Variable Stars Observed During the Cape Bright Star Programmes

by

A. W. J. Cousins and P. R. Warren

In drawing up observing programmes for general photometry at the Cape Observatory known variable stars have generally been omitted since a limited number of observations made at irregular intervals does not usually contribute much to our knowledge of the nature of the light variations. However, a number of variable stars, some of them already known, were included in the First Bright Star Programme. Two lists of stars, whose variability was noted during the reductions, have been published (1). Known variable stars were added to these lists for completeness, even if they had not been observed.

Stars with discordant observations were usually kept on the observing list to ascertain, if possible, the reason for the large residuals, with the result that quite a number of observations were made of some stars. On account of their distribution these observations are not well suited for finding periods, but in cases where the period is known they may be combined to give some indication of the light curve and used to check or improve this period. With this in mind it seemed worthwhile to collect and examine the available observations of several bright stars that were known to be, or strongly suspected of being, variable. With the exception of N Velorum no red stars have been studied.

Many of the observations reported here were made prior to 1952 with a Fabry photometer, as part of the First Bright Star Programme or the concurrent E region programme. They have now been reduced to the S'Pg system. This was chosen in preference to the V system as these observations were made in the blue region and not accompanied by a measure of colour. When more recent observations, made photoelectrically, were available these were reduced to the same system, and combined with the earlier measures. Approximate transformations to B and V are possible by using the appropriate data in Table I. The average standard error for unit weight is $\pm 0^{m}.012$ for the Fabry observations and somewhat less for those made photoelectrically. Observations given half or quarter weight are marked with one or two colons, respectively, in the lists that follow. Times given to the third decimal place of a day are heliocentric.

Table I gives a list of the stars that have been studied. The spectral type and type of variation have been taken, when available, from the General Catalogue of Variable Stars (2). For the remaining stars the spectral types are from various sources and the type of variation is based on the present observations.

Maximum and minimum magnitudes are given when these can be derived from the Cape observations, but in no case was the depth of an eclipse adequately observed. Mean values of B - V and U - B are based on photoelectric measures. There is little, if any, evidence of change of colour, so the transformation to B, using B - S'Pg, should be valid for all phases. The use of $\overline{B - V}$ to obtain V may not always be justified.

The observations of δ Scuti and the eclipsing variables of short period are given in Table II. For these stars phases have been computed using the reciprocal periods given, with JD 2430000 as the starting point. The corresponding phase of a maximum or minimum usually taken from (2), is added at the end.

The observations of the remaining stars are given in Table III. Some remarks about the individual stars are given after Table III.

The observations discussed in this paper were made in several different programmes in which various members of the observatory staff took a share. The results were collected and examined by one of us (P.R.W.) while working as a Vacation Student at the Royal Observatory.

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References

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TABLE I

HR	Name	Spect.	S'Pg Max.	S'Pg Min.	B-S'Pg	$\overline{B-V}$	$\overline{U-B}$	Type
338	ζ Phe	B6 V	3.62	-	+0.22	-0.07	-0.40:	E
1338	Υ Dor	F2 IV	4.31	4.35	+0.23	+0.32	+0.01	I?
1463	ν Eri	B2 III	3.44?	3.60?	+0.21	-0.21	-0.90:	βC
1788	η Ori	B1 V	2.93	-	+0.21	-0.19	-0.91	EB
1811	ψ Ori	B2 IV	4.15?	4.20?	+0.21	-0.22	-0.91	-
2745	27 CMa	B3 IIIpe	4.08	4.32	+0.22	-0.09ø	-0.91	I?
2749	28 CMa	B3 IVe	3.50	3.66	+0.21	-0.18	-0.66	I
2781	UW CMa	08f+08f	4.46	-	+0.22	-0.15:	-	EB
3803	N Vel	gK5	4.57	4.63	+0.10	+1.55	+1.88	I
4140	p Car	B5 ne	2.88	3.05	+0.22	-0.09:	-	I
6084	σ Sco	B1 III	2.74	2.85?	+0.23	+0.14	-0.71	βC
6247	μ' Sco	B1.5 V	2.55	-	+0.21	-0.20	-	EB
6812	μ Sgr	B8 Iap	3.78	3.90*	+0.23	+0.24	-0.54	EA
7020	δ Sct	F3 III-IV	4.75	4.93	+0.23	+0.36	+0.10	δ Sc
8322	δ Cap	A7 IIIm	2.95	-	+0.23	+0.30:	-	EA

* This does not include the eclipse minimum.

ø Measured with 18-inch. Earlier measures more negative.

TABLE II

Observations of Variable Stars

J.D. 2430000+	Phase	S'Pg	J.D. 2430000+	Phase	S'Pg	J.D. 2430000+	Phase	S'Pg
HR 338 = ζ Phoenecis			P = $1^d.6697597$			$\frac{1}{P} = 0.59888857^{d-1}$		
2874.356	.419	3.64	2899.349	.386	3.62	6228.285	.049	3.63
2874.369	427	3.63	3188.394	493	3.61:	6235.276	236	4.01
2874.381	434	3.62	3587.303	395	3.57::	6242.271	425	3.63
2898.318	770	3.85	3895.404	913	3.60::	6243.268	022	3.62
2898.338	782	3.77	3926.325	431	3.63:	6540.430	989	3.61
2899.316	367	3.64	6225.288	253	4.11	6541.430	588	3.61
2899.333	377	3.62		Minimum		2432667.012	242	-

J.D. 2430000+	Phase	S'Pg	J.D. 2430000+	Phase	S'Pg	J.D. 2430000+	Phase	S'Pg
HR 1788 = η Oricnis			$P = 7^d.98926$			$\frac{1}{P} = 0.125168^{d-1}$		
3258.39	.846	3.16:	3361.25	.721	2.97	8063.39	.278	2.94
3280.33	592	2.95:	3680.38	666	2.91::	8065.38	527	2.93
3286.31	340	3.10	3687.36	540	2.92:	8066.37	651	2.94
3286.31	341	3.10	3688.36	664	2.98	8067.36	775	2.97
3288.31	591	2.97:	3690.36	914	2.93:	8068.36	900	2.94
3288.31	592	2.97:	3691.34	038	2.95:	8071.37	277	2.96
3344.28	597	2.96	3692.35	164	2.95::	8074.35	651	2.98
3344.30	599	2.96	8062.39	153	2.90	8075.33	773	2.95
HR 1811 = ψ Orionis			$P = 2^d.52588$			$\frac{1}{P} = 0.391943^{d-1}$		
3644.454	.417	4.24:	6277.250	.322	4.14	7638.449	.834	4.16
3674.367	141	4.16	6931.373	700	4.15	7639.433	219	4.15
3676.368	926	4.20	6933.465	520	4.15	7647.414	347	4.14
3680.355	488	4.20	6934.448	906	4.14	7649.403	127	4.15
3683.343	656	4.14	7091.378	414	4.11	7665.357	380	4.14
3684.337	049	4.22	7094.352	579	4.15	7670.349	337	4.16
6210.440	136	4.16	7108.388	080	4.16	7671.336	723	4.17
6272.263	367	4.16	7112.362	638	4.16	7672.332	114	4.16
6273.249	754	4.17	7115.287	784	4.15		Mean	4.16
HR 2781 = UW (29) Canis Majoris			$P = 4^d.3934$			$\frac{1}{P} = 0.227614^{d-1}$		
1828.363	.161	4.54::	2958.334	.359	4.87	3280.449	.676	4.51:
2955.343	678	4.47	3279.351	427	4.71	3302.380	668	4.45
2956.329	902	4.86	3279.442	447	4.68	3304.389	126	4.47:
				Minimum		2424982.21	881	-
HR 6247 = μ' Scorpii			$P = 1^d.4462691$			$\frac{1}{P} = 0.6914343$		
1971.370	.073	2.70:	3166.244	.250	2.60::	3483.380	.528	2.69
2779.306	707	2.60	3166.287	279	2.55	3484.371	214	2.60
2779.346	735	2.57	3167.274	962	2.55	3492.343	726	2.59
2782.294	773	2.57	3167.281	967	2.57	3522.352	475	2.61
2782.348	811	2.55	3436.349	009	2.59	3523.349	164	2.64:
				Minimum		2432001.045	591	-

J.D. 2430000+	S'Pg	J.D. 2430000+	S'Pg	J.D. 2430000+	S'Pg
HR 2745 = 27 Canis Majoris					
1855.29	4.13:	3310.35	4.12	7025.34	4.10
1939.23	4.14::	3329.29	4.06:	7028.35	4.11:
2955.32	4.19	3331.29	4.10	7034.31	4.10
2956.31	4.18	6942.38*	4.32	7035.32	4.11
2958.32	4.21	6949.37*	4.25	7036.32	4.11
3279.40	4.11	6975.35*	4.17	7040.30	4.10
3279.44	4.12	6992.43	4.11	7041.30	4.11
3307.31	4.09	7001.39	4.11	7048.29	4.12
3307.36	4.08	7015.38	4.10	7081.19	4.18
3308.31	4.08	7017.36	4.12	7082.20	4.15
3308.35	4.08:	7021.35	4.10	7086.20	4.14
* Observations continued for $3\frac{1}{2}$ hours.					
HR 2749 = 28 (ω) Canis Majoris					
2634.32	3.51	4826.34	3.57	6992.44	3.64
2634.34	3.52:	4847.28	3.58	7001.40	3.65
2635.31	3.52::	5147.46	3.55:	7015.39	3.64
3018.29	3.58	5175.37	3.53	7017.37	3.64
3297.38	3.50	6563.37	3.62	7021.35	3.64
3302.36	3.48	6566.36	3.65:	7025.34	3.64
3304.37	3.51:	6651.38	3.62	7028.35	3.63:
3307.37	3.51	6653.37	3.64	7034.32	3.60
3308.35	3.53:	6717.20	3.65	7035.32	3.54
3310.35	3.50	6722.22	3.67	7040.31	3.52
3329.30	3.53::	6723.20	3.64	7041.30	3.51
3331.29	3.52	6942.38	3.66	7048.29	3.56:
4706.48	3.57:	6949.37	3.66	7056.27	3.54:
4768.49	3.55	6975.35	3.64	7081.20	3.53:
HR 3803 = N Velorum					
1900	4.62:	3670	4.61 (2)	6220	4.59 (4)
3310	4.61 (1)	3800	4.63 (3)	6600	4.57 (4)

J.D. 2430000+	S'Pg	J.D. 2430000+	S'Pg	J.D. 2430000+	S'Pg
HR 4140 = p Carinae					
1964.27	3.06::	3380.29	2.92	3441.30	2.88
2269.34	3.02	3391.36	2.94	3448.21	2.96:
2269.43	3.00:	3408.21	2.92	3663.44	3.02::
2656.38	2.92:	3408.31	2.94	3704.32	3.06:
2657.38	2.92	3412.30	2.98	3704.33	3.08:
2696.26	2.88:	3413.31	2.94:	3705.31	3.00:
3338.41	2.90	3418.28	3.00:	3706.32	2.94
3354.36	2.96::	3419.28	2.98	3707.32	3.04:
3369.32	2.88	3421.28	2.92	3708.31	3.04:
3378.29	2.94	3422.28	2.94		
3378.39	2.98:	3438.31	2.92:		
HR 6084 = σ Scorpii					
1972.349	2.83::	3478.285	2.81:	3499.222	2.79
2756.350	2.79::	3484.264	2.80:	3546.252	2.79:
2782.270	2.78	3492.233	2.77	3547.249	2.78
3166.255	2.77:	3492.312	2.72:	7486.246	2.80:
3167.249	2.80	3495.319	2.80	7491.260	2.86:
3167.257	2.77	3497.232	2.75	7492.237	2.88:
3436.343	2.78	3498.229	2.74		
HR 6812 = μ Sagittarii					
3101.40	3.80	3524.39	3.82	3848.26	3.84:
3110.37	3.86	3784.43	3.82:	3849.25	3.82
3114.36	3.84	3803.38	3.84::	3938.25	3.84:
3125.27	3.84	3808.37	3.80:	6726.38	3.88
3471.33	3.78	3809.36	3.82:	6730.37	3.90
3472.33	3.78	3810.38	3.80::	6734.37	3.92
3481.31	3.80:	3833.30	3.80	6751.33	3.86
3485.29	3.84:	3834.30	3.82:	6754.32	3.82
3511.22	3.80:	3836.30	3.82:	6755.31	3.83
3523.39	3.80:	3837.28	3.86::	6758.29	3.86
3524.38	3.80	3839.28	3.82:		

REMARKS

HR 338 = ζ Phoenecis

The phases have been computed using the period derived by Hagemann (3) from spectroscopic observations. A comparison between the Cape observations and Hogg's mean minimum (4) gives $1^{d}.669767$, but the former, based on a longer interval and more material, is presumably the more accurate.

HR 1338 = γ Doradus

This star is in E2 and was at one time used as a comparison star for β Doradus. As a result there are 129 observations available but these are not given individually. It has been classified by Evans (5) as F2 IV, which is consistent with its colour and known parallax. The radial velocity does not appear to be variable. It has not been possible to find a regular period to fit the observations but the large standard error, $\pm 0^{m}.020$, compared with an average of $\pm 0^{m}.011$ for non-variable stars would imply a range of variation of $0^{m}.04$ or $0^{m}.05$. The mean magnitude is 4.33 S'Pg.

HR 1463 = ν Eridani

Nine observations of this β Cephei-type variable are available. J. J. Kumsishvili has made an extensive investigation of this star (6). His observations overlap in time those given here but as his principal comparison star "a" (HR 1441) appears to be slightly variable, according to Cape observations (7), it is not easy to make a direct comparison of the magnitudes. His two comparison stars have the following magnitudes and colours:

a = HR 1441	V = 5.76 ± 0.05	B-V = -0.15	S'Pg = 5.40 ± 0.05
μ Eri	V = 4.02	B-V = -0.15	S'Pg = 3.66

HR 1788 = η Orionis

The available observations, including some made recently, are not sufficient to define the light curve. It would appear that the variations are not strictly regular.

HR 1811 = ψ Orionis

This spectroscopic binary star was thought to be variable in the course of the Bright Star Programme but as only one out of 20 recent photoelectric measures differs by more than $0^m.02$ from the mean the variation cannot be considered confirmed. The variation, if any, does not appear to be connected with the spectroscopic period of 2.5 days.

HR 2745 = 27 Canis Majoris

Observations made on three nights early in 1960, when the star happened to be fainter than usual, revealed no significant variations over periods of $3\frac{1}{2}$ hours, so it is clear that the observed variations are not a direct result of the orbital motion with a period of six hours discovered by Mrs Ringuelet-Koswalder (8). It is more likely that they are connected with the shell structure of this composite system. The range of variation exceeds $0^m.2$.

HR 2749 = 28 (ω) Canis Majoris

The variability of this star was discovered when it was being used as a comparison star for HR 2745, with the result that 42 observations are available. The light remains almost steady for long periods at a time. The observed range is from 3.50 to 3.66 S'Pg.

HR 2781 = UW (29) Canis Majoris

The computed phase of Seyfert's (9) minimum is .881. This is consistent with the present rather scanty data and the adopted period. Gaposchkin's (10) minimum corresponds to phase .914, which implies a shorter period. Pearce (11) derived a slightly longer period ($4^d.3935$) spectroscopically.

HR 3805 = N Velorum

This star was included in a list of "One Hundred Important Variable Stars" (12) as an irregular variable star. Recent observations range from 4.57 to 4.63 S'Pg only, and are given as mean magnitudes in the table (with weights in parentheses)

HR 4140 = p Carinae

This star has varied between 2.90 and 3.06 S'Pg. The light-changes are probably irregular.

HR 6084 = σ Scorpii

A. R. Hogg (13) has made a detailed study of this β Canis Majoris type variable. His observations overlap with those given here.

HR 6247 = μ^{1} Scorpii

The observations confirm the period and type of variation but are inadequate to define the minima.

HR 6812 = μ Sagittarii

None of the observations fall within 10 days of a minimum computed from the elements: minimum (J.D.) = 2429051 + 180.45 E (14) and from this it is concluded that the observed variation is intrinsic and not caused by an eclipse.

HR 7020 = δ Scuti

The light curve of this type-star is reasonably well defined by the present observations.

HR 8322 = δ Capricorni

The observations confirm the period but are not well enough distributed to define the light curve.

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M N A S S A

Monthly Notes of the Astronomical Society of Southern Africa

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M N A S S A

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N O T I C E S

Nominations The following nominations for Membership of the Society have been received:

Mr. W. R. Atkins, 17 Bristol Road, Parkwood, Johannesburg, Tvl..
Mr. G. Booth, 14 Oakdale Road, Newlands, Cape.
Mr. A. Leiman, P. O. Box 1772, Bulawayo, Southern Rhodesia.
Mr. K. A. Wynn, 2 Holdengarde Avenue, Hillside, Bulawayo, Southern Rhodesia.

Officers for the 1963-64 Session As only sufficient nominations were received by June 15, no election will be necessary this year. The Council for 1963-64 will, therefore, be constituted as follows:

President	:	Mr. A. G. F. Morrisby
Vice-Presidents	:	Dr. A. W. J. Wesselink, Messrs H. C. Lagerweij and J. A. Bruwer
Hon. Secretary	:	Mr. A. Menzies
Hon. Treasurer	:	Mr. G. Orpen
Members of Council	:	Dr. David S. Evans, Mr. P. Smits, Dr. R. H. Stoy and Dr. A. D. Thackeray

The five additional Members of Council who will represent the individual centres have still to be nominated by the centre committees.

Annual General Meeting The Cape section of the Annual General Meeting of the Society will be held at the Royal Observatory at 8.00 p.m. on Wednesday, July 24.

Subscriptions Members are reminded that the annual subscription of five rand for the year 1963-64 becomes due on July 1 and should be paid as soon as possible to the Hon. Treasurer, Mr. Garrett Orpen, No. 1 Buccleuch, Ascot Road, Kenilworth, Cape. Those who intend paying by postal order should make these payable at Cape Town and not at Observatory or Kenilworth. Those who pay by cheque will receive no immediate acknowledgement but will have their receipt pasted on the back of the cheque.