THE FREQUENCY OF OUTBURSTS IN SS AURIGAE

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Abstract

SS Aurigae is a U Geminorum-type dwarf nova that displays both narrow and wide outbursts. Narrow outbursts predominate during intervals of frequent outbursts and wide outbursts predominate during intervals of less frequent outbursts. The outbursts are found to occur not strictly at random but with intervals of more or less frequent outbursts.

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1. Introduction

SS Aurigae is a U Geminorum-type dwarf nova with outbursts that occur with a mean frequency of every 55.7 days as determined by Mattei *et al*. (1986). The duration of the outbursts displays a bimodal distribution of narrow (duration 4 days) and wide (duration 11 days) outbursts. Narrow outbursts are more common than wide. In this study we examine the history of the occurrence of outbursts.

2. Discussion

Using the data in Table I of Mattei *et al*. we calculated residuals from the times of onset of maxima predicted by the equation:

$$JD(\text{max onset}) = 2417940 + 55.7E. \qquad (1)$$

Observed *minus* computed (O-C) residuals from equation (1) are shown in Figure 1 plotted against the observed date of onset of maximum. If the outbursts were nearly periodic, then the O-C curve would approximate a straight line. Instead, trends in Figure 1 are obvious and dramatic. There are numerous segments in which the curve slopes upward, indicating that the interval between outbursts is longer than the mean 55.7 day interval. There are even more segments in which the curve slopes downward, indicating an interval between outbursts shorter than the mean interval.

By inspection of the O-C curve, we selected segments of the curve for analysis. End points of segments were determined by selecting the points after which the slope of the O-C curve changed. A minimum of four observed outbursts in the segment was used as a criterion for this investigation. The average frequencies of outbursts in the segments were determined by dividing the length of the interval by the number of outbursts. The outburst frequencies determined are listed in Table I. Also included in Table I are the counts of narrow and wide outbursts in each interval. In several instances, the width of an outburst could not be determined due to a lack of observations in the original data. These outbursts of uncertain width were not included in the counts of wide or narrow maxima; they were simply ignored. They were, however, included in counts used in determining outburst frequency.

A most interesting property of the segments appears when we examine the nature of the outbursts during the different intervals. The data points in Figure 1 are shown with two symbols. Dots (•) are used for narrow (and uncertain) maxima and circles (o) for wide maxima. There are marked differences in the behavior of the star between the intervals of frequent outbursts and infrequent outbursts. When the interval between outbursts is longest, wide maxima predominate. When outbursts are most frequent, wide maxima are absent. There is one interval of five years between wide outbursts with 33 observed consecutive narrow outbursts. The probability of this occurring due to a random variation in occurrence of wide and narrow maxima is less than one in one million. During this interval of narrow maxima, the outbursts were frequent, occurring once every 36.9 days. During the 11-year interval when the outbursts occurred on an average of every 70.6 days, the wide outbursts outnumbered the narrow outbursts by 27 to 15, a factor of 1.8, a reversal of the general trend. Taken over the AAVSO's recorded history of SS Aur, it is the narrow outbursts which outnumber wide outbursts by a factor of 1.9 (Mattei et al. 1986).

A plot of the numerical distribution of the frequencies showed that the frequency of outbursts ranges between once per 29 days and once per 95 days.

A question arises concerning the predictability of maxima. Having shown that the star "fixes" on an outburst regularity for long periods of time, is it possible to predict the occurrence of succeeding maxima with somewhat less uncertainty than by using the mean outburst frequency of once each 55.7 days?

As an exercise, we chose every fortieth (or forty-first when gaps occurred in the data) outburst from Table I of Mattei et al. and "predicted" the date of the following outburst by using the average outburst interval of the four (or occasionally five) maxima preceding the subject maximum. The standard deviation of our prediction from the actual outburst date was 24.6 days, not a very good result. Mattei et al. found the standard deviation of the interval between outbursts to be 22.4 days. Thus, there is a considerable statistical variation within the intervals we selected.

3. Conclusion

In conclusion, we have found SS Aur to exhibit long intervals where the mean frequency of outbursts differed substantially from the mean. When the outbursts occur infrequently, most of the maxima are wide. When they occur frequently, most or all of the maxima are narrow. Considerable variation from mean occurrence frequencies occurs even in the intervals, and the succeeding outbursts remain unpredictable.

At present, it is not clear if the wide outbursts occur because the interval between outbursts is longer than average or if the interval between outbursts is long because wide maxima are occurring. The obvious question which flows from this investigation is this: is the absence of abundance of wide maxima the cause of the variation in outburst frequency or is it the effect?

4. Acknowledgement

The writer wishes to express his appreciation to Dr. Janet A. Mattei for reviewing the observations of SS Aur for verification of the missed maxima and for several helpful and stimulating discussions.

REFERENCE

Mattei, J. A., Cook, L. M., Piening McMahon, A. T., Foster, R. M. 1986, **Journ. Amer. Assoc. Var. Star Obs. 15**, 3.

TABLE I

Frequency of Outbursts and Abundance of Wide and Narrow Outbursts of SS Aurigae

Interval JD 2400000+		Interval Outburst Frequency	Number of Outbursts Wide/Narrow
17940	18368	61.1	3/3
18368	18651	47.2	1/4
18651	19512	77.2	8/2
19674	20381	44.2	4/9
20381	21374	55.1	6/11
21374	21880	72.0	3/3
21880	22082	40.5	0/5
22082	22436	70.7	3/1
22436	22664	45.7	1/3
22664	23030	67.3	3/2
23030	23844	50.8	5/10
23844	24326	94.2	3/2
24374	24865	49.1	2/8
24865	25500	70.7	5/2
25500	25666	28.9	1/5
25666	26237	63.4	3/5
26237	26391	30.7	0/5
26391	26841	56.4	2/5
26841	27520	39.9	2/14
27520	28487	50.9	4/11
28487	28878	65.0	2/3
28878	29611	48.0	3/3
29311	33419	70.6	27/15
33508	34417	45.8	4/11
34417	34765	69.7	2/2
34765	35088	40.4	1/4
35088	37350	64.8	10/19
37350	38060	47.3	4/9
38060	38655	67.4	2/3
38655	38998	49.0	1/4
38998	42089	36.9	0/33
40430	40688	65.0	1/3
40792	41207	31.0	0/10
41207	45010	55.9	16/45
45010	45669	35.5	3/14

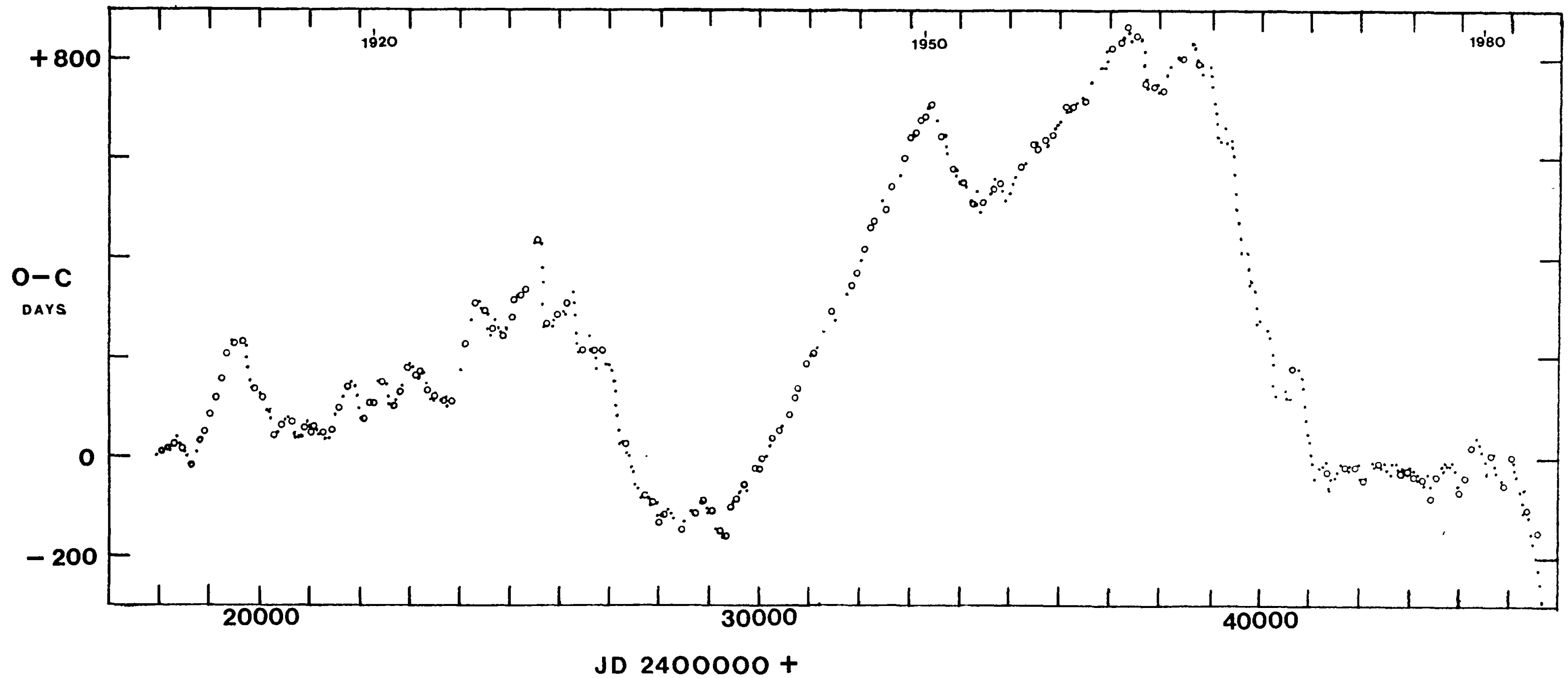

Figure 1. Observed _minus_ computed (O-C) residuals from equation (1) are plotted against the observed date of onset of maximum for SS Aurigae.