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Photoelectric Observations of Southern Long Period Variable Stars

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UBV observations of six long period variables of different types are presented. They are: one Mira star (S Car), two SRb type stars (RR Car, SW Vir), one RV Tauri (?) star (IW Car) and two irregular ones (RW Vir, U Hya). The results are in good agreement with earlier observations by Smak (1964).

Key words: long period variable stars

1. Introduction

The Long Period variable stars (hereinafter referred to as LPVS) form a large and rather inhomogeneous subdivision of the family of variable stars. They have a wide range of periods and amplitudes, and a large number have no period at all. Extensive work with respect to the spectra of LPVS has been carried out. Reviews of the spectral characteristics have been given by Merrill (1960) and Ledoux and Walraven (1958). Extensive work as regards the light curves is carried out by amateur astronomers all over the world (see e.g. Campbell, 1955). Photoelectric observations however are scanty, and most previous observations refer to the maximum or near-maximum phases only (see e.g. Eggen, 1961; Smak, 1964: Evans, 1970). A review is given by Smak (1966). For a summary of problems of LPVS see Wing (1967).

The present paper gives the first results of a season devoted entirely to the study of LPVS. The stars are selected from the general catalogue of variable stars (GCVS) (Kukarkin *et al.*, 1958, 1969), using the criterion that they must have a minimum brighter than $m \approx 10$. Thus we must be able to cover the whole range of the variation.

2. Observations and Reductions

The observations were made with the 50-cm Boller and Chivens Cassegrain reflector of the Republic Observatory and a *UBV* photometer consisting of an unrefrigerated EMI 6685 photomultiplier and 2 mm UG 2 (U), 1 mm BG 12 + 2 mm GG 13 (B) and 2 mm OG 4 (V) filters. The natural system has been transformed to the *UBV* system using a method described

Table 1. *Data on variables and comparison stars*

Star	α_{1970}	δ_{1970}	V	$B—V$	$U—B$
S Car	$10^h08^m24^s$	—61°24°			
CPD—60°1646	10 04 45	—61 00	$+7^m_.07$	$+1^m_.42$	$+1^m_.70$
RR Car	9 57 06	—58 40			
CPD—58°1781	9 59 18	—58 52	+7.89	+1.55	+1.78
IW Car	9 26 11	—63 30			
CPD—63°1122	9 23 45	—63 33	+8.62	+0.62	+0.09
U Hya	10 35 50	—13 14			
SAO 156170	10 40 40	—13 47	+6.42	+1.51	+1.83
RW Vir	12 05 42	—06 36			
SAO 138579	12 03 50	—05 41	+6.77	+1.53	+1.84
SW Vir	13 12 31	—02 39			
SAO 139224	13 11 30	—02 55	+9.44	+1.52	+1.86

SAO = Smithsonian Astrophysical Obs. star catalogue.

Table 2. *Individual Observations Δ indicates (variable — comparison)*

S Carinae JD 2440000	ΔV	Δ(B—V)	Δ(U–B)
701.240	$+1^{m}.029$	$+0^{m}.155$	$-0^{m}.216$
703.267	+0.903	+0.147	—0.239
705.236	+0.772	+0.129	—0.255
706.259	+0.696	+0.135	—0.226
708.260	+0.549	+0.129	—0.239
709.259	+0.498	+0.096	—0.350
713.233	+0.207	+0.087	—0.264
715.232	+0.076	+0.041	—0.229
718.256	—0.120	+0.042	—0.315
722.243	—0.321	—0.004	—0.403
723.227	—0.374	—0.003	—0.233
725.253	—0.420	+0.017	—0.421
726.218	—0.440	—0.003	—0.440
727.216	—0.449	—0.021	—0.525
728.234	—0.497	—0.017	—0.464
729.228	—0.513	—0.029	—0.493
733.214	—0.595	—0.049	—0.595
735.221	—0.640	—0.052	—0.667
737.227	—0.712	—0.055	—0.694
740.233	—0.849	—0.061	—0.777
742.202	—0.936	—0.076	—0.767
744.223	—1.048	—0.063	—0.859
746.207	—1.130	—0.063	—0.881
754.220	—1.262	0.000	—0.887
758.223	—1.318	+0.083	—0.871
760.203	—1.336	+0.117	—0.796
763.196	—1.397	+0.152	—0.759
768.198	—1.468	+0.183	—0.694
770.191	—1.448	+0.240	—0.765
772.191	—1.444	+0.248	—0.688

RR Carinae JD 2440000	ΔV	Δ(B–V)	Δ(U–B)
704.240	$-0^{m}.599$	$+0^{m}.073$	$-0^{m}.715$
705.221	—0.607	+0.078	—0.828
708.242	—0.610	+0.096	—0.629
709.241	—0.593	+0.084	—0.476
713.216	—0.593	+0.050	—0.664
715.217	—0.576	+0.100	—0.736
718.241	—0.529	+0.096	—0.304
723.213	—0.469	+0.077	—0.692
726.202	—0.418	+0.090	—0.723
727.202	—0.440	+0.091	—0.645
728.220	—0.402	+0.098	—0.713
729.214	—0.399	+0.102	—0.738
733.200	—0.349	+0.093	—0.767
735.208	—0.332	+0.083	—0.818
737.213	—0.309	+0.083	—0.834
740.176	—0.283	+0.085	—0.776
742.188	—0.249	+0.103	—0.587
744.208	—0.228	+0.091	—0.855
746.193	—0.247	+0.091	—0.858

Table 2 (continued)

RR Carinae JD 2440000	ΔV	Δ(V–B)	Δ(U–B)
747.213	$-0^{m}.190$	$+0^{m}.085$	$-0^{m}.845$
754.206	—0.201	+0.122	—0.960
758.208	—0.174	+0.102	—0.981
760.187	—0.180	+0.081	—0.872
762.195	—0.133	+0.090	—0.912

IW Carinae JD 2440000	ΔV	Δ(B–V)	Δ(U–B)
669.318	$-0^{m}.154$	$+0^{m}.302$	$+0^{m}.824$
680.241	—0.109	+0.387	+0.814
682.314	—0.110	+0.397	+0.833
683.216	—0.130	+0.394	+0.717
686.359	—0.147	+0.364	+0.746
690.251	—0.180		
695.253	—0.279	+0.307	+0.647
698.219	—0.347	+0.242	+0.625
701.214	—0.460	+0.203	+0.591
702.213	—0.466	+0.157	+0.545
703.244	—0.485	+0.170	+0.595
704.223	—0.494	+0.152	+0.554
705.202	—0.519	+0.131	+0.591
706.218	—0.527	+0.132	+0.587
708.224	—0.544	+0.132	+0.572
709.216	—0.516	+0.137	+0.564
713.193	—0.526	+0.136	+0.604
714.217	—0.514	+0.137	+0.645
715.201	—0.492	+0.135	+0.654
717.248	—0.491	+0.158	+0.606
718.226	—0.479	+0.165	+0.587
722.205	—0.468	+0.191	+0.626
723.199	—0.410	+0.200	+0.642
726.188	—0.368	+0.226	+0.658
727.188	—0.374	+0.241	+0.664
728.206	—0.351	+0.244	+0.676
729.197	—0.334	+0.252	+0.682
733.187	—0.256	+0.270	+0.713
735.193	—0.256	+0.296	+0.694
737.198	—0.201	+0.296	+0.701
740.202	—0.193	+0.320	+0.711
741.193	—0.184	+0.311	+0.696
743.209	—0.151	+0.291	+0.672
745.189	—0.125	+0.335	+0.761
754.191	—0.146	+0.339	+0.767
758.191	—0.181	+0.339	+0.704

RW Virginis JD 2440000	ΔV	Δ(B–V)	Δ(U–B)
714.293	$+0^{m}.613$	$-0^{m}.044$	$-0^{m}.784$
717.307	+0.562	—0.024	—0.767
718.303	+0.564	—0.026	—0.767

Table 2 (continued)

RW Virginis JD 2440000	ΔV	$\Delta(B-V)$	$\Delta(U-B)$
728.310	$+0^{\rm m}.428$	$-0^{\rm m}.030$	$-0^{\rm m}.723$
729.304	+0.404	−0.004	−0.730
732.311	+0.346	−0.007	−0.667
737.308	+0.234	+0.011	−0.595
738.254	+0.239	+0.011	−0.648
740.293	+0.281	+0.016	−0.645
742.261	+0.229	+0.024	−0.642
744.272	+0.231	+0.030	−0.633
746.294	+0.203	+0.029	−0.629
755.262	+0.295	+0.031	−0.683
759.246	+0.269	+0.014	−0.648
761.248	+0.261	+0.017	−0.639
762.259	+0.251	+0.020	−0.648
770.206	+0.316	+0.016	−0.648
774.201	+0.315	+0.004	−0.648
780.212	+0.299	+0.002	−0.664

SW Virginis JD 2440000	ΔV	$\Delta(B-V)$	$\Delta(U-B)$
703.327	$-2^{\rm m}.323$	$+0^{\rm m}.046$	$-1^{\rm m}.199$
706.350	−2.349	+0.037	−1.164
709.323	−2.366	+0.011	−1.210
714.325	−2.348	+0.026	−1.201
717.336	−2.345	+0.024	−1.191
718.334	−2.335	+0.013	−1.214
728.341	−2.235	+0.013	−1.201
729.336	−2.205	+0.017	−1.044
732.341	−2.182	+0.022	−1.120
735.307	−2.117	+0.017	−1.242
738.270	−2.072	+0.033	−1.157
740.323	−2.039	+0.035	−1.245
742.295	−2.023	+0.031	−0.950
744.288	−1.987	+0.042	−1.145
759.316	−1.798	−0.002	−1.346
761.278	−1.802	−0.009	−1.359
762.289	−1.767	−0.017	−0.994
770.220	−1.668	−0.006	−1.101
774.216	−1.619	−0.013	−1.141
776.241	−1.595	−0.046	−1.315
780.243	−1.565	−0.024	−1.344
781.227	−1.537	−0.044	−1.208
788.220	−1.546	−0.046	−1.136
789.233	−1.562	−0.017	−1.845
792.232	−1.578	−0.009	−1.116

U Hydrae JD 2440000	ΔV	$\Delta(B-V)$	$\Delta(U-B)$
701.269	$-1^{\rm m}.431$	$+1^{\rm m}.103$	$+2^{\rm m}.858$
702.258	−1.417	+1.101	+3.417
706.306	−1.446	+1.108	+3.379
709.280	−1.458	+1.106	+3.064

Table 2 (continued)

U Hydrae JD 2440000	ΔV	$\Delta(B-V)$	$\Delta(U-B)$
714.245	$-1^{\rm m}.447$	$+1^{\rm m}.101$	$+2^{\rm m}.831$
717.262	−1.456	+1.106	+3.149
718.287	−1.455	+1.121	+3.426
728.278	−1.484	+1.108	+3.409
729.273	−1.483	+1.109	+2.954
735.236	−1.511	+1.106	+3.048
737.260	−1.505	+1.077	+3.111
741.248	−1.514	+1.075	+3.803
743.243	−1.524	+1.071	+3.315
744.257	−1.509	+1.061	+3.398
745.224	−1.522	+1.068	+3.375
746.239	−1.515	+1.074	+3.233
758.254	−1.502	+1.073	+3.100
760.230	−1.483		
761.198	−1.539	+1.081	+3.231
762.225	−1.494	+1.042	+3.111

by Hardie (1962). Southern standard stars have been selected from a list given by Cousins and Stoy (1963). Although the atmospheric conditions sometimes changed rapidly, mean extinction coefficients have been used in the computation of magnitudes and colours of the comparison stars.

Comparison stars were selected as close to the variable as possible and preferably of the same spectral type. Data on variables and comparison stars are listed in Table 1.

After some experiments the series sky – comp. – var. – var. – comp. – sky in three colours was chosen to give one observation of a variable. If the readings did not reproduce well enough, i.e. within one or two per cent, that particular observation was repeated.

The differences (variable-comparison) are listed in Table 2. The uncertainties are estimated to be: $V \pm 0^{\rm m}.01$, $(B-V) \pm 0^{\rm m}.02$, $(U-B) \pm 0^{\rm m}.04$.

3. Light- and Colour-curves

In order to obtain a good coverage of the light- and colour-curves an attempt has been made to observe each star at least every two or three nights. By doing so it should be possible to observe small irregularities in the light variations.

Unfortunately the programme was begun a little too late in the season, so for a number of stars only part of the light curve has been covered. A discussion of the individual stars and of the observed light and colour curves is given in the next section.

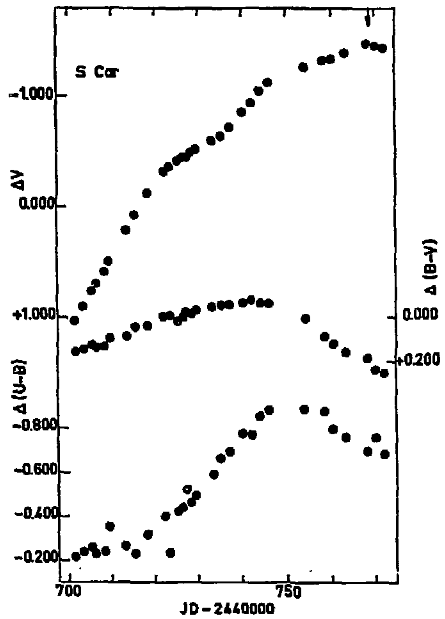

Fig. 1. Light and colour curves of S Carinae. The vertical arrow indicates the time of the predicted maximum. Everywhere Δ indicates (var.-comp.)

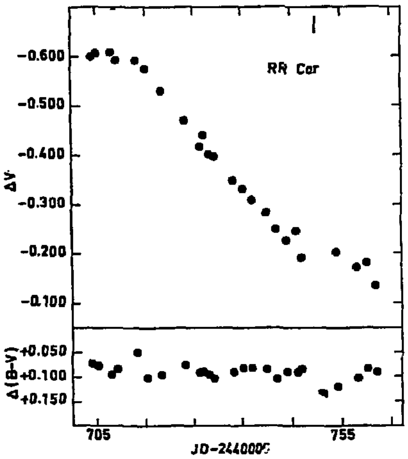

Fig. 2. Light and colour curves of RR Carinae. The vertical segment indicates the time of the predicted maximum

4. Discussion

S *Carinae*

S Car is a Mira variable with a period of 149.53 days and it has spectral type K7-M4e. An earlier photoelectric light curve has been published by Eggen (1961) and an extensive study of the spectrum at various phases has been made by Hain (1969).

Inspection of the light- and colour-curves reveals some interesting facts (Fig. 1). On the rising branch of the light curve one can observe two changes in slope (a 'shoulder'), also visible, although less convincingly, in the blue and ultraviolet light curves. The light curve in V has a broad maximum. Those in B and U show a maximum at the time that the light curve in V bends to its rather flat maximum. The B curve has a secondary maximum coinciding with the maximum of the V curve, while the U curve shows only a shoulder.

Eggen's light curve also shows a change in slope on the rising branch. The colour curves both show a maximum about 25 days before maximum light, the $(B-V)$ being a little earlier, but almost coinciding with the maxima of the B and U curves. After its maximum there is a rapid decrease of about $0^m.35$ in the $(B-V)$ curve, in the same time that the V light curve reaches its maximum.

This could perhaps be explained partly by the fact that the effective temperature reaches a maximum light, as found by Hain (1969). Smak (1964, 1966) showed that for most of the Mira variables the maximum in $(B-V)$ occurs at about phase 0.8, in agreement with the present result (0.83). However, the $(U-B)$ displays a totally different behaviour, compared with Smak's results. For Miras in general the $(U-B)$ has a minimum at maximum light. Smak observed in some Miras however (e.g. W Lyr) the same sort of maximum in $(U-B)$ as found for S Car. A possible explanation could be, as also suggested by Smak, that strong hydrogen emission lines are present near maximum light.

The same behaviour of the colour curves has been found by Eggen (1961).

R R *Carinae*

R R Car is an SRb type variable of spectral type M6 and was discovered by Fleming in 1894. Payne-

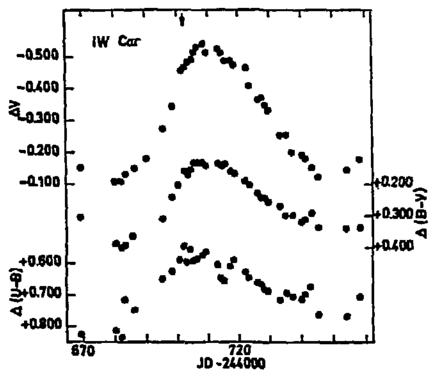

Fig. 3. Light and colour curves of IW Carinae. The vertical arrow indicates the time of the predicted maximum

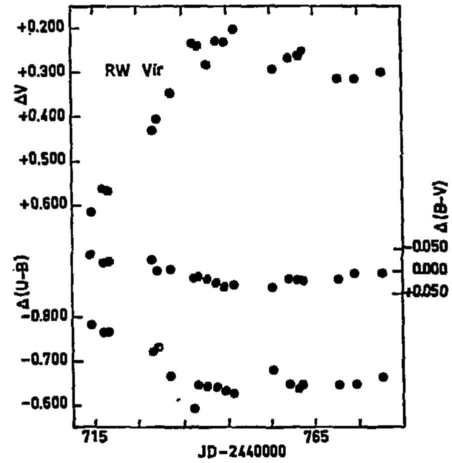

Fig. 4. Light and colour curves of RW Virginis

Gaposchkin (1946) derived a period of 109 ± 20 days from observations of the AAVSO.

From the present observations it is not certain whether a maximum has been observed or not, but it is quite plausible that it has. (Fig. 2). It is interesting to see that the $(B-V)$ curve stays more or less constant and it is also clear, in spite of the large scatter, that the $(U-B)$ is rising (see Table 2), while the light curve is descending. These effects are presumably due to the TiO absorption bands (Smak, 1964).

IW *Carinae*

IW Car was discovered by O'Connell in 1937 and discussed later by the same author (1946). The star has a short period variation of 67.5 days and a long term behaviour with a period of 1500 days. At a maximum of the long period, on which the short period variation is superimposed, the amplitude of the light variation is greater than at the minimum. The spectrum is double ($G_0 + A_0$).

IW Car is classified RVb in the GCVS, although it does not show the alternating main and secondary minima, characteristic of the RV Tauri stars. The short period variation appears to be quite regular. The present observations show some small irregularities in the descending branch of the light curve (Fig. 3). The colour curves are almost perfectly in phase with the light curve.

It will be noticed, that the second minima of the light and colour curves are somewhat higher than the first ones, indicating perhaps that IW Car is on the rising branch of the 1500 day variation, which can also be found from O'Connell's results.

RW *Virginis*

RW Vir is an Ib type variable of spectral type M5III, discovered by Lause (1932).

The observed part of the light curve shows a very smooth rising branch followed by a slow decrease. Oscillations with an amplitude of about 0^m05 are superimposed on the descending branch (Fig. 4). The colour curves show a decrease in brightness until the light curve reaches its maximum. Thereafter the $(B-V)$ curve rises again, while the $(U-B)$ remains more or less constant.

It has been observed in other Ib type stars (e.g. U Delphini, Wisse and Wisse, in prep.) that not only are their large scale variations irregular, but also that small scale variations may be present.

SW *Virginis*

SW Vir is denoted in the GCVS as an SRb type variable with a period of about 150 days and spectral type M6. A previous discussion of the star is given by Payne-Gaposchkin (1950).

The present observations show a maximum and a minimum, separated by about 75 days, or half the period. The descending branch of the light curve is fairly smooth (Fig. 5).

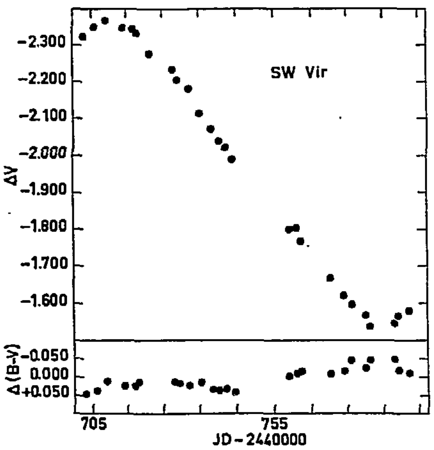

Fig. 5. Light and colour curves of SW Virginis

The $(B-V)$ curve shows a very slow variation with an amplitude of about 0ᵐ05, with possibly minor variations superimposed.

The star is bluer at the minimum. Probably because of the very faint comparison star the $(U-B)$ has a large scatter. The results are nevertheless given in Table 2, but no conclusions can be drawn from the observations.

U *Hydrae*

U Hya is a very red star of spectral type N_2. The variations are very irregular, and sometimes the brightness is almost constant (Payne-Gaposchkin, 1952).

During the period of observation (two months) the star increased about 0ᵐ1 in brightness. The $(B-V)$ curve runs almost parallel to the light curve. The $(U-B)$ observations have a very large scatter, and no conclusions can be drawn.

5. Conclusions

It is of course somewhat premature to draw any conclusions from the observations of six stars of different types.

The most that can be said is, that the present results do not contradict with the results, obtained by Smak (1964).

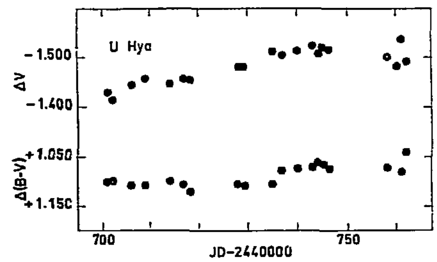

Fig. 6. Light and colour curves of U Hydrae

As the mechanism of variability and the atmospheric conditions of LPVS are still largely unknown, it is clear that many more observations are needed.

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Photoelectric Observations of the Mira Variable S Carinae

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New photoelectric observations of S Car are presented and compared with earlier results. It has been found that the star is redder in both $(B-V)$ and $(U-B)$ when the lightcurve has a higher maximum, and also that in the same cases the maxima of the colourcurves occur at a later phase. S Car has tentatively been placed at a distance of 525 pc.

Key words: photometry — variable stars

The Mira variable S Carinae ($\alpha_{1970} = 10^h08^m24^s$, $\delta_{1970} = -61°24'$; $l = 284.°8$, $b = -4.°6$; $P = 149.^d53$) is one of the brighter members of its class. It is a Ib supergiant of spectral type K7-M4e. Feast (1963) derived a residual velocity of 277 km s^{-1}. Apparently S Carinae is a high velocity object.

In this note we compare all the available *U B V* observations (Eggen, 1961; Wisse and Wisse, 1971 (Paper I) and the present results).

The present observations have been made and reduced in the same way as described in Paper I. The same comparison star (CPD −60° 1646) was used. New and perhaps better magnitude and colours are: $V = 7.00 \pm 0.059$, $(B-V) = +1.45 \pm 0.026$, $(U-B) = +1.70 \pm 0.064$. The strongly and rapidly varying transparency of the Johannesburg atmosphere is responsible for the large mean errors. (The visual seeing, however, remains as good as ever). The uncertainty in ΔV, $\Delta(B-V)$ and $\Delta(U-B)$ is much smaller, because variable and comparison are very close to each other and have been measured within a short time interval. Light and colourcurves are shown in Fig. 1. Everywhere Δ indicates variable minus comparison.

All four observed maxima have different heights: $V_{max} = 5.^m35$ (Eggen), $5.^m55$ (Paper I), $5.^m85$ and $5.^m15$ (this paper).

In Table 1 are given the maxima of light and colourcurves and the phases at which the maxima of the colourcurves occur. All phases have been computed with formula:

$$\varphi = 1 - \frac{JD(V_{max}) - JD((B-V)_{max}; (U-B)_{max})}{149.53}.$$

It is interesting to see that at a higher maximum the star is redder than at a low one.

Table 1. *Maxima of the light and colourcurves and their phases*

	V_{max}	$(B-V)_{max}$	$\varphi(B-V)_{max}$	$(U-B)_{max}$	$\varphi(U-B)_{max}$
This paper	$5.^m15$	$+1.^m62$	0.95	$+0.^m90$	0.95
Eggen	5.35	+1.45	0.87	+0.85ᵃ)	0.87
Paper I	5.55	+1.37	0.83	+0.80	0.88

ᵃ) Eggen gives $(U-B)_\sigma = 2.10$. This has been converted to the standard system using Table II given by Cousins and Stoy (1963).

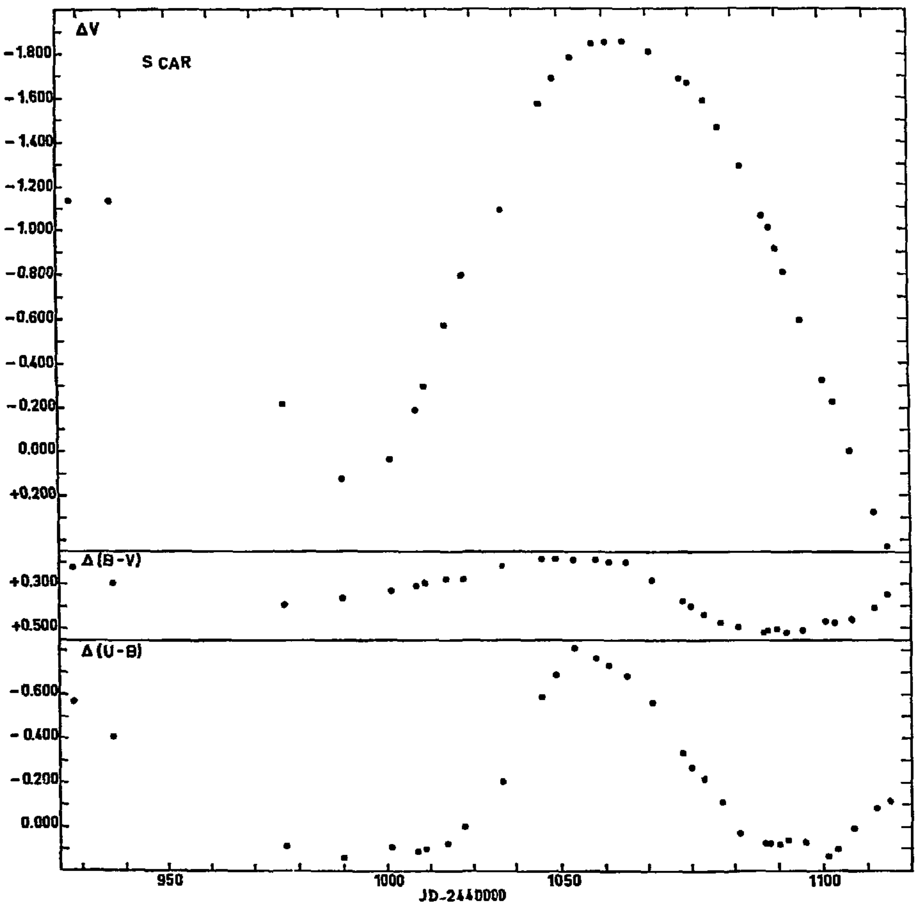
The variations are larger in $(B-V)$ than in $(U-B)$; the behaviour of the TiO bands is possibly the main cause of this phenomenon. It can also be seen that the maxima of the colourcurves come at a later phase when the lightcurve has a higher maximum.

The lightcurves in Paper I and this paper both clearly show a shoulder on the rising branch. Since only one minimum has been observed, the amplitude of the light variations could not be included in the analysis.

In 1970 the loop of S Carinae in the $(U-B)/(B-V)$-plane was wider than in 1971 and shifted towards the bluer part of the diagram.

An attempt has been made to determine approximately the distance to S Carinae, assuming that the star *is not reddened*. From $P-L$ relations given by Clayton and Feast (1970) absolute magnitudes have been derived, yielding a distance of about 310 pc.

One can also derive the absolute magnitude from Table V, given by Osvalds and Risley (1961). $M_v = -3.1$, probably more in agreement with the



F.. 1. Light and colourcurves for S Carinae

fact that S Carinae is a supergiant. In this case we find a distance of 525 pc.

Acknowledgement. We like to thank Dr. M. Feast for his comments on an earlier draft of the paper.

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Photoelectric Observations of the Bright RV Tauri Stars R Scuti and U Monocerotis

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Summary. Photoelectric observations of the RV Tauri stars R Sct and U Mon are presented. An unusually deep minimum of R Sct and other pecularities in its light and colour curves have been observed. U Mon shows a decreasing mean magnitude. A short description of two spectra of R Sct, taken at the Radcliffe Observatory, is given.

Key words: pulsating variables – RV Tauri stars

The two RV Tauri stars R Scuti ($\alpha_{1970} = 18^h45^m53^s$; $\delta_{1970} = -5°44'$) and U Monocerotis ($\alpha_{1970} = 7^h29^m22^s$; $\delta_{1970} = -9°43'$) have been studied quite extensively in the past: R Scuti: McLaughlin (1939) and Preston (1962); U Monocerotis: Sanford (1933), Abt (1955) and Aliev (1967). Those studies have been favored by the fact that both R Sct and U Mon are quite bright.

Only a few photoelectric light curves are known however, which was the reason for the authors to include the stars in their survey of southern red variables.

The method of observation and reduction has been described earlier (e.g. Wisse and Wisse, 1971).

The following two stars have served as comparison stars: for U Mon: SAO 152986; $V = 6.53 \pm 0.040$; $B-V = +1.62 \pm 0.015$; $U-B = +2.06 \pm 0.081$; for R Sct: SAO 142572; $V = 6.63 \pm 0.038$; $B-V = +1.90 \pm 0.026$; $U-B = +2.16 \pm 0.102$.

The large mean errors are caused by rapid changes in transparancy of the Johannesburg atmosphere. The observations $\Delta \equiv$ (variable-comparison) are a factor of two more accurate however.

The light and colour curves of both stars are extremely interesting and sometimes puzzling (Figs. 1, 2, 3).

First of all we were lucky to observe an unusually deep minimum of R Scuti, around JD (2440) 755. This minimum is more than two magnitudes fainter than those usually observed! (Cfr. Preston's (1962) light curve.) Secondly we see that the secondary *minimum* is very shallow.

The behaviour of $(B-V)$ is more or less normal (see Preston *et al.*, 1963) up till JD 780, but then it remains constant till JD 840. The $(U-B)$ rises slowly over the same period.

In 1961 R Scuti was as red as in 1971, but it was much bluer in 1970. We have not been able to find a decent explanation for these phenomena. The maxima of R Sct observed in 1971 were about $0^m.5$ fainter than those in 1970. Note also the prolonged secondary maximum and the comparatively shallow primary minimum. Now the colour curves behave more normally, i.e. maxima coinciding with the rising branch of the light curve. This is probably due to the occurrence of hydrogen emission lines during the ascending phase of the light variation.

The observed colour curves of U Mon also behave in this way.

The light curve of U Mon consists of a few cycles which become fainter and fainter. The amplitudes of the individual cycles seem to be more or less equal, while the average magnitude decreases with a few tenths of a magnitude over a period of 170 days. It is not very well possible to distinguish between primary and secondary maxima and minima. Note that the observed minima coincide with the predicted times of maximum, indicated by the vertical arrows.

Observations in the infrared on both variables have been published by Gehrz and Woolf, who found an excess radiation at 11 μ for U Mon. They give an infrared colour index $[3.5\,\mu] - [11\,\mu] = +4.2$ for U Mon and $+1.2$ for R Scuti. It would be interesting to see how these colour indices vary over a whole cycle.

Dr. P. Warren kindly communicates a description of two spectra of R Scuti, taken at the Radcliffe Observatory.

1) Cc 8916: 49 Å mm^{-1} at H. Blue region of the spectrum. Exposed 22 July 1970 at 0116 SAST.

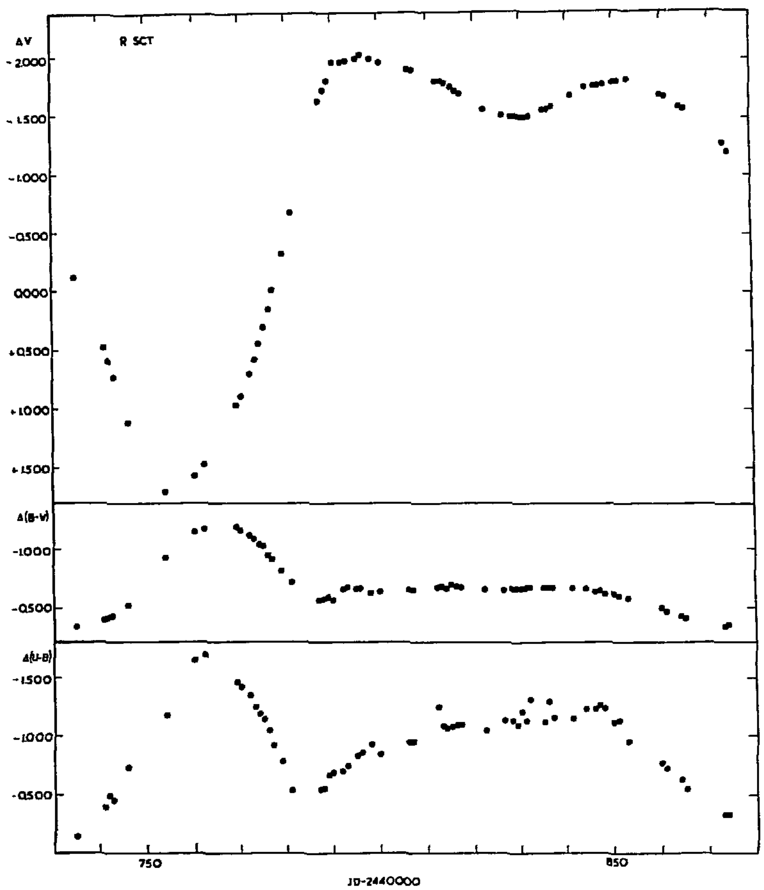

Fig. 1. The light and colour curves of R Scuti in 1970

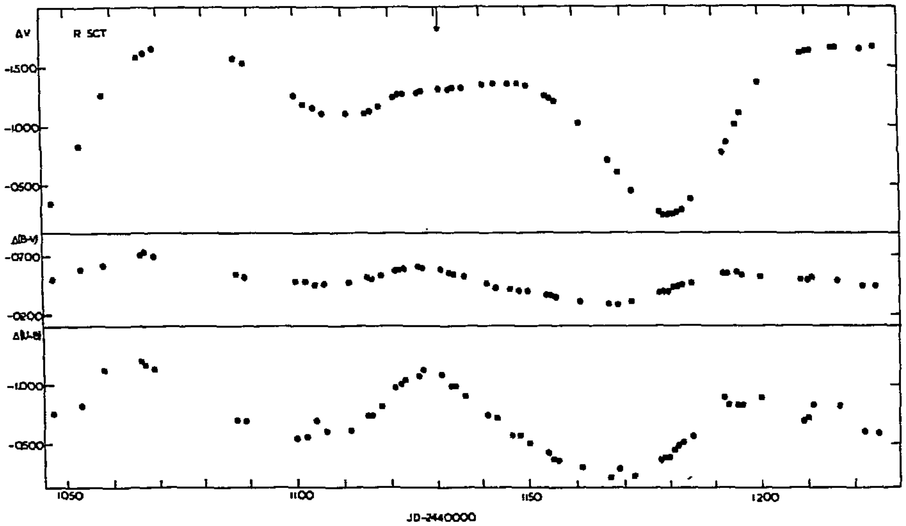

Fig. 2. The light and colour curves of R Scuti in 1971

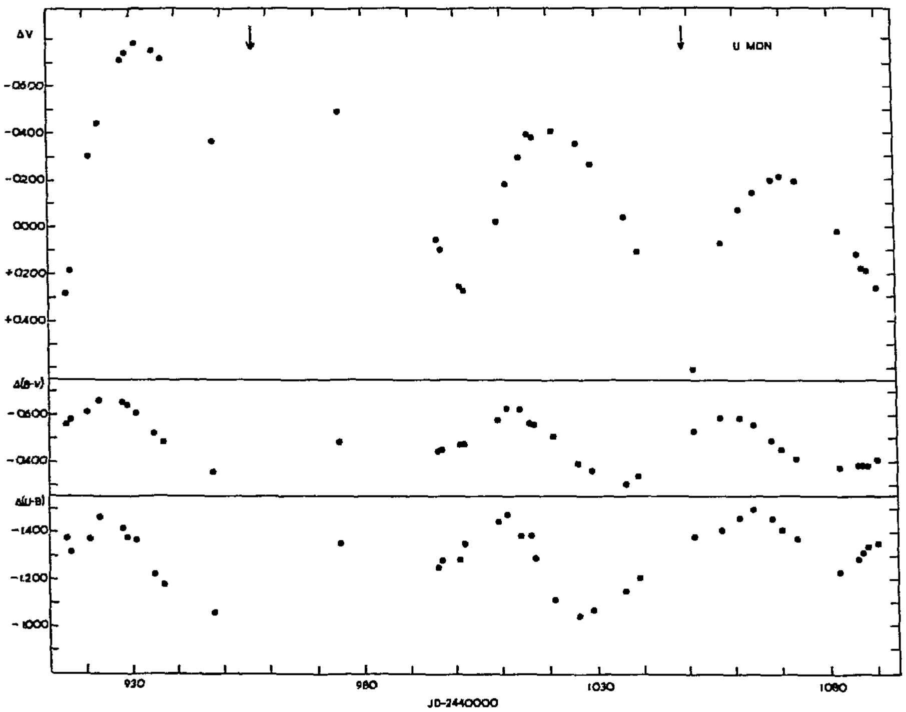

Fig. 3. The light and colour curves of U Monocerotis. Vertical arrows indicate predicted times of maximum

H_β, H_γ, H_δ are all seen in emission. The type seems to be K 2 or later.

2) DY 2849: 5600–6800 Å; 13 Å mm^{-1}. Exposed 15 May 1971, 0522 SAST. The two remarkable features of this spectrum are:

a) A doubling of the sodium D lines with a distance between the components of 54 km s^{-1}. The red component is two to three times stronger than the blue.

b) H_α emission displaced 44 km s^{-1} to the blue. Preston shows spectra where the H_α emission is also visible to the red of the absorption. This is not seen on this plate.

No lines, found by Preston to be doubled, appeared double on this plate. It was not possible on this plate to detect doublings less than 20 μm or 13 km s^{-1}.

The spectral type is later than G 2, but not as late as K 2.

Acknowledgements. We thank Drs. M. Feast and P. Warren for their kind cooperation.

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Stellingen

1. Aan de door FitzGerald gevonden intrinsieke waarden voor (U-B) en (B-V) voor M type reuzensterren mag niet teveel waarde worden gehecht.
   (M.P. FitzGerald, 1970, Astron. Astrophys. 4, 243)

   ✗

2. Celis' conclusie over het gedrag van de lichtkrommen van Mirasterren (bv. S Carinae) is onjuist.
   (L. Celis S. 1977, Astron. Astrophys. Suppl. 29, 15)

   ✗

3. De conclusies van Celis aangaande de intrinsieke amplitude van Mirasterren zijn aan ernstige twijfel onderhevig.
   (L. Celis S. 1978, Astron. Astrophys. 1978 63, 53)

   ✗

4. In beschouwingen over rode reuzensterren wordt te vaak over het hoofd gezien, dat het merendeel van deze sterren waarschijnlijk veranderlijk is.

   ✗

5. De door Baud gegeven afleiding van de Derde wet van Kepler bevat een fundamentele onjuistheid.
   (B. Baud, in: Astronomie in Beweging, Red. F.P. Israel, Elsevier 1976)

   ✗

6. Het doet vreemd aan, dat Eggen wel Fernie's waarde voor E(B-V)/E(U-B) voor rode reuzen gebruikt, terwijl hij de door Fernie in hetzelfde artikel ontraden methode voor de bepaling van E(B-V) zonder commentaar toepast.
   (O.J. Eggen 1973, Mem. R. astr. Soc. 77, 159;
   J.D. Fernie 1963, Astron. J. 68, 780)

   ✗

7. Het in het natuurkundeprogramma voor het VWO opgenomen onderdeel 'De bouw van het Heelal' is slecht omschreven en weinig samenhangend.
Het is zinvoller om, bij ieder onderdeel waar dit mogelijk is, astrophysische toepassingen verplicht in het programma op te nemen.

8. Een voordeel van de snelle opkomst van de radio sterrenkunde is, dat de optische astronoom op de opmerking: 'Alweer een veranderlijke ster' eindelijk kan antwoorden: 'Alweer een HII gebied.'

9. Aan het vrijwel immer overbodige gebruik van Engelse of quasi-Engelse woorden in het Nederlands dient wettelijk paal en perk te worden gesteld.

10. Het gebruik van kogelpennen bij het schrijfonderricht op de lagere scholen moet met klem worden ontraden, en de invoering van het 'Italic' of 'Kanselarijschrift' dient met kracht te worden bevorderd.

11. Het gebruik van toepasselijke kleding bij promoties, concerten en andere officiële gebeurtenissen is niet uit de tijd. Het draagt in grote mate bij aan de sfeer van het gebeuren en het is een uiting van het belang dat alle betrokkenen aan het geheel hechten.