# THE SHORT-PERIOD VARIABLE STAR
## RV CANUM VENATICORUM[1]

By J. SCHILT

ABSTRACT

*Light-curve.*—From ninety-one plates the light-curve of RV Canum Venaticorum is found to be of the type of W Ursae Majoris, with a period of 0.269572 day. This makes it highly probable that the star is a dwarf eclipsing binary, instead of a variable of the cluster type, as stated by Graff.

*Spectrum and range in light.*—The spectrum is F8; the photographic range is 0.75 mag. and apparently does not exceed the visual range.

The variability of this star, which is 25' from the center of the globular cluster M3, was first detected by J. Larink,[2] who found a period of 0.134786 day. A photometric visual light-curve has been published by K. Graff,[3] who calls attention to many irregularities. The reality of these irregularities seems doubtful. I have combined Graff's observations into groups of three. The dispersion of the deviations of such normal points from a symmetrical smooth curve is ±0.062±0.019 mag. (mean error). Graff gives a mean error of ±0.06 mag. for his individual observations, which, if the latter are independent, amounts to ±0.036 mag. for the normal points. The difference between the observed dispersion and the value given is 0.026±0.019 mag. Whether this is accidental or a consequence of some systematic error in Graff's observations cannot be settled. It will be seen, however, that the present observations do not corroborate the alleged irregularities.

To determine the photographic light-curve, ninety-six plates, each with eight minutes' exposure, were taken, mainly during four nights, with the 60-inch reflecting telescope. The plates used are Eastman 40, size 4 by 5 inches, so that the center of the globular cluster M3 is just on the following edge of the plates. Ninety-one of these plates have been measured with the thermopile microphotometer. The magnitudes of the comparison stars were derived

[1] *Contributions from the Mount Wilson Observatory*, No. 330.

[2] *Astronomische Nachrichten*, **214**, 71, 1921.

[3] *Ibid.*, **217**, 310, 1923.

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from the comparison plates SS 145, 146, and 147, which have the following exposures and zenith distances:

| Plate | First Exposure | Second Exposure |
|---|---|---|
| SS 145........ | Selected Area 57, 15° | RV Can. Ven., 12° |
| 146........ | RV Can. Ven., 13 | Selected Area 57, 8 |
| 147........ | Selected Area 57, 5 | RV Can. Ven. 4 |

Because of the small zenith distances, no correction for differential extinction is required. The magnitudes, on the international scale, of the stars of the Selected Area were kindly supplied by Mr. Seares, and the resulting magnitudes of the comparison stars, together with their rectangular co-ordinates, are entered in Table I.

TABLE I

VARIABLE AND COMPARISON STARS

| STAR | $X$ | $Y$ | PG. MAG. | |
|---|---|---|---|---|
| | | | Provis. | Adopted |
| RV Can. Ven.... | $0''$ | $0''$ | .......... | .......... |
| $a$.............. | $+358$ | $+35$ | 15.74 | 15.78 |
| $b$.............. | 320 | 41 | 15.33 | 15.38 |
| $c$.............. | $+274$ | 30 | 14.72 | 14.59 |
| $d$.............. | $-279$ | 37 | 16.20 | 16.16 |
| $e$.............. | $-417$ | $+ 8$ | 14.62 | 14.71 |

The provisional values were derived directly from the three comparison plates, whereas the adopted magnitudes are the smoothed values found by using measurements from all the plates. The comparison stars $c$ and $e$ happen to be the same as Graff's stars $f$ (vis. mag., 13.41) and $a$ (vis. mag., 13.66), respectively.
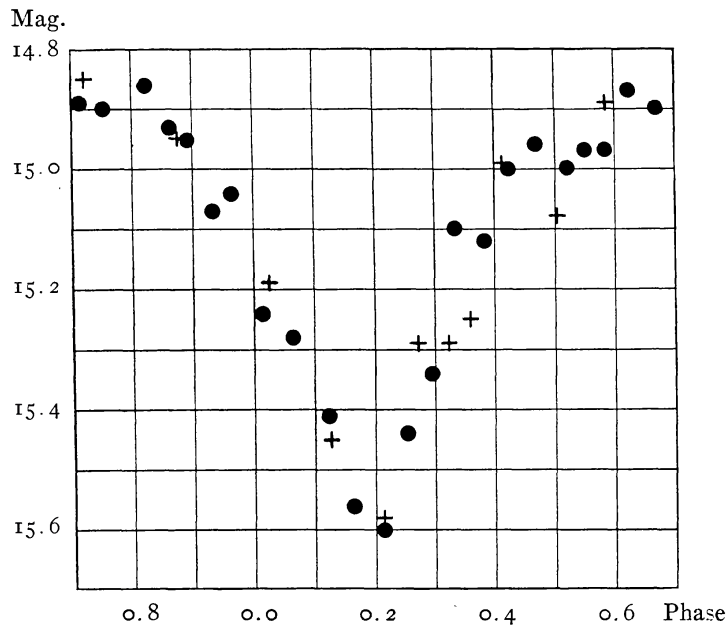
The observational data are entered in Table II. The observations have been combined into groups of four in order of phase. The normal points thus obtained are given in Table III, and are shown graphically in Figure 1. The computed minimum is at phase 0.185 $P$. The mean magnitude at maximum from the eighteen observations between phases 0.685±0.100$P$ is 14.897±0.014 mag. (mean error); from the eleven observations between the narrower limits 0.685± 0.050 it is 14.883±0.017 mag. (mean error). The adopted maximum light is 14.88 mag. The magnitude at minimum is estimated to be 15.63±0.04 mag., from which the photographic range is 0.75±0.04 mag.

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## TABLE II

### THE OBSERVATIONS

| Plate | J.D. Hel. G.M.T. 2424000+ | Epoch and Phase | Mag. | Plate | J.D. Hel. G.M.T. 2424000+ | Epoch and Phase | Mag. |
|---|---|---|---|---|---|---|---|
| SS 64.. | 564.9255 | 0.000P | 15.33 | SS 128.. | 620.9386 | 415.571P | 14.85 |
| 65.. | .9330 | .055 | 15.38 | 129.. | .9455 | .622 | 14.87 |
| 66.. | .9400 | .106 | 15.56 | 130.. | .9524 | .673 | 14.83 |
| 67.. | .9469 | .158 | 15.69 | 131.. | .9593 | .724 | 14.90 |
| 68.. | .9538 | .209 | 15.70 | 132.. | .9766 | .853 | 14.94 |
| 69.. | .9608 | .261 | 15.61 | 138.. | 621.7003 | 421.222 | 15.55 |
| 70.. | .9677 | .312 | 15.38 | 139.. | .7072 | .273 | 15.44 |
| 72.. | .9816 | .415 | 15.23 | 140.. | .7142 | .325 | 15.10 |
| 73.. | .9885 | .467 | 15.06 | 141.. | .7211 | .376 | 15.02 |
| 74.. | .9954 | .518 | 15.11 | 142.. | .7280 | .427 | 14.94 |
| 75.. | 565.0024 | .569 | 15.15 | 143.. | .7349 | .470 | 14.82 |
| 76.. | .0093 | .621 | 14.89 | 144.. | .7418 | .530 | 14.90 |
| 77.. | .0163 | .672 | 14.95 | 145.. | .7883 | .875 | 14.86 |
| 78.. | .0232 | .723 | 14.93 | 146.. | .7953 | .927 | 15.06 |
| 79.. | .0301 | .775 | 14.95 | 147.. | .8243 | 422.142 | 15.60 |
| 80.. | .0371 | .826 | 14.78* | 149.. | .8804 | .558 | 14.93 |
| 81.. | .0440 | .878 | 15.03 | 150.. | .8874 | .610 | 15.04 |
| 82.. | .0510 | .930 | 15.02 | 151.. | .8943 | .661 | 14.98 |
| 83.. | .0579 | 0.981 | 15.06 | 152.. | .9012 | .712 | 14.87* |
| 98.. | 619.9025 | 407.884 | 15.02 | 153.. | .9082 | .764 | 14.91 |
| 99.. | .9140 | .969 | 14.90 | 154.. | .9151 | .816 | 14.94 |
| 102.. | 620.7307 | 414.029 | 15.25 | 155.. | .9220 | .867 | 14.97 |
| 103.. | .7377 | .080 | 15.34 | 156.. | .9289 | .918 | 15.10 |
| 104.. | .7446 | .131 | 15.58 | 157.. | .9358 | .969 | 15.13 |
| 105.. | .7515 | .182 | 15.67 | 158.. | .9428 | 423.021 | 15.18 |
| 106.. | .7585 | .234 | 15.58 | 159.. | .9497 | .072 | 15.20 |
| 107.. | .7654 | .286 | 15.36 | 171.. | 642.6838 | 576.902 | 14.86 |
| 108.. | .7724 | .338 | 15.24 | 172.. | .6908 | .954 | 15.07 |
| 109.. | .7793 | .389 | 15.13 | 173.. | .6977 | 577.005 | 15.19 |
| 110.. | .7862 | .440 | 15.03 | 174.. | .7046 | .056 | 15.19 |
| 111.. | .7932 | .492 | 14.94 | 175.. | .7115 | .108 | 15.31 |
| 112.. | .8001 | .543 | 14.89 | 176.. | .7184 | .159 | 15.39 |
| 113.. | .8070 | .594 | 14.86 | 177.. | .7253 | .210 | 15.55 |
| 114.. | .8140 | .646 | 14.82 | 178.. | .7323 | .262 | 15.28 |
| 115.. | .8209 | .697 | 14.86 | 179.. | .7392 | .313 | 15.18 |
| 116.. | .8278 | .749 | 14.83 | 180.. | .7461 | .364 | 15.10 |
| 117.. | .8347 | .800 | 14.84 | 181.. | .7530 | .415 | 15.00 |
| 118.. | .8416 | .851 | 14.95 | 182.. | .7600 | .467 | 14.98 |
| 119.. | .8486 | .903 | 14.88 | 183.. | .7669 | .518 | 14.95 |
| 120.. | .8555 | .954 | 15.10 | 184.. | .7738 | .570 | 14.94 |
| 122.. | .8971 | 415.263 | 15.28 | 185.. | .7807 | .621 | 14.91 |
| 123.. | .9040 | .314 | 14.95 | 186.. | .7877 | .673 | 14.84 |
| 124.. | .9110 | .366 | 15.11 | 187.. | .7946 | .724 | 14.90 |
| 125.. | .9179 | .417 | 15.04 | 188.. | .8113 | .848 | 14.89 |
| 126.. | .9248 | .468 | 14.97 | 190.. | 642.8535 | 578.161 | 15.50 |
| 127.. | .9317 | .520 | 15.01 | | | | |

\* Taken through the glass.

The observations by Graff have been plotted as crosses in Figure I, each cross representing the mean of three successive observations. In order to make the ordinates correspond to the photographic light-curve, a constant, +1.35 mag., has been applied to Graff's visual observations. The magnitudes at maximum, 13.48±0.03 mag., and at minimum, 14.29±0.05 mag., give a visual range on



Fig. 1.—Observations of RV Canum Venaticorum in groups of four (dots) plotted according to phase as calculated from Larink's period (half-period). Crosses represent means of three consecutive observations by Graff, reduced to the zero point of the Mount Wilson measures.

Graff's scale of 0.81±0.06 mag. The difference between the photographic and visual amplitudes is thus −0.06±0.075 mag., from which we may conclude that, on the basis of the adopted scales, the photographic amplitude does not exceed the visual range.

It is evident from the measures that the light-curve is of the type of W Ursae Majoris, and this conclusion is not contradicted by Graff's observations.

The spectrum obtained with a slitless spectrograph at the 60-inch reflector is F8. The lines seem to be diffuse, though there is some uncertainty on account of the low dispersion used.

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The data so far obtained indicate that RV Canum Venaticorum is a very faint representative of the W Ursae Majoris class of stars, and presumably a dwarf. As it is an eclipsing binary, Larink's period

### TABLE III
#### NORMAL POINTS

| Phase | Mag. | Phase | Mag. |
|---|---|---|---|
| 0.014P | 15.24 | 0.550P | 14.97 |
| .066 | 15.28 | .586 | 14.97 |
| .122 | 15.41 | .628 | 14.87 |
| .165 | 15.56 | .670 | 14.90 |
| .212 | 15.60* | .714 | 14.89 |
| .255 | 15.44 | .753 | 14.90 |
| .296 | 15.34 | .822 | 14.86 |
| .335 | 15.10 | .862 | 14.93 |
| .386 | 15.12 | .892 | 14.95 |
| .425 | 15.00 | .932 | 15.07 |
| .470 | 14.96 | 0.968 | 15.04 |
| 0.512 | 15.00 | | |

* Mean of three observations.

### TABLE IV
#### NORMAL POINTS FOR REVOLUTION PERIOD

| Phase | Mag. | Phase | Mag. |
|---|---|---|---|
| 0.006P | 15.61 | 0.514P | 15.40 |
| .057 | 15.40 | .553 | 15.21 |
| .122 | 15.11 | .586 | 15.08 |
| .172 | 14.97 | .624 | 14.99 |
| .206 | 14.98 | .656 | 14.94 |
| .242 | 14.90 | .694 | 14.90 |
| .276 | 14.88 | .744 | 14.86 |
| .310 | 14.88 | .820 | 14.90 |
| .344 | 14.95 | .871 | 14.99* |
| .370 | 15.02 | .928 | 15.32 |
| .396 | 15.11 | 0.974 | 15.61 |
| 0.440 | 15.22 | | |

* Mean of three observations.

must be doubled. New normal points for the complete period of revolution are entered in Table IV, where the phase is now counted from the primary minimum.[1] The light-curve for the double period,

[1] It is suspected that the comparison star *e* may be variable. The magnitudes were therefore determined a second time without using star *e*. The average difference, without regard to sign, between the two sets of values is 0.02 mag. The results of the first reduction have been retained.

shown in Figure 2, has slightly different minima and an asymmetry which, even if real, need cause no surprise, since it is quite comparable with asymmetries found in other stars of this class.

The heliocentric time of principal minimum derived from the present observations is J.D. (Greenwich Mean Time) 2424642.5863,
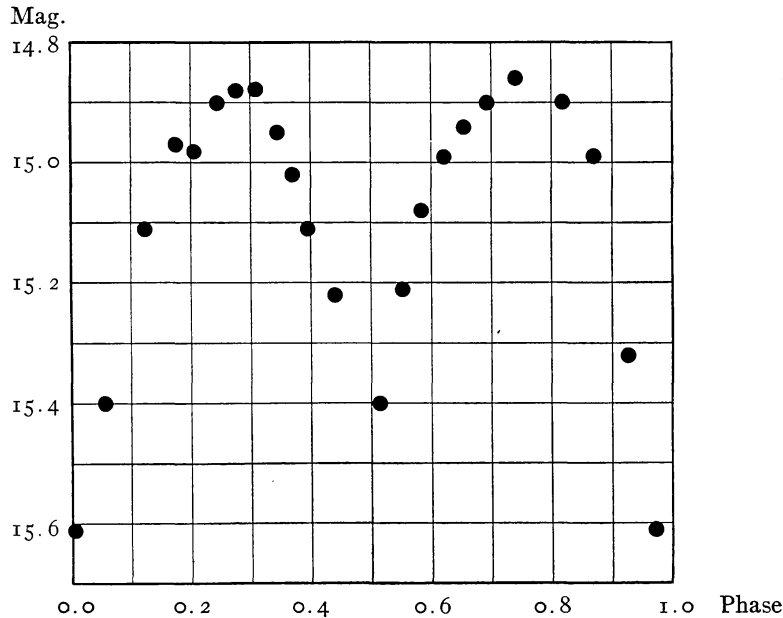


Fig. 2.—Normal points for RV Canum Venaticorum corresponding to complete period of revolution.

while that of the minimum observed by Graff is 2422811.5540. Since the period is known only with an accuracy of one second,[1] the interval between the two epochs is, unfortunately, too large to determine the number of intervening revolutions. The revised elements are:

$$\text{Min. (J.D. Hel. G.M.T.)} = 2424642.5863 \pm 0.269572E$$
$$\pm .0020 \pm 0.000023 \text{ (m.e.)}$$

Maximum light........14.88±0.02 mag. (m.e.)
Primary minimum......15.65±0.10
Secondary minimum....15.48±0.10

where the period is Larink's value doubled.

Mount Wilson Observatory
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[1] J. Larink, *loc. cit.*