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VARIABLE STARS IN HIGH GALACTIC LATITUDES

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When the systematic study of variable stars in the Milky Way was begun on a comprehensive plan at the Harvard Observatory about ten years ago, seventy two variable star fields were also selected for comparative purposes in various high galactic latitudes. The emphasis for several years on the fields in low latitude has led to the discovery and study of about two thousand variable stars, most of them in the fourth quadrant of the Milky Way (λ 270° to λ 360°). It now appears advisable to shift the emphasis to the fields in high latitude, where the irregularities of galactic structure and the difficulties with the general and localized absorption of light do not seriously affect deductions concerning galactic dimensions and the space frequency of variable stars. The studies in low latitude have provided much information concerning individual variables and the relative frequencies of the various types; but they do not contribute so satisfactorily to knowledge of distances as do studies of regions in latitudes higher than ±30°.

The chosen high latitude fields (see Harvard Reprint 68, Fig. 17, and accompanying text) have been photographed regularly during the past few years, chiefly with the 10-inch Metcalf telescope at Bloemfontein, and for several of the fields the accumulation of plates has been sufficient for a study of the variable stars. Miss Hughes has published in the Harvard Bulletins a report of her work on three of the southern high latitude fields. The results are summarized in Table I. For work on many of the variables, especially the bright stars of long period, the survey plates were supplemented by large numbers of other plates from the observatory's collection.

TABLE I

Field	λ	β	Number of Plates Survey	Number of Plates Others	Variables Known	Variables New	Publication
MWF 213	0°	−60°	144	286	2	35	H.B. 883
215	180	−60	110	89	1	20	877
217	180	−80	97	21	1	10	877

The cluster type Cepheid variables in fourteen of the high latitude fields (including those listed above) have been discussed provisionally by Shapley (Harvard Reprint 81, 1933) in their bearing on the problem of the dimensions of the galactic system. The material is both important and scanty. The cluster type Cepheid is certainly one of the most useful instruments available for the measurement of the Galaxy. Recent work on the proper motions of the nearer members of this class have fully supported the earlier indication that the absolute median magnitude of cluster type Cepheids is very close to zero (H.B. 893, 1933). The dispersion of cluster Cepheids throughout all latitudes also adds greatly to

TABLE II

DATA ON EIGHT FIELDS

MWF	R.A.		Dec.	λ	β	No. Pairs of Plates Compared	Number of Positives	Plates		Variables		Sequence
	h	m	°	°	°			MF	Others	New	Known	
202	21	30	+25	45	−20	46	4	130	98	67	6	S.A. 66 / Star Counts
204	3	43	+24	135	−20	25	3	111	173	17	9	Taurus 19 / Star Counts
209	21	05	−15.5	0	−40	32	4	118	96	70	9	Star Counts
211	4	12	−15.1	170	−40	40	4	111	37	32	3	S.A. 120
212	0	40	−78	270	−40	42	3	80	400	63	5	Star Counts
214	0	50	+00.3	95	−60	36	3	84	68	17	1	Star Counts
216	0	40	−58	270	−60	36	4	99	150	22	4	Star Counts
218	0	00	−29.7	356	−80	41	4	95	120	21	2	Star Counts

their usefulness in measuring distances. Furthermore, the recent investigations of external galaxies at Mount Wilson and Harvard have shown quite definitely that in latitudes higher than $\pm 30°$ light absorption is not sufficient to interfere with our use of Cepheids in the photometric measurement of distance.

By studying the magnitudes of the faint cluster type Cepheids in the galactic polar cap, we therefore readily obtain a measure of the extent of the system at right angles to its plane; and through our studies of the faintest attainable variables of this class between galactic latitudes 20° and 30° we may be able to learn more about the extent of the Milky Way system in its own plane than we can by photometric investigations near the darkness-troubled galactic circle.

To carry out successfully the investigation of galactic measurements, it has accordingly become necessary within the past year to inaugurate a program for covering completely the high galactic latitude skies. To magnitude 15.5 or 16.0 the number of cluster type Cepheids

TABLE III

DISTRIBUTION AMONG TYPES

MFW	Total New	Number Known	Eclipsing No.	Eclipsing Per cent	Cluster No.	Cluster Per cent	Cepheid No.	Cepheid Per cent	Long Period No.	Long Period Per cent	Irregular No.	Irregular Per cent	Short or Unknown No.	Short or Unknown Per cent
202	67	6	25	34	14	19	0	0	18	25	9	12	7	10
204	17	9	6	23	3	12	0	0	5	19	7	27	5	19
209	70	9	19	24	34	43	1	1	5	6	14	18	6	8
211	32	3	10	29	13	37	0	0	3	8	7	20	2	6
212	63	5	17	25	25	37	3	4	6	9	11	16	6	9
213	35	2	12	32	15	41	0	0	5	13	1	3	4	11
214	17	1	2	11	7	39	0	0	1	5	3	17	5	28
215	20	1	8	38	7	33	0	0	1	5	0	0	5	24
216	22	4	2	7	13	50	0	0	5	19	3	12	3	12
217	10	1	1	9	7	64	0	0	1	9	0	0	2	18
218	21	2	5	22	10	43	0	0	4	17	2	9	2	9
Total	374	43	107	23	148	38	4	0.4	54	12.3	57	12.3	47	14

per field of one hundred square degrees will be small, and the project will be expensive in photographic plates when compared with studies in the rich regions of the Milky Way. We believe, however, that the ultimate contribution to knowledge of variable stars as well as to the measurement of the Milky Way will justify the plan. The plates are being made with the 8-inch Bache and 10-inch Metcalf telescopes at the Boyden Station and with a new 8-inch Ross lens at the Oak Ridge Station.

A preliminary examination of thirty nine fields on the basis of only five plates for each field has resulted in the discovery of a total of 556 new variable stars. Nearly forty per cent of these are cluster type Cepheids. Altogether, the Harvard survey has added about 300 cluster type variables to the 153 already known in latitudes greater than $\pm 20°$. Most of these stars are fainter than the thirteenth magnitude, and the median magnitudes of many correspond to distances in excess of ten thousand parsecs.

In addition to the three fields already published, eight other high latitude fields have now been investigated in detail by Miss Hughes and the results are given in the accompanying tables. The positions of the fields and data concerning the photographic plates, the variables, and the comparison star sequences are given in Table II. A total of 309 new variable stars have been found in fields where only thirty nine were heretofore known. The variables were found by the method of the superposition of positives and negatives. Plates made in the seven year interval from 1926 to 1933 in the MF series (10-inch Metcalf) have been used almost exclusively for Cepheids and eclipsing stars, but additional plates of various series were used from the plate collection for long period variables and some of the irregular stars. These additional plates extend over the interval from 1890 to 1933.

The sequences have been established, except for Field 211, by the star count method, which should be fairly dependable in the magnitude range here involved. For Fields 202 and 204, in galactic latitude – 20°, we have supplemented the star count sequences with a Selected Area sequence (Kapteyn) and a special magnitude sequence established by Miss Payne.

The distribution of the variable stars among the various types is shown for each field in Table III, where, for purposes of comparison, are also included the previously published fields, Nos. 213, 215, and 217. The almost complete absence of classical Cepheids in these regions is noteworthy. The considerable number of variables now classed as irregular will decrease with further study. Among the eclipsing stars is a high percentage of W Ursae Majoris variables; they are probably nearby double star systems of approximately solar brightness.

It is not possible to publish the individual observations or the light curves of the 309 new variable stars found in the eight fields. In Table IV, however, the results are collected for each field in the form used in previous publications. For stars of the W Ursae Majoris type the published periods are of course twice the intervals between successive minima. Most of the work on Fields 209 and 216 was done by Miss Olmsted. Special remarks on individual fields and on some of their variable stars follow:

MWF 204. This field is centered on the Pleiades, which make nearly one square degree in the central part of the field scarcely usable. For a low latitude, the region has surprisingly few variables, and those found are of an unusual brightness, which perhaps indicates their position in front of the obscuring matter in Taurus. The obscuration may also account for the many irregular variables.

The known variable WZ Tauri is a close double star. On the assumption that the preceding component is a non-variable of magnitude 12.8, the measures of the combined light, when corrected, show for the following component a semiregular variation with a range from $12^m.4$ to $15^m.4$, in cycles of about 150 days. YZ Tauri is of the W Ursae Majoris type; the elements are J.D. 2425570.4 + $0^d.822947$. This period, the longest of the three suggested for the star by Kooreman (B.A.N., **5**, 209, 1930), satisfies the 109 MF (10-inch) observations as well as thirty nine of Kooreman's forty five current observations. The variable 47.1933 seems to be of irregular type rather than a classical Cepheid, as was suspected by Rügemer (A.N., **248**, 410, 1933). UU, VV, VW, 90.1901, 46.1933, and 49.1933 Tauri were not found to be variable on these plates. They may be long period stars with no maxima appearing, or irregular variables, or possibly asteroids mistaken for variables.

MWF 209. The globular cluster Messier 72, with thirty one known variables, which is at the edge of this field, has not been included in the examination. The field is of interest because of the large number of stars that are variable, one of them an unusual classical Cepheid with a period of 1.32752 days.

MWF 211. There are fewer variables here than in other fields of the same galactic latitude, and, since many of those found are faint, the deficiency is apparently real and is not due to selection of plate material.

MWF 212. The field includes the southern portion of the Small Magellanic Cloud; the region which has been previously searched for variables on large scale plates has been omitted from the

TABLE IV VARIABLE STARS IN EIGHT HIGH GALACTIC LATITUDE FIELDS

H.V.	R.A.(1900)	Dec.	Max.	Min.	Type	Epoch J.D. 2420000.+	Period ^{d}	Remarks
					MWF 202			
6116	$21^h12^m54^s$	$+21°28'.8$	$12^m.8$	$13^m.3$	Eclipsing			
6117	14 55	+21 38.1	12.9	13.7	Eclipsing	4767.70	0.403252	W UMa type
6118	15 00	+22 56.3	14.8	15.4	Eclipsing			W UMa type
6119	16 41	+23 56.2	12.6	[16.5	Long	4800	409.0	35 epochs
6120	18 25	+26 36.3	13.6	14.5	Eclipsing	4759.70	0.251828	W UMa type
6121	18 26	+21 39.0	13.3	14.2	Eclipsing			11 minima
6122	18 31	+23 28.3	13.3	14.7	Cluster	4758.70	0.55543	
6123	18 48	+23 02.7	12.9	[16.0	Long	4800	426.0	37 epochs
6124	21 01	+27 25.6	12.8	13.5	Eclipsing	4767.70	0.45347	W UMa type
6125	22 35	+20 57.0	12.0	12.6	Eclipsing			
6126	22 38	+27 44.5	11.9	12.5	Short			
6127	23 22	+26 08.2	12.7	[16.5	Long	4800	414	7 epochs
6128	23 30	+22 44.9	13.4	14.1	Short:			
6129	23 40	+25 25.8	14.4	15.1	Eclipsing			W UMa type
6130	23 55	+21 36.8	13.4	14.0	Short:			
6131	26 18	+24 40.5	14.0	14.8	Eclipsing	4769.66	0.377052	W UMa type
6132	27 18	+28 13.8	13.0	13.6	Short:			
6133	27 20	+26 57.2	13.2	14.5	Semiregular:			Red; 140 obs.
6134	27 22	+28 59.8	13.2	14.3	Eclipsing			11 minima
6135	27 47	+24 02.9	11.1	12.2	Semiregular:			
6136	28 08	+27 18.1	13.2	13.7	Short			
6137	28 43	+22 18.1	12.0	12.5	Eclipsing	4850.74	0.246078	N.1; W UMa type
6138	29 47	+20 31.5	13.7	16.3	Eclipsing	4789.60	1.57485	
6139	30 54	+27 04.7	14.5	[16.5	Long	5130	260	7 epochs
6140	31 14	+27 52.0	12.9	15.1	Long	4770	194	N.2;74 epochs
6141	31 58	+25 52.4	11.9	13.2	Cluster	4791.70	0.55678	Follows $13^m.4$ comp.
6142	32 38	+23 39.7	12.3	12.9	Long:	4767	78.8	N.3;194 epochs
6143	32 51	+25 41.7	13.7	14.8	Irregular			Red
6144	33 26	+28 29.1	13.1	13.7	Short			
6145	33 32	+26 21.4	14.2	16.3	Long	4770	306	6 epochs
6146	33 36	+21 02.9	14.1	15.2	Eclipsing	4772.65	1.58392	
6147	33 52	+24 27.3	11.0	12.5	Irregular			
6148	34 11	+25 56.8	13.5	14.2	Eclipsing			Red; W UMa type
6149	34 25	+26 15.3	11.3	12.3	Eclipsing	4786.60	0.280422	W UMa type
6150	34 29	+21 24.9	13.3	14.0	Irregular			Short?
6151	34 29	+27 39.7	12.9	13.6	Eclipsing	4745.75	0.341935	W UMa type
6152	34 54	+22 34.5	10.6	11.1	Eclipsing			
6153	35 16	+25 54.7	14.0	15.3	Eclipsing	4763.70	1.25797	
6154	35 16	+27 57.8	12.6	13.3	Eclipsing	4791.68	0.60563	Secondary min. $12^m.9$
6155	36 06	+20 38.0	13.6	14.7	Cluster	4769.65	0.57104	
6156	36 19	+24 42.4	13.2	14.2	Eclipsing	4789.60	0.64202	
6157	36 44	+25 44.9	14.8	15.5	Eclipsing	4766.70	0.413728	W UMa type
6158	36 48	+24 19.6	10.8	12.2	Cluster	4761.70	0.46715	
6159	36 54	+22 43.7	13.2	13.8	Cluster	4762.70	0.50173	
6160	37 48	+21 44.6	13.5	15.0	Cluster	4745.70	0.71857	

H.V.	R.A.(1900)	Dec.	Max.	Min.	Type	Epoch J.D. 2420000.+	Period d	Remarks
					MWF 202(continued)			
6161	$21^h 38^m 00^s$	+21° 13'.2	$12^m.3$	$13^m.2$	Long	4810	260	N.4;57 epochs
6162	38 14	+28 22.4	11.0	11.8	Irregular			Possibly short
6163	38 18	+25 10.4	14.3	16.0	Long	5450	181.5	66 epochs
6164	38 38	+23 17.6	14.8	15.8	Cluster	4744.70	0.37783	
6165	38 55	+26 23.8	13.8	15.2	Cluster	4745.70	0.63214	
6166	40 42	+26 16.6	13.6	14.3	Short			Eclipsing?
6167	40 44	+22 00.6	13.9	16.5	Long	4800	260	7 epochs
6168	41 07	+25 43.1	14.6	15.8	Cluster	4769.65	0.57872	
6169	41 47	+26 28.5	13.4	14.8	Cluster	4761.70	0.57202	
6170	42 14	+26 02.8	14.3	15.5	Long	4825	203.5	21 epochs
6171	42 22	+24 15.3	12.8	14.6	Cluster	4763.70	0.56454	
6172	42 49	+25 05.3	12.3	14.2	Long	5150	351.5	43 epochs;217 obs.
6173	43 17	+26 47.5	11.1	14.3	Eclipsing	5444.53	3.8800	
6174	43 38	+21 47.4	12.9	14.4	Cluster	4744.70	0.56288	
6175	44 02	+27 39.3	11.8	16.1	Eclipsing	4759.70	2.3726	
6176	44 08	+22 14.7	12.7	13.9	Irregular			Red
6177	44 42	+25 24.7	11.6	12.7	Semiregular:			215 obs.
6178	44 57	+22 13.5	13.2	16.5	Long	4800	235.0	N.5;61 epochs
6179	45 11	+20 41.0	12.3	13.4	Cluster	4769.65	0.64795	
6180	45 54	+24 34.5	13.4	14.4	Eclipsing	4758.70	0.56223	Secondary min. $13^m.9$
6181	47 30	+22 05.5	10.6	11.7	Cluster	4759.70	0.39036	BD+21°4633
6182	49 25	+26 35.2	13.3	16.1	Long	5420	360	41 epochs
					MWF 204			
6183	3 25 05	+28 21.2	11.8	13.2	Semiregular			
6184	27 37	+26 32.4	13.7	14.2	Short			
6185	30 29	+23 50.7	13.8	15.4	Long	5150	240	70 epochs;108 obs.
6186	34 51	+26 21.0	13.2	13.9	Semiregular			
6187	41 13	+24 48.5	11.3	12.4	Cluster	4769.80	0.1663334	
6188	41 48	+28 04.8	13.1	13.8	Eclipsing			W UMa type
6189	42 20	+22 00.8	11.9	12.6	Short			
6190	42 30	+20 02.6	13.5	15.5	Cluster	4801.80	0.56856	
6191	43 06	+25 17.0	12.4	13.2	Short			
6192	43 33	+26 12.3	12.8	13.8	Semiregular			
6193	45 00	+20 11.1	13.6	14.6	Cluster			Too few maxima
6194	45 37	+25 27.4	11.9	12.7	Irregular			
6195	47 12	+19 54.5	10.0	12.0	Irregular			BD+19°607; semireg.?
6196	48 45	+23 01.8	11.6	12.2	Short			
6197	56 47	+20 46.5	11.8	15.8	Long	5570	243	BD+20°688;70 ep;155 obs.
6198	59 12	+22 13.7	10.8	11.5	Short:			N.5; BD+22°628
6199	4 01 20	+27 35.4	13.9	14.6	Eclipsing			W UMa type;too few obs.

H.V.	R.A. (1900)	Dec.	Max.	Min.	Type	Epoch J.D. 2420000.+	Period d	Remarks
					MWF 209			
6200	$20^h47^m03^s$	-15° 25'.8	$13^m.1$	$13^m.7$	Cluster:			
6201	47 17	-17 17.3	13.5	14.5	Eclipsing			Too few minima
6202	48 01	-15 02.1	12.8	14.2	Irregular			
6203	48 25	-17 49.8	13.5	14.5	Cluster	5413.60	0.62553	
6204	48 27	-14 09.6	14.3	15.4	Cluster	5481.40	0.63238	
6205	49 05	-13 14.5	15.4	16.0	Cluster			
6206	49 31	-13 26.1	14.1	14.7	Eclipsing			
6207	49 40	-12 43.3	13.0	14.7	Cluster	5442.50	0.453325	
6208	50 00	-18 06.0	13.5	14.3	Long:	5500	139:	N. 6
6209	50 10	-12 46.2	13.0	13.9	Irregular			
6210	51 02	-16 02.4	14.0	15.3	Cluster	5498.40	0.53282	
6211	51 42	-17 20.6	13.5	14.6	Semiregular			
6212	51 50	-13 35.4	14.2	14.8	Eclipsing			
6213	52 39	-11 25.2	12.7	14.2	Cluster	5447.50	0.65781	N. 5
6214	52 44	-13 36.6	12.5	14.1	Cluster	5418.60	0.53100	N. 5
6215	52 52	-11 43.8	13.0	13.7	Irregular			
6216	53 16	-11 06.4	13.1	14.1	Semiregular			Irregular?
6217	53 38	-18 31.0	14.0	15.4	Cluster	5479.40	0.50177	
6218	53 53	-14 24.8	14.2	15.8	Cluster	5449.55	0.49706	
6219	55 20	-12 16.0	14.0	15.7	Long:	5445	163:	N.7
6220	55 25	-12 28.4	12.3	13.3	Semiregular			
6221	55 28	-13 01.0	13.4	14.0	Eclipsing			
6222	55 35	-11 27.3	12.9	13.8	Cluster	5425.57	0.12406	Preceding of pair
6223	55 58	-11 03.5	12.9	13.7	Cluster			Following of pair
6224	57 11	-19 39.8	13.8	14.8	Irregular			Semiregular?
6225	57 37	-19 05.3	13.0	13.9	Eclipsing			W UMa type
6226	58 16	-19 10.8	11.1	11.6	Irregular			BD-19° 6003;very red
6227	58 23	-11 58.0	15.3	16.1	Short			
6228	58 36	-17 50.3	12.6	13.5	Cluster	5409.60	0.31426	
6229	59 07	-13 10.7	13.1	13.7	Short			Following of pair
6230	59 58	-14 58.6	14.5	15.0	Eclipsing			
6231	21 00 03	-15 00.8	13.8	14.4	Eclipsing			W UMa type:
6232	00 33	-14 47.4	14.3	15.5	Cluster	5413.60	0.59542	
6233	00 45	-19 13.5	13.8	15.5	Cepheid	5418.60	1.32752	1450 epochs
6234	00 48	-11 29.5	14.2	15.4	Eclipsing			Too few minima
6235	01 28	-13 10.8	12.6	13.3	Short			
6236	01 44	-13 24.4	14.4	15.1	Eclipsing:			Too few minima
6237	01 52	-17 02.3	15.6	16.2	Cluster:			
6238	02 24	-12 52.0	12.1	12.9	Irregular			Red
6239	02 27	-11 57.0	12.2	12.6	Eclipsing			
6240	02 56	-14 17.6	13.0	13.6	Eclipsing	5409.40	0.70356	W UMa type
6241	02 58	-13 25.2	12.5	13.6	Long	5170	105.5	240 obs.;30 ep;very red
6242	03 08	-15 38.0	16.2	16.7	Cluster			
6243	03 30	-19 23.6	13.1	13.6	Short			
6244	03 31	-14 51.2	13.2	13.9	Cluster	5423.60	0.60189	
6245	03 46	-16 15.0	15.4	16.0	Cluster			
6246	03 54	-15 47.5	14.4	15.8	Cluster	6447.55	0.64464	
6247	04 41	-14 44.8	13.7	14.9	Cluster	5481.40	0.56107	
6248	05 24	-16 03.3	14.3	15.9	Cluster	5447.55	0.46572	
6249	05 30	-14 42.3	13.7	14.5	Eclipsing	5424.58	0.98006	

H.V.	R.A.(1900)	Dec.	Max.	Min.	Type	Epoch J.D. 2420000.+	Period ^{d}	Remarks
					MWF 209(continued)			
6250	$21^h05^m45^s$	$-10°49'.4$	$12^m.6$	$14^m.0$	Cluster	5442.50	0.56985	Following of pair
6251	05 45	-14 23.4	13.6	14.5	Eclipsing	5423.65	0.51449	Sec. min. $14^m.2$; β Lyr
6252	06 30	-12 52.4	15.6	16.2	Cluster:			Following of pair
6253	06 48	-18 26.8	14.7	15.8	Cluster	5439.50	0.85524	
6254	07 09	-17 48.3	13.7	14.9	Cluster	5413.60	0.46564	
6255	08 36	-12 18.0	13.5	14.5	Irregular			Semiregular?
6256	10 52	-13 00.0	14.3	16.2	Cluster	5423.65	0.53966	
6257	11 16	-14 27.8	13.3	13.8	Cluster:			
6258	12 27	-13 03.8	15.2	15.9	Eclipsing			Too few minima
6259	13 00	-11 40.0	14.6	16.2	Cluster	5447.55	0.48297	
6260	13 12	-19 34.0	14.0	14.5	Eclipsing			
6261	13 59	-15 32.1	10.9	11.6	Cluster			BD-15°5948
6262	16 13	-14 43.6	12.4	[16.6	SS Cygni			N. 8
6263	17 16	-14 22.2	14.3	15.1	Cluster			
6264	17 46	-15 36.1	14.0	14.7	Eclipsing	5424.58	0.313086	W UMa type
6265	18 33	-12 58.8	14.5	15.3	Eclipsing			W UMa type
6266	20 11	-13 57.5	12.1	12.7	Eclipsing			Too few minima
6267	20 30	-15 28.2	12.5	13.5	Cluster			
6268	21 10	-18 44.4	14.5	15.1	Cluster:			
6269	21 44	-19 33.6	12.7	13.8	Short			
					MWF 211			
6270	3 57 31	-13 57.7	14.0	14.7	Cluster	4772.80	0.50690	
6271	57 31	-14 01.7	12.8	[16.3	Long	4820	400	33 epochs
6272	57 40	-12 23.3	14.2	15.3	Cluster	4767.90	0.71016	
6273	4 01 34	-18 55.3	11.8	12.4	Irregular			BD-19°816
6274	05 25	-14 20.9	14.5	15.0	Short			
6275	06 43	-14 07.0	12.7	13.5	Cluster	4763.90	0.55425	
6276	06 53	-15 39.4	14.6	[16.5	SS Cygni			N. 9
6277	07 08	-12 03.0	11.5	12.2	Eclipsing			BD-12°818
6278	07 21	-14 36.6	12.7	13.4	Eclipsing			
6279	07 36	-18 11.3	15.4	16.1	Cluster	4766.85	0.35744	
6280	08 20	-11 00.4	13.9	15.0	Eclipsing	4766.85	0.45206	Secondary min. $14^m.4$
6281	09 02	-11 49.2	12.8	13.3	Eclipsing	4801.80	0.50085	
6282	11 16	-18 38.8	14.7	15.5	Cluster	4801.80	0.57400	
6283	11 33	-14 49.3	13.3	14.8	Cluster	4766.90	0.48207	
6284	13 20	-16 54.5	14.8	15.5	Cluster			
6285	13 27	-16 47.0	14.7	16.0	Cluster	5234.32	0.46988	
6286	14 29	-15 29.6	14.5	15.2	Cluster	4798.80	0.62140	
6287	15 32	-18 58.4	12.4	13.2	Irregular			
6288	15 38	-10 39.4	13.4	15.7	Long	5520	250	52 epochs
6289	16 03	-16 10.3	13.0	13.8	Irregular			Possibly short
6290	17 09	-14 18.2	13.2	14.2	Irregular:			
6291	17 46	-15 39.7	14.0	15.4	Cluster	4763.90	0.51248	
6292	18 04	-13 36.0	13.5	[16.5	SS Cygni			N.10
6293	18 26	-16 31.0	14.7	15.8	Cluster	4766.85	0.61950	
6294	18 39	-12 36.2	14.2	15.0	Eclipsing			11 minima

H.V.	R.A.(1900) Dec.		Max.	Min.	Type	Epoch J.D. 2420000.+	Period d	Remarks
					MWF 211(continued)			
6295	4h 20m 46s	-11°50′.8	12.3	13.3	Irregular			
6296	21 10	-19 02.1	12.5	13.5	Eclipsing	5201.45	2.6303	
6297	23 37	-17 24.2	13.3	14.4	Cluster	5244.35	0.65694	
6298	25 14	-12 27.9	14.4	15.2	Eclipsing	4791.85	0.31643	N.11; W UMa type
6299	27 30	-17 33.7	14.4	15.4	Eclipsing	4772.84	0.42821	Secondary min. 14m.9
6300	27 37	-17 58.3	11.8	13.8	Eclipsing	5586.40	9.299	
6301	28 10	-16 44.5	14.9	15.7	Cluster	4744.90	0.42114	
					MWF 212			
6302	23 08 12	-79 21.0	15.0	16.2	Cluster	5441.60	0.62774	
6303	18 30	-77 35.6	13.0	16.0	Irregular			
6304	28 51	-79 12.7	15.2	16.2	Cluster:			
6305	31 05	-80 23.0	13.9	15.7	Cluster	5447.60	0.41247	
6306	32 06	-78 15.8	14.8	15.5	Eclipsing			W UMa type
6307	40 10	-82 02.7	14.7	16.1	Cluster	5451.45	0.58341	
6308	41 18	-79 15.5	13.8	14.9	Eclipsing			
6309	44 12	-74 45.2	13.5	14.9	Cluster	5481.50	0.55891	
6310	44 43	-79 14.3	12.9	13.7	Cluster	5447.60	0.56772	
6311	45 44	-74 49.7	13.2	14.9	Cluster	5451.55	0.56030	
6312	46 08	-74 07.6	12.2	13.0	Short			
6313	47 35	-78 25.6	12.8	13.6	Irregular			XX Ophiuchi type
6314	49 16	-77 33.9	12.8	13.6	Cluster?			
6315	57 24	-79 26.6	14.9	15.7	Eclipsing:			
6316	58 55	-76 22.8	14.1	14.7	Cluster:			
6317	0 00 21	-78 42.5	15.4	16.0	Short			
6318	00 57	-74 40.0	14.9	15.8	Cluster	5479.55	0.46619	N.5
6319	01 20	-76 54.9	13.9	14.7	Eclipsing			
6320	05 35	-75 44.0	14.8	16.4	Cepheid	5565.20	10.093	134 obs.;1493 epochs
6321	07 44	-74 38.5	11.2	12.2	Irregular			Red; CPD-74°14
6322	09 01	-82 20.9	14.0	14.7	Eclipsing			
6323	09 24	-73 10.4	13.8	15.2	Cluster	5525.40	0.50909	
6324	10 39	-77 11.6	12.8	14.1	Eclipsing			
6325	14 17	-74 35.4	13.1	14.3	Irregular			XX Ophiuchi type?
6326	14 48	-80 28.2	12.0	13.0	Eclipsing	5452.56	0.90312	
6327	15 49	-74 26.2	15.4	[16.5	Irregular			SS Cygni type?
6328	16 39	-76 21.0	13.0	14.0	Eclipsing			
6329	20 03	-76 50.2	13.0	14.3	Cluster	5531.40	0.56875	
6330	22 15	-80 05.0	14.2	15.3	Short			
6331	24 27	-79 55.0	13.9	15.2	Eclipsing	5851.55	0.70108	β Lyrae-type
6332	25 04	-81 27.8	13.8	15.2	Cluster	5477.50	0.59396	
6333	29 07	-80 13.6	13.0	[16.1	Long	6200	281	96 obs.;55 epochs
6334	30 04	-73 49.3	11.4	[16.3	Nova			N.12
6335	36 41	-80 34.7	12.8	16.0	Long	6000	308.5	111 obs.;50 epochs
6336	42 55	-79 22.1	10.4	14.0	Eclipsing	5481.50	3.53597	288 obs.;CPD-79°16
6337	44 52	-75 08.6	13.3	14.3	Cluster			
6338	45 02	-77 32.2	15.0	16.3	Cluster	4789.60	0.45038	
6339	48 19	-76 31.7	13.2	13.8	Eclipsing:			
6340	53 00	-80 34.7	12.4	13.3	Irregular			
6341	58 05	-75 44.8	12.6	13.4	Cluster:			

H.V.	R.A.(1900) Dec.	Max.	Min.	Type	Epoch J.D. 2420000.+	Period d	Remarks
				MWF 212(continued)			
6342	$1^h04^m33^s$ -75°55′.6	12.0	12.8	Short			
6343	04 36 -82 24.4	13.3	14.3	Long	5800.	194	100 obs.;79 epochs
6344	05 16 -81 14.0	14.8	15.5	Short			
6345	07 35 -76 01.0	14.8	16.0	Cluster	5441.63	0.44108	
6346	08 02 -77 22.4	10.0	16.0	Long	5850	215.5	N.5;196 ep.;73 obs.
6347	09 33 -79 42.7	13.2	14.1	Eclipsing	5480.50	0.284038	W UMa type
6348	17 44 -81 51.3	13.4	13.9	Eclipsing			
6349	20 17 -82 05.3	14.8	16.2	RV Tauri	4780	157	117 obs.;98 epochs
6350	20 22 -80 50.3	11.8	12.8	Eclipsing	5477.40	7.19505	N.13
6351	20 52 -75 57.6	15.0	15.7	Short			
6352	30 25 -79 00.1	12.5	13.3	Cluster	5481.50	0.55577	
6353	31 23 -79 50.8	14.4	15.6	Cluster	5483.45	0.61966	CPD-75°103
6354	32 26 -75 45.3	11.0	15.5	Long	6650	319	215 obs.;50 epochs
6355	33 56 -74 23.7	13.8	15.5	Cepheid	5452.60	15.172	N.5;237 obs.;1010 ep.
6356	37 04 -76 04.2	14.8	16.2	Cluster	5439.60	0.54888	
6357	38 50 -75 00.8	12.5	14.4	Cepheid	5462.00	33.32	N.5;271 obs.;459 ep.
6358	43 02 -80 30.7	12.5	13.8	Cluster	5441.60	0.34835	
6359	43 37 -76 06.7	14.8	15.4	Eclipsing			
6360	43 40 -77 52.3	12.6	13.6	Eclipsing:			
6361	44 16 -78 15.4	14.5	15.8	Cluster	5444.65	0.53890	
6362	45 45 -80 41.2	11.0	12.0	Cluster			CPD-80°33
6363	45 46 -73 50.7	13.8	15.5	Cluster	5530.40	0.48760	
6364	49 50 -78 02.6	14.3	15.0	Eclipsing			W UMa type
6365	53 38 -76 52.2	11.0	11.8	Irregular			CPD-76°150
6366	2 01 23 -78 34.3	11.8	13.1	Irregular			
6367	08 10 -78 17.1	12.5	13.5	Cluster	5469.50	0.31067	
6368	19 00 -79 53.0	13.4	15.5	Irregular			R CrB type?
				MWF 214			
6369	0 32 54 +3 08.1	13.5	14.2	Short			Eclipsing?
6370	35 00 +2 23.0	14.0	14.5	Short			
6371	36 12 +4 47.7	13.8	15.4	Cluster	5177.30	0.521265	
6372	36 39 -3 33.6	15.0	15.7	Cluster			
6373	38 50 -0 30.8	15.0	16.2	Cluster			
6374	41 18 -3 48.7	13.8	14.5	Eclipsing			
6375	42 47 -1 51.6	13.2	14.6	Semiregular			Period around 200 days
6376	43 00 +0 18.0	13.5	14.4	Irregular			
6377	43 55 +1 53.0	13.4	15.0	Cluster	5197.35	0.52654	
6378	44 26 +1 50.6	13.7	15.2	Cluster	5197.35	0.54264	
6379	53 43 +2 31.8	12.4	13.0	Short			Cluster?
6380	57 22 +4 51.4	12.4	13.8	Cluster	5180.30	0.67354	
6381	59 17 -1 03.1	14.3	15.0	Short			Eclipsing?
6382	59 54 -3 14.9	12.5	13.2	Irregular			BD-3°147
6383	1 00 54 -0 50.8	14.0	15.4	Cluster			
6384	01 12 +1 57.4	14.0	14.7	Eclipsing:			
6385	01 55 +3 27.2	12.4	13.0	Short			

H.V.	R.A.(1900)	Dec.	Max.	Min.	Type	Epoch J.D. 2420000.+	Period d	Remarks
					MWF 216			
3019	0h10m17s	-60°46'.8	12.2	13.8	Long		105.2	With irregularities
6386	10 50	-59 26.1	13.3	14.4	Cluster	4765.80	0.62536	
6387	11 52	-55 54.1	14.4	14.9	Short			
6388	14 22	-56 42.4	14.2	14.8	Eclipsing			W UMa type
6389	19 32	-54 58.9	14.2	15.1	Cluster	4761.75	0.52654	
6390	21 51	-59 46.1	14.7	15.9	Cluster	4760.75	0.51104	
6391	22 23	-61 21.8	14.5	16.1	Cluster	4763.70	0.66517	
6392	25 48	-56 45.4	13.1	13.8	Irregular			
6393	30 39	-59 06.9	14.4	15.2	Cluster			
6394	31 27	-56 22.5	13.1	13.7	Irregular			
6395	32 56	-54 19.0	15.3	15.9	Cluster:			
6396	40 47	-60 18.6	14.6	15.6	Cluster	4761.75	0.73396	
6397	42 10	-55 10.0	11.7	12.2	Eclipsing			W UMa type;AGC-55°147
6398	45 36	-56 06.4	15.4	16.0	Cluster	4759.75	0.60650	
6399	46 52	-59 35.9	13.6	14.2	Cluster:			
6400	47 13	-56 23.2	13.7	14.4	Short			
6401	49 50	-57 41.0	13.4	14.2	Cluster:			
6402	58 55	-61 23.2	14.9	15.6	Short			
6403	59 02	-62 18.0	14.3	15.6	Cluster	4761.70	0.83750	N.5
6404	59 05	-57 18.5	13.6	14.1	Irregular			
6405	1 05 33	-57 06.7	14.9	15.8	Cluster	4765.80	0.55620	
6406	11 12	-59 51.8	13.3	14.5	Cluster	4762.75	0.45676	
6407	13 24	-61 32.3	13.8	15.1	Long:	5810	268	Secondary max. 14m2
					MWF 218			
6408	23 38 24	-32 40.0	13.0	13.8	Cluster:			CD-32°17640
6409	41 33	-30 33.5	14.3	15.2	Eclipsing			
6410	42 55	-33 32.0	14.8	16.0	Eclipsing			
6411	46 26	-29 43.9	14.3	14.9	Eclipsing	5446.60	1.1567	
6412	47 43	-30 43.8	14.3	15.4	Cluster	5449.60	0.59724	
6413	48 25	-33 00.4	14.7	15.4	Cluster:			
6414	49 28	-31 19.7	12.1	13.0	Irregular:			CD-31°19504
6415	49 30	-34 01.6	13.5	14.4	Cluster	5441.60	0.38110	
6416	50 12	-26 51.6	12.5	13.7	Cluster	5446.60	0.72777	
6417	52 57	-34 18.0	14.3	15.8	Cluster	5530.35	0.65020	
6418	55 41	-29 22.4	14.6	15.6	Cluster	5479.45	0.58293	
6419	56 15	-27 08.8	14.5	16.0	Eclipsing	5538.20	3.447	
6420	57 11	-30 03.1	14.2	14.9	Short			
6421	57 25	-30 59.4	13.8	[16.0	Irregular			Preceding of double
6422	0 00 57	-30 11.5	14.2	15.1	Short			
6423	01 09	-33 22.0	10.3	11.7	Long	5550	144	N.14;108 ep.;240 obs*
6424	01 52	-30 10.2	14.7	15.8	Cluster	5482.50	0.52943	
6425	02 29	-26 02.3	12.4	[16.3	Long	6160	411	N.5;38 ep.;173 obs.
6426	08 20	-29 05.4	15.8	16.5	Cluster:			
6427	10 43	-31 39.3	13.1	13.8	Eclipsing	5446.60	0.32084	CD-31°76;W UMa type
6428	11 53	-30 47.2	13.8	16.2	Long	5470	132.7	116 ep.;203 obs.

*CD-33°16843

NOTES TO TABLE IV

1. H.V. 6137 has an apparent change of period satisfied by the following elements: J.D. 2424850.74 + $0^{\mathrm{d}}.246078$ + $0^{\mathrm{d}}.18$ sin $0^{\circ}.034$E. There are 175 observations throughout 7800 epochs.
2. H.V. 6140. The period gives an anomalous light curve. Fifty days after primary maximum($13^{\mathrm{m}}.0$) there is a primary minimum at $14^{\mathrm{m}}.7$ followed forty days later by a secondary maximum at $12^{\mathrm{m}}.9$, much narrower than the primary maximum; thirty five days later there is a minimum at $15^{\mathrm{m}}.1$, followed twenty five days later by a 'hump' on the ascending branch of the curve, maximum at $14^{\mathrm{m}}.2$, minimum at $14^{\mathrm{m}}.4$. There are 145 observations, fourteen of them on plates of the A and I series(24-inch and 8-inch) between J.D. 2412343 and 2417430; the rest are later than J.D. 2424700. Additional observations may resolve the anomalies.
3. H.V. 6142 is definitely shown by yellow MC(16-inch Metcalf)plates to be red. The period $78^{\mathrm{d}}.8$ fits all but ten of the 172 observations. These ten are $0^{\mathrm{m}}.5$ brighter than the mean light curve, and occur on its descending branch fifty days after maximum, in 1919, 1921, and 1930. In these years the star was too scantily observed to show the exact nature of the irregularity.
4. H.V. 6161. A period of 260 days fits the 168 observations, but gives an anomalous light curve. From maximum the star decreases rapidly in brightness for sixty days, when it reaches a minimum at $13^{\mathrm{m}}.2$. It then rises for fifty days, to $12^{\mathrm{m}}.7$, where it remains almost constant for 100 days before rising to maximum.
5. The following ten variables have been discovered independently as noted, half of them between the time of Harvard discovery and the time of publication.

H.V.	Other Designation	Reference	Discoverer	Remarks
6178	Ross 124	A.J., 36,168, 1925	Ross	
6198	101.1934	A.N., 252,392, 1934	Morgenroth	Eclipsing variable
6213	BY Aquarii	A.N., 251,261, 1934	Schajn	
6214	BU Aquarii	A.N., 249,261, 1933	Neujmin,Okunev	Neujmin's 37 current obs. fit this period
6318	H.V. 809	H.A., 60,No.4, 1908	Leavitt	Small Magellanic Cloud
6346	H.V. 861	H.A., 60, " 4, 1908	"	" " "
6355	H.V.2233	H.A., 60, " 4, 1908	"	" " "
6357	H.V. 865	H.A., 60, " 4, 1908	"	" " "
6403	49.1932	A.N., 246,437, 1932	Luyten	
6425	150.1932	A.N., 247,281, 1933	Hoffmeister	

6. H.V. 6208. The period probably should be doubled, since the width of maximum appears to alternate between forty and sixty days.
7. H.V. 6219. Possibly the period should be doubled. The minimum magnitude fluctuates, being $15^{\mathrm{m}}.7$ in 1926, 1927, and 1928; $15^{\mathrm{m}}.0$ in 1928 and 1929, and $14^{\mathrm{m}}.3$ in 1930 and 1931.
8. H.V. 6262 has two observed maxima, at $12^{\mathrm{m}}.4$ on J.D. 2426505 and $15^{\mathrm{m}}.3$ on 2426205.
9. H.V. 6276 has only ten positive observations, all on recent plates. The rise and fall of this star, from the time of its first appearance to disappearance below the plate limit, do not occupy more than thirteen days. Observed maxima are:

Magnitude	Julian Day	Observations
14.8	2424798	6
14.6	5183	2
15.0	5867	2

10. H.V. 6292 has observed maxima occurring at the following times:

Magnitude	Julian Day	Magnitude	Julian Day
14.5	2413799	14.9	2425512
13.5	14885	14.0	5560
13.9	18278	14.1	5895
14.4	24804	14.9	5977
14.0	25183	14.0	6239
15.0	25244	15.0	6566

The rise and fall occupy not more than ten days.

11. H.V. 6298. There is a difference of $0^{\mathrm{m}}.15$ between successive maxima of this star, probably due to some periastron effect.
12. H.V. 6334. This star is probably a nova. Of the 553 observations covering the years 1890 to 1933, it is seen only late in 1927, when, during sixty days, it rises from less than $16^{\mathrm{m}}.0$ to $12^{\mathrm{m}}.9$: then, after a break of no observations for eighteen days, it falls from $11^{\mathrm{m}}.4$ to $14^{\mathrm{m}}.6$ in fifteen days. Two hundred days later, the star is seen at $15^{\mathrm{m}}.5$, and soon disappears below the plate limit. See H.B. 898, 1935.
13. H.V. 6350 is an eclipsing star showing eccentricity of orbit but no apparent rotation of the apsides. Throughout the 2243 epochs, with 293 observations, the period is constant. The secondary minimum, at $12^{\mathrm{m}}.4$, occurs 4.4 days after the primary minimum.
14. H.V. 6423 was discovered by Mrs. Fleming, but never published. She gave the range from B spectrum plates, as not more than $0^{\mathrm{m}}.5$, with a spectrum of Md3.

present study. Notable here are the three classical Cepheids, H.V. 6320, 6355, and 6357. The periods determined for them are uniform throughout forty two years, and fall on the period-luminosity curve, after a correction has been applied to bring the magnitude scale into agreement with the sequences in the Cloud; this conformity indicates that the variables are members of the Cloud. H.V. 6334 appears to be a nova that is also a member of the Cloud.

MWF 214. Surprisingly few variables are found in this field, perhaps because of extremely poor plate distribution. The star noted by Ross as variable, Number 136 (A.J., **36**, 168, 1925), was not found on the plates of the region; possibly it was an asteroid.

The bearing of the material of Table IV on the problem of galactic dimensions will be discussed elsewhere. Significant conclusions can not be expected, however, until much further progress has been made in the new program for high galactic latitudes.

November, 1934