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THE VARIABILITY OF M-STARS

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SUMMARY

The photometry at 5500, 6500 and 8700 Å of seventy-nine HD stars of type M is presented. Eleven of these stars are known variables. Forty-five of the remaining 68 have been found to be variable. These observations indicate that one may expect to find that about one-third of the HD stars of type Ma and four-fifths of those of type Mb are variable.

The transformation of the photometry at 5500, 6500 and 8700 Å to the *VRI* system is given and luminosities are obtained from the $(M_I, R-I)$ relation of Eggen. Proper motions have been collected for about 70 per cent of the stars and used to obtain space motion components. Population discrimination is made using the position of the stars in the (U, V) plane.

The spatial distribution of the different populations agrees with that of Eggen.

Observations of fifteen K5-stars in one region suggest that the proportion of field giants of lower metal abundance in that region is small.

1. INTRODUCTION

In a recent paper Eggen (1970) discussed a photometric study of M-stars near the South Galactic pole, which yielded 43 new variables from the 105 stars observed. The present programme is an extension of that study to other parts of the sky and comprises the photometry of M-stars in four regions.

	l^{II}	b^{II}
Region A	196° to 280°	−32° to −49°
Region B	262° to 278°	−6° to +6°
Region C	252° to 286°	+13° to +53°
Region D	328° to 335°	+39° to +49°

Also observed were fifteen K5-stars in Region D.

2. THE OBSERVATIONS

The observations were made with the 16-inch telescope at Siding Spring Observatory from February to July 1970. The photometric system employed filters at 5500, 6500 and 8700 Å and used an RCA 7102 photomultiplier. The filter combination at 5500 Å (2 mm GG11+3 mm BG18 filter glass) when used with the RCA 7102 approximates very closely the *V* response of the *UBV* system, while the filters at 6500 and 8700 Å are narrow-band filters of half widths 280 Å and 220 Å, and peak transmission of 80 and 49 per cent respectively and are centred on relatively line-free regions within the broad bands of the *R* and *I* filters respectively. The observations were reduced to give the natural magnitudes V_s and (65) (the magnitude at 6500 Å) and the colour (87, 65) (the difference between the magnitudes at 6500 and 8700 Å).

3. THE STANDARD STARS

The standard stars are listed in Table I(a), with the adopted values of *V*, *R* and *R–I*, and the observed values of V_s, (65) and (87, 65). In order to provide a transformation for the redder stars where constant standards were not available, simultaneous observations of red variable stars were made by O. J. Eggen (using the 40-inch telescope at Siding Spring Observatory) in *V* or in *R* and *I*. These observations are listed in Table I(b). Fig. 1 shows the adopted transformation curves in which DV ($= V_s - V$), DR ($= (65) - R$) and *R–I* are plotted against the observed colour (87, 65).

4. THE PROGRAMME STARS

The programme stars were selected from the HD catalogue. Table II lists the HD number, the 1950 position, the galactic coordinates, the HD magnitude P_v and spectral type Sp, and the best available proper motion and its source, *S*. The sources of the proper motions are:

- BL: Blackwell & Lowne (1968).
- Y: Photographic determinations from the Yale Zone Catalogues for stars north of $-30°$, and the probable error in both coordinates—in parentheses and in units of $0''\cdot001$.
- YC: Mean values determined by Hoffleit (1968, 1969, 1970) from the Yale and Cape Zone Catalogues for stars between $-30°$ and $-40°$, and $-40°$ and $-50°$.
- CAZ: Cape Astrographic Zone ($-40°$ to $-52°$).
- C: Cape Photographic Zone Catalogues for stars south of $-52°$.
- ZC: Zodiacal Catalogue.
- C2: Second Cape Catalogue.
- I: Ikaunieks, J. (ed.), (1966).
- GC: Boss General Catalogue.

The proper motions are on the N30 system.

Region A contains 25 of the 33 Ma-stars, 11 of the 13 Mb-stars, all three Mc- and two of the four Md-stars which appear within this region in the HD catalogue. One Ma-, two Mc- and both Md-stars observed are known variables.

In Regions B and C attention was focused on the Mb-stars, where the new variables were most likely to be discovered (Eggen 1970). All eight Mb-stars in Region B were observed; one of these is a known variable. Fourteen of the 28 Mb-stars, and the two Mc-stars in Region C were observed; two of the Mb- and both of the Mc-stars are known variables.

In Region D Eggen has noted (Eggen 1970) that those field giants, thought to be representative of the members of globular clusters of lower metal abundance, have a spectral type earlier than M. In order to get a possible estimate of the proportion of field giants with lower metal abundance in the small Region D,

TABLE I(a)

The standard stars

Name BD, HD	R.A. 1950.0	Dec 1950.0	Sp	*V*	*R*	*R–I*	V_s	(65)	(87, 65)	*n*
							R.M.S. Dev			
−18 359	02 02.6	−17 52		10.18	9.00	1.02	10.60	10.58	−0.185	6
							.012	.011	.015	
18331	02 54.1	−03 55	A1V	5.22	5.26	−0.04	5.59	6.65	−1.63	12
							.018	.014	.010	
22049	03 30.6	−09 38	K2V	3.73	3.33	0.30	4.09	4.67	−1.225	12
							.011	.012	.007	
32450	05 00.3	−21 19	K5	8.32	7.43	0.72	8.69	8.82	−0.665	18
							.014	.012	.013	
33793	05 09.7	−45 00	K2	8.85	7.84	0.77	9.22	9.30	−0.565	16
							.015	.010	.017	
36395	05 28.9	−03 41	K2	7.97	6.87	0.84	8.33	8.38	−0.465	17
							.019	.016	.018	
+05 1668	07 24.7	+05 18	M5	9.82	8.40	1.19	10.29	10.15	0.165	10
							.035	.031	.023	
71155	08 23.2	−03 45	A0V	3.90	4.03	−0.10	4.27	5.42	−1.73	21
							.016	.017	.011	
74280	08 40.6	+03 35	B3V	4.30	4.47	−0.21	4.67	5.87	−1.90	20
							.024	.022	.027	
102870	11 48.1	+02 03	F8V	3.61	3.39	0.16	3.97	4.75	−1.41	17
							.019	.019	.010	
103932	11 55.5	−27 25	K5	6.96	6.38	0.41	7.33	7.73	−1.105	17
							.017	.017	.014	
134140	15 06.0	−26 18	MA	6.95			7.32	7.37	−0.33	13
							.019	.016	.012	
136140	15 16.7	−08 58	MB	7.09	5.45	1.43	7.48	7.30	+0.59	16
							.026	.025	.027	
140573	15 41.8	+06 35	K2III	2.65	2.10	0.37	3.00	3.50	−1.115	16
							.024	.025	.009	

TABLE I(b)

Observations of long period variables used in the determination of the transformation to the standard system

Name	R.A. 1950.0	Dec 1950.0	Sp	*V*	*R*	*R–I*	V_s	(65)	(87, 65)
RT HYA	08 27.2	−06 09	M6E						
1970-02-27					4.92	1.79		7.33	1.305
1970-03-03					5.04	1.79		7.38	1.340
R LEO	09 44.9	+11 40	M8E						
1970-04-06				7.29			7.52		1.67
1970-04-12				7.12			7.35		1.66
1970-05-28				5.07			5.39		1.285
1970-06-24				5.45			5.75		1.380
R HYA	13 27.0	−23 01	M7E						
1970-04-06				8.65			8.90		1.69
1970-04-12					4.09	2.16		7.13	1.88
1970-05-27					4.07	2.145		6.79	1.72
1970-05-28				8.26			8.53		1.725
1970-05-29					4.02	2.135		6.80	1.74
1970-05-30				8.20			8.46		1.74
1970-06-23				7.48			7.81		1.72
T CEN	13 38.9	−33 21	M0E						
1970-02-26				7.32			7.78		0.15
1970-04-12					5.12	0.725		6.61	−0.70
1970-06-27					5.66	0.88		7.18	−.405
W HYA	13 46.2	−28 07	M8E						
1970-05-28				6.12			6.37		1.425
1970-04-06				6.67			6.90		1.52
1970-06-24				6.61			6.89		1.46

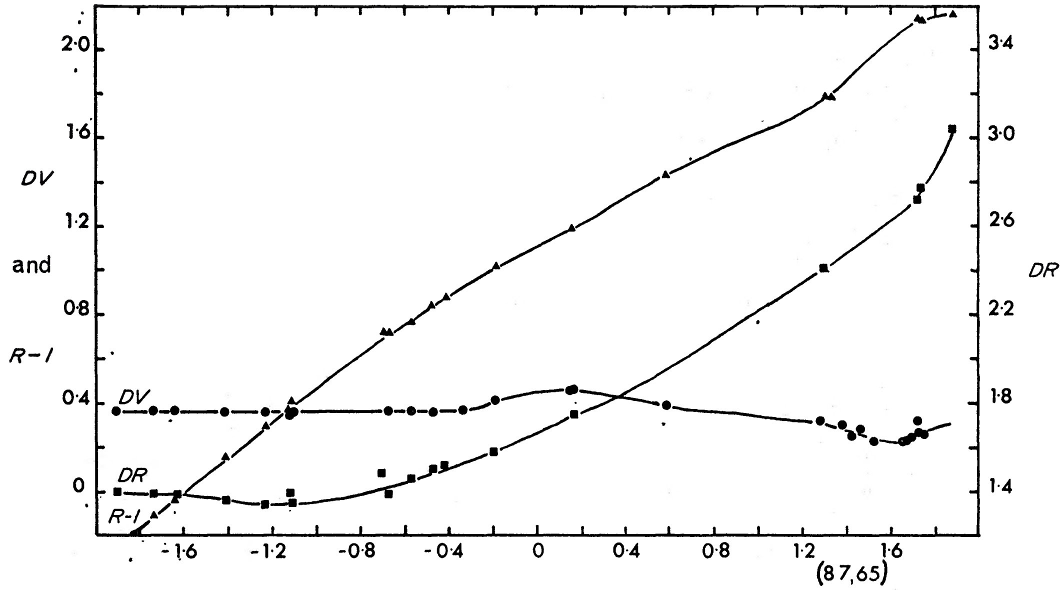

FIG. 1. *The transformation from the instrumental system* V_8, (65), (87, 65) *to the standard system, V, R, (R–I). DV =* V_8*–V, DR =* (65)*–R.*

observations were also made of those stars of spectral type K5, as well as those of type M. Fifteen of the 17 stars, four of the six Ma-, all eight Mb- and the two Mc-stars were observed; one of the Mc-stars is a known variable.

(The criteria for the spectral classification of M-stars in the HD catalogue are as follows:

Ma: The TiO bands are noticeable,
Mb: the TiO bands are conspicuous,
Mc: the spectrum is fluted by the strong bands,
Md: the Mira variables, Hγ, Hβ in emission.)

5. THE OBSERVATIONAL RESULTS

(a) *The known variables*

The period (P) and amplitude (ΔV) of the known variables is given in Table II and the individual observations V_8, (65) and (87, 65) are shown in Figs 2, 3 and 4 and listed in Table III.

(b) *The new quasi-periodic variables*

The period and amplitude of the variations observed are given in Table II, while the individual observations are shown in Figs 5, 6, 7, 8, 9, 10 and 11 and are listed in Table IV. In the four regions were found:

A: Fourteen new variables—seven Ma, six Mb and one Mc.
B: Seven new variables—all Mb.
C: Nine new variables—all Mb.
D: Nine new variables—two Ma, six Mb and one Mc.

TABLE II

The programme stars

HD	R.A. 1950.0	Dec	L	B	P_v	Sp	P.M. 0·001 sec arc		S	ΔV	T	P (days)
EGION A												
25725	04 02.0	−15 52	208	−44	VAR	MC	−22	+9	BL	0.4	P	(97)
25755	04 02.1	−20 44	215	−46	9.0	MA	−5	+22	Y(10)	−	CON	−
25761	04 01.7	−39 32	243	−49	8.9	MA	−1	+43	YC	0.54	P	97
25921	04 03.6	−10 26	202	−41	7.3	MB	+34	0	I	0.15	P	25
26009	04 03.9	−29 49	228	−47	8.79	MA	+31	−41	Y(11)	−	CON	−
26231	04 05.7	−39 38	243	−48	9.1	MA	+24	+4	YC	0.22	P	50
26258	04 06.5	−08 14	200	−40	9.4	MC	−19	−21	Y(9)	0.3+	P	100+
26431	04 06.5	−60 35	272	−43	9.4	MA	−	−	−	0.5+	P	100+
26487	04 08.2	−34 38	235	−47	7.25	MA	+3	+40	YC	−	CON	−
26534	04 09.1	−07 06	199	−39	9.4	MB	+9	−26	Y(7)	−	CON	−
26535	04 08.9	−20 11	215	−44	8.9	MB	+6	+6	Y(10)	0.15+	P	150+
26692	04 10.7	−04 00	196	−37	7.74	MA	+22	+8	Y(6)	−	CON	−
26750	04 11.1	−10 30	204	−40	7.7	MB	+10	−28	Y(12)	0.2	P	30
26829	04 11.8	−16 07	210	−42	7.65	MA	−6	+17	Y(10)	−	CON	−
26832	04 11.3	−36 40	239	−47	7.7	MA	+21	+20	YC	0.12	P	36
27002	04 12.2	−50 42	259	−45	8.4	MA	−	−	−	0.21	P	52
27098	04 15.1	−50 32	258	−45	8.4	MA	+19	+26	C2	−	CON	−
27199	04 13.8	−53 08	262	−45	9.0	MB	−	−	−	0.15+	P	80+
27443	04 14.9	−67 03	280	−40	9.9	MA	−	−	−	0.15	EC	−
27498	04 17.8	−02 45	196	−34	7.30	MB	+19	−4	I	−	CON	−
27598	04 18.5	−16 57	212	−41	7.32	MA	+20	0	I	0.20	P	82
27930	04 20.2	−59 16	270	−42	8.6	MA	−	−	−	−	CON	−
27957	04 21.6	−27 57	227	−43	8.1	MB	+9	+39	Y(8)	0.20	P	60
28290	04 23.9	−51 35	259	−43	9.5	MA	−	−	−	−	CON	−
28493	04 25.5	−55 19	264	−42	8.4	MA	−	−	−	−	CON	−
28572	04 26.8	−40 02	243	−44	8.5	MA	+9	−1	YC	−	CON	−
28836	04 29.3	−36 22	238	−43	8.2	MA	+1	−5	YC	−	CON	−
28915	04 28.6	−64 41	276	−39	8.60	MA	−	−	−	−	CON	−
29046	04 30.9	−40 19	244	−43	8.1	MA	−	−	−	−	CON	−
29277	04 33.1	−42 08	246	−43	7.7	MA	−8	·8	YC	−	CON	−
29383	04 33.0	−63 08	274	−39	VAR	MD	−	−	−	(7.0)	P	(278)
29704	04 37.4	−30 33	231	−40	8.5	MB	−27	+5	YC	−	CON	−
29712	04 36.2	−62 10	273	−39	VAR	MC	−57	−75	BL	(1.0)	P	(338)
29844	04 38.7	−38 20	241	−41	VAR	MD	−	−	−	(7.0)	P	(391)
29906	04 38.8	−52 29	260	−41	9.2	MB	−	−	−	0.18	P	60
30622	04 46.3	−19 57	219	−36	7.88	MA	+9	+20	Y(10)	−	CON	−
30642	04 45.0	−59 53	269	−39	VAR	MA	−	−	−	3.0	P	(168)
31036	04 49.1	−40 17	244	−39	8.6	MA	−	−	−	0.12	EC	−
31275	04 49.3	−66 55	278	−37	9.9	MB	−	−	−	0.25	EC	−
31301	04 51.7	−12 32	211	−32	8.1	MB	+27	+12	Y(10)	−	CON	−
31311	04 51.1	−43 08	248	−39	7.1	MA	+26	+39	YC	0.15	P	52
EGION B												
79402	09 10.5	−43 34	267	03	VAR	MB	−32	+3	YC	(1.5)	P	(63)
79669	09 12.0	−48 26	270	00	9.6	MB	+5	+7	CAZ	0.22	P	75
81099	09 19.9	−58 28	278	−06	8.4	MB	−	−	−	0.25	P	75
81575	09 23.2	−43 45	268	05	7.0	MB	−48	+31	YC	0.13	P	120+
81576	09 23.2	−45 09	269	04	8.14	MB	−8	−32	YC	0.2	P	120+
81922	09 25.1	−53 17	275	−02	7.2	MB	−9	+19	C	0.7	P	117
82850	09 31.4	−45 17	271	05	8.2	MB	−17	+2	YC	0.12	P	37
85008	09 45.8	−46 25	273	05	10.2	MB	−	−	−	0.3	P	120

TABLE II (*continued*)

HD	R.A. 1950.0	Dec	*L*	*B*	P_v	Sp	P.M. 0·001 sec arc		*S*	Δ*V*	*T*	*P* (days)
REGION C												
87041	09 59.4	-37 50	270	14	8.7	MB	-8	+16	YC	0.25+	P	120+
87555	10 02.9	-21 07	259	27	8.6	MB	-17	-13	Y(9)	0.2	EC	–
88517	10 09.9	-10 04	252	36	VAR	MB	-25	+16	Y(6)	0.5+	P	96
92017	10 34.8	-23 39	267	30	8.2	MB	-8	-33	Y(12)	0.19	P	50
92096	10 35.4	-11 46	259	39	VAR	MB	–	–	–	(2+)	P	(20)
95850	11 01.0	-02 56	258	50	VAR	MC	+2	-9	Y(8)	(0.5)	P	–
96297	11 03.5	-08 53	264	46	8.3	MB	-4	+25	Y(7)	0.23	P	77
97754	11 12.1	-25 47	277	32	8.3	MB	–	–	–	0.13	EC	–
98218	11 15.3	-21 52	276	36	7.76	MB	-23	-32	Y(10)	0.3+	P	300+
99056	11 21.4	-19 39	276	38	(VAR)	MC	+5	-15	Y(10)	0.6+	P	(70)
99448	11 23.9	-25 29	280	33	8.70	MB	-3	-27	Y(13)	0.55	P	95
99690	11 25.5	-19 46	278	39	9.2	MB	–	–	–	0.56	P	80
100141	11 28.6	-04 02	268	53	9.2	MB	-6	-7	Y(9)	0.5	P	115
100766	11 33.2	-17 40	279	41	9.2	MB	–	–	–	0.28	P	65
102276	11 43.7	-24 36	285	36	7.63	MB	-8	-23	Y(10)	–	CON	–
102620	11 46.2	-26 28	286	34	5.45	MB	-26	-16	GC	0.21	P	61
REGION D												
123214	14 03.9	-13 57	329	45	6.69	MB	-4	-15	I	0.18	P	55
123412	14 05.1	-11 55	331	47	8.8	K5	+16	+6	Y(10)	–	CON	–
123454	14 05.4	-13 08	330	45	8.81	K5	-3	+10	Y(10)	–	CON	–
123576	14 06.0	-08 37	333	49	8.7	MB	-17	-8	Y(7)	0.18	EC	–
123580	14 06.1	-17 30	328	41	8.9	K5	-9	-13	ZC	–	CON	–
123764	14 07.2	-12 09	331	46	9.3	K5	-13	-23	Y(10)	–	CON	–
123787	14 07.3	-13 05	331	45	10.5	K5	–	–	–	–	CON	–
123921	14 08.0	-11 24	332	47	9.6	K5	-14	-3	Y(10)	–	CON	–
123934	14 08.1	-16 04	329	42	5.10	MA	-2	-8	ZC	0.20	P	80
124036	14 08.7	-10 14	333	48	8.7	MB	-20	+12	Y(8)	0.3+	P	100+
124072	14 08.9	-11 39	332	46	9.3	K5	-14	-16	Y(12)	–	CON	–
124188	14 09.7	-18 31	328	40	9.2	MB	-20	+2	Y(10)	0.18	P	38
124274	14 10.2	-13 31	331	45	8.8	K5	+6	+6	Y(12)	–	CON	–
124304	14 10.4	-13 37	331	44	7.18	MB	-4	-28	ZC	0.35	P	120
123359	14 10.7	-16 08	330	42	9.6	K5	-19	-13	Y(12)	–	CON	–
124410	14 11.1	-13 07	332	45	7.96	K5	+1	+9	Y(12)	–	CON	–
124498	14 11.6	-15 07	331	43	10.0	K5	–		– –	–	CON	–
124629	14 12.3	-13 59	332	44	10.7	K5	–	–	–	–	CON	–
124630	14 12.3	-14 40	331	43	9.6	K5	–	–	–	–	CON	–
124778	14 13.1	-14 09	332	44	10.2	K5	–	–	–	–	CON	–
124804	14 13.2	-11 58	333	46	8.3	MA	-1	+21	Y(11)	–	CON	–
124989	14 14.3	-16 13	331	42	8.7	MB	–	–	–	0.15+	P	100+
125024	14 14.5	-16 32	331	41	11.1	MB	–	–	–	0.15+	P	100+
125146	14 15.2	-14 29	332	43	(VAR)	MC	-9	+8	Y(12)	0.15+	P	(100)
125356	14 16.5	-13 12	333	44	8.9	MC	+21	-18	Y(12)	0.3+	P	100+
125522	14 17.5	-10 51	335	46	10.2	K5	–	–	–	–	CON	–
125624	14 18.3	-18 46	331	39	8.7	MA	+1	+5	Y(7)	0.20	P	39
125662	14 18.2	-11 37	335	45	9.6	MA	-37	-40	Y(10)	–	CON	–
125787	14 19.4	-16 56	332	41	9.8	MB	+10	-7	Y(8)	–	CON	–

Under column 'T' (type): CON = constant; EC = erratic variable; P = quasi-periodic variable.

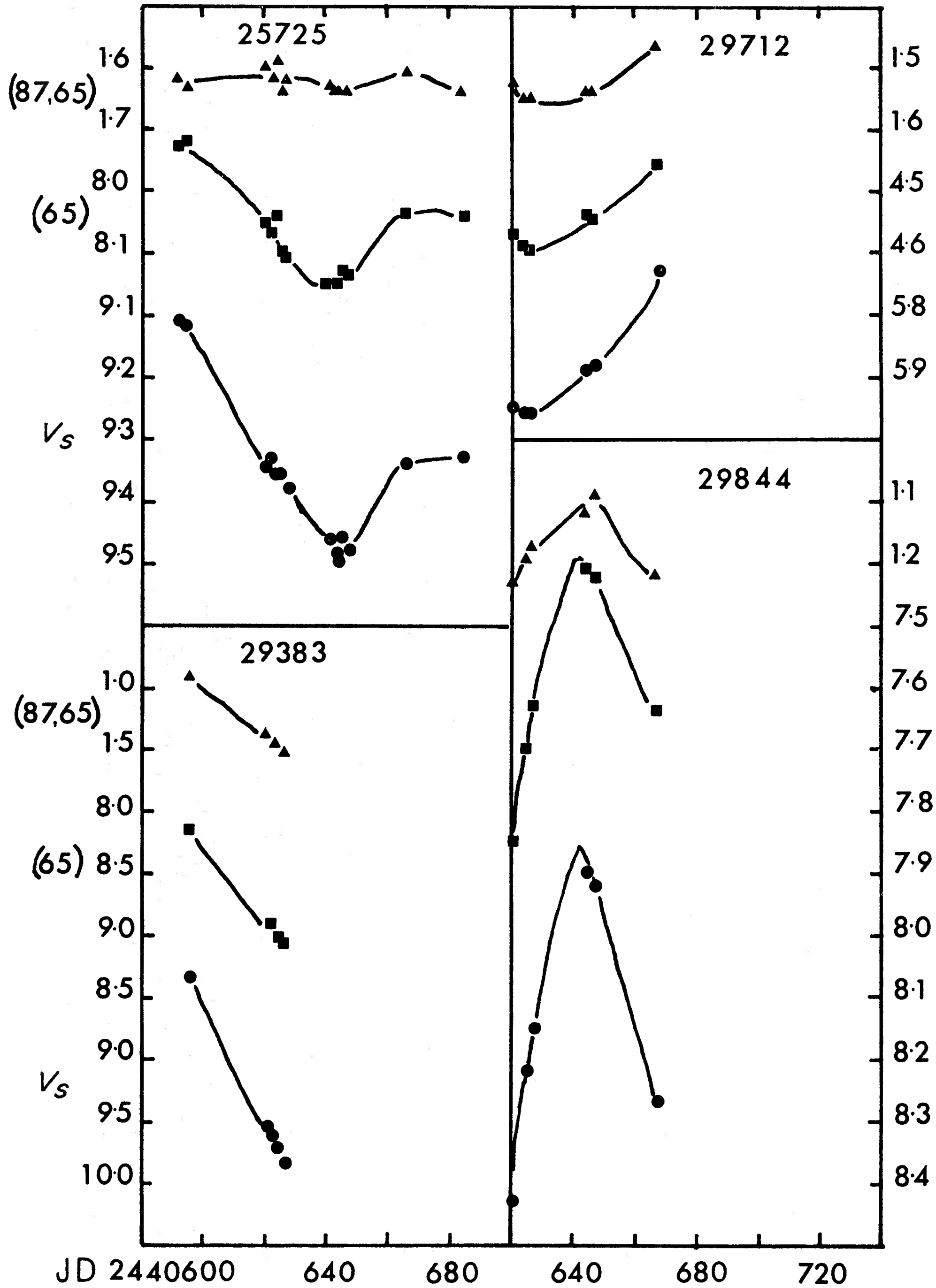

FIG. 2. *The light (V_s and (65)) and colour (87, 65) variations of the known variables. Note the occasional change of scale in the vertical axis.*

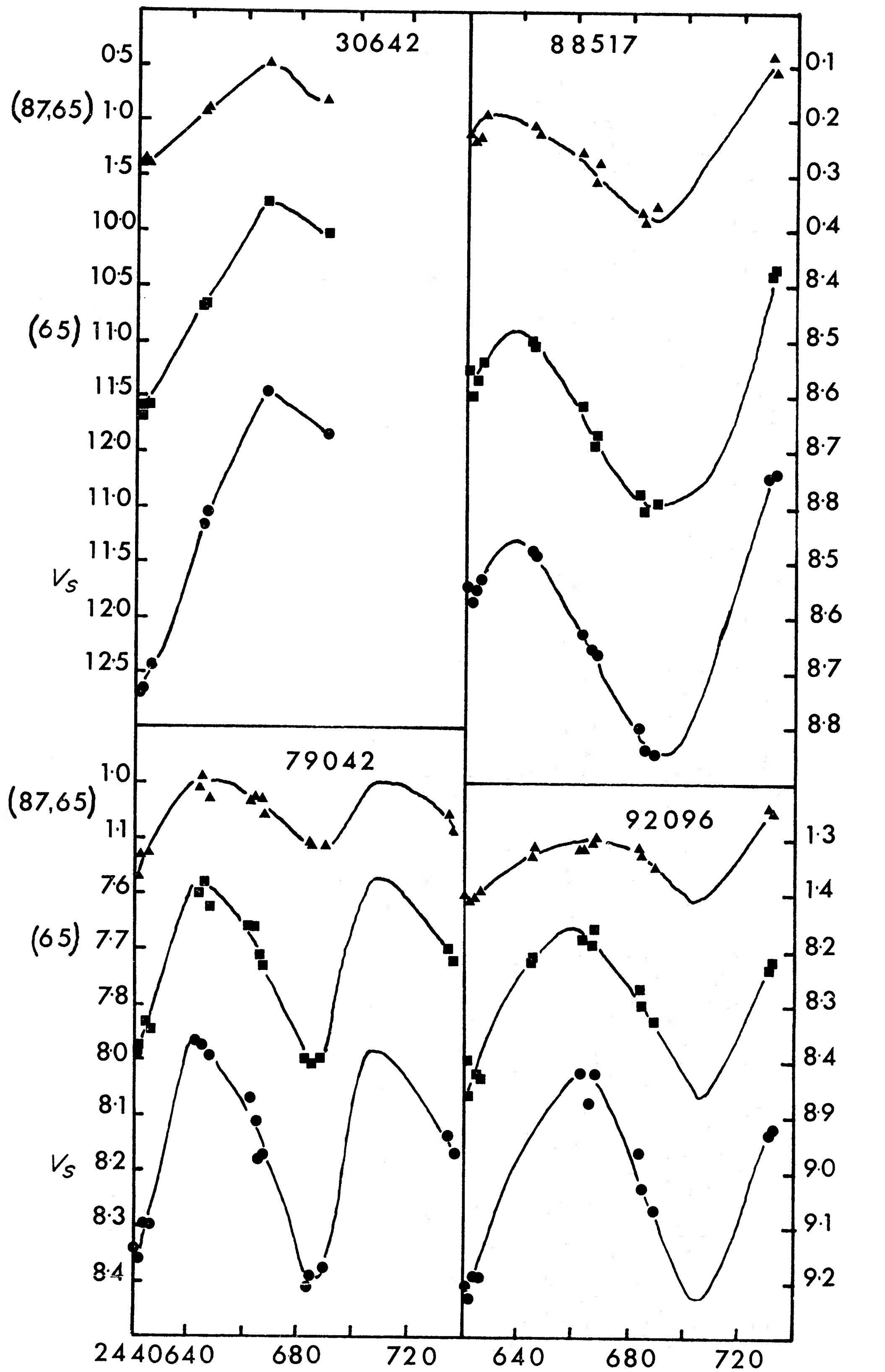

FIG. 3. *The light* (V_s *and* (65)) *and colour* (87, 65) *variations of the known variables. Note the occasional change of scale in the vertical axis.*

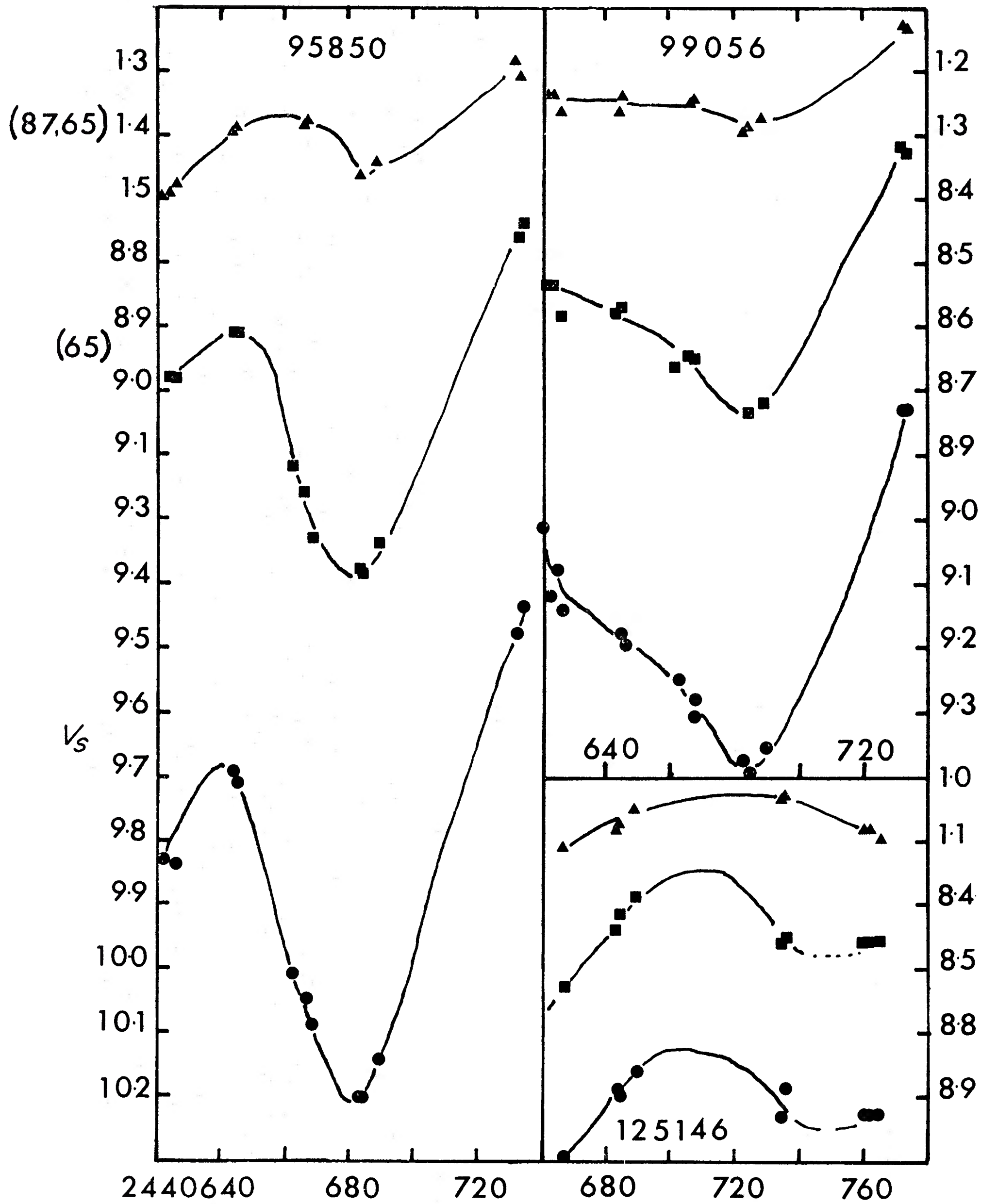

FIG. 4. *The light (V_s and* (65)) *and colour* (87, 65) *variations of the known variables. Note the occasional change of scale in the vertical axis.*

(c) *The new erratic variables*

These are stars which have shown erratic variations with amplitudes greater than 0·1 mag. These amplitudes are given in Table II. The individual observations of these stars are shown in Fig. 12 and listed in Table V. In the four regions were found:

A: Three erratic variables—two Ma and one Mb.
B: No erratic variables.
C: Two Mb-stars erratic.
D: One Mb erratic.

TABLE III

Individual observations of known variables

HD	J.D. 2440	*Vs*	(65)	(87, 65)
25725	592.0	9.11	7.93	1.619
V ERI	595.0	9.12	7.92	1.630
	620.0	9.35	8.05	1.602
	621.9	9.33	8.07	1.619
	623.9	9.36	8.04	1.587
	624.9	9.36	8.10	1.641
	625.9	9.38	8.11	1.622
	640.9	9.46	8.15	1.627
	642.9	9.49	8.15	1.637
	643.9	9.50	8.15	1.627
	644.9	9.46	8.13	1.629
	646.9	9.48	8.14	1.633
	665.9	9.34	8.04	1.611
	683.9	9.33	8.04	1.637
29383	595.5	8.32	8.15	.912
R RET	621.1	9.57	8.92	1.382
	622.0	9.63	8.92	1.416
	624.0	9.75	9.03	1.459
	626.0	9.84	9.09	1.526
29712	620.0	5.95	4.57	1.531
R DOR	624.0	5.96	4.59	1.546
	626.0	5.96	4.60	1.553
	644.0	5.89	4.54	1.539
	647.0	5.88	4.55	1.538
	666.9	5.73	4.46	1.473
29844	620.1	8.43	7.83	1.231
R CAE	624.0	8.22	7.70	1.191
	626.0	8.15	7.63	1.166
	644.0	7.90	7.41	1.123
	647.0	7.92	7.42	1.093
	666.0	8.27	7.64	1.217
30642	621.1	12.67	11.69	1.507
T DOR	622.1	12.65	11.59	1.470
	625.0	12.43	11.60	1.511
	644.0	11.19	10.73	.929
	645.0	11.04	10.66	.867
	667.0	9.94	9.76	.501
	688.9	10.35	10.03	.835
79402	620.1	8.36	7.88	1.176
SY VEL	621.1	8.34	7.89	1.134
	622.1	8.36	7.88	1.149
	624.1	8.30	7.83	1.111
	626.1	8.30	7.85	1.136
	644.1	7.97	7.60	1.009
	645.1	7.98	7.58	.992
79402	647.0	8.00	7.63	1.032
(CONTD)	662.0	8.07	7.66	1.035
	664.1	8.11	7.66	1.017
	666.0	8.18	7.71	1.029
	667.0	8.17	7.73	1.058
	683.0	8.43	7.90	1.104
	684.0	8.39	7.91	1.116
	688.9	8.38	7.90	1.116
	733.9	8.14	7.70	1.057
	734.8	8.17	7.72	1.087
88517	620.2	8.64	8.[illegible]5	.226
RT SEX	622.2	8.67	8.60	.243
	624.2	8.65	8.57	.235
	626.1	8.63	8.54	.193
	644.1	8.58	8.50	.211
	645.1	8.58	8.51	.228
	662.0	8.73	8.62	.263
	666.1	8.76	8.69	.316
	667.1	8.77	8.67	.280
	683.0	8.90	8.78	.368
	684.0	8.94	8.81	.389
	689.0	8.95	8.79	.359
	734.0	8.44	8.38	.088
	734.9	8.44	8.37	.116
92096	620.2	9.21	8.40	1.395
FF HYA	622.2	9.23	8.46	1.414
	624.2	9.19	8.42	1.405
	626.1	9.19	8.43	1.398
	644.2	8.92	8.22	1.330
	645.1	8.92	8.21	1.312
	662.0	8.82	8.18	1.320
	666.1	8.88	8.19	1.304
	667.1	8.82	8.16	1.294
	683.0	8.97	8.27	1.318
	684.0	9.03	8.30	1.332
	689.0	9.07	8.33	1.356
	734.0	8.93	8.23	1.241
	734.9	8.92	8.22	1.249
95850	620.2	9.81	8.96	1.496
SX LEO	622.2	9.83	9.00	1.498
	624.2	9.80	8.98	1.494
	626.1	9.84	8.98	1.476
	644.2	9.69	8.91	1.393
	645.1	9.71	8.91	1.386
	662.1	10.01	9.12	1.454
	666.1	10.05	9.16	1.384
	667.1	10.09	9.23	1.375

TABLE III (*continued*)

Individual observations of known variables

HD	J.D. 2440	V_s	(65)	(87, 65)
95850 (CONTD)	683.0	10.20	9.28	1.467
	684.0	10.20	9.29	1.465
	689.0	10.14	9.24	1.443
	734.0	9.48	8.76	1.304
	734.9	9.44	8.74	1.330
99056 T CRT	620.2	9.01	8.46	1.225
	622.2	9.12	8.54	1.235
	624.2	9.08	8.54	1.234
	626.2	9.15	8.59	1.266
	644.2	9.18	8.58	1.267
	645.1	9.20	8.57	1.237
	662.1	9.25	8.67	1.346
	666.1	9.31	8.65	1.250
	667.1	9.28	8.66	1.241
99056 (CONTD)	683.0	9.38	8.74	1.299
	684.1	9.40	8.74	1.287
	689.0	9.36	8.72	1.275
	734.0	8.83	8.32	1.122
	734.9	8.83	8.33	1.133
125146 AN VIR	667.3	9.00	8.53	1.112
	683.3	8.89	8.44	1.080
	684.2	8.90	8.42	1.072
	689.2	8.86	8.39	1.046
	735.1	8.93	8.46	1.037
	736.0	8.89	8.45	1.034
	760.0	8.93	8.46	1.080
	761.9	8.93	8.46	1.081
	765.0	8.93	8.46	1.104

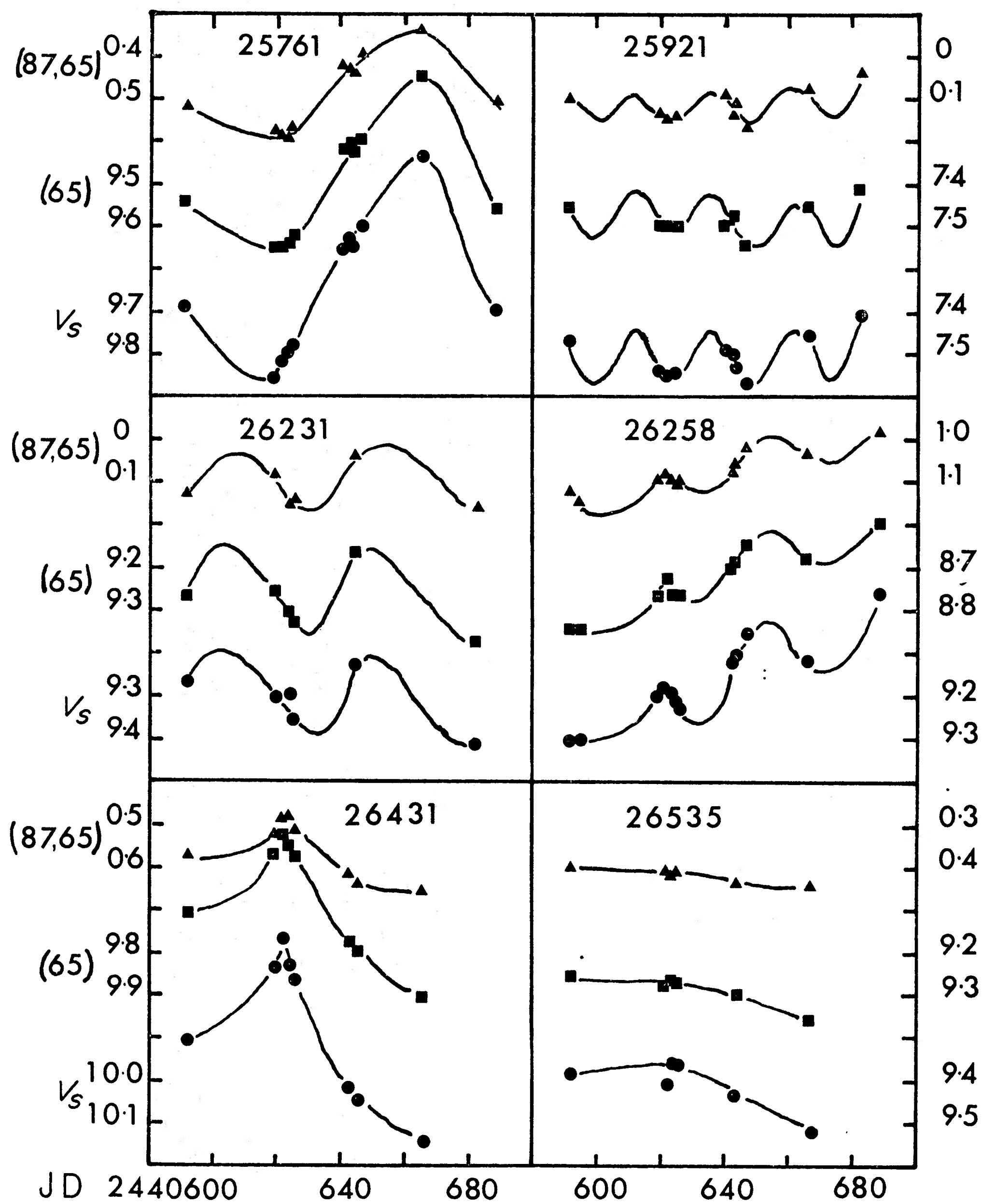

FIG. 5. *The light (V_s and (65)) and colour (87, 65) variations of the P variables.*

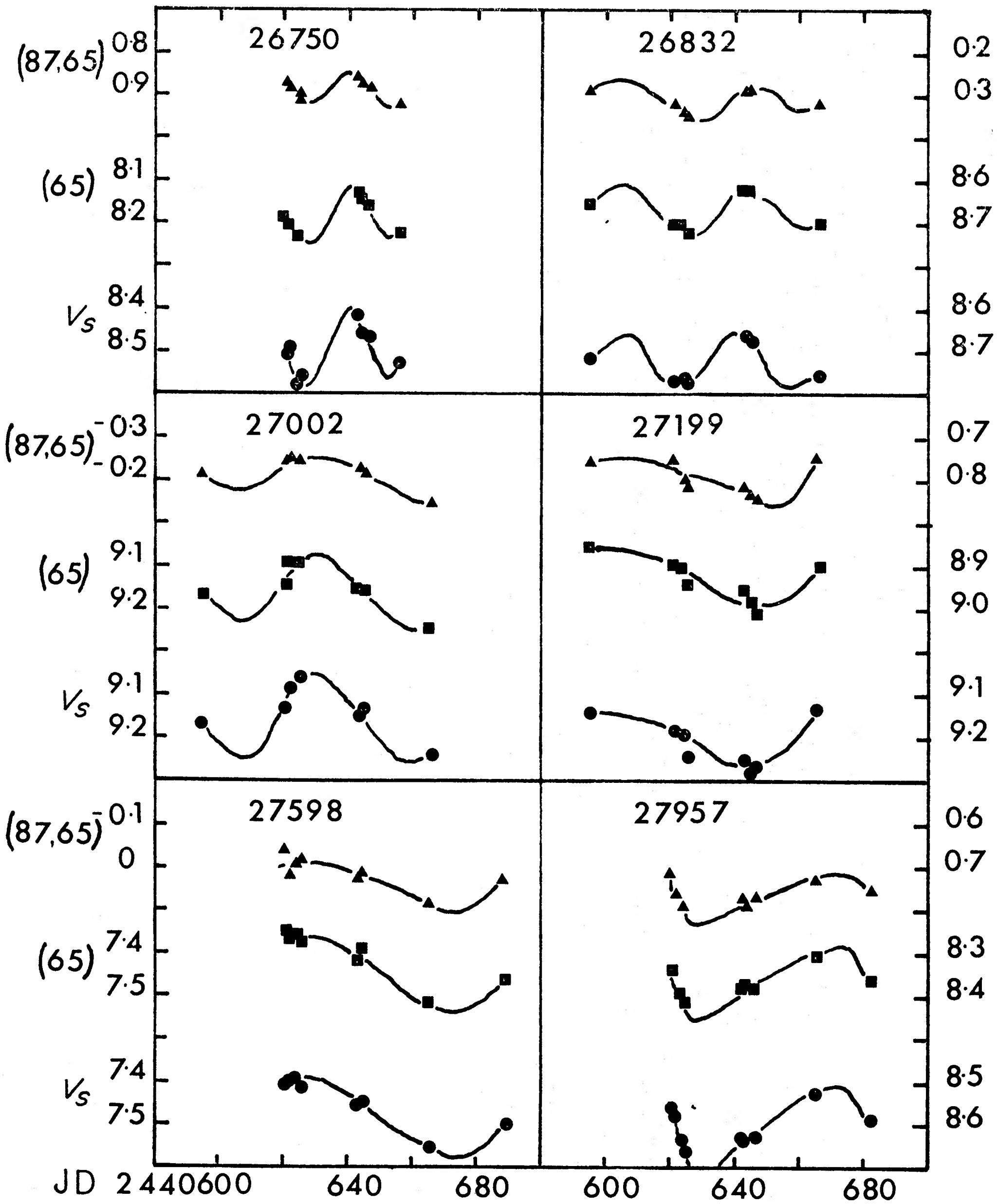

FIG. 6. *The light* (V_s *and* (65)) *and colour* (87, 65) *variations of the P variables.*

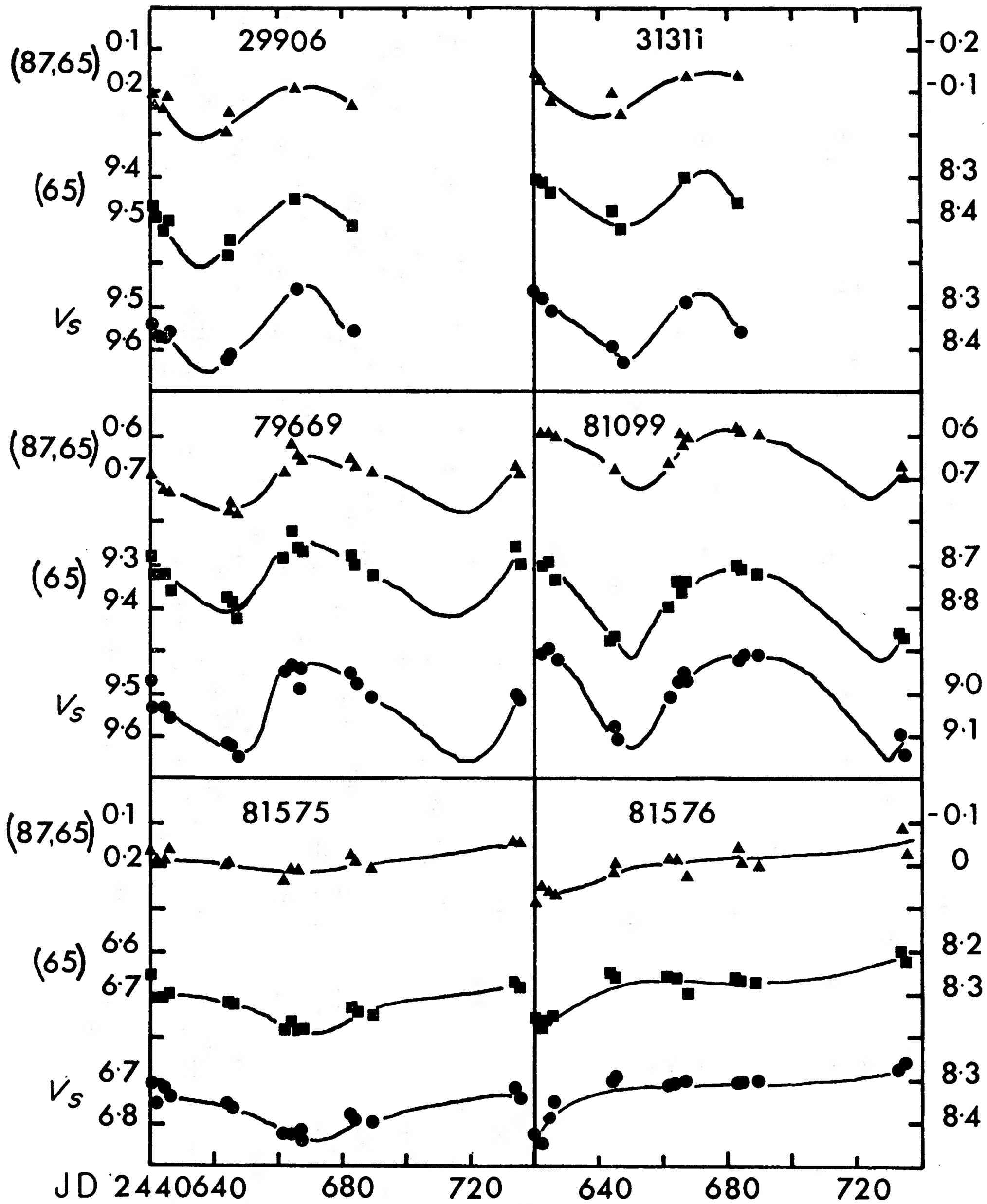

FIG. 7. *The light (V_s and* (65)) *and colour* (87, 65) *variations of the P variables.*

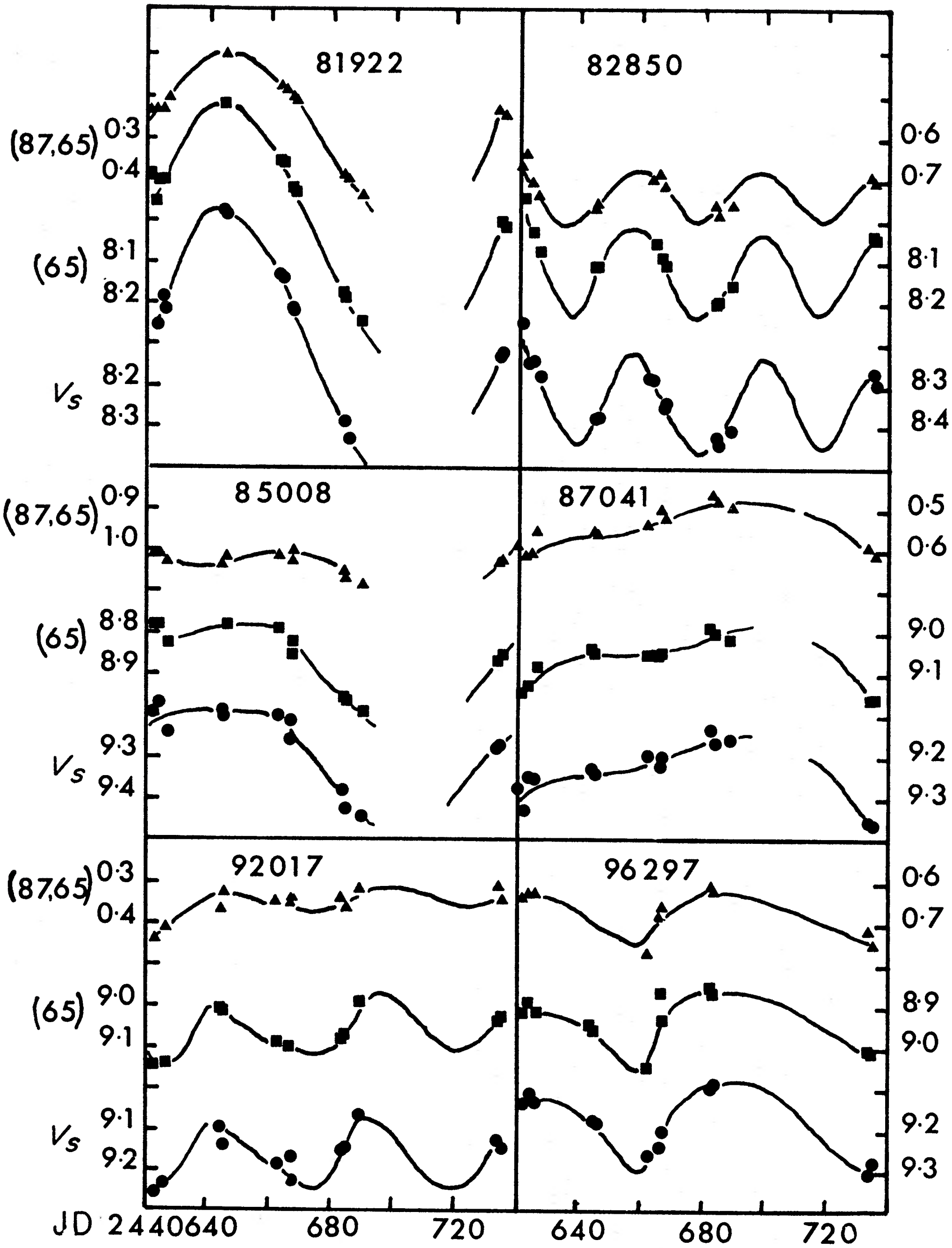

FIG. 8. *The light* (V_s *and* (65)) *and colour* (87, 65) *variations of the P variables.*

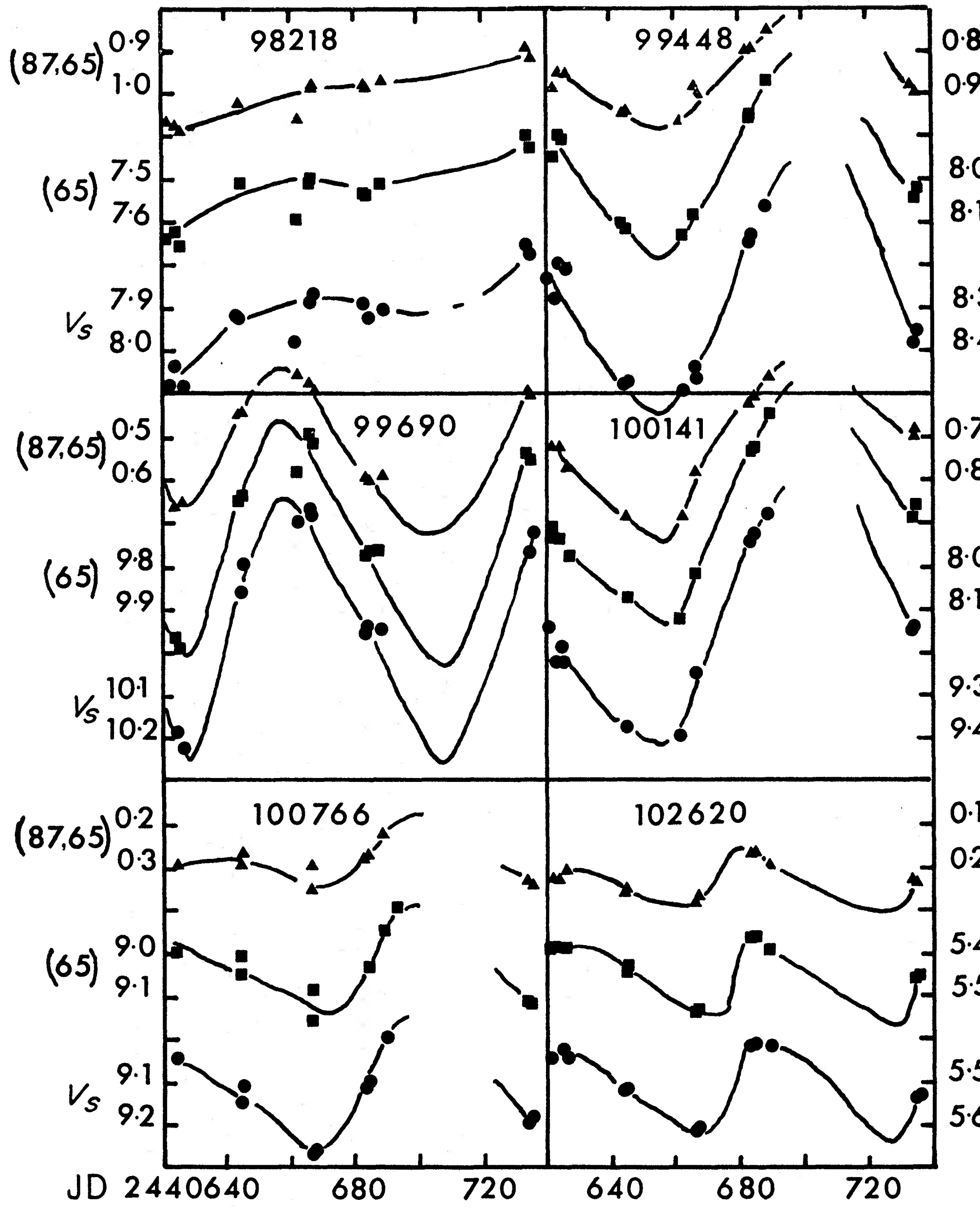

FIG. 9. *The light* (V_s *and* (65)) *and colour* (87, 65) *variations of the P variables.*

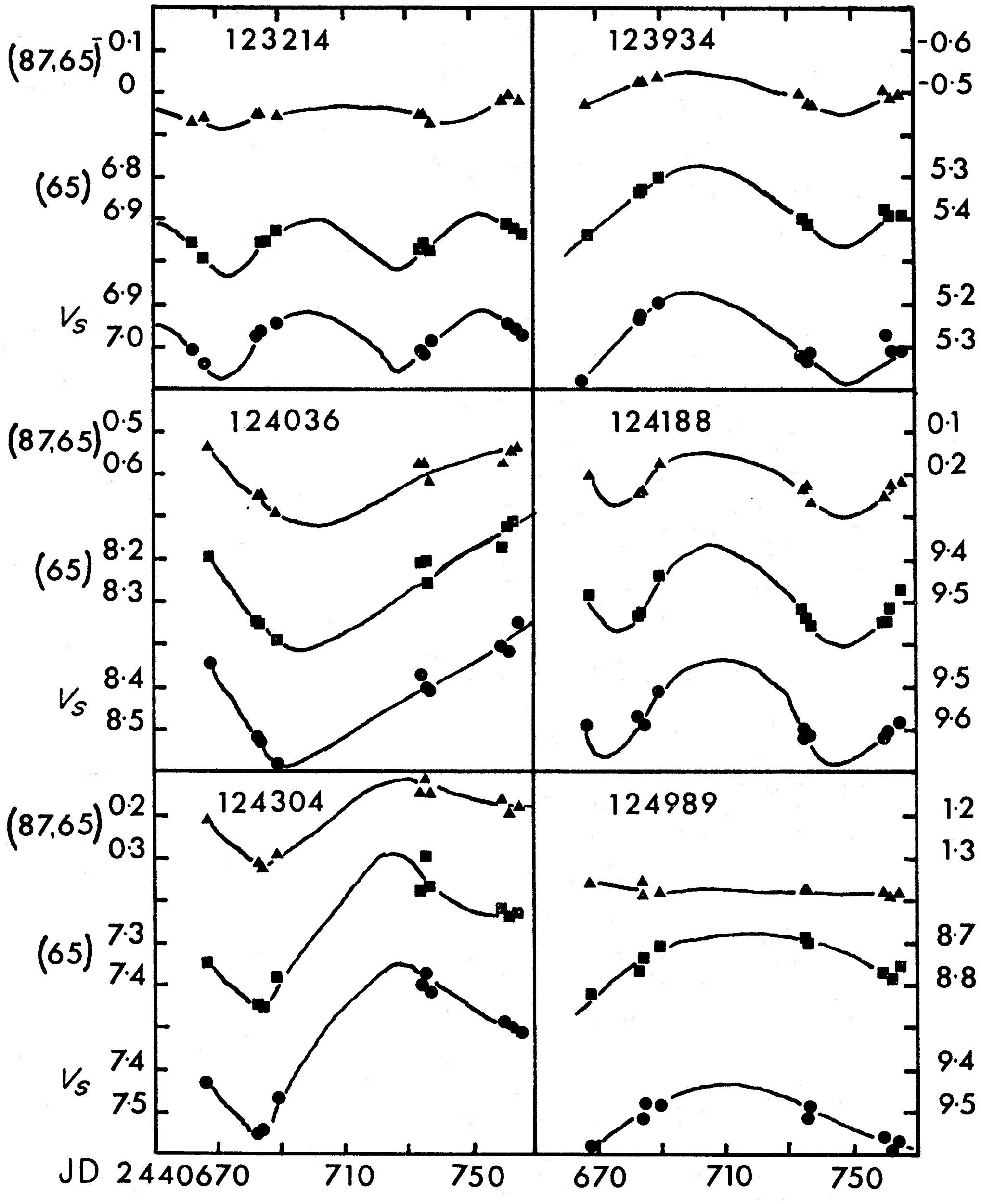

FIG. 10. *The light (V_s and (65)) and colour (87, 65) variations of the P variables.*

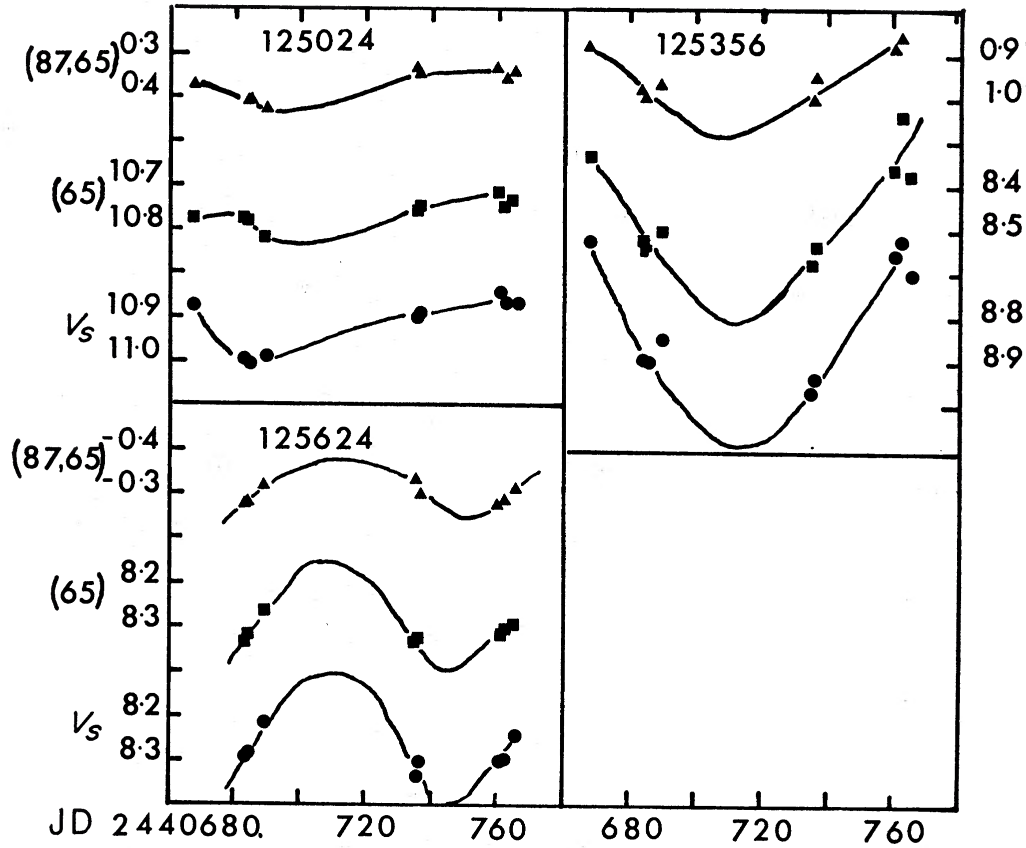

FIG. 11. *The light* (V_s *and* (65)) *and colour* (87, 65) *variations of the P variables.*

(d) *The constant stars*

Table VI lists M-stars from Table II which have variations in V_s of less than 0·1 mag. Values of V_s, (65), (87, 65) and *n*, the number of observations, are given; *V*, *R* and *R–I* are obtained using the transformation shown in Fig. 1. Table VII lists the corresponding values for the K-stars—which were all constant. In the four regions were found:

A: Twenty stars constant—sixteen Ma and four Mb.
B: No stars constant.
C: One Mb-star constant.
D: Eighteen constant—all fifteen K5-stars, two Ma and one Mb.

6. THE COLOUR–AMPLITUDE RELATIONSHIP

Tables VIII and IX give the values of V_s, (65) and (87, 65) at maximum light, and the corresponding values of *V*, *R* and *R–I*, for the erratic variables and the new quasi-periodic variables, respectively. The *R–I* range for the constant stars is 0·80 to 1·35 mags, for the erratic variables 0·99 to 1·54 and for the quasi-periodic variables 0·80 to 2·04. In Fig. 13 the amplitude of the variations are plotted against *R–I* at maximum light for the variable stars, and r.m.s. deviation in V_s against *R–I* for the constant stars. The known variables are plotted as open triangles, the new quasi-periodic variables as filled triangles, the erratic variables as filled circles and the constant M-stars as open circles in this figure.

Table IV

Individual observations of new quasi-periodic variables

HD	J.D. 2440	V_s	(65)	(87, 65)
25761	592.0	9.69	9.55	.520
	620.0	9.86	9.65	.578
	622.0	9.82	9.65	.592
	623.9	9.80	9.64	.593
	624.9	9.78	9.62	.562
	640.9	9.56	9.42	.433
	642.9	9.53	9.41	.434
	643.9	9.55	9.43	.444
	646.9	9.50	9.40	.398
	665.9	9.34	9.25	.340
	688.9	9.70	9.56	.510
25921	592.0	7.47	7.46	.102
	620.0	7.54	7.50	.135
	622.0	7.55	7.50	.150
	624.9	7.55	7.50	.139
	640.9	7.49	7.50	.094
	642.9	7.50	7.49	.138
	643.9	7.53	7.48	.112
	646.9	7.57	7.54	.170
	666.9	7.45	7.45	.079
	682.9	7.41	7.41	.038
26231	592.0	9.26	9.27	.129
	620.0	9.31	9.26	.087
	624.0	9.30	9.30	.155
	626.0	9.36	9.33	.145
	644.9	9.23	9.17	.041
	682.9	9.42	9.38	.157
26258	592.0	9.31	8.84	1.121
	595.0	9.30	8.85	1.147
	620.0	9.21	8.76	1.097
	622.0	9.18	8.72	1.085
	624.0	9.19	8.76	1.097
	625.0	9.21	8.76	1.106
	626.0	9.22	8.77	1.099
	642.9	9.12	8.71	1.077
	643.9	9.10	8.69	1.054
	646.9	9.05	8.65	1.021
	665.9	9.12	8.68	1.035
	688.9	8.96	8.60	.982
26431	592.0	9.91	9.71	.573
	620.0	9.74	9.57	.526
	622.0	9.66	9.53	.487
	624.0	9.73	9.55	.484
	625.0	9.77	9.57	.517
	642.9	10.02	9.78	.616
	644.9	10.05	9.80	.643
26431 (CONTD)	665.9	10.15	9.91	.661
26535	592.0	9.38	9.26	.403
	622.0	9.41	9.28	.410
	624.0	9.36	9.26	.414
	625.0	9.36	9.27	.408
	644.0	9.44	9.30	.438
	666.9	9.52	9.36	.445
26750	620.0	8.51	8.19	.880
	622.0	8.50	8.21	.892
	624.0	8.58	8.24	.919
	625.0	8.56	8.23	.902
	643.0	8.42	8.14	.866
	644.0	8.46	8.15	.881
	646.9	8.47	8.16	.885
	655.9	8.53	8.23	.930
26832	595.0	8.72	8.67	.296
	621.0	8.78	8.71	.322
	624.0	8.76	8.71	.343
	625.0	8.78	8.73	.360
	643.0	8.67	8.63	.293
	645.0	8.68	8.62	.286
	665.9	8.76	8.71	.320
27002	595.0	9.17	9.17	-.206
	621.0	9.14	9.15	-.241
	622.0	9.09	9.10	-.246
	625.0	9.06	9.09	-.240
	643.0	9.16	9.16	-.220
	645.0	9.14	9.16	-.210
	665.9	9.25	9.26	-.138
27199	595.0	9.15	8.86	.760
	621.0	9.19	8.90	.751
	624.0	9.20	8.91	.802
	625.0	9.25	8.95	.827
	643.0	9.25	8.96	.817
	645.0	9.28	8.99	.840
	646.9	9.27	9.02	.851
	665.9	9.13	8.91	.751
27598	621.0	7.41	7.36	-.031
	622.0	7.40	7.37	.026
	624.0	7.40	7.37	-.001
	626.0	7.42	7.38	-.005
	643.0	7.46	7.42	.029
	645.0	7.45	7.39	.027
	665.9	7.56	7.52	.090

TABLE IV (*continued*)

HD	J.D. 2440	V_s	(65)	(87, 65)
27598 (CONTD)	688.9	7.51	7.46	.034
27957	621.0	8.57	8.35	.717
	622.0	8.59	8.35	.767
	624.0	8.64	8.40	.794
	625.0	8.67	8.42	.795
	643.0	8.64	8.40	.779
	644.0	8.64	8.38	.796
	647.0	8.64	8.39	.769
	665.9	8.53	8.31	.731
	682.9	8.59	8.37	.754
29906	621.1	9.55	9.47	.205
	622.0	9.57	9.50	.235
	624.1	9.57	9.53	.241
	626.0	9.56	9.50	.212
	644.0	9.63	9.59	.298
	645.0	9.62	9.55	.251
	666.0	9.46	9.45	.194
	683.9	9.56	9.52	.234
31311	620.1	8.27	8.31	-.141
	622.1	8.28	8.31	-.126
	625.1	8.32	8.34	-.077
	644.0	8.39	8.38	-.099
	647.0	8.43	8.42	-.049
	667.0	8.30	8.30	-.140
	683.9	8.36	8.36	-.136
79669	620.1	9.47	9.28	.692
	621.1	9.54	9.33	.688
	624.1	9.53	9.33	.727
	626.1	9.56	9.37	.734
	644.1	9.62	9.37	.779
	645.1	9.62	9.38	.753
	647.0	9.65	9.43	.780
	662.0	9.45	9.28	.687
	664.1	9.44	9.22	.620
	666.0	9.49	9.27	.650
	667.0	9.44	9.27	.661
	683.0	9.46	9.28	.651
	684.0	9.48	9.30	.675
	688.9	9.51	9.33	.688
	733.9	9.50	9.26	.671
	734.9	9.51	9.30	.689
81099	622.1	8.90	8.70	.597
	624.1	8.89	8.69	.594
	626.1	8.92	8.74	.603
	644.1	9.09	8.87	.604
81099 (CONTD)	645.1	9.11	8.87	.679
	662.0	9.01	8.79	.665
	664.1	8.97	8.74	.591
	666.0	8.96	8.76	.622
	667.0	8.97	8.73	.605
	683.0	8.92	8.70	.587
	684.0	8.92	8.71	.591
	689.0	8.91	8.72	.601
	733.9	9.10	8.86	.671
	734.9	9.14	8.88	.700
81575	620.1	6.71	6.66	.172
	622.1	6.76	6.72	.188
	624.1	6.72	6.71	.193
	626.1	6.75	6.70	.168
	644.1	6.76	6.72	.204
	645.1	6.77	6.72	.195
	662.0	6.84	6.79	.235
	664.1	6.83	6.77	.211
	666.0	6.85	6.79	.214
	667.0	6.83	6.79	.214
	683.0	6.78	6.73	.179
	684.0	6.80	6.74	.198
	689.0	6.81	6.76	.213
	733.9	6.72	6.67	.148
	734.9	6.75	6.69	.153
81576	620.1	8.43	8.36	.086
	622.1	8.46	8.39	.046
	624.1	8.39	8.36	.059
	626.1	8.36	8.36	.066
	644.1	8.31	8.26	.020
	645.1	8.30	8.27	-.003
	662.0	8.32	8.27	-.015
	664.1	8.32	8.27	-.011
	667.0	8.31	8.30	.026
	683.0	8.31	8.27	-.040
	684.0	8.31	8.27	0.000
	689.0	8.31	8.28	.005
	733.9	8.28	8.21	-.080
	734.9	8.27	8.24	-.022
81922	620.2	8.01	7.90	.236
	622.1	8.06	7.95	.235
	624.1	7.99	7.92	.237
	626.1	8.02	7.91	.205
	644.1	7.78	7.72	.106
	645.1	7.79	7.72	.094
	662.0	7.93	7.86	.176
	664.1	7.95	7.86	.192

TABLE IV (*continued*)

HD	J.D. 2440	V_s	(65)	(87, 65)
81622	666.0	8.02	7.92	.209
(CONTD)	667.0	8.02	7.94	.221
	683.0	8.29	8.19	.393
	684.0	8.33	8.20	.402
	689.0	8.39	8.25	.441
	733.9	8.13	8.02	.234
	734.9	8.13	8.02	.251
82850	620.2	8.13	7.93	.686
	622.2	8.25	7.95	.644
	624.1	8.25	8.03	.710
	626.1	8.28	8.08	.739
	644.1	8.38	8.12	.772
	645.1	8.38	8.13	.756
	662.0	8.28	8.03	.703
	664.1	8.28	8.05	.702
	666.0	8.36	8.09	.688
	667.1	8.35	8.11	.722
	683.0	8.43	8.20	.764
	684.0	8.45	8.21	.790
	639.0	8.41	8.16	.762
	733.9	8.27	8.05	.696
	734.9	8.29	8.05	.708
85008	622.2	9.20	8.79	1.018
	624.1	9.18	8.78	1.013
	626.1	9.25	8.83	1.033
	644.1	9.20	8.79	1.040
	645.1	9.21	8.79	1.025
	662.0	9.20	8.79	1.018
	666.0	9.27	8.86	1.030
	667.1	9.22	8.83	1.003
	683.0	9.39	8.96	1.060
	684.0	9.43	8.97	1.077
	689.0	9.45	9.00	1.089
	733.9	9.28	8.87	1.029
	734.9	9.28	8.85	1.027
87041	620.2	9.28	9.08	.596
	622.2	9.34	9.15	.624
	624.1	9.26	9.13	.619
	626.1	9.26	9.09	.562
	644.1	9.24	9.05	.562
	645.1	9.25	9.06	.566
	662.0	9.21	9.06	.547
	666.1	9.24	9.06	.507
	667.1	9.21	9.06	.529
	683.0	9.14	8.99	.474
	684.0	9.18	9.02	.489
	689.0	9.17	9.02	.500
87041	733.9	9.37	9.17	.603
(CONTD)	734.9	9.37	9.17	.620
92017	620.2	9.25	9.10	.411
	622.2	9.27	9.16	.448
	626.1	9.24	9.15	.417
	644.2	9.11	9.02	.378
	645.1	9.14	9.03	.337
	662.0	9.19	9.10	.357
	666.1	9.24	9.11	.362
	667.1	9.17	9.08	.348
	683.0	9.16	9.08	.353
	684.0	9.16	9.09	.373
	689.0	9.07	9.00	.324
	734.0	9.14	9.05	.323
	734.9	9.16	9.03	.354
96297	620.2	9.11	8.89	.624
	622.2	9.15	8.93	.649
	624.2	9.13	8.91	.644
	626.1	9.15	8.93	.640
	644.2	9.20	8.96	.699
	645.1	9.20	8.98	.701
	662.1	9.28	9.06	.785
	666.1	9.25	8.89	.693
	667.1	9.22	8.95	.670
	683.0	9.11	8.87	.624
	684.0	9.11	8.89	.633
	734.0	9.33	9.03	.726
	734.9	9.30	9.03	.766
98218	620.2	7.97	7.57	1.062
	622.2	8.09	7.63	1.068
	624.2	8.04	7.62	1.076
	626.1	8.09	7.66	1.089
	644.2	7.92	7.51	1.022
	645.1	7.93	7.51	1.021
	662.1	7.98	7.60	1.063
	666.1	7.89	7.51	.988
	667.1	7.87	7.50	.981
	683.0	7.89	7.54	.989
	684.0	7.93	7.54	.992
	689.0	7.90	7.51	.977
	734.0	7.76	7.40	.895
	734.9	7.78	7.43	.918
99448	620.2	8.23	7.92	.889
	622.2	8.28	7.96	.888
	624.2	8.20	7.90	.853
	626.2	8.21	7.92	.856

TABLE IV (*continued*)

HD	J.D. 2440	V_s	(65)	(87,65)	HD	J.D. 2440	V_s	(65)	(87, 65)
99448	644.2	8.48	8.11	.947	102620	624.2	5.43	5.39	.226
(CONTD)	645.2	8.48	8.12	.941	(CONTD)	626.2	5.44	5.39	.202
	662.1	8.50	8.13	.968		644.2	5.52	5.45	.258
	666.1	8.44	8.08	.886		645.2	5.51	5.43	.242
	667.1	8.47	8.09	.903		666.2	5.62	5.54	.282
	683.0	8.15	7.87	.800		667.2	5.61	5.54	.267
	684.1	8.13	7.86	.797		683.1	5.41	5.36	.166
	689.0	8.06	7.77	.753		684.1	5.41	5.37	.167
	734.0	8.38	8.04	.886		689.1	5.42	5.39	.197
	734.9	8.36	8.02	.902		734.0	5.53	5.46	.226
						734.9	5.53	5.46	.234
99690	624.2	10.19	9.97	.664					
	626.2	10.22	9.99	.648	123241	645.2	6.94	6.91	.038
	644.2	9.86	9.65	.451		662.2	7.01	6.96	.071
	645.2	9.79	9.64	.443		666.2	7.05	7.00	.061
	662.1	9.70	9.58	.358		683.1	6.98	6.96	.058
	666.1	9.68	9.49	.374		684.1	6.97	6.96	.055
	667.2	9.68	9.52	.397		689.1	6.95	6.93	.061
	683.1	9.95	9.78	.596		734.1	7.01	6.98	.057
	684.1	9.94	9.77	.604		735.0	7.02	6.96	.060
	689.0	9.95	9.76	.590		736.9	6.99	6.98	.078
	734.0	9.76	9.54	.397		759.6	6.93	6.91	.023
	734.9	9.72	9.55	.406		761.9	6.95	6.92	.012
						764.9	6.96	6.93	.025
100141	620.2	9.14	8.88	.746					
	622.2	9.23	8.93	.724	123934	666.2	5.38	5.44	−.471
	624.2	9.19	8.93	.724		683.2	5.24	5.34	−.520
	626.2	9.22	8.98	.774		684.2	5.23	5.33	−.520
	645.2	9.37	9.08	.884		689.1	5.20	5.30	−.530
	662.1	9.40	9.13	.887		734.1	5.32	5.40	−.494
	666.1	9.25	9.01	.781		735.9	5.33	5.42	−.465
	683.1	8.94	8.74	.625		737.0	5.32	5.31	−.461
	684.1	8.92	8.73	.604		760.0	5.27	5.38	−.497
	689.0	8.88	8.66	.555		761.9	5.31	5.40	−.482
	734.0	9.15	8.89	.704		764.9	5.31	5.40	−.487
	734.9	9.14	8.86	.686					
					124036	667.2	8.35	8.20	.541
100766	620.2	9.03	8.94	.271		683.2	8.53	8.35	.650
	624.2	9.05	8.99	.300		684.2	8.54	8.36	.649
	644.2	9.15	9.05	.297		689.1	8.59	8.40	.694
	645.2	9.11	9.00	.264		734.1	8.37	8.20	.576
	666.2	9.27	9.16	.354		735.9	8.41	8.20	.576
	667.2	9.26	9.09	.296		737.0	8.41	8.27	.621
	683.1	9.11	9.04	.279		760.0	8.31	8.18	.576
	684.1	9.10	9.03	.274		761.9	8.32	8.13	.545
	689.1	9.00	8.94	.218		764.9	8.26	8.11	.539
	734.0	9.20	9.12	.326					
	734.9	9.18	9.12	.348	124188	667.2	9.60	9.49	.204
						683.2	9.58	9.54	.245
102620	620.2	5.45	5.39	.226		684.2	9.59	9.53	.242

TABLE IV (*continued*)

HD	J.D. 2440	V_s	(65)	(87, 65)
124036 (CONTD)	689.1	9.52	9.44	.177
	734.1	9.63	9.52	.234
	735.9	9.61	9.55	.224
	737.0	9.62	9.56	.271
	760.0	9.62	9.55	.254
	761.9	9.61	9.52	.226
	764.9	9.59	9.47	.216
124304	667.2	7.44	7.35	.220
	683.2	7.55	7.45	.317
	684.2	7.55	7.46	.329
	689.2	7.47	7.39	.293
	734.1	7.21	7.18	.146
	736.0	7.17	7.10	.117
	737.0	7.22	7.17	.149
	760.0	7.29	7.22	.164
	761.9	7.31	7.24	.199
	764.9	7.32	7.23	.184
124989	667.2	9.58	8.82	1.359
	683.2	9.52	8.77	1.390
	684.2	9.48	8.74	1.360
	689.2	9.48	8.71	1.381
	735.1	9.52	8.69	1.380
	736.0	9.48	8.70	1.380
	760.0	9.56	8.77	1.383
	761.9	9.60	8.79	1.390
	765.0	9.57	8.76	1.385
125024	667.3	10.88	10.78	.380
	683.3	11.01	10.78	.415
	684.2	11.02	10.79	.413
	689.2	11.00	10.83	.437
	735.1	10.91	10.76	.341
	736.0	10.89	10.74	.351
	760.0	10.85	10.71	.338
	761.9	10.88	10.75	.363
	765.0	10.88	10.74	.345
125356	667.3	8.63	8.34	.887
	683.3	8.90	8.53	.983
	684.2	8.91	8.55	1.005
	689.2	8.86	8.50	.976
	735.1	8.97	8.58	1.002
	736.0	8.94	8.54	.955
	760.0	8.66	8.36	.890
	761.9	8.62	8.24	.864
	765.0	8.71	8.37	.797
125624	683.3	8.29	8.34	-.277
	684.2	8.29	8.32	-.282
	689.2	8.22	8.26	-.313
	735.1	8.34	8.34	-.329
	736.0	8.31	8.33	-.293
	760.0	8.31	8.32	-.277
	761.9	8.30	8.30	-.286
	765.0	8.25	8.30	-.308

7. LUMINOSITIES, MOTIONS AND SPATIAL DISTRIBUTION

Tables VI, VII, VIII and IX also give the reddening, M_I and the space motions U, V and W for the constant M-stars, the K5-stars, the erratic variables and the quasi-periodic variables respectively. Also given is the radial velocity, when known, or else the fractions $U(\rho)$, $V(\rho)$, $W(\rho)$ of the unknown radial velocity that should be applied to U, V and W.

The reddening was determined assuming

$$E(R\text{–}I) = 0{\cdot}7\,E(B\text{–}V)$$

For the intermediate galactic latitudes of the stars in Regions A, C and D the following relationship was employed:

$$E(B\text{–}V) = \beta \csc b(1-\exp(r \sin b/h))$$

with $\beta = 0{\cdot}057$ and $h = 187$ parsecs (Abt & Golson 1962). In Region B, in the galactic plane, data discussed by Sharov (1964) was used.

The luminosities were derived from the (M_I, R–I) relation for old disk giants (Eggen 1970, 1971). The relationship used is reproduced in Fig. 14.

Although for R–I in the range 0·70 to 1·20 the relationship for the young disk stars lies a little below that for the old disk stars shown in the figure, the one relationship was used for all stars. Only two or three stars at the most may

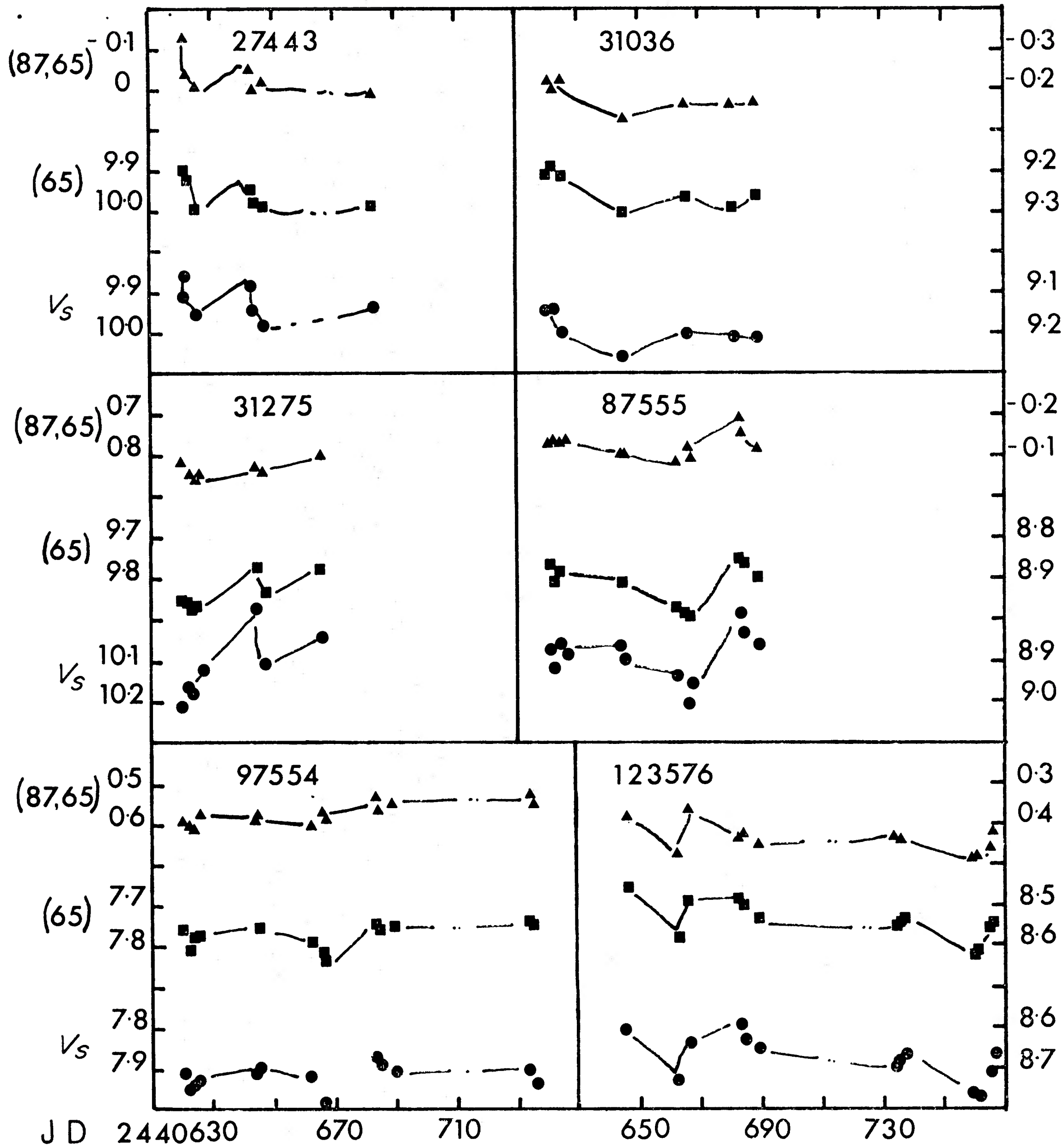

FIG. 12. *The light* (V_s *and* (65)) *and colour* (87, 65) *variations of the EC variables.*

be affected by this approximation. As the space motions derived (many with unknown radial velocities) are used as a statistical indicator only, no error of significance should be introduced by this procedure.

In Fig. 15 the U, V values for the programme stars are plotted, the constant stars being represented by filled circles, the K-stars by filled squares, the erratic variables by open circles and the quasi-periodic variables by filled triangles.

The position of each star in the (U, V) plane can be used as a basis for population assignment (Eggen 1969). The irregular outlined area towards the centre of Fig. 15 encloses the young disk stars. Those with eccentricity, e, of less than 0·5 in the galactic orbit are assumed to be old disk objects and those with e greater than 0·5, to be halo stars.

TABLE V

Individual observations of new erratic variables

HD	J.D. 2440	V_s	(65)	(87, 65)
27443	595.0	10.01	10.00	-.008
	621.0	9.91	9.90	-.127
	622.0	9.86	9.92	-.034
	625.0	9.96	10.00	-.004
	643.0	9.88	9.95	-.049
	644.0	9.95	9.98	.001
	646.9	9.98	9.98	-.016
	682.9	9.93	9.99	.011
31036	620.1	9.15	9.21	-.220
	622.1	9.14	9.19	-.193
	625.0	9.20	9.22	-.218
	645.0	9.26	9.31	-.118
	666.0	9.21	9.27	-.166
	680.9	9.21	9.29	-.161
	688.9	9.22	9.26	-.168
31275	620.1	10.21	9.86	.818
	622.1	10.16	9.86	.852
	624.1	10.18	9.87	.864
	626.0	10.12	9.87	.841
	644.0	9.97	9.77	.831
	647.0	10.12	9.84	.840
	666.0	10.05	9.78	.800
87555	620.2	8.88	8.87	-.127
	622.1	8.92	8.91	-.138
	624.2	8.86	8.89	-.134
	626.1	8.88	8.90	-.135
	644.1	8.87	8.92	-.107
	645.1	8.89	8.91	-.109
	662.0	8.94	8.98	-.082
	666.1	9.01	8.99	-.117
	667.1	8.96	8.98	-.090
87555 (CONTD)	683.0	8.79	8.85	-.187
	684.0	8.84	8.87	-.151
	689.0	8.86	8.90	-.111
	734.0	8.81	8.83	-.169
	734.9	8.83	8.85	-.187
97554	620.2	7.91	7.76	.594
	622.2	7.95	7.81	.606
	624.2	7.94	7.78	.611
	626.1	7.93	7.78	.576
	644.2	7.91	7.76	.588
	645.1	7.90	7.74	.573
	662.1	7.92	7.79	.606
	666.1	7.98	7.82	.574
	667.1	8.00	7.84	.589
	683.0	7.87	7.74	.537
	684.0	7.89	7.76	.567
	689.0	7.90	7.75	.553
	734.0	7.91	7.74	.525
	734.9	7.94	7.75	.556
123576	645.2	8.61	8.46	.389
	662.2	8.73	8.58	.475
	666.2	8.64	8.49	.364
	683.1	8.59	8.49	.437
	684.1	8.63	8.50	.423
	689.1	8.66	8.53	.453
	734.1	8.70	8.56	.437
	735.0	8.69	8.54	.437
	736.9	8.67	8.53	.441
	759.9	8.77	8.62	.488
	761.9	8.77	8.61	.483
	764.9	8.71	8.55	.460
	765.9	8.67	8.53	.421

The position of all the stars in the (X, Z) plane is shown in the two panels of Fig. 16. (X is positive in the direction away from the galactic centre and Z is perpendicular to the galactic plane and positive towards the North Galactic Pole.) The irregular outlines segregate the stars of the four regions observed. In the left-hand panel are plotted the constant stars; young disk stars as open circles, old disk stars as filled circles and halo stars as triangles. The K-stars are plotted as filled squares. In the right-hand panel the quasi-periodic variables are plotted, the symbols being as for the left-hand panel for the population separation. The two erratic variables, both of old disk population, are plotted as filled squares.

The young disk objects, with four exceptions, are all within 400 parsecs of the galactic plane. The four exceptions, HD 26535, 28573, 28836 and 100141 all have very small proper motions (less than 0″·010 in both coordinates) and their space motions are therefore very uncertain.

The old disk objects are all within 900 parsecs of the galactic plane and the halo stars are found from 600 to 900 parsecs from the plane.

TABLE VI

M stars with DV less than 0·1 mag

HD	V_s	(65)	(87, 65)	*n*	*V*	*R*	*R–I*	Sp	*E*(*R–I*)	M_I	*U*	*V*	*W*
25755	9.335	9.335	−.120	6	8.90	7.73	1.05	MA	.05	−3.39	70	85	8
RMS DEV	.018	.021	.028								+.57	−.40	−.72
26009	8.835	8.41	.010	4	8.38	7.13	1.16	MA	.05	−3.66	−88	−174	65
	.014	.016	.013								+.45	−.50	−.74
26487	7.635	7.675	−.277	5	7.25	6.12	0.97	MA	.05	−3.21	78	42	9
	.025	.012	.018								+.39	−.56	−.73
26534	9.585	9.485	.232	6	9.13	7.72	1.23	MA	.05	−3.75	−63	−130	−21
	.012	.021	.013								+.74	−.26	−.62
26692	7.925	7.935	−.053	6	7.56	6.48	0.81	MA	.05	−2.90	28	−20	44
	.030	.019	.008								+.77	−.23	−.60
26829	7.58	7.665	−.429	4	7.21	6.18	0.87	MA	.05	−2.92	20	32	2
	.007	.010	.007								+.64	−.38	−.67
27098	8.87	8.935	−.337	4	7.50	7.41	0.92	MA	.06	−3.04	116	−14	37
	.013	.014	.009								+.14	−.69	−.71
27498	7.41	7.405	.037	7	6.95	5.73	1.13	MB	.06	−3.58	77	−51	−26
	.028	.026	.014								RHO = +87		
27930	8.955	8.995	−.180	5	8.54	7.41	1.02	MA	.06	−3.32	–	–	–
	.025	.032	.030										
28290	9.80	9.775	.150	4	9.34	8.04	1.19	MA	.06	−3.70	–	–	–
	.009	.008	.011										
28493	8.82	8.885	−.300	5	8.44	7.34	0.95	MA	.06	−3.13	–	–	–
	.030	.033	.036										
28572	9.015	9.105	−.354	5	8.64	7.58	0.92	MA	.06	−3.04	+7	−26	28
	.032	.025	.023								+.32	−.65	−.69
28836	8.69	8.655	.095	5	8.23	6.95	1.16	MA	.06	−3.66	−15	−11	1
	.022	.026	.026								+.38	−.62	−.68
28915	8.475	8.60	−.358	8	8.10	7.08	0.92	MA	.06	−3.04	–	–	–
	.035	.020	.020										
29046	8.80	8.815	−.159	4	8.38	7.22	1.03	MA	.06	−3.34	–	–	–
	.018	.016	.023										
29277	8.59	8.695	−.434	7	8.22	7.21	0.87	MA	.05	−2.90	−32	+6	−20
	.031	.023	.020								+.30	−.67	−.68
29704	8.69	8.64	.438	7	8.26	6.77	1.35	MB	.06	−3.94	−8	68	−68
	.010	.014	.014								+.48	−.59	−.65
30622	7.93	8.055	−.502	5	7.56	6.59	0.82	MA	.05	−2.70	39	16	29
	.009	.017	.022								+.63	−.51	−.58
31301	8.225	8.16	−.017	5	7.81	6.50	1.10	MB	.06	−3.50	37	−24	72
	.020	.019	.017								+.73	−.44	−.52
102276	7.96	7.89	.309	14	7.51	6.09	1.28	MB	.06	−3.84	−8	−35	−50
	.041	.053	.044								−.21	−.79	+.58
124804	8.35	8.42	−.324	9	7.98	6.89	0.94	MA	.05	−3.12	26	43	41
	.017	.022	.014								−.62	−.31	+.72
125662	9.525	9.555	−.266	8	9.13	7.99	0.97	MA	.06	−3.19	56	−272	−63
	.024	.018	.011								−.63	−.30	+.71
125787	9.955	10.05	−.371	8	9.59	8.53	0.91	MA	.06	−3.00	−56	12	−51
	.032	.020	.016								−.67	−.38	+.65

TABLE VII

The K stars

HD	V_s	(65)	(87, 65)	*n*	*V*	*R*	*R–I*	Sp	*E(R–I)*	M_I	*U*	*V*	*W*
123412	9.22	9.40	−.679	7	8.86	7.97	0.70	K5	.05	−2.09	−7	28	7
RMS DEV	.009	.011	.019								−.60	−.34	+.73
123454	9.41	9.81	−.951	7	9.05	8.44	0.51	K5	.05	−1.29	19	16	24
	.017	.025	.018								−.61	−.35	+.71
123580	9.15	9.48	−.901	7	8.79	8.11	0.55	K5	.05	−1.48	7	−43	−19
	.023	.016	.040								−.64	−.40	+.66
123764	9.68	10.06	−.996	7	9.32	8.70	0.47	K5	.05	−1.09	3	−84	−36
	.021	.024	.030								−.61	−.33	+.72
123787	10.07	10.31	−.797	6	9.71	8.92	0.62	K5	.06	−1.71	–	–	–
	.019	.012	.016										
123921	9.39	9.56	−.644	7	9.03	8.13	0.73	K5	.05	−2.26	36	−45	10
	.015	.017	.021								−.60	−.32	+.73
124072	9.38	9.44	−.324	6	9.01	7.91	0.93	K5	.05	−3.08	19	−98	−28
	.014	.012	.017								−.61	−.32	+.72
124274	9.18	9.52	−.897	6	8.82	8.15	0.55	K5	.05	−1.49	−7	25	6
	.020	.010	.019								−.62	−.34	+.70
124359	9.82	10.09	−.796	6	9.46	8.70	0.62	K5	.06	−1.70	39	−90	−12
	.019	.013	.023								−.64	−.37	+.67
124410	8.16	8.30	−.588	5	7.80	6.86	0.77	K5	.05	−2.50	6	17	13
	.010	.016	.014								−.62	−.34	+.71
124498	10.73	10.93	−.621	6	10.37	9.50	0.74	K5	.06	−2.29	–	–	–
	.055	.045	.033										
124629	10.78	11.28	−1.079	5	10.42	9.93	0.41	K5	.06	−0.01	–	–	–
	.026	.023	.057										
124630	10.17	10.48	−.897	5	10.81	9.11	0.55	K5	.06	−1.46	–	–	–
	.009	.024	.053										
124778	10.46	10.94	−1.031	5	10.10	9.58	0.45	K5	.06	−1.0	–	–	–
	.028	.014	.044										
125522	10.39	10.91	−1.178	4	10.03	9.56	0.34	K5	.06	+0.5	–	–	–
	.016	.014	.035										

TABLE VIII

Motions and luminosities of the erratic variables

HD	V_s	(65) at maxi-mum	(87, 65)	*V*	*R* at maxi-mum	*R–I*	Sp	*E(R–I)*	M_I	*U*	*V*	*W*
27443	9.86	9.90	−.05	9.43	8.26	1.08	MA	.06	−3.45	–	–	–
31036	9.14	9.19	−.22	8.74	7.63	0.99	MA	.06	−3.22	–	–	–
31275	9.97	9.77	.80	9.60	7.69	1.54	MB	.06	−4.16	–	–	–
87555	8.80	8.85	−.20	8.39	7.27	1.01	MB	.08	−3.24	80	5	−2
										.07	−.94	+.33
97754	7.87	7.74	.54	7.47	5.82	1.21	MB	.06	−3.73	–	–	–
123576	8.59	8.49	.36	8.15	6.65	1.33	MB	.05	−3.92	30	−55	1
										.58	−.29	+.76

Table IX

Motions and luminosities of the quasi-periodic variables

HD	V_s	(65) at maxi-mum	(87, 65)	V	R at maxi-mum	$R–I$	Sp	$E(R–I)$	M_I	U	V	W
25725	9.12	7.92	1.60	8.89	5.28	2.04	MC	.04	−4.7	−4 .64	37 −.35	−22 −.70
25761	9.34	9.25	0.33	8.89	7.43	1.29	MA	.05	−3.86	122 .70	148 −.27	69 −.66
25921	7.40	7.41	0.04	6.95	5.73	1.13	MB	.05	−3.61	60 RHO = +49	−60	15
26231	9.20	9.16	0.04	8.75	7.48	1.13	MA	.05	−3.59	56 +.31	−63 −.60	74 −.74
26258	8.95	8.6	0.98	8.60	6.40	1.62	MC	.06	−4.30	−60 .72	−8 −.27	−64 −.64
26431	9.66	9.53	0.48	9.24	7.64	1.37	MA	.06	−3.96	–	–	–
26535	9.35	9.25	0.40	8.91	7.40	1.33	MB	.06	−3.91	30 .59	0 −.42	26 −.69
26750	8.42	8.14	0.86	8.06	6.02	1.56	MB	.05	−4.21	−36 .71	−67 −.31	−7 −.64
26832	8.66	8.6	0.28	8.21	6.85	1.19	MA	.05	−3.71	87 .36	−13 −.59	53 −.73
27002	9.05	9.09	−.25	8.66	7.53	0.98	MA	.05	−3.21	–	–	–
27199	9.13	8.86	0.75	8.76	6.61	1.51	MB	.05	−4.14	–	–	–
27598	7.40	7.35	0.00	6.94	5.68	1.11	MA	.05	−3.56	76 RHO = +99	−66	−36
27957	8.50	8.30	0.73	8.13	6.26	1.50	MB	.05	−4.12	97 .50	46 −.53	35 −.69
29383		NO MAXIMUM OBSERVED					MD			–	–	–
29712		NO MAXIMUM OBSERVED					MC			– RHO = +26	–	–
29844	7.87	7.40	1.10	7.53	5.12	1.67	MD	.04	−4.39	–	–	–
29906	9.45	9.45	0.20	8.99	7.68	1.22	MB	.06	−3.74	–	–	–
30642	9.94	9.76	0.50	9.52	7.86	1.39	MA	.06	−3.98	–	–	–
31311	8.27	8.30	−.15	7.84	6.70	1.03	MA	.06	−3.34	128 .29	−6 −.72	+67 −.63
79402	7.95	7.60	1.00	7.60	5.32	1.67	MB	.07	−4.35	47 .06	0 −1.0	−41 0.6
79669	9.43	9.25	0.65	9.05	7.26	1.46	MB	.17	−3.92	7 .01	0 −1	35 0
81099	8.90	8.70	0.60	8.51	6.74	1.44	MB	.13	−3.95	–	–	–
81575	6.72	6.68	0.15	6.26	4.93	1.19	MB	.06	−3.68	84 RHO = +40	−39	−13
81576		NO MAXIMUM OBSERVED					MB			–	–	–
81922	7.77	7.60	0.10	7.31	5.89	1.16	MB	.09	−3.35	40 .01	−4 −1	18 0
82850	8.25	8.00	0.70	7.87	5.98	1.49	MB	.10	−4.03	35 .01	−2 −1	−25 +.08
85008	9.18	8.78	1.00	8.83	6.57	1.63	MB	.13	−4.20	–	–	–
87041	9.16	9.00	0.47	8.74	7.12	1.37	MB	.11	−3.89	65 0	8 −.97	30 +.24
88517		NO MAXIMUM OBSERVED					MB			–	–	–
92017	9.07	9.00	0.35	8.63	7.18	1.30	MB	.07	−3.84	−47 .04	−67 −.87	−115 +.49
92096	8.80	8.16	1.30	8.49	5.75	1.78	MB	.05	−4.54	–	–	–
95850	9.68	8.90	1.38	9.40	6.44	1.84	MC	.05	−4.45	−19 .13	−18 −.63	−11 +.77
96297	9.10	8.80	0.55	8.71	6.87	1.41	MB	.05	−4.01	59 .07	55 −.70	48 +.71
98218		NO MAXIMUM OBSERVED					MB			–	–	–

TABLE IX (*continued*)

HD	V_s	(65) at maximum	(87, 65)	V	R at maximum	$R–I$	Sp	$E(R–I)$	M_I	U	V	W
99056		NO MAXIMUM OBSERVED					MC			–	–	–
99448	8.00	7.70	0.75	7.63	5.64	1.51	MB	.05	–4.13	–27 .14	–25 –.82	–44 +.55
99690	9.68	9.50	0.35	9.24	7.68	1.30	MB	.06	–3.86	–	–	–
100141	8.90	8.65	0.55	8.51	6.72	1.41	MB	.05	–4.01	6 .02	–25 –.60	–19 +.80
100766	9.00	8.95	0.22	8.54	7.17	1.23	MB	.06	–3.76	–	–	–
102620	5.31	5.36	0.16	4.85	3.62	1.19	MB	.03	–3.74	–3 RHO = +7	–13	–8
123214	6.91	6.90	0.05	6.45	5.26	1.08	MB	.04	–3.50	–9 RHO = +8	–24	–8
123934	5.17	5.28	–.54	4.80	3.83	0.80	MA	.02	–2.74	–12 RHO = +18	–11	9
124036		NO MAXIMUM OBSERVED					MB			–	–	–
124188	9.47	9.40	0.15	9.01	7.67	1.19	MB	.06	–3.69	75 .65	–59 –.40	39 +.64
124304	7.20	7.15	0.15	6.74	5.42	1.19	MB	.04	–3.72	16 RHO = –45	–24	–63
124989	9.45	8.68	1.37	9.16	6.22	1.84	MB	.05	–4.63	–	–	–
125024		NO MAXIMUM OBSERVED					MB			–	–	–
125146	8.84	8.38	1.00	8.49	6.17	1.63	MC	.05	–4.32	25 .64	–1 –.34	23 +.68
125356		NO MAXIMUM OBSERVED					MC			–	–	–
125624	8.17	8.20	–.22	7.77	6.67	0.93	MA	.05	–3.08	4 .68	9 –.38	10 +.67

8. NOTES ON THE KNOWN VARIABLES

The types and periods are quoted from the General Catalogue of Variable Stars (1969).

V Eri	(HD 25725)	SRc	97^{d}	The current observations agree with the type and period.
R Ret	(HD 29383)	M	$278^{d}\cdot 32$	No maximum or minimum observed.
R Dor	(HD 29712)	SRb	$338^{d} \pm$	Minimum observed at JD 2440625.
R Cae	(HD 29844)	M	$391^{d}\cdot 02$	Ephemeris maximum at JD 2440653. Observed maximum at JD 2440645.
T Dor	(HD 30642)	M	$167^{d}\cdot 6$	Ephemeris maximum at JD 2440636. Observed maximum at JD 2440665. The mean period from epoch JD 2429910 is $168^{d}\cdot 0$.
SY Vel	(HD 79402)	SRb	63^{d}	The current observations agree with the type and period.
RT Sex	(HD 88517)	Lb		Irregular, but period observed about 80^{d}.
FF Hya	(HD 92096)	SR	20^{d}	Observed period 85^{d}, amplitude 0·4 mag.
SX Leo	(HD 95850)	Lb		Irregular, period about 100^{d}.

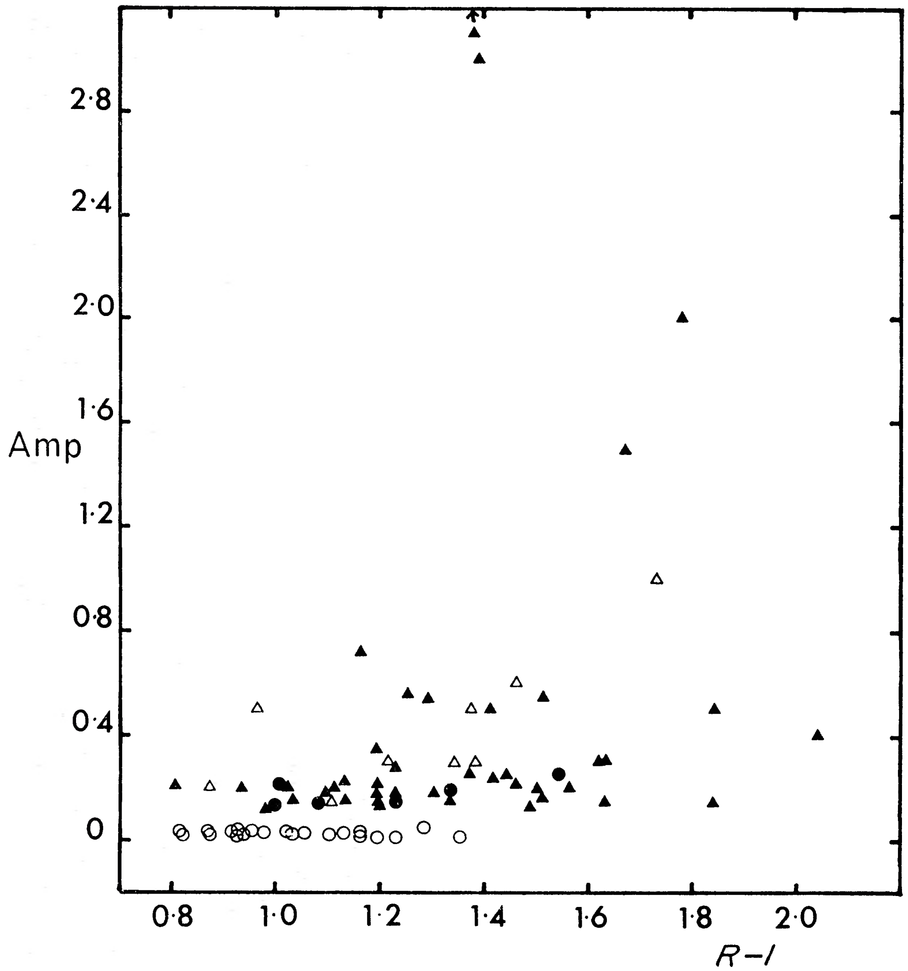

FIG. 13. *The visual light amplitude DV_8 as a function of the mean value of R–I for the constant stars and of the minimum value of R–I for the EC and P variables.*

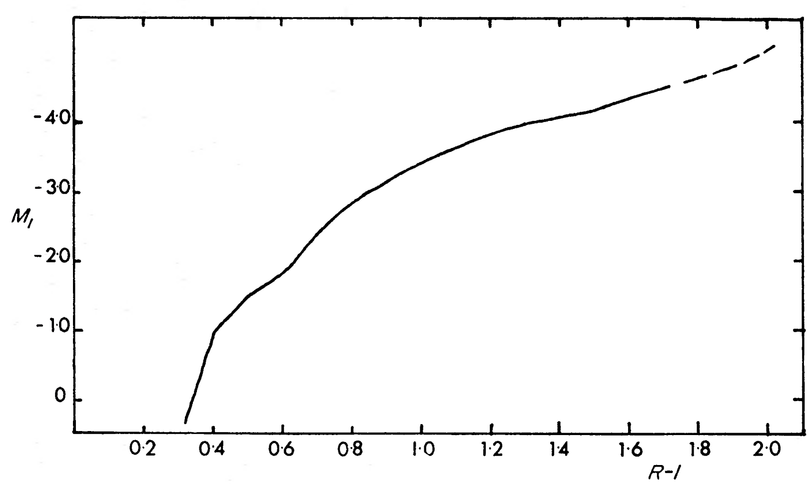

FIG. 14. *The M_I, R–I relation. For R–I* 0·3 *to* 0·65 *from Eggen* (1971), *for R–I* 0·65 *to* 1·8 *from Eggen* (1970).

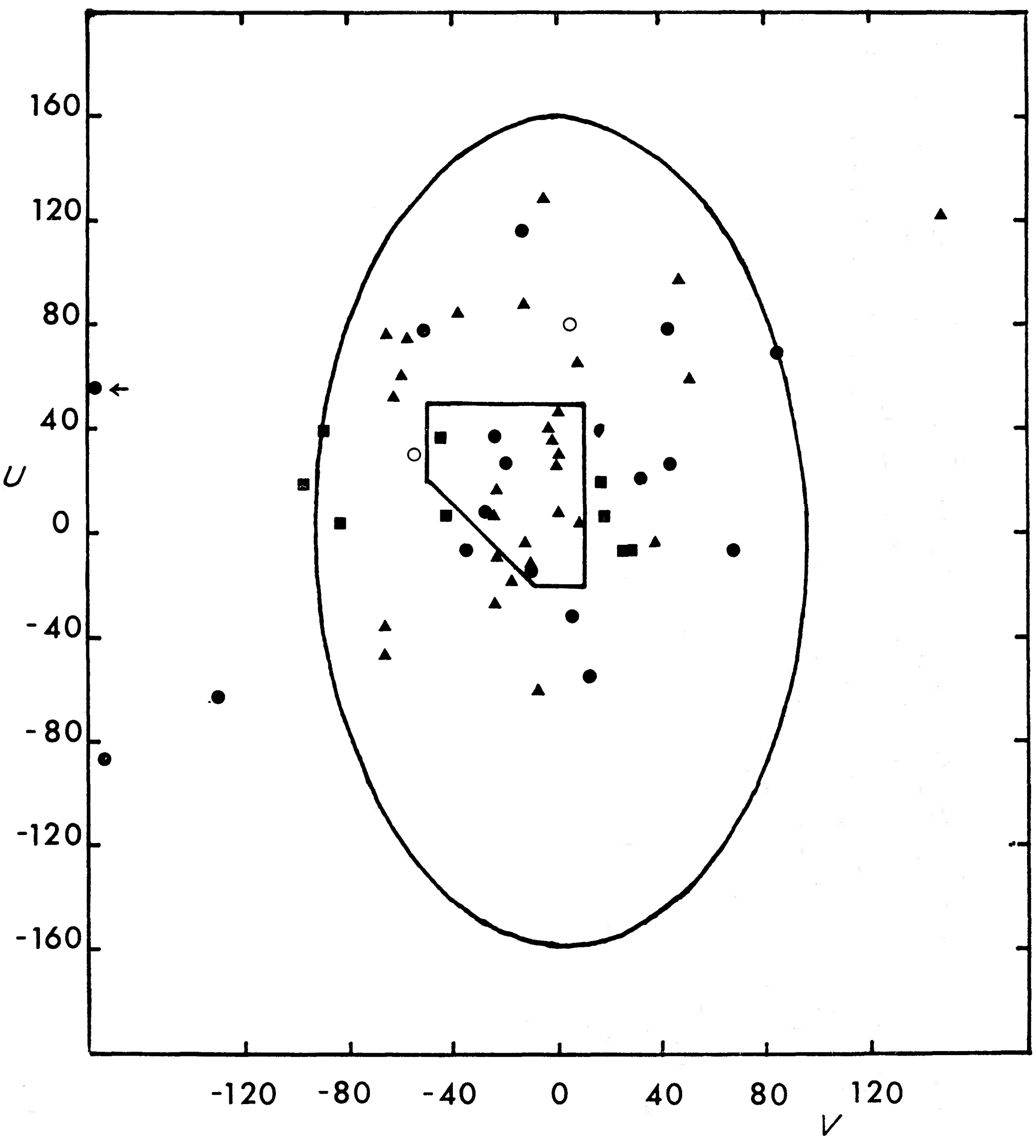

FIG. 15. *The positions of the stars in the (U, V) plane.*

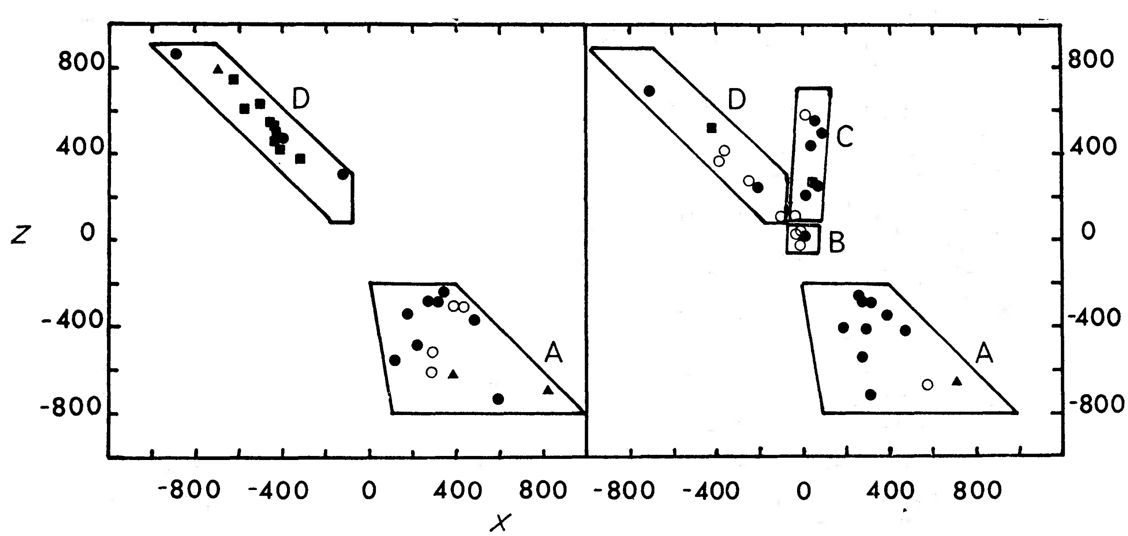

FIG. 16. *The positions of the stars in the (X, Z) plane.*

T Crt	(HD 99056)	SRb	$70^{d}\pm$	The cycle observed has a period of about 100^{d}.
AN Vir	(HD 125146)	SRb	100:	The cycle observed has a period of about 90^{d}.

9. CONCLUSIONS

Grouping together the erratic and quasi-periodic we have the following percentages of variable stars of spectral types Ma and Mb:

	Ma	Mb	
Region A:	36%	64%	
Region B:	—	100%	
Region C:	—	93%	
Region D:	50%	88%	

Also

SGP:	14%	72%	(Eggen 1970)

On the average then, one may expect to find 1/3 of those stars classified Ma and 4/5 of those stars classified Mb in the HD catalogue to be variable.

The result for the spatial distribution of the different populations is the same as that obtained by Eggen, Lynden-Bell & Sandage (1962), Eggen (1969) and (1970): i.e. that the young disk stars are within 400 parsecs of the galactic plane, the old disk stars within 900 parsecs of the plane and the halo stars from 600 parsecs outwards.

The small sample of K-stars observed forms a fairly compact group of old disk objects. These stars were all constant and so we can only estimate that the proportion of field giants with lower metal abundance is small in the region studied.

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REFERENCES

Abt, H. A. & Golson, J. C., 1962. *Astrophys. J.*, **136**, 363.
Blackwell, K. L. & Lowne, C. M., 1968. *R. Obs. Bull.*, No. **142**.
Eggen, O. J., 1969. *Publ. astr. Soc. Pacific*, **81**, 553.
Eggen, O. J., 1970. *Astrophys. J. Suppl.*, **22**, 289.
Eggen, O. J., 1971. *Astrophys. J.*, **163**, 313.
Eggen, O. J., Lynden-Bell, D. & Sandage, A., 1962. *Astrophys. J.*, **136**, 748.
Hoffleit, D., 1968. *Trans. Yale Obs.*, **28**.
Hoffleit, D., 1969. *Trans. Yale Obs.*, **29**.
Hoffleit, D., 1970. *Trans. Yale Obs.*, **30**.
Ikaunieks, J., 1966. *Trans. Astrophys. Lab. Acad. Sc. of Latvian S.S.R.*, **X**.
Kukarkin, B. V. *et al.*, 1969. *General Catalogue of Variable Stars*, ANSSR, Astr., Soviet.
Sharov, A. S., 1964. *Sov. Astr. A.J.*, **7**, 689.