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INTERMEDIATE BAND PHOTOMETRY OF THE SCORPIO-CENTAURUS ASSOCIATION AND SOUTHERN BRIGHT STARS

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SUMARIO

Se han hecho observaciones fotométricas en el sistema *(33, 35, 37, 40, 45, 52, 58, 63)* de trescientas treinta y tres estrellas pertenecientes al hemisferio austral. Aproximadamente un tercio de ellas están localizadas en la región de la Asociación Estelar Escorpio-Centauro. Posiblemente la mayoría de ellas sean miembros físicos de esta asociación.

Las observaciones se han usado, en forma provisional, para obtener parámetros independientes de extinción interestelar. También se ha dado una calibración de magnitudes absolutas basada en las paralajes de setenta estrellas de tipo B de la asociación Escorpio-Centauro. Con sólo hipótesis sencillas se encuentran resultados satisfactorios.

ABSTRACT

We have made photometric observations in the *(33, 35, 37, 40, 45, 52, 58, 63)*—system of 333 stars of the Southern Hemisphere. Approximately one third of them are located in the Scorpio-Centaurus Association region. Possibly most of them can be considered physical members of this stellar aggregate.

The observational data have been used to derive provisional reddening-free indices. An absolute magnitude calibration is also given based on the parallaxes of 70 B-type stars in the Scorpio-Centaurus region. Satisfactory results are obtained under simple assumptions.

I. Introduction

A color system which encompasses the properties of the many special photometric systems appeared in the literature in recent years; it is the thirteen-color system defined by Johnson, Mitchell, and Latham (1967) and by Mitchell, and Johnson (1969). This system is defined by 961 stars, 959 of which are contained in the Bright Star Catalogue (Hoffleit, 1964). Eight colors are observed in the blue and green spectral region using an RCA IP21 as detector: while six colors are obtained in the red spectral region using an RCA 7102 photo-multiplier. The tie-in of the two sets of observations is made through the overlap of two filters, one for each cell, peaked at approximately 5830 Å.

Similar systems to the above eight-color one have been used to study the interstellar extinction law (Borgman 1961; Boggess and Borgman 1964) and the use of several reddening-free indices for luminosity and spectral type determinations (Borgman and Blaauw 1964; Mendoza 1969, 1971). Johnson and Mitchell (1968) discussed the spectral energy curves of subdwarfs using their eight-color system. These and other studies suggest the general utility of this intermediate band photometry.

This paper shows the *(33, 35, 37, 40, 45, 52, 58, 63)*—photometry of 333 Southern Objects, including over 100 stars in the Scorpio-Centaurus region. The observations were obtained with the 16-inch telescopes of the Cerro Tololo Inter-American Observatory in February and May 1966. Mr. Mitchell kindly made available to us data for some southern bright stars observed by Mr. Forbes with the 24-inch telescope at Tololo in October 1969. These observations include all the thirteen colors; however, we only list eight colors covering the blue-green region. We also observed a few stars in the Upper Scorpio-Centaurus region with the 28-inch telescope at the University of Arizona in May 1967.

II. The Observations

The observational data on the *(33, 35, 37, 40, 45, 52, 58, 63)*—system have been obtained with a set of filters made at the same time as those which define the intermediate—band photometric system of Johnson *et al.* (1967). A number of standard stars and a few objects in the Scorpio-Centaurus region were also observed by us using the original filters. No systematic difference was found between the two sets of measurements. Table I lists the standard stars used by us. Generally, each night ten different stars were observed three times to obtain the extinction coefficients and transformation equations. The columns of Table 1 contain: first, the name of the star; second through ninth, the *52*-magnitude and the *33-52, 35-52, 37-52, 40-52, 45-52, 52-58,* and *52-63* color indices, respectively; tenth, the number of different nights in which the standard stars were observed; and last, the MK-type.

TABLE 1

Standard Stars

Name	*52*	*33-52*	*35-52*	*37-52*	*40-52*	*45-52*	*52-58*	*52-63*	*n*	*MK*
BS 875	5.21	+0.17	+0.15	+0.12	+0.11	+0.04	+0.05	+0.09	7	A1 V
ε Eri	3.98	+1.06	+0.95	+1.22	+1.11	+0.34	+0.50	+0.78	7	K2 V
ν Ori	4.58	−1.72	−1.59	−1.05	−0.34	−0.08	−0.09	−0.15	20	B0 V
β Cnc	3.94	+3.10	+2.70	+2.77	+2.18	+0.64	+0.75	+1.17	32	K4 III
η Hya	4.27	−1.24	−1.14	−0.75	−0.25	−0.06	−0.06	−0.10	30	B3 V
90 Leo	5.91	−1.11	−1.00	−0.64	−0.21	−0.05	−0.06	−0.09	7	B3 V
BS 4550*	6.64	+0.55	+0.41	+0.74	+0.87	+0.34	+0.39	+0.65	3	G8 Vp
β Lib	2.60	−0.57	−0.53	−0.46	−0.17	−0.04	−0.03	−0.05	32	B8 V
α Ser	2.93	+2.20	+2.01	+2.05	+1.64	+0.51	+0.57	+0.87	30	K2 III
β Oph	3.07	+2.18	+2.01	+2.04	+1.63	+0.50	+0.58	+0.89	12	K2 III
γ Oph	3.76	+0.06	+0.06	+0.08	+0.05	+0.01	+0.01	+0.02	12	A0 V
10 Lac*	4.85	−1.65	−1.53	−0.99	−0.29	−0.05	−0.06	−0.10	3	O9 V
BS 8832*	5.88	+1.43	+1.30	+1.59	+1.29	+0.32	+0.63	+0.94	3	K3 V

* Observed only at Catalina.

Table 2 gives the new photometric data. The columns of this table list; first, the Henry Draper Catalogue number (HD); second through ninth, the *52*-magnitude and the *33-52, 35-52, 37-52, 40-52, 45-52, 52-58*, and *52-63* color indices, respectively; tenth, the number of different nights in which the program stars were observed; and last, the spectral type (mostly MK-type) taken from the Bright Star Catalogue and the Catalogue of Stellar Spectra Classified in the Morgan-Keenan System (Jaschek, Conde and Sierra 1964). In Table 2 an asterisk after the HD number indicates that the star was observed by Mr. Forbes and reduced by Mr. Mitchell. Because of weather conditions during Forbes' observing run no successful magnitudes were obtained. Instead, the Cape *V*-magnitudes were transformed to *52*-magnitude using the *52-58* color index (cf. Johnson *et al.* 1967).

The probable error of a single observation is approximately ± 0.015 mag for the magnitude and colors listed in Table 2. The observed extinction coefficients have been given elsewhere (Mendoza, Moreno and Stock 1968; Mendoza 1971). The comparison of this photometric system with other data has been published by Johnson *et al.* (1967).

III. Provisional Reddening-free indices

The analysis of the *(33, 35, 37, 40, 45, 52, 58, 63)*—photometry contained in Table 2 could include many comparisons of the several color indices. Herein we only make use of three of these, namely, *33-35 37-40* and *52-58* in order to study in a preliminary and approximate way some characteristics of B-type stars.

It is quite plausible that the law of interstellar extinction may not be the same everywhere in the Galaxy (cf. Johnson 1968). However, in this paper we are going to assume that the color ratios E_{33-35}/E_{52-58} and E_{37-40}/E_{52-58} are constant.

The difference between the intrinsic gradients in the ultraviolet and the blue is known to be sensitive to spectral type in the region of the O and B stars (cf. Divan 1954).

Here we restrict our study of the relation between *33-35* and *52-58* to all O9 and O9.5 stars observed in this eight color system. The data are given in Table 3. The columns of this Table contain: first, the Bright Star Catalogue number (Hoffleit 1964); second and third, the *33-35* and *52-58* color indices, respectively; last, the MK-type. From a least-squares solution we find

$$E_{33-35}/E_{52-58} = +0.521 \pm 0.005 \quad \text{(m.e.)};$$

this relation is illustrated graphically in Figure 1.

The higher members of the Balmer series are crowded in the transmission region of the filter *37*, making the *37-40* color index very sensitive to luminosity variations. Here we confine our study of the relation between *37-40* and *52-58* to all "normal" O9.5-B3 supergiant (class Ia) stars for which

TABLE 2

Eight-Color Photometry of Southern Stars

HD	52	33-52	35-52	37-52	40-52	45-52	52-58	52-63	n	MK
496 *	4.14	+1.74	+1.44	+1.60	+1.32	+0.49	+0.51	+0.76	2	K0 III
1581 *	4.39	+0.38	+0.24	+0.46	+0.67	+0.32	+0.31	+0.49	2	G2 V
2151 *	2.96	+0.56	+0.41	+0.57	+0.74	+0.34	+0.31	+0.49	2	G2 IV
2261 *	2.69	+1.84	+1.51	+1.68	+1.41	+0.52	+0.57	+0.85	2	K0 III
2262 *	4.00	+0.30	+0.17	+0.25	+0.18	+0.12	+0.11	+0.13	2	A7 Vn
2429 *	5.17	+3.82	+3.16	+3.04	+2.36	+0.88	+0.71	+1.28	2	g M4
3919 *	4.84	+1.52	+1.27	+1.44	+1.25	+0.50	+0.48	+0.72	2	G8 III
4815 *	5.45	+2.92	+2.52	+2.62	+1.94	+0.58	+0.75	+1.09	2	M1 III
6595 *	3.54	+1.33	+1.09	+1.22	+1.13	+0.46	+0.45	+0.66	3	G8 III
9053 *	3.84	+3.46	+2.92	+2.98	+2.29	+0.72	+0.84	+1.25	2	K5 II
9362 *	4.19	+1.54	+1.25	+1.41	+1.25	+0.48	+0.48	+0.74	2	K0 III-IV
10144 *	0.47	-0.98	-0.95	-0.69	-0.22	-0.01	-0.02	-0.09	2	B5 IV
11695 *	4.73	+3.69	+2.98	+2.91	+2.24	+0.86	+0.64	+1.25	2	M4 III
11937 *	3.92	+1.08	+0.86	+1.09	+1.02	+0.43	+0.45	+0.66	2	G5 IV
11977 *	4.93	+1.43	+1.13	+1.30	+1.19	+0.49	+0.49	+0.74	1	G8 III
12274 *	4.42	+3.55	+3.00	+3.03	+2.31	+0.70	+0.81	+1.24	2	M1 III
12311 *	2.96	+0.48	+0.32	+0.32	+0.35	+0.18	+0.18	+0.22	2	F0 V
14228 *	3.57	-0.61	-0.63	-0.41	-0.16	0.00	0.00	-0.06	2	B8 V
16815 *	4.37	+1.62	+1.32	+1.48	+1.31	+0.50	+0.50	+0.78	2	K0 III
17652 *	4.70	+1.55	+1.28	+1.40	+1.28	+0.50	+0.47	+0.73	2	G6 III
18293 *	5.13	+2.64	+2.31	+2.47	+1.88	+0.58	+0.73	+1.07	2	g K4
18622 *	2.95	+0.36	+0.29	+0.19	+0.18	+0.11	+0.08	+0.09	2	A3 V
18978 *	4.14	+0.26	+0.19	+0.21	+0.20	+0.10	+0.10	+0.13	2	A5 V
20010 *	3.99	+0.21	+0.09	+0.33	+0.51	+0.25	+0.27	+0.45	2	F8 IV
20720 *	4.02	+3.67	+3.00	+2.90	+2.25	+0.83	+0.63	+1.24	2	g M3
20794 *	4.47	+0.65	+0.48	+0.74	+0.83	+0.35	+0.39	+0.59	2	G5 V
22663 *	4.87	+1.61	+1.37	+1.50	+1.33	+0.49	+0.56	+0.82	2	K0 III
23319 *	4.90	+2.18	+1.93	+2.10	+1.57	+0.50	+0.61	+0.92	2	g K2
23817 *	4.15	+2.03	+1.72	+1.87	+1.52	+0.53	+0.59	+0.88	1	K0 IV
24160 *	4.41	+1.38	+1.12	+1.32	+1.14	+0.45	+0.46	+0.71	2	G5 III
24512 *	3.67	+3.51	+2.93	+2.98	+2.31	+0.74	+0.82	+1.31	1	M0 III
25422 *	4.98	+3.64	+3.00	+2.96	+2.35	+0.74	+0.83	+1.30	1	M2 III
25705 *	4.86	+3.69	+3.11	+2.91	+2.30	+0.89	+0.71	+1.31	1	g M5
25728 *	5.35	+2.94	+2.48	+2.65	+2.03	+0.60	+0.77	+1.14	1	g K4
26967 *	4.15	+1.91	+1.60	+1.79	+1.41	+0.50	+0.57	+0.86	1	K1 III

TABLE 2 (continued)

HD	52	33-52	35-52	37-52	40-52	45-52	52-58	52-63	n	MK
27256*	3.58	+1.39	+1.12	+1.29	+1.15	+0.45	+0.45	+0.68	2	G6 II
27376*	3.57	-0.69	-0.68	-0.43	-0.20	-0.04	+0.02	-0.01	1	B8.5 V
28028*	4.35	+3.19	+2.72	+2.24	+2.20	+0.64	+0.76	+1.16	1	M1 III
29291*	4.06	+1.49	+1.21	+1.39	+1.20	+0.46	+0.47	+0.76	1	K0 III
29305*	3.27	-0.58	-0.59	-0.36	-0.19	-0.02	-0.01	-0.05	1	A0 si
29712*	4.97	+4.06	+2.11	+1.33	+0.76	+1.46	+0.92	+2.41	1	g M7
32831*	4.88	+2.07	+1.77	+2.02	+1.54	+0.52	+0.64	+0.99	1	g K3
32887*	3.58	+3.08	+2.64	+2.78	+2.10	+0.60	+0.76	+1.17	2	K5 III
36079	3.00	+1.11	+0.85	+0.98	+1.01	+0.39	+0.37	+0.62	4	G5 III
36597*	4.15	+2.13	+1.74	+1.92	+1.52	+0.54	+0.55	+0.83	1	g K1
37020-3	4.63	-1.27	-1.15	-0.70	-0.05	+0.09	+0.06	+0.24	12	Trap.
37350	3.94	+1.38	+1.14	+1.09	+1.14	+0.42	+0.41	+0.64	1	F8 Ia
37795*	2.64	-0.70	-0.69	-0.51	-0.21	-0.01	-0.01	-0.03	2	B8 Ve
38393*	3.73	+0.26	+0.14	+0.36	+0.53	+0.24	+0.26	+0.41	1	F6 V
39060	3.90	+0.18	+0.15	+0.24	+0.22	+0.08	+0.12	+0.14	4	A3 V
39425*	3.41	+2.09	+1.80	+1.97	+1.53	+0.50	+0.57	+0.87	2	K2 III
40808*	4.25	+2.01	+1.72	+1.87	+1.54	+0.57	+0.57	+0.86	1	K0 III
44402*	2.99	-1.18	-1.14	-0.71	-0.29	-0.04	-0.06	-0.13	2	B2.5 V
45348	-0.68	+0.78	+0.62	+0.14	+0.15	+0.09	+0.15	+0.19	5	F0 Ib
47670*	3.17	-0.54	-0.57	-0.53	-0.19	+0.01	0.00	-0.02	2	B8 III
50241	3.32	+0.41	+0.30	+0.26	+0.26	+0.12	+0.14	+0.20	4	A5 V
50310	3.24	+2.25	+2.04	+2.02	+1.70	+0.54	+0.61	+0.91	3	K0 III
52089*	1.46	-1.56	-1.48	-0.94	-0.38	-0.08	-0.07	-0.11	2	B2 II
53138*	2.99	-1.25	-1.20	-0.81	-0.25	-0.02	-0.04	0.00	1	B3 Ia
54605*	2.02	+1.30	+0.97	+0.78	+0.73	+0.30	+0.35	+0.50	2	F8 Ia
55865	3.83	+1.29	+1.14	+1.22	+1.17	+0.42	+0.45	+0.72	3	G8 III
56855*	3.11	+2.34	+2.17	+2.38	+2.13	+0.78	+0.80	+1.26	2	K5 III
57623	4.19	+1.13	+0.92	+0.91	+0.98	+0.38	+0.39	+0.61	1	F8 II
63295	4.23	+1.63	+1.45	+1.51	+1.36	+0.47	+0.49	+0.78	3	K0 III
65575	3.44	-1.12	-1.00	-0.69	-0.24	-0.05	-0.04	-0.09	3	B2 IV
66342	5.65	+3.51	+3.13	+3.10	+2.60	+0.86	+0.83	+1.39	1	M0 II
66591	4.80	-1.11	-1.01	-0.67	-0.22	-0.05	-0.06	-0.11	1	B3 IV
68520	4.35	-0.79	-0.74	-0.50	-0.17	-0.04	-0.04	-0.06	1	B5 III
71129	2.25	+0.78	+0.88	+1.18	+1.44	+0.64	+0.76	+1.16	3	K0 II + B
71878	4.08	+2.03	+1.82	+1.86	+1.55	+0.49	+0.57	+0.87	3	K2 III

TABLE 2 (continued)

HD	52	33-52	35-52	37-52	40-52	45-52	52-58	52-63	n	MK
72350	6.37	-0.80	-0.75	-0.53	-0.10	+0.03	+0.03	+0.04	4	B5 IV
73390	5.24	-1.02	-0.96	-0.61	-0.20	-0.04	-0.05	-0.07	4	B3 Vn
74195	3.58	-1.05	-0.97	-0.67	-0.23	-0.05	-0.04	-0.09	3	B3 III
74375	4.34	-1.30	-1.22	-0.80	-0.20	-0.02	-0.02	-0.03	1	B1 III
74455	5.55	-1.53	-1.37	-0.90	-0.25	-0.06	0.00	+0.04	3	B3 Vn
74560	4.82	-1.16	-1.03	-0.70	-0.28	-0.10	-0.08	-0.10	4	B4 IV
74956	1.95	+0.12	+0.12	+0.12	+0.06	+0.03	+0.04	+0.04	3	A0 V
75149	5.60	-0.57	-0.51	-0.26	+0.26	+0.23	+0.19	+0.34	4	B3 Ia
75311	4.50	-1.27	-1.13	-0.78	-0.29	-0.10	-0.08	-0.01	4	B2 Vne
76161	5.86	-0.96	-0.88	-0.58	-0.23	-0.04	-0.05	-0.07	4	B6: Vn
76728	3.84	-0.73	-0.67	-0.48	-0.16	-0.03	-0.02	-0.04	3	B8 II
76805	4.67	-0.90	-0.81	-0.51	-0.17	-0.04	-0.04	-0.06	1	B5 V
77002	4.91	-1.32	-1.17	-0.80	-0.31	-0.11	-0.10	-0.10	4	B3 IV
78045	4.05	+0.21	+0.17	+0.24	+0.21	+0.05	+0.07	+0.10	1	A5 V
78764	4.64	-1.42	-1.33	-0.88	-0.26	-0.05	-0.08	-0.04	2	B2 Ve
79351	3.41	-1.24	-1.12	-0.77	-0.30	-0.05	-0.07	-0.11	4	B2 IV
79447	3.98	-1.24	-1.10	-0.77	-0.25	-0.07	-0.08	-0.13	4	B3 IV
NGC 2808	7.45	+0.92	+0.72	+0.85	+1.00	+0.47	+0.50	+0.83	4	——
80007	1.67	+0.20	+0.18	+0.02	-0.01	+0.01	0.00	0.00	3	A1 IV
80094	5.97	-0.73	-0.68	-0.43	-0.17	-0.03	-0.03	-0.05	4	B7 IV
80404	2.30	+0.31	+0.21	+0.19	+0.18	+0.10	+0.10	+0.15	3	F0 I
80781	6.24	-0.83	-0.80	-0.56	-0.19	-0.02	-0.04	-0.06	4	B7 IV
81188	2.44	-1.24	-1.16	-0.79	-0.27	-0.06	-0.08	-0.14	5	B2 IV
82668	3.60	+3.27	+2.91	+2.93	+2.32	+0.65	+0.80	+1.22	4	K5 III
83183	4.12	-0.79	-0.73	-0.54	-0.07	+0.04	+0.03	+0.08	1	B5 II
83944	4.57	-0.39	-0.31	-0.15	-0.06	-0.01	-0.02	-0.01	5	B9 V
83979	5.06	-1.01	-0.96	-0.61	-0.23	-0.07	-0.07	-0.07	4	B5 IV
84461	5.53	-0.18	-0.17	-0.12	-0.10	-0.03	-0.01	-0.04	4	A0 V
84816	5.55	-1.24	-1.14	-0.75	-0.23	-0.04	-0.08	-0.13	4	B3 V
85123	3.05	+0.73	+0.67	+0.19	+0.24	+0.15	+0.17	+0.24	3	A9 II
85980	5.62	-0.87	-0.77	-0.39	-0.16	-0.03	-0.06	-0.10	4	B4 V
86440	3.53	-0.95	-0.86	-0.66	-0.15	-0.01	-0.02	-0.04	3	B5 II
88206	4.85	-1.08	-1.01	-0.71	-0.22	-0.01	-0.04	-0.06	4	B2 V
89080	3.31	-0.39	-0.36	-0.41	-0.14	-0.02	-0.04	-0.04	3	B7 IV
89104	6.10	-1.24	-1.09	-0.71	-0.19	-0.02	-0.03	-0.04	4	B3

TABLE 2 (continued)

HD	52	33-52	35-52	37-52	40-52	45-52	52-58	52-63	n	MK
89388	3.80	+3.01	+2.78	+2.78	+2.28	+0.72	+0.76	+1.13	3	K5 Ib
89890	4.46	-0.93	-0.86	-0.63	-0.20	-0.04	-0.04	-0.08	1	B3 IV
90589	4.08	+0.15	+0.08	+0.23	+0.40	+0.18	+0.17	+0.28	1	F3 IV-V
90853	3.77	+0.83	+0.70	+0.32	+0.31	+0.14	+0.17	+0.25	1	F0 II
91375	4.76	+0.14	+0.12	+0.10	+0.02	+0.01	+0.01	0.00	1	A2 m
91465	3.31	-1.06	-0.98	-0.69	-0.17	-0.03	-0.03	0.00	3	B5 Ve
93030	2.72	-1.60	-1.51	-1.00	-0.32	-0.06	-0.11	-0.17	4	O9.5 V
93163	5.78	-0.81	-0.76	-0.48	-0.05	+0.04	0.00	+0.01	4	B3: V
93194	4.80	-1.16	-1.08	-0.77	-0.19	-0.04	-0.07	-0.11	4	B5 Vn
93308	6.14	-0.17	-0.12	+0.23	+0.88	+0.52	+0.13	+1.20	5	Pec.
93607	4.87	-0.98	-0.92	-0.61	-0.19	-0.04	-0.07	-0.11	4	B3 IV
93845	4.44	-1.19	-1.12	-0.72	-0.24	-0.07	-0.08	-0.13	4	B3 V
94510	4.02	+1.30	+1.16	+1.28	+1.21	+0.43	+0.45	+0.71	3	K0 III-IV
96918	4.23	+2.23	+1.88	+1.76	+1.64	+0.60	+0.63	+0.90	1	G0 Ia-0
98718	3.88	-1.08	-0.94	-0.62	-0.22	-0.06	-0.09	-0.14	4	B5 Vn
99264	5.64	-0.88	-0.84	-0.51	-0.05	+0.06	+0.04	+0.06	4	B3 III
99556	5.29	-0.89	-0.84	-0.59	-0.18	0.00	-0.02	-0.04	4	B5 IV
100261	5.51	+1.97	+1.67	+1.35	+1.30	+0.54	+0.57	+0.87	4	G0 Ia
100262	5.30	+0.59	+0.45	+0.13	+0.44	+0.29	+0.28	+0.46	3	A2 Ia
100673	4.60	-0.34	-0.30	-0.26	-0.12	-0.03	-0.03	-0.04	1	B9 V
100841	3.14	-0.06	-0.05	-0.25	-0.10	0.00	-0.01	-0.04	3	B9 II
102249	3.67	+0.27	+0.29	+0.25	+0.19	+0.07	+0.06	+0.08	3	A7 II-III
102776	4.34	-1.08	-0.97	-0.66	-0.22	-0.06	-0.07	-0.12	4	B3 Vne
103079	4.90	-1.01	-0.94	-0.59	-0.23	-0.06	-0.05	-0.09	4	B4 IV
103884	5.55	-1.12	-1.05	-0.59	-0.26	-0.06	-0.08	-0.09	4	B3 V
104174	4.89	-0.32	-0.31	-0.15	-0.07	-0.02	-0.04	-0.05	1	B9 Vn
104671	4.39	+0.24	+0.18	+0.22	+0.28	+0.14	+0.13	+0.23	1	Am
104841	4.71	-1.02	-0.94	-0.50	-0.16	-0.01	-0.04	-0.05	1	B3 IV
105382	4.47	-1.23	-1.09	-0.71	-0.24	-0.07	-0.08	-0.13	4	B6 III
105416	5.30	+0.08	+0.11	+0.05	-0.01	+0.03	+0.01	+0.03	5	A1 V
105435	2.52	-1.43	-1.30	-0.82	-0.20	-0.02	-0.06	-0.02	4	B2: V: pe
105937	3.95	-1.08	-1.00	-0.63	-0.23	-0.07	-0.11	-0.17	4	B4 V
106490	2.75	-1.46	-1.37	-0.92	-0.33	-0.09	-0.12	-0.21	5	B2 IV
106911	4.24	-0.91	-0.88	-0.56	-0.20	-0.05	-0.05	-0.08	1	B6 V
106983	4.02	-1.15	-1.09	-0.71	-0.27	-0.06	-0.10	-0.17	4	B3 IV

TABLE 2 (continued)

HD	52	33-52	35-52	37-52	40-52	45-52	52-58	52-63	n	MK
107446	3.98	+2.76	+2.48	+2.53	+2.01	+0.59	+0.71	+1.07	3	g K3
108248	0.76	-1.63	-1.49	-1.03	-0.35	-0.09	-0.11	-0.20	3	B1 IV
108257	4.79	-1.03	-0.98	-0.65	-0.25	-0.05	-0.09	-0.13	4	B4 IV
108483	3.87	-1.31	-1.22	-0.80	-0.29	-0.07	-0.10	-0.17	4	B2 V
108903	2.03	+3.48	+2.94	+2.86	+2.27	+0.80	+0.61	+1.24	1	M3 II
109026	3.83	-1.01	-0.97	-0.63	-0.24	-0.06	-0.08	-0.14	4	B5 V
109668	2.65	-1.38	-1.29	-0.85	-0.31	-0.08	-0.11	-0.19	4	B3 IV
110335	4.95	-0.63	-0.55	-0.46	-0.14	+0.01	-0.01	-0.01	4	B7 IV
110879	3.02	-1.23	-1.17	-0.75	-0.28	-0.07	-0.11	-0.18	4	B2.5 V
110956	4.62	-1.06	-1.04	-0.67	-0.24	-0.07	-0.09	-0.20	4	B3 IV
111123	1.22	-1.64	-1.49	-1.01	-0.37	-0.08	-0.12	-0.21	4	B0.5 IV
112078	4.60	-1.01	-0.96	-0.62	-0.23	-0.05	-0.08	-0.16	4	B5: Vn
112091	5.09	-0.99	-0.97	-0.56	-0.17	-0.01	-0.03	+0.02	4	B5 Ve
112092	4.02	-1.29	-1.18	-0.77	-0.28	-0.07	-0.09	-0.16	4	B3 IV
112985	3.94	+2.33	+1.97	+2.01	+1.64	+0.52	+0.58	+0.88	3	K2 III
113314	4.86	-0.02	-0.08	+0.04	+0.05	+0.02	+0.02	+0.02	5	A0 V
113703	4.67	-1.00	-0.92	-0.59	-0.23	-0.05	-0.06	-0.12	4	B5 V
113791	4.25	-1.30	-1.23	-0.72	-0.29	-0.06	-0.06	-0.14	5	B2 V
114529	4.50	-0.72	-0.68	-0.40	-0.14	-0.03	-0.05	-0.06	1	B8 V
114911	4.76	-0.67	-0.62	-0.36	-0.14	-0.04	-0.08	-0.08	1	B8 V
115823	5.49	-0.76	-0.71	-0.43	-0.19	-0.05	-0.04	-0.09	4	B5 III
116087	4.49	-1.03	-0.96	-0.60	-0.22	-0.05	-0.08	-0.15	5	B5 V
118716	2.27	-1.56	-1.35	-0.94	-0.34	-0.08	-0.09	-0.19	4	B1 V
120307	3.33	-1.46	-1.32	-0.86	-0.30	-0.07	-0.08	-0.15	9	B2 IV
120324	3.29	-1.43	-1.34	-0.83	-0.23	-0.03	-0.04	+0.01	5	B2 V: pne
120640	5.67	-1.22	-1.08	-0.68	-0.22	-0.03	-0.05	-0.08	5	B4 III
120908	5.96	-0.66	-0.57	-0.36	-0.02	+0.06	+0.04	+0.07	5	B5 V
120955	4.67	-0.85	-0.74	-0.48	-0.16	-0.02	-0.03	-0.06	5	B5 III
121743	3.73	-1.33	-1.18	-0.75	-0.26	-0.05	-0.07	-0.12	5	B2 IV
121790	3.79	-1.28	-1.14	-0.72	-0.26	-0.05	-0.07	-0.12	5	B2 V
122980	4.29	-1.28	-1.09	-0.66	-0.24	-0.04	-0.08	-0.11	5	B3 V
123335	6.34	-0.78	-0.67	-0.37	-0.02	+0.05	+0.06	+0.11	5	B5 IV
122980	4.29	-1.28	-1.09	-0.66	-0.24	-0.04	-0.08	-0.11	5	B3 V
123335	6.34	-0.78	-0.67	-0.37	-0.02	+0.05	+0.06	+0.11	5	B5 IV
124197	6.66	-0.83	-0.75	-0.45	-0.08	+0.01	+0.03	+0.04	4	B6 V

TABLE 2 (continued)

HD	52	33-52	35-52	37-52	40-62	45-52	52-58	52-63	n	MK
124367	4.93	-0.98	-0.94	-0.64	-0.11	+0.06	0.00	+0.09	4	B3 Ve
124771	5.12	-0.97	-0.89	-0.57	-0.17	-0.03	-0.04	-0.04	4	B3 V
125823	4.48	-1.28	-1.19	-0.77	-0.26	-0.05	-0.04	-0.08	3	B3 V
126341	4.60	-1.30	-1.20	-0.80	-0.24	-0.04	-0.04	-0.06	3	B3 III
126354	4.49	+0.59	+0.41	+0.40	+0.42	+0.21	+0.22	+0.38	1	dF7
126981	5.57	-0.47	-0.43	-0.32	-0.14	-0.04	0.00	-0.01	3	B6 IV + A1:
127972	2.34	-1.35	-1.25	-0.83	-0.29	-0.06	-0.05	-0.08	3	B1.5 V: ne
129056	2.37	-1.48	-1.35	-0.92	-0.31	-0.07	-0.07	-0.10	3	B2 II
129116	4.04	-1.21	-1.12	-0.73	-0.26	-0.06	-0.05	-0.11	3	B3 V
130807	4.41	-1.08	-1.01	-0.65	-0.24	-0.07	-0.03	-0.06	3	B6 III:
131120	5.05	-1.16	-1.09	-0.69	-0.24	-0.04	-0.05	-0.09	3	B6 V
131492	5.53	-0.99	-0.92	-0.63	-0.14	0.00	-0.01	+0.08	3	B3 Vne
132058	2.74	-1.47	-1.38	-0.92	-0.38	-0.08	-0.07	-0.12	3	B2 IV
132200	3.19	-1.35	-1.25	-0.83	-0.30	-0.08	-0.07	-0.12	3	B2 V
132955	5.48	-1.04	-0.92	-0.59	-0.19	-0.03	-0.05	-0.07	3	B3 V
133937	6.06	-0.82	-0.74	-0.49	-0.20	-0.05	-0.03	-0.04	3	B7: V:nn
133955	4.11	-1.19	-1.12	-0.72	-0.25	-0.06	-0.05	-0.09	3	B3 V
134687	4.85	-1.22	-1.12	-0.73	-0.25	-0.06	-0.06	-0.09	3	B3 III
136298	3.25	-1.49	-1.36	-0.93	-0.32	-0.11	-0.07	-0.12	3	B2 IV
136504	3.39	-1.28	-1.18	-0.78	-0.27	-0.06	-0.06	-0.10	3	B3 IV
136664	4.59	-1.11	-1.02	-0.66	-0.24	-0.06	-0.05	-0.08	3	B5 V
137432	5.47	-0.96	-0.88	-0.55	-0.22	-0.04	-0.03	-0.07	3	B5 V
138485	5.52	-1.25	-1.15	-0.75	-0.21	-0.05	-0.02	-0.02	2	B2 Vnn
138690	2.82	-1.41	-1.29	-0.87	-0.31	-0.07	-0.07	-0.11	3	B2 Vn
138764	5.15	-0.80	-0.74	-0.47	-0.13	-0.02	-0.01	-0.05	2	B7 IV:
138769	4.60	-1.21	-1.11	-0.72	-0.25	-0.06	-0.05	-0.09	3	B5 IV
139160	6.22	-0.73	-0.72	-0.44	-0.07	+0.02	+0.01	+0.02	2	B8 V
139365	3.63	-1.20	-1.12	-0.73	-0.25	-0.05	-0.07	-0.12	3	B2.5 V
140008	4.74	-0.98	-0.90	-0.56	-0.20	-0.05	-0.03	-0.06	4	B6 V
140543	8.88	-1.29	-1.22	-0.74	-0.07	+0.06	+0.02	+0.03	2	B0.5 III
141168	5.92	-0.44	-0.36	-0.22	-0.11	-0.02	+0.03	+0.07	2	B8 V
141404	7.73	+0.27	+0.22	+0.07	+0.12	+0.09	+0.07	+0.11	2	B9 V
141556	4.01	-0.25	-0.20	-0.15	-0.07	-0.02	-0.02	-0.03	3	Ap
141637	4.64	-1.09	-1.00	-0.54	-0.10	-0.01	+0.01	0.00	2	B2.5 Vn
142096	5.02	-0.94	-0.85	-0.51	-0.07	+0.02	+0.03	+0.02	1	B3 V

TABLE 2 (continued)

HD	52	33-52	35-52	37-52	40-52	45-52	52-58	52-63	n	MK
142114	4.57	-1.04	-0.95	-0.58	-0.12	+0.01	-0.02	-0.05	3	B2.5 Vn
142165	5.36	-0.67	-0.64	-0.36	-0.04	+0.03	+0.02	+0.02	2	B6 V
142184	5.37	-0.97	-0.89	-0.54	-0.08	+0.03	0.00	0.00	2	B2 Vnn
142250	6.12	-0.75	-0.67	-0.44	-0.10	0.00	-0.05	-0.07	1	B7 V
142301	5.86	-0.96	-0.91	-0.55	-0.13	-0.02	+0.01	-0.01	2	B7 IV:
142315	6.87	-0.30	-0.25	-0.15	0.00	+0.04	+0.01	+0.03	1	B9 V
142378	5.94	-0.87	-0.79	-0.48	-0.07	+0.02	+0.04	+0.02	1	B5 V:
142669	3.91	-1.33	-1.23	-0.82	-0.26	-0.05	-0.09	-0.12	2	B2 V
142883	5.84	-0.73	-0.64	-0.34	+0.01	+0.05	0.00	+0.03	2	B3: V
142983	4.78	-0.59	-0.51	-0.59	-0.15	+0.01	-0.02	-0.02	1	Bp
142990	5.51	-1.05	-0.92	-0.60	-0.14	-0.01	-0.02	-0.03	2	B3: V
143018	2.85	-1.46	-1.33	-0.87	-0.25	-0.05	-0.09	-0.12	2	B1 V
143118	3.47	-1.44	-1.30	-0.88	-0.29	-0.06	-0.05	-0.09	2	B2 V
143275	2.29	-1.43	-1.32	-0.83	-0.20	0.00	-0.05	-0.07	2	B0 V
143567	7.20	-0.10	-0.09	+0.02	+0.08	+0.06	+0.03	+0.06	1	B9 V
143699	4.95	-1.02	-0.90	-0.58	-0.19	-0.04	-0.02	-0.04	2	B7 IV:
144294	4.30	-1.21	-1.09	-0.74	-0.26	-0.06	-0.04	-0.07	2	B2 Vn
144334	5.88	-0.94	-0.85	-0.53	-0.14	-0.02	-0.02	-0.02	2	B9: III
144470	3.92	-1.25	-1.15	-0.68	-0.10	+0.04	-0.02	0.00	1	B1 V
144661	6.29	-0.80	-0.72	-0.45	-0.09	+0.01	-0.02	-0.03	1	B7 IV:
144844	5.85	-0.49	-0.44	-0.23	0.00	+0.04	0.00	+0.02	2	B9 V
145102	6.60	-0.19	-0.16	-0.14	+0.03	+0.05	+0.05	+0.10	2	B9 V
145502	3.99	-0.99	-0.92	-0.55	-0.02	+0.06	+0.06	+0.08	1	B2 IV-V
145482	4.53	-1.23	-1.12	-0.72	-0.21	-0.03	-0.08	-0.10	2	B2.5 Vn
145554	7.66	+0.14	+0.04	+0.02	+0.13	+0.09	+0.07	+0.14	2	B9 V
145631	7.60	+0.03	+0.05	+0.07	+0.15	+0.10	+0.06	+0.15	1	B9.5 V
145792	6.41	-0.69	-0.62	-0.35	0.00	+0.04	+0.04	+0.10	2	B7 IV
146001	6.07	-0.57	-0.51	-0.29	+0.01	+0.05	+0.04	+0.08	2	B8 IV
146029	7.39	-0.04	-0.03	0.00	+0.07	+0.07	+0.04	+0.09	1	B9 V
146416	6.61	-0.26	-0.24	-0.12	-0.01	+0.03	+0.03	+0.05	1	B9.5: V
147009	8.13	+0.39	+0.35	+0.38	+0.29	+0.15	+0.15	+0.27	2	B9.5 V
147010	7.47	-0.37	-0.39	-0.19	+0.06	0.00	+0.19	+0.30	2	——
147084	4.75	+1.95	+1.71	+0.99	+0.85	+0.46	+0.46	+0.83	2	A5 II
147152	5.42	-0.68	-0.59	-0.41	-0.10	+0.01	+0.01	+0.03	2	B6 IV
147196	7.08	-0.10	-0.08	-0.03	+0.14	+0.14	+0.07	+0.18	2	B5 V

TABLE 2 (continued)

HD	52	33-52	35-52	37-52	40-52	45-52	52-58	52-63	n	MK
147888	6.81	-0.37	-0.34	-0.05	+0.28	+0.21	+0.18	+0.35	2	B3 V:
147889	8.08	+0.36	+0.29	+0.54	+0.83	+0.54	+0.39	+0.77	2	B1.5 V
148184	4.59	-0.95	-0.96	-0.43	+0.16	+0.19	+0.15	+0.37	2	B2 Ve
148594	6.93	-0.34	-0.29	-0.17	+0.06	+0.08	+0.12	+0.22	2	B9: V
148605	4.77	-1.20	-1.08	-0.69	-0.19	-0.02	-0.03	-0.05	2	B2 V
148703	4.33	-1.34	-1.23	-0.80	-0.24	-0.06	-0.03	-0.05	2	B2 IV
149438	2.82	-1.65	-1.52	-0.99	-0.34	-0.05	-0.04	-0.10	2	B0 V
149711	5.90	-0.95	-0.85	-0.52	-0.09	+0.01	+0.03	+0.05	2	B3 IV
149757	2.59	-1.25	-1.18	-0.70	-0.06	+0.06	+0.03	+0.08	2	O9.5 V
151680*	2.58	+2.15	+1.85	+1.99	+1.55	+0.51	+0.58	+0.86	1	K2 III-IV
151890	2.88	-1.33	-1.20	-0.79	-0.29	-0.07	-0.05	-0.08	2	B1.5 V
151985	3.55	-1.38	-1.22	-0.79	-0.22	-0.05	-0.02	-0.04	2	B2 IV
153716	5.78	-0.93	-0.79	-0.50	-0.15	-0.03	+0.04	+0.05	1	B5 V
155203*	3.46	+0.46	+0.29	+0.36	+0.43	+0.23	+0.23	+0.33	1	F0 IVn
156325	6.52	-0.45	-0.35	-0.27	+0.08	+0.11	+0.22	+0.24	2	B6 IVe
157056	3.24	-1.39	-1.28	-0.80	-0.28	-0.05	-0.05	-0.12	5	B2 IV
158408	2.70	-1.39	-1.30	-0.80	-0.31	-0.07	-0.06	-0.11	4	B3 Ib
158926*	1.59	-1.41	-1.35	-0.85	-0.32	-0.05	-0.08	-0.13	2	B1 V
160578*	2.38	-1.42	-1.36	-0.88	-0.32	-0.06	-0.06	-0.13	2	B2 IV
161471*	3.15	+1.45	+1.06	+0.54	+0.54	+0.31	+0.26	+0.42	2	F2 Ia
161756	6.33	-0.61	-0.54	-0.32	+0.07	+0.11	+0.11	+0.20	3	B3 IV
165024*	3.67	-1.28	-1.24	-0.76	-0.21	+0.02	+0.01	-0.02	2	B0.5 II
165135*	3.24	+1.15	+3.57	+1.60	+1.35	+0.50	+0.49	+0.82	1	K0 III
167618*	3.44	+3.53	+2.85	+2.81	+2.24	+0.78	+0.65	+1.25	2	M3 II
168454*	3.04	+2.85	+2.44	+2.56	+2.00	+0.65	+0.67	+1.00	2	K2 III
168905	5.27	-1.15	-1.06	-0.70	-0.24	-0.06	-0.06	-0.08	2	B3 Vn
169022*	1.86	+0.10	0.00	-0.19	-0.09	+0.02	+0.01	-0.02	3	B9 IV
169767*	4.38	+1.67	+1.36	+1.56	+1.26	+0.40	+0.49	+0.80	1	gK0
169916*	3.05	+1.83	+1.57	+1.80	+1.45	+0.54	+0.47	+0.77	1	K2 III
170465	5.02	-0.74	-0.64	-0.46	-0.17	-0.04	-0.01	-0.02	2	B6 IV
170523	5.18	-1.11	-0.86	-0.60	-0.20	-0.04	-0.03	-0.03	2	B5 IV
171759*	4.28	+2.03	+1.73	+1.94	+1.56	+0.53	+0.52	+0.85	1	K2 III
172910	4.91	-1.24	-1.12	-0.72	-0.23	-0.05	-0.06	-0.04	2	B2 V
173300*	3.15	-0.56	-0.56	-0.41	-0.15	-0.01	-0.02	-0.04	2	B8 III
173375	7.18	-0.35	-0.29	-0.16	+0.16	+0.14	+0.11	+0.22	3	B6 V

TABLE 2 (continued)

HD	52	33-52	35-52	37-52	40-52	45-52	52-58	52-63	n	MK
173948	4.31	-1.41	-1.26	-0.85	-0.24	-0.03	-0.03	-0.05	2	B1 Ve
175191*	1.99	-1.19	-1.12	-0.71	-0.25	-0.04	-0.07	-0.15	3	B2 V
175362	5.39	-1.19	-1.05	-0.69	-0.23	-0.08	-0.01	-0.03	2	B9 III:
176687*	2.62	+0.21	+0.13	+0.16	+0.09	+0.04	+0.06	+0.04	1	A2 III
177716*	3.61	+2.19	+1.88	+2.08	+1.58	+0.53	+0.58	+0.90	2	K1 III
178253*	4.13	+0.17	+0.09	+0.15	+0.03	+0.04	+0.03	+0.02	2	A2
178322	5.93	-0.78	-0.69	-0.47	-0.14	-0.01	0.00	0.00	2	B5 V
178345*	4.38	+2.17	+1.85	+1.97	+1.63	+0.61	+0.52	+0.83	2	g G3
178524*	2.99	+0.76	+0.59	+0.37	+0.41	+0.24	+0.22	+0.31	2	F2 II-III
180885	5.64	-0.95	-0.86	-0.59	-0.19	-0.03	-0.03	-0.04	2	B4 IV
182180	6.01	-1.12	-1.02	-0.66	-0.17	-0.02	-0.01	-0.01	2	B5 IV
186837	6.29	-0.98	-0.87	-0.60	-0.22	-0.06	-0.03	-0.03	2	B5 V
188114*	4.40	+1.86	+1.50	+1.68	+1.39	+0.54	+0.54	+0.82	2	K0 III
188376*	4.90	+0.87	+0.66	+0.88	+0.92	+0.40	+0.39	+0.60	2	d G5
189763*	4.91	+3.69	+3.04	+2.91	+2.22	+0.89	+0.62	+1.28	2	M4 III
189831*	5.15	+2.99	+2.54	+2.69	+1.99	+0.61	+0.74	+1.11	2	g K5
190248*	3.77	+0.92	+0.77	+0.99	+0.95	+0.36	+0.41	+0.60	2	G8 V
190421*	5.33	+3.35	+3.01	+3.03	+2.31	+0.73	+0.78	+1.22	3	M2 III
193924	1.93	-1.18	-1.09	-0.73	-0.26	-0.03	-0.03	-0.08	3	B3 IV
196171*	3.36	+1.62	+1.37	+1.51	+1.32	+0.50	+0.48	+0.74	2	K0 III
197051*	3.47	+0.44	+0.31	+0.24	+0.21	+0.13	+0.12	+0.11	2	A5 IV
197692*	4.25	+0.22	+0.11	+0.29	+0.46	+0.21	+0.24	+0.36	3	F5 V
198048*	5.17	+2.37	+1.92	+2.02	+1.59	+0.57	+0.55	+0.90	1	g K5
198542*	4.55	+2.99	+2.49	+2.54	+2.39	+0.76	+0.84	+1.27	2	K5 III
198700*	3.96	+2.39	+2.01	+2.17	+1.74	+0.63	+0.61	+0.87	2	K0 III
200914*	4.29	+3.63	+3.05	+3.04	+2.37	+0.74	+0.85	+1.27	2	M1 III
203608*	4.37	+0.16	0.00	+0.29	+0.49	+0.29	+0.29	+0.43	2	F8 V
204075*	3.98	+1.35	+1.16	+1.33	+1.34	+0.51	+0.47	+0.68	2	G5 p
205478*	4.03	+1.71	+1.44	+1.62	+1.31	+0.47	+0.53	+0.77	2	K0 III
206742*	4.35	-0.14	-0.20	-0.10	-0.06	+0.03	+0.03	-0.03	2	A0 si
207971*	3.01	-0.55	-0.55	-0.41	-0.16	0.00	-0.01	-0.06	3	B8 III
209100*	5.05	+1.58	+1.38	+1.72	+1.33	+0.34	+0.71	+1.00	2	K5 V
209952*	1.74	-0.77	-0.76	-0.51	-0.21	-0.02	0.00	-0.06	2	B5 V
211088*	5.00	+1.48	+0.89	+1.03	+0.96	+0.42	+0.42	+0.62	2	g G4
211416*	3.23	+2.81	+2.38	+2.54	+1.97	+0.64	+0.74	+0.07	2	K3 III

TABLE 2 (continued)

HD	52	33-52	35-52	37-52	40-52	45-52	52-58	52-63	n	MK
212087 *	6.97	+4.06	+3.75	+3.59	+3.07	+1.35	+0.68	+1.65	4	S4.7
213009 *	4.22	+1.71	+1.44	+1.56	+1.39	+0.53	+0.50	+0.73	2	g G5
213080 *	4.42	+3.79	+3.09	+2.93	+2.27	+0.89	+0.61	+1.24	2	g M6
213442 *	5.14	+3.84	+3.09	+3.03	+2.26	+0.87	+0.66	+1.29	1	g M4
214952 *	2.41	+3.61	+2.88	+2.78	+2.15	+0.93	+0.59	+1.25	2	M3 II
215104 *	5.11	+1.66	+1.34	+1.56	+1.29	+0.49	+0.51	+0.77	1	g G8
215369 *	5.15	+2.23	+1.74	+1.92	+1.52	+0.56	+0.59	+0.91	1	g K2
215789 *	3.52	+0.32	+0.21	+0.12	+0.07	+0.06	+0.08	+0.06	2	A2 V
216763 *	4.45	+1.50	+1.20	+1.40	+1.19	+0.47	+0.47	+0.73	2	g G8
216956 *	1.18	+0.19	+0.12	+0.18	+0.11	+0.05	+0.05	+0.03	3	A3 V
217364 *	4.35	+1.55	+1.23	+1.43	+1.24	+0.47	+0.47	+0.73	2	G5 III
218594 *	3.95	+2.33	+1.96	+2.12	+1.67	+0.57	+0.60	+0.89	2	K0 III
218670 *	4.15	+1.74	+1.48	+1.62	+1.36	+0.48	+0.49	+0.75	2	K0 III
219571 *	4.10	+0.29	+0.15	+0.27	+0.42	+0.23	+0.22	+0.34	2	F0 III
219784 *	4.70	+2.01	+1.71	+1.88	+1.50	+0.52	+0.56	+0.84	2	G8 III
220321	4.22	+1.87	+1.58	+1.71	+1.44	+0.51	+0.53	+0.84	4	K0 III
220704	4.79	+3.19	+2.77	+2.81	+2.20	+0.64	+0.76	+1.19	5	K5 III
224889	5.13	+2.55	+2.12	+2.29	+1.72	+0.55	+0.68	+1.00	2	K2 III

TABLE 3

Data to compute the ratio E_{33-35}/E_{52-58}

BS	*33-35*	*52-58*	*MK*
1542	−0.082	+0.072	O9.5 Ia
1852	−0.117	−0.094	O9.5 II
1899	−0.132	−0.080	O9 III
1931	−0.131	−0.069	O9.5 V
1948/9	−0.114	−0.051	O9.5 Ib
6175	−0.070	+0.029	O9.5 V
7589	−0.107	−0.003	O9.5 III
8327	+0.003	+0.170	O9 II
8622	−0.122	−0.066	O9 V

we have eight color data; they are listed in Table 4, of which the columns give: first, the BS number (see above); second and third, the *37-40* and *52-58* color indices, respectively; last, the MK-type. From a least-squares solution we find

$$E_{37-40}/E_{52-58} = +0.781 \pm 0.009 \text{ (m.e.)}$$

this relation is also illustrated graphically in Figure 2.

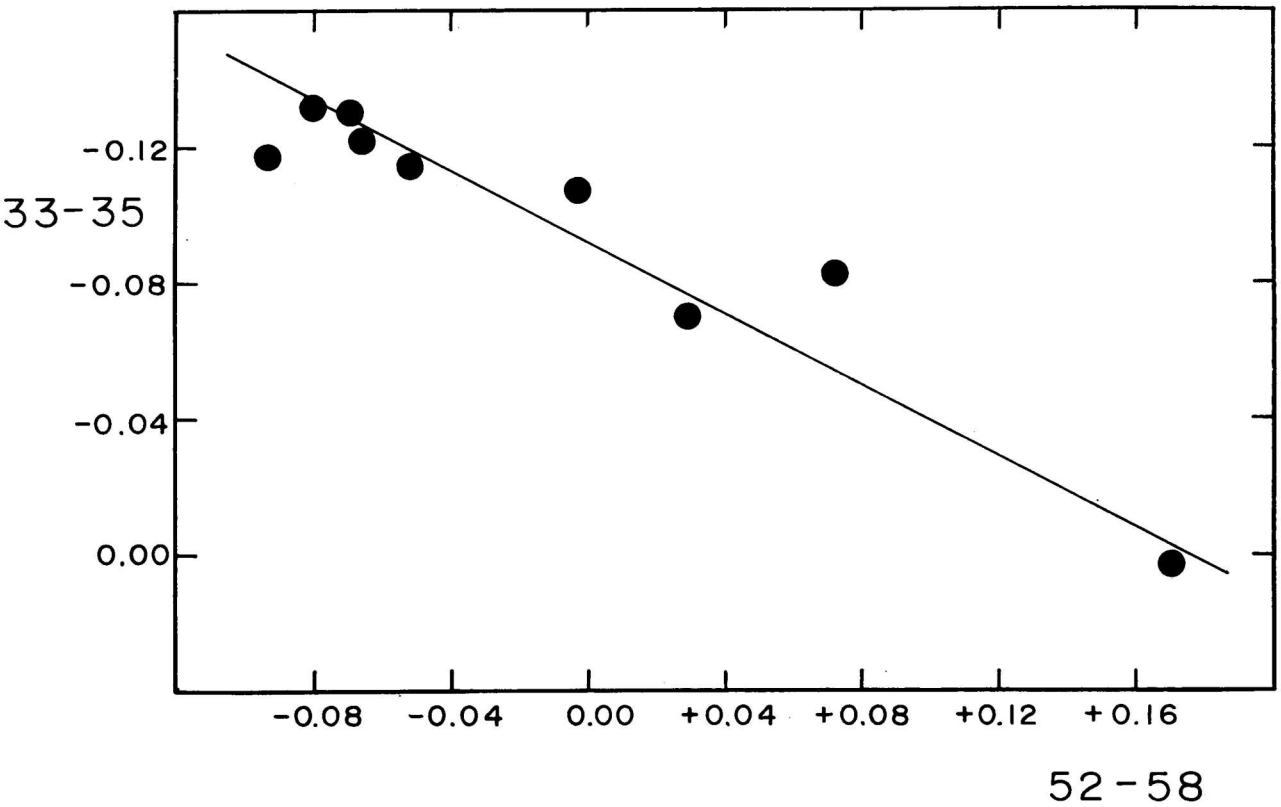

Fig. 1.—*The relationship between the color indices 33-35 and 52-58 for the stars listed in Table 3. The slope of the line is the ratio* E_{33-35}/E_{52-58}.

TABLE 4

Data to compute the ratio E_{37-40}/E_{52-58}

BS	*37-40*	*52-58*	*MK*
130	−0.650	+0.092	B1 Ia
696	−0.578	+0.188	B2 Ia
1542	−0.676	+0.072	O9.5 Ia
1903	−0.715	−0.046	B0 Ia
2135	−0.618	+0.138	B2 Ia
2240	−0.489	+0.260	B3 Ia
3494	−0.520	+0.190	B3 Ia
7977	−0.530	+0.227	B3 Ia

Next, we define two classification parameters most likely reddening-free.

$$a = 33\text{-}35 - 0.52\ (52\text{-}58)$$

and

$$b = 37\text{-}40 - 0.78\ (52\text{-}58)$$

where the two coefficients in these definitions represent the mean color excess ratios derived above. a and b are independent of interstellar extinction under the assumption that the two color excess ratios are constant; this is probably not strictly true.

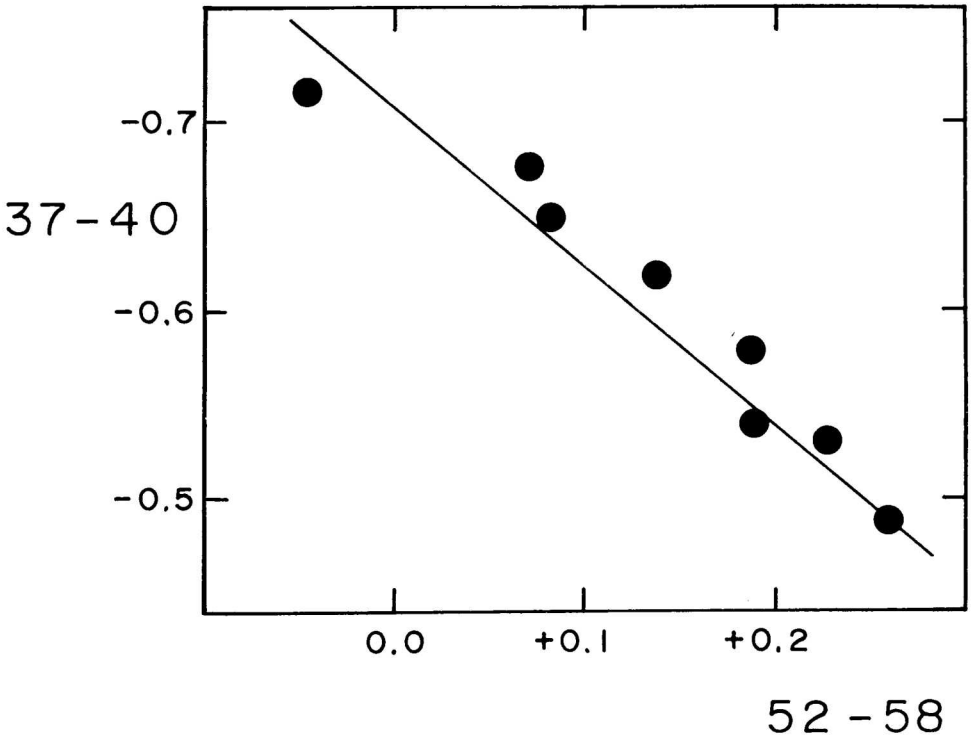

Fig. 2.—*The relationship between the color indices* 37-40 *and* 52-58 *for the stars listed in Table 4. The slope of the line is the ratio* E_{37-40}/E_{52-58}.

IV. The Absolute Magnitudes

The observational data given in Table 2 and the parallaxes obtained by Bertiau (1958) for the Scorpio-Centaurus association can be combined to determine absolute magnitudes using the following equation

$$M_v = V - \frac{A_v}{E_{52-58}} [(52\text{-}58)-(52\text{-}58)_o] + 5 \log \pi + 5.$$

Where

M_v is the absolute visual magnitude,

V is the visual magnitude which can be obtained from the eight-color photometry by $V = 52\text{-}0.0059\text{-}0.5362\ (52\text{-}58)$,

π is the parallax,

A_v is the visual interstellar extinction,

$52\text{-}58$ is the observed color index,

$(52\text{-}58)_o$ is the intrinsic color index, and

E_{52-58} is the color excess defined by $(52\text{-}58) - (52\text{-}58)_o$.

The quantities A_v/E_{52-58} and $(52\text{-}58)_o$ can also be derived from our observations.

We have seventy B-type stars with both parallaxes and eight color photometry. For the sake of simplicity, we just take the absolute magnitudes obtained by Gutierrez and Moreno (1968); their data were computed under the assumption of $R = A_v/E_{B-V} = 6.0$ for stars in the Upper Scorpius region and $R = 3.0$ for the remaining stars studied by Bertiau. These absolute magnitudes have been plotted *versus* our b index in Figure 3. In this Figure the smooth line represents the standard function $M_v(b)$ which has been extrapolated, taking into consideration the values indicated by Galactic and Magellanic Cloud supergiant B-type stars (cf. Mendoza 1970) at the upper end and by Sirius and Vega at the lower end. Perhaps α CMa has anomalous colors for its spectral type; thus, in spite of its reliable trigonometric parallax it may not be a reliable star for calibration. $M_v(b)$ is given in numerical form in Table 5. The values listed in brackets in this Table are those that lie outside the range of absolute magnitudes of the Scorpio-Centaurus association.

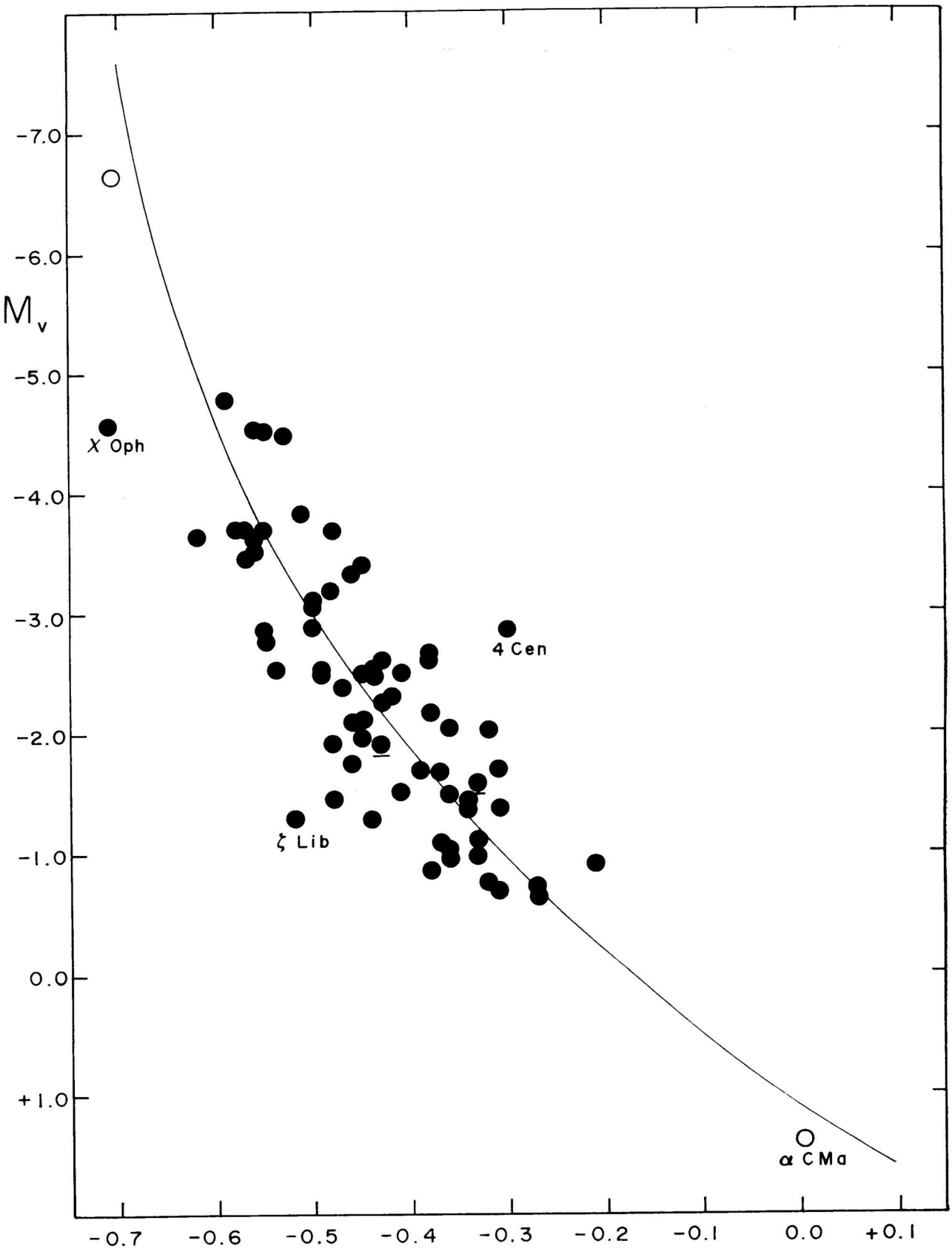

Fig. 3.—*The relationship between the* b-*index and the absolute visual magnitude The symbols represent: filled circles, Scorpio-Centaurus stars studied by Bertiau; lower open circle, Sirius; upper open circle, the mean value of supergiant stars listed in Table 4* ($M_v = -6.6$, *Blaauw 1963*). *The smooth curve represents the standard function* M_v(b), *which seems to represent, in a first approximation, the Scorpio-Centaurus stars.*

TABLE 5

Calibration of M_v as function of b

M_v	b	M_v	b
(−7.0	−0.68:)	−2.0	−0.41
(−6.0	−0.66)	−1.5	−0.36
(−5.0	−0.62)	−1.0	−0.30
−4.5	−0.60	−0.5	−0.24
−4.0	−0.57	0.0	−0.17
−3.5	−0.54	(+0.5	−0.10)
−3.0	−0.50	(+1.0	−0.02)
−2.5	−0.46	(+1.5	+0.08:)

Three stars lie well outside of the standard function $M_v(b)$ plotted in Figure 3; these are 4 Cen, a double star; ζ Lib, a B2 Vnn; and χ Oph, a well known Be star. Other Be and Bn stars lie on the smooth line given in Figure 3 or are very close to it. The mean error, in deriving $M_v(b)$, excluding the above three stars is not larger than ± 0.07 mag.

Figure 3 or Table 5 can be used to derive distance moduli of stellar aggregates. We have 10 B-type stars in the Pleiades and 24 in Orion which were not used at all in the derivation of the data given in Table 5; thus, we can use them for an independent check of the above results. The distance moduli of the Pleiades and Orion associations thus obtained are exactly the same as derived by the photometric method starting from the Hyades cluster (cf. Mendoza 1967).

V. Final Remarks

The preliminary analysis of the intermediate-band photometric system presented in this paper although of provisional character is satisfactory. The results might be improved taking into account effects such as duplicity of stars, rotation, differences in chemical composition, etc. To investigate other combinations of the color indices to obtain luminosities, spectral types, ages, metallicity and so on, it is desirable, not only to study early type stars but to extend it to all types. Observations of additional stars for such special purposes are needed.

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