ROYAL ASTRONOMICAL SOCIETY OF NEW ZEALAND.

VARIABLE STAR SECTION.

CIRCULAR NO. 184.

PHOTOELECTRIC OBSERVATIONS AT AUCKLAND OBSERVATORY.

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SUMMARY:

Three-colour photoelectric observations made at the Auckland Observatory of selected variables and suspected variables are given. The methods of standardisation with the Johnson UBV system and probable errors are discussed in the first part of this Circular. The second part provides details of the standards used whilst the observations, for the period 1969 September to 1970 December 31, are tabulated in the third section.

Similar summaries on an annual basis will be presented in future.

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METHODS OF STANDARDISATION.

Since mid 1969 photoelectric observations have been made on a number of variable stars, mainly of U Gem and R CrB types, and of some other stars, generally of small range or of doubtful variability.

The accuracy of the observations is variable, being somewhat erratic at first but improving with increasing familiarity with the techniques. As from 1970 May 11 a generally high accuracy, both in respect to apparent magnitude (mV) and colours (B-V and U-B) has been obtained.

In the observations published in part 3 of this Circular a quality scale has been used wherever possible. This is:-

1. Excellent conditions--probable error smaller than quoted.
2. Good conditions--star well placed.
3. Fair -- errors may possibly exceed those quoted by a small amount.
4. Rather poor--accuracy $\pm$ 0.05m to $\pm$ 0.10m
5. Not particularly reliable.

In addition a colon after a reading signifies a lesser accuracy, two colons an unreliable observation.

Prior to 1970 May 11 the mV values are fairly reliable but the colours less so, especially when the No. 2 tube was used. Where doubt exists this is noted.

In some cases a final tie-in to UBV standards has not been made. Where this is so, details of the basis of the observations and the sub-standard or sub-standards used is presented. Estimations of possible errors are given. We feel that there is considerable value in the presentation of these observations, even without this final correction. The internal accuracy of the system is not affected by this. The nature of the correction, if any, required will be as follows:

mV. The visual magnitude of the sub-standard will have been taken from available sources, not photoelectric. In general, the best fit with the VSS visual sequence has been used, but in some cases a simple zero-point correction of up to 0.5m may be required. In most cases it will be rather less.

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B-V. A rather complicated method, based upon the absolute average response of the system and average extinction values, has been used to derive this colour value when standards are not available. The final correction required will be a simple zero-point adjustment of 0.05m or less.

U-B. As with B-V except that the correction may be as much as 0.1m in some extreme cases.

The internal consistency of the observations is good, except when the measure is less than 14.0m, or otherwise noted. When brighter than 12.0m the errors are not greater than:

MV	±	0.02
B-V	±	0.02
U-B	±	0.05

There is a gradual deterioration between 12.0m and 14.0m.

Other matters affecting the observations are noted under the individual stars in part 2.

PART 2. DETAILS OF STANDARDS.

For each star a reference is given to charts in use (1). Then are given the standards used and the source of the data given for them. Comparison stars are listed together with the magnitudes derived for them in most cases and finally general comments are given.

A. U Gem Variables.

1. VW Hyi. (Series 1 N/N)

Standards from ROB 64 (2).

H.D.	25938	V	6.57	B-V	+0.08	U-B ...
	26823		8.64		+0.48	(1.57)c

The main comparison star was CPD -71° 250 (SPg= 9.98; SPv=9.47; Spec. kO). A variety of other stars was used for check purposes; magnitudes are available from the authors.

2. MU Cen. (Series 4, Charts 123 & 124).

Standards from ROB 64 (2).

HD 106083 V 7.92 B-V +1.16 U-B +1.01:

HD 106083 is marked on charts 123 and 124 as "79".

3. BV Cen. (Series 2, charts 22 and 23).

Standards from ROB 64 (2).

HD	118258	V	7.97	B-V	+0.85
	120329		8.34		+0.74

It was necessary to use the method explained earlier to derive the U-B values but these are expected to be within 0.05m. Values assigned to comparison stars were:-

CPD -54° 5629	"c" on chart 23	mV	11.08	B-V	+0.76	U-B	+0.28
...	"g" on chart 23		11.76		+1.73		+1.53:
...	"l" on chart 23		12.61		+1.44		+1.49:

Until 1970 March 23 either "g" or "l", or both, were used for comparison stars but since then "c" has been used with the neighbouring star as a check.

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B. R CrB Variables.

1. UW Cen. (Series 4 Charts 119 & 120).

This field has not been standardised but the star CPD -53° 5219 (SPg=9.70; SPv=9.31 F8) and CPD -53° 5294 (SPg= 9.14; SPv=9.3; B9) have been used. The latter star is lettered "a" on chart 120. Values adopted are:-

CPD -53°5219	mV	9.28	B-V	+0.55	U-B +0.06
-53 5294		9.26		-0.05	-0.41

2. DY CEN (Series 2 chart 22).

As DY Cen is on the same chart as BV Cen the same standards have been used. Values adopted for comparison stars are:-

CPD -54°5629 "c"	mV	11.08	B-V	+0.76	U-B +0.28
...		11.10		+0.47	0.00

The latter star is not shown on chart 22 but is 5'N and $0^{m}.4$W of the variable on the opposite side of a ninth magnitude star marked on the chart.

3. S Aps. (Series 1 N/N).

Standard from ROB 64 (2).

HD 133049 mV 6.50 B-V +1.59 U-B +1.86:

Comparison star:

CPD -71°1733 mV 9.93 B-V +1.10 U-B +0.70

This star is marked "104" on chart.

4. RY Sgr. (Series 1 N/N).

Standards have been published by Cousins & Lagerwey (3). Their values have been used.

C. CONSTANT or DOUBTFUL VARIABLE STARS.

1. SX Pav. (Series 6, chart 242).

Standards as published by Cousins & Lagerwey (3) for Y Pav.

2. UV Pav. (Series 2, charts 31-32).

Observations have been carried out in order to detect variability. As a result, no attempt has as yet been made to standardise this sequence. Comparison stars used have been assigned magnitudes and colours as follows:-

CPD -62° 5721	mV	9.60	B-V	+1.05	U-B +0.76
-62 5713		10.40		+0.49	0.00
...		11.05		+1.40	+1.58

CPD -62°5721 appears on chart 32 marked "96" and CPD -62°5713 is the star 4mm N.W. of UV on the same chart, whilst the star given above as mV 11.05 appears on the chart 9mm S.W. of "96".

D. GENERAL.

1. R Scl. (Series 3, chart 70).

Standards selected from ROB 64 and U-B values added in Auckland. Using these standards values for comparison stars are:-

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HD 8498	mV 5.83	B-V +1.61	U-B ...
9026	8.10	+0.35	+0.07
CoD -33° 523	9.32	+0.58	+0.16
-33 510	9.60	+0.48	0.00

2. R Dor (Series 3, chart 78).

The comparison star used was HD 30610, for which a U-B value was added to the Cape values from Auckland measurements.

HD 30610 mV 6.45 B-V +1.08 U-B +1.00

3. R Vol. (Series 3, charts 90 & 91).

Comparison star:-

HD 52449 mV 7.65 B-V +0.54 U-B ...

4. W Pav. (Series 2, charts 31 & 32).

The same qualifications as for UV Pav apply. CPD -62°5721 was used for the chief comparison star.

5. S Pav. (Series 6, chart 245).

Observations were carried out in this field to check a visual sequence star but were discontinued. No attempt has been made to standardise this field. The comparison star used was CPD -59° 7545, which is shown as "98" on chart 245, 12mm S. of S Pav and 2mm E of S Pav.

CPD -59° 7545 mV 9.80 B-V +0.51 U-B +0.01

6. Y Pav. (Series 6, chart 242).

Cousins & Lagerwey (3) have published standards for this variable. From these we have selected the following comparison stars:

HD 204507	V 7.51	B-V +1.22	U-B +1.22
205348	6.74	-0.10	-0.31

E. STARS NOT IN GCVS.

1. HD 37212.

This star is not listed as variable but is mentioned by Rumsey as possibly variable because of its spectral classification. The comparison stars used, with U-B values assigned in Auckland, were:-

HD 37065	mV 8.79	B-V +0.94	U-B +0.64
37495	5.26	+0.50	0.00

2. HD 51208

This star was listed by Rumsey. Comparison stars used were:-

HD 50785	mV 6.51	B-V +0.42	U-B +0.09
49942	7.32	-0.11	-0.36
49850	7.40	+0.16	+0.10

3. HD 52432.

This star was listed by Rumsey. Comparison stars used were:-

HD 52666	mV 5.20	B-V +1.68	U-B +2.04
52533	7.70	+0.09	-0.95

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4. HD 75021

This star was listed by Rumsey. Comparison star used with U-B values added in Auckland:

HD 75057 mV 7.88 B-V +0.41 U-B 0.00

5. .... Muscae.

This star was discovered by Ward (see Circular 163). Standards from ROB 64 were used to derive the following comparisons:-

Chart Letter Circ. 163	"b"	mV	11.27	B-V	+0.27	U-B ...
do	"c"		10.27		+1.27	...
do	"d"		9.89		+0.04	...

ACKNOWLEDGEMENTS.

We wish to thank the Trustees of the Auckland Observatory for the use of their 50cm Zeiss reflector and auxiliary equipment with which these observations were made. We are indebted to N.J. Rumsey for drawing attention to some stars which might be variable on the basis of their spectra.

Our appreciation is also due to the Director of the Variable Star Section, RASNZ (F.M. Bateson) for assistance in many matters and in this discussion.

1971 July 26.

REFERENCES.

(1) 1958-70. "Charts for Southern Variables" Series 1 to 7 by F.M. Bateson, A.F. Jones & I. Stranson. Published by F.M. Bateson.

(2) 1963. Royal Obs. Bull. 64. "Photoelectric Magnitudes & Colours of Southern Stars" by A.W.J. Cousins & R.H. Stoy. H.M. Stat. Office, London.

(3) 1970. MNASSA, XXIX, pp 7-12.

OBSERVATIONS.

A. U Gem Variables.

J.D. 2,440,000+	mV	B-V	U-B	J.D. 2,440,000+	mV	B-V	U-B
	VW Hyi				VW Hyi		
576.92	11.82	+0.06	-0.85	939.93	9.58	-0.05	-0.74
723.77	14.38	+0.02	-0.97	939.95	9.64	-0.07	-0.72
750.23	10.12	+0.02	-0.66	940.00	9.57	-0.04	-0.67
785.17	12.60	-0.04	-0.86	940.05	9.61	+0.01	-0.77
813.15	13.61	+0.69	-0.99	940.87	9.77	-0.03	-0.70
834.04	13.93	+0.11	-0.84	940.95	9.81	-0.04	-0.74
917.99	14.02	+0.15	-0.89	940.99	9.66	-0.05	-0.68
923.88	14.12	+0.02	-0.67	941.05	9.64	-0.12	-0.75
937.95	9.06	-0.09	-0.82	947.97	13.30	+0.12	-0.95
938.00	9.07	-0.09	-0.74	950.07	13.57	+0.03	-0.93
938.91	9.27	-0.06	-0.81	950.90	13.71	-0.01	-1.06
939.00	9.25	-0.08	-0.75	952.94	13.81	+0.04	-1.07

J.D. 2,440,000*	mV	B-V	U-B	QUAL.
		MU Cen.		
716.95	13.11	+0.11	-0.70	2
717.98	13.74	+0/16	-0.77	2
		BV Cen.		
466.85	12.11	...	...	4
638.04	12.25	...	...	4
639.92	11.93	...	...	4
647.97	12.24	+0.36	...	3
651.97	12.64	0.31	...	4
654.88	13.07	0.18	...	4
666.08	13.21	0.37	...	4
668.91	12.95	0.68	...	3
682.98	12.95	0.87	-0.26	3
689.01	13.06	0.76	0.32	2
692.99	13.00	0.82	0.26	3
697.00	13.15	0.76	-0.48	2
709.95	13.16	0.84	+0.03	5
710.98	13.01	0.65	-0.16	1
718.02	12.97	0.75	0.32	2
721.87	13.18	0.72	0.08	2
723.89	12.95	0.75	0.19	1
733.98	12.89	0.76	0.35	2
746.77	12.85	0.83	0.36	2
758.11	13.11	0.58	0.56	3

J.D.	mV	B-V	U-B	QUAL.
		BV Cen		
775.82	12.88	+0.77	-0.49	1
783.81	12.97	0.57	0.36	2
798.84	13.40	0.77	0.14	2
814.82	11.77	0.93	0.16	3
821.84	12.80	0.82	0.17	3
838.89	12.18	0.29	0.89	3
842.89	12.59	0.12	0.45	3
847.87	11.92	0.18	0.86	3
850.87	11.96	0.20	0.92	4
856.87	12.27	0.71	0.27	3
861.84	12.88	0.55	0.34	3
870.84	12.79	+0.36	-0.69	

B. RCrB Variables.

		UW Cen.		
775.9	9.20	+0.72	+0.19	1
		DY Cen.		
723.9	12.21	+0.30	-0.58	2
758.1	11.87	0.52	0.39	3
783.8	12.06	0.30	0.59	3
798.8	12.33	0.37	0.62	3
821.8	12.74	0.19	0.67	3
838.9	12.15	0.41	0.71	3
850.9	12.26	+0.63	-0.75	
		S Aps.		
758.1	9.79	+1.21	+0.63	3
775.9	9.92	1.23	0.63	2
783.8	9.83	1.22	0.55	2
878.9	9.78	1.21	0.63	3
881.9	10.09	1.27	0.35	4
891.9	9.80	1.22	0.73	3
896.9	9.71	1.26	0.60	3
898.9	9.66	1.24	0.65	3

		RY Sgr.		
813.1	6.81	+0.77	+0.47	3
823.1	6.48	0.50	0.09	2
824.0	6.42	0.48	0.05	2
834.1	6.28	0.67	0.33	3
838.9	6.38	0.73	0.39	2
842.9	6.49	0.77	0.45	3
850.8	6.58	0.69	0.34	1
857.9	6.42	0.45	0.05	1
863.9	6.34	0.49	0.06	2
870.9	6.47	0.69	0.32	3
878.9	6.81	0.85	0.54	3
881.8	6.95	0.92	0.65	2
891.9	6.79	0.80	0.58	3
896.9	6.55	0.60	0.34	3
898.9	6.44	0.59	0.27	3
901.9	6.38	0.52	0.21	2
906.8	6.20	0.58	0.19	2

C. CONSTANT OR DOUBTFUL VARIABLE STARS.

		SX Pav.		
839.0	5.53	+1.55	+1.36	4
842.9	5.53	1.57	1.36	2
848.0	5.56	1.54	1.35	3
870.9	5.70	1.48	1.32	4
876.0	5.57	1.46	1.27	4
877.9	5.55	1.39:	1.20:	5
878.9	5.54	1.52	1.35	2
881.8	5.52	1.51	1.32	3
882.0	5.50	1.54	1.32	2
891.9	5.53	1.54	1.38	2
896.9	5.54	1.52	1.32	1
898.8	5.50	1.52	1.30	1
901.9	5.44	1.52	1.32	2
905.9	5.38	1.53	1.36	4
916.9	5.43	1.54	1.35	2
923.9	5.58	1.55	1.30	2

		UV Pav.		
722.1	11.53	+1.62	+1.33	2
750.2	11.86	1.62	...	2
758.1	11.74	1.65	...	2
775.9	11.47	1.70	...	2
783.9	11.37	...	...	4
785.2	11.37	1.57	...	3
799.0	11.25:	1.76	...	5
801.0	11.23	1.67	+1.45	3
807.9	11.22	1.66	1.27	2
813.1	11.31	1.58	...	2
823.0	11.40	1.64	0.99	2
833.9	11.79	1.65	...	3
838.9	11.91	1.75	...	2
842.9	12.01	1.48	0.84	3
847.9	12.03	1.67	...	2
851.0	12.10:	1.48:	...	4

J.D.	mV	B-V	U-B	QUAL.
2,440,000+				
	UV Pav.			
857.9	12.00	+1.68	...	3
861.9	11.98	1.98:	...	5
863.9	11.91	1.56	...	-
866.9	11.82	1.66	...	2
870.8	11.76	1.70	...	3
876.0	11.62	1.75	...	5
877.8	11.56	+1.66	...	2
878.8	11.52	+1.66	...	2
881.9	11.41	1.61	...	2
891.9	11.41	1.54	...	3
896.9	11.33	1.69	...	3
898.9	11.31	1.79	...	3
916.9	11.67	1.91	...	3
923.9	11.85	+1.88	...	3

D. GENERAL.

	R Scl.			
813.1	6.59	+4.63	+2.53	1
823.0	6.47	4.52	2.79:	1
834.1	6.30	4.52	2.67	1
839.0	6.20	4.63	2.50	-
843.0	6.13	4.53	2.65	1
848.0	5.95	4.52	2.56	4
870.9	5.86	4.40	3.00	3
876.0	5.79	4.32	3.32	4
878.9	5.80	4.33	3.19	2
882.0	5.77	4.28	3.25	2
891.9	5.69	4.26	3.21	3
896.9	5.71	4.23	3.23	1
918.1	5.70	4.28	3.09	2
924.9	5.81	4.12	3.15	4
932.0	5.81	4.06	3.23	3
943.0	5.84	4.06	3.02	3
950.9	5.88	+4.00	+2.60:	3
	R Dor			
919.0	5.44	+1.66	+0.77	2
932.0	5.44	1.66	0.67	2
943.9	5.47	+1.71	+0.60	3
	R Vol			
944.0	10.76	+4.52	...	3
	W Pav			
722.1	9.63	+1.32	+0.69	2
750.2	10.74	1.32	+0.17	2
758.1	11.22	1.40	+0.10	2
775.9	12.01	1.27	-0.33	2
783.9	12.32	+1.23	-0.30	3
	W Pav			
798.9	12.86	+1.08	-0.26	5
801.0	12.87	1.26	-0.34	3
809.9	12.97	1.37	-0.15	2
823.0	13.37	+1.28	...	
	S Pav			
750.2	7.89	+1.63	+0.48	2
758.2	7.92	1.64	0.44	2
777.0	7.97	1.60	0.45	2
807.9	7.82	+1.63	+0.44	4
	Y Pav			
823.0	6.64	+2.82	+3.71:	2
834.0	6.68	2.87	3.45:	3
839.0	6.66	2.89	3.20:	4
842.9	6.69	2.88	3.34:	2
848.0	6.69	2.89	3.20:	3
863.9	6.64	2.90	3.07:	4
870.9	6.68	2.78	3.42:	4
876.0	6.63	2.83	3.19:	4
878.9	6.63	2.87	3.06:	2
881.8	6.65	2.83	3.65:	3
891.9	6.61	2.91	3.09:	1
896.9	6.57	2.90	3.30:	1
898.8	6.57	2.90	3.04:	1
905.9	6.51	2.92	3.27:	4
916.9	6.45	2.84	3.53:	2
923.9	6.40	2.72	3.65:	2
943.0	6.21	+2.74	+3.26	3

E. STARS NOT IN GCVS.

	HD 37212			
892.0	7.58	+2.27	+3.34	2
899.0	7.63	2.27	3.39	2
919.0	7.93	+2.25	+3.24:	2
	HD 51208			
918.1	6.37	+2.24	+2.86	2
944.0	6.37	+2.31	+2.81	3
	HD 52432			
919.0	7.28	+1.70	+2.26	2
944.0	7.29	+1.71	+2.28	2
	HD 75057 21			
944.0	7.29	+1.83	+2.53	2
951.0	7.31	1.85	2.43	3
	- MUSCAE (see Circular 163).			
681.8	11.82	+1.86	...	
688.8	12.07	1.85	...	
692.9	12.11	2.07	...	
721.9	12.19	1.94	...	
723.8	12.15	1.82	...	
733.9	12.17	1.72	...	
746.8	12.03	1.79	...	
752.9	11.94	1.76	...	
758.1	11.96	2.02	...	