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Faint photometric BVR_c CCD sequences[⋆,⋆⋆]

The North galactic pole ($b \simeq 85°$) and the anticenter ($l = 133\overset{\circ}{.}2$, $b = -1\overset{\circ}{.}6$)

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Abstract. Lists of CCD photometric standard stars in the BVR_c system of Johnson and Cousins are presented for two regions of importance in studies of galactic structure and kinematics: one at the North galactic pole (NGP) ($b_\mathrm{II} = 85°$), and a second on the galactic equator toward the anti–center ($l_\mathrm{II} = 133\overset{\circ}{.}2$, $b_\mathrm{II} = -1\overset{\circ}{.}6$). Precision of both magnitudes and colors is better than 0.05 mag down to $V = 18.5$ for the NGP sample, and to $V = 18.0$ for the set on the galactic plane. Accuracy is also better than 0.05 mag, as shown by comparison to standard (intrinsic) color-color diagrams.

These sequences should fulfil the needs for faint reference stars in the photometric calibration of old and new large-area surveys using wide-angle photographic plates. This is the case, for example, of the new multicolor surveys of the Palomar Observatory, which uses the Oschin Schmidt telescope, and the Second Generation Southern Sky Survey, which utilizes UK Schmidt of the Anglo Australian Observatory in Siding Spring.

Key words: catalogs — Galaxy: structure — techniques: photometric

1. Introduction

Considerable attention has been devoted in recent years to the complex structure of phase space in the Galaxy, as depicted by both narrow angle deep CCD multicolor star counts and large-angle surveys of colors and proper motions (Robin et al. 1992; Majewski 1992; Spagna et al. 1996). Large-area surveys covering several square degrees utilize large format photographic plates, usually taken at Schmidt-type telescopes[1]. Noticeable examples of photographic surveys on Schmidt plates are the first Palomar sky survey, POSS I (Minkowski & Abell 1963), its present day continuation, POSS II (Reid et al. 1991), the Quick-V survey, taken specifically for the construction of the first guide star catalog for the Hubble Space Telescope (Lasker et al. 1990b), and, for the Southern hemisphere, the ESO/SERC survey (Tritton 1983), and the on-going Second Epoch Southern (SES) survey ($\delta \leq -17\overset{\circ}{.}5$) with the UK Schmidt (Lasker & Cannon 1990a).

As discussed by many authors, the photometric calibration of such large format plates is challenging (see e.g. Bienaymé et al. 1992; Andruk et al. 1994; Ojha et al. 1994; Spagna et al. 1996). Precisions to 0.1 mag or better are possible, especially for Kodak IIIa emulsions, but photometric quality appears to be particularly vulnerable to position-dependent systematics. Faint photometric standards, distributed evenly over the area studied, are essential for the most accurate results. Although the recent release of the TYCHO catalog will certainly help (especially for the zero-point "flat fielding" across plates) today, the situation is far from ideal! Faint photometric standards of suitable bandpasses are not always available; and, when so, they tend to be concentrated in small regions compared to the extent of the plates. These are the motivations for the extension of the first Guide Star Photometric Catalog (GSPC I; Lasker et al. 1988) into the GSPC II (Postman et al. 1992).

The GSPC II is a joint effort of the ST ScI and the Osservatorio Astronomico di Torino. This project aims at the creation of a catalog of photometric standard sequences throughout the celestial sphere down to $V \approx 19$ in the B, V, R_c bandpasses, with an accuracy of 5% (Ferrari et al. 1993). More details on the project can be found in

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⋆ This work is based in part on the thesis of AS, presented in partial fulfillment of the PhD degree.
⋆⋆ Tables 3 and 4 are available in electronic form at the CDS via anonymous ftp to cdsarc.u-strasbg.fr (130.79.128.5) or via to http://cdsweb.u-strasbg.fr/Abstract.html

[1] See Morgan (1995) and Lasker (1995) for recent reviews.

the cited references. The data presented in this article are part of the GSPC II photometric database.

2. CCD observations and data reductions

The standard photometry presented here satisfies the needs for photographic photometry calibrations in two fields along the meridian section of the Milky Way toward the galactic anticenter; the North galactic pole (NGP) region is centered at ($l \simeq 162°$, $b \simeq 87°$), and the galactic plane region (GPR) at ($l \simeq 134°$, $b \simeq -2°$) around the open cluster Stock 2. These fields are part of a systematic study (which includes a total of twelve regions) aiming at the detailed investigation of the structural and kinematical properties of the Galaxy (Spagna et al. 1996, and references therein). New CCD observations have been obtained to establish sequences of standard stars in the BVR_c Johnson-Cousins photometric system, down to $V \simeq$ 18.0 and 18.5, for GPR and NGP respectively.

BVR_c CCD data for the GPR and NGP fields were taken at Mt. Hopkins using the 1.2 m telescope equipped with a CCD camera (scale $\simeq 0\farcs67$/pixel), covering $11' \times 11'$. The GPR, that was observed on October 15 1993, is centered on star No. 49 from the list of Krzeminski & Serkowski (1967). The NGP fields, which were imaged the night of June 5 1994, are located respectively to the center (I), the North-East (II) and North-West (III) edges of the NGP region on the photographic plates we tackled. The center coordinates of all the fields are reported in Table 1.

Table 1. Celestial (J2000.0) and galactic coordinates of the CCD fields

Field	α_c	δ_c	l_{II}	b_{II}
GPR	$2^h\,13^m\,46^s$	59° 37′ 08″	133°.19	−1°.61
NGP I	$12^h\,46^m\,10^s$	28° 47′ 14″	157°.68	87°.97
NGP II	$12^h\,49^m\,37^s$	31° 32′ 03″	127°.97	85°.58
NGP III	$12^h\,35^m\,01^s$	32° 04′ 04″	157°.79	83°.91

The CCD frames were reduced utilizing standard packages; bias subtraction and flat-field corrections were handled with MIDAS (Grøsbol & Ponz 1985), and image centering and instrumental magnitudes with DAOPHOT 2.0 in MIDAS (Stetson 1987). The final transformations, including extinction correction and color transforms to the Johnson-Cousins standard system, were done with a version of the code SNOPY developed at ESO, properly modified to run on CCD data by Pizzuti (1991) and Mitton (1992).

The average precision of the standard sequences derived here is, for both regions, better than 0.05 mag for V, $B-V$, and $V-R_c$.

2.1. *The galactic plane field*

The BVR_c CCD frames specifically taken for the photometric calibration of the GPR were calibrated using, as in-situ standards, those stars in Krzeminski & Serkowski (1967) within the $11' \times 11'$ field covered by the CCD (Table 2).

These photoelectric standards are all too bright ($V \leq$ 12.22) for a direct calibration of the frames down to $V \simeq 18$. To bridge the magnitude gap, we took frames of different exposures (1, 2, 10, 60 s in R; 2, 4, 20, 120 s in V; 4, 8, 40, 240 s in B) using field stars as standards for the deeper frames. Krzeminski and Serkowski only provide UBV photometry. Therefore, R_c magnitudes of the bright photometric calibrators were computed from spectral types, $E(B-V)$, and V magnitudes as given in Krzeminski & Serkowski (1967), the $(V-R_c)_0$ intrinsic colors from Table 7 (p. 311) of Straizys (1992), and the ratios of red to blue reddening $E(V-R_c)/E(B-V)$ as published by Taylor (1986); these are summarized in Table 2.

Table 2. GPR. Primary photometric calibrators

K-S No.	V	$B-V$	$V-R_c^*$
32	12.04	+0.94	+0.56
35	10.66	0.47	0.19
38	12.22	0.76	0.42
49	9.42	0.59	0.34
54	10.95	0.59	0.23
57	10.33	0.58	0.32
58	10.00	0.49	0.27

* Synthetic color (see text).

The experimental color equations we found, which transform the CCD magnitudes b, v, and r into the standard ones, are:

$$V - v = 0.049(\pm 0.011) \cdot (B - V) + \zeta_V \quad (1)$$
$$B - V = 1.041(\pm 0.023) \cdot (b - v) + \zeta_{BV} \quad (2)$$
$$V - R_c = 1.232(\pm 0.028) \cdot (v - r) + \zeta_{VR} \quad (3)$$

and

$$V - v = 0.031(\pm 0.013) \cdot (B - V) + \zeta_V \quad (4)$$
$$B - V = 1.041(\pm 0.011) \cdot (b - v) + \zeta_{BV} \quad (5)$$
$$V - R_c = 1.142(\pm 0.020) \cdot (v - r) + \zeta_{VR} \quad (6)$$

for the second and fourth exposures, respectively; the two exposures were merged in the final list. The formal errors on the fitted value of the zero points ζ_i are less than 0.05 mag.

As an external check on the accuracy of these results, and in particular on that of the $V-R_c$ color (being based on synthetic red magnitudes), we looked at the $(V-R_c)$ vs. $(B-V)$ plot of the derived colors. Figure 1 shows these colors (dots) superimposed to the main sequence (solid line)

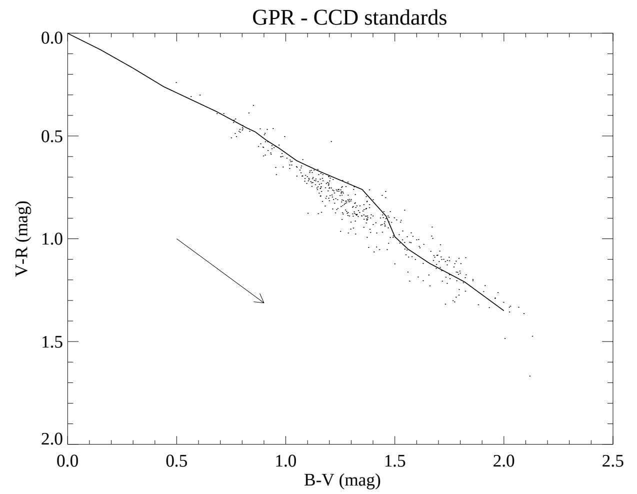

Fig. 1. GPR. Two-color diagram. The points show the colors as derived from the CCD data. The solid line represents the intrinsic colors of Straizys (1992), and the arrow the slope of the reddening

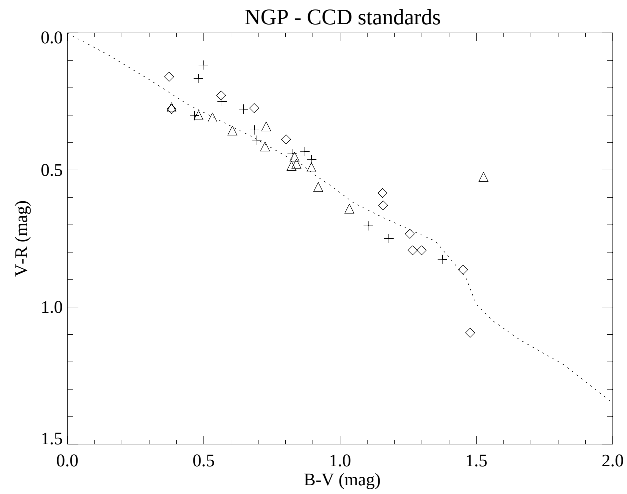

Fig. 2. NGP. Two-color diagram. Crosses, triangles and diamonds show the colors as derived from the CCD data for the central (I), North-East (II) and North-West (III) fields. The solid line represents the intrinsic colors of Straizys (1992)

obtained using the *intrinsic* BVR_c color data as given in Straizys (1992). Apart from the expected shift along the curve defined by the intrinsic colors, due to the strong interstellar absorption in this field ($A_V = 4.0$ mag/kpc), the observed colors have practically the same slope as that defined by the intrinsic colors. Again, this was expected as the selective reddening ratio $E(V-R_c)/E(B-V)$ is about the same as the natural slope of the intrinsic color sequence, and it shows that the R_c calibration is consistent with the observed B and V magnitudes. Any systematic effect on the red magnitudes would manifest itself as a translation along the $(V-R_c)$ axis.

2.2. The North galactic pole field

For each of the three CCD fields imaged in the direction of the NGP region, we proceeded in a way similar to that adopted for the GPR region. To bridge the magnitude range needed for a proper calibration of the photographic photometry, we took four series of exposures for each bandpass used: 1, 2, 10, 60 s in R_c, 2, 4, 20, 120 s in V, and 4, 8, 40, 240 s in B.

The low star density and a noticeable variation of the telescope point-spread-function (PSF) across the chip suggested the use of aperture photometry, instead of PSF fitting (which was the method of choice for the low latitude field) for the derivation of the instrumental magnitudes. In particular, we used the growth curve technique (Stetson 1990; Da Costa 1992) for the determination of the optimal software aperture.

The transformation to the standard Johnson-Cousins system was done via the usual method of observing a set of primary photometric standard stars at different air masses throughout the same night. Stars[2] from Landolt (1992) in the magnitude range $12.116 \leq V \leq 15.530$, and in the color ranges $0.516 \leq (B-V) \leq 1.344$, $0.351 \leq (V-R_c) \leq 0.897$, were used.

The best-fit to the color equations[3] provided:

$$V - v = -0.010(\pm 0.028) \cdot (B - V) + \zeta_V \quad (7)$$

$$B - V = 1.154(\pm 0.019) \cdot (b - v) + \zeta_{BV} \quad (8)$$

$$V - R = 1.125(\pm 0.045) \cdot (v - r) + \zeta_{VR} \quad (9)$$

with internal errors on the zero points ζ_i of $0.05-0.06$ mag.

The final list of faint photometric standard stars was derived from the second and fourth exposures. In the magnitude range covered by both exposures, proper averaging was applied.

As for the GPR, Fig. 2 shows the color-color plot for the NGP field with superimposed Straizys' unreddened main sequence. Besides the reliability of the photometric calibration, this plot confirms the predicted low reddening along this line of sight. (Visual inspection of the image shows that the outlier with $B-V \approx 1.5$ and $V-R \approx 0.5$ is a suspected double object and is not listed in the final table.)

Here, the CCD-based standard colors have been corrected for an offset of -0.04 and $+0.05$ mag in $(B-V)$ and $(V-R_c)$ respectively. These offsets can be interpreted as the expected effect of the zero point errors in the transformation from instrumental to standard magnitude and

[2] Numbers 107-599, 107-602, 107-611, 107-612, 107-614, 113-233, 113-239, 113-241, 113-337, 113-339, 113-L1.

[3] Note that a new CCD, different from that used for GPR, was mounted.

colors. The correction on $B-V$ was inferred from comparisons with independent UBV photometric catalogs (see Spagna et al. 1996 for details). The $\Delta(V-R_c)$ correction was derived directly from the color-color diagram, as the shift which best matches the observed and theoretical sequences.

3. The faint photometric sequences

The lists of standards are presented in Tables 3 and 4. Table 3 contains 56 stars for the NGP region, and Table 4 lists 207 stars for the GPR. Each object is identified by two indices: (1) $N_{\rm CCD}$, the identification number from the CCD frames (cf. Table 1), and (2) $\rm ID_{POSS}$, the identifier derived from star positions at J2000, also listed in the tables.

These data are also available electronically at the Osservatorio Astronomico di Torino, via anonymous ftp to ftp.to.astro.it.

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Table 3. NGP: photometry and position of the CCD standards in fields I, II, III

ID_{POSS}	N_{CCD}	V (mag)	$B-V$ (mag)	$V-R_c$ (mag)	R.A. (J2000) h m s	Dec. (J2000) ° ′ ″
1245519N285225	7-I	14.387	0.646	0.278	12 45 51.9	+28 52 25
1245560N285153	9-I	16.685	1.375	0.826	12 45 56.0	+28 51 53
1246003N284440	10-I	16.060	0.896	0.462	12 46 00.3	+28 44 40
1246004N284219	11-I	17.259	1.179	0.750	12 46 00.4	+28 42 19
1246010N285034	12-I	18.063	0.879	0.608	12 46 01.0	+28 50 34
1246110N284912	15-I	16.614	0.466	0.302	12 46 11.0	+28 49 12
1246119N284832	16-I	15.901	0.687	0.354	12 46 11.9	+28 48 32
1246133N284811	17-I	18.048	0.747	0.633	12 46 13.3	+28 48 11
1246138N284858	18-I	15.134	0.480	0.166	12 46 13.8	+28 48 58
1246168N284753	19-I	16.319	0.824	0.441	12 46 16.8	+28 47 53
1246201N284634	20-I	16.787	0.498	0.117	12 46 20.1	+28 46 34
1246206N284613	21-I	16.473	1.103	0.704	12 46 20.6	+28 46 13
1246237N285049	22-I	17.821	0.763	0.049	12 46 23.7	+28 50 49
1246242N284712	23-I	14.914	0.871	0.432	12 46 24.2	+28 47 12
1246291N285029	25-I	16.608	0.567	0.250	12 46 29.1	+28 50 29
1246316N285219	26-I	18.283	0.592	0.194	12 46 31.6	+28 52 19
1249115N312948	2-II	14.601	0.725	0.414	12 49 11.5	+31 29 48
1249224N313416	4-II	15.807	0.920	0.562	12 49 22.4	+31 34 16
1249239N313554	5-II	18.075	1.010	0.598	12 49 23.9	+31 35 54
1249236N312813	6-II	17.997	0.786	0.638	12 49 23.6	+31 28 13
1249295N313553	7-II	17.229	0.481	0.300	12 49 29.5	+31 35 53
1249299N313633	8-II	17.959	0.398	0.210	12 49 29.9	+31 36 33
1249300N313713	9-II	16.790	0.729	0.341	12 49 30.0	+31 37 13
1249345N313111	10-II	15.489	1.034	0.641	12 49 34.5	+31 31 11
1249347N313208	11-II	14.826	0.895	0.490	12 49 34.7	+31 32 08
1249352N313355	13-II	18.399	0.109	0.435	12 49 35.2	+31 33 55
1249362N313259	14-II	18.059	1.047	0.929	12 49 36.2	+31 32 59
1249380N313005	15-II	18.589	0.650	0.359	12 49 38.0	+31 30 05
1249394N313101	16-II	16.199	0.840	0.477	12 49 39.4	+31 31 01
1249422N313518	17-II	16.194	0.822	0.485	12 49 42.2	+31 35 18
1249420N313013	18-II	18.346	0.930	0.640	12 49 42.0	+31 30 13
1249429N313537	19-II	14.014	0.532	0.308	12 49 42.9	+31 35 37
1249426N313041	20-II	12.821	0.833	0.451	12 49 42.6	+31 30 41
1249427N312809	21-II	18.107	0.595	0.381	12 49 42.7	+31 28 09
1249455N313008	22-II	16.777	0.605	0.356	12 49 45.5	+31 30 08
1249517N313336	23-II	18.295	1.446	1.072	12 49 51.7	+31 33 36
1249526N313610	24-II	18.171	0.812	0.556	12 49 52.6	+31 36 10
1249590N313538	26-II	16.259	0.382	0.271	12 49 59.0	+31 35 38
1234433N320449	2-III	13.845	0.802	0.388	12 34 43.3	+32 04 49
1234450N315930	3-III	15.138	1.158	0.629	12 34 45.0	+31 59 30
1234525N320401	5-III	15.160	1.256	0.733	12 34 52.5	+32 04 01
1234544N320250	7-III	18.095	0.247	0.527	12 34 54.4	+32 02 50
1234570N320235	8-III	17.257	1.477	1.094	12 34 57.0	+32 02 35
1234580N320218	10-III	16.931	0.373	0.160	12 34 58.0	+32 02 18
1235033N320308	11-III	14.023	0.564	0.228	12 35 03.3	+32 03 08
1235057N320440	12-III	16.499	0.685	0.274	12 35 05.7	+32 04 40
1235070N320348	13-III	15.675	1.156	0.584	12 35 07.0	+32 03 48
1235096N320445	15-III	16.791	0.382	0.278	12 35 09.6	+32 04 45
1235140N320622	18-III	17.957	0.559	0.053	12 35 14.0	+32 06 22
1235145N320729	19-III	18.238	1.138	0.468	12 35 14.5	+32 07 29
1235174N320722	20-III	18.289	0.577	0.120	12 35 17.4	+32 07 22
1235180N320505	21-III	15.627	1.299	0.793	12 35 18.0	+32 05 05
1235184N320448	23-III	18.208	1.523	0.963	12 35 18.4	+32 04 48
1235192N320717	24-III	16.773	1.266	0.793	12 35 19.2	+32 07 17
1235199N320720	25-III	14.975	1.451	0.864	12 35 19.9	+32 07 20
1235211N320721	26-III	18.177	0.411	0.906	12 35 21.1	+32 07 21

Table 4. GPR: photometry and position of the CCD standards

ID_{POSS}	N_{CCD}	V (mag)	$B-V$ (mag)	$V-R_c$ (mag)	R.A. (J2000) h m s	Dec. (J2000) ° ′ ″
0213033N593734	42	14.972	0.978	0.601	2 13 03.3	+59 37 34
0213071N593719	51	12.048	0.904	0.487	2 13 07.1	+59 37 19
0213041N593434	72	16.318	1.723	1.100	2 13 04.1	+59 34 34
0213032N594110	82	17.938	1.906	1.257	2 13 03.2	+59 41 10
0213040N593720	92	15.268	1.170	0.718	2 13 04.0	+59 37 20
0213044N593443	112	17.593	1.714	1.101	2 13 04.4	+59 34 43
0213039N594051	122	16.331	0.901	0.494	2 13 03.9	+59 40 51
0213130N594121	150	14.861	1.263	0.813	2 13 13.0	+59 41 21
0213146N594201	180	15.513	1.162	0.731	2 13 14.6	+59 42 01
0213170N593409	190	15.116	2.029	1.328	2 13 17.0	+59 34 09
0213205N593228	210	14.882	1.573	1.019	2 13 20.5	+59 32 28
0213078N593313	222	14.874	1.136	0.718	2 13 07.8	+59 33 13
0213232N593531	241	13.260	1.774	1.121	2 13 23.2	+59 35 31
0213266N594159	301	13.078	0.914	0.468	2 13 26.6	+59 41 59
0213086N593505	302	16.776	0.906	0.528	2 13 08.6	+59 35 05
0213275N593929	311	12.237	0.762	0.423	2 13 27.5	+59 39 29
0213320N593923	330	15.751	1.203	0.705	2 13 32.0	+59 39 23
0213341N593542	341	13.089	1.959	1.288	2 13 34.1	+59 35 42
0213354N594003	350	15.656	0.968	0.544	2 13 35.4	+59 40 03
0213090N593958	362	16.536	1.160	0.748	2 13 09.0	+59 39 58
0213383N593828	370	14.918	1.167	0.706	2 13 38.3	+59 38 28
0213101N593353	372	17.250	1.144	0.761	2 13 10.1	+59 33 53
0213394N594144	380	15.934	1.797	1.157	2 13 39.4	+59 41 44
0213101N593628	382	17.446	1.090	0.691	2 13 10.1	+59 36 28
0213460N593446	411	15.143	1.208	0.527	2 13 46.0	+59 34 46
0213106N593605	412	15.783	1.051	0.652	2 13 10.6	+59 36 05
0213486N593633	431	12.212	0.801	0.458	2 13 48.6	+59 36 33
0213487N593839	440	15.659	1.794	1.247	2 13 48.7	+59 38 39
0213500N593811	451	11.293	0.802	0.449	2 13 50.0	+59 38 11
0213113N593819	452	17.126	1.109	0.678	2 13 11.3	+59 38 19
0213122N593313	462	17.215	1.253	0.777	2 13 12.2	+59 33 13
0213125N593328	472	17.972	1.285	0.872	2 13 12.5	+59 33 28
0213530N594202	490	15.715	0.800	0.471	2 13 53.0	+59 42 02
0213579N593345	511	10.946	0.565	0.308	2 13 57.9	+59 33 45
0213128N593352	512	17.786	1.695	1.080	2 13 12.8	+59 33 52
0213596N593904	520	15.748	1.271	0.828	2 13 59.6	+59 39 04
0213136N593304	542	16.652	0.882	0.465	2 13 13.6	+59 33 04
0214020N593342	551	12.209	1.122	0.708	2 14 02.0	+59 33 42
0213136N593632	572	17.760	1.263	0.778	2 13 13.6	+59 36 32
0214080N593612	611	13.873	1.196	0.729	2 14 08.0	+59 36 12
0213140N593734	622	17.015	1.472	0.896	2 13 14.0	+59 37 34
0213139N593847	632	17.720	1.242	0.761	2 13 13.9	+59 38 47
0213146N593454	652	16.786	1.857	1.198	2 13 14.6	+59 34 54
0214173N594254	660	15.415	1.118	0.728	2 14 17.3	+59 42 54
0213145N593537	662	17.688	1.197	0.697	2 13 14.5	+59 35 37
0214233N593221	671	15.121	0.851	0.351	2 14 23.3	+59 32 21
0213153N593641	712	17.820	0.985	0.599	2 13 15.3	+59 36 41
0214255N594256	721	13.297	0.917	0.528	2 14 25.5	+59 42 56
0214260N594022	730	14.897	0.760	0.434	2 14 26.0	+59 40 22
0214285N594208	770	15.324	1.028	0.623	2 14 28.5	+59 42 08
0213164N593250	772	17.646	1.357	0.834	2 13 16.4	+59 32 50

Table 4. continued

ID_{POSS}	N_{CCD}	V (mag)	$B-V$ (mag)	$V-R_c$ (mag)	R.A. (J2000) h m s	Dec. (J2000) ° ′ ″
0213044N593652	791	13.761	1.673	0.998	2 13 04.4	+59 36 52
0213046N593838	800	14.087	1.235	0.768	2 13 04.6	+59 38 38
0213078N593518	820	15.826	0.830	0.388	2 13 07.8	+59 35 18
0213175N593443	832	17.941	1.239	0.760	2 13 17.5	+59 34 43
0213135N593605	860	15.167	1.544	1.018	2 13 13.5	+59 36 05
0213177N593332	862	16.440	0.834	0.477	2 13 17.7	+59 33 32
0213172N594031	892	17.434	1.339	0.840	2 13 17.2	+59 40 31
0213262N593721	900	14.973	1.022	0.625	2 13 26.2	+59 37 21
0213290N593443	920	15.807	1.574	0.971	2 13 29.0	+59 34 43
0213402N594218	970	14.596	0.750	0.509	2 13 40.2	+59 42 18
0213186N594248	972	17.217	0.930	0.582	2 13 18.6	+59 42 48
0213446N593304	981	12.146	0.874	0.551	2 13 44.6	+59 33 04
0213195N593741	982	17.683	1.157	0.710	2 13 19.5	+59 37 41
0213474N593818	1001	13.456	1.069	0.679	2 13 47.4	+59 38 18
0213206N593358	1002	17.783	1.593	1.101	2 13 20.6	+59 33 58
0213561N594154	1011	12.219	0.715	0.391	2 13 56.1	+59 41 54
0214021N593551	1041	12.532	0.802	0.465	2 14 02.1	+59 35 51
0214030N593803	1051	10.306	0.606	0.301	2 14 03.0	+59 38 03
0213219N593856	1052	17.066	1.391	0.883	2 13 21.9	+59 38 56
0213227N593543	1062	17.308	1.017	0.658	2 13 22.7	+59 35 43
0214040N593604	1070	15.345	1.748	1.090	2 14 04.0	+59 36 04
0214059N593947	1091	9.999	0.497	0.240	2 14 05.9	+59 39 47
0214064N593544	1101	13.782	0.953	0.653	2 14 06.4	+59 35 44
0214103N594142	1121	14.094	2.118	1.668	2 14 10.3	+59 41 42
0214232N593504	1171	15.082	1.770	1.137	2 14 23.2	+59 35 04
0213259N593429	1192	17.907	1.752	1.194	2 13 25.9	+59 34 29
0213112N593434	1201	13.516	1.913	1.228	2 13 11.2	+59 34 34
0213415N594048	1211	15.492	0.941	0.464	2 13 41.5	+59 40 48
0213260N594245	1212	16.581	1.599	1.005	2 13 26.0	+59 42 45
0213492N593503	1221	11.784	0.684	0.391	2 13 49.2	+59 35 03
0213257N594108	1240	15.083	1.135	0.737	2 13 25.7	+59 41 08
0213295N593712	1332	15.347	1.705	1.060	2 13 29.5	+59 37 12
0213333N593215	1432	17.689	1.098	0.698	2 13 33.3	+59 32 15
0213349N593233	1512	17.214	1.248	0.790	2 13 34.9	+59 32 33
0213347N593455	1522	17.320	1.284	0.810	2 13 34.7	+59 34 55
0213363N593552	1592	17.887	1.739	1.217	2 13 36.3	+59 35 52
0213373N594150	1652	16.801	1.823	1.255	2 13 37.3	+59 41 50
0213398N593924	1702	17.520	1.451	0.925	2 13 39.8	+59 39 24
0213408N593734	1732	17.611	1.332	0.863	2 13 40.8	+59 37 34
0213407N594006	1742	17.788	1.308	0.843	2 13 40.7	+59 40 06
0213408N593959	1762	16.914	1.186	0.793	2 13 40.8	+59 39 59
0213425N593521	1822	16.720	1.353	0.865	2 13 42.5	+59 35 21
0213467N593804	1882	15.542	1.253	0.843	2 13 46.7	+59 38 04
0213473N593346	1892	17.610	1.374	0.905	2 13 47.3	+59 33 46
0213468N594103	1902	17.844	1.306	0.879	2 13 46.8	+59 41 03
0213473N594122	1912	17.540	1.492	0.986	2 13 47.3	+59 41 22
0213483N593535	1962	17.584	1.435	0.933	2 13 48.3	+59 35 35
0213494N593335	1992	17.705	1.258	0.746	2 13 49.4	+59 33 35
0213512N593415	2062	17.406	1.129	0.666	2 13 51.2	+59 34 15
0213524N593418	2112	17.606	1.123	0.726	2 13 52.4	+59 34 18
0213531N593948	2172	16.829	1.017	0.641	2 13 53.1	+59 39 48
0213537N594137	2192	16.046	0.936	0.562	2 13 53.7	+59 41 37

Table 4. continued

ID_{POSS}	N_{CCD}	V (mag)	$B-V$ (mag)	$V-R_c$ (mag)	R.A. (J2000) h m s	Dec. (J2000) ° ′ ″
0213541N594008	2202	17.919	1.185	0.731	2 13 54.1	+59 40 08
0213555N593336	2222	14.991	1.208	0.753	2 13 55.5	+59 33 36
0213573N594200	2292	16.548	1.750	1.107	2 13 57.3	+59 42 00
0213592N593827	2302	17.594	1.348	0.889	2 13 59.2	+59 38 27
0213598N594033	2332	17.394	1.260	0.839	2 13 59.8	+59 40 33
0214016N594144	2482	17.607	1.695	1.080	2 14 01.6	+59 41 44
0214027N593905	2502	16.919	1.019	0.617	2 14 02.7	+59 39 05
0214032N593941	2512	15.696	0.884	0.538	2 14 03.2	+59 39 41
0214032N594013	2522	14.353	2.024	1.333	2 14 03.2	+59 40 13
0214040N593403	2532	16.368	0.936	0.547	2 14 04.0	+59 34 03
0214035N594240	2542	17.953	1.443	0.884	2 14 03.5	+59 42 40
0214083N593313	2672	17.158	1.822	1.189	2 14 08.3	+59 33 13
0214082N593924	2692	15.163	1.429	1.053	2 14 08.2	+59 39 24
0214113N593834	2772	17.153	1.366	0.855	2 14 11.3	+59 38 34
0214116N593639	2782	13.952	1.740	1.105	2 14 11.6	+59 36 39
0214127N593618	2802	15.936	1.106	0.711	2 14 12.7	+59 36 18
0214124N594014	2812	14.931	0.790	0.482	2 14 12.4	+59 40 14
0214126N594234	2822	17.152	1.074	0.695	2 14 12.6	+59 42 34
0214137N594222	2912	17.498	1.404	1.064	2 14 13.7	+59 42 22
0214142N593822	2932	17.481	1.223	0.827	2 14 14.2	+59 38 22
0214155N593859	2972	17.192	1.257	0.788	2 14 15.5	+59 38 59
0214164N594302	3022	17.002	1.369	0.852	2 14 16.4	+59 43 02
0214181N593506	3062	17.682	1.211	0.787	2 14 18.1	+59 35 06
0214250N594008	3292	15.140	1.147	0.747	2 14 25.0	+59 40 08
0214251N594213	3312	17.315	0.918	0.571	2 14 25.1	+59 42 13
0214253N594139	3322	17.629	1.299	0.809	2 14 25.3	+59 41 39
0214265N593933	3342	17.800	1.026	0.641	2 14 26.5	+59 39 33
0214271N593642	3382	17.364	1.183	0.803	2 14 27.1	+59 36 42
0213050N594024	3492	17.405	1.120	0.678	2 13 05.0	+59 40 24
0213066N593808	3532	16.880	1.110	0.670	2 13 06.6	+59 38 08
0213084N593351	3562	17.896	1.218	0.809	2 13 08.4	+59 33 51
0213113N593759	3652	15.938	1.076	0.694	2 13 11.3	+59 37 59
0213112N594117	3662	16.779	1.213	0.797	2 13 11.2	+59 41 17
0213121N593912	3692	17.665	1.689	1.145	2 13 12.1	+59 39 12
0213134N593706	3722	17.890	1.824	1.092	2 13 13.4	+59 37 06
0213141N593807	3752	17.089	1.260	0.772	2 13 14.1	+59 38 07
0213192N593315	3822	17.191	1.441	0.931	2 13 19.2	+59 33 15
0213197N594218	3852	16.738	1.690	1.125	2 13 19.7	+59 42 18
0213216N593454	3862	16.549	1.632	1.027	2 13 21.6	+59 34 54
0213212N594043	3892	15.451	1.255	0.821	2 13 21.2	+59 40 43
0213223N594306	3922	17.807	1.297	0.816	2 13 22.3	+59 43 06
0213233N594058	3962	17.731	1.678	1.082	2 13 23.3	+59 40 58
0213239N593726	3982	16.491	0.952	0.550	2 13 23.9	+59 37 26
0213242N593715	3992	16.358	1.251	0.762	2 13 24.2	+59 37 15
0213252N593417	4012	16.293	1.676	1.106	2 13 25.2	+59 34 17
0213252N593848	4022	17.631	1.195	0.698	2 13 25.2	+59 38 48
0213260N593534	4032	16.548	1.124	0.702	2 13 26.0	+59 35 34
0213298N593512	4162	14.886	2.067	1.333	2 13 29.8	+59 35 12
0213323N593418	4212	17.273	1.826	1.175	2 13 32.3	+59 34 18
0213327N593536	4222	17.588	0.975	0.601	2 13 32.7	+59 35 36
0213335N594146	4282	17.443	1.318	0.914	2 13 33.5	+59 41 46
0213363N593258	4302	16.162	1.146	0.663	2 13 36.3	+59 32 58

Table 4. continued

ID_{POSS}	N_{CCD}	V (mag)	$B-V$ (mag)	$V-R_c$ (mag)	R.A. (J2000) h m s	Dec. (J2000) ° ′ ″
0213384N594120	4342	17.468	1.442	0.968	2 13 38.4	+59 41 20
0213395N593837	4382	17.039	1.478	0.994	2 13 39.5	+59 38 37
0213400N594134	4412	16.789	1.562	1.089	2 13 40.0	+59 41 34
0213432N593545	4442	17.897	1.308	0.890	2 13 43.2	+59 35 45
0213484N593519	4522	16.849	1.277	0.825	2 13 48.4	+59 35 19
0213512N593826	4552	16.192	1.288	0.815	2 13 51.2	+59 38 26
0213521N593358	4562	17.233	1.791	1.173	2 13 52.1	+59 33 58
0213566N593503	4632	17.764	1.273	0.817	2 13 56.6	+59 35 03
0213586N593711	4682	17.924	2.130	1.474	2 13 58.6	+59 37 11
0213591N593504	4692	17.448	1.375	0.897	2 13 59.1	+59 35 04
0214016N593254	4732	17.395	1.324	0.885	2 14 01.6	+59 32 54
0214011N593924	4752	16.486	0.932	0.589	2 14 01.1	+59 39 24
0214012N593908	4762	17.940	1.857	1.204	2 14 01.2	+59 39 08
0214027N594044	4782	17.959	1.959	1.290	2 14 02.7	+59 40 44
0214045N593554	4822	17.595	1.357	0.884	2 14 04.5	+59 35 54
0214049N593309	4832	17.983	1.932	1.335	2 14 04.9	+59 33 09
0214062N593322	4862	17.317	1.048	0.649	2 14 06.2	+59 33 22
0214055N594238	4872	16.246	1.196	0.735	2 14 05.5	+59 42 38
0214062N594003	4892	16.133	1.499	1.122	2 14 06.2	+59 40 03
0214090N593641	4932	17.080	1.114	0.722	2 14 09.0	+59 36 41
0214096N593824	4952	17.072	1.567	1.017	2 14 09.6	+59 38 24
0214096N594308	4972	17.400	1.219	0.767	2 14 09.6	+59 43 08
0214112N594058	4992	17.667	1.285	0.788	2 14 11.2	+59 40 58
0214115N594041	5012	17.518	1.388	0.899	2 14 11.5	+59 40 41
0214139N593646	5042	14.673	1.731	1.111	2 14 13.9	+59 36 46
0214139N594254	5052	17.410	1.119	0.745	2 14 13.9	+59 42 54
0214164N593612	5082	16.866	1.313	0.869	2 14 16.4	+59 36 12
0214182N593540	5142	16.860	1.237	0.810	2 14 18.2	+59 35 40
0214190N593732	5172	17.618	1.291	0.889	2 14 19.0	+59 37 32
0214237N593840	5242	16.454	1.103	0.718	2 14 23.7	+59 38 40
0214237N593819	5252	15.906	1.318	0.825	2 14 23.7	+59 38 19
0214244N593853	5272	17.805	1.167	0.818	2 14 24.4	+59 38 53
0214244N593940	5282	16.971	0.905	0.593	2 14 24.4	+59 39 40
0214267N593914	5352	15.965	1.064	0.666	2 14 26.7	+59 39 14
0214280N593751	5402	16.528	0.897	0.597	2 14 28.0	+59 37 51
0213029N593213	5432	15.758	1.116	0.667	2 13 02.9	+59 32 13
0213038N594128	5442	16.927	1.611	1.037	2 13 03.8	+59 41 28
0213073N594200	5482	16.602	1.780	1.109	2 13 07.3	+59 42 00
0213087N593343	5502	17.443	1.802	1.121	2 13 08.7	+59 33 43
0213300N594157	5592	16.914	1.181	0.752	2 13 30.0	+59 41 57
0213317N593637	5612	15.710	1.692	1.081	2 13 31.7	+59 36 37
0213525N594118	5702	16.050	1.614	1.044	2 13 52.5	+59 41 18
0213574N593224	5712	17.803	1.275	0.746	2 13 57.4	+59 32 24
0214039N593508	5752	17.579	1.400	0.931	2 14 03.9	+59 35 08
0214223N594253	5782	17.344	1.198	0.754	2 14 22.3	+59 42 53
0214263N594247	5792	16.342	1.095	0.731	2 14 26.3	+59 42 47
0214281N593808	5812	17.501	1.087	0.707	2 14 28.1	+59 38 08
0213107N594142	5842	14.357	1.453	0.917	2 13 10.7	+59 41 42
0213253N593518	5892	17.191	1.069	0.655	2 13 25.3	+59 35 18
0213296N594048	5902	16.802	1.358	0.905	2 13 29.6	+59 40 48
0214047N593959	5952	17.993	1.379	1.042	2 14 04.7	+59 39 59
0214209N593528	5962	17.968	1.629	1.204	2 14 20.9	+59 35 28