THE PERIOD OF RU SEXTANTIS

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Abstract

Observations on 193 Harvard plates confirm that RU Sex is an RR Lyrae variable. A period search by discrete Fourier transform found candidate periods near 0.26, 0.35, and 0.54 day. Analysis of the times of maxima and phased light curves indicates that the best period is 0.3502323 day. The periods near 0.26 and 0.54 day are aliases differing in frequency by one cycle per sidereal day.

1. Introduction

The variable star RU Sextantis (BV 715, BD -6° 2990) was discovered at Bamberg and reported to be an eclipsing binary of Beta Lyr type with a period of 13.07 days and magnitude range of 10.6–11.4 ptg (Strohmeier *et al.* 1965).

Although the system would be of considerable interest if it were indeed so similar to Beta Lyrae in period and depth of eclipses, the star was neglected until a study by Brelstaff and Isles (1986), based on 57 visual estimates. They concluded that RU Sex is probably an RR Lyr variable with a period of 0.5398 day and a small visual range of about magnitude 10.5–10.9.

2. Observations

I was unfamiliar with this work when I selected RU Sex for investigation on the Harvard College Observatory patrol plates. Strohmeier *et al.* (1965) used only two comparison stars. I used their estimated magnitudes for these two stars to interpolate and extrapolate a more extended and conveniently placed comparison star sequence. I then estimated the magnitude of RU Sex on 193 blue photographic plates of the Damon series, 1974–1989.

3. Analysis

The estimated magnitudes were distributed fairly evenly over the observed range, indicating continuous variation. However, the 13.07-day period was immediately rejected because the variable appeared near maximum and minimum on plates exposed only one or two days apart. I sought a new period by discrete Fourier transform, using a Maria Mitchell Observatory program published by Belserene (1988). The period search was conducted using a selected subset of 33 observations to minimize computer running time. Periods were tested over the range from 14.0 to 0.22 days. The strongest frequency peaks were equivalent to the following periods:

P = 0.2592 day,	10.9	(relative strength)
0.3502	9.6	
0.5398	7.8	

The third period is identical to that found by Brelstaff and Isles (1986). They found and rejected some longer alias periods but did not report testing any periods shorter than

0.5398 day. Since the DFT power spectrum showed stronger frequency peaks at 0.2592 and 0.3502 day, these shorter periods required investigation. I promptly found that when the three periods are expressed as frequencies in cycles per day, each pair differs by one cycle per sidereal day, that is:

$$1/P1 - 1/P2 = 1/SD \quad (1)$$

Alias periods related to the sidereal day are a common problem with short-period variables, particularly when a southern star such as RU Sex is observed from the northern hemisphere and vice versa. Observations are necessarily made when the star is near the meridian. Meridian passages occur at intervals of one sidereal day, so it becomes difficult to disentangle the true period from alias periods with frequencies related to the sidereal day.

Table 1 lists the midexposure times of 20 plates on which the variable was estimated at maximum. Each of the three candidate periods was first tested by introducing the 20 times of maxima into a linear least squares solution with that initial period and then calculating the O-C residuals of the maxima from the resulting light elements. The true period should produce the smallest dispersion in the O-C residuals, which are listed for each period in the Table. The 0.35-day period yields the smallest mean error; indeed, the uncertainty of 0.03 day is only slightly greater than the typical exposure times of the plates. The mean error for the 0.26-day period is not much larger, but it is almost twice as significant when considered as a fraction of the period being tested. The mean error of the 0.54-day period is fully 0.2 P.

Table 1. RU Sextantis, epochs of maxima from Harvard plates.

HJD 2400000+	O-C 0.26 d	O-C 0.35 d	O-C 0.54 d
42149.598	-0.016	-0.018	-0.021
42404.902	-0.029	-0.033	-0.042
44251.715	-0.051	+0.005	+0.122
44259.819	+0.017	+0.053	+0.129
44311.629	-0.014	+0.029	+0.118
44672.991	+0.016	-0.049	-0.184
44690.572	-0.029	+0.021	+0.123
45111.579	+0.030	+0.048	+0.088
45317.112	+0.013	-0.005	-0.043
45405.040	+0.070	+0.015	-0.102
45703.098	+0.043	+0.025	-0.012
45737.030	+0.019	-0.016	-0.088
46030.889	-0.061	-0.002	+0.121
46109.993	-0.014	-0.050	-0.125
46110.052	+0.045	+0.009	-0.066
46195.818	+0.014	-0.032	-0.128
46521.935	+0.051	+0.019	-0.049
46947.779	+0.021	-0.020	-0.106
47561.765	-0.049	+0.009	+0.130
47861.897	-0.077	-0.008	+0.134
Mean Error:	±0.040	±0.029	±0.109

The least-squares light elements for each period were then used to plot a phased light curve of all 193 observations (Figure 1). The 0.35-day period produces the most convincing light curve.

The three periods can be tested further by using the new light elements to calculate O-C residuals for the previously published times of minima from Strohmeier *et al.* (1965) and maxima from Brelstaff and Isles (1986). O-C values for the times of minima can be calculated by assuming M–m = 0.4 P as found by Brelstaff and Isles and confirmed by this study (Figure 1, 0.35-day light curve). Table 2 shows the results. For each of the three periods, the mean error is similar to that found from the Harvard plate maxima (Table 1), and the residuals from the 0.35-day period are by far the smallest.

Table 2. RU Sextantis, previously published epochs of minima and maxima.

Minima by Strohmeier *et al.* JD 2400000+	O-C P = 0.26d	O-C P = 0.35d	O-C P = 0.54d
38471.360	-0.031	0.024	0.141
38817.404	-0.026	0.038	0.175
38818.402	-0.065	-0.015	0.093
38824.400	-0.029	0.030	0.153
38844.338	-0.049	0.004	0.119
38883.217	-0.051	0.008	0.132
Mean error	0.042	0.020	0.135
Maxima by Brelstaff and Isles HJD 2400000+	**O-C P = 0.26d**	**O-C P = 0.35d**	**O-C P = 0.54d**
45012.408	-0.125	-0.007	0.240
45037.331	-0.086	0.050	-0.208
45045.313	0.120	-0.024	0.217
45052.340	-0.111	-0.001	0.227
45438.372	-0.035	0.075	-0.237
45440.377	-0.104	0.022	0.149
45731.431	0.122	0.011	0.252
46109.273	0.043	-0.069	0.235
46113.528	-0.108	-0.017	0.172
Mean error	0.095	0.031	0.215

4. Conclusions

An analysis of observations from 193 Harvard plates shows that RU Sex is an RR Lyr variable with the following light elements:

$$\text{Max} = \text{HJD } 2442149.616 + 0\overset{d}{.}3502323\,E \qquad (2)$$
$$\pm 0.016 \quad \pm 0.0000016$$

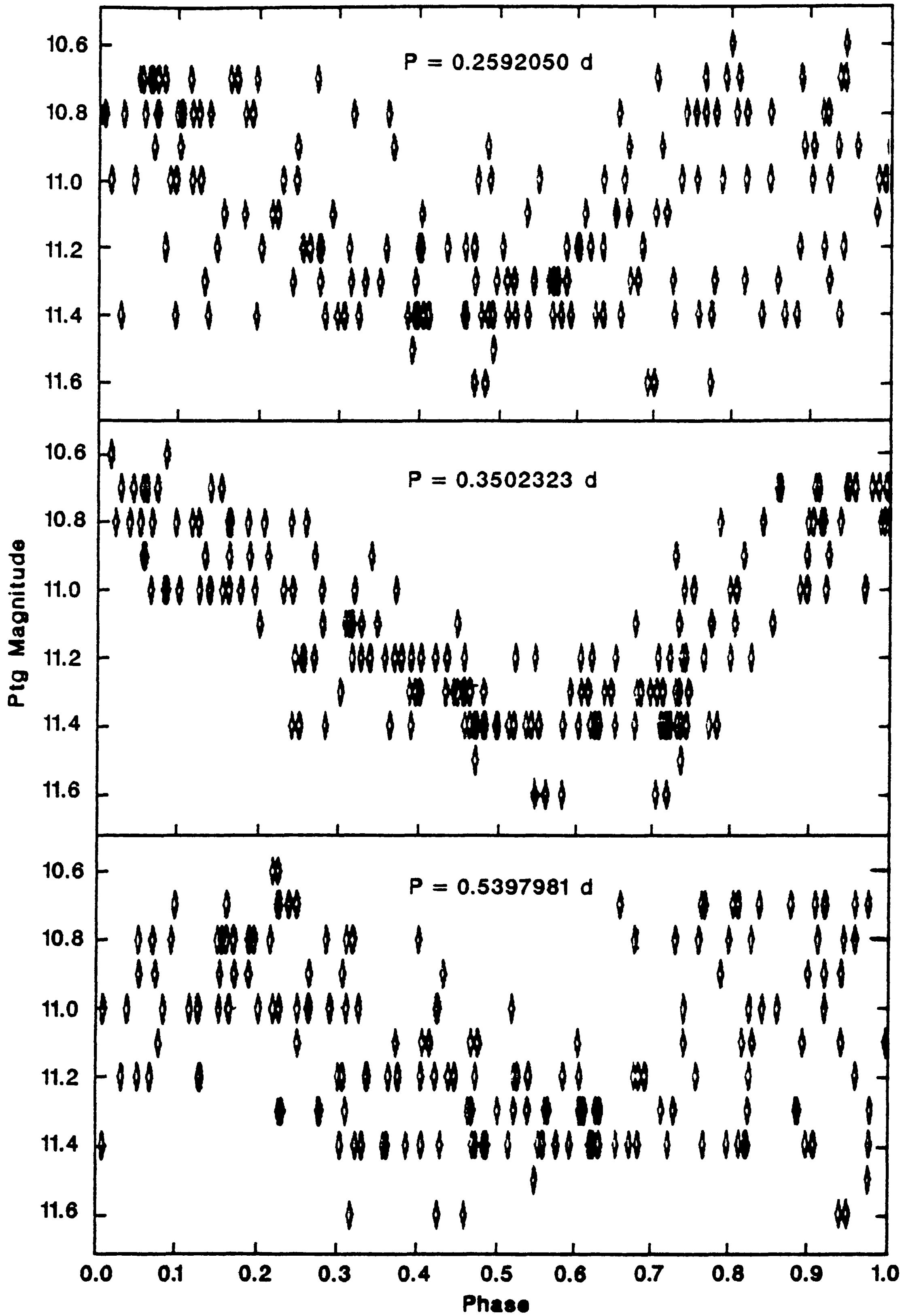

Figure 1. RU Sextantis, observations phased to the three candidate periods near 0.26, 0.35, and 0.54 day.

The light curve is mildly asymmetric, the rise from minimum to maximum requiring 0.4 P. The mean magnitude of 11 observations at maximum (phase interval 0.95–0.05) is 10.76 ptg, and the mean of 14 estimates at minimum (phase interval 0.55–0.65) is 11.36 ptg, based on the zero point and scale of the two comparison stars cited by Strohmeier *et al.* (1965). The mean range of variation, 0.60 ptg, confirms the small visual range (0.4 magnitude) found by Brelstaff and Isles (1986). The amplitude in the blue passband is greater than in the visual passband because RR Lyr stars are redder at minimum and therefore fainter at shorter wavelengths.

5. Acknowledgments

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References

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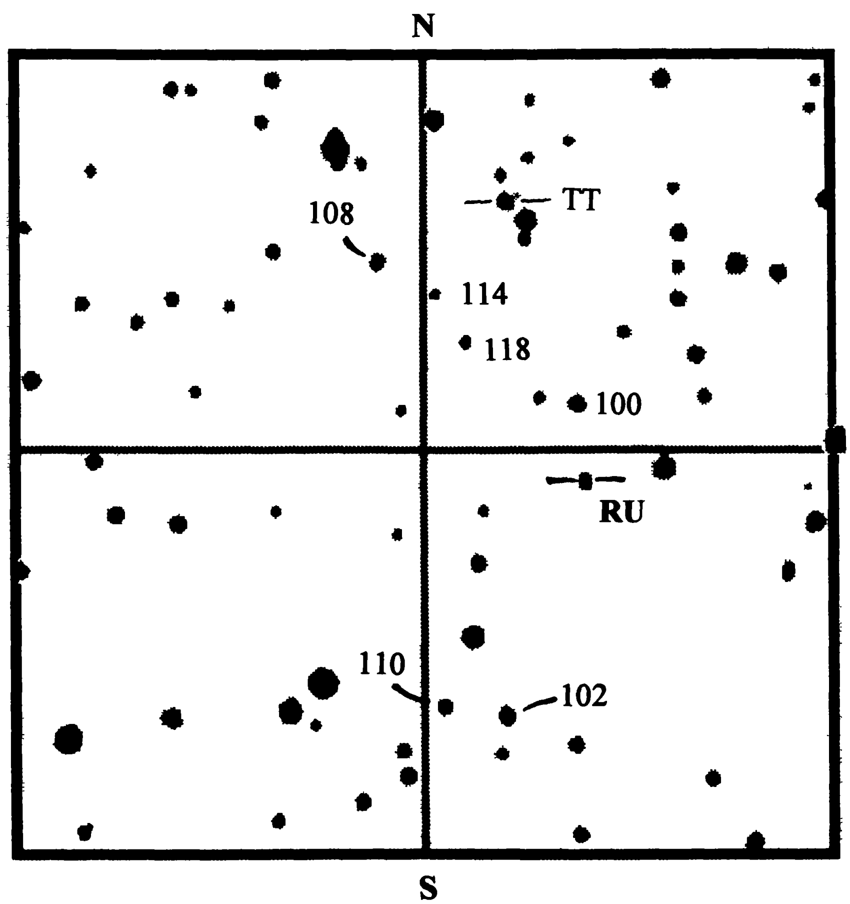

Figure 2. RU Sex finder chart with estimated photographic (blue) magnitudes of comparison stars. 2° x 2° enlargement from the *Bonner Durchmusterung*.