

## VARIABLE STAR SECTION.

CIRCULAR 157.

FQ SCORPII.

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SUMMARY: A summary of visual observations of the U Gem type variable, FQ Sco, is presented for the period 1954 March 17 (J.D. 2,434,819) to 1968 June 30 (J.D. 2,440,038). The majority of the maxima are just brighter than the limit of the instruments used. By combining the visual observations with previous photographic observations by Swope it is concluded that the mean cycle is approximately 48 days. In the absence of reliable magnitudes for comparison stars, the range in steps of maxima is from 0 to 19. This corresponds to about 1.6 magnitudes. Nothing can be reported about minima as this star falls well below the thresholds of the instruments available.

INTRODUCTION.

The position of FQ Scorpii is:-

(1950): 17h 04m 51s S. 32° 37.8'

This star is HV 4389, discovery being announced by H.H. Swope (1) from an examination of plates of Milky Way region No. 185. On discovery it was classed as a long period variable with a range of 12.8 to <16.5 ptg.

H.H. Swope (2) reported further on FQ Sco giving a list of 28 maxima between J.D. 2,411,517 and 2,428,428. The range was given by her as 12.0 to <16.5 ptg., with maxima magnitudes from 12.1 to 13.0ptg. She also listed observations for three typical maxima and concluded that cycles are apparently multiples of 23 to 25 days.

CHARTS:

Swope (3) published an identification chart. Charts have been published by Brun & Petit (4); Bateson, Jones & Stranson (5).

OBSERVATIONS:

For the period 1954 March 17 (J.D. 2,434,819) to 1968 June 30 (J.D. 2,440,038) a total of 1,290 visual observations were made, of which 1,166 were by Jones and 124 by Bateson.

The distribution of observations is shown in Table 1, under monthly totals for each year. The observing season is essentially April to October inclusive. Observations in January and February are restricted to low altitudes in the morning as this region emerges from the Sun. March records are confined to morning observations but generally at higher altitudes than is possible in the two preceding months. Observations in November are limited and have been made only at low altitudes. No observations are possible in December.

COMPARISON STARS:

Three comparison stars suffice for observations of maxima. These are designated "u", "w" and "x" on the chart published by Bateson, Jones & Stranson (5). In the absence of well determined magnitudes, step estimates are used in the following discussion. The zero point was taken as "u" making the step estimates:-

"u" = 0      "w" = 6      "x" = 14

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DISCUSSION:

The plate material used by Swope(2) is widely scattered in time so that the intervals between successive maxima, listed in her table, range from 2,542 to 26 days. She suggested that "cycles are apparently multiples of 23 to 25 days." A simple mean of the intervals in her table is 72 days suggesting that the true mean cycle could be some fraction of this.

Swope's maxima are from 12.1 to 13.0 ptg with a full range of 12.0 to <16.5. Such a range, of 4 to 5 magnitudes, suggests that the period for the mean cycle should be around 50 days or more. From her three examples of typical maxima it appears that maxima are steep, with the variable remaining at maximum for no more than three days.

The visual observations suffer from the following drawbacks:-

(a) The brightest maxima are not more than 1.0 to 1.5 magnitudes brighter than the thresholds of the instruments used, depending on seeing conditions.

(b). The fainter maxima just become visible.

(c). Because of moonlight and adverse weather the chances of a maximum being missed is large especially when the variable is bright for only a few days.

The majority of the visual records consist of observations that the variable was invisible. A record was always made of the faintest comparison star seen. However there are a number of observations when the variable was noted as "just visible", or as "Trace", without it being possible to make a definite estimate. Such records present a problem. Do they represent a real brightening to the limits for the instruments used and for seeing conditions at the time? At brighter maxima such observations often precede a rise and follow a decline by a few days, suggesting that the variable was glimpsed. For faint maxima there is no such check.

Because all records have been made by the two most experienced observers of the Section, these observations have been treated as definite brightenings, provided they were either supported by other observations and were not classed as "3" (doubtful) by the observer.

The list of possible maxima, including fainter ones conforming to the above stipulations, are given in Table 2. Because of the break in the observing season each year this Table is arranged in years. The first column gives the J.D. of maxima. The next column gives the brightness in step estimates. The third column gives the interval in days between successive maxima. This is followed by the number of observations used to determine each maximum. The final column contains remarks which make it clear how well observed the maximum was and on which branch, or branches, of the curve the observations fell.

If we accept all dates listed as representing real maxima then the mean cycle for each year. is:-

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<u>YEAR.</u>	<u>MEAN CYCLE.</u>	<u>No. of MAXIMA.</u>
1954	23.2 days	10
1955	31.8	10
1956	36.6	7
1957	24.7	8
1958	34.7	8
1959	27.7	8
1960	45.5	5
1961	27.8	7
1962	30.5	9
1963	60.7	5
1964	100.5	3
1965	63.0	5
1966	43.6	6
1967	56.3	4
1968 to June 30	49.0	2

To find a true mean cycle from the above the records can be treated in several ways. Firstly, by combining all the intervals, a mean cycle of 37.2 days is found. Secondly, a value of 59.6 days is found if only those maxima for which a definite step value is given in Table 2 are used. This figure is probably in excess of the true value because there are six intervals, ranging from 102 to 178 days, during which at least one other maximum took place but was unobserved. If these six intervals are omitted then the mean cycle becomes 47 days.

This last value is close enough to 48 days, which is a multiple of the figure suggested by Swope to warrant further investigation. It also suggests that the mean cycle could be half of this. Both Swope's list of maxima and the visual results imply that the mean cycle is unlikely to be a large multiple of 24 days.

U Gem type variables show normally a wide variety of maxima with large deviations from strict periodicity. Such deviations obey the normal law of errors. The conception of a mean period for these stars is still valid. The material available is not really adequate for a detailed discussion, because of both the break in the observing season and the nature of the results.

For Fq Sco J.D. 2,424,732, from Swope's list of typical maxima, was taken as Epoch of maximum. The standard deviations from her table for a 48 day mean cycle is  $\pm 12.5$  days; from the visual results  $\pm 12.0$  days. The combined value from both photographic and visual results is  $\pm 12.2$  days, or 25.4% of the period. If a period of 24 days is taken as the mean cycle the deviations, O-C, are  $\pm 6.3$  days and 26.2% of the period. For U Gem variables deviations from a mean cycle of 25% are not unusual. However, considering all the results it appears to us that a 48 day period for the mean cycle is the best value.

Plots of the small segments of maxima observed visually, and which were bright enough for visibility to last several days, indicate that Fq Sco has two types of maxima. Both have sharp rises but with a slower decline for some maxima than for others. Those with the slower decline give maxima that are broader, lasting for around ten days.

We suggest that FQ Sco be studied by those members with large apertures capable of observing the variable over most, if not all, of its light curve.

1970 June 25

18 POOLES ROAD,  
GREERTON.  
TAURANGA.  
NEW ZEALAND.

REFERENCES:

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- (2) SWOPE, H.H. H.A. 90, 8 (1938).
- (3) SWOPE, H.H. H.B. 887, (1932).
- (4) BRUN, A. & PETIT, M. Variable Stars, 12, 1 (97). (1957).
- (5) BATESON, F.M., JONES, A.F. & STRANSON, I. "Charts for Southern Variables", Series 8, (1970) (In Press).

TABLE 1.

FQ SCORPII---MONTHLY TOTALS OF OBSERVATIONS.

<u>YEAR.</u>	<u>JAN.</u>	<u>FEB.</u>	<u>MAR.</u>	<u>APR.</u>	<u>MAY.</u>	<u>JUNE</u>	<u>JULY</u>	<u>AUG.</u>	<u>SEP.</u>	<u>OCT.</u>	<u>NOV.</u>	<u>DEC.</u>	<u>TOTALS.</u>
1954	-	-	7	11	17	13	16	18	12	12	-	-	106
1955	4	3	11	15	14	11	11	9	7	5	1	-	91
1956	1	3	8	8	8	13	9	12	8	2	1	-	73
1957	-	4	4	7	9	13	14	8	10	7	-	-	76
1958	2	5	5	8	12	21	15	14	16	8	1	-	107
1959	4	6	6	9	15	20	9	20	11	9	-	-	109
1960	2	7	5	8	11	16	15	10	6	6	1	-	87
1961	1	4	7	6	8	19	7	10	7	4	1	-	74
1962	1	3	3	8	4	12	11	10	2	3	1	-	58
1963	-	2	3	13	13	12	9	10	5	6	-	-	73
1964	1	-	2	9	12	10	4	7	12	6	-	-	63
1965	3	8	5	8	13	12	7	14	7	7	-	-	84
1966	2	3	9	15	13	20	18	17	4	6	-	-	107
1967	1	10	7	14	18	21	20	10	11	13	2	-	127
1968 to June 30	4	10	9	15	10	7							55
<b>TOTALS</b>	<b>26</b>	<b>68</b>	<b>91</b>	<b>154</b>	<b>177</b>	<b>220</b>	<b>165</b>	<b>169</b>	<b>118</b>	<b>94</b>	<b>8</b>		<b>1290</b>

TABLE 2.

FQ SCORPII ==VISUAL MAXIMA OBSERVED.

<u>J.D.</u>	<u>STEPS.</u>	<u>INT.</u> d	<u>NO. of</u> <u>Obs.</u>	<u>REMARKS.</u>
1954				
2,434,826	?	-	2	Just visible
842	?	16	3	do
877	0	35	7	Both branches
893	?	16	1	Just visible
913	?	20	5	do
932	?	19	4	do
962	17	30	3	
986	3	24	7	Both branches
2,435,016	19	30	3	Just visible
035	?	19	4	do

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TABLE 2 (cont).

<u>J.D.</u>	<u>STEPS.</u>	<u>INT.</u> <u>d</u>	<u>NO. of</u> <u>OBS/</u>	<u>REMARKS.</u>
<u>1955</u>				
2,435,137	?	-	1	Just visible
189	?	52	1	do
222	17	33	6	do
245	2	23	7	Max. & decreasing
274	?	29	2	Just visible
307	?	33	1	do
344	?	37	1	do
368	?	24	2	do
391	?	23	1	do
423	5	32	1	
<u>1956</u>				
2,435,540	?	-	1	Just visible
556	?	16	1	do
585	18	29	1	
597	9	12	3	At. max.?
649	3	52	4	At max. & descending
688	?	39	1	Just visible
760	8	72	1	
<u>1957</u>				
2,435,951	5?	-	3	Descending.
980	15	29	1	
993	8	13	2	Descending.
2,436,022	8	29	2	
043	8	21	8	Max. & descending.
073	18	30	2	
090	17	17	1	
124	20	34	2	
<u>1958</u>				
2,436,257	8	-	3	Max. & descending
303	10	46	3	Descending
358	5	55	7	Both branches
406	?	48	1	Just visible.
423	3	17	8	Ascending & max.
440	?	17	2	Just visible
470	?	30	1	do
499	6	29	2	Descending
<u>1959</u>				
2,436,662	?	-	1	Just visible
690	3	28	5	Both branches
715	?	25	1	Just visible
749	?	34	1	do
783	5	34	10	Max. & descending
818	19	35	1	
831	?	13	1	Just visible
856	3	25	2	One each side max.
<u>1960</u>				
2,437,068	7?	-	2	Descending
114	?	46	2	Just visible
142	9	28	2	One each branch
162	11	20	1	
250	?	88	1	Just visible
<u>1961</u>				
2,437,388	3	-	5	Descending
410	?	22	1	Just visible
471	10	61	2	Descending
489	?	18	1	Just visible
502	?	13	1	do
523	5	21	8	Both branches; some scatter.
555	19	32	1	

V.S.S. CIRCULAR 157 (cont).

TABLE 2 (cont).

<u>J.D.</u>	<u>STEPS.</u>	<u>INT.</u> <u>d</u>	<u>NO of</u> <u>OBS.</u>	<u>REMARKS.</u>
<u>1962</u>				
2,437,728	?	-	1	Just visible
742	?	14	1	do
762	?	20	1	do
814	8	52	1	
852	12	38	2	
876	?	24	2	Just visible
933	?	57	1	do
954	14	21	1	
972	16	18	1	
<u>1963</u>				
2,438,074	?	-	1	Just visible
149	?	75	1	do
166	4	17	5	Both branches
265	9	99	4	Both branches
317	?	52	1	Just visible
<u>1964</u>				
2,438,500	6	-	5	Both branches
662	10	162	3	Descending
701	9	39	2	One on each branch.
<u>1965</u>				
2,438,783	6	-	3	Descending
854	?	71	1	Just seen
885	?	31	1	do
941	9	56	5	Both branches
2,439,035	7	94	4	Both branches
<u>1966</u>				
2,439,161	5	-	2	Ascending
263	8	102	6	Max. & descending
295	?	32	1	Just seen
316	?	21	1	do
356	12	40	1	
379	7	23	1	
<u>1967</u>				
2,439,543	9	-	2	Descending
597	11	54	2	Ascending
653	12	56	3	Descending
712	4	59	4	Both branches
<u>1968 to June 30.</u>				
2,439,921	8	-	3	Both branches
970	10	49	2	Ascending