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THE DISTANCE OF THE LOCAL-GROUP GALAXY IC 1613 OBTAINED FROM BAADE'S WORK ON ITS STELLAR CONTENT*

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ABSTRACT

Fifty-nine variables were found by Baade over the face of IC 1613 from a series of plates taken with the 100-inch reflector from 1929 to 1937. Of these, thirty-seven are definite Cepheids ranging in period from 146 days to 2 days, four are probable Cepheids, thirteen are irregular, one is a probable SRc, one is an eclipsing binary, and three are of unknown type.

Photometry depends on a photoelectric sequence of thirty-eight stars measured with the 200-inch reflector in the interval $11.6 \leq B \leq 21.7$. Magnitudes of 279 secondary standards used for the variables have been determined relative to the basic sequence. The values are listed in the Appendix.

Two interpretations of the period-luminosity relation are given for the Cepheids. The apparent blue modulus is $(m - M)_{AB} = 24.55$ as found from the most recent calibration of the P-L relation. A reddening of $E(B - V) \simeq 0.03$ gives the true modulus as $(m - M)_0 = 24.43$. The integrated absolute magnitude of IC 1613 is $M_B = -14.45$.

The brightest blue supergiant is star 22A with $M_B = -7.55$. The brightest red supergiant is the irregular red variable V42 with $M_B = -6.05$, or $M_V \simeq -8.0$ if $B = V$ is assumed to be 2.0. The largest H II region has a linear size of 167 pc. These absolute magnitudes and linear dimensions are much smaller than corresponding values in intrinsically brighter late-type galaxies.

The total extent of the Population II component of IC 1613 is 25'.0 by 20'3, or 5600 by 4500 pc. The Population I component covers a region only half these dimensions.

I. INTRODUCTION

The galaxy IC 1613 [$\alpha_{1950} = 1^h02^m16^s.1$, $\delta_{1950} = +1°52'29''$; $l^{II} = 130°$, $b^{II} = -61°$] was discovered by Wolf (1906) with the Bruce 16-inch refractor at Heidelberg. Baade (1928), using plates taken with the Bergedorf 40-inch reflector, classified it as a Magellanic-Cloud-type galaxy. From its resolution into individual stars at $m_{pg} \simeq 17$ mag, Baade concluded that the system was a member of the Local Group with a distance similar to that of NGC 6822 (Hubble 1925).

A series of plates was taken by Hubble with the 100-inch reflector from 1929 to 1932, after which Baade began his long study of the galaxy with the use of the 60-, 100-, and 200-inch reflectors. Baade's extensive results, principally on the variable stars, were never published, probably because of his reluctance to leave the problem in the face of uncertainties in the magnitude scale.

Between 1932 and 1955 three separate magnitude systems were carried. The first was based on the Seares scales (Seares, Kapteyn, and van Rhijn 1930) in SA 68, as extended by Baade to fainter magnitudes by photographic methods (exposure ratios, and neutral half-filters). The system was revised in 1939 by Baade's new work in SA 68 (Baade 1944), and again in 1955 by photographic transfers to Stebbins, Whitford, and Johnson (1950) photoelectric sequence in SA 68, as supplemented by Baum's unpublished extension to fainter magnitudes in this area.

Baade was not satisfied with the magnitude scale even after 1955 because of the very shallow slope for his Cepheid period-luminosity (P-L) relation. It seemed desirable to check this slope by photoelectric measurements of some of the sequence stars in IC 1613 directly. At Baade's request, this direct calibration was begun at the 200-inch in 1958

* With an Appendix on the adopted magnitude system by A. Sandage, Basil Katem, and Ann Hearn Matthews.

and was completed in 1963. Thirty-eight stars, measured in the magnitude interval $11.6 \leq B \leq 21.7$, formed the basis for transforming all secondary-sequence stars to the photoelectric system. The secondary-sequence reduction was made by Basil Katem, who used photographic iris photometry for all such stars which had been measured earlier by Mrs. Ann Hearn Matthews under Baade's direction. Details of the magnitude system for the thirty-eight photoelectric standards and the 279 secondary-sequence stars are given in the Appendix.

With each sequence calibrated, Baade's Argelander estimates for each variable were transformed to the B system, and all reductions of the light curves were made anew. The result of the work is discussed in this paper.

Baade's death in 1960 occurred while the new calibration was in progress, and before the final P-L relation was available. Baade's extensive series of plates, his discovery of the variables, choice of the sequence stars near each variable, period determination, and his intensity estimates form the basis of the present discussion. The photoelectric sequence, the reduction to the final magnitude system, and the analysis of the results are new. Baade cannot be held responsible for such errors as may yet be present in the adopted sequences, or for the necessarily tentative conclusions contained in the remaining sections.

II. PURPOSE

Why is IC 1613 so important? This galaxy is the faintest member of the Local Group [M_B(total) $\simeq -14.6$] among those which contain Cepheids. It is highly resolved into bright OBAF stars, it has well-defined H II regions, and the red supergiants are clearly visible. Once its distance modulus is known, the galaxy provides the low-luminosity anchor for calibrations of the size of H II regions, the M_B of the brightest blue stars, and the M_v of the brightest red stars as a function of galaxian luminosity class—calibrations which are first steps in a new determination of the Hubble constant.

But Baade's motivations were different. IC 1613 appears to have negligible internal absorption (many faint background galaxies appear over the entire face). Furthermore, the galactic absorption is small [$E(B - V) \lesssim 0.03$ from data in the Appendix], and its gradient over the face of the galaxy must be small or negligible. This galaxy is, therefore, one of the few members of the Local Group where the shape of the Cepheid P-L relation and the intrinsic dispersion about the ridge line are not affected by variations of the absorption. The hope of determining this dispersion is the reason Baade took such meticulous steps to insure the homogeneity of the magnitude sequences. Although the present material is not suited to find this dispersion for reasons discussed in § IV, the importance of IC 1613 as a fundamental calibrator remains crucial in the wider context of the Hubble constant. The primary purpose of the present work is, then, to obtain the distance.

III. THE VARIABLES

a) *Discovery*

A total of 106 plates of adequate quality were taken with either the 60-inch or the 100-inch reflector between 1929 and 1937, mostly by Baade, but a few were taken by Hubble, Duncan, and van Maanen. All plates were blue-sensitive, and were exposed without filters with exposure times ranging generally between 1 and 2 hours.

Hubble had blinked early plates of the series and discovered the Cepheids now labeled V16 and V18. From the same series, Mayall found variables 2 and 19. Baade blinked thirty-four plate pairs from the sample and gave numbers to a total of fifty-seven stars, of which numbers 4, 5, 33, and 35 later proved to be nonvariable. Six additional stars (V58–V63) were found in later comparisons, giving a total of fifty-nine confirmed variables. A discovery record was kept, from which the completeness of the search can be estimated by the method of van Gent (1933) (see also Plaut 1964). Analysis led Baade to conclude that a total of seventy-one variables may be present to the working limit of excellent 100-inch plates ($B = 22.2$, cf § III*d*), a conclusion which shows that the present sample is about 83 percent complete.[1]

b) *Identification*

The fifty-nine variables are identified in Figure 1 (Plate 1). Also marked are the thirty-eight primary photoelectric standards listed in the Appendix. As an aid for future work, the sequence stars used for each variable are identified on the large-scale reproductions of the four quadrants in Figures 2–6 (Plates 2–6).

Table 1, to be used with Figures 2–6, is a finding directory for the fifty-nine variables and their sequences. The type of star is listed in column (2) (δ for Cepheid, SRc for the variable V19, RI for red irregular, BI for the one blue irregular V44, I for intermediate-color irregular, and E for the eclipsing variable). Of the fifty-nine stars, thirty-seven are definite Cepheids, four are probable Cepheids, twelve are irregular red variables, one is a blue irregular, one is an eclipsing variable, one is a semiregular long-period

TABLE 1

DIRECTORY OF THE FIFTY-NINE VARIABLES IN IC 1613

No. (1)	Type (2)	Quadrant (3)	Status (4)	No. (1)	Type (2)	Quadrant (3)	Status (4)
1	δ	SE	F	34	δ	SW	F
2	δ	SW	F	35	δ	NW	TBD (3^d)
3	δ	SE	F	36	δ	NW	TBD ($2^d.4$)
6	δ	NW	F	37	δ	SW	F
7	δ	NE	TBD ($7^d.1$)	38	RI	NE2	F
8	?	NE2	TBD	39	δ	NE2	F
9	δ	NE	F	40	RI	NE	TBD
10	δ	NE	F	41	δ?	NW	TBD
11	δ	NW	F	42	RI	NW	F
12	δ	NE2	F	43	RI	NE2	F
13	δ	NE	F	44	BI	SW	F
14	δ	SE	F	45	RI	NE	F
15	δ	SW	F	46	δ?	NW	TBD
16	δ	NW	F	47	δ	SE	TBD ($29^d.3$)
17	δ	NW	F	48	δ?	SW	TBD ($2^d.666$)
18	δ	NE	F	49	δ	NE	TBD ($8^d.84$)
19	SRc	SW	F	50	RI	SW	F
20	δ	SE	F	51	?	SW	TBD
21	RI	NE2	F	52	I	NE	F
22	δ	NE2	F	53	δ	NE	TBD ($3^d.85$)
23	RI	SE	F	54	δ	NE	TBD (4^d)
24	δ	NW	F	56	RI	NE2	F
25	δ	SW	F	57	δ?	NW	TBD
26	δ	SW	F	58	I?	NE	TBD
27	δ	SW	F	59	δ	SW	TBD (2^d)
28	δ	SW	TBD ($2^d.7$?)	60	δ	SW	TBD (2^d)
29	δ	NE	F	61	δ	SW	TBD ($3^d.99$)
30	δ	NW	F	62	δ	SW	TBD (3^d)
31	E	NE	F	63	?	SW	TBD
32	RI	NE	F				

NOTE.—See text for explanations of cols. (2) and (4).

[1] Tabulations were separately kept for plates in two quality groups: (*a*) excellent to very good and (*b*) average plates. The mean discovery rate was 13.1 variables per pair of quality (*a*), and 6.7 variables per pair of quality (*b*). Baade notes "this shows how vital it is to have plates taken under the very best seeing conditions for finding variables in extragalactic systems of the Local Group. Plates taken under average seeing conditions yield only half as many variables as the best plates. This is probably the reason that Hubble found only Cepheids with $P > 10^d$ in M31, M33, and NGC 6822."

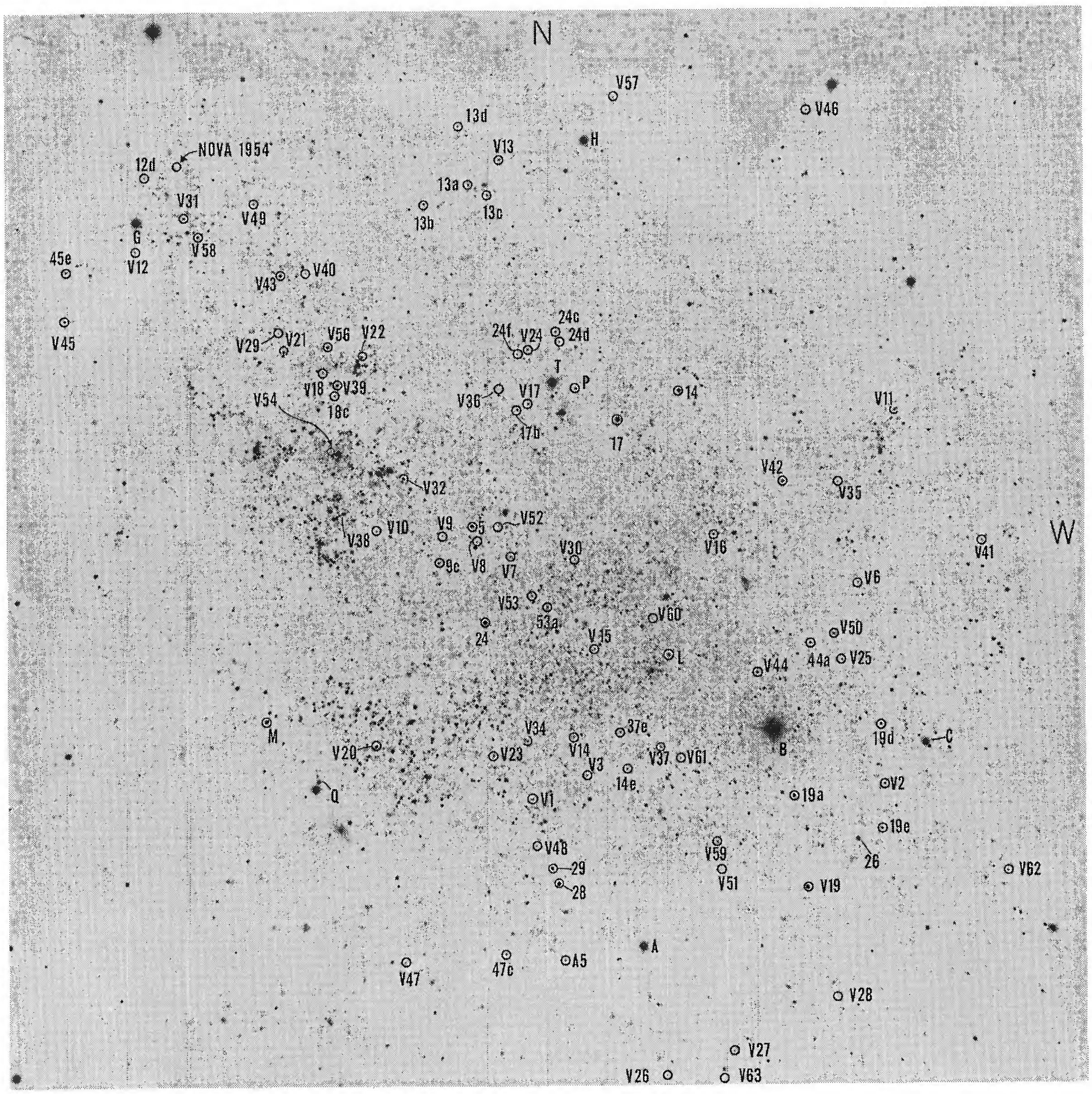

FIG. 1.—Identification chart for the 59 variables and 38 primary photoelectric standards. The variable star numbers are all preceded by the symbol V. All others have photoelectric magnitudes listed in Table A1 of the Appendix.

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PLATE 2

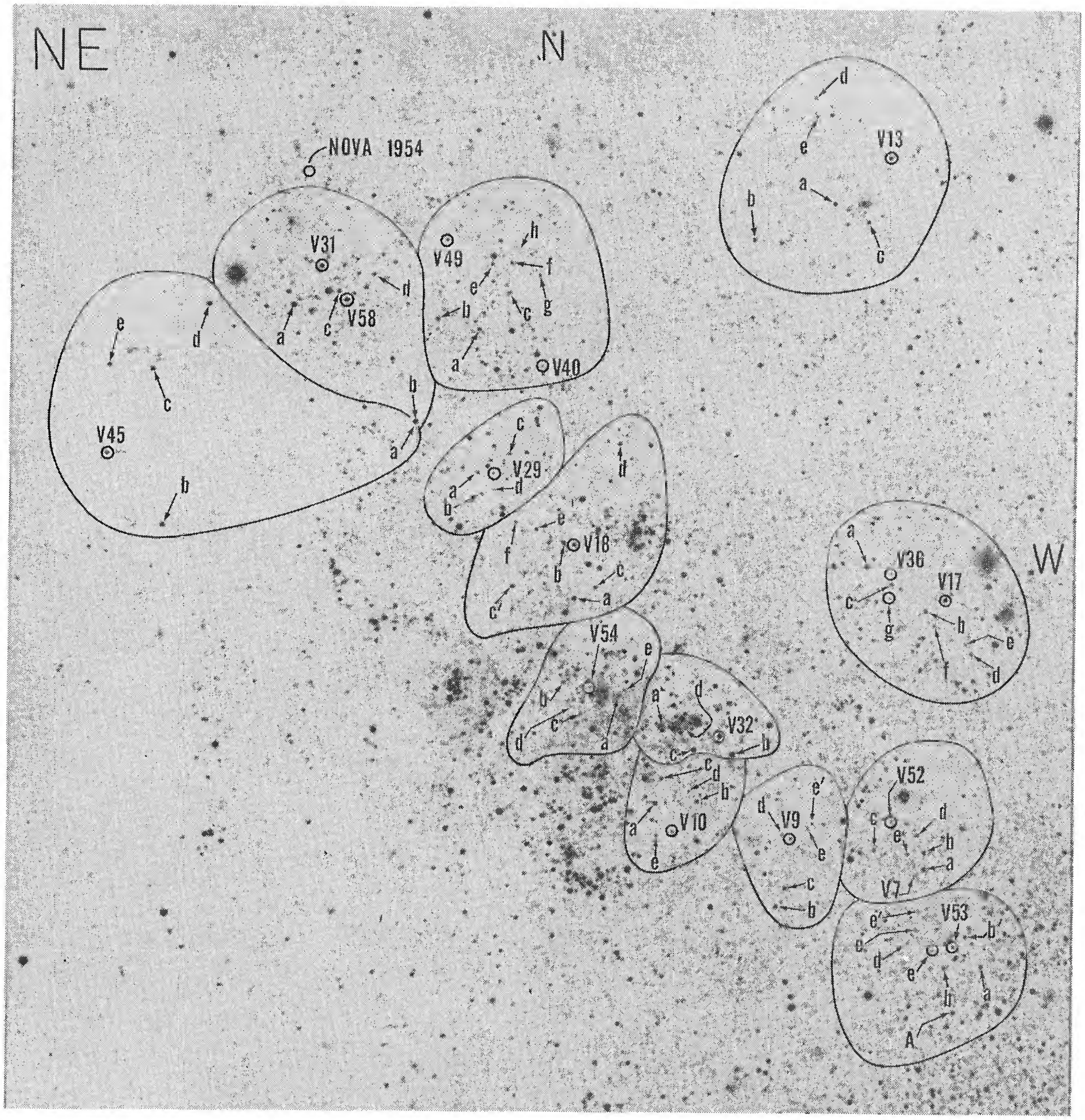

FIG. 2.—Identification chart for the variables and secondary sequence stars in the NE quadrant of IC 1613. Photograph is an enlargement from a 103a-O + GG13 plate taken with the Hale 200-inch telescope.

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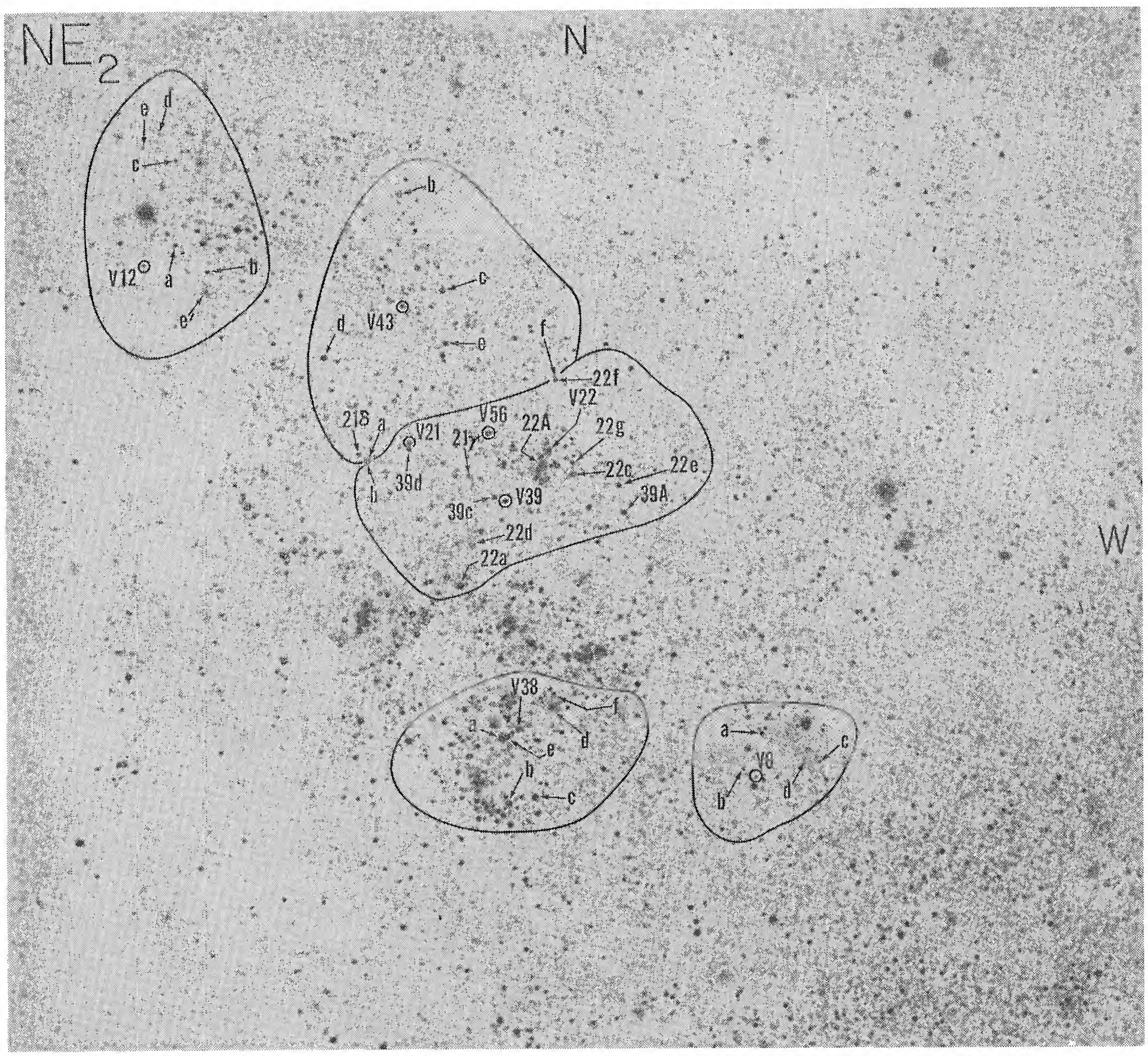

FIG. 3.—Same as Fig. 2 for additional stars in the NE quadrant

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1971ApJ...166...13S

PLATE 4

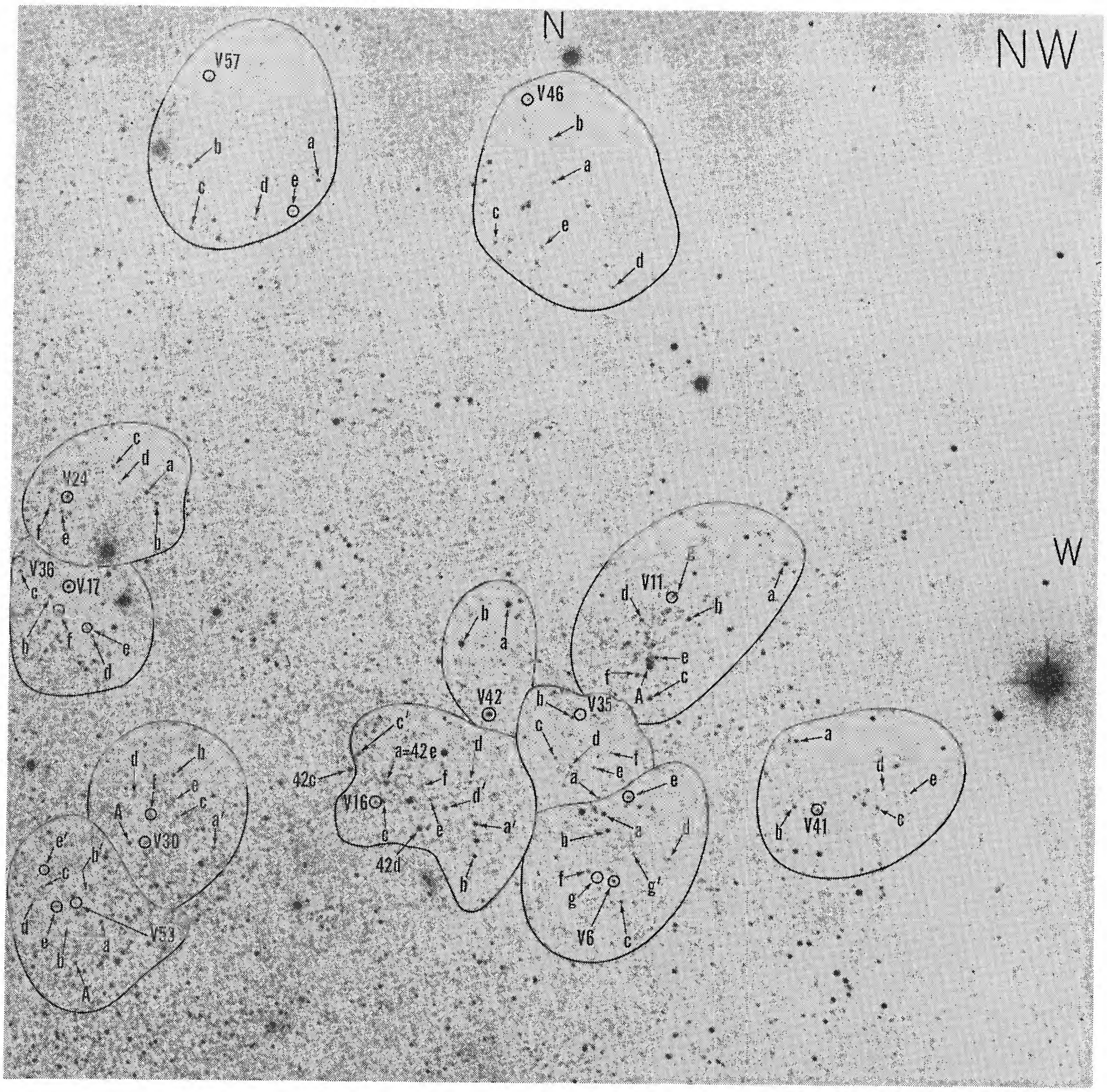

FIG. 4.—Same as Fig. 2 for the NW quadrant

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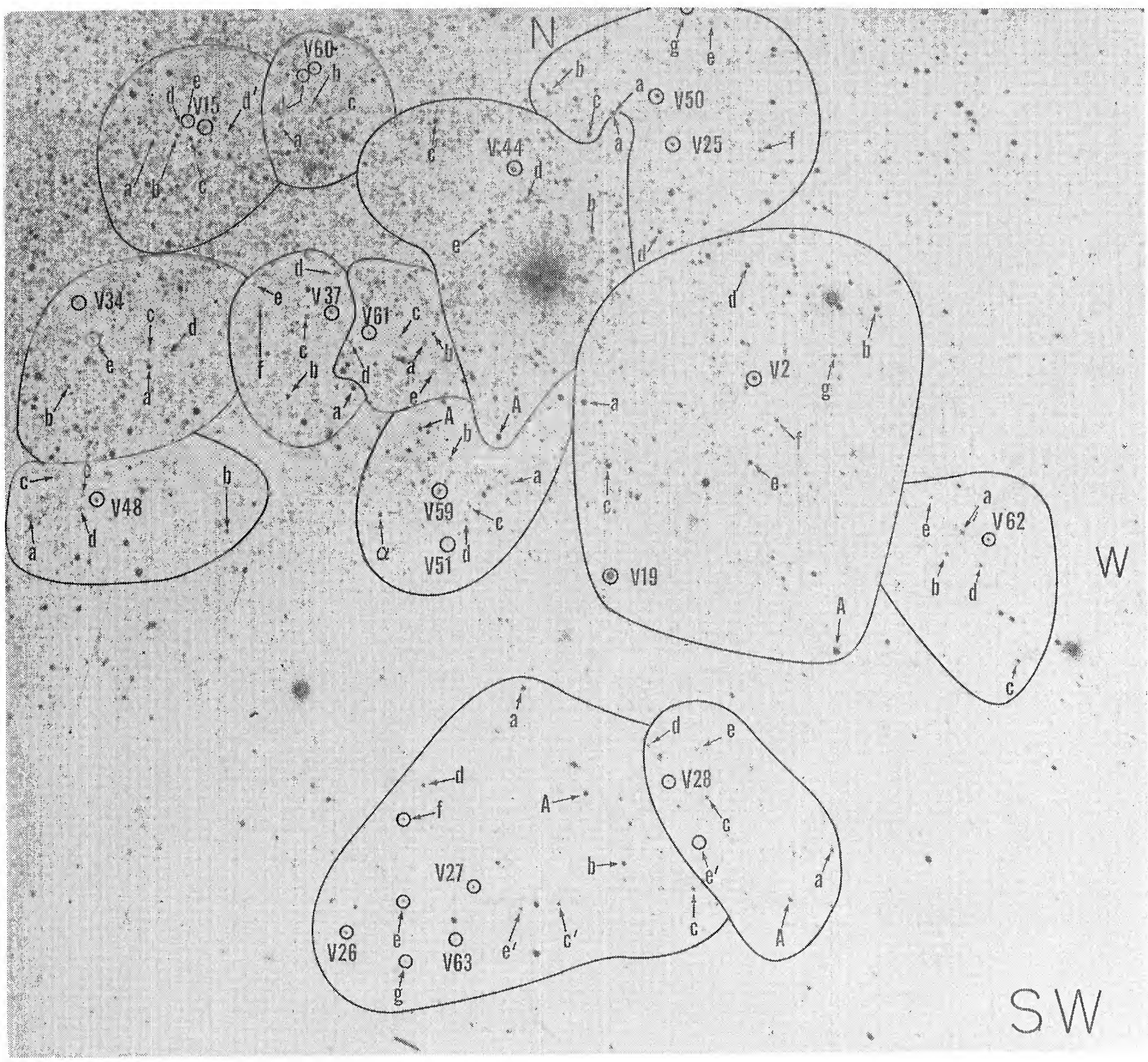

FIG. 5.—Same as Fig. 2 for the SW quadrant

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PLATE 6

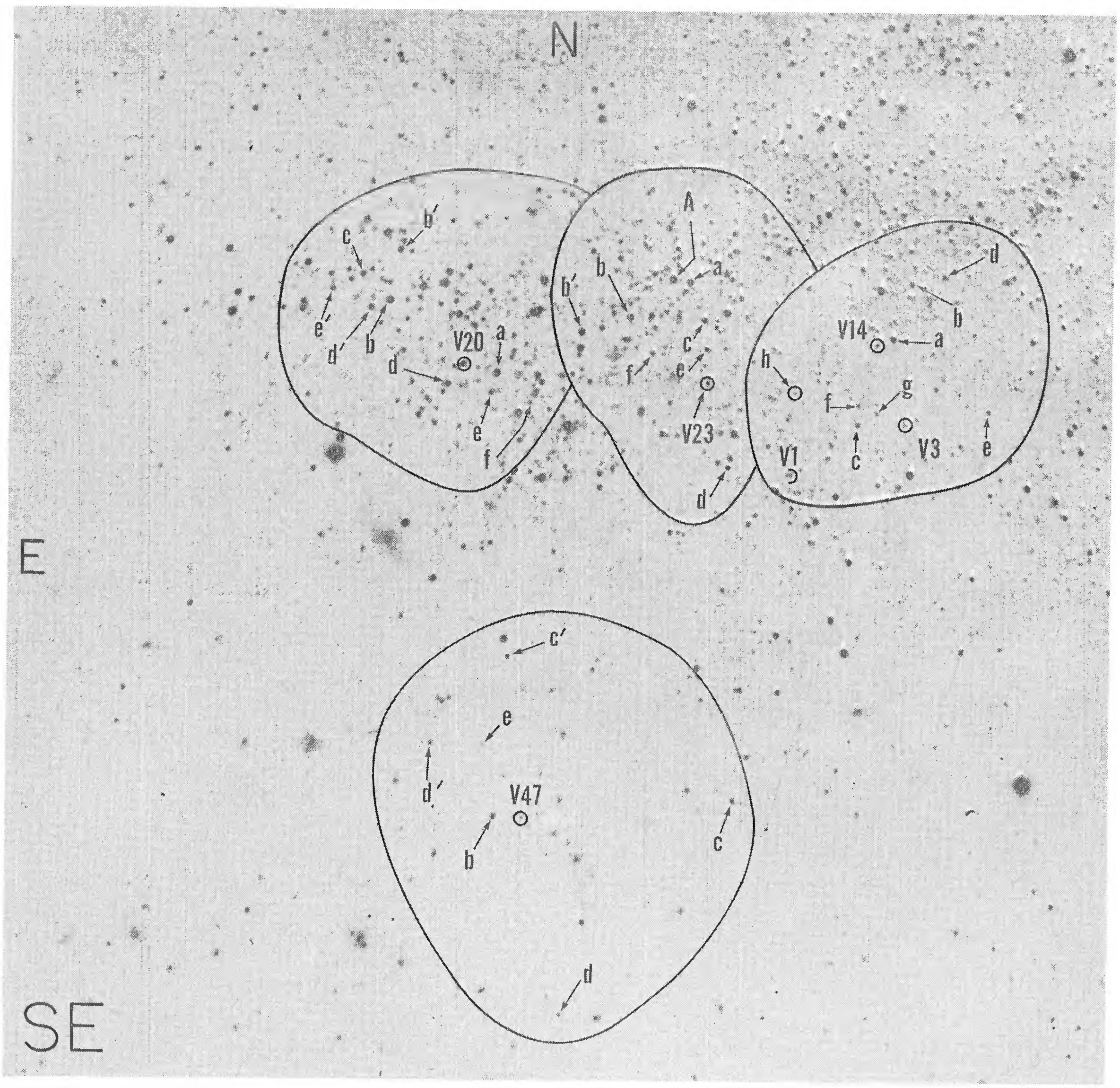

FIG. 6.—Same as Fig. 2 for the SE quadrant

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variable, and three are of unknown type. The chart name where each variable and its sequence is identified is listed in column (3), and the status of the work is in column (4) (F for finished, TBD for to be done). Baade completed preliminary work on some of the TBD stars, and his suggested periods are listed. *Work was finished on only those variables which remained above plate limit at minimum.* The TBD stars are generally very faint and are not seen during part of their light curve. This restriction causes a bias in the P-L plot below $P \simeq 3$ days which, in the presence of intrinsic dispersion, must be accounted for in determining the distance modulus (§ IV).

c) Photometry

Baade made eye estimates of all variables, relative to the sequence stars, by the Argelander method (i.e., if the sequence stars are labeled *a*, *b*, etc., in order of image size, and if the image size of a variable appears to be, say, 0.7 of the way from its sequence star *a* to *b*, its brightness is listed as *a7b*). The method proved to be of enormous advantage because changes in the magnitude system do not affect the estimates. Reduction to magnitudes can be made at any later time when new sequence values are available.

Two independent Argelander estimates of each variable were made on each plate, separated by a suitable time interval such that the memory was lost between. Baade had reduced his estimates first to the 1937 magnitude system and later to that of 1939. I reworked the reduction using the magnitudes adopted in the Appendix, Table A2, but the procedure was not straightforward due to the following circumstance.

Between 1929 and 1934 the telescope mirrors had been coated with silver, freshly applied every 6 months. But in early 1935 John Strong successfully deposited aluminum coats on both the 60-inch and 100-inch mirrors, causing the ultraviolet transmission to increase greatly. This led to an abrupt change in the color system. However, the IC 1613 plates had been taken without filters, and the increased ultraviolet sensitivity had an immediate effect, though it was discovered only after the 1935–1937 plates had been reduced and compared with the earlier series. The standard stars are predominantly blue, being main-sequence members of IC 1613 brighter than $M_B \simeq -2.5$. But the Cepheids are red. With aluminum-coated mirrors, more ultraviolet light is added to the images of the standard stars than to Cepheids, making them brighter relative to Cepheids; i.e., a color equation exists. What Baade found was: if the adopted magnitudes of the standards are kept constant, *all Cepheids appeared fainter after 1935 than before that date.*[2]

Because colors of the standards were not known, so that the plates could not be reduced with a color equation in the normal manner, Baade adopted the following procedure. Each sequence was estimated internally relative to itself (e.g., star *b* of the sequence was estimated relative to stars *a* and *c*, such as, say, $b = a6c$; *c* was estimated relative to *b* and *d*, such as $c = b3d$; etc., down the line). This was done for both the aluminum and the silver systems. By adopting a zero-point magnitude for the endpoint star *a* and the faintest star, it was possible to find smoothed magnitudes for the other sequence members, *on the color system of the plates.* These magnitudes, of course, differed between the aluminum and silver systems by the (unknown) color equation. They also differed in an absolute sense because the endpoint stars (the brightest and faintest) themselves have a color equation relative to the Cepheids. Hence, final zero-point adjustments were made for each Cepheid separately by forcing the segments of its own light curves to coincide for the two intervals from 1929 to 1934 and from 1935 to 1937.

I encountered the same difficulties in the new magnitude system of the Appendix. I proceeded in the same way, using Baade's individual "homogenization" equations (i.e., $b = a\mathrm{n}c$, $c = b\mathrm{m}d$, $d = c\mathrm{q}e$, etc., where n, m, q, etc., are the observed size ratios)

[2] Plates taken after 1937 were "corrected to the silver system" by adding a minus *UV* filter (Schott WG2), but this did not alleviate the problem between 1935 and 1937.

for each sequence for both the silver and aluminum series, and adopting the endpoint magnitudes for the brightest and faintest star as in the Appendix. The additional proviso was made that the derived magnitudes for stars *b, c, d, . . . , on the silver system* should agree in the mean with those in the Appendix. This provides a check and a smoothing of Baade's homogenization equations because silver mirrors with blue plates without filter closely imitate the B photometric system of Table A2 (Appendix).

Comparison between the "silver" and "aluminum" light curves then provided zero-point adjustments to the final *silver* system which was adopted as the best approximation to B. It is, however, expected that a small color equation still exists, depending in each case on (1) the difference in color index between the sequence star and the Cepheid and (2) the exact difference in effective wavelength between a bare silver mirror with 103a-O plates and the B photoelectric system. Although small, the effect must be considered in a future extension of the present work when colors of the Cepheids are derived, if B values of this paper are used.

A second method was used to check all values. Baade had listed the reductions (corrected to the silver system) of all variables to his 1939 magnitude system. There were also tables of his 1939 silver magnitudes for all sequence stars. Comparison of these with the B values of Table A1 (Appendix) gave a *mean* correction curve $m_{pg}(1939) - B = f[m(1939)]$ from which the 1939 magnitudes could be reduced to the new photoelectric system.[3] Katem undertook this parallel *mean* reduction of the Cepheids. The results are not tabulated since they suffer in principle from the uncertainty mentioned in footnote 3, but the agreement with the more detailed reduction is satisfactory in the mean.

Final adopted magnitudes of the Cepheids are listed in Table 2. This table lists phases of the variables calculated by using the epoch of maximum and the period listed later in Table 6. All dates are Julian Day reduced to Greenwich Mean Time, but not to the Sun because the periods of the variables are long compared with the light-time across the Earth's orbit.

d) The Cepheids

Light curves for twenty-four of the Cepheids are shown in Figures 7 and 8, displayed in order of period. To test if errors remain between the silver and aluminum systems, different symbols have been used: open circles are the silver system (1929–1934); filled circles are aluminum points (1935–1937) reduced to the silver system. The lack of systematic error appears to be quite satisfactory.

With the exception of a few Cepheids, the scatter in the light curves is close to that expected from the estimated probable error of ± 0.10 mag for a single entry in Table 2. This error was estimated from comparison of (1) the first and second estimates of intensity and (2) scatter in estimated magnitudes for several stars carried as variables but later shown to be constant.

Of the Cepheids, only V22 ($P = 146^{d}.35$) and one other needs special mention. V22 has an unusually long period and is the only Cepheid which does not repeat well. However, its period has remained constant over the observing interval, comprising 18 cycles, as shown by the lack of systematic trend in the observed minus computed epoch of maximum for ten well-observed maxima The period of 146 days is abnormally long for a Cepheid. Known Cepheids with periods greater than 100 days include HV 1956 ($P = 210^{d}$) and HV 821 ($P = 127^{d}$) in the Small Magellanic Cloud, HV 2447 ($P = 118^{d}$) and HV 883 ($P = 134^{d}$) in the Large Magellanic Cloud, and H42 in M31 ($P = 176^{d}.7$, Baade and Swope 1965). V22 in IC 1613 is the Cepheid with the third longest

[3] The disadvantage of the method was that Baade's (1939) m_{pg} for the sequence stars were based on his first attempt to tie all sequence stars together (by overlapping 100-inch plates taken with the 84-inch diaphragm to minimize coma effects). Baade later rehomogenized the sequence stars in 1955 by using Mrs Matthews's measurements of 200-inch plates; the new material is the basis for Table A2, hence the new reduction is preferred.

TABLE 2

B MAGNITUDES FOR CEPHEIDS IN IC 1613

JD 2,420,000+	Year	Plate	V1* Phase	V1* B	V2 Phase	V2 B	V3 Phase	V3 B	V6 Phase	V6 B	V9 Phase	V9 B	V10 Phase	V10 B	V11 Phase	V11 B	V12 Phase	V12 B	V13 Phase	V13 B	V14 Phase	V14 B	V15 Phase	V15 B	V16 Phase	V16 B	V17 Phase	V17 B
5829.958	1929	H1097H	0.799	20.93	0.457	20.28	.....	.....	0.712	21.46:	0.766	21.52	0.145	20.96	.....	.....	.....	.....	.....	.....	0.885	20.91:	.....	.....	.....	.....	0.949	20.63
6211.962	1930	H1166H	0.110	21.06'	0.740	20.90	.....	.....	0.219	20.70	0.247	21.17	0.111	21.15	0.109	20.01	.....	.....	.....	.....	0.139	21.06	.....	.....	0.030	20.20	0.536	21.44
6268.788	"	H1184H	0.272	21.10'	0.162	19.62	.....	21.20	0.245	20.63	0.434	21.37	0.089	20.93	0.314	20.38	.....	.....	.....	.....	0.185	20.97:	.....	.....	0.475	21.24	0.442	21.29
6269.792	"	H1194H	.....	.....	0.203	19.70	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
6304.642	"	H1199H	0.683	21.30	0.690	21.05	.....	.....	0.047	20.68	0.865	<21.30	.....	.....	.....	.....	.....	.....	.....	.....	0.154	21.06	.....	.....	0.911	20.30	0.692	21.41
6594.976	1931	H1324H	.....	.....	0.066	19.52	.....	.....	.....	.....	.....	.....	.....	.....	0.971	19.75	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
6619.781	"	H1328H	0.038	20.46'	0.123	19.62	.....	.....	0.464	21.30:	0.357	~21.40	0.428	21.65	0.933	19.84	.....	.....	.....	.....	0.411	21.37	.....	.....	0.108	20.32	0.624	21.60
6688.709	"	B5B	.....	.....	0.061	19.55	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
6925.960	1932	B107B	0.790	21.24	0.173	19.68	.....	.....	0.931	20.87	0.246	21.32	0.745	21.41	.....	.....	0.777	21.92	0.788	21.60:	0.927	20.91	0.691	21.50	0.448	21.14	0.994	20.57
6926.946	"	B111B	0.966	20.46'	0.216	19.88	0.995	20.93	0.036	20.46	0.423	21.35	0.989	20.61	0.852	21.10	0.009	20.96	0.992	20.79	0.120	20.82	0.925	21.38	0.542	21.19	0.166	21.13
6956.944	"	B118B	0.330	20.98	0.494	20.70	0.554	≤21.45	0.216	20.66	0.798	21.78	0.367	21.51	0.016	19.70	0.005	20.94	0.182	21.13	0.949	20.74	0.021	20.66	0.417	20.93	0.395	21.71
6957.971	"	B125B	0.514	21.45	0.538	20.71	0.814	22.12:	0.325	20.83	0.983	20.94'	0.620	21.41	0.055	19.74	0.245	21.60	0.395	21.76	0.149	21.03	0.265	21.34	0.515	21.20	0.574	21.46
6958.944	"	B135B	0.688	21.38	0.579	20.95	0.058	21.16	0.428	21.10	0.158	21.28	0.858	21.59	0.093	19.82	0.471	21.86	0.595	21.66	0.338	21.42	0.494	21.59	0.608	21.13	0.744	21.74
6959.920	"	B142B	0.863	21.29	0.621	20.90	0.305	21.68	0.532	21.46	0.333	21.44'	0.101	21.00	0.131	20.11	0.700	21.79	0.798	21.79	0.529	21.35	0.726	21.54	0.702	20.87	0.914	21.12
6984.807	"	B146B	0.313	21.02'	0.682	20.94	0.577	<21.45	0.172	20.83	0.794	21.52	0.221	21.17	0.097	19.83	.....	.....	.....	.....	0.367	21.21:	0.612	21.45	0.087	20.30	0.252	21.18
6984.921	"	B147B	0.333	21.06	0.687	20.92	0.605	21.90	0.183	20.90	0.814	21.46	0.248	21.38	0.101	19.89	0.534	21.82	0.958	20.77	0.388	21.39	0.639	21.43	0.097	20.26	0.272	21.17
6985.898	"	B151B	0.508	21.33'	0.728	20.92	0.852	21.45	0.287	20.87	0.990	20.82'	0.490	21.51	0.139	20.12	0.763	21.82	0.160	21.10	0.579	21.42	0.870	21.48	0.191	20.72	0.442	21.54
6986.883	"	B154B	0.684	21.62'	0.770	20.75	0.101	21.36	0.391	21.27	0.167	21.14	0.731	21.54	0.177	20.25	0.992	21.04	0.363	21.71	0.769	21.55	0.102	20.87	0.285	20.95	0.614	21.76
7007.764	"	B157B	0.418	21.34'	.....	.....	0.363	≤21.45	0.605	<21.30	.....	.....	0.868	21.65	0.987	19.74	.....	.....	.....	.....	0.828	21.26	0.043	20.69	0.286	20.82	0.254	21.34
7007.836	"	B158B	0.431	21.33	0.663	21.02	0.383	≤21.45	0.614	21.24	0.923	21.62	0.888	21.55	0.990	19.71	0.882	21.82	0.689	21.72	0.843	21.31	0.059	20.50	0.293	20.87	0.266	21.44
7008.709	"	B162B	0.587	21.38'	0.701	20.86	.....	.....	0.706	21.63	.....	.....	0.101	20.94	0.024	19.80	.....	.....	.....	.....	0.012	20.53	0.267	<21.3	0.377	21.13	0.418	21.57
7008.780	"	B163B	0.600	21.35'	0.704	20.95	0.602	22.16	0.713	21.62	0.091	20.97'	0.118	21.10	0.027	19.80	0.100	21.39	0.883	21.69	0.026	20.81	0.284	21.52	0.384	21.04	0.431	21.62
7036.661	"	B170B	0.586	21.12	0.892	20.45	0.645	<21.90	0.670	21.51	0.090	20.94'	0.977	20.70	0.109	20.20	0.604	21.74	0.638	21.69:	0.445	21.22	0.877	≤21.64	0.055	20.17	0.291	21.20
7039.714	"	B172B	.....	.....	0.022	19.44	.....	.....	0.993	20.36	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
7064.656	"	B177B	0.592	21.23	0.085	19.50	0.701	<21.3	0.638	21.44	0.109	21.00	0.863	21.65	0.196	20.37	0.138	21.51:	0.418	21.68	0.888	21.06	0.501	21.47	0.738	20.53	0.170	21.12
7277.951	1933	B246B	0.734	20.98	0.177	19.77	0.456	<<21.5	0.255	20.89	0.348	21.39	0.327	21.34	.....	.....	0.903	21.57	0.445	21.75	0.348	21.07	0.955	21.07	0.177	20.55	0.350	21.31
7278.928	"	B250B	0.909	20.70	0.219	19.87	.....	.....	0.358	21.01	0.524	21.74	0.568	21.45	.....	.....	0.131	21.50	0.648	<<21.65	.....	.....	0.187	<21.2	0.270	20.79	.....	.....
7311.941	"	B275B	0.812	20.93	0.625	20.80	0.023	21.08	0.860	21.23	0.441	21.56	0.689	21.50	.....	.....	0.833	21.86	0.462	21.73	0.955	20.82	0.996	20.55	0.434	21.23:	0.275	21.21
7335.851	"	B278B	0.088	20.76'	0.644	20.95	0.048	20.90	0.395	21.19	0.728	21.76	0.571	21.45	.....	.....	0.411	21.80	0.397	21.69	0.603	21.35	0.650	21.68	0.725	20.92	0.443	21.54
7342.817	"	M2016	0.334	21.04	0.941	19.87	0.804	<21.45	0.135	21.03	0.979	20.96'	0.285	21.45	0.989	19.76	0.037	21.11	0.836	21.80	0.957	20.66	0.300	<<21.3	0.392	21.15	0.657	21.83
7342.791	"	B281B	0.369	21.07'	0.664	20.90	0.081	21.25	0.934	20.92	0.022	20.89	0.460	21.40	0.647	21.21	0.996	20.93	0.339	21.70	0.256	21.21	0.315	21.31	0.019	20.27	0.616	21.65
7359.863	"	B282B	0.382	21.17'	0.667	21.02	0.098	21.37	0.941	20.86	0.034	20.94'	0.477	21.38	0.650	21.12	0.014	21.05	0.353	21.79	0.270	21.09	0.331	21.49	0.026	20.29	0.628	21.61
7366.850	"	B290B	.....	.....	0.965	19.34	.....	.....	0.683	21.65:	.....	.....	0.197	21.05:	0.921	20.03	.....	.....	.....	.....	.....	.....	0.984	20.63	0.695	~21.04:	0.846	21.43
7369.844	"	B292B	0.167	20.90'	0.093	19.52	0.615	22.10:	0.000	20.37	0.823	21.58	0.932	21.15	0.037	19.84	.....	.....	0.413	21.79	0.210	21.01	0.691	21.76	0.982	20.24	0.368	21.51
7391.749	"	B296B	0.084	20.51'	0.027	19.26	0.136	21.07	0.323	20.86	0.751	21.62'	.....	.....	0.887	20.81	0.453	21.79	0.936	20.78	0.468	21.30	0.873	21.60	0.081	20.26	0.186	20.98
7392.699	"	B300B	0.254	20.75	0.067	19.37	0.375	<<21.5	0.424	21.34	.....	.....	0.553	21.41:	0.924	19.89	.....	.....	0.132	20.98	.....	.....	0.097	20.76	.....	.....	0.352	21.47
7393.735	"	B307B	0.439	21.32'	0.111	19.42	0.635	22.14:	0.533	21.37	0.106	20.88'	0.806	21.50	0.964	19.81	0.915	21.54	0.345	21.43	0.853	21.09	0.341	21.52	0.271	20.85	0.533	21.52
7417.670	"	B311B	0.719	21.50'	0.132	19.72	0.668	22.03:	0.072	20.69	0.398	21.60	0.696	21.57	0.893	20.53	0.502	21.74	0.286	21.40	0.507	21.39	0.005	20.67	0.565	21.19:	0.705	21.63
7449.645	"	B317B	.....	.....	0.494	20.37	.....	.....	0.462	21.46	0.129	21.26:	0.561	21.50	0.133	20.27	0.959	20.92	0.886	≤21.15	0.721	≤21.45	.....	.....	0.629	21.22	0.278	21.26
7451.654	"	B327B	0.796	21.42'	0.580	20.90	0.232	21.45	0.675	21.50	0.489	21.67	0.054	20.86	0.208	20.20	.....	.....	0.300	21.46	0.112	21.30	0.042	20.81:	0.821	20.45	0.628	21.60
7659.954	1934	B394B	0.045	20.51'	0.459	20.52	.....	.....	0.761	21.37	0.837	21.52	.....	.....	0.294	20.36	0.028	20.97	0.298	21.43	0.602	21.38	0.317	21.72	0.782	20.54	0.937	20.67
7660.978	"	B399B	0.228	21.22'	0.502	20.70	0.988	21.06	0.871	21.29	0.022	21.03	0.546	21.59	0.334	20.41	0.268	21.73	.....	.....	0.802	21.39	0.560	21.76	0.880	20.23	0.116	20.85
7661.941	"	B402B	0.401	21.31	0.544	20.78	0.229	21.44	0.973	20.61	0.194	21.19'	0.782	21.36	0.371	20.45	0.492	21.60	0.709	21.75	0.987	20.65	0.787	~21.64	0.972	20.21	0.284	21.25
7684.877	"	B406B	0.502	21.43	0.521	20.90	0.013	20.93	0.406	21.16	0.307	21.29	0.423	21.62	0.261	20.35	0.845	21.89	0.444	21.77	0.448	21.34	0.215	21.46	0.170	20.68	0.282	21.48
7686.934	"	B372	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
7687.970	"	B377	.....	.....	0.653	20.95	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
7689.867	"	B414B	0.394	21.31'	0.734	20.98	0.270	21.68	0.935	19.37	0.201	21.25	0.652	21.56	0.455	20.72	0.009	20.91	0.474	21.77:	0.418	21.31	0.395	21.58	0.648	21.09	0.152	21.17
7689.954	"	B415B	.....	.....	0.738	21.00	.....	.....	0.943	19.32	0.215	21.24	0.672	21.58	.....	.....	0.028	20.98	0.490	21.73	0.433	21.07	.....	.....	0.656	21.19	0.167	21.17
7691.882	"	HubbleA	.....	.....	0.820	20.90	.....	.....	.....	.....	.....	.....	0.145	21.28:	.....	.....	.....	.....	.....	.....	0.808	21.38	.....	.....	.....	.....	0.503	21.63
7713.833	"	H1635H	.....	.....	0.756	20.72	0.307	~21.45	0.476	21.29	0.497	21.38	0.546	21.60	0.385	20.35	0.600	<21.75	.....	.....	0.075	20.86	0.061	20.83	0.944	20.50	0.329	21.45
7718.874	"	B380	.....	.....	0.970	19.26	.....	.....	0.011	20.50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.208	<20.9
7719.882	"	B386	.....	.....	0.014	19.21	.....	.....	0.118	20.80	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.383	<20.9

*Star V1 is double. Magnitudes marked ' designate plates where the variable is separated from the companion.

TABLE 2—*Continued*

JD 2,420,000+	Year	Plate	V1* Phase	V1* B	V2 Phase	V2 B	V3 Phase	V3 B	V6 Phase	V6 B	V9 Phase	V9 B	V10 Phase	V10 B
7721.897	"	B419B	0.122	20.83!	0.099	19.60	.....	.....	0.332	21.00	.....	.....	0.531	21.62
7722.812	"	B425B	0.286	20.98	0.138	19.54	.....	.....	0.428	21.24	0.108	21.16!	0.755	21.56
7723.809	"	B429B	0.464	21.41!	0.181	19.80	0.822	21.94	0.534	21.52	0.287	21.26	0.000	20.59
7744.726	"	B433B	0.205	20.98!	0.072	19.58	0.096	21.08	0.753	21.57	0.036	20.93	0.145	21.19
7747.741	"	B389B	.....	.....	0.201	19.83	.....	.....	0.072	20.63	.....	.....	.....	.....
7748.726	"	B395	.....	.....	0.243	19.89	.....	.....	0.177	20.80	.....	.....	.....	.....
7752.731	"	B442B	0.636	21.17	0.413	20.53	0.111	21.28	0.601	21.44	0.472	21.60	0.113	20.99
7809.653	"	B449B	.....	.....	0.840	20.94	.....	.....	.....	.....	.....	.....	0.116	20.99:
8016.953	1935	B538B	0.885	21.01	0.676	21.06	0.700	21.79	0.619	21.46	0.843	21.72!	0.111	20.93
8017.949	"	B544B	0.063	20.43!	0.718	21.02	0.953	21.03	0.725	21.52	0.023	20.92!	0.357	21.31
8018.947	"	B549B			0.761	20.93	0.204	21.39	0.831	21.42	0.203	21.27!	.....	.....
8019.950	"	B555B	0.421	21.10!	0.803	20.91	0.456	21.59	0.937	20.84	0.382	21.49!	0.849	21.46
8020.951	"	B561B	0.600	21.38!	0.846	20.82	0.708	21.90	0.042	20.77	0.561	21.45!	0.093	20.79
8021.959	"	Δ559	0.780	21.38!	0.889	20.88	0.963	20.84	0.149	20.89	0.742	21.68!	0.342	21.38
8045.906	"	B566B	0.063	20.76!	0.910	20.82	0.000	21.08	0.689	21.54	0.036	20.98!	0.234	21.38
8046.931	"	B572B	.....	.....	0.954	19.71	0.257	21.52	0.797	21.52	0.219	21.26	0.485	21.49
8047.938	"	B577B	0.426	21.50!	0.997	19.30	0.509	21.96:	0.904	21.05	0.400	21.44	0.733	21.53
8048.942	"	B584B	0.606	21.51!	0.040	19.28	0.764	21.80	0.011	20.50	0.579	21.52	0.979	20.73
8049.951	"	B588B	.....	.....	0.083	19.50	0.018	20.86	0.118	20.89	0.760	21.67	0.229	21.18
8067.817	"	B589B	0.981	20.44	0.844	20.87	0.522	21.90:	0.013	20.40	0.965	20.86	0.625	21.53
8068.842	"	B590B	0.164	21.00	0.888	20.87	0.779	<21.7	0.121	20.93	0.147	21.18	0.876	21.51
8069.826	"	B591B	.....	.....	0.930	20.13	0.028	21.08	0.226	20.87	.....	.....	0.118	20.96
8069.905	"	B592B	0.354	21.25!	0.933	20.12	0.048	21.06	0.233	20.77	0.337	21.55	0.135	21.11
8070.829	"	B593B	0.519	21.39!	0.973	19.46	0.280	21.57	0.332	21.07	0.504	21.65	0.364	21.48
8071.830	"	B597B	.....	.....	0.015	19.18	0.532	~21.90	0.438	21.36	0.683	21.63	0.610	21.49
8071.909	"	B598B	0.713	21.74!	0.019	19.20	0.552	21.80	0.445	21.39	0.697	21.52	0.630	21.45
8072.826	"	B599B	0.877	21.06	0.058	19.37	.....	.....	0.544	21.52	.....	.....	0.856	21.50
8072.903	"	B600B	0.890	21.08!	0.061	19.41	0.801	<21.90	0.551	21.50	0.875	21.46	0.873	21.35
8073.821	"	B601B	0.055	20.46	0.100	19.46	0.033	20.96	0.649	21.50	0.039	20.89	0.101	21.14
8074.911	"	B603B	0.249	21.03	0.147	19.48	0.307	21.44	0.764	21.42	.....	.....	0.369	21.35
8075.806	"	B604B	.....	.....	0.185	19.69	0.534	21.90	0.860	21.24	.....	.....	0.590	21.52
8075.880	"	B605B	0.423	21.28!	0.188	19.76	0.552	<21.90	0.867	21.40	0.409	21.30!	0.608	21.50
8077.809	"	B606B	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
8078.802	"	B607B	0.945	20.74	0.312	20.16	0.287	≤21.45	0.177	20.97	0.932	21.28	0.325	21.42
8079.815	"	B611B	0.126	20.69	0.355	20.23	0.542	21.48	0.284	20.90	0.113	20.97	0.573	21.60
8080.816	"	B612B	0.305	21.28!	0.398	20.33	0.796	21.96	0.391	21.24	0.294	21.22	0.822	21.65
8366.955	1936	B690B	0.474	21.14!	0.594	20.80	0.910	21.06	0.732	21.58	0.595	21.65	.....	.....
8367.935	"	B694B	.....	.....	0.635	20.96	.....	.....	.....	.....	.....	.....	0.447	<20.93
8406.943	"	B703B	.....	.....	.....	.....	0.988	20.82	0.973	20.64	0.766	21.80	0.042	20.79
8430.877	"	B717B	.....	.....	0.319	20.11	0.023	20.95	0.511	21.49	0.057	20.98	0.930	21.23
8431.872	"	B719B	0.083	20.69	0.361	20.36	0.272	21.10	0.616	21.56	0.235	21.27	0.175	21.19
8482.764	"	B721B	0.183	20.95	0.530	20.69	.....	.....	0.013	20.57	0.359	21.58	0.694	21.39
8483.751	"	B728B	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
8484.701	"	B730B	0.530	21.50!	0.613	20.92	0.585	<21.90	0.218	20.63	0.706	21.76	0.170	20.99
8485.727	"	B732B	0.713	21.14	0.657	21.06	0.844	<21.7	0.328	20.91	0.891	21.13	0.421	21.45
8779.931	1937	H1880H	0.324	21.16!	0.197	19.76	0.990	21.00	0.525	21.39	0.638	21.52	0.790	21.47
8780.974	"	B811B	0.510	21.39!	0.241	19.86	0.252	21.39	0.635	21.58	0.825	21.51	0.047	20.80
8781.920	"	B815B	0.679	21.55!	0.282	20.02	0.491	21.90	0.736	21.58	0.995	20.85	0.280	21.21
8782.920	"	B819B	0.858	21.39!	0.324	19.92	0.743	<21.7	0.842	21.24	0.174	21.18	.....	.....
8783.933	"	B823B	0.039	20.44	0.367	20.30	0.998	21.02	0.949	20.70	0.355	21.44	0.775	21.46
8784.919	"	B827B	0.216	21.06!	0.410	20.72	0.247	21.36	0.054	20.49	0.533	21.72	0.020	20.63
8785.913	"	B831B	0.393	21.36!	0.452	20.32	0.496	21.64	0.159	20.74	0.710	21.59	0.263	21.18
8786.909	"	B836B	0.572	21.21	0.494	20.37	0.748	<21.7	0.265	20.77	0.889	21.23	0.509	21.47
8787.873	"	B841B	0.744	21.18	0.535	20.59	0.990	20.99	0.367	20.98	0.061	20.90	0.745	21.33

JD 2,420,000+	V11 Phase	V11 B	V12 Phase	V12 B	V13 Phase	V13 B	V14 Phase	V14 B	V15 Phase	V15 B	V16 Phase	V16 B	V17 Phase	V17 B
7721.897	0.697	20.90	.....	.....	0.085	20.75	0.644	21.30	0.972	20.99	0.717	20.95	0.735	21.62
7722.812	.....	.....	.....	.....	.....	.....	0.821	21.36	0.187	21.01	0.805	20.27	0.894	21.27
7723.809	0.772	21.21	0.929	21.59	0.480	21.73	0.015	20.86	0.423	21.76	0.900	20.34:	0.068	20.67
7744.726	0.584	21.08	0.810	21.79	0.798	21.71	0.081	21.02	0.371	21.47	0.905	20.39	0.714	21.74
7747.741	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.240	21.25
7748.726	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.411	21.50
7752.731	0.894	20.69	.....	.....	0.449	21.53	0.637	21.34	0.262	21.22	0.672	21.18	0.109	20.71
7809.653	0.102	19.85	0.957	21.12	.....	.....	0.701	<20.95	.....	.....	0.126	20.23	0.032	20.54
8016.953	0.146	20.18	0.322	21.78:	0.990	20.72	0.996	20.65	0.766	21.60	0.990	20.40	0.166	21.08
8017.949	0.185	20.36	0.555	21.77	0.196	21.43	0.190	21.02	0.002	20.81	0.086	20.26	0.340	21.47
8018.947	0.223	20.39	0.789	21.89	0.403	21.49	0.385	21.21	0.239	21.43	0.182	20.55	0.514	21.66
8019.950	0.262	20.45	0.023	21.09	0.609	21.72	0.579	21.16	0.475	21.64	0.278	20.90	0.689	21.63
8020.951	0.301	20.62	.....	.....	0.815	21.78	0.774	21.33	0.712	21.67	0.374	20.99	0.863	21.60
8021.959	0.340	20.69	0.492	21.81	0.024	20.84	0.970	20.81	0.951	21.03	0.470	21.07	.....	.....
8045.906	0.270	20.59	0.079	21.25	0.968	20.83	0.625	21.36	0.615	21.56	0.765	20.92	0.213	21.22
8046.931	0.309	20.50	0.317	21.75	0.178	21.38	0.824	21.32	0.856	21.71	0.863	20.37	0.392	21.50
8047.938	0.348	20.64	0.553	21.87	0.387	21.80	0.020	20.78	0.097	21.06	0.960	20.39	0.567	21.62
8048.942	0.387	20.65	0.786	21.88	0.593	21.80	0.214	21.08	0.333	21.24	0.056	20.38	0.742	21.76
8049.951	0.426	20.74	0.021	20.94	0.802	21.72	0.411	21.09	0.572	21.64	0.152	20.29	0.918	20.89
8067.817	0.120	20.17	0.191	21.66	0.490	21.58	0.884	21.09:	0.799	21.49	0.864	20.40	0.032	20.57
8068.842	0.159	20.06	.....	.....	0.701	21.80	0.083	20.84	0.040	20.75	0.963	20.36	0.211	21.22
8069.826	0.198	20.05	0.660	21.77	0.905	21.39	0.275	21.07	0.274	21.41	0.057	20.50	0.383	21.51
8069.905	0.200	20.24	0.677	21.91	0.920	21.21	0.289	21.37	0.291	21.41	0.065	20.36	0.396	21.44
8070.829	0.237	20.40	0.894	21.75	0.112	20.94	0.469	21.30	0.511	21.56	0.153	20.50	0.557	21.63
8071.830	0.275	20.48	0.126	21.30	0.318	21.67	0.664	21.50	0.747	<21.56	0.249	20.72	0.732	21.63
8071.909	0.279	20.51	0.145	21.28	0.335	21.67	0.679	21.52	0.766	21.50	0.257	20.71	0.746	21.76
8072.826	.....	.....	0.359	21.59	0.524	21.69:	0.858	21.24	0.984	21.00	0.344	21.04	.....	.....
8072.903	0.317	20.53	0.376	21.58	0.539	21.64	0.872	21.08	0.000	20.89	0.352	21.07	0.919	21.12
8073.821	0.353	20.58	0.590	21.74	0.729	21.73	0.051	20.65	0.218	21.44	0.440	21.04	0.079	20.67
8074.911	.....	.....	0.845	21.89	0.954	20.95	.....	.....	0.475	<21.17	0.544	21.17	.....	.....
8075.806	.....	.....	0.056	21.16	0.140	21.21	0.437	<21.45	0.688	<21.1	0.630	21.15	0.425	21.45
8075.880	.....	.....	0.072	21.36	0.154	21.45	0.451	21.37	0.705	21.52	0.637	21.18	0.438	21.57
8077.809	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
8078.802	.....	.....	0.754	<21.80	0.757	21.78	0.019	20.88	0.395	21.39	0.917	20.22	0.947	20.60
8079.815	0.585	20.94	0.989	21.08	0.965	20.98	0.215	20.85	0.634	21.60	0.014	20.20	0.124	21.02
8080.816	0.624	20.98	0.224	21.69	0.174	21.43	0.411	21.42	0.873	21.56	0.110	20.38	0.298	21.50
8366.955	0.727	21.15	0.982	21.25	0.237	21.40	0.030	20.73	.....	.....	0.529	21.25	0.175	21.24
8367.935	0.765	21.22	.....	.....	.....	.....	0.220	21.21	.....	.....	.....	.....	0.346	21.40:
8406.943	0.279	20.63	0.313	21.70	0.491	21.69	0.803	21.30	0.017	20.75	0.361	21.14:	0.146	21.20
8430.877	0.207	20.35	0.898	<21.65	.....	.....	0.457	21.09	0.681	21.32	0.654	21.16	0.318	21.45
8431.872	0.246	20.34	0.131	21.57	0.637	21.60:	0.649	21.39	0.915	21.42	0.750	20.73	0.491	21.38
8482.764	0.220	20.29	0.002	20.87	0.142	21.06	0.541	21.62	0.953	20.82	0.626	21.17	0.362	21.41
8483.751	0.259	20.32	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
8484.701	0.296	20.56	.....	.....	0.543	21.75	0.918	20.86	0.412	21.44	0.812	20.58	0.700	21.60
8485.727	0.335	20.62	.....	.....	0.755	21.70	0.119	20.96	.....	.....	0.910	20.48	0.879	21.61
8779.931	0.751	21.26	0.338	21.71	0.484	21.75:	0.306	21.07	0.248	21.42	0.102	20.14	0.162	20.98
8780.974	0.791	21.06	0.581	21.76	0.699	21.81	0.508	21.30	0.494	21.49	0.202	20.58	.....	.....
8781.920	0.828	21.20	0.803	21.85	0.895	21.36	0.693	21.55	0.719	21.66	0.292	20.84	0.508	21.63
8782.920	0.867	21.01	0.035	20.96	0.101	20.89	0.887	20.97	0.955	20.82	0.388	21.06	0.683	21.73
8783.933	0.906	20.48	0.271	21.71	0.310	21.47	0.083	20.76	0.194	20.96	0.485	21.05	0.859	21.47
8784.919	0.945	19.75	0.502	21.85	0.514	21.73	0.276	21.07	0.428	21.41	0.580	21.10	0.031	20.52
8785.913	0.983	19.71	0.733	21.82	0.718	21.81	0.468	21.21	0.662	21.49	0.675	21.18	0.204	21.40
8786.909	0.022	19.90	0.966	20.93	0.925	20.92	0.662	21.36	0.899	21.41	0.770	20.57	0.378	21.56
8787.873	0.059	19.86	.....	.....	0.123	21.21	0.849	21.38	0.125	21.04	0.863	20.17	0.546	21.56

TABLE 2—*Continued*

JD 2,420,000+	Plate	V18 Phase	V18 B	V20 Phase	V20 B	V22 Phase	V22 B	V24 Phase	V24 B
5829.958	H1097H	0.785	21.12	0.440	20.09	0.773	18.76	0.878	21.37
6211.962	H1166H	0.028	20.27	0.546	20.50	0.384	19.90	0.525	21.52
6268.788	H1184H	0.485	21.23	0.900	19.99	0.773	19.78	0.952	20.50
6269.792	H1194H	.....	.....	0.924	19.80:	0.780	19.72	0.101	20.48:
6304.642	H1199H	0.667	21.12	0.755	20.55	0.017	17.87	0.269	21.36:
6594.976	H1324H	.....	.....	.....	.....	0.002	17.87	.....	.....
6619.781	H1328H	0.841	21.09	0.267	20.10	0.171	18.13	0.001	20.38
6688.709	B5B	0.035	20.30	.....	.....	0.642	19.66:	.....	.....
6925.960	B107B	0.471	21.31	0.565	20.70	0.263	19.09	0.405	21.35
6926.946	B111B	0.531	21.21	0.588	20.42	0.269	19.16	0.552	21.52
6956.944	B118B	0.356	21.08	0.303	19.86	0.474	19.70	0.999	20.51
6957.971	B125B	0.418	21.26	0.328	19.93	0.482	19.63	0.152	20.74
6958.944	B135B	0.477	21.12	0.351	20.08	0.488	19.90	0.295	21.25
6959.920	B142B	0.537	21.31	0.374	20.15	0.495	19.64	0.441	21.36
6984.807	B146B	0.051	20.35	0.968	19.06	0.665	19.28	0.132	20.58
6984.921	B147B	0.058	20.30	0.970	19.15	0.666	19.63	0.148	20.78
6985.898	B151B	0.117	20.70	0.994	19.15	0.672	19.70	0.293	21.06
6986.883	B154B	0.177	20.89	0.017	18.94	0.679	19.90	0.439	21.42
7007.764	B157B	0.448	21.21	0.515	20.28	0.822	18.70	0.535	21.48
7007.836	B158B	0.452	21.32	0.517	20.27	0.822	18.57	0.547	21.38
7008.709	B162B	0.505	21.23	0.537	20.42	0.828	18.66	0.676	21.47
7008.780	B163B	0.510	21.33	0.539	20.30	0.829	18.66	0.686	21.60:
7036.661	B170B	0.206	20.83	0.204	19.79	0.020	18.08	0.820	21.28
7039.714	B172B	.....	.....	0.276	19.80	0.040	17.94	.....	.....
7064.656	B177B	0.909	20.49	0.871	20.19	0.211	19.09	0.973	20.63
7277.951	B246B	0.887	20.96	0.955	19.37	0.668	19.72	0.602	21.38
7278.928	B250B	0.947	20.35	0.978	19.02	0.674	19.54	0.747	21.45
7311.941	B275B	0.955	20.30	0.765	20.48	0.900	18.03	0.642	21.49
7335.851	B278B	0.410	21.14	0.335	19.87	0.064	18.16	0.188	20.81
7342.817	M2016	0.834	21.02	0.501	20.41	0.111	18.39	0.221	20.95
7342.791	B281B	0.867	21.00	0.906	19.90	0.228	19.18	0.738	21.52
7359.863	B282B	0.871	21.18	0.907	19.75	0.228	19.45	0.748	21.52
7366.850	B290B	0.296	20.94:	0.074	19.45	0.275	19.11	0.785	<21.30
7369.844	B292B	0.478	21.32	0.121	19.65	0.296	19.29	0.228	21.07
7391.749	B296B	0.811	20.98:	0.668	20.61	0.446	20.29	0.477	21.38
7392.699	B300B	0.869	20.95:	0.690	20.72	0.452	20.18	0.618	21.40:
7393.735	B307B	0.932	20.41	0.715	20.53	0.459	20.28	0.771	21.40
7417.670	B311B	0.388	21.24	0.285	20.01	0.623	20.52	0.321	21.00
7449.645	B317B	0.334	20.98:	0.047	19.25	0.841	19.72	0.062	20.67
7451.654	B327B	.....	.....	0.095	19.25	0.855	19.28	0.360	21.12
7659.954	B394B	0.130	20.33	0.060	19.07	0.279	18.63	0.249	21.02
7660.978	B399B	0.192	20.60	0.085	19.37	0.286	19.26	0.402	21.36
7661.941	B402B	0.251	20.95	0.108	19.52	0.292	19.22	0.544	21.50
7684.877	B406B	0.646	21.33	0.655	20.63	0.449	20.20	0.946	20.51
7686.934	B372	.....	.....	.....	.....	0.463	≤19.93	.....	.....
7687.970	B377	.....	.....	.....	.....	0.470	20.10	.....	.....
7689.867	B414B	0.950	20.34	0.774	20.70	0.483	20.29	0.686	21.52
7689.954	B415B	0.955	20.34	0.775	20.63	0.484	20.01	0.698	21.42
7691.882	HubbleA	0.073	20.50	.....	.....	0.497	20.16	0.984	20.58
7713.833	H1635H	0.408	21.16	0.345	19.86	0.646	20.17	0.239	21.09
7718.874	B380	0.715	20.98:	.....	.....	0.681	20.16	.....	.....
7719.882	B386	.....	.....	.....	.....	0.688	20.16	.....	.....

JD 2,420,000+	V25 Phase	V25 B	V26 Phase	V26 B	V27 Phase	V27 B	V29 Phase	V29 B	V30 Phase	V30 B
5829.958	0.273	20.40	.....	.....	.....	.....	.....	.....	0.164	21.58:
6211.962	0.744	21.24	0.959	21.27	0.839	21.46	.....	.....	0.634	21.97:Ie
6268.788	0.912	20.64	0.730	<21.62	0.371	21.24	.....	.....	0.943	21.61
6269.792	0.022	20.18	.....	.....	.....	.....	.....	.....	.....	.....
6304.642	0.806	21.39	0.894	21.53:	0.754	~21.62	.....	.....	0.341	21.47:
6594.976	0.326	20.34	.....	.....	.....	.....	.....	.....	.....	.....
6619.781	0.018	20.14	0.078	21.07	0.069	20.65	.....	.....	0.150	21.49:
6688.709	0.502	20.59	.....	.....	.....	.....	.....	.....	.....	.....
6925.960	0.258	20.40	0.721	<21.62	0.039	20.63	.....	.....	0.861	21.91
6926.946	0.366	20.74	0.890	21.78	0.187	20.91	0.732	21.90:	0.092	21.35
6956.944	0.621	21.37	0.048	21.09	0.691	21.66	0.188	21.35	0.118	21.39
6957.971	0.733	<21.45	0.224	21.38	0.845	21.53	0.546	.....	.....	.....
6958.944	0.838	21.08	0.392	21.59	0.992	20.65	0.885	21.60	0.586	21.72:
6959.920	0.945	20.36	0.560	21.82	0.138	20.82	0.225	21.48	0.815	21.69
6984.807	0.647	21.45	0.838	21.50:	0.875	21.39	0.899	.....	.....	.....
6984.921	0.659	21.38	0.858	21.69:	.....	.....	0.939	21.43	0.670	21.84
6985.898	0.766	21.31	0.026	21.07	0.038	20.68	0.280	.....	0.899	21.97Ie
6986.883	0.872	21.19	0.195	21.59	0.186	20.90	0.623	.....	0.130	21.56
7007.764	0.139	20.38	.....	.....	0.321	21.35	.....	.....	0.020	21.26
7007.836	0.147	20.38	0.798	21.85	0.332	21.27	0.926	21.58:	0.037	21.12
7008.709	0.242	20.43	0.948	21.09	0.463	<21.38	.....	.....	0.242	21.76
7008.780	0.250	20.38	0.960	21.22	0.474	21.46	0.255	21.70	0.258	21.67
7036.661	0.276	20.35	0.754	21.80	0.660	21.75	0.973	21.25	0.789	21.93
7039.714	0.607	20.93	.....	.....	.....	.....	.....	.....	.....	.....
7064.656	0.316	20.40	.....	.....	0.863	21.20:	.....	.....	0.345	21.98:Ie
7277.951	0.471	21.11	0.240	21.37	.....	.....	0.074	21.38	0.302	21.46
7278.928	0.578	21.45	.....	.....	0.034	20.67	.....	.....	.....	.....
7311.941	0.162	20.52	0.084	21.20	0.991	20.56	0.921	.....	.....	.....
7335.851	0.757	21.45	0.195	21.28	0.581	21.42	0.254	21.68	0.862	21.86
7342.817	0.514	21.12	0.393	21.76	0.626	21.33	0.682	21.98	0.494	21.56:
7342.791	0.356	20.92	0.311	21.35	0.175	20.91	0.599	21.84	0.470	21.83
7359.863	0.364	20.80	0.324	21.29	0.186	20.91	0.624	21.93	0.486	21.87
7366.850	0.123	20.36	.....	.....	.....	.....	0.059	21.32	.....	.....
7369.844	0.447	20.93	0.040	21.22	0.684	21.61	0.103	21.34	0.824	21.90
7391.749	0.826	21.37	0.806	21.93	0.973	20.60	0.738	22.03	0.954	21.46
7392.699	0.930	21.34	0.969	21.18	0.116	20.68	0.069	21.32	.....	.....
7393.735	0.041	20.33	0.148	21.25	0.271	21.40	0.430	21.82	0.420	21.68
7417.670	0.640	21.21	0.263	21.48	0.865	21.50	0.772	21.89	0.026	21.36
7449.645	0.111	20.38	.....	.....	0.666	<21.38	.....	.....	.....	.....
7451.654	0.329	20.63	0.106	21.14	0.967	20.75	0.617	<<21.9	0.985	21.13
7659.954	0.943	20.33	.....	.....	0.242	20.85	.....	.....	0.771	21.71:
7660.978	0.055	20.35	0.096	21.36	0.395	21.33	0.576	≤21.9	0.011	21.02
7661.941	0.160	20.40	0.262	21.38	0.540	21.25	0.912	21.74	0.237	21.46
7684.877	0.649	21.37	0.205	21.38	0.983	20.47	0.906	21.74	0.609	21.80
7686.934	0.872	<20.74	.....	.....	.....	.....	.....	.....	.....	.....
7687.970	0.985	20.53:	.....	.....	.....	.....	.....	.....	.....	.....
7689.867	0.191	20.54	0.063	21.07	0.724	21.58	0.297	21.85:	0.543	21.86
7689.954	0.200	20.57	0.078	21.14	0.746	21.58	.....	.....	.....	.....
7691.882	.....	.....	.....	.....	0.035	20.56	.....	.....	0.249	<<21.6
7713.833	0.793	21.57	0.184	21.38	0.331	21.42	0.999	21.23	0.391	21.55
7718.874	0.339	20.65	.....	.....	.....	.....	.....	.....	.....	.....
7719.882	0.449	21.0	.....	.....	.....	.....	.....	.....	.....	.....

JD 2,420,000+	V34 Phase	V34 B	V37 Phase	V37 B	V39 Phase	V39 B	V31 Phase	V31 B	V42 B
5829.958	.....	.....	0.410	.....	0.837	19.80	0.882	20.13	19.33
6211.962	.....	21.04	0.182	20.72	0.138	19.61	0.830	20.14	18.88
6268.788	.....	21.44	0.760	21.01:	0.117	19.68	0.137	20.15	19.08
6269.792	.....	.....	.....	.....	0.152	19.75	0.403	20.03	19.49
6304.642	.....	.....	0.648	.....	0.365	20.15	0.635	20.12	19.31
6594.976	.....	.....	.....	.....	0.474	19.39	0.551	.....	18.83
6619.781	.....	.....	0.034	20.45	0.338	19.67	0.122	20.13	19.23
6688.709	.....	.....	.....	.....	0.738	.....	0.383	.....	19.81
6925.960	0.026	20.74	0.698	21.06	0.999	18.63	0.236	20.08	18.94
6926.946	0.142	21.00	0.777	21.12	0.033	18.98	0.497	20.20	18.90
6956.944	.....	.....	0.193	20.78	0.077	18.98	0.444	20.07	18.70
6957.971	0.802	20.99	0.276	20.93	0.113	19.46	0.716	20.06	18.83
6958.944	0.916	20.63	0.354	21.06	0.147	19.55	0.974	.....	18.96
6959.920	0.031	20.74	0.433	21.26	0.181	19.55	0.232	20.18	18.90
6984.807	0.967	20.74	0.438	21.24	0.248	18.94	0.825	20.04	19.38
6984.921	0.980	20.72	0.477	21.15	0.052	18.96	0.856	20.07	19.03
6985.898	0.096	20.74	0.526	21.23	0.086	19.25	0.114	20.10	19.31
6986.883	0.212	21.18	0.605	21.29	0.120	19.48	0.375	20.02	19.13
7007.764	0.675	21.33	0.287	20.67	0.847	19.47	0.907	20.15	18.90
7007.836	.....	.....	0.292	20.89	0.849	19.65	0.926	20.16	18.83
7008.709	.....	.....	0.363	20.95	0.880	19.18	0.157	20.15	19.06
7008.780	0.794	21.28	0.369	20.92	0.882	19.13	0.176	20.18	18.80
7036.661	0.083	20.59	0.615	21.20	0.853	19.57	0.563	20.18	19.01
7039.714	.....	.....	.....	.....	0.959	18.66	0.371	20.01	18.66
7064.656	0.385	21.31	0.871	20.76	0.828	19.61	0.979	20.72	19.37
7277.951	0.543	21.72	0.052	20.44	0.255	19.74	0.487	20.34	19.50
7278.928	0.658	≤21.53	0.130	.....	0.289	19.79	0.744	20.20	19.53
7311.941	.....	.....	0.790	20.79	0.438	19.45	0.490	20.16	19.37
7335.851	0.372	21.41	0.716	21.36:	0.271	19.72	0.824	20.06	18.63
7342.817	0.193	21.30	0.277	20.90	0.513	19.21	0.670	20.16	19.41
7342.791	0.195	21.18	0.644	21.22	0.104	19.71	0.166	20.16	19.37
7359.863	0.204	21.02	0.650	21.22	0.107	19.82	0.168	20.18	19.27
7366.850	0.028	20.64	0.213	20.76	0.350	19.67	0.037	20.54	19.33
7369.844	0.381	21.39	0.454	21.10	0.454	19.37	0.830	20.14	19.33
7391.749	0.965	20.77	0.219	20.77	0.217	19.76	0.633	20.18	19.53
7392.699	0.077	20.60	0.296	.....	0.250	19.72	0.884	20.08	19.33
7393.735	0.199	21.12	0.379	21.11	0.286	19.88	0.159	20.15	19.31
7417.670	0.022	20.59	0.307	21.14	0.119	19.84	0.500	20.43	18.43
7449.645	.....	.....	.....	.....	0.233	19.82	0.971	20.35	18.78
7451.654	0.031	20.68	0.044	20.47	0.303	19.74	0.503	20.37	18.66
7659.954	0.599	~21.53	0.823	21.04	0.555	19.37	0.686	20.12	19.63
7660.978	.....	.....	0.906	20.67	0.591	19.73	0.957	20.54	19.37
7661.941	0.833	20.77	0.984	20.31	0.625	19.69	0.212	20.12	19.13
7684.877	0.539	21.67	0.832	20.80	0.423	19.65	0.288	20.11	18.79
7686.934	.....	.....	.....	.....	0.495	19.38	0.833	20.14	19.44
7687.970	.....	.....	.....	.....	0.531	19.38	0.108	20.11	19.06
7689.867	0.120	21.19	0.234	20.90	0.597	19.88	0.610	20.17	19.31
7689.954	0.138	21.00	0.240	20.86	0.600	19.72	0.634	20.14	19.43
7691.882	.....	.....	.....	.....	0.667	19.71	0.144	.....	19.66
7713.833	0.954	.....	0.164	20.70	0.432	19.72	0.960	.....	18.56
7718.874	.....	.....	.....	.....	0.607	19.43	0.295	20.18	19.29
7719.882	.....	.....	.....	.....	0.642	19.64	0.562	20.15	19.08

TABLE 2—*Continued*

JD 2,420,000+	Plate	V18 Phase	V18 B	V20 Phase	V20 B	V22 Phase	V22 B	V24 Phase	V24 B	V25 Phase	V25 B	V26 Phase	V26 B
7721.897	B419B	.....	.....	0.537	20.11	0.702	19.99	0.436	21.22	0.668	21.37	.....	.....
7722.812	B425B	0.955	20.39	0.559	20.18	0.708	19.78	0.571	21.45	0.767	21.28	.....	.....
7723.809	B429B	0.015	20.30	0.583	20.52	0.715	20.52	0.719	21.52	0.875	20.86	0.899	21.74
7744.726	B433B	0.288	21.07	0.081	19.52	0.858	19.70	0.821	21.52	0.147	20.39	0.495	21.71
7747.741	B389B	.....	.....	.....	.....	0.878	19.21	.....	.....	0.473	21.02	.....	.....
7748.726	B395	.....	.....	.....	.....	0.885	19.10	.....	.....	0.581	<20.98	.....	.....
7752.731	B442B	0.775	21.12	0.272	19.93	0.912	18.76	0.007	20.50	0.025	20.20	0.872	21.63
7809.653	B449B	0.238	20.81	0.629	20.57	0.301	19.15	0.448	21.44	0.194	20.32	.....	.....
8016.953	B538B	0.852	21.02	0.570	20.62	0.717	20.42	0.189	21.22	0.700	21.31	0.301	21.56
8017.949	B544B	0.912	20.71	0.594	20.57	0.724	20.42	0.337	21.22	0.809	21.16	0.472	21.67
8018.947	B549B	0.973	20.21	0.618	20.60	0.731	20.36	0.485	21.38	0.918	20.74	0.644	21.80
8019.950	B555B	0.034	20.25	0.614	20.54	0.738	20.44	0.634	21.51	0.025	20.28	0.816	21.67
8020.951	B561B	0.095	20.55	0.665	20.53	0.745	20.41	0.782	21.53	0.134	20.43	0.988	21.03
8021.959	Δ559	0.156	20.89	0.689	20.63	0.752	20.40	0.932	20.63	0.243	20.29	0.161	21.32
8045.906	B566B	0.613	21.46	0.260	19.91	0.916	19.04	0.483	21.34	0.843	.....	0.279	21.49
8046.931	B572B	0.676	21.51	0.285	19.92	0.922	18.75	0.635	21.53	0.955	20.26	0.455	21.64
8047.938	B577B	0.737	21.16	.....	.....	0.929	18.75	0.784	21.44	0.064	20.19	0.628	21.86
8048.942	B584B	0.798	21.21	0.332	19.92	0.936	18.77	0.933	20.53	0.173	20.54	0.801	21.75
8049.951	B588B	0.859	20.89	0.356	19.95	0.943	18.53	0.082	20.49	0.282	20.41	0.974	21.00
8067.817	B589B	0.946	20.28	0.782	20.76	0.065	18.06	0.732	21.52	0.223	20.39	0.046	21.08
8068.842	B590B	0.009	20.28	0.807	20.56	0.072	18.02	0.884	21.24	0.333	20.36	0.222	21.34
8069.826	B591B	0.069	20.50	0.830	20.66	0.079	18.02	0.030	20.57	0.441	.....	0.391	21.55
8069.905	B592B	0.073	20.69	0.832	20.55	0.079	18.05	0.041	20.54	0.449	21.17	0.405	21.62
8070.829	B593B	0.130	20.57	0.854	20.39	0.085	18.27	0.179	21.08	0.550	21.13	0.564	21.79
8071.830	B597B	0.191	20.95	0.878	20.36	0.092	18.60	0.327	21.20	0.658	21.33	0.736	21.84
8071.909	B598B	0.195	20.84	0.880	20.38	0.093	18.50	0.339	21.23	0.667	21.41	0.750	21.72
8072.826	B599B	0.251	21.02	0.902	20.07:	0.099	18.37	0.475	21.52	0.767	21.45	0.907	21.56
8072.903	B600B	0.256	21.16	0.904	20.30	0.100	18.54	0.486	21.52	0.774	21.33	0.920	21.53
8073.821	B601B	0.312	21.17	0.925	19.86	0.106	18.62	0.622	21.52	0.874	20.96	0.078	21.08
8074.911	B603B	0.378	21.16:	0.951	19.25	0.113	18.06	0.784	21.52	0.993	20.10	.....	.....
8075.806	B604B	0.432	21.20	0.973	19.19	0.120	18.47	0.917	20.91	.....	.....	0.420	21.46
8075.880	B605B	0.437	21.16	0.975	19.27	0.120	18.50	0.928	20.64	0.098	20.29	0.432	21.56
8077.809	B606B	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
8078.802	B607B	0.615	21.29	0.044	19.20	0.140	18.75	0.361	21.25	0.415	20.71	0.935	21.62
8079.815	B611B	0.676	21.20	0.068	19.42	0.147	18.81	0.511	21.52	0.525	21.16	0.109	21.22
8080.816	B612B	0.737	21.18	0.092	19.77	0.154	18.85	0.660	21.48	0.634	21.57	0.281	21.56
8366.955	B690B	0.147	20.58	0.913	19.82	0.109	18.47	0.091	20.51	0.697	21.59	0.478	21.55
8367.935	B694B	0.207	20.99	0.936	19.45	0.115	18.08	0.236	20.87	0.805	.....	.....	.....
8406.943	B703B	0.580	21.39	0.866	20.63	0.382	19.53	0.021	20.51	0.038	20.22	0.354	21.50
8430.877	B717B	0.037	20.30	0.436	20.16	0.546	20.19	0.571	21.52	0.637	21.33	.....	.....
8431.872	B719B	0.097	20.36	0.460	19.97	0.553	20.37	0.718	21.52	0.745	21.47	.....	.....
8482.764	B721B	0.194	20.73	0.673	20.65	0.901	18.79	0.264	21.00	0.269	20.45	0.390	21.53
8483.751	B728B	.....	.....	0.697	20.41	0.907	18.53	.....	.....	.....	.....	.....	.....
8484.701	B730B	0.312	21.18	0.719	20.65	0.914	18.64	0.552	21.49	0.480	21.27	.....	.....
8485.727	B732B	0.374	21.29	0.744	20.70	0.920	18.43	0.705	21.52	0.592	21.35	.....	.....
8779.931	H1880H	0.275	20.85	0.756	20.72	0.931	18.65	0.332	21.13	0.532	20.90	0.483	21.52:
8780.974	B811B	0.338	21.04	0.781	21.47	0.938	18.07	0.486	21.40	0.645	21.29	.....	.....
8781.920	B815B	0.396	20.98	0.804	20.48	0.944	18.03	0.627	21.47	0.748	.....	0.825	21.73
8782.920	B819B	0.457	21.20	0.828	20.45	0.951	17.99	0.775	21.52	0.857	21.09	0.997	20.96
8783.933	B823B	0.518	21.19	0.852	20.39	0.958	17.90	0.925	20.82	0.967	20.08	0.172	20.27
8784.919	B827B	0.578	21.43	0.875	20.27	0.965	17.81	0.072	20.58	0.073	20.41	.....	.....
8785.913	B831B	0.639	21.20	0.899	20.00	0.972	17.74	0.219	20.82	0.180	20.49	0.512	21.72
8786.909	B836B	0.699	.....	0.923	20.39	0.978	17.66	0.367	20.90	0.289	20.40	0.683	21.73
8787.873	B841B	0.758	20.93	0.946	19.35	0.985	17.68	0.509	21.38	0.393	20.80	0.849	<21.58

JD 2,420,000+	Plate	V27 Phase	V27 B	V29 Phase	V29 B	V30 Phase	V30 B	V34 Phase	V34 B	V37 Phase	V37 B	V39 Phase	V39 B	V31 Phase	V31 B	V42 B
7721.897	B419B	0.542	21.42	.....	.....	.....	.....	0.905	.....	0.813	.....	0.712	19.91	0.096	20.21	19.46
7722.812	B425B	.....	.....	0.128	21.68	.....	.....	0.031	20.51	0.887	21.00	0.744	20.04	0.338	20.23	19.08
7723.809	B429B	0.829	21.53	0.476	21.79	0.727	21.98	0.131	21.00	0.967	20.31	0.779	19.61	0.602	20.13	19.61
7744.726	B433B	0.969	20.58	.....	.....	0.626	21.83	0.598	21.66	0.653	21.13	0.507	19.03	0.144	20.20	19.06
7747.741	B389B	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.612	19.43	0.942	20.34	18.59
7748.726	B395	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.646	19.45	0.203	20.08	18.76
7752.731	B442B	0.171	21.10	0.556	~21.9	0.501	21.79	0.542	<21.53	0.297	20.92	0.786	19.73	0.264	20.21	19.06
7809.653	B449B	.....	.....	.....	.....	.....	.....	.....	.....	0.883	.....	0.768	19.72	0.344	20.07	19.23
8016.953	B538B	0.842	21.50	0.650	.....	0.385	21.71	0.706	21.62	0.582	21.33	0.986	18.60	0.262	20.04	19.44
8017.949	B544B	0.991	20.52	0.997	21.20	0.618	21.94	0.824	21.05	0.662	21.22	0.021	18.80	0.526	20.34	19.44
8018.947	B549B	0.141	20.85	0.345	21.72	0.852	21.90	0.942	20.82	0.743	21.16	0.055	19.25	0.791	20.14	19.62
8019.950	B555B	0.292	21.16	0.695	21.94	0.087	21.36	0.060	20.54	0.823	20.90	0.090	18.94	0.056	20.25	19.60
8020.951	B561B	0.442	21.38	0.044	21.22	0.321	21.65	0.178	21.20	0.904	20.57	0.125	19.29	0.322	20.13	19.67
8021.959	Δ559	0.593	21.51	0.395	21.89	0.557	21.83	0.297	21.31	0.985	20.41	0.160	19.47	0.589	20.16	19.60
8045.906	B566B	0.189	20.93	0.742	21.99	0.166	21.53	0.121	20.92	0.914	20.72	0.994	18.60	0.933	20.20	19.18
8046.931	B572B	0.342	21.23	0.099	21.40	0.406	21.72	0.242	21.23	0.996	20.41	0.030	18.80	0.204	20.14	19.13
8047.938	B577B	0.494	21.52	0.450	21.98	0.642	21.95	0.361	21.66	0.078	20.44	0.065	19.33	0.471	20.24	19.20
8048.942	B584B	0.644	21.47	0.800	21.91	0.877	21.85	0.479	21.80	0.159	20.62	0.100	19.13	0.737	20.22	19.41
8049.951	B588B	0.796	21.63	0.151	21.58	0.114	21.26	0.598	21.72	0.240	20.84	0.135	19.13	0.004	20.87	19.63
8067.817	B589B	0.478	21.43	0.379	21.91	0.298	21.71	0.706	21.40	0.679	21.25	0.757	19.46	0.737	20.17	19.57
8068.842	B590B	0.632	21.52	.....	.....	0.538	<<21.56	0.827	20.94	0.761	21.08	0.793	19.46	0.009	20.72	19.61
8069.826	B591B	.....	.....	0.079	21.38	0.768	<21.84	.....	.....	0.841	21.00	0.827	19.51	0.270	20.08	19.56
8069.905	B592B	0.792	21.67	0.106	21.31	0.787	21.88	0.952	20.98	0.847	20.78	0.830	19.50	0.290	20.06	19.53
8070.829	B593B	0.931	20.91	0.428	21.76	0.003	21.16	0.061	20.63	0.921	20.46	0.829	19.54	0.535	20.21	19.66
8071.830	B597B	0.081	20.72	0.777	≤21.89	0.238	21.47	0.179	21.02	0.002	20.39	0.897	19.35	0.800	20.15	19.68
8071.909	B598B	0.093	20.82	0.805	≤21.89	0.256	21.56	0.188	21.02	0.009	20.38	0.899	19.03	0.821	20.13	19.71
8072.826	B599B	.....	.....	0.124	.....	0.471	<<21.55	.....	.....	0.083	20.46	0.931	18.58	0.064	20.10	19.71
8072.903	B600B	0.242	21.09	0.151	.....	0.489	21.78	0.306	21.30	0.089	20.46	0.934	18.63	0.085	20.23	19.51
8073.821	B601B	0.380	21.31	0.471	.....	0.704	21.87	0.414	21.56	0.163	20.73	0.966	18.78	0.328	20.06	19.59
8074.911	B603B	0.543	21.59	.....	.....	0.959	21.61	0.542	<21.43	0.250	20.80	0.004	18.87	0.617	20.09	19.66
8075.806	B604B	.....	.....	0.163	21.52	0.169	21.68	0.648	21.69	0.322	20.96	0.035	19.11	0.854	20.20	19.57
8075.880	B605B	0.689	21.74	0.189	21.43	0.186	.....	0.657	21.90	0.329	21.04	0.038	18.94	0.873	20.13	19.50
8077.809	B606B	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.105	.....	0.384	20.06:	18.97
8078.802	B607B	0.128	20.84	.....	.....	0.871	21.69:?	0.001	20.58	0.564	21.30	0.139	19.62	0.647	20.06	19.18
8079.815	B611B	0.280	21.08	0.560	22.00	0.108	21.48	0.121	20.92	0.645	21.17	0.175	19.66	0.916	20.17	19.41
8080.816	B612B	0.430	21.55	0.909	21.70	0.342	21.81	0.239	21.30	0.727	21.13	0.209	19.48	0.181	20.16	19.47
8366.955	B690B	0.391	21.29	0.642	21.82	0.360	21.56	0.989	20.72	0.776	20.85	0.173	19.83	0.985	20.78	19.66
8367.935	B694B	.....	.....	.....	.....	.....	.....	0.104	20.62	0.855	.....	0.207	19.73	0.245	20.05	19.61
8406.943	B703B	0.395	21.48	0.580	21.84	0.725	21.97Ie	0.705	21.89	0.996	20.49	0.565	19.68	0.579	20.04	18.74
8430.877	B717B	0.988	20.73	0.922	21.86	0.331	21.61	0.528	≤21.43	0.926	20.45	0.398	19.66	0.919	20.23	19.71
8431.872	B719B	0.138	20.76	0.269	21.92	0.564	21.71	0.645	21.70	0.005	20.40	0.433	19.31	0.183	20.06	19.63
8482.764	B721B	0.779	21.53	0.007	21.18	0.484	21.75	0.648	21.70	0.105	20.64	0.205	19.77	0.665	20.04	19.63
8483.751	B728B	.....	.....	.....	.....	.....	.....	.....	.....	0.184	20.55	0.239	19.79	0.927	20.09	19.71
8484.701	B730B	0.069	20.67	0.682	21.86	0.937	21.39	0.876	20.90	0.261	21.02	0.272	19.89	0.179	20.09	19.57
8485.727	B732B	.....	.....	0.040	21.48	0.178	21.46:	0.997	20.73	0.344	21.24	0.308	19.75	0.450	20.20	19.61
8779.931	H1880H	0.395	21.53	0.583	21.96	0.084	21.38	0.698	21.30	0.043	20.41	0.552	19.89	0.391	20.11	19.52
8780.974	B811B	0.552	21.53	0.947	21.48	0.328	21.63	0.821	20.79	0.126	20.47	0.588	19.72	0.667	20.14	19.62
8781.920	B815B	0.694	21.55	0.276	21.82	0.550	21.77	0.933	20.71	0.203	20.47	0.621	19.79	0.918	20.14	19.54
8782.920	B819B	0.844	21.70	0.625	22.00	0.784	21.96Ie	0.051	20.51	0.284	20.86	0.656	19.80	0.183	20.16	19.57
8783.933	B823B	0.996	20.52	0.978	21.26	0.021	21.38	0.170	20.94	0.365	21.09	0.691	19.82	0.451	20.17	19.31
8784.919	B827B	0.144	20.81	0.322	21.91	0.252	21.68	0.286	21.20	0.445	21.21	0.726	19.83	0.713	20.05	19.03
8785.913	B831B	0.294	21.27	0.668	22.00	0.485	22.00Ie	0.404	21.58	0.524	21.26	0.760	19.79	0.982	20.75	18.78
8786.909	B836B	0.443	21.48	0.015	21.29	0.718	>22.00Ie	0.521	21.58	0.605	21.25	0.795	19.75	0.240	20.12	18.70
8787.873	B841B	0.588	21.46	0.351	21.91	0.944	21.42	0.635	21.43	0.682	21.17	0.828	19.78	0.495	20.17	18.96

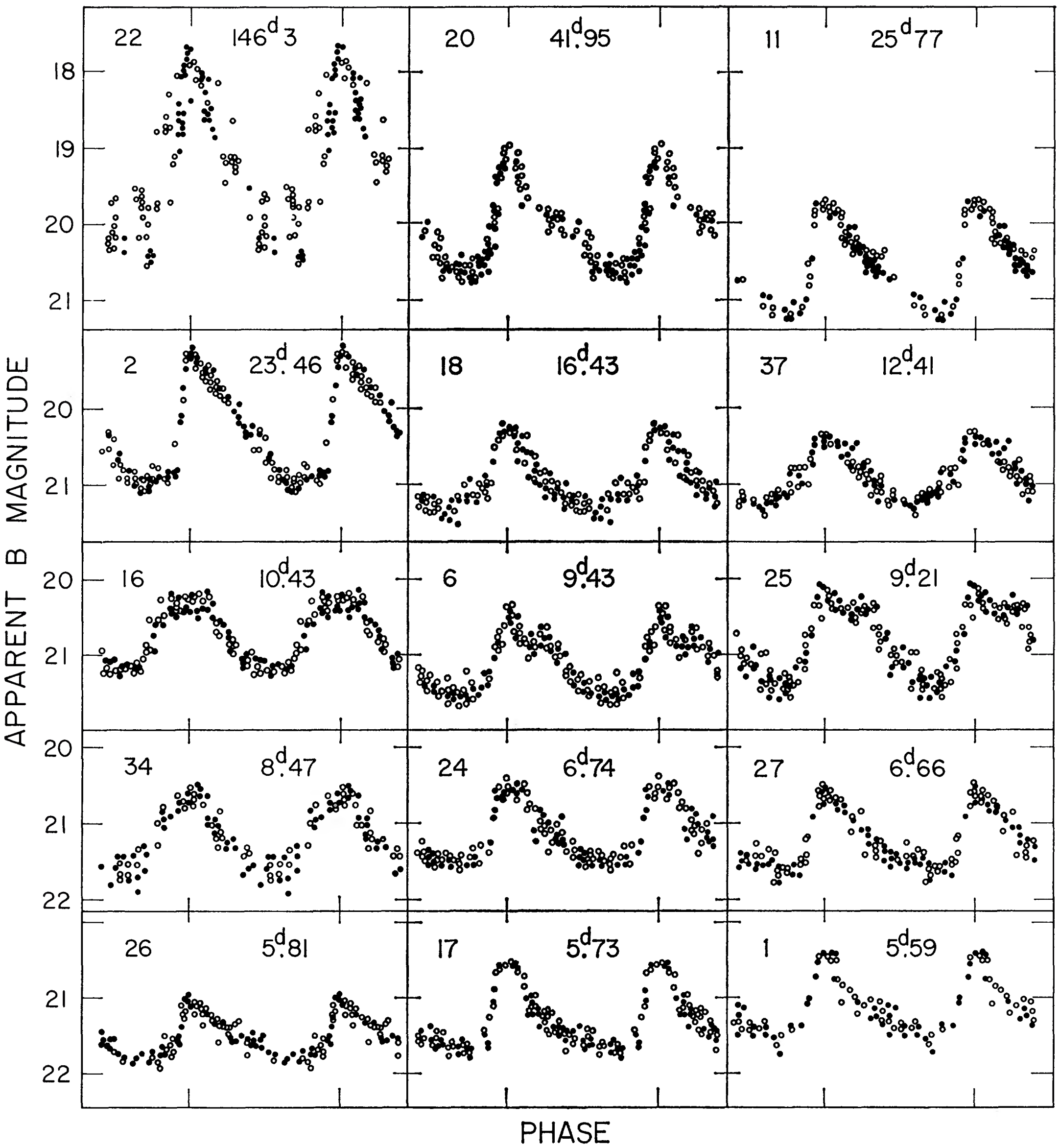

FIG. 7 —Blue light curves for Cepheids arranged in order of period. Data are from Table 2.

period known. That the star is undoubtedly a Cepheid follows from the shape of the light curve and from classification of a spectrum taken by Baade with the 100-inch (14 hours exposure) during a maximum in 1941 September ($m_{pg} = 17.5$). Baade comments on the spectrum: "Joy classified the type as cK2 by the following arguments, (1) Ca I λ4226 is strong. This line does not occur [in such strength] earlier than K0. (2) [The high luminosity lines of] Sr II λ4215, λ4077 are present. (3) Joy states that H and K are somewhat sharper than expected, which is consistent with the high luminosity. Humason classified the spectrum as F5 to G0 from the strength of the hydrogen lines and the H and K lines only. His early spectral type is consistent with Joy's later type since it is well known that hydrogen lines have abnormal strength in Cepheids of Type I. Adams and Joy (1918) stated many years ago that at maximum light the spectral class

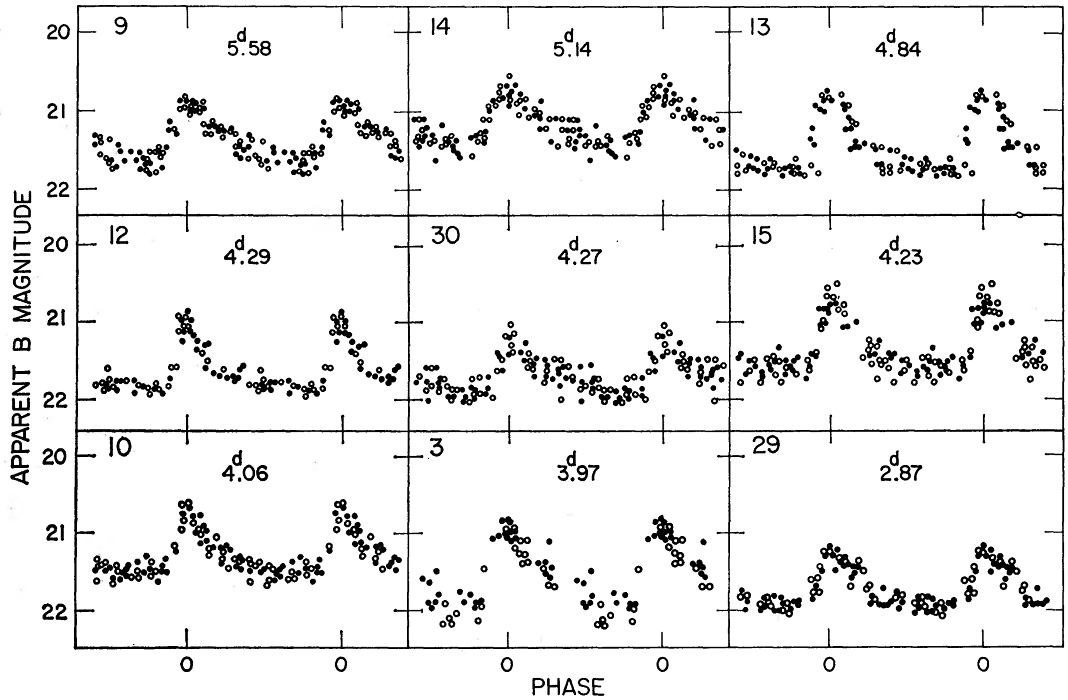

FIG. 8.—Same as Fig. 7 for the remaining Cepheids

of a Cepheid is on the average 8 spectral subdivisions earlier when classified from hydrogen lines than from general metal lines." This description shows that the spectrum of V22 is similar to that of other Cepheids of shorter period, and that there should be no hesitation in assigning it to the Cepheid class.

The only other abnormal variable is V39, which Baade did not classify as a Cepheid for two reasons: (*a*) The shape of the light curve is quite unusual, as shown in Figure 9. The rise to maximum and fall to a first minimum is symmetrical about the phase ± 0.2. Centered at phase 0.5 is a second lower maximum. The light curve can be described as an *inverted* β Lyrae eclipsing variable, and appears to be unique among Cepheids. Because of the peculiar light curve, various attempts have been made to disprove the period. Harold Weaver, working with Baade on other problems sometime after 1940, obtained a period of $28^{\mathrm{d}}.687$ after many trials at other periods. Baade himself obtained $P = 28^{\mathrm{d}}.71$ from the material from 1932 to 1937. G. A. Tammann recently reworked the problem and obtained what is here adopted as $P = 28^{\mathrm{d}}.720$. There appears to be no

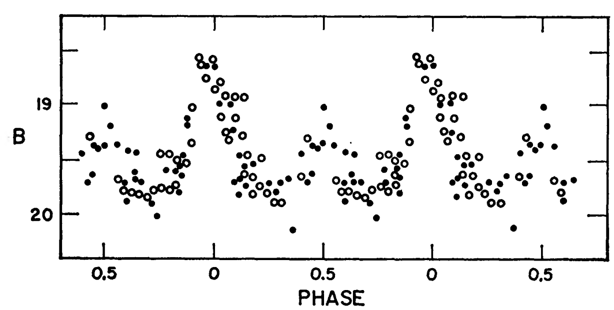

FIG. 9.—Light curve for the peculiar regular variable V39. The star is considered to be a Cepheid in the text, but was not so considered by Baade. It lies high in the P-L relation.

possibility that this period is spurious because of the dense distribution of plates, especially in 1935. (*b*) Baade's second reason was that V39 falls 0.9 mag brighter than the apparent P-L relation for the twenty-four other Cepheids. Baade's interpretation was that the P-L relation has only a very small intrinsic scatter about the ridge line ($\sigma \simeq$ 0.15 mag), and because V39 differed by 6 σ from this line the variable was not considered to be a Cepheid, despite the high regularity of its period and light curve. A new interpretation of the data is discussed in § IV.

The only other point to be mentioned concerns the Hertzsprung (1926) relation between light-curve shapes and period. Hertzsprung first noticed that if light curves of Cepheids are ordered by period, a systematic perturbation occurs on an otherwise smooth curve in the period interval from 6 to 16 days. At the short-period limit, a hump appears on the descending part of the curve, just prior to minimum light. The hump progressively moves toward the maximum as the period increases, producing double maxima near 9 days, then a single-peaked maximum near 10 days, moving through the maximum phase to appear on the ascending branch for periods between 10 and 16 days. For longer-period stars such as RU Sct ($P = 19^{\mathrm{d}}.70$), SW Vel ($P = 23^{\mathrm{d}}.47$), X Pup ($P = 25^{\mathrm{d}}.96$), and U Cen ($P = 38^{\mathrm{d}}.76$) the hump again appears on the descending branch but with less prominence than for stars with periods between 6 and 9 days. The phenomenon is general, occurring among Cepheids in M31 (cf., e.g., Baade and Swope 1963, 1965), the SMC (cf. Gaposchkin and Gaposchkin 1966), and the LMC (Mohr 1938). A convincing theoretical explanation has been given by Christy (1970) in terms of a reflection by the core of accelerations originating in the helium-ionization zone. The reflected pulse, upon reaching the surface after traveling entirely through the star, appears at various phases in the light curve depending on the travel time.

The Hertzsprung phenomenon appears only weakly in Figures 7 and 8, principally because the critical period range is not well represented. However, the double maximum near 9 days is clearly visible in V25 ($P = 9^{\mathrm{d}}.21$) and V6 ($P = 9^{\mathrm{d}}.43$), with some indication of a perturbation near maximum for V34 ($P = 8^{\mathrm{d}}.47$) and V16 ($P = 10^{\mathrm{d}}.43$), and a moderately definite indication of a hump on the ascending branch for V37 ($P = 12^{\mathrm{d}}.41$) and V18 ($P = 16^{\mathrm{d}}.43$).

The final remarks on Figures 7 and 8 concern the limiting magnitude of the 100-inch telescope during these prewar years when the Los Angeles valley was relatively dark. The working limit appears to be $B \simeq 22.2$ as shown for V3 of Figure 8. The actual limit for detectability was somewhat fainter, perhaps at $B = 22.5$. We earlier determined that the limit of the Mount Wilson 60-inch was $B \simeq 21.5$ before 1950 (Tammann and Sandage 1968), which is in essential agreement with $B \simeq 22.5$ for the 100-inch, when one considers the ratio of the apertures, at the same focal ratio of f/5 for both telescopes.

e) Irregular Variables

Eleven irregular variables are listed in Table 1. Of these, eight are very red and are undoubtedly similar to those found in the h and χ Per association. Similar red variables are found in M31 (Baade and Swope 1963, 1965), M33 (Humason and Sandage, unpublished), NGC 6822 (Kayser 1967), and NGC 2403 (Tammann and Sandage 1968). Of the other three variables, V21 and V42 are of intermediate color and V44 is very blue, perhaps of the type discussed by Hubble and Sandage (1953) in M31 and M33, but much fainter intrinsically.

The final column of Table 2 lists B magnitudes for the unusual irregular V42. Table 3 lists individual magnitudes from 1929 to 1942 for V23, V32, V43, V44, V45, and V56. These, together with V52 (which was seen only in the 1935–1936 season, rising above plate limit to $B = 21.5$), are illustrated in Figure 10. Variations on a scale of 100 days are evident for the red stars, and the longer-term variation on a scale of several years characterizes the blue irregular V44.

TABLE 3

B MAGNITUDES OF NON-CEPHEIDS

JD 2,420,000 +	V23	V32	V43	V44	V45	V56
5830	19.99	19.13	19.44	20.58	19.70	19.40
6212	20.05	.....	19.02	20.68	19.75	19.28
6269	19.83	19.35	19.44	20.77	19.77	19.28
6306	19.99	.....	19.51	20.68	19.76	19.28
6595	19.72	.....	19.71	.....	.....	19.17
6620	20.14	19.60	19.86	20.65	19.93	19.12
6689	19.77	.....	.....	.....	.....	19.40
6925	20.14	19.53	19.71	20.54	19.94	19.37
6956	.....	19.51	19.75	.....	.....	.....
6958	.....	19.61	.....	.....	.....	19.30
6960	20.29	19.74	.....	20.61	20.25	.....
6988	20.56	19.77	19.68	20.68	19.89	19.28
7010	20.80	19.79	19.60	20.68	20.13	19.37
7040	20.84	19.80	19.70	20.62	20.08	19.28
7066	20.85	19.80	.....	20.73	19.92	19.48
7278	20.10	19.01	.....	20.73	19.77	19.10
7312	20.08	19.14	19.45	20.62	19.77	19.14
7340	20.08	19.52	19.26	20.73	19.94	19.28
7360	20.10	19.68	19.18	20.66	19.93	19.38
7395	20.38	19.74	19.65	20.65	19.80	19.40
7418	20.43	19.77	19.70	20.56	19.77	19.40
7450	20.45	19.77	19.99	20.51	19.77	19.40
7662	20.21	19.81	19.81	20.11	20.13	18.90
7688	.....	19.77	19.58	.....	20.12	19.38
7690	20.04	.....	.....	20.11	.....	19.25
7692	.....	19.91	19.67	.....	20.08	.....
7720	.....	19.77	19.86	.....	19.88	19.18
7725	20.01	19.85	.....	20.09	.....	.....
7750	20.04	19.85	19.83	20.03	19.85	19.30
7790	.....	.....	.....	20.09	.....	.....
7810	20.47	19.73	19.71	.....	19.80	19.45
8020	20.04	19.50	19.77	20.01	20.20	19.50
8048	20.00	19.61	19.83	19.98	20.20	19.68
8073	19.92	19.63	19.84	20.02	20.34	19.60
8370	20.13	19.91	19.77	20.04	19.61	19.40
8408	20.47	19.94	.....	19.94	.....	.....
8432	20.38	19.99	19.73	20.06	19.65	19.70
8485	20.05	20.05	19.71	20.08	19.84	19.45
8516	.....	.....	.....	.....	.....	.....
8783	20.45	19.99	19.74	20.24	19.84	19.32
9200	20.01	19.77	19.74	20.32	20.41	.....
9530	20.28	19.62	19.76	20.33	19.80	.....
9550	.....	.....	.....	.....	20.01	.....
9850	.....	.....	.....	20.43	.....	.....
9880	.....	.....	.....	20.70	.....	.....
9900	.....	.....	.....	20.16	.....	.....
9920	.....	.....	.....	20.11	.....	.....
9980	.....	.....	.....	19.98	.....	.....
30320	.....	.....	.....	20.32	.....	.....

Four stars not illustrated have the following characteristics:

V21.—Intermediate color and small amplitude. From 1929 to 1937 the star varied from $B = 19.60$ to $B = 20.34$. The largest variations occurred between 1929 and 1932, after which the star remained relatively constant to within ± 0.2 mag at $B \simeq 20.0$.

V38.—Very red. Optical double. The variable is the eastern component. From 1933 to 1937 the star was very nearly constant at $B = 19.2$. The greatest variability occurred in 1931 and 1932, when the star reached $B = 18.6$ in one burst in 1932, and with less certainty $B \simeq 18.5$ in 1931. At faintest minimum, the star was $B = 19.6$, which occurred in 1933. This star is one of the brightest red variables in the galaxy, reaching $M_B = -6.0$ at maximum (or $M_V \simeq -8.0$ if a color of 2.0 is assumed).

V42.—Intermediate color. Rapid changes of 0.6 mag in intervals of 3 days. Especially rapid changes of this type were observed in 1934, 1935, and 1937. The star was considered to be possibly periodic ($P \simeq 80^d$?), but no satisfactory analysis has been achieved. It is one of the brightest stars in the galaxy at maximum light ($B \simeq 18.5$, $M_B = -6.0$).

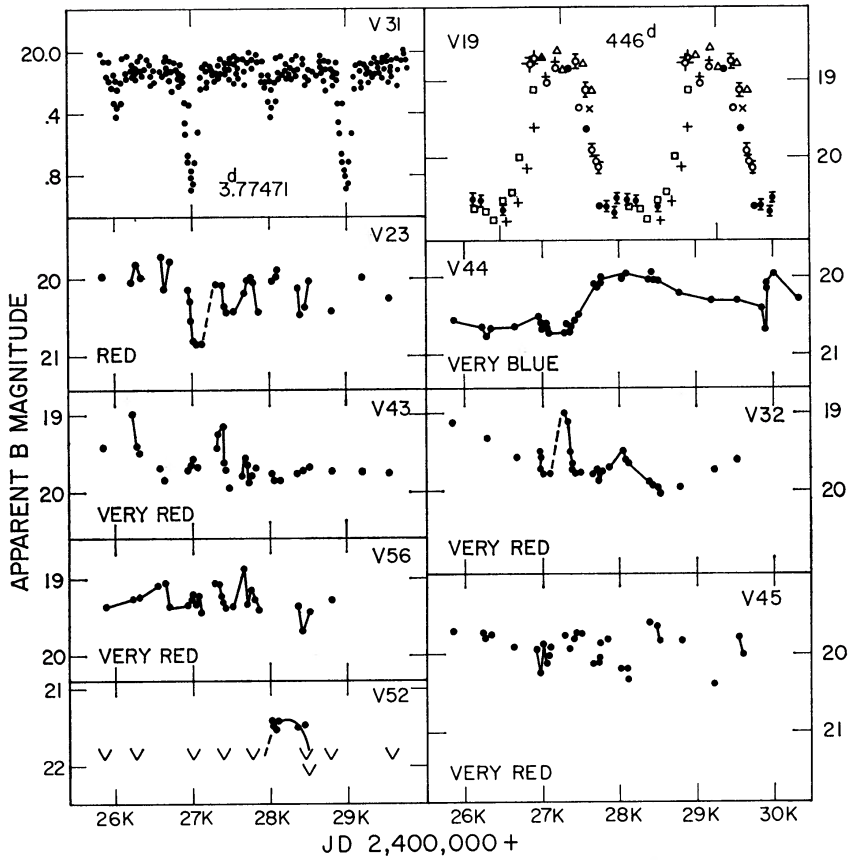

FIG. 10.—Light curves for seven irregular variables, for the eclipsing binary, and for the semiregular red star V19. Data are from Tables 3 and 5. Only data from 1929 to 1937 are plotted for V19, where the symbols ×, ●, ○, +, □, ⧫, ϕ, △, and ⟡ are used in succession for the nine years.

V50.—Reddish color but not extreme. Slow variation of small amplitude, ranging from $B = 20.45$ to $B = 20.93$ in a sinusoidal fashion from 1930 to 1937. Its "period" is $\sim$2600 days.

Table 4 summarizes the characteristics of the irregular variables. The final column lists absolute magnitudes at maximum light, if an apparent blue modulus of $(m - M)_{AB} = 24.55$ (§ IV) is assumed.

f) The Semiregular Variable V19

The light curve for V19 is shown in Figure 10 as plotted from the data listed in Table 5. The variable presents problems in classification. The period is moderately regular, as shown by the well-defined light curve plotted from 11 cycles covered between 1929 and 1946. The light curve does not repeat perfectly from cycle to cycle, but the period appears to be relatively stable. For example, the star rose toward maximum more rapidly and fell toward minimum more slowly during the 1939–1940 season than in other cycles, artificially giving the appearance of a flat top to Figure 10.

The amplitude of only $A_B = 2.2$ mag is too small for a normal Mira according to the standard definition (cf. Kukarkin *et al.* 1957), but the period may be too regular for the object to be classed as a semiregular variable. We are forced, however, to an SRc classification because of the absolute magnitude. If V19 is in IC 1613, its absolute magnitude at maximum is $M_B \simeq -6.0$, which is far brighter than any Mira (Merrill and Wilson

TABLE 4

SUMMARY OF IRR VARIABLES

No.	B(max)	B(min)	A_B	Color	M_B(max)
21........	19.60	20.34	0.74	INT	−4.95
23........	19.72	20.85	1.13	R	−4.83
32........	19.00	20.05	1.05	VR	−5.55
38........	18.6	19.6	1.0	VR	−5.95
42........	18.5	19.8	1.3	I	−6.05
43........	19.02	19.99	0.97	VR	−5.53
44........	20.00	20.78	0.78	VB	−4.55
45........	19.60	20.40	0.80	VR	−4.95
50........	20.45	20.93	0.48	I-R	−4.10
52........	21.4	>22	>0.8	?	−3.15
56........	18.90	19.70	0.80	VR	−5.65

TABLE 5

PHOTOMETRY OF THE SEMI-REGULAR V19

JD 2,400,000+	E	Phase	B	JD 2,400,000	E	Phase	B	JD 2,400,000	E	Phase	B
25,830	-3	0.175	19.38	27,661	1	0.280	20.65	29,194	4	0.718	18.65
26,212	-2	0.031	18.87	685	1	0.334	20.73	197	4	0.725	18.63
269	-2	0.159	19.65	691	1	0.348	20.54	552	5	0.520	19.98
305	-2	0.240	20.65	721	1	0.415	20.57	612	5	0.656	18.87
595	-2	0.890	19.05	749	1	0.478	20.57	848	6	0.185	18.60
620	-2	0.946	18.84	810	1	0.614	20.65	871	6	0.235	18.89
689	-1	0.101	19.37	28,019	2	0.083	18.76	903	6	0.308	19.61
927	-1	0.635	20.83	048	2	0.148	19.13	933	6	0.376	19.96
959	-1	0.706	20.58	071	2	0.199	19.93	969	6	0.455	20.01
986	-1	0.767	20.15	075	2	0.208	20.07	30,226	7	0.031	18.54
27,009	-1	0.818	19.63	080	2	0.220	20.12	236	7	0.054	18.09
039	-1	0.886	18.98	367	2	0.863	18.70	259	7	0.105	18.49
065	-1	0.944	18.79	407	2	0.953	18.58	322	7	0.246	19.05
278	0	0.422	20.66	432	3	0.009	18.85	613	7	0.899	18.26
312	0	0.498	20.69	484	3	0.126	18.77	641	7	0.962	18.22
339	0	0.558	20.81	516	3	0.197	19.13	672	8	0.031	18.37
365	0	0.617	20.58	782	3	0.794	18.80	705	8	0.105	18.68
393	0	0.679	20.47	786	3	0.803	18.73	727	8	0.155	18.39
418	0	0.735	20.00	787	3	0.805	18.47	32,031	11	0.078	18.47
451	0	0.809	19.15	193	4	0.715	18.74				

Phase computed from Max at JD 2427090 + $446^{d}n$

1942; Osvalds and Risley 1961; Smak 1966). That it is not a foreground Mira or an ordinary giant SRa or SRb ($M_V \simeq -1$) follows from its faintness at B(max) = 18.6, which would place it at intergalactic distances (i.e., $m - M \simeq 19.6$). We therefore believe that V19 belongs to IC 1613, and that the best classification is an abnormally regular example of the supergiant SRc class whose members include μ Cep, α Ori, α Sco, and RW Cyg, all of which are of exceeding high luminosity (usually luminosity class Ia).

g) The Eclipsing Variable and a Nova

Figure 10 shows the light curve for V31, which is a typical eclipsing binary of the Algol type with a definite secondary minimum at phase 0.5. The star is very blue, and has a period of $3^{d}77$. The magnitudes are $B = 20.15$ at maximum, 20.90 at primary minimum, and 20.42 at secondary minimum.

One nova was found by Baade with the 200-inch in 1954 November. The position is marked in Figures 1 and 2. The nova had an extremely rapid rise. It was invisible on a

200-inch plate taken 1954 November 21, but was present on three plates taken 24 hours later at $B \simeq 17.5$. No further plates of IC 1613 were taken during that season, and the star was not see again. With $(m - M)_{AB} = 24.55$, the absolute magnitude was $M_B = -7.0$ on November 21. Very likely the nova was caught before its maximum.

IV. PERIOD-LUMINOSITY RELATION AND THE DISTANCE

Table 6 lists elements for the twenty-five Cepheids shown in Figures 7, 8, and 9. The periods in column (3) are as derived by Baade. Column (4) gives the error of these periods (in units of 10^{-5} days) derived by finding the limits of period change which would cause detectable phase spreading in the plotted light curves. The intensity mean $\langle B \rangle$ in the penultimate column was found by converting the light curves to intensity units, planimetering, and converting back to magnitudes. The P-L relation can be discussed from these data.

a) Baade's Interpretation

Figure 11 shows the P-L relation without V39, as plotted from the data in Table 6. A least-squares line gives $\langle B \rangle = -1.518 \log P + 22.422$ which is shown as the heavy ridge line in Figure 11. The scatter from this line, read as a magnitude residual, gives $\sigma(M) = 0.158$ mag. The two boundary lines in the diagram are drawn at $\pm 2\ \sigma = \pm 0.32$ mag. For a normal distribution, 95 percent of the sample should be enclosed within these boundaries, and this is the case.

Two points concerning this solution are very disturbing: (1) the slope of the P-L relation is exceedingly small compared with the relation in other galaxies; (2) the dispersion is smaller by a factor of 2 than is required by available data on the width of the instability strip for Cepheids in the H-R diagram for all other galaxies in the Local Group. Both points are serious, as shown by the following preponderance of evidence to the contrary.

TABLE 6

ELEMENTS OF 25 CEPHEIDS AND ONE ECLIPSER IN IC 1613

No	JD 2,420,000+	P(days)	$E^d \times 10^5$	log P	B(MAX)	B(MIN)	B(MED)	⟨B⟩	A_B
1	7,931.28	$5^{\mathrm{d}}.59210$	±28	0.748	20.45	21.55	21.00	21.12	1.14
2	7,391.11	23.4611	170	1.370	19.20	20.98	20.09	20.30	1.78
3	8,049.88	3.96789	21	0.599	20.94	22.00	21.47	21.61	1.06
6	7,718.77	9 43048	19	0.974	20.40	21.56	20.98	21.04	1.16
9	8,073.59	5 57738	37	0.746	20.94	21 66	21.30	21.37	0.72
10	7,723.80	4 06529	16	0.609	20.60	21.50	21.05	21.31	0.90
11	7,807.01	25.7719	250	1.411	19.74	21.20	20.47	20.47	1 46
12	7,689.83	4.28604	22	0.632	20.92	21.86	21.39	21.63	0.94
13	8,017.00	4.84448	10	0.685	20.76	21.78	21.27	21.37	1.02
14	8,016.97	5.14450	18	0.711	20.70	21.48	21.09	21.15	0.78
15	7,311.963	4.22744	13	0.626	20.66	21.60	21.13	21.33	0.94
16	7,370.03	10.43584	39	1.019	20.26	21.20	20.73	20.66	0.94
17	8,067.631	5.73687	18	0.759	20.56	21.66	21.11	21.21	1.10
18	7,361.98	16.4353	200	1.216	20.26	21.32	20.79	20.89	1.06
20	7,279.84	41.953	500	1.622	18.98	20.64	19.81	19.86	1.66
22	8,058.3	146.35	23000	2.166	17 74	20.40	19.07	19 07	2.66
24	7,752 68	6.74350	19	0.829	20.53	21.50	21.01	21.08	0.97
25	7,393.358	9.2112	20	0 960	20.10	21.44	20.77	20.67	1.34
26	7,689.50	5.81614	7	0.765	20.98	21.84	21.41	21.49	0.86
27	8,044.65	6.66043	48	0.820	20.56	21.62	21.09	21.16	1.06
29	8,017.957	2.869059	2	0.458	21.21	21.94	21.58	21.76	0.73
30	7,660.93	4.26963	22	0.630	21.10	21.90	21.50	21.64	0.80
34	8,078.796	8.47833	4	0.928	20.52	21.60	21.06	21.12	1.08
37	7,662.14	12.4140	330	1.084	20.38	21.31	20.85	20.87	0.93
39	6,926.00	28.720		1.458	18.60	19.90	19.25	....	1.30
31	8,049.935	3.77471	4	0.577	20.10	20.90	.....	.....	0.80

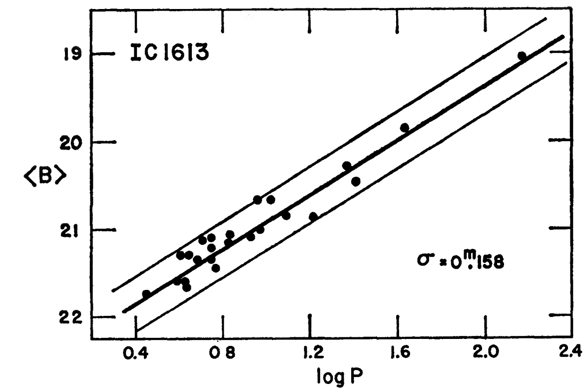

FIG. 11.—Baade's interpretation of the P-L relation from data in Table 6. Variable 39 is excluded, and the bias caused by the absence of known Cepheids that disappear below plate limit at minimum is neglected. Least-squares equation of the ridge line is $B = -1.518 \log P + 22.42$.

1. The slope of the P-L relation is well determined to be near -3.00 in the Magellanic Clouds. The data of Woolley *et al.* (1962) gave $d\langle B\rangle/d \log P = -2.85$. The result was confirmed by Gascoigne and Kron (1965), and more recently by Gascoigne (1969).[4] Arguments were presented by Sandage and Tammann (1968, Figs. 1 and 4) that the slope of the P-L relation for Cepheids in LMC, SMC, M31, and NGC 6822 is the same, and that in the linear part of the P-L relation its value is close to $d\langle B\rangle/d \log P = -2.85$. In view of these extensive data, the very small slope of -1.5 for IC 1613 in Figure 11 would be most disturbing because it would be the first evidence for a significant difference in the intrinsic properties of Cepheids in different galaxies.

2. The intrinsic width of the P-L relation is a result of the finite width of the instability strip in the H-R diagram (Sandage 1958). The available data from our own and other galaxies shows that the composite P-L relation has a rather well-defined intrinsic width of $\Delta B = \pm 0.60$ mag (Sandage and Tammann 1968) for members of the Local Group. This requires (cf. eq. [5] of Sandage and Tammann 1968) that the total width of the H-R strip be $\Delta(B - V) = \Delta M_B/3.52 = 0.34$ mag, which is close to what is observed (cf. Dickens and Carey 1967, Fig. 8; Christy 1970, Fig. 11). But the intrinsic spread of the P-L relation for IC 1613 is only $\pm 2\,\sigma = \pm 0.32$ mag, which is anomalously small by a factor of 2.

If these differences between IC 1613 and other galaxies are real, then the base upon which distance determinations to galaxies are made becomes suspect, because if differences exist among Cepheids, they may exist among other indicators (brightest stars and sizes of H II regions). However, an alternative explanation of Figure 11 appears possible.

b) Alternative Interpretation and the Distance

Figure 12 shows the data of Figure 11 and Table 6, together with the added variable V39 (Fig. 9). Superposed are the boundary lines of the P-L relation previously established from other galaxies of the Local Group (Sandage and Tammann 1968, Table A1) as later revised by 0.05 mag (Sandage and Tammann 1969). The upper panel shows the data at maximum light; the lower, at mean light. The fit has been made so that no stars exist outside the boundary lines in $\langle B\rangle$, and equal deviations exist above and below the lines in B(max).

Known observational selection effects explain at least part of the nonuniform filling

[4] The earlier contrary result of Arp (1960) in the SMC that $d\langle B\rangle/d \log P \simeq -2.25$ is discussed by Gascoigne and Kron (1965), by Gascoigne (1969), and by Andrews working at Pretoria, and is attributed to a scale error in Arp's magnitudes fainter than $V \simeq 14$.

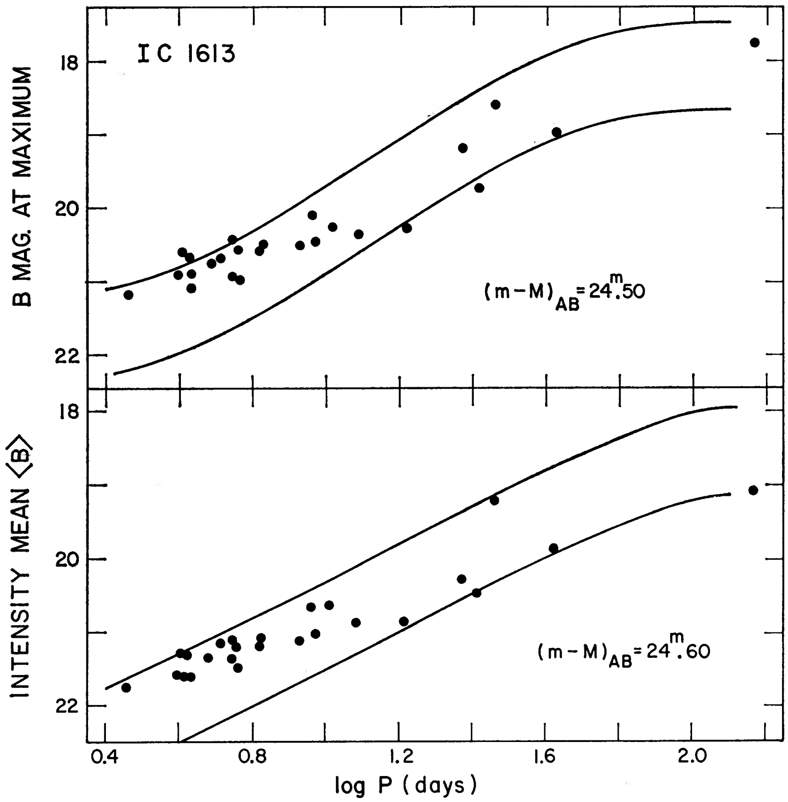

FIG. 12.—Preferred interpretation of the P-L relation. Boundary lines are from the calibration of Sandage and Tammann (1968) as derived from galaxies in the Local Group and later modified by 0.05 mag brighter (Sandage and Tammann 1969).

of the boundaries in Figure 12. (1) Baade studied only those variables which were above plate limit at all phases. Many fainter variables are known in the period interval from 2 to 9 days (V7, 28, 35, 36, 47, 48, 49, 53, 54, 59, 60, 61, and 62; see Table 1). When the light curves are eventually obtained, these stars will appear in the fainter regions of Figure 12 in the interval $0.95 \geq \log P \geq 0.3$. (2) It is known (Sandage and Tammann 1971) that Cepheids in this period range have maximum amplitudes at the blue edge of the instability strip, monotonically decreasing toward the red. By a well-known argument, the blue edge of the strip maps into the upper envelope line of Figure 12; the red edge, into the lower. Hence, the probability of discovery of the faintest Cepheids decreases as one proceeds from left to right in Figure 12 near $\langle B \rangle \simeq 21.8$, and this adds to the bias.

Although reasonable at the faint end, these two effects do not explain the lack of bright stars near the upper envelope for $\log P > 1.2$ in Figure 12. However, the number of stars is so small that small-sample statistics may be involved. An important test of the correctness of the fitting procedure in Figure 12 would be to correlate colors with magnitude deviations from the P-L ridge line. Comparison with the well-defined correlations which exist for Cepheids in the LMC, the SMC, and the Galaxy (Sandage and Tammann 1968, 1969) should be decisive for a choice between the fit of Figure 11 and the fit of Figure 12. Colors are not now available, and the problem remains to be investigated.

The present decision has been to accept Figure 12 as more reasonable than Figure 11, and to adopt the mean apparent blue modulus as $(m - M)_{AB} = 24.55$. The reddening is $E(B - V) = 0.03$ mag (Sandage 1962, Table 1; and the Appendix here), giving $(m - M)_0 = 24.43$ as the true modulus. The total integrated luminosity is then $M_B \simeq$

-14.45 which follows from Holmberg's (1950) measurement of m_{pg}(total) $= 10.00$ which transforms to $B = 10.10$.

V. BRIGHTEST BLUE AND RED STARS

The absolute magnitude of the brightest stars in galaxies is a function of integrated galaxian luminosity. The data in IC 1613 are important in calibrating this relation at the faint end (Sandage and Tammann 1971).

The brightest star that can definitely be assigned to IC 1613 is the comparison star 22A, marked on the NE_2 identification chart of Figure 3 (Plate 3). The star is extremely blue, and is undoubtedly a member of the galaxy. The magnitude and color, listed in Table A2 of the Appendix, are $B = 17.00$, $B - V = -0.15$. Using the apparent modulus of $(m - M)_{AB} = 24.55$ gives $M_B = -7.55$. This is considerably fainter than the brightest stars of more luminous galaxies, such as M33 where the brightest blue stars reach $M_B \simeq -9.5$, or M101 where they are brighter than $M_B \simeq -10.0$. Star 22A is near the center of an ill-defined H II region later marked as number 19. The star occurs with several other bright blue stars and with the longest-period Cepheid (V22). These form a small association of about 15″ in diameter (52 pc at a true modulus of $(m - M)_0 = 24.43$). A more prominent association containing stars which are almost as bright is centered on the well-developed H II region later called number 10 (§ VI). This association is also about 50 pc in diameter.

The brightest red stars have been found by blinking a matched pair of 200-inch 103a-O and 103a-D plates. Many of these are variable, and the brightest of these are listed in Table 4. The variable V42 at B(max) $= 18.5$ is followed closely in brightness by V38 with B(max) $= 18.6$, V56 with B(max) $= 18.9$, and V43 with B(max) $= 19.0$, corresponding to absolute magnitudes M_B between -6.05 and -5.53. Visual magnitudes have not yet been measured, but provisional colors of $B - V \simeq +2.0$ put $M_V = -8.05$ for the absolute magnitude of the brightest red supergiants. This agrees well with M_V values for the brightest red stars in other galaxies (Tammann and Sandage 1968). Curiously, the brightest luminosity for red supergiants appears to be independent of total luminosity of the parent galaxy, in contrast to the situation for brightest blue stars. A more complete discussion is given elsewhere (Sandage and Tammann 1971).

VI. LINEAR SIZES OF THE H II REGIONS

Nineteen H II regions are marked in Figure 13 (Plate 7), which is from a 200-inch plate taken by Baade on Eastman 103a-E + RG1 filter. IC 1613 has very few H II regions; and of the nineteen marked, all but three are concentrated in the northeast sector of the galaxy. Most have low surface brightness, although numbers 8, 11, and 19 are exceptions. These are small. Number 8 has a major diameter of 5″.4 ($d = 20$ pc), while number 11 is only 2″ in diameter ($d = 7$ pc). The radial velocity of the galaxy was determined by Humason from spectra of number 8.

The intricate pattern of overlapping regions in the northeast quadrant is shown in the enlargement of Figure 14 (Plate 8). Region 10 appears as a classical Strömgren sphere which contains several of the brightest blue stars in the galaxy near its center.

Only regions 10, 3, 14, and the ring region number 1 are well enough defined among the larger regions to give useful angular diameters. The linear dimensions, are: $d = 44''.6$ (167 pc) for number 10; $d = 34''.0$ (127 pc) for number 3; $d = 19''.4$ (72 pc) for 14, and $d = 15''.7$ (59 pc) for number 1 according to the measurements by Baade. These dimensions are much smaller than the largest H II regions in brighter galaxies such as NGC 604 in M33, 30 Dor in the LMC, and the regions in NGC 2403. The linear size of the largest H II regions in Sc, Sd, and Sm galaxies appears to be a steep function of galaxian absolute magnitude.

Besides the extended H II regions, Baade began a search for unresolved "stellar" nebulosities. Two were found by blinking the 103a-E + RG1 plate with a 103a-D + GG11 plate, and are marked as objects A and B in Figure 13.

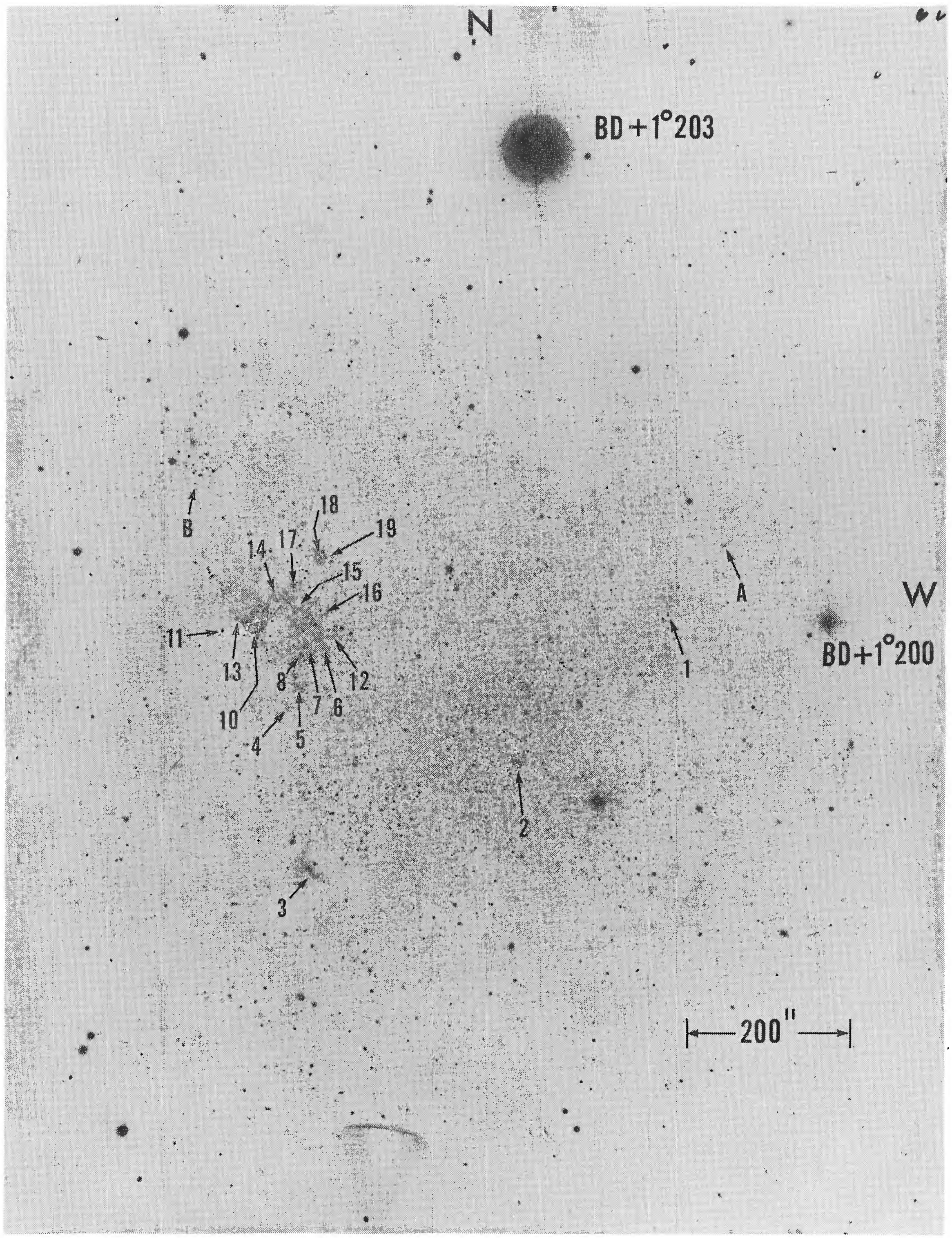

FIG. 13.—Identification chart for the H II regions from a 103a-E + RG1 plate taken with the 200-inch Hale reflector.

SANDAGE (*see* page 31)

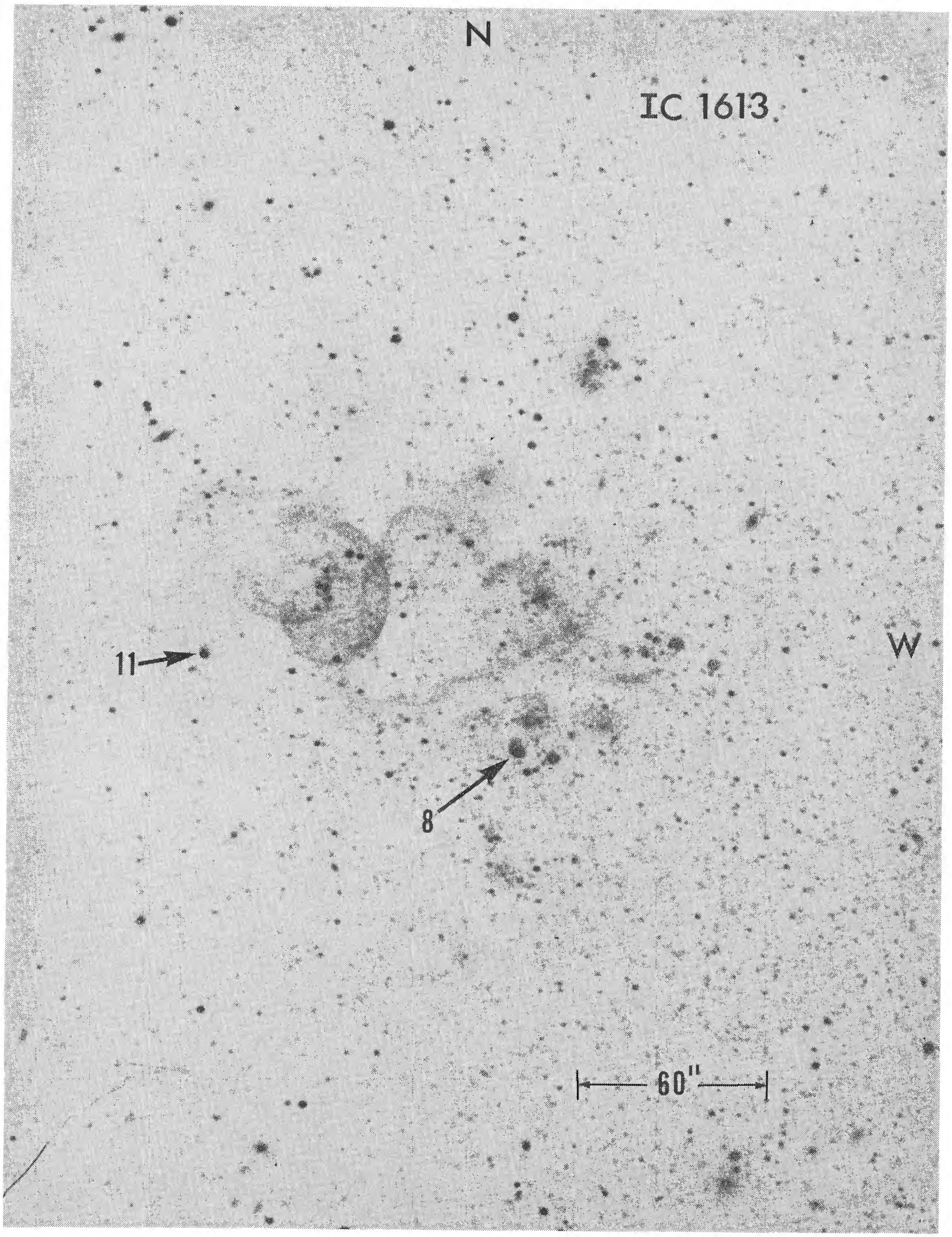

FIG. 14.—Enlarged portion of the NE quadrant of Fig. 13

SANDAGE (*see* page 31)

VII. ANGULAR EXTENT OF THE GALAXY

Baade took a series of deep red plates to search for the extent of the background sheet of Population II stars, which begins suddenly to resolve into stars at $V \simeq 21.5$. The series of 200-inch plates was centered to map the boundary on the East, South, and West sides adequately, as marked on the reproduction from a blue 48-inch Schmidt plate shown in Figure 15 (Plate 9).

The limiting boundary is roughly elliptical, with major and minor axes of 25'.07 and 20'.27, respectively, at a position angle of about 90°. The linear dimensions are 5600 by 450 pc, which represent the extreme size to which the oldest stars can be traced. Figure 15 shows that the prominent Population I component is confined well within these boundaries by about a factor of 2. IC 1613 is an exceedingly small galaxy.

VIII. REMAINING OPTICAL PROBLEMS

The preceding reconnaissance study can be extended in several ways. Of most immediate concern is a test between the interpretations of Figures 11 and 12. This can be done by obtaining light curves for the faint TBD variables in Table 1, and by measuring all the variables on a series of 103a-D + GG11 plates for color indices. Because V-magnitude standards exist for many sequence stars (Table A2 of the Appendix), the task is not large once an adequate series of yellow plates is available.

The color-magnitude diagram to $V \simeq 22$, together with the luminosity function for main-sequence and supergiant red stars, would provide an important comparison of evolutionary lifetimes of supergiants and Cepheids.

First plates to obtain the C-M diagram have been measured by Katem, but the program is not now complete.

It is a pleasure to thank Basil Katem for his help in the long and tedious task of reducing all data to the new magnitude system, and in measuring the areas of the light curves to obtain mean intensities. It is also a pleasure to thank Felice Woodworth for her excellent preparation of the illustrations for press, and Judy Harstine for the difficult work of typing Table 2. I am most grateful to Henrietta Swope for critically reading the manuscript.

APPENDIX

THE ADOPTED SCALE AND ZERO POINT OF THE MAGNITUDE SYSTEM

A. SANDAGE, BASIL KATEM, AND ANN H. MATTHEWS

Photoelectric UBV measurements of thirty-eight stars in and near IC 1613, measured at the 200-inch prime focus, are listed in Table A1. Stars fainter than $V = 19.3$ were centered in the photometer diaphragm by blind-offset techniques. A sky-blocking diaphragm of 7''.6 diameter was used in all cases. The listed stars have been identified in Figure 1.

Stars of the photoelectric sequence brighter than $V = 17.5$ are undoubtedly foreground. Seven of these have adequate $U - B$, $B - V$ data to estimate the reddening. Because of the high latitude ($b = -61°$), some mild intrinsic ultraviolet excess is expected for those foreground stars in the near halo. The excess is present for stars T, H, and 17, but the effect on the reddening determination is minor. The data require $E(B - V) \leq 0.03$, and it could be zero. In any case, it is almost certainly smaller than the $E(B - V) = 0.07$ which is predicted from the cosecant law with a "standard" reddening half-thickness of $E(B - V) = 0.06$ mag. IC 1613 is, then, another example of low reddening in the pole for individual objects as shown by the high-latitude globular clusters (Sandage 1969), by E galaxies (Peterson 1970), and by NGC 2403, for example (Tammann and Sandage 1968).

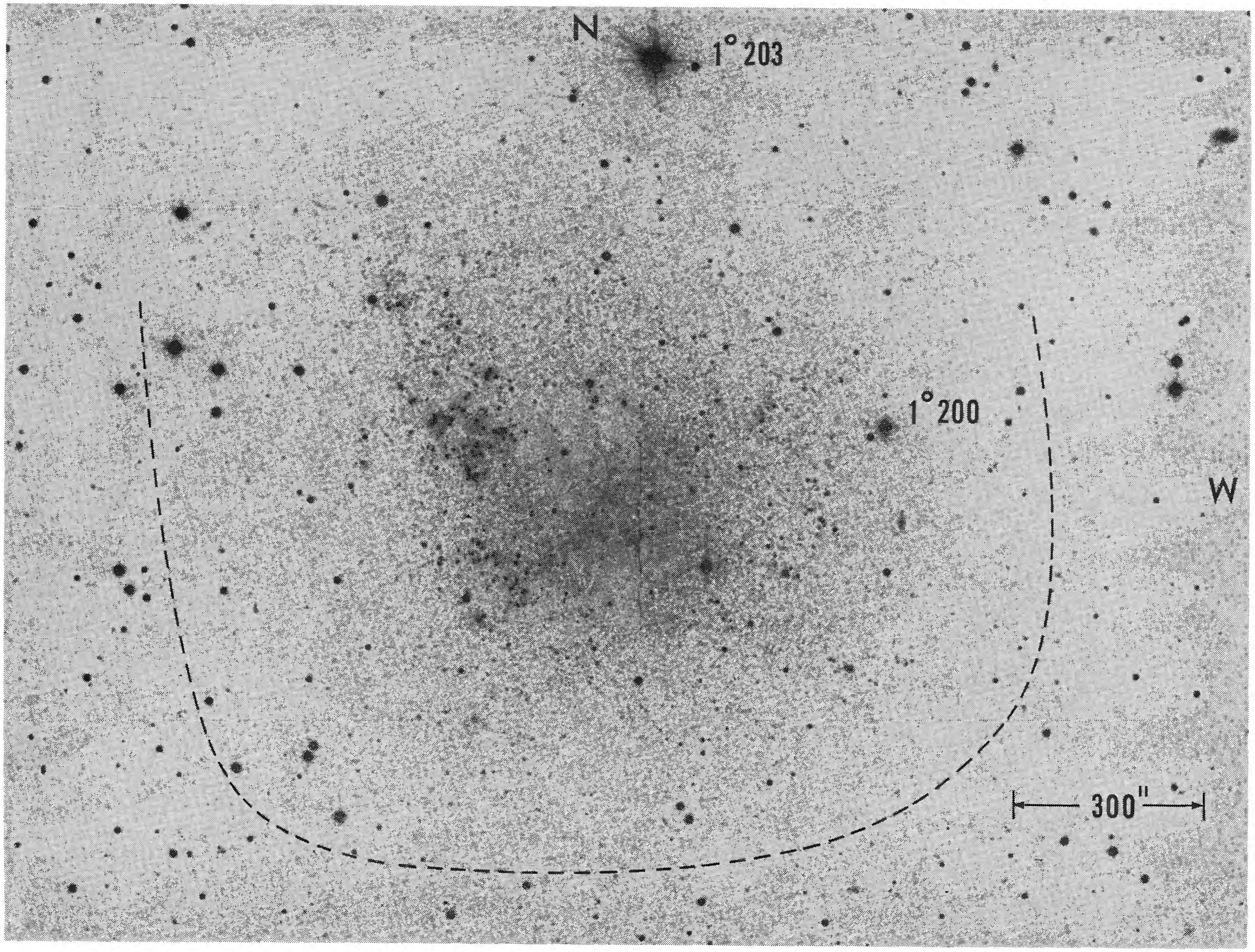

FIG. 15.—Enlarged copy of the blue plate of IC 1613 from the *Palomar Sky Survey*. The extent of the Population II component of the galaxy is marked as found from red 200-inch plates taken of the E, S, and W sectors.

SANDAGE (*see* page 32)

Extensive photographic smoothing was done on the photoelectric data so that the crowding problem could be statistically overcome. The results are shown in the final column of Table A1, and are plotted in Figure A1. There seems to be little difficulty brighter than $B \simeq 20.8$, but fainter than this the scatter becomes larger, and it seems clear that accuracies of ± 0.1 mag have not yet been reached for the faintest stars. However, no gross random errors larger than ± 0.2 mag appear to exist to the limit of the data at $B \simeq 21.7$.

The area of good definition on 100-inch 5 × 7-inch plates is considerably smaller than the angular extent of IC 1613. Because it was crucial to place all secondary sequence stars on a homogeneous magnitude system, Baade took a series of plates at different centers over the face of IC 1613 so that the areas of good definition overlapped. He did this initially with 100-inch plates, and later with 5- and 15-minute exposures with the 200-inch. Under his direction, these overlapping plates were measured with an iris diaphragm photometer by Mrs. Matthews so that all sequence stars could be tied to a single system. Correlation curves were drawn for all stars in the overlap regions, thereby permitting reduction of all readings to a single plate. A final list of mean iris readings was produced.

TABLE A1

PHOTOELECTRIC SEQUENCE IN IC 1613

Star	V	B	$B-V$	$U-B$	n	B_{pg}
B	10.97	11.58	+0.61	+0.16	16	...
T	13.71	14.31	+0.60	+0.01	2	...
G	13.72	14.50	+0.78	+0.42	1	...
A	14.24	14.98	+0.74	+0.29	3	...
H	14.58	15.11	+0.53	−0.04	1	...
C	14.74	15.55	+0.81	+0.40	1	...
26	16.40	17.60	+1.20	+1.17	2, 1	17.58
17	16.42	16.96	+0.54	−0.05	2	16.99
28	17.02	18.39	+1.37	...	1	18.46
24	17.23	17.86	+0.63	...	1	17.73
Q	18.22	18.25	+0.03	−0.50	2, 1	18.20
L	18.56	18.36	−0.20	−0.84	1	18.21
M	18.57	18.43	−0.14	−0.72	1	18.27
14	18.86	18.55	−0.31	−1.02	1	18.47
5	18.91	18.66	−0.25	−1.05	1	18.53
44a	18.96	19.86	+0.90	+0.76	2, 1	19.96
18c	19.24	21.21	+1.97	...	1	20.85
19a	19.26	19.25	−0.01	...	1	19.26
53a	19.32	21.28	+1.96	...	1	20.79
P	19.78	19.82	+0.04	+0.21	1	...
29	19.86	19.73	−0.13	−0.15	1	19.70
19d	20.12	20.33	+0.21	+0.06	1	20.32
24f	20.21	21.62	+1.41	...	1	21.55
13d	20.40	21.49	+1.09	...	V1, B2	21.65
9c	20.52	21.02	+0.50	...	1	21.05
13c	20.56	20.88	+0.32	...	1	21.15
47c	20.63	20.89	+0.26	...	1	21.00
19e	20.65	20.56	−0.09	...	1	20.48
13b	20.71	20.65	−0.06	...	2	20.90
45e	20.73	20.64	−0.09	...	1	20.75
12d	20.78	21.68	+0.90	...	2	21.69
13a	20.93	20.74	−0.19	(−0.81)	1	20.75
17b	20.93	20.64	−0.29	...	1	20.67
24d	20.98	21.49	+0.52	...	1	21.30
37e	21.22	21.26	+0.04	...	1	21.19
14e	21.49	21.08	−0.41	(−1.36)	1	20.95
A5	21.53	21.52	−0.01	(−0.86)	1	21.33
24c	21.70	21.26	−0.44	(−1.29)	1	21.00

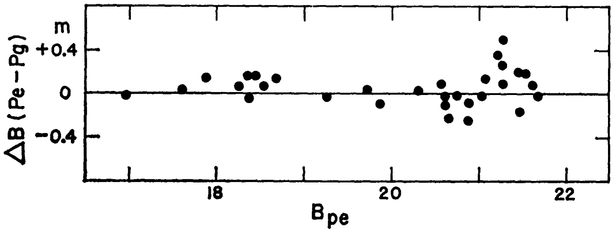

FIG. A1.—Comparison of the photoelectric and photographically smoothed primary stars sequence listed in Table A1.

TABLE A2

ADOPTED MAGNITUDES OF COMPARISON STARS

Star	B	(B-V)
1/3/14		
a	20.03	-0.10
b	20.23	0.12
c	20.51	0.59
d	20.85	0.44
e	20.95	0.28
f	21.10	0.38
g	21.45	....
h	21.90	....
2/19		
A	18.20	0.10
a	19.28	-0.15
b	19.70	-0.11
c	19.91	-0.15
d	20.31	0.27
e	20.46	0.15
f	20.78	-0.12
g	21.08	-0.22
6a	20.12	0.26
b	20.50	0.43
c	21.16	-0.35
d	21.30	....
e	21.51	....
f	21.65	....
7/52		
a	20.42	0.25
b	20.66	0.32
c	21.08	....
d	21.32	....
e	21.50	....
8a	20.67	0.53
b	21.14	-0.05
c	21.34	....
d	21.65	....
9b	20.73	0.33
c	21.05	0.61
d	21.30	0.51
e	21.76:	....
e′	21.77:	....
10a	20.36	0.06
b	20.77	-0.06
c	21.03	....
d	21.45	....
e	21.65	....
11A	18.47	-0.58
a	19.80	-0.06
b	19.88	-0.19
c	20.10	0.16
d	20.50	-0.19
e	20.73	-0.44
f	20.82	1.45
g	21.21	0.17
12a	20.80	-0.25
b	21.00	0.34
c	21.39	0.14
d	21.69	....
e	21.89	....
e′	21.80	....

Star	B	(B-V)
13a	20.75	-0.07
b	20.90	0.13
c	21.15	....
d	21.65	1.47
e	21.80:	....
15a	20.31	0.00
b	20.56	0.19
c	20.91	0.07
d	21.25	0.20
d′	21.25	....
e	21.64	....
16a	19.91	0.32
b	20.34	-0.09
c	20.71	-0.25
c′	20.48	0.22
d	21.11	-0.27
d′	21.04	-0.07
e	21.23	0.15
f	21.39	....
17/36		
a	20.20	0.35
b	20.67	0.26
c	20.89	-0.14
d	21.34	....
e	21.66	....
f	21.85	....
18a	20.16	-0.21
b	20.42	-0.15
c	20.85	1.66
c′	20.83	-0.03
d	21.30	....
e	21.35	....
f	21.65	....
20a	18.78	-0.23
b	18.94	0.35
b′	19.76:	....
c	19.83	-0.05
d	19.90	-0.12
d′	20.09	0.06
e	20.59	0.12
e′	20.29	0.07
f	20.91	0.03
21γ	20.50	-0.02
δ	20.78	-0.01
22A	17.00	-0.15
a	17.91	-0.26
b*	18.19	....
c	18.93	-0.44
d	19.31	-0.40
e	19.93	-0.08
f	20.35	-0.11
g	20.60	-0.16
23A	18.64	-0.24
a	18.87	-0.11
b	19.57	-0.15
b′	19.58:	-0.17
c	19.92	0.00
d	20.4:	0.12
e	20.54	0.12
f	20.73	1.80

Star	B	(B-V)
24a	20.29	0.11
b	20.77	0.07
c	21.00	-0.12
d	21.30	0.52
e	21.52	....
f	21.55	1.35
25/50		
a	20.00	1.01
b	20.24	0.08
c	20.40	0.22
d	20.74	0.47
e	20.98	-0.52
f	21.45	0.43
g	21.78	....
26/27/63		
A	20.27	0.12
a	20.43	0.18
b	20.68	0.29
c	20.94	....
c′	21.44	....
d	21.38	....
e	21.62	....
e′	21.68	....
f	21.83	....
28A	20.74	0.18
a	21.15	0.55
c	21.37	1.53
d	21.65	....
e	21.91:	....
e′	21.87	
29a	21.10	....
b	21.48	....
c	21.70	....
d	21.89	....
30A	20.40	0.13
a′	20.64	-0.02
b	20.98	-0.15
c	20.99	-0.11
d	21.48	0.88
e	21.53:	....
f	21.62:	....
31/58		
a	19.32	-0.35
45a=b	19.73	-0.16
c	20.46	-0.20
d	20.94	-0.66
32a	18.62	-0.48
b	19.44	-0.14
c	19.90	-0.21
d	19.95	-0.24
34a	20.49	+0.49
b	20.82	-0.08
c	21.16	+0.37
d	21.53	....
e	21.96	....
35a	21.19	....
b	21.19	-0.07
c	21.38	....
d	21.67	....
e	21.77	....
f	21.9:	....

Star	B	(B-V)
37a	20.28	+0.08
b	20.60	0.32
c	20.83	-0.49
d	21.01	0.32
e	21.19	0.35
f	21.45	....
38a	18.10	-0.09
b	18.55	-0.41
c	18.86	-0.5
d	19.26	-0.4
e	19.11	-0.47
f	19.78	0.09
39/56		
A	19.13	1.87
a	18.90	0.75
b	19.25	0.04
c	19.56	0.17
d	19.97	0.20
40/49		
a	20.73	-0.12
b	20.90	-0.42
c	21.08	....
e	21.35	....
f	21.70	....
g	21.80	....
h	22.0:	....
41a	21.02	0.90
b	21.25	....
c	21.40	....
d	21.85	....
e	22.0:	....
42a	18.70	-0.50
b	18.66	-0.49
c	19.13	-0.08
d	19.41	-0.31
e	19.85	-0.14
43a	18.56	-0.65
b	19.17	0.00
c	19.43	-0.27
d	19.76	-0.12
e	20.02	-0.09
f	20.32	-0.09
44A	19.81	0.13
a	19.96	1.04
b	19.96	0.14
c	20.11	0.35
d	20.39	0.49
e	20.74	0.52
45a	19.73	-0.16
b	20.21	-0.03
c	20.50	-0.21
d	20.57	0.05
e	20.75	0.19
46a	21.09	....
b	21.21	....
c	21.60	....
d	21.67	1.16
e	faint	....

Star	B	(B-V)
47b	20.55	1.39
c	21.04	0.28
c′	20.91	-0.34
d	21.37	....
d′	21.44	....
e	21.79	....
48a	21.20	0.04
b	21.35	0.30
c	21.47	0.47
d	21.64	....
e	21.90	....
51/59A	21.01	1.24
α	20.72	0.22
a	21.14	1.35
b	21.37	....
c	21.58	....
d	21.74	....
52a	20.42	0.22
b	20.67	0.31
c	21.08	....
d	21.32	....
e	21.50	....
53A	20.70	0.10
a	20.79	1.77
b′	21.13	0.08
b	21.10	0.93
c	21.18	0.26
d	21.38	....
e	21.69	....
e′	21.75:	....
54a	20.78	-0.47
b	21.08	0.06
c	21.26	....
d	21.60	....
e	21.72:	....
57a	20.98	0.18
b	21.25	....
c	21.50	....
d	21.52	....
e	faint	....
60a	21.03	-0.12
b	21.22	0.06
c	21.25	0.45
d	faint	....
61a	20.91	-0.01
b	21.31	....
c	21.46	0.39
d	21.67	....
e	21.75:	....
62a	20.90	-0.14
b	20.92	-0.44
c	20.88	0.13
d	21.43	1.08
e	21.68	....

Stars for the photoelectric sequence were chosen from this list. All that was then required was to draw calibration curves of B_{pe} versus iris values for the primary standards, from which magnitudes of all secondary stars were then determined.

Four complete series of overlapping 200-inch plates were measured and reduced in this way. The series were (*a*) 5-minute exposures behind a Schott GG1 filter, (*b*) 5-minute exposures behind a GG13, (*c*) 15-minute exposures behind a GG1, and (*d*) special measurements by Katem for a separate program on the color-magnitude diagram in which a number of the secondary standards were carried as unknowns. After applying a color equation to the two GG1 series to reduce them to the GG13 system, all four series were averaged for each star to form the adopted B-magnitude system for the sequences.

A special series of yellow plates (103a-D + GG11) was measured by Katem to obtain *preliminary* V magnitudes. The weight of these is considerably less than for the blue magnitudes (which depend on four series, each series consisting of about five plates), but they are useful at this stage as an indication of $B - V$ color.

The final data for 279 stars are listed in Table A2, which is, in a sense, more fundamental than Table A1 because all values in Tables 2, 3, 4, 5, and 6 depend directly on it. Future work to improve the magnitude scale will aim at improving Table A2.

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