NEW ELEMENTS FOR SOME ECLIPSING BINARY STARS, II

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Examination of eclipsing binaries under observation by the AAVSO reveals several stars with appreciable deviations from the linear elements listed by Kukarkin (1969). Nine of these stars were discussed in an earlier paper (Baldwin, 1973) in which the revised periods and initial epochs were listed. To illustrate the conclusions drawn about each of the variables' behavior, diagrams were used to show the progress, with time, of the differential between the observed and computed times of minima. We continue here with the examination of seven additional stars falling within the same category. As before, minima timings used to construct the O-C diagrams are drawn from both published and unpublished observations by AAVSO observers and from published minima by the Swiss observing group, Bedeckungsveraenderlichen Beobachter der Schweizerischen Astronomischen Gesellschaft (BBSAG) working under the direction of Kurt Locher.

The format of this presentation is similar to that given in the earlier paper and should, in fact, be considered a continuation of that paper.

STARS EVALUATED

RY Aqr (211411) GCVS elements: JD 2433872.405 + 1.966637E
Revised elements: JD 2440824.414 + 1.966594E

RY Aquarii has been under observation by Swiss and American amateurs for five years with the majority of the work being done by the BBSAG. Examination of the O-C diagram reveals a shortened period and continued deviation from the GCVS elements. The first supplement to the GCVS (Kukarkin, 1971) recognizes a new period, 1.966623 days, shorter than that listed in the main edition, but still much longer than we find here. The current period is nearly the same as that prior to JD 2431900. There is some limited evidence of a sudden discontinuity in the O-C diagram between observations made in 1970 and 1971, displacing the O-C line upward by about 0.012 day. If this phenomenon is real, then the current period may be even shorter than we have given here.

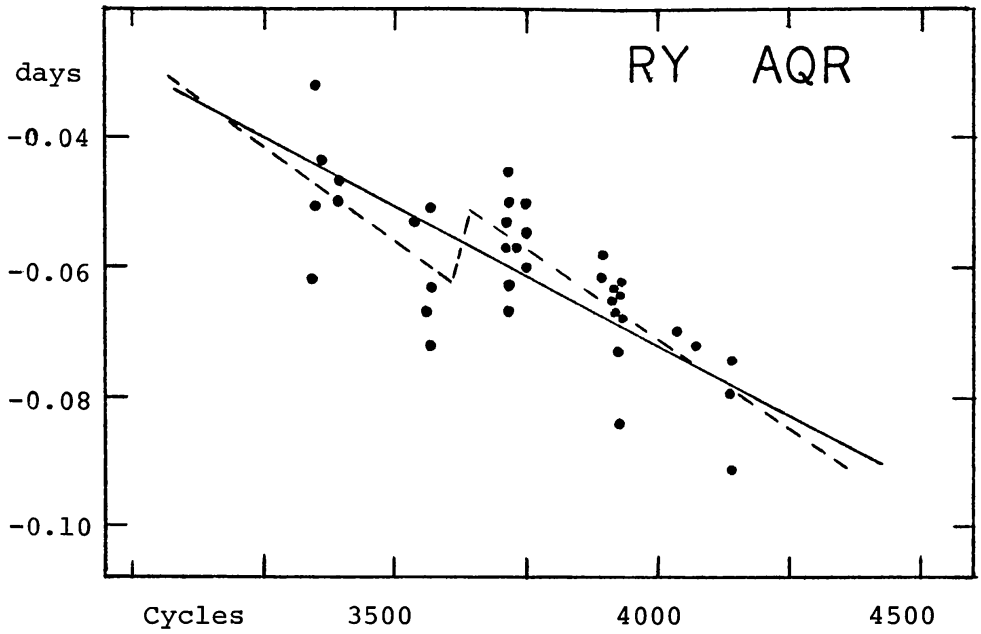

Figure 1. RY Aqr, O-C Residuals

ZZ Cyg (202046) GCVS Elements: JD 2421137.4377 + 0.62861764E
Revised elements: JD 2440512.6640 + 0.62861544E

Although this analysis provides revised linear elements adequately describing the behavior of ZZ Cygni through the 1965-1973 era, it should also be noted that the 1969 GCVS elements include a non-linear component which fits the O-C diagram very well. Therefore, the GCVS elements are verified through 1973. The revised linear elements may be useful for predicting minima over the next few years without the need for resorting to non-linear computations.

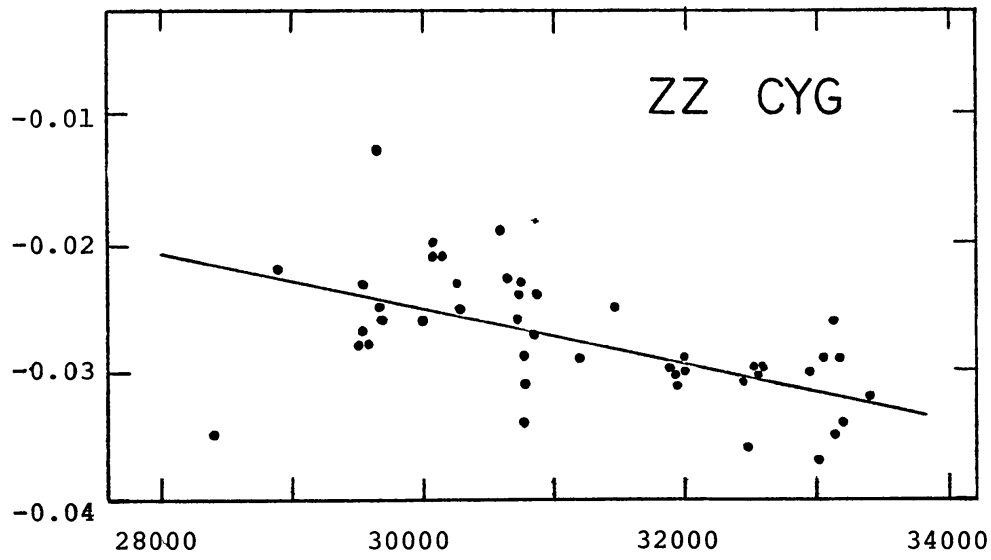

Figure 2. ZZ Cyg, O-C Residuals.

VX Lac (223637) GCVS elements: JD 2434224.465 + 1.074504E
Revised elements: JD 2441246.311 + 1.0744879E

Unlike several other stars examined during this analysis, VX Lacertae, although undergoing a definite change of period, does not appear to have experienced a quantum discontinuity in the period, but has, instead, undergone a gradual period modification over several years time. The revised linear elements given here fit well the means of the twenty-four minima observed by the BBSAG and the AAVSO during the past three years. It may be noted that the 1971 supplement to the GCVS lists other elements for VX Lacertae which provide a moderately good fit for the first five years' data shown on the O-C diagram.

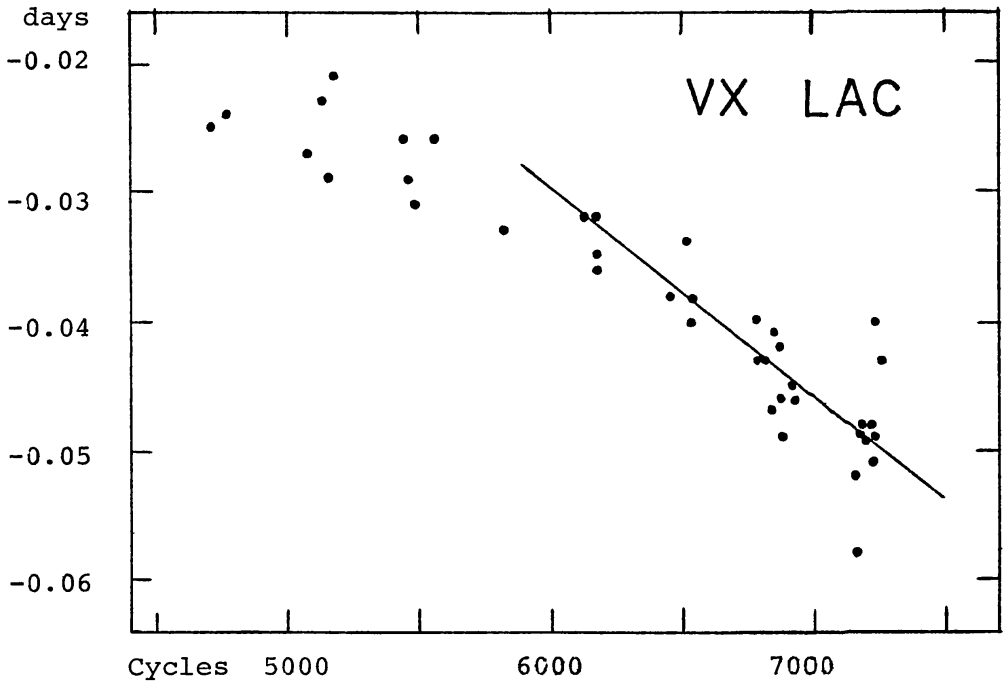

Figure 3. VX Lac, O-C Residuals

EW Lyr (182937) GCVS elements: JD 2434988.378 + 1.948737E
Revised elements: JD 2441450.429 + 1.948736E

When two discordant minima near epoch 3135 are discounted a period change near epoch 3300 becomes evident. Accordingly, observations prior to JD 2441450 are satisfied by the elements: JD 2440066.807 + 1.948763E, and subsequent observations follow the revised elements given above. The net result now amounts to the occurrence of minima nearly one hour later than the GCVS elements indicate, but the revised period does not differ significantly from the GCVS period. Both discordant minima, but none of the others, were timed by the same individual.

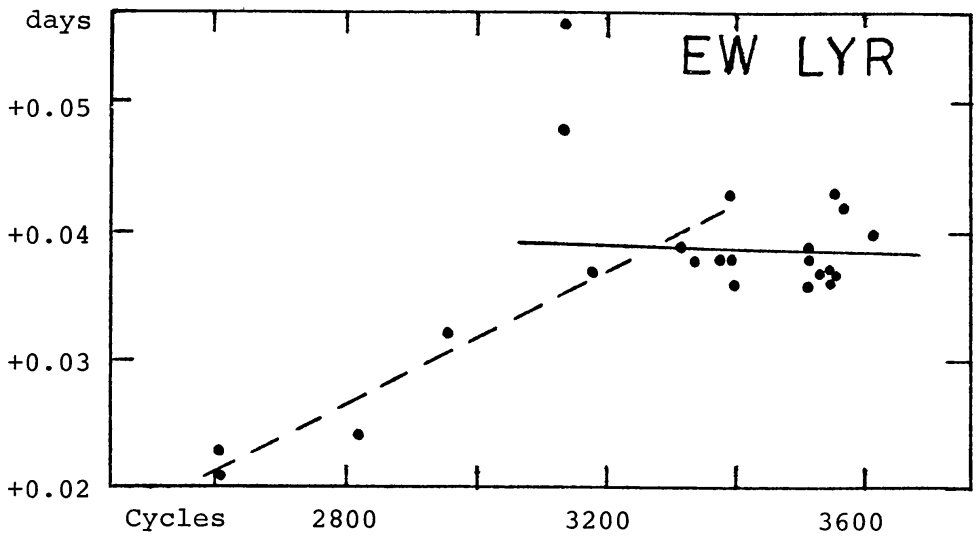

Figure 4. EW Lyr, O-C Residuals.

RW Tau (035721) GCVS elements: JD 2417198.410 + 2.7688463E
Revised elements: JD 2441245.771 + 2.7688463E

At least one minimum of RW Tauri has been observed each of the last nine years by members of the AAVSO or the BBSAG. The forty-four minima recorded by these two observing groups are sufficient to demonstrate that RW Tau has followed three distinct periods through various intervals within the past nine years. The revised elements shown above represent the most recent of these intervals. Effective from approximately JD 2441200 to the present the period remains identical to that given in the 1969 GCVS although the minima are displaced by about 100 minutes (early). The two earlier intervals are best represented by the following elements -- from JD 2439000 to 2440300, JD 2440229.594 + 2.7688313E; and from JD 2440300 to 2441200, JD 2440913.506 + 2.7688762E. In BBSAG Bulletin No. 5 Roger Diethelm noted important period changes then underway following a stable interval of some 50 years without appreciable period changes. These recent changes demonstrated by RW Tauri should place it high on observers' priority lists.

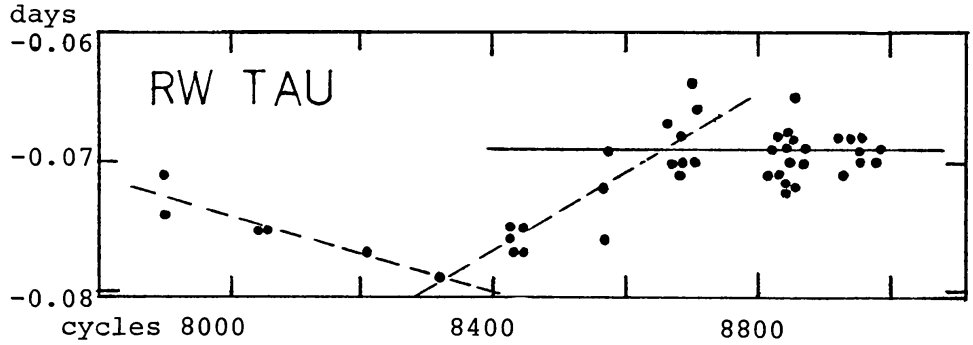

Figure 5. RW Tau, O-C Residuals

X Tri (015427) GCVS elements: JD 2437572.1994 + 0.9715382E
Revised elements: JD 2442074.276 + 0.9715270E

In many ways the X Trianguli O-C diagram proved to be the most difficult to analyze. A wealth of data, 185 visually determined times of minima, was available for this study. The individually plotted O-C values proved to be too numerous for satisfactory depiction on a small diagram. Hence, the data were consolidated to mean values for each observing season. Large and small dots represent incorporation of large and small numbers of data points respectively. Unfortunately, only one minimum was available in each of the years 1960 and 1961, and none was available during the following two years. During the ten year interval beginning in 1964 sufficient data have been available to establish mean points with a high degree of confidence. The times of minima are represented here by two sets of linear elements with the initial epoch, JD 2438717.641, and period 0.9715355 day, accounting for the star's mean behavior from JD 2437000 to 2439800. The revised elements given above are effective since JD 2439800. However, these mean linear elements cannot be accepted absolutely, for it is highly probable that deviations from these elements in 1965, 1968 and 1969 are real, and not just the result of observational error. Sporadic fluctuations in X Trianguli's period appear likely. A search of the literature for other minima, and particularly for high quality photoelectric data, for validation of these period fluctuations should be a highly worthwhile project.

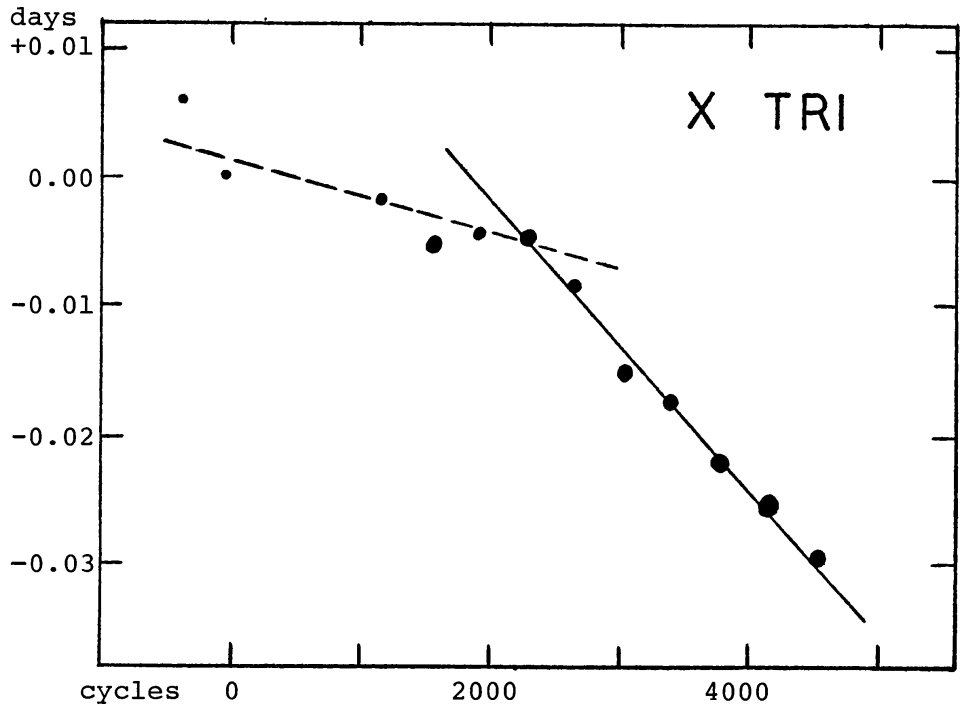

Figure 6. X Tri, O-C Residuals.

VV UMa (093156) GCVS elements: JD 2437348.9309 + 0.68736464E
Revised elements: JD 2441080.690 + 0.6873664E

Establishing revised elements for this star is straightforward. Although the O-C is large (about one and one-half hours) the deviation from the GCVS period is very small. No change of period during the past six years is indicated. Projected backward, the revised elements do not converge with the GCVS initial epoch. During an earlier era a period appreciably longer than the current period may have been in effect.

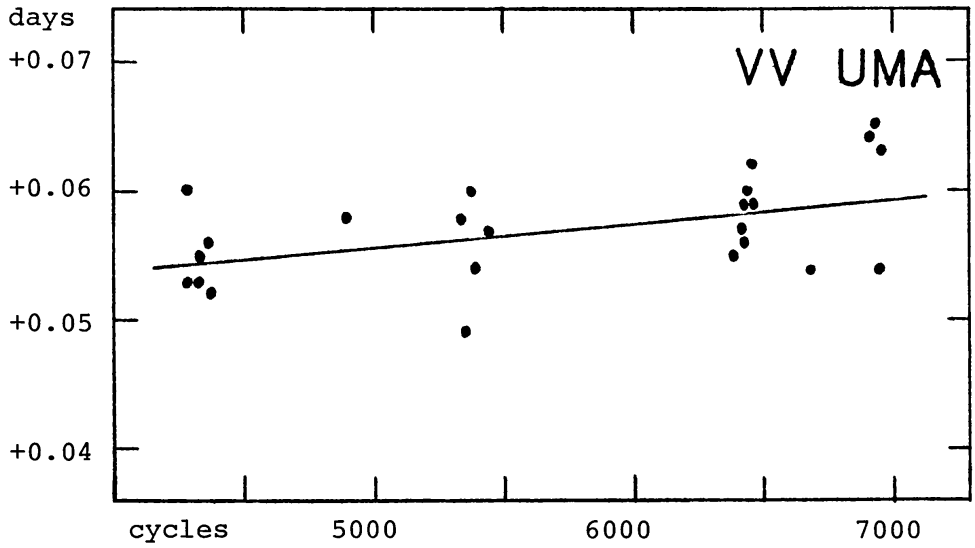

Figure 7. VV UMa, O-C Residuals.

REFERENCES

Baldwin, M. 1973a, I.A.U. Information Bulletin on Variable Stars, No. 795.
Baldwin, M. 1973b, JAAVSO, 2, 7.
Diethelm, R., Germann, R., Locher, K., and Peter, H. 1972-1974, BBSAG Bulletin No. 1-14.
Diethelm, R., and Locher, K. 1968-1972, Orion No. 104, 109,112, 115, 116, 117, 118, 120, 121, 122, 123, 126, 127, and 128.
Kukarkin, B. V., et al. 1969, General Catalog of Variable Stars, Moscow.
_____. 1971, General Catalog of Variable Stars, First Supplement, Moscow.
Robinson, L. 1965-1968, I.A.U. Information Bulletin on Variable Stars No. 111, 114, 119, 129, 154, 180, 221, and 247.
Sky and Telescope 1965, 29, 255.