RU Sextantis, an RR Lyrae star?

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RU Sextantis is catalogued as a Beta Lyrae variable with a period of 13.07 days. Visual observations by Brelstaff, however, indicate that it is probably an RR Lyrae star (type RRAB). From all available data, the period is found to be 0.539806 day.

Introduction

The *General Catalogue of Variable Stars*[1] lists RU Sextantis (= BV 715 = BD −6° 2990) as a Beta Lyrae variable with photographic range $10^m.6$-$11^m.4$; the secondary minimum, given as $11^m.3$, is almost as deep as the primary. No spectral class is given. The elements are quoted as

$$\text{Min} = \text{JD } 2438504.130 + 13.07\ E.$$

The reference is to a report by Strohmeier *et al.*[2] on bright southern Bamberg variables studied on sky patrol plates of the Bamberg Southern Station at Boyden Observatory, South Africa.

According to the Cracow yearbook[3], no minima of RU Sex have been reported since 1964. The system was therefore selected by Tristram Brelstaff for inclusion in his work for the BAA Variable Star Section's Eclipsing Binary Programme. The catalogued period suggested that it would be relatively easy to cover the whole light curve of RU Sex within a year by making one estimate per night.

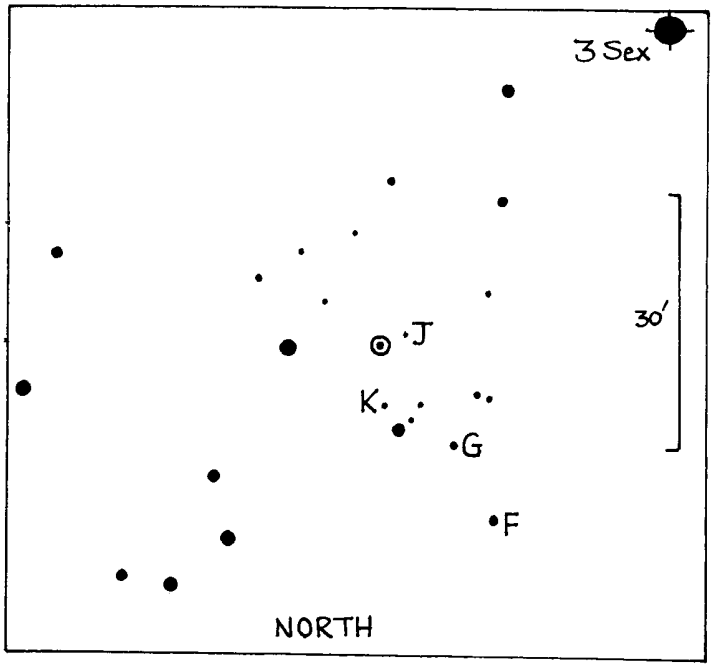

Figure 1. Field chart for RU Sex (1950.0: $09^h\ 43^m.2$, −06° 30′). Grades of comparison stars have been derived from Brelstaff's step estimates as follows: F = 5.0; G = 6.2; J = 10.0. If the visual range is as estimated in the text, these equate to the following magnitudes: F = 10.5; G = 10.6; J = 11.0.

Observations

Visual observations began on 1982 January 12, using a 200mm reflector. The variable was identified by means of a field sketch from the Papadopoulos atlas[4]. Magnitude estimates were made by the Pogson step method, using comparison stars selected at the telescope (figure 1). The working methods are described in greater detail in a recent paper[5].

Observations were at first made once nightly, on 23 nights in 1982, four in 1983, and seven in 1984. It became evident early on that the period of the object was not 13.07 days; that the visual range was barely half that in the catalogue; and that RU Sex was probably not an eclipsing binary at all, as it was seen more often at minimum than at maximum.

The 1982-83 observations were reported to John Isles, who is Secretary of the Eclipsing Binary Programme. He identified the most likely period as $0^d.5398$, using a 'length of a piece of string' computer search of the kind described by Dworetsky[6]. The light curve (figure 2(a)) suggested that RU Sex might be an RR Lyrae star. As most of the observations had been made when the object was fairly close to the meridian, however, a number of longer alias periods satisfied the data nearly as well. In particular, a possible period of $6^d.792$ (figure 2(b)), roughly half that of the catalogue, yielded a light curve resembling that of a Population II cepheid (W Virginis star). These two possible periods were related by the equation

$$1/0.5398 + 1/6.792 \simeq 2.$$

To decide between these (and other possible periods), observations were needed at various times during the night. Accordingly, Brelstaff observed RU Sex on three nights in 1985 February, for intervals ranging from 2.5 to 4 hours. Appreciable variation occurred during the course of two nights, the star being brightest at the same phase of the $0^d.5398$ period as had been the case in 1982-84 (see figure 3). This confirmed

the reality of the variation, as well as the correctness of the 0ᵈ.5398 period. The observations on the three nights showed some slight systematic differences, which we consider are quite compatible with the errors of visual observation.

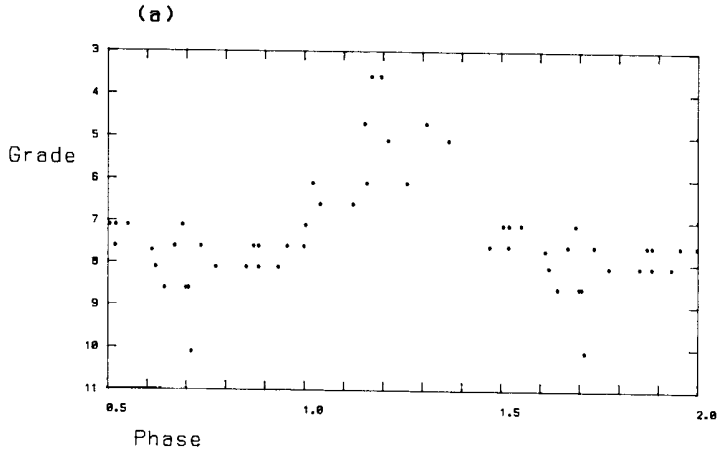

Figure 2. Visual observations of RU Sex by Brelstaff in 1982-84, phase-folded using the trial periods (a) 0ᵈ.5398 and (b) 6ᵈ.792. Zero phase corresponds to JD 2400000.0.

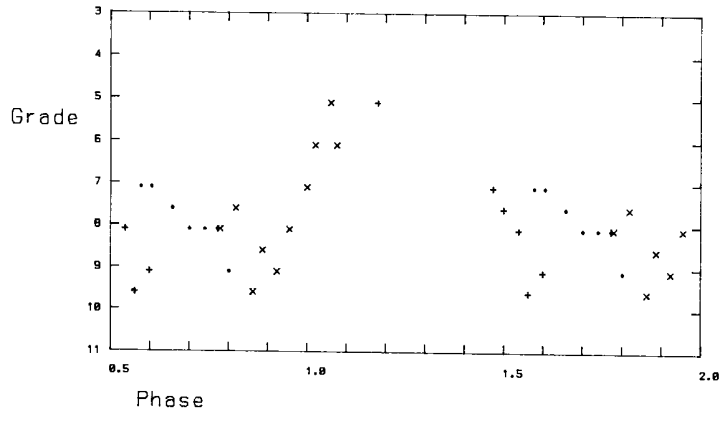

Figure 3. Visual observations of RU Sex by Brelstaff on 1985 February 12 (vertical crosses). 16 (diagonal crosses) and 17 (dots), phase-folded using the trial period 0ᵈ.5398. Zero phase corresponds to JD 2400000.0

Discussion

We reproduce in figure 4 the light curve by Strohmeier *et al.*[2]. This appears to us most uncharacteristic of a Beta Lyrae variable; in fact it resembles two cycles of an RR Lyrae type curve swept out backwards, through identification of an alias period. The two minima are equally deep and the two sections of the curve show asymmetry in the same sense.

Strohmeier *et al.* remark that their derived light elements are tentative. They give the times of six individual plates on which RU Sex was within 0ᵐ.2 of minimum. From figures 2(a) and 3 we estimate that maximum occurs at phase 0.2, and minimum at phase 0.8. Hence the rise time as a proportion of the period, (M-m)/P, is about 0.4. If, as we believe, figure 4 traces the variations in reverse, it confirms this value. By adding 0.4 cycle (= 0ᵈ.216) to the times of minima given by Strohmeier *et al.*, we obtain the first six times

Table 1
Maxima of RU Sextantis

Helio JD (24....)	*Cycle No.*	*O-C d*	*Observer*
38471.576	0	+0.008	Strohmeier *et al.**
38817.620	641	+0.036	〃
38818.618	643	−0.045	〃
38824.616	654	+0.015	〃
38844.554	691	−0.021	〃
38883.433	763	−0.007	〃
45012.408	12117	+0.011	Brelstaff
45037.331	12163	+0.103	〃
45045.313	12178	−0.012	〃
45052.340	12191	−0.002	〃
45438.372	12906	+0.069	〃
45440.377	12910	−0.086	〃
45731.431	13449	+0.013	〃
46109.273	14149	−0.009	〃
46113.528	14157	−0.073	〃

*reported time of minimum +0ᵈ.216.

Cycle No. and *O-C* are based on the least squares elements, of which rounded values are given in the text.

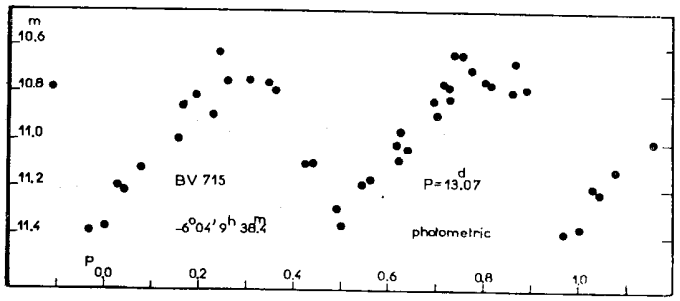

Figure 4. Photographic observations of RU Sex by Strohmeier *et al.*[2], phase-folded using the incorrect period of 13ᵈ.07. Zero phase corresponds to JD 2438504.130.

of maximum listed in table 1. The other nine times are those of Brelstaff's brightest estimates.

The phase shift between figures 2(a) and 3 is unlikely to exceed 0.05 cycle, as the rise to maximum near phase 0 is closely aligned in both plots. The mean dates of the observations in the two plots are 845 days apart, or about 1565 cycles. The period therefore should not differ from $0^d.5398$ by more than 0.05 parts in 1565, or less than $0^d.00002$. Hence the number of cycles elapsed between the two groups of maxima in table 1 can apparently be established without ambiguity, and the deduced cycle numbers are given in column 2. Our final estimate of the elements by least squares (with standard errors) is

$$\text{Max} = \text{JD } 2438471.57 + 0.539806\ E.$$
$$(0.02) \quad (0.000002)$$

We conclude that RU Sex is probably an RR Lyrae star of type RRAB (since the curve is asymmetric, (M-m)/P = 0.4; and the period is longer than $0^d.5$, the upper limit for type RRC). If so, its average colour index is likely to be about $+0^m.3$. If the mean photographic magnitude is $11^m.0$, as implied by the catalogue, the visual range is about $10^m.5$-$10^m.9$. This is only half the photographic range given in the catalogue. The difference may be due to errors in either the visual or the photographic magnitude scale. RR Lyrae stars are, however, generally redder at minimum; RR Lyr itself has a V range $0^m.3$ less than its B range[1].

Acknowledgement

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References

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