SS AURIGAE - AN ANOMALY

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SS Aurigae (060547) is a unique U Geminorum type star, discovered in 1906 by Silbernagel (1907) on plates taken earlier at Hamburg. The star has a visual magnitude range of 10.5 to 14.8 and an average period of 54.1 days (GCVS, 1969), and has a peculiar spectrum (Herbig, 1960).

Flareups of several magnitudes at irregular intervals are typical of U Gem type stars. Such outbursts are unpredictable. However, if the number of maxima during a 10-year period is noted, about the same number will be seen to occur in any other 10-year period. Besides the unpredictability of the frequency of outbursts, there are wide variations in the length of the outbursts.

Kraft (1965) has shown that like other U Gem type stars, SS Aur is a binary and has a period of 4 hours and 20 minutes. However, the orbital plane of the SS Aur system is so inclined to our line of sight that it is impossible to observe eclipses.

SS Aur has been under careful observation since its discovery. AAVSO Bulletin 22 (1960) contains 362 dates of observed maxima from 1907 to 1960. Since the exact dates of maxima are not well defined, the dates on which the star reached median magnitude of 12.0 on the ascending branch and again on the descending branch of the light curve are listed. The first 192 maxima were determined by Leon Campbell and the rest by Margaret Mayall.

During the first 20 years after its discovery SS Aur showed no erratic behavior, varying as a normal U Gem type star. However, in 1929 it began to show eccentricities (Campbell and Jacchia, 1941). Before reaching minimum it would brighten again. This peculiar behavior lasted several months, after which the star returned to its normal behavior. The light curve of SS Aur (Fig. 1) shows a period of fluctuations during which maxima occurred at about one-half of the normal period. The range during these fluctuations was less than normal. AAVSO Report 29 (1972) shows a similar period of rapid maxima in 1962 (Fig. 2). Another period of abnormally fast maxima was from June 28, 1970 to October 25, 1970 (JD 2440765 to JD 2440886) during which time there were five maxima in 121 days. Such rapid activity is more normal to SU Ursae Majoris (080362) than to SS Aur, but this type of rapid fluctuation is also shown at times by SS Cygni, which had such spells in 1907 and 1908, but not again until 1930.

After fainter than average maxima of about $12^{m}.5$ on January 30th (JD 2440982) and February 27, 1971 (JD 2441010) SS Aur assumed a stillstand, fluctuating between $13^{m}.2$ and $13^{m}.7$. After about 30 days the range of fluctuation increased but no clear-cut maxima or minima occurred until on July 21, 1971 (JD 2441154) it dropped to $14^{m}.5$. From then until February 12, 1972 (JD 2441360) the star seemed to have returned to normal U Gem type variation. The February 12th maximum of only $12^{m}.9$ was followed by a bright maximum on March 18th (JD 2441394), after which the star underwent a period of fluctuations between $11^{m}.2$ and $13^{m}.2$. This continued until September 1972 when SS Aur seemingly returned once more to its normal U Gem activity. Erratic behavior started again in December 1972 and continued into January 1973, with the star fluctuating rapidly between

$13^m.4$ and $14^m.4$. A maximum of $11^m.0$ on January 22nd (JD 2441705) indicated an apparent return to normal once again.

Campbell and Jacchia (1941) point out that another type of abnormality to which SS Aur is subject is that of the maximum with a slower rise than the normal of approximately 24 hours. These slow maxima take several days for the rise, and the following descent is usually symmetrical.

Like the U Gem type stars, the Z Camelopardalis type stars are a subgroup of the dwarf novae. They differ from the U Gem type stars in having a smaller magnitude range and shorter periods. The most outstanding difference between the two groups is that the Z Cam type stars are subject to "stillstand" periods of intermediate brightness.

Let us next consider the Z Cam stars in relation to SS Aur. Shortly after its discovery, Z Cam itself showed some remarkable peculiarities. After some maxima it would not return to its usual minimum, but would assume a stillstand period, fluctuating halfway between maximum and minimum. Such stillstands would last from a few days to a year or more. Usually the star would return to minimum after such a stillstand period, but on some occasions the star would go from the intermediate stillstand back up to maximum, and then into a period of regular variation. The stillstand magnitude for a Z Cam star fluctuates very little. In the case of Z Cam, $11^m.2$ to $11^m.7$ is generally noted. In the case of SS Aur, however, a wide magnitude range was apparent when the star was fluctuating abnormally.

SS Aur has had at least one definite stillstand period. Are the intermediate fluctuations of SS Aur analogous to the stillstands of Z Cam? SS Aur never reaches maximum or minimum during these periods, and, in spite of their wide magnitude range, the fluctuations appear more typical of Z Cam than of U Gem type activity. Is it possible that SS Aur is slowly changing to the point where it may have to be reclassified? Is the star's recent behavior indicative of its being a connecting link between the U Gem and Z Cam types? Continuous observations are needed to monitor all activities of this most interesting star. Since it is very nearly circumpolar in mid-northern latitudes, it can be observed almost all year. Early morning observations are especially important to keep the record complete.

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* Observations by AAVSO observers Peltier, Hurless, Kelley, Scovil, Lowder, and Mayer, and by the Variable Star Section of the British Astronomical Association and the Association Française D'Observateurs D'Etoiles Variables, as reported by Ian Howarth, have all helped to confirm the behavior of this star during the last two years. Many of these observations have been reported in the AAVSO Circular and the Journal of the Royal Astronomical Society of Canada.

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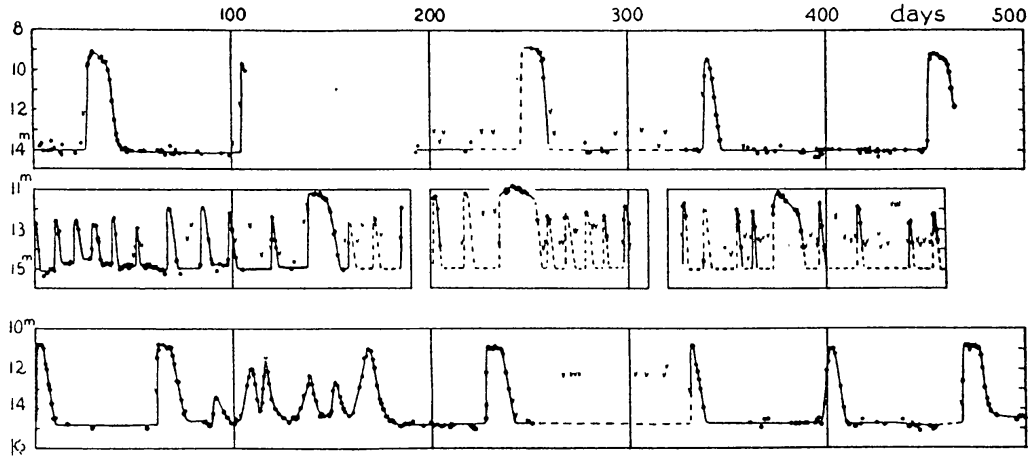

Figure 1. Light Curves of Typical U Geminorum Stars. U Geminorum (top); SU Ursae Majoris (center) SS Aurigae (bottom) (After Campbell and Jacchia.) The next to last maximum of SS Aurigae is of the slow rise type, with symmetrical descent.

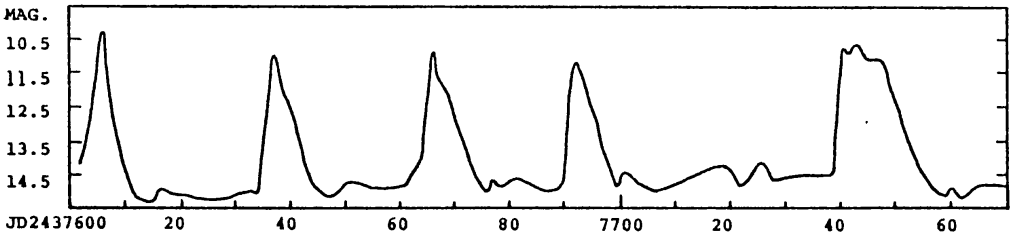

Figure 2. Light Curve of SS Aurigae (from AAVSO Report 29) Showing four rapid maxima and one at the normal interval.

_____ While in press a paper by Ian D. Howarth, JBAA, 83, 179 (1973) has come to our attention, in which the reclassification of SS Aur as a Z Cam star is also discussed. - Ed.