| 44492.666 | 13459 | 0.003 | 3564 | 0.012 | 10 | G. Samolyk |
| 44537.702 | 13570 | -0.026 | 3675 | -0.017 | 14 | P. Goodwin |
| 44542.606 | 13582 | 0.006 | 3687 | 0.015 | 12 | G. Hanson |
| 44544.619 | 13587 | -0.011 | 3692 | -0.001 | 13 | G. Hanson |
| 44598.647 | 13720 | 0.020 | 3825 | 0.030 | 19 | P. Goodwin |
| 44622.583 | 13779 | 0.002 | 3884 | 0.013 | 12 | G. Hanson |
| 45291.640 | 15427 | -0.018 | 5532 | 0.005 | 9 | G. Samolyk |
| 45315.599 | 15486 | -0.013 | 5591 | 0.010 | 16 | G. Samolyk |
| 45643.633 | 16294 | -0.022 | 6399 | 0.008 | 10 | G. Samolyk |
| 46017.544 | 17215 | -0.031 | 7320 | 0.005 | 9 | G. Samolyk |
| 46021.603 | 17225 | -0.032 | 7330 | 0.004 | 9 | D. Williams |
| 46025.650 | 17235 | -0.045 | 7340 | -0.009 | 8 | D. Williams |
| 46060.555 | 17321 | -0.055 | 7426 | -0.018 | 10 | D. Williams |
| 46071.527 | 17348 | -0.045 | 7453 | -0.008 | 9 | D. Williams |
| 46114.593 | 17454 | -0.014 | 7559 | 0.023 | 14 | G. Samolyk |
| 46714.600 | 18932 | -0.066 | 9037 | -0.017 | 7 | G. Samolyk |
| 47161.618 | 20033 | -0.047 | 10138 | 0.010 | 11 | G. Samolyk |
| 47524.564 | 20927 | -0.059 | 11032 | 0.004 | 9 | G. Samolyk |
| 47539.573 | 20964 | -0.072 | 11069 | -0.009 | 8 | G. Samolyk |
| 47856.641 | 21745 | -0.085 | 11850 | -0.016 | 12 | M. Smith |
| 48176.580 | 22533 | -0.069 | 12638 | 0.006 | 11 | G. Samolyk |
| 48219.612 | 22639 | -0.072 | 12744 | 0.003 | 14 | G. Samolyk |
| 48232.590 | 22671 | -0.086 | 12776 | -0.010 | 12 | G. Samolyk |

Table 2. New times of minima for TY Boo.

| *JD (min) Hel. 2400000+* | *Equation 3* Cycle | O-C | *Equation 4* Cycle | O-C | *N* | *Observer* |
|---|---|---|---|---|---|---|
| 43330.741 | 27906 | -0.008 | 0 | -0.010 | 10 | D. Ruokonen |
| 43330.749 | 27906 | 0.000 | 0 | -0.002 | 16 | G. Samolyk |
| 43351.672 | 27972 | -0.008 | 66 | -0.011 | 9 | D. Ruokonen |
| 43587.802 | 28716.5 | 0.005 | 810.5 | 0.000 | 12 | G. Samolyk |
| 43970.760 | 29924 | 0.007 | 2018 | -0.002 | 13 | G. Samolyk |
| 43980.901 | 29956 | -0.001 | 2050 | -0.009 | 12 | G. Samolyk |
| 44334.709 | 31071.5 | 0.029 | 3165.5 | 0.017 | 16 | G. Samolyk |
| 44348.806 | 31116 | 0.013 | 3210 | 0.000 | 16 | G. Samolyk |
| 44402.725 | 31286 | 0.017 | 3380 | 0.004 | 20 | G. Hanson |
| 45173.715 | 33717 | 0.021 | 5811 | -0.000 | 15 | G. Samolyk |
| 45492.777 | 34723 | 0.032 | 6817 | 0.008 | 11 | G. Samolyk |
| 46210.798 | 36987 | 0.031 | 9081 | -0.001 | 15 | P. Atwood |
| 46210.800 | 36987 | 0.033 | 9081 | 0.001 | 17 | G. Samolyk |
| 46590.741 | 38185 | 0.031 | 10279 | -0.005 | 10 | R. Hill |
| 46591.719 | 38188 | 0.058 | 10282 | 0.022 | 12 | R. Hill |
| 46600.723 | 38216.5 | 0.023 | 10310.5 | -0.013 | 8 | R. Hill |
| 46606.766 | 38235.5 | 0.040 | 10329.5 | 0.004 | 16 | G. Samolyk |
| 46678.602 | 38462 | 0.042 | 10556 | 0.006 | 11 | G. Samolyk |
| 46875.716 | 39083.5 | 0.049 | 11177.5 | 0.010 | 17 | G. Samolyk |
| 46951.669 | 39323 | 0.045 | 11417 | 0.006 | 10 | G. Samolyk |
| 47010.655 | 39509 | 0.042 | 11603 | 0.002 | 12 | G. Samolyk |
| 47219.806 | 40168.5 | 0.034 | 12262.5 | -0.009 | 11 | G. Samolyk |
| 47299.743 | 40420.5 | 0.049 | 12514.5 | 0.006 | 12 | G. Samolyk |
| 47316.706 | 40474 | 0.045 | 12568 | 0.002 | 13 | G. Samolyk |
| 47681.751 | 41625 | 0.053 | 13719 | 0.006 | 13 | G. Samolyk |
| 48161.594 | 43138 | 0.052 | 15232 | -0.000 | 10 | G. Samolyk |
| 48330.641 | 43671 | 0.059 | 15765 | 0.005 | 10 | G. Samolyk |
| 48331.741 | 43674.5 | 0.049 | 15768.5 | -0.005 | 15 | G. Samolyk |
| 48661.897 | 44715.5 | 0.054 | 16809.5 | -0.003 | 11 | G. Samolyk |
| 48717.715 | 44891.5 | 0.054 | 16985.5 | -0.003 | 12 | G. Samolyk |
| 48724.844 | 44914 | 0.047 | 17008 | -0.010 | 14 | G. Samolyk |
| 48770.670 | 45058.5 | 0.045 | 17152.5 | -0.013 | 17 | G. Samolyk |

Table 3. New times of minima for DF Hya.

| *JD (min) Hel. 2400000+* | *Equation 5* Cycle | O-C | *Equation 6* Cycle | O-C | *N* | *Observer* |
|---|---|---|---|---|---|---|
| 42787.782 | 35237 | 0.276 | 0 | 0.005 | 9 | G. Wedemayer |
| 43141.854 | 36308 | 0.278 | 1071 | -0.001 | 10 | G. Wedemayer |
| 43144.832 | 36317 | 0.281 | 1080 | 0.001 | 8 | G. Samolyk |
| 43549.817 | 37542 | 0.283 | 2305 | -0.005 | 9 | G. Samolyk |
| 43876.785 | 38531 | 0.290 | 3294 | -0.006 | 11 | G. Samolyk |
| 44191.845 | 39484 | 0.290 | 4247 | -0.012 | 11 | G. Samolyk |
| 44279.799 | 39750 | 0.305 | 4513 | 0.001 | 10 | G. Samolyk |

Table 3 continued.

| JD (min) Hel. 2400000+ | Equation 5 Cycle | O-C | Equation 6 Cycle | O-C | N | Observer |
|---|---|---|---|---|---|---|
| 44281.779 | 39756 | 0.302 | 4519 | -0.003 | 7 | G. Hanson |
| 44286.747 | 39771 | 0.311 | 4534 | 0.006 | 7 | G. Hanson |
| 44292.703 | 39789 | 0.316 | 4552 | 0.011 | 8 | P. Goodwin |
| 44295.670 | 39798 | 0.308 | 4561 | 0.003 | 8 | P. Goodwin |
| 44300.624 | 39813 | 0.303 | 4576 | -0.002 | 16 | G. Hanson |
| 44327.733 | 39895 | 0.303 | 4658 | -0.003 | 23 | P. Goodwin |
| 44328.727 | 39898 | 0.305 | 4661 | -0.001 | 23 | P. Goodwin |
| 44630.895 | 40812 | 0.307 | 5575 | -0.006 | 15 | G. Hanson |
| 45021.664 | 41994 | 0.309 | 6757 | -0.012 | 12 | G. Samolyk |
| 45373.766 | 43059 | 0.324 | 7822 | -0.005 | 15 | G. Samolyk |
| 45797.772 | 44341.5 | 0.339 | 9104.5 | 0.000 | 11 | G. Samolyk |
| 47897.935 | 50694 | 0.379 | 15457 | -0.007 | 16 | G. Samolyk |
| 48295.652 | 51897 | 0.387 | 16660 | -0.008 | 17 | G. Samolyk |
| 48335.665 | 52018 | 0.398 | 16781 | 0.002 | 17 | G. Samolyk |
| 48682.805 | 53068 | 0.410 | 17831 | 0.006 | 12 | G. Samolyk |

Table 4. New times of minima for Z Lep.

| JD (min) Hel. 2400000+ | Equation 7 Cycle | O-C | Equation 8 Cycle | O-C | N | Observer |
|---|---|---|---|---|---|---|
| 43452.852 | 16130 | -0.082 | 0 | 0.014 | 14 | G. Wedemayer |
| 44270.647 | 16953 | -0.114 | 823 | -0.009 | 13 | G. Samolyk |
| 44279.592 | 16962 | -0.113 | 832 | -0.007 | 13 | G. Hanson |
| 44573.740 | 17258 | -0.104 | 1128 | 0.004 | 9 | G. Samolyk |
| 44576.713 | 17261 | -0.113 | 1131 | -0.004 | 15 | G. Samolyk |
| 45373.668 | 18063 | -0.117 | 1933 | 0.001 | 13 | G. Samolyk |
| 45671.780 | 18363 | -0.120 | 2233 | 0.002 | 15 | G. Samolyk |
| 46489.591 | 19186 | -0.136 | 3056 | -0.005 | 11 | G. Samolyk |
| 46793.669 | 19492 | -0.135 | 3362 | 0.000 | 10 | G. Samolyk |
| 46804.602 | 19503 | -0.133 | 3373 | 0.002 | 10 | G. Samolyk |
| 47894.698 | 20600 | -0.142 | 4470 | 0.005 | 13 | G. Samolyk |

Table 5. New times of minima for TY UMa.

| JD (min) Hel. 2400000+ | Equation 9 Cycle | O-C | Equation 10 Cycle | O-C | N | Observer |
|---|---|---|---|---|---|---|
| 43144.870 | 10189 | -0.020 | -3356 | -0.001 | 10 | G. Samolyk |
| 43165.808 | 10248 | -0.000 | -3297 | 0.018 | 14 | G. Samolyk |
| 43165.814 | 10248 | 0.006 | -3297 | 0.024 | 15 | G. Wedemayer |
| 43175.912 | 10276.5 | -0.000 | -3268.5 | 0.018 | 13 | G. Wedemayer |
| 43184.952 | 10302 | -0.001 | -3243 | 0.017 | 11 | G. Samolyk |

Table 5 continued.

| *JD (min) Hel. 2400000+* | *Equation 9* | | *Equation 10* | | | |
|---|---|---|---|---|---|---|
| | *Cycle* | *O-C* | *Cycle* | *O-C* | *N* | *Observer* |
| 43185.843 | 10304.5 | 0.003 | -3240.5 | 0.022 | 10 | G. Wedemayer |
| 43271.655 | 10546.5 | 0.017 | -2998.5 | 0.034 | 7 | D. Ruokonen |
| 43587.722 | 11438 | 0.013 | -2107 | 0.024 | 13 | G. Samolyk |
| 43646.743 | 11604.5 | 0.003 | -1940.5 | 0.013 | 13 | G. Samolyk |
| 43883.750 | 12273 | 0.001 | -1272 | 0.007 | 16 | G. Samolyk |
| 43979.622 | 12543.5 | -0.029 | -1001.5 | -0.025 | 13 | G. Samolyk |
| 44334.747 | 13545 | 0.025 | 0 | 0.023 | 9 | G. Samolyk |
| 44348.731 | 13584.5 | 0.005 | 39.5 | 0.002 | 9 | G. Samolyk |
| 44598.857 | 14290 | 0.004 | 745 | -0.003 | 11 | G. Samolyk |
| 45082.795 | 15655 | -0.003 | 2110 | -0.019 | 16 | G. Samolyk |
| 45416.780 | 16597 | 0.006 | 3052 | -0.015 | 18 | G. Samolyk |
| 45785.703 | 17637.5 | 0.032 | 4092.5 | 0.004 | 17 | G. Samolyk |
| 45797.760 | 17671.5 | 0.035 | 4126.5 | 0.007 | 12 | G. Samolyk |
| 46142.718 | 18644.5 | 0.027 | 5099.5 | -0.008 | 16 | G. Samolyk |
| 46144.685 | 18650 | 0.044 | 5105 | 0.009 | 19 | G. Samolyk |
| 46413.953 | 19409.5 | 0.040 | 5864.5 | 0.001 | 16 | G. Samolyk |
| 46553.811 | 19804 | 0.032 | 6259 | -0.009 | 18 | G. Samolyk |
| 46560.722 | 19823.5 | 0.030 | 6278.5 | -0.012 | 17 | G. Samolyk |
| 46820.805 | 20557 | 0.058 | 7012 | 0.012 | 18 | G. Samolyk |
| 46857.670 | 20661 | 0.051 | 7116 | 0.005 | 16 | G. Samolyk |
| 46875.754 | 20712 | 0.054 | 7167 | 0.007 | 14 | G. Samolyk |
| 46915.638 | 20824.5 | 0.052 | 7279.5 | 0.005 | 9 | G. Samolyk |
| 47554.685 | 22627 | 0.044 | 9082 | -0.016 | 17 | G. Samolyk |
| 47897.911 | 23595 | 0.076 | 10050 | 0.011 | 14 | G. Samolyk |
| 48041.656 | 24000.5 | 0.056 | 10455.5 | -0.012 | 14 | G. Samolyk |
| 48066.845 | 24071.5 | 0.073 | 10526.5 | 0.004 | 10 | G. Samolyk |
| 48297.832 | 24723 | 0.078 | 11178 | 0.005 | 14 | G. Samolyk |
| 48330.626 | 24815.5 | 0.077 | 11270.5 | 0.004 | 14 | G. Samolyk |
| 48633.751 | 25670.5 | 0.071 | 12125.5 | -0.007 | 13 | G. Samolyk |
| 48654.860 | 25730 | 0.085 | 12185 | 0.007 | 18 | G. Samolyk |
| 48661.778 | 25749.5 | 0.090 | 12204.5 | 0.011 | 15 | G. Samolyk |
| 48709.804 | 25885 | 0.076 | 12340 | -0.004 | 15 | G. Samolyk |
| 48717.788 | 25907.5 | 0.083 | 12362.5 | 0.003 | 17 | G. Samolyk |
| 48724.869 | 25927.5 | 0.073 | 12382.5 | -0.007 | 13 | G. Samolyk |

## References

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Tsesevich, V. P. 1954, *Odessa Isvestia,* **IV**, 2, 137.
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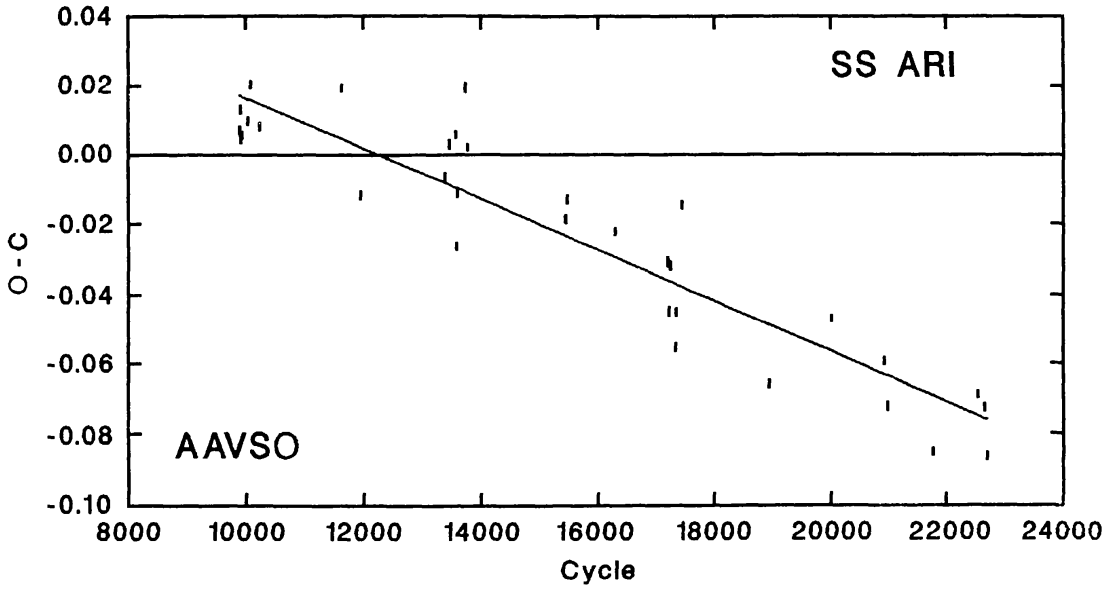


Figure 1. O-C plot of times of minima for SS Ari per equation 1. The line represents equation 2.

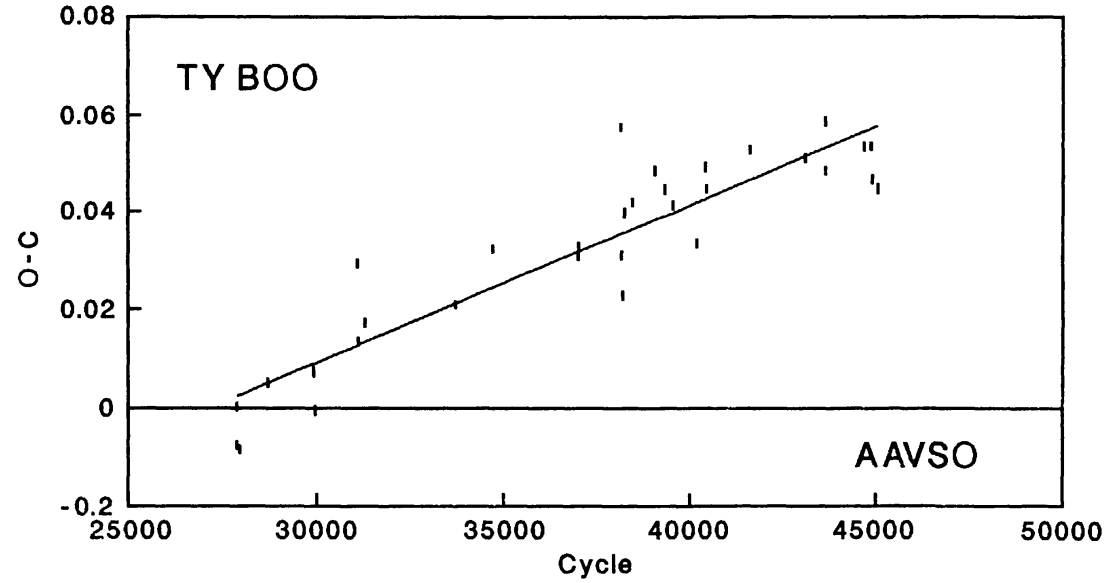


Figure 2. O-C plot of times of minima for TY Boo per equation 3. The line represents equation 4.

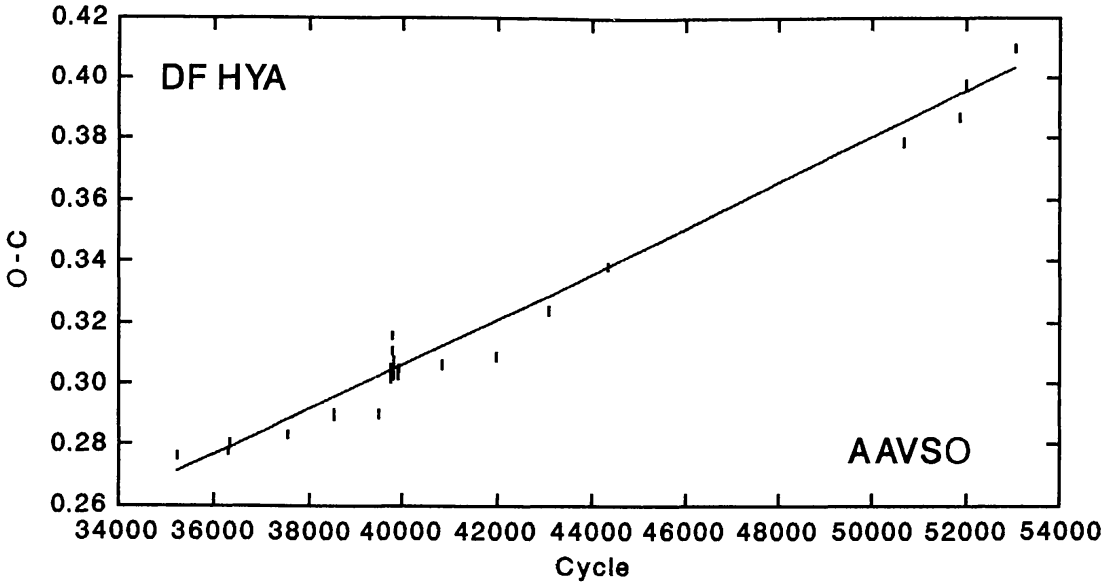


Figure 3. O-C plot of times of minima for DF Hya per equation 5. The line represents equation 6.

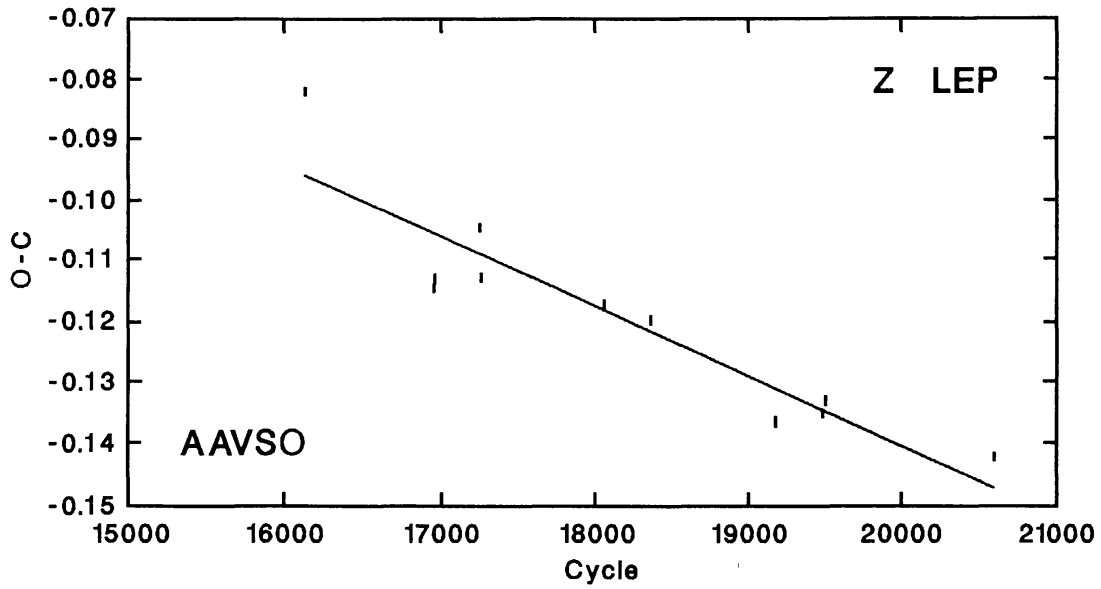


Figure 4. O-C plot of times of minima for Z Lep per equation 7. The line represents equation 8.

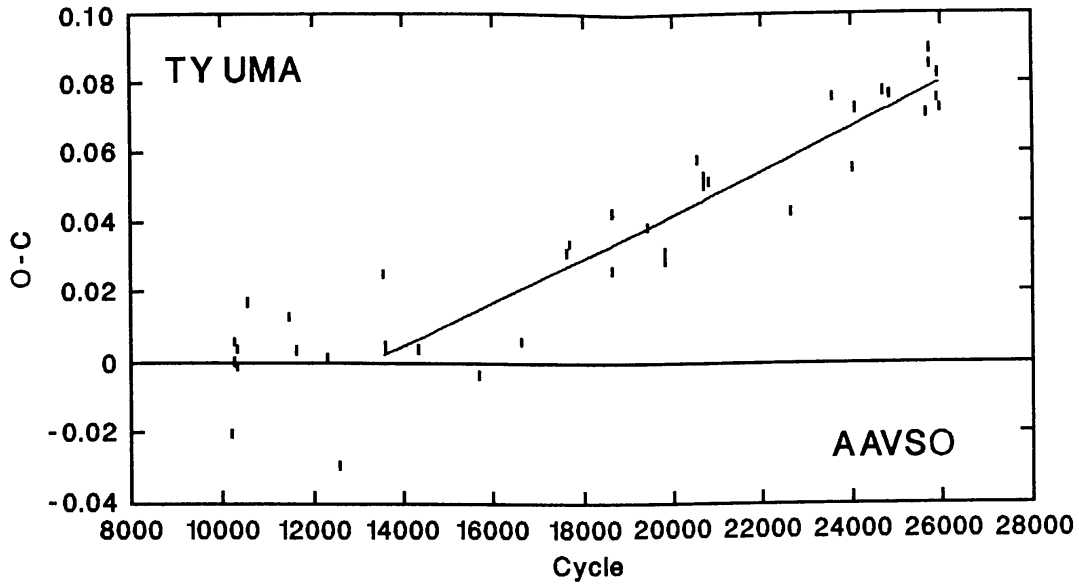


Figure 5. O-C plot of times of minima for TY UMa per equation 9. The line represents equation 10.