CEPHEIDS IN GALACTIC CLUSTERS. I. CF CASS IN NGC 7790

ALLAN SANDAGE
Mount Wilson and Palomar Observatories
Carnegie Institution of Washington, California Institute of Technology
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ABSTRACT

Light-curves in three colors have been measured photoelectrically for the classical cepheid CF Cass. This star is very probably a member of the galactic cluster NGC 7790. The double cepheid system CE Cass a and CE Cass b is also probably a cluster member, but no photometric data were obtained for the components A new eclipsing star has been found which may also be a member Both components of the binary are probably B1 V stars with $M_V \approx -3\ 6$ Fragmentary data are given for the star, but no period was found

Photometric data for 133 stars in NGC 7790 are given The apparent modulus of the cluster is $m-M = 14.35 \pm 0\ 15$, the reddening is $E(B-V) = 0\ 52 \pm 0\ 04$, $E(U-B) = 0\ 38 \pm 0\ 03$ The true modulus is $m-M = 12\ 8 \pm 0\ 15$ The distance is 3630 ± 250 parsecs in the direction $l = 83^\circ.5$, $b = -0^\circ.8$ The cepheid CF Cass has a period of 4 87513 days, an amplitude of $\Delta V = 0\ 55$ mag , normal mean color indices of $(B-V)_0 = 0\ 72 \pm 0\ 04$, $(U-B)_0 = 0\ 49 \pm 0\ 03$, and mean absolute magnitudes of $\bar{M}_B = -2.50 \pm 0.15$, and $\bar{M}_V = -3\ 22 \pm 0\ 15$

I. INTRODUCTION

This is the first of a series of papers on cepheid variable stars in galactic clusters. The papers will be written by Arp, Irwin, Kraft, and Sandage. The aim of the series is to give the photometric and spectroscopic data for each of at least eight clusters which contain cepheids so that normal colors and absolute magnitudes of the cepheids can be found. A final discussion of the colors and of the period-luminosity relation will be made when all the cluster data are available. This should occur after the 1958–1959 observing season for the right ascension region of 0^h to 6^h. The individual papers will appear in the order in which they have been completed. Photometric material is now complete on CF Cass in NGC 7790, EV Sct in NGC 6664, S Nor in NGC 6087, and U Sgr in M25. The results for NGC 7790 appear in this paper. The spectroscopic data for NGC 129, NGC 6664, and NGC 7790 are reported by Kraft in Paper II. The data for NGC 6664 are given by Arp in Paper III. Two subsequent papers by Irwin will give data on NGC 6087 and M25.

In 1954, Olin Eggen called my attention to the galactic cluster NGC 7790, which contains the three cepheids CF Cass, CE Cass a, and CE Cass b. The double star CE Cass a and b is unique. Each component of the pair is a cepheid with periods of 4.4462 and 5.1275 days (G. A. Starikova, quoted in Russian *Variable Star Catalogue*). The separation of the stars is 2″ at a position angle of 266°. The third cepheid in the cluster is CF Cass, which is a normal variable of period 4.87522 days (Parenago and Kukarkin 1940).

The recent search for cepheids in galactic clusters by Kraft (1957) and by van den Bergh (1957) failed to list CF Cass or CE Cass as probable members of NGC 7790. This is because the right ascension for NGC 7790 is, as quoted by Dreyer, Shapley, and Trumpler, incorrect by about 1^m30^s (Kraft 1958). The three variables are actually located within the cluster area as outlined by the bright member stars, and there is little question of membership. Although radial velocities are not available to check membership, the general agreement of the positions of CF Cass in the color-magnitude diagram of NGC 7790, compared with M25 and NGC 6087 (Irwin 1958), with NGC 6664 (Arp 1958), and with NGC 129 (Arp, Sandage, and Stephens 1958), make it almost certain that CEa, CEb, and CF Cass belong to NGC 7790.

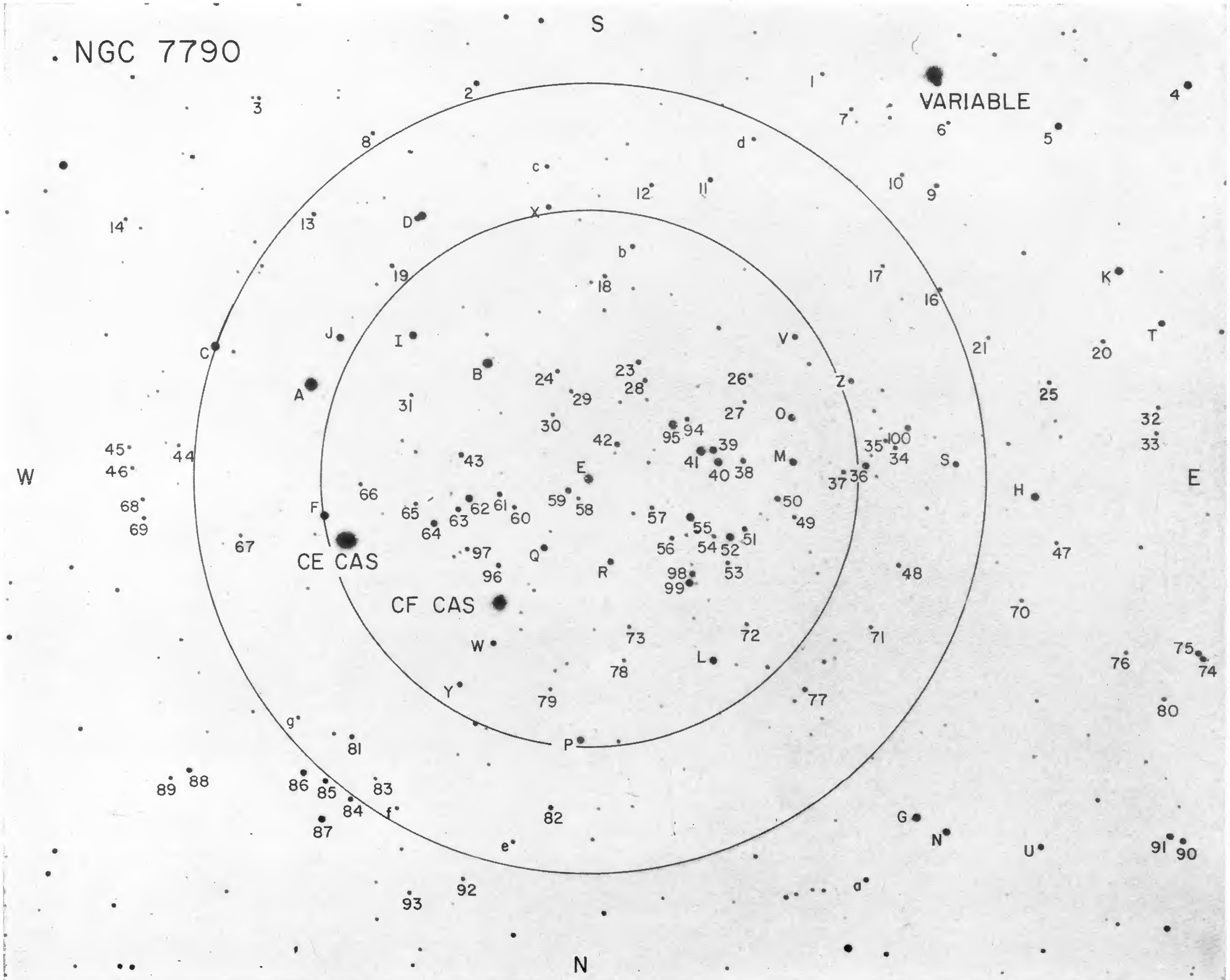

FIG. 1.—The identification chart for stars in and near NGC 7790. The lettered stars are the photoelectric standards of Table 1. The numbered stars are the photographic stars of Table 2. The plate is a 1-minute exposure on Eastman 103a-D behind a Schott GG11 filter taken with the

Olin Eggen knew of the probable connection of these three variables with NGC 7790 in 1952, and he generously made finding charts and other information available to me in 1954.

II. PHOTOMETRIC DATA

NGC 7790 forms a double cluster with NGC 7788. The positions for these clusters are R.A. = $23^h54^m42^s$, Dec. = $+61°10'$ (1960) for NGC 7788 and R.A. = $23^h56^m26^s$, Dec. = $+61°00'$ (1960) for NGC 7790. The data for 7790 are given in this paper. The data for 7788 are given in a following paper. The usual combination of photoelectric and photographic techniques was used to obtain the color-magnitude diagram, the reddening, and the true and apparent distance modulus for NGC 7790.

1. *The Photoelectric Observations*

Three-color photoelectric observations were made in NGC 7790 of thirty-three stars on ten nights between July 13, 1956, and October 7, 1956, with the 60-inch telescope on Mount Wilson. The photometer used has been described by Walker (1954). The photoelectric filters were Corning 9863 in the ultraviolet, 1 mm of of Schott BG12 plus 2 mm of Schott GG13 in the blue and 2 mm of Schott GG11 in the yellow. An end-on EMI was used for the photomultiplier. Deflections were read from a Brown strip-chart recorder and were reduced in the usual way to outside the atmosphere, with nightly extinction coefficients determined from two or more extinction stars of different color index. Iteration of the extinction values was performed by the method of conditioned coefficients.

All data were transformed to the Johnson U, B, V system with coefficients found from observations of thirty-four Johnson standards taken from Tables 3 and 5 of Johnson and Morgan's paper (1953). A total of one hundred and twenty-six separate observations of these Johnson standard stars was made from September, 1954, to October, 1956. The transformation from the instrumental magnitudes to the U, B, V system was very good, with probable errors in V, $B-V$, and $U-B$ all less than ± 0.01 mag. in the mean.

Table 1 gives the V, $B-V$, and $U-B$ values for the thirty-three photoelectric stars in NGC 7790. The stars are identified in Figure 1.

2 *The Photographic Observations*

Photographic plates in ultraviolet, blue, and visual wave lengths were taken of NGC 7790 with the 60-inch and 200-inch telescopes. The plate and filter combinations were Eastman 103*a*-O behind 2 mm of Schott UG2 for the ultraviolet, Eastman 103*a*-O behind 2 mm of Schott GG13 for the blue, and Eastman 103*a*-D behind 2 mm of Schott GG11 for the visual. The ultraviolet plates were taken with the 60-inch diaphragmed to 32 inches. The blue and visual plates were taken with the 200-inch with the *f*3.67 Ross corrector lens.

Two plates in the ultraviolet and three plates each in the blue and visual were measured by Miss Cynthia Stephens with the iris-diaphragm Eichner photometer at the California Institute of Technology. Two plates in each of the ultraviolet, blue, and visual wave lengths were measured by Sandage. The dispersion of the residuals of Stephens *minus* Sandage for measurements on the same plate was $\sigma = 0.039$ mag , with no significant systematic difference. If each operator has the same personal error, then σ (Stephens) = σ (Sandage) = 0.028 mag. The probable error of a single measurement due to the personal equation is therefore ± 0.019 mag. This error of measurement is about 1.5 times higher than we have found in other similar investigations. But it is still small enough that the final photographic values are accurate to ± 0.02 mag. as computed below.

The magnitudes and colors for the thirty-three photoelectric standards were read back through the photographic calibration-curves. The means are given in the righthand section of Table 1. The residuals of these values from the photoelectric values show no dependence on either V or $B-V$. Consequently, there is no magnitude or color equation between the photoelectric and the photographic results. Therefore, all data are on Johnson's U, B, V system to within the accuracy of the measurements.

Colors and magnitudes for one hundred additional stars were obtained by photographic interpolation from the two plates in the U and the three plates in the B and V. These stars are identified in Figure 1. The area around the cluster has been divided into three regions. Region 1 is a circle of 111″ centered on star E. Region 2 is the annulus between circles of radii 111″ and 161″ centered on star E. Region 3 is the area outside regions 1 and 2. The adopted V, $B-V$, and $U-B$ values for the hundred additional stars are given in Table 2. The distribution of the residuals of each measurement from

TABLE 1

PHOTOMETRIC STANDARDS IN NGC 7790

Star	Photoelectric Data				From Photographic Plates			Region*
	V	$B-V$	$U-B$	n	V	$B-V$	$U-B$	
A	11 08	+0 24	−0 59	38	11 08	+0 24	−0 63	2
B	12 16	+0 38	− 11	3	12 13	+0 41	+ 02	1
C	12 47	+0 55	+ 21	7	12 50	+0 56	+ 18	2
D†	12 59	+0 44	+ 26	2	12 68	+0 31	.	2
E	12 79	+0 37	− 08	1	12 78	+0 36	− 07	1
F	12 82	+1 98		1	12 82	+2 26		1
G	13 13	+0 55	+ 26	1	13 02	+0 62	+ 31	3
H	13 15	+0 49	+ 29	2	13 13	+0 47	+ 42	3
I	13 18	+1 20	+ 85	1	13 09	+1 32	+ 67	1
J	13 20	+0 53	+ 31	3	13 30	+0 46	+ 36	2
K	13 21	+1 52		3	12 98	+1 72	.	3
L.	(13 25):	+0 69	+ .12	2	13 23	+0 72	+ 08	1
M	13 32	+0 37	− 14	1	13 32	+0 38	. .	1
N	13.48	+0 39	+ 09	1	13 49	+0 46	00	3
O	13 54	+0 36	− 16	1	13 50	+0 36		1
P	13 60	+0 79	+ 12	2	13 60	+0 80	+ 07	1
Q	13 72	+0 47	+ 02	1	13 81	+0 42	− 07	1
R	14 16	+0 40	− 03	1	14 14	+0 35	− 05	1
S	(14 32):	(+0 46):	− 29	2	14 24	+0 52	− 36	2
T .	14 30	+0 68	.	1	14 11	+0 82	+ 23	3
U	14 48	+0 56	+ 34	1	14 52	+0 58	+ 24	3
V.	14 51	+0 44	+ 02	1	14 56	+0 44	00	1
W	14 55	+1 44	.	3	14 55	+1 52	. .	1
X .	14.62	+0 42	+ 06	2	14 62	+0 46	− 08	2
Y	14 72	+1 35		3	14 68	+1 34		1
Z	14 75	+0 48	− 07	1	14 75	+0 43	00	2
a	14 93	+0 73	. .	1	14 89	+0 78	. . .	3
b	15 18	+0 48	−0 06	1	15 08	+0 51	+0 08	1
c	15 29	+0 82		1	15 39	+0 83		2
d	15 65	+0 91		3	15 72	+0 80		2
e	15 76	+0 51		1	15 76	+0 50		2
f	15 98	+0 80		1	15 94	+0 76		2
g	16 22	+0 83		1	16 14	+0 86		2

* Region 1 is a circle of radius 111″ centered on star E Region 2 is the annulus between circles of radii 111″ and 161″ centered on star E Region 3 is everything outside regions 1 and 2

† Double star; p e measure includes companion

TABLE 2

MAGNITUDES AND COLORS FOR 100 STARS IN AND NEAR NGC 7790 DETERMINED FROM PHOTOGRAPHIC PLATES

Star	V	B−V	U−B	Region*	Star	V	B−V	U−B	Region*
1	15 78	0 53		3	51	14 82	0 40	−0 04	1
2	14 47	1 24		3	52	13 13	0 33	− 04	1
3	15 77	1 20		3	53	15 64	0 53		1
4	13 17	1 66		3	54	15 65	0 46	.	1
5	13 56	1 54		3	55	13 06	0 34	+ 02	1
6	15 99	0 88		3	56	15 34	0 49		1
7	15 92	0 70		3	57	15 80	0 54		1
8	15 59	0 55		3	58	15 90	0 52		1
9	15 20	.		3	59	14 19	1 41		1
10	16 00	0 66		3	60	15 48	0 50		1
11	14 88	1 69		2	61	14 67	0 44	− 13	1
12	15 74	0 53		2	62	13 32	0 41	+ 10	1
13	15 30	0 60		2	63	14 84	0 39	− 03	1
14	15 82	0 59		3	64	13 69	1 60		1
15	15 60	0 49		3	65	15 72	0 58		1
16	15 43	0 55		3	66	15 67	0 73		1
17	16 00	0 50		2	67	16 15	0 51		2
18	15 58	0 51		1	68	15 77	0 58		3
19	15 26	0 47		2	69	15 64	0 98		3
20	15 67	1 11		3	70	16 00	0 50	.	3
21	15 95	0 72		3	71	15 82	0 51		2
22	15 60	. . .		1	72	15 99	0 51		1
23	14 83	1 70		1	73	16 00	0 73	. .	1
24	15 32	0 42		1	74	14 38	0 34	+ 18	3
25	15 50	0 64		3	75	14 45	0 27	− 14	3
26	15 68	0 54		1	76	15 83	0 91		3
27	16 06	0 43		1	77	14 97	0 85		2
28	15 30	0 54		1	78	16 05	0 52		1
29	15 81	0 70		1	79	15 98	0 55		1
30	16 10	0 48		1	80	15 59	0 50		3
31	16 04	0 75		1	81	15 12	0 46		2
32	15 74	0 72		3	82	15 18	0 52		3
33	15 78	0 58		3	83	16 13	0 48		2
34	15 61	0 48		2	84	15 16	0 88		2
35	15 64	1 09		2	85	14 81	0 72		
36	13 66	0 40	0 00	2	86	14 02	0 45	. .	3
37	15 36	0 60	. .	1	87	13 68	0 37	− .21	3
38	14 63	0 45	− 08	1	88	14 89	0 45	− 19	3
39	13 36	0 16	+ 08	1	89	15 70	0 54	. .	3
40	13 07	0 26	− 01	1	90	14 40	0 84	+ 03	3
41	12 60	0 32	− 08	1	91	14 25	0 65	+ 25	3
42	14 88	0 88	.	1	92	15 77	0 72		3
43	14 63	0 77	+0 15	1	93	15 63	0 51		3
44	16 02	0 73		3	94	15 30	0 45		1
45	15 90	0 77		3	95	12 67	0 33	− 11	1
46	15 95	0 85		3	96	15 04	1 66		1
47	16 07	0 80		3	97	15 39	1 46		1
48	15 20	0 91		2	98	14 36	0 29	− 12	1
49	15 74	1 00		1	99	13 34	0 40	+ 03	1
50	14 48	1 63		1	100	14 36	0 48	−0 08	3

* See footnote to Table 1 for description of region designation

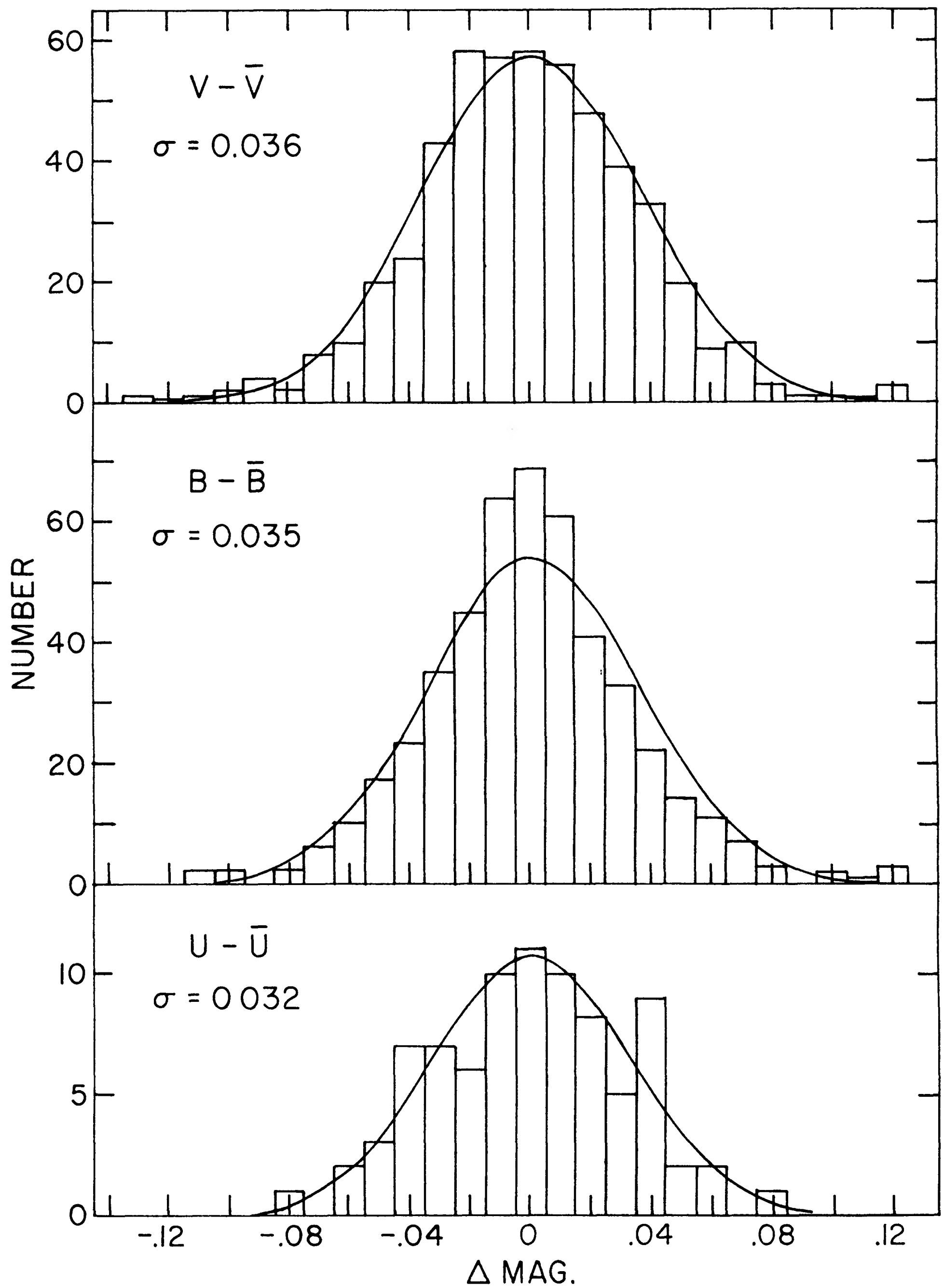

FIG 2.—The distribution of the residuals of the individual magnitude measurements from the tabulated values of Tables 1 and 2.

the tabulated magnitudes of Tables 1 and 2 is shown in Figure 2. The dispersions of these distributions give probable errors of ± 0.024 mag. for V, ± 0.023 mag. for B, and ± 0.021 mag. for U. The probable error of the tabulated values in Tables 1 and 2 should, therefore, be ± 0.014 mag. for V, ± 0.013 mag. for B, and ± 0.015 mag. for U.

III. THE COLOR-MAGNITUDE DIAGRAM FOR NGC 7790

The color-magnitude diagram for stars inside regions 1 and 2 is shown in Figure 3. A well-populated main sequence is evident. Many red stars populate the diagram fainter than $V = 14$. These are likely to be field stars not physically connected with the cluster.

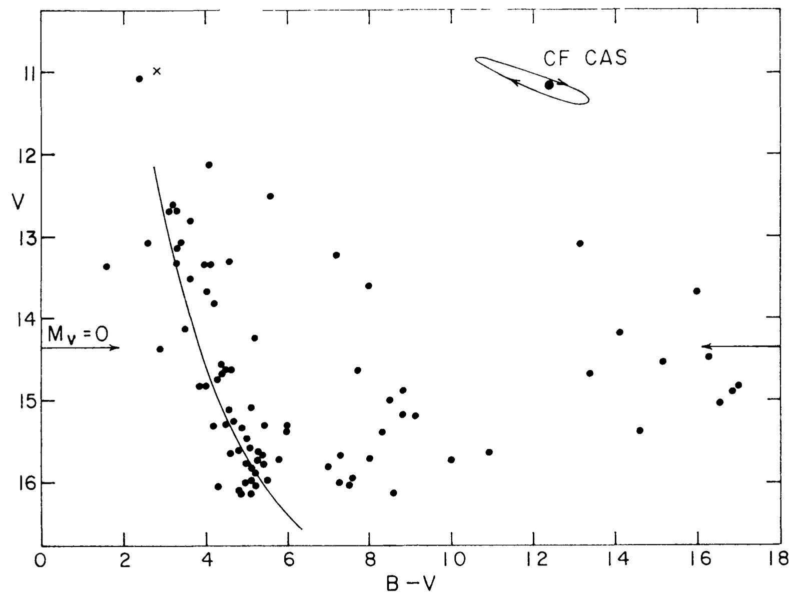

FIG. 3 —The color-magnitude diagram for all stars in regions 1 and 2 centered on star E in NGC 7790 The age-zero main sequence is drawn, assuming $E(B - V) = 0\ 52$ and an apparent modulus of $m - M = 14\ 35$. The position of CF Cass is shown. The position at mean light is shown by a circle The position of a single component of the new eclipsing binary is shown by a cross.

TABLE 3

STARS WITH SPECTRAL TYPES IN NGC 7790

Star	Sp Type*	M_V(Sp)	V Observed	$m-M$	$B-V$ Observed	$(B-V)_{0,\ Sp}$	$E(B-V)$† Sp Type	$(B-V)_0$‡ Three-color	$E(B-V)$ Three-color
A	B2 III–IV	−3 2	11 08	14 28	+0 24	−0 24	0 48	−0 27	0 51
D	B9 III	−2 0	12 59	14 59	+ 44	− 05	49	Double	.
E	B5 IV:	−2 2	12 79	14 99	+ 37	− 16	53	− 13	50
O	B9 IV	−1 0	13 54	14 54	+ 36	− 05	41	− 15	51
40§	B8 IV	−1 7	13 07	14 77	+ 26	− 09	35	− 08	34
95	B5 IV	−2 2	12 67	14 89	+ 33	− 16	49	− 13	46
99	B7 IV:	−1 8	13 34	15 14	+0 40	−0 13	0 53	−0 10	0 50
Mean				14 74			0 49	.	0 50

* From Kraft, Paper II of present series

† Found from normal color–spectral-type relation of Johnson and Morgan in *Ap J*, **117**, 313, 1953

‡ From the present U, B, V measures

§ Star No 40 was omitted from the mean values

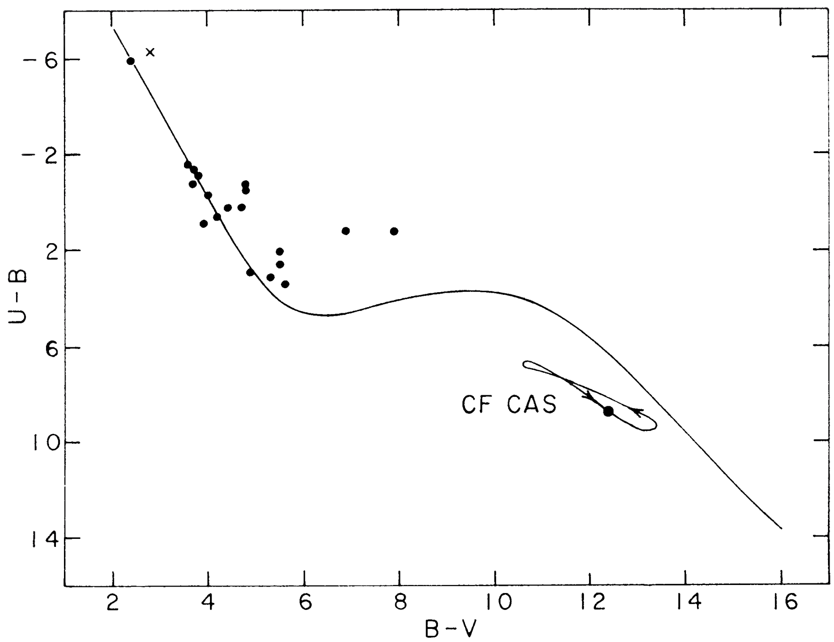

FIG 4.—The $U - B$, $B - V$ diagram. Only stars with photoelectric values are plotted Johnson and Morgan's normal relation is shown but shifted by $E(B - V) = 0\ 52$ and $E(U - B) = 0\ 38$ CF Cass is plotted The position at mean light is indicated by a circle. The position of the eclipsing binary is shown by a cross

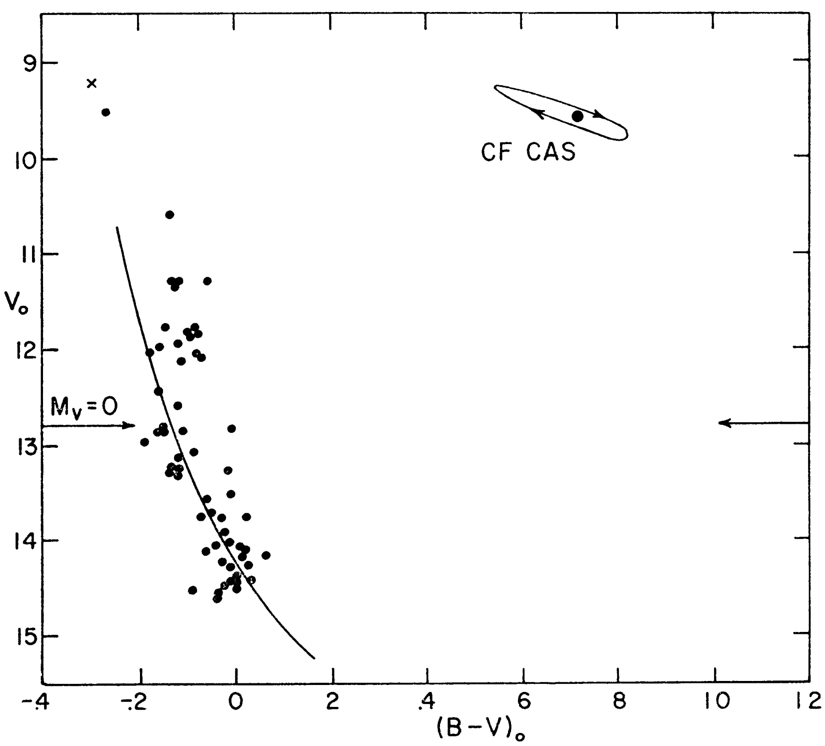

FIG. 5.—The color-magnitude diagram for NGC 7790 corrected to zero reddening. All stars with $U - B$, $B - V$ values were individually corrected. Stars fainter than $V_0 = 13\ 5$ were taken from the main sequence of Fig. 3 and corrected by $E(B - V) = 0.52$. The age-zero main sequence is drawn with $m - M = 12.80$. The position of CF Cass at mean light is shown by a circle. The position of a single component of the eclipsing binary is shown by a cross.

The reddening of the cluster stars was found by two independent methods. Kraft has determined spectral types on the MK system for seven stars in the field of NGC 7790. These are reported and discussed in Kraft's paper in the present series (1958). Table 3 of the present paper gives the data and the computation of the reddening from the spectral types. The measured colors from Tables 1 and 2, together with Johnson and Morgan's normal colors, gives $E(B-V) = 0.49 \pm 0.024$ (p.e.) from the spectral data.

The $B-V = f(U-B)$ method of Johnson and Morgan (1953) gives an independent estimate. Individual $E(B-V)$ values were found for every star of Tables 1 and 2 which has both $B-V$ and $U-B$ available. A reddening line of slope 0.73 was assumed. Twenty-four stars with unambiguous values of $E(B-V)$ between 0.40 and 0.65 in regions 1 and 2 were assumed to be cluster members. The mean $E(B-V)$ for these twenty-four stars is 0.522 ± 0.040 (p.e.), which is in good agreement with $E(B-V) = 0.49 \pm 0.024$ (p.e.). There is no evidence for differential reddening across the cluster.

Figure 4 shows the individual $U-B$, $B-V$ values for all photoelectric stars in Table 1. The solid curve is Johnson's normal relation for main-sequence stars shifted by $E(B-V) = 0.52$ and $E(U-B) = 0.38$. In the following analysis $E(B-V) = 0.52$ is assumed to hold for all cluster stars.

The apparent modulus of the cluster was found by fitting the age-zero main sequence (Johnson and Hiltner 1956; Sandage 1957), shifted by $E(B-V) = 0.52$, to the observed main sequence of Figure 3. The fit was made for stars fainter than $V = 15$, so that the evolution of the brighter stars would not influence the result. The apparent modulus of NGC 7790 is $m-M = \pm 14.35 \pm 0.15$.

The effects of absorption and reddening were next removed from all stars which had $B-V$ and $U-B$ values. Each star was corrected individually along a reddening line of slope 0.73. Figure 5 shows the resulting diagram. Stars fainter than $V = 15$ were added from the main sequence of Figure 3 but were shifted by $E(B-V) = 0.52$, $A_V = 1.56$. The true modulus of the cluster is $m-M = 12.80 \pm 0.15$, as determined by fitting the age-zero main sequence to Figure 5.

IV. THE VARIABLE STARS

1. *The Cepheids*

Twenty-nine separate photoelectric observations were obtained of CF Cass. The data are given in Table 4. The phases were computed from an arbitrary epoch at heliocentric JD 2435688.931 with an assumed period of 4.87522 days, as tabulated in the Russian *Catalogue*. This period fits the present observations. Figure 6 shows the light- and color-curves from the data of Table 4. CF Cass is a cepheid of Eggen type A.

The physically interesting quantity for CF Cass is the mean energy radiated by the star over long time intervals. This gives the rate of energy production in the stellar interior. To find the mean values, the light-curves for each of the three wave-length bands were changed into intensity units. The average intensity was found by planimetry, and this value was converted back to magnitudes. These mean values, together with other photometric parameters, are given in Table 5. The unreddened parameters quoted in this table follow from the reddening corrections of $E(B-V) = 0.52$, $E(U-B) = 0.38$, and $A_V = 1.56$. The absolute magnitudes at maximum, minimum, and mean light follow from the true modulus of $m-M = 12.80$. The significance of these values will be discussed in the final paper of the present series.

The present observations give:

$$\text{Epoch } V(\text{max.}) = \text{Helio. JD } 2435671.76 \pm 0.05 ,$$

$$\text{Epoch } V(\text{min.}) = \text{Helio. JD } 2435670.39 \pm 0.03 .$$

This epoch at maximum light combined with the epoch of JD 2428651.57 quoted in the Russian *Catalogue* gives an improved period of 4.87513 days for CF Cass.

TABLE 4

PHOTOMETRIC DATA FOR CF CASS

Helio JD 2435+	Phase*	V	B−V	U−B
668 936	0 001	11 20	1 302	0 957
669 825	0 183	11 31	1 350	930
669 962	0 211	11 34	1 332	900
670 828	0 389	11 22	1 240	820
670 966	0 417	11 13	1 188	750
687 768	3 864	11 06	1 253	922
687 867	3 884	11 10	1 260	907
687 965	3 904	11 10	1 268	903
688 863	4 088	11 25	1 320	930
688 964	4 109	11 29	1 297	965
689 811	4 283	11 39	1 324	922
689 973	4 316	11 39	1 322	954
690 855	4 497	10 91	1 088	697
690 870	4 500	10 90	1 090	680
690 974	4 521	10 87	1 060	662
691 779	4 687	10 92	1 126	690
691 973	4 726	10 99	1 160	768
752 723	17 187	11 32	1 360	983
752 739	17 191	11 34	1 338	970
752 967	17 237	11 32	1 342	960
754 773	17 608	10 84	1 070	702
1128 876	94 343	11 32	1 326	865
1128 898	94 348	11 32	1 277	.
1129 803	94 533	10 87	1 030	686
1130 638	94 705	10 93	1 133	758
1130 644	94 706	10 95	1 134	734
1130 915	94 762	11 00	1 178	772
1130 933	94 765	11 01	1 161	817
1135 620	95 727	10 94	1 156	0 785

* Phase computed from epoch at helio JD 2435668 931

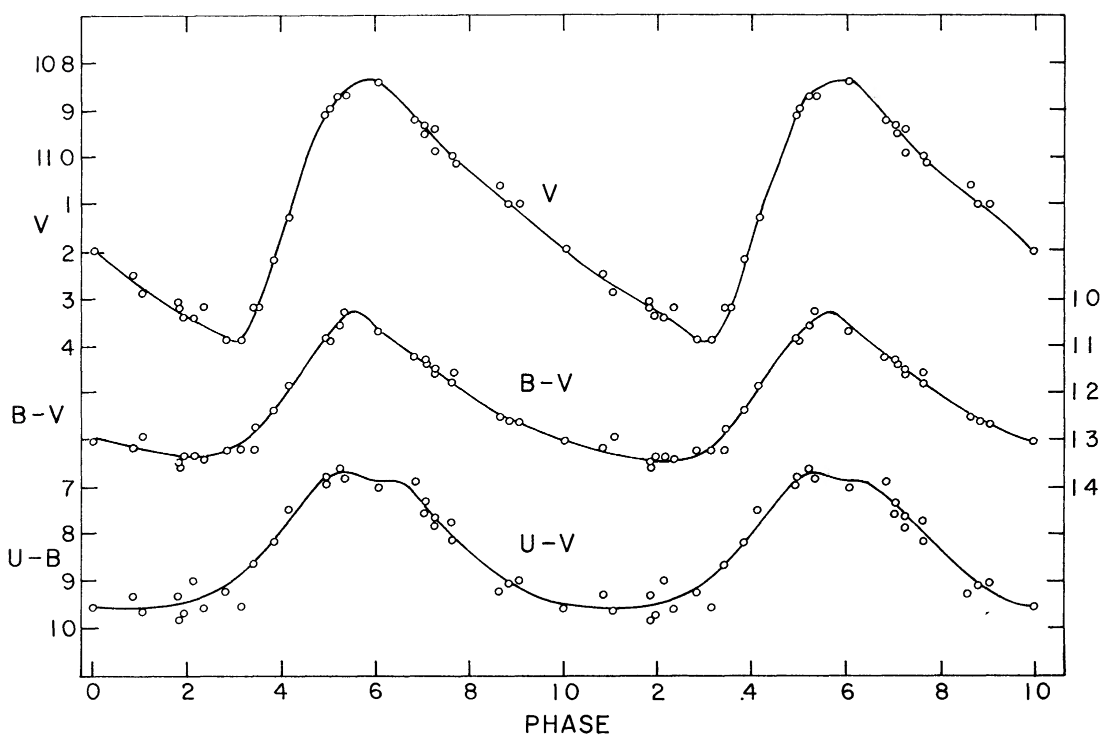

FIG 6—The light- and color-curves of CF Cass

The position of CF Cass in the color-magnitude diagram and the color-color diagram is shown in Figures 3, 4, and 5. The cepheid follows a well-defined loop in each diagram.

No complete data were obtained for CE Cass a and b because the components could not be separately measured with either the photoelectric equipment or plates at the 60-inch telescope. The components were adequately separated on plates taken with the 200-inch telescope diaphragmed to 100 inches with 9 seconds' exposure, but not enough plates were obtained to get complete coverage of the light- and color-curves.

2. *A New Eclipsing Binary*

The star marked "variable" in Figure 1 was used as a secondary photoelectric standard for several nights. But during observations on August 2/3, 1956, and October 7/8, 1956, the star decreased in luminosity from about $V = 10.17$ to $V = 10.65$ in about 7 hours. During this time the colors remained constant within the errors of observation. The star is undoubtedly an eclipsing binary with both components of about the same spectral class. Table 6 gives the observations which are available. The depth of eclipse

TABLE 5

PHOTOMETERIC PARAMETERS FOR CF CASS*

	Max	Min	Mean	Amplitude
V	10 84	11 39	11 14	0 55
$B-V$	1 03	1 35	1 24	32
$U-B$	0 67	0 96	0 87	29
V_0† . . .	9 28	9 83	9 58	55
$(B-V)_0$†	0 51	0 83	0 72	32
$(U-B)_0$†	0 29	0 58	0 49	29
M_{V_0}‡	−3 52	−2 97	−3 22	55
M_{B_0}‡	−3 01	−2 14	−2 50	0 87

* Epoch V(Max) = 2435671 76 + 4 87522n

† $E(B-V)$ = 0 52, $E(U-B)$ = 0 38, A_V = 1 56 assumed

‡ $(m-M)_0$ = 12 80 assumed

is at least 0.50 mag. and may be as large as 0.75 mag., which suggests the possibility of a total eclipse of two similar components.

Table 6 shows that the magnitudes for the system out of eclipse are about $V = 10.18$, $B-V = 0.28$, and $U-B = -0.63$. If we assume equal components of the same spectral type, then V for each star is 10.93 with the colors unchanged. The color data further indicate that $E(B-V) = 0.57$, $E(U-B) = 0.42$, as determined from the $B-V = f(U-B)$ relation of Johnson and Morgan (1953). The unreddened magnitude and color for each star are predicted to be $V_0 = 9.22$, $(B-V)_0 = -0.29$, $(U-B)_0 = -1.04$ if the components are equal. The predicted spectral type is about B1. Finally, if $m-M = 12.80$, as for NGC 7790, then $M_V = -3.6$, which is quite normal for a B1 V star (Morgan and Keenan 1951). The predicted position of each component in the color-magnitude diagram is shown in Figures 3 and 5 as a cross.

More work on this star is badly needed. Radial velocities should be obtained to check membership in NGC 7790. Spectroscopic and photometric observations should be made to determine the period and eclipse characteristics of the binary. If it really turns out that we know the distance, then this star can provide a calibration point for the effective temperature scale because L and R will be known. Then T_e follows from its defining equation $L = 4\pi R^2 \sigma T_e^4$.

I should like to express thanks to Dr. Olin Eggen, who called my attention to this unique cluster and its cepheids. It is also a real pleasure to thank Miss Cynthia Stephens for her efficient and knowledgeable help in the measurement and reduction of the plates and for many other detailed tasks connected with this paper. She has been a real asset.

TABLE 6

COLORS AND MAGNITUDES FOR VARIABLE STAR IN FIELD OF NGC 7790

Helio JD 2435+	V	B−V	U−B
687 885	10 19	0 28	−0 65
687 978	10 19	26	− 62
688 772	10 24	26	− 62
688 814	10 32	28	− 62
688 844	10 38	28	− 62
688 966	10 63	26	− .62
689 817	10 20	26	− 62
689 919	10 22	26	− 64
689 965	10 22	26	− .64
690 880	10 17	29	− 63
690 970	10 21	26	− 64
691 790	10 20	23	− 58
691 868	10 19	27	− 63
691 922	10 20	27	− 63
691 964	10 22	27	− 64
752 740	10 22	.	.
754 648	10 17	28	− 59
754 701	10 17	29	− 59
754 877	10 35	28	− 62
754 962	10 55	28	− 58
754 994	10 67	0 26	−0 59

Added August 25, 1958.—Mr. Andrew Young has called my attention to the fact that the suspected eclipsing binary is not a new discovery. It was first found by G. E. Erleksova of the Stalinabad Astronomical Observatory of the Tadzhik Academy of Sciences and was published in the *Astronomical Circular* (U.S.S.R.), No. 155, p. 15, 1954. The spectral class is quoted in the Eighth Supplement to the *Russian Variable Star Catalogue* as B2. The star has been named QX Cas. No period was given.

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