Baltic Astronomy, vol. 5, 563–577, 1996.

INTERSTELLAR EXTINCTION IN THE CAMELOPARDALIS DARK CLOUDS

K. Zdanavičius, J. Zdanavičius and A. Kazlauskas

Institute of Theoretical Physics and Astronomy, Goštauto 12, Vilnius 2600, Lithuania

Received July 31, 1995.

Abstract. An area of about 3×3 deg in the direction of the Camelopardalis dark clouds is investigated using the Vilnius photometric system. Magnitudes V, color indices, spectral classes, absolute magnitudes, color excesses, interstellar extinctions and distances are determined for 126 stars. The interstellar extinction begins at 100 pc distance. It grows monotonically and reaches about 2 mag at 300 pc.

Key words: interstellar medium: clouds, extinction – stars: fundamental parameters, distances – techniques: photometric

1. INTRODUCTION

For investigation of distant objects, we need the value of interstellar extinction in diverse directions. Usually, the mean value of interstellar extinction in different sky areas is evaluated by using stars for which both photometric and spectral classification data are available. This has been done in a number of investigations which concern either separate sky areas or the solar vicinity in all directions. Among the latter category of investigations the papers by Fernie (1962), Neckel (1966), FitzGerald (1968), Lucke (1978), Neckel & Klare (1980), Arenou, Grenon & Gomez (1992) may be mentioned.

However, in many directions new studies of interstellar extinction are needed, especially, at low galactic latitudes. Among the least investigated directions in the Milky Way are the dark clouds in the Camelopardalis constellation (galactic longitudes between 140° and 150°). In this direction the local spiral arm seems to abrupt, and at l of about 150° our view crosses the Perseus arm. For the present investigation, we choose the area with coordinates: $\alpha(2000)$ from 3^h16^m to 3^h45^m and δ (2000) with 56°30′– 59°30′($l \approx 143°$, $b \approx 1.5°$)

2. OBSERVATIONS, REDUCTIONS AND CLASSIFICATION OF STARS

The observations were made at the Molėtai Observatory in Lithuania in 1993–1994 and 1994–1995 winter months with the 165-cm telescope. A new computer-controlled photometer with a permanently rotating filter wheel was used during its test period. Seven filters of the Vilnius system and a thermoelectrically cooled photomultiplier FEU-79 were used. During the observation run, only equal integration times with each filter were possible. The photometer works in a photon counting mode.

To track the changes of atmospheric transparency during a night, a comparison star has been observed almost after each observation of a program star. The star BD+57°730 (F6 V) was used for comparison. Its magnitude V and color indices in the Vilnius system have been deduced from observations made during the most stable nights. For obtaining the transformation equations to the standard Vilnius system, the stars from the standard regions SA 4 (Černis & Jasevičius 1992), SA 59 and SA 64 (Zdanavičius et al. 1978) have been observed.

Reductions of the magnitudes and color indices to outside the atmosphere were made both with constant and time-dependent atmospheric extinction coefficients. The latter were obtained from the observations of the comparison star. Since the comparison star and the program stars are close (the angular distance between them never exceeded 3 degrees), their air mass differences are always small. As a result, there was no difference between the results obtained by both methods. In both cases the extinction corrections depending on star's spectral class and luminosity were included (Zdanavičius 1975). The instrumental color indices were transformed to the standard system using linear equations. All the calculations have been done with a new program code written for an IBM PC by one of the authors (K. Z.).

The results are presented in Table 1 which gives the following information: the identification number (shown on the chart in Fig. 1), BD number, right ascension and declination (for 2000), V magnitude, color indices (six columns) and the number of independent observations, n. The line below gives the rms errors of the magnitude and color indices. A few faint and red stars have the errors of ± 0.1 mag or larger: these indices are omitted in Table 1. The values having the errors ≥ 0.05 mag are marked by a colon.

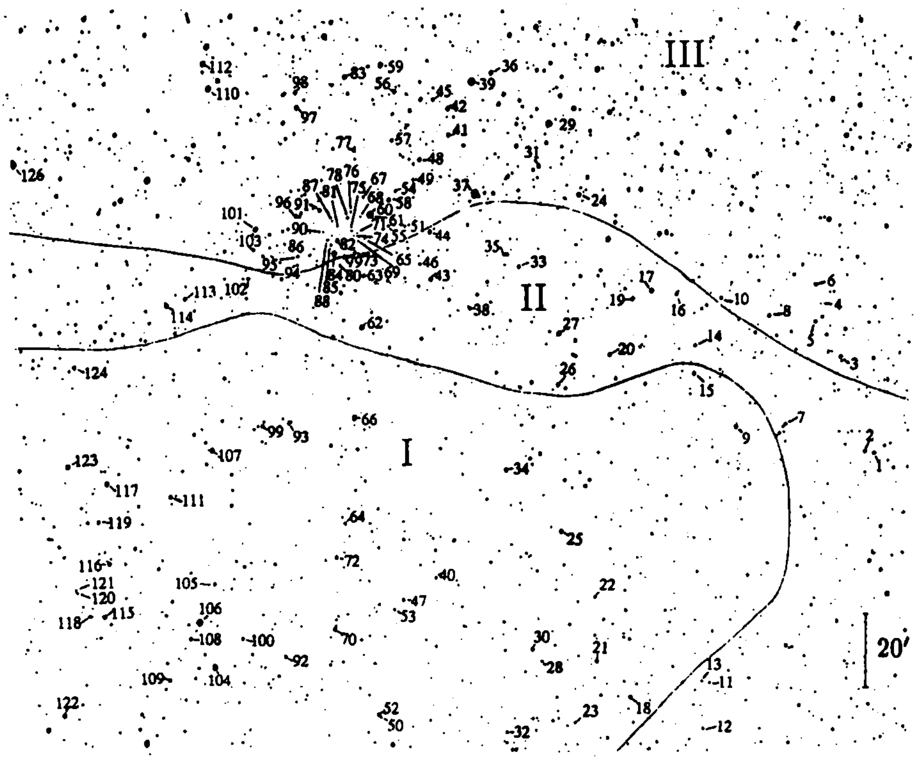

Fig. 1. The identification chart.

Spectral classes, absolute magnitudes, extinctions A_V and distances r were determined using a special program code written by one of the authors (K. Z.) for the classification of normal stars, as well as the program CLASS written by Vansevičius & Bridžius (1994). The first program code includes three methods: (1) finding the closest standard by fitting parameters Q of a program star with Qs from a set of standards, (2) classification by calibrated Q, Q diagrams (Straižys et al. 1982) and (3) finding the most probable standards (usually up to five or more) from the same set of standards which is used in method (1). This is done by calculating the "weights" of each Q-parameter.

In most cases, the different methods give spectral classes which agree within one spectral subclass. The differences of the absolute magnitudes usually are of several tenths of magnitude. However, for some stars it may be as great as 3 – 5 mag (bad observation or a peculiar star). These cases, as well as the cases with the largest rms errors, are marked by a colon following the values given in Table 2. In it the following information is given: the identification number, BD and HD numbers, galactic longitude l and latitude b, the adopted spectral class and M_V, color excess E_{B-V}, interstellar extinction A_V, photometric distance r (in pc rounded to the nearest number multiple of 10) and σ_{Sp} (indicator of the accuracy of spectral classification).

The color excess E_{B-V} is calculated from color excesses of the Vilnius system, mainly from E_{Y-V}, but for the accuracy control E_{X-V}, E_{Z-V} and E_{V-S} are used, too. A_V is calculated from E_{B-V} using a variable ratio R value from Straižys & Jodinskienė (1981). σ_{Sp} indicates a mean difference in 0.01 mag units between the dereddened color indices of a program star and the intrinsic color indices of the standard star of the same spectral type. Its meaning is similar to σ_{dQ} described by Straižys et al. (1992).

3. DISCUSSION

All the observed stars are in an area of about $3° \times 3°$. There is a considerable scatter of the absorption values A_V in an absorption vs. distance diagram. Trying to minimize this scatter and taking into account the surface density of stars on the Palomar Sky Atlas, the area was divided into three zones, as shown in Fig. 1. The A_V versus distance plots in each zone are shown in Figs. 2 – 3. The highest extinction is observed in Zone I. The extinction rise starts at 100 pc. At about 300 pc, the extinction is 2.0 mag.

In Zone II, the extinction grows slower: it reaches 2 mag at about 500 pc distance (Fig. 2, dots). This zone occupies a narrow belt to the north and west from Zone I. It looks like an edge of the absorbing cloud of Zone I. In Zone I, there are some small areas (for instance, stars Nos. 47, 64 and 72 or stars Nos. 105, 106, 108, 116 and 119), where the interstellar extinction shows intermediate values between Zones I and II. A slower rise of extinction with increasing distance is seen in Fig. 3 for Zone III. Most of the stars are at the greater

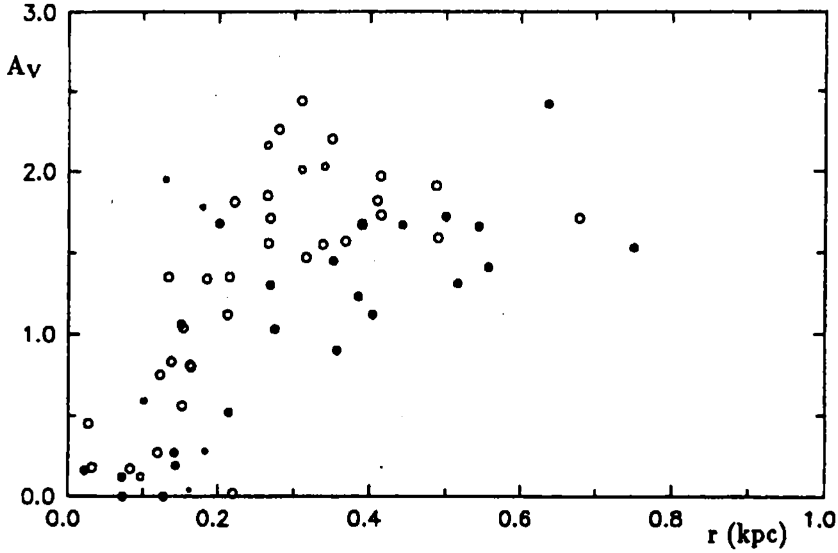

Fig. 2. Dependence of interstellar extinction on distance in Zones I (circles) and II (dots). The largest symbols are for stars with $\sigma_{Sp} \leq 3$, the smallest ones are for stars with $\sigma_{Sp} > 6$.

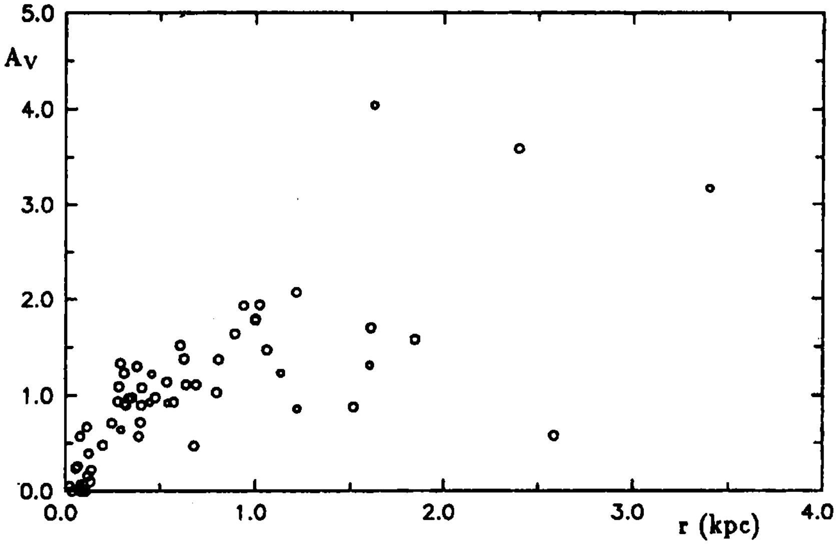

Fig. 3. Dependence of interstellar extinction on distance in Zone III.

galactic latitude ($b > 2°$). Here the mean interstellar extinction reaches 1.5 mag at $r > 1$ kpc.

It seems that in all our zones the absorbing matter appears at the distances of 100 pc, and probably a bit nearer in the areas which are closer to the galactic plane. However, there are too few stars observed at this small distance. To fix the exact distance of the nearest absorbing clouds in the investigated direction, we need observations of close, intrinsically faint stars.

ACKNOWLEDGMENTS. We thank R. Janulis for permission to use the photometer during its testing period, Mrs. R. Mikutavičienė for assistance during the observations and V. Straižys for useful discussions and helpful comments concerning the manuscript. We are grateful to the International Science Foundation for a partial support by the grant No. LE9000.

REFERENCES

Arenou F., Grenon M., Gomez A. 1992, A&A, 258, 104

Černis K., Jasevičius V. 1992, Baltic Astronomy, 1, 168

Fernie J.D. 1962, AJ, 67, 224

FitzGerald M.P. 1968, AJ, 73, 983

Lucke P.B. 1978, A&A, 64, 367

Neckel T. 1966, Z. Astrophys., 63, 221

Neckel T., Klare G. 1980, A&AS, 42, 251

Straižys V., Černis K., Kazlauskas A., Meištas E. 1992, Baltic Astronomy, 1, 149

Straižys V., Jodinskienė E. 1981, Bull. Vilnius Obs., No. 56, 3

Straižys V., Kurilienė G., Jodinskienė E. 1982, Bull. Vilnius Obs., No. 60, 3

Vansevičius V., Bridžius A. 1994, Baltic Astronomy, 3, 193

Zdanavičius K. 1975, Bull. Vilnius Obs., No. 41, 3

Zdanavičius K., Gurklytė A., Sūdžius J., Jasevičius V., Kazlauskas A. 1978, Bull. Vilnius Obs., No. 49, 3

Table 1. Results of photometry in the Vilnius system

No.	BD	$\alpha(2000)$ h m s	$\delta(2000)$ ° ′	V	U–V	P–V	X–V	Y–V	Z–V	V–S	n
1.	57°708	3 16 12	57 45.2	9.66	3.66	3.02	2.10	0.90	0.35	0.82	2
				0.03	0.04	0.02	0.01	0.01	0.02	0.01	
2.	57°709	3 16 31	57 45.7	9.94	2.03	1.58	1.11	0.60	0.20	0.50	2
				0.03	0.03	0.02	0.02	0.02	0.02	0.01	
3.	57°710	3 17 19	58 10.7	9.39	1.79	1.35	0.84	0.47	0.18	0.35	2
				0.03	0.02	0.02	0.01	0.02	0.02	0.02	
4.		3 17 58	58 29.6	10.00	2.41	1.77	0.80	0.34	0.16	0.28	1
				0.04	0.02	0.02	0.01	0.01	0.02	0.01	
5.	57°711	3 18 11	58 19.9	8.86	5.72	4.84	3.36	1.27	0.61	1.19	2
				0.03	0.02	0.03	0.04	0.01	0.02	0.02	
6.	57°712	3 18 11	58 29.8	9.62	2.69	2.15	1.46	0.65	0.26	0.57	1
				0.03	0.03	0.03	0.02	0.02	0.02	0.02	
7.	57°713	3 19 14	57 52.9	9.13	2.40	1.67	0.85	0.43	0.17	0.33	2
				0.03	0.02	0.02	0.01	0.01	0.02	0.01	
8.	57°714	3 19 46	58 21.5	9.26	1.66	1.23	0.74	0.40	0.18	0.29	2
				0.03	0.02	0.02	0.01	0.02	0.02	0.01	
9.	57°715	3 20 51	57 52.5	7.79	4.72	3.94	2.75	1.09	0.43	0.99	2
				0.03	0.02	0.04	0.02	0.02	0.02	0.02	
10.	57°716	3 21 24	58 26.3	9.33	3.87	3.24	2.28	0.92	0.34	0.86	2
				0.04	0.03	0.02	0.03	0.02	0.02	0.03	
11.	56°806	3 21 37	56 45.2	10.84?	2.60	1.88	1.03	0.52	0.19	0.41	3
				0.14	0.02	0.03	0.03	0.03	0.02	0.01	
12.	56°807	3 21 51	56 32.7	10.54	2.85	2.00	1.05	0.50	0.19	0.41	2
				0.03	0.03	0.03	0.01	0.01	0.02	0.01	
13.		3 21 53	56 45.5	11.57:			1.17:	0.54	0.21	0.45	2
				0.05			0.06	0.02	0.02	0.02	
14.	57°717	3 22 13	58 13.7	10.35	2.18	1.78	1.27	0.54	0.20	0.52	2
				0.03	0.02	0.02	0.01	0.02	0.02	0.01	
15.	57°718	3 22 17	58 06.4	8.81	4.66	3.99	2.77	1.12	0.45	1.00	2
				0.03	0.03	0.02	0.01	0.01	0.02	0.01	
16.	57°719	3 22 57	58 28.0	9.75	2.79	2.03	1.04	0.49	0.20	0.40	2
				0.03	0.02	0.02	0.01	0.02	0.02	0.01	
17.	57°720	3 23 49	58 28.1	7.82	2.19	1.68	1.07	0.46	0.16	0.44	2
				0.03	0.02	0.02	0.03	0.01	0.02	0.01	
18.	56°808	3 24 12	56 41.0	9.07	2.44	1.78	1.04	0.55	0.20	0.44	2
				0.04	0.04	0.05	0.03	0.01	0.02	0.02	
19.	57°721	3 24 27	58 25.8	9.45	2.18	1.60	0.93	0.48	0.19	0.35	2
				0.03	0.03	0.02	0.02	0.01	0.02	0.01	
20.	57°722	3 25 09	58 11.1	9.32	2.22	1.61	0.92	0.50	0.20	0.37	3
				0.03	0.03	0.02	0.02	0.01	0.03	0.02	
21.	56°809	3 25 17	56 51.7	9.42:	2.35	1.75	1.12	0.60	0.22	0.48	5
				0.12	0.03	0.02	0.03	0.02	0.02	0.02	

Table 1 (continued)

No.	BD	α(2000) h m s	δ(2000) ° ′	V	$U-V$	$P-V$	$X-V$	$Y-V$	$Z-V$	$V-S$	n
22.	56°810	3 25 21	57 08.2	9.78	5.06	4.29	2.94	1.20	0.48	1.08	2
				0.04	0.05	0.02	0.03	0.01	0.02	0.01	
23.	56°811	3 25 49	56 33.3	10.85	2.85	2.31	1.62	0.72	0.27	0.65	2
				0.03	0.02	0.02	0.02	0.02	0.02	0.01	
24.	58°601	3 26 20	58 53.4	8.87	2.13	1.67	1.10	0.46	0.16	0.46	1
				0.03	0.02	0.02	0.02	0.02	0.02	0.01	
25.	56°812	3 26 33	57 25.2	8.40	3.13	2.64	1.84	0.72	0.32	0.70	3
				0.03	0.02	0.02	0.01	0.02	0.02	0.01	
26.	57°723	3 26 51	58 03.0	9.46	1.94	1.48	0.90	0.50	0.19	0.40	2
				0.03	0.03	0.02	0.02	0.01	0.02	0.01	
27.	57°724	3 26 51	58 16.4	8.52	2.31	1.85	1.23	0.50	0.20	0.48	2
				0.03	0.02	0.02	0.01	0.01	0.02	0.02	
28.		3 27 06	56 53.7	11.60	3.27:	2.39	1.50	0.74	0.26	0.62	1
				0.03	0.06	0.04	0.03	0.03	0.04	0.02	
29.	58°602	3 27 22	59 11.8	8.02?	1.49	1.14	0.80	0.45	0.18	0.34	1
				0.14	0.02	0.02	0.01	0.01	0.02	0.01	
30.	56°813	3 27 23	56 53.7	9.47	2.19	1.63	0.95	0.49	0.18	0.39	3
				0.03	0.02	0.02	0.01	0.01	0.02	0.01	
31.	58°603	3 27 44	59 00.5	9.85	1.76	1.32	0.77	0.42	0.16	0.32	2
				0.03	0.02	0.02	0.01	0.01	0.02	0.01	
32.	56°814	3 28 08	56 31.3	10.50	2.11	1.59	1.00	0.52	0.21	0.45	2
				0.03	0.03	0.02	0.01	0.01	0.03	0.01	
33.	58°604	3 28 18	58 34.0	10.13	2.35	1.86	1.30	0.57	0.23	0.54	6
				0.04	0.02	0.02	0.01	0.01	0.02	0.01	
34.	57°725	3 28 29	57 40.3	8.69	2.16	1.71	1.15	0.50	0.19	0.48	1
				0.03	0.02	0.02	0.01	0.01	0.02	0.01	
35.	58°605	3 28 41	58 36.6	10.31	2.68	1.94	0.99	0.46	0.19	0.37	4
				0.03	0.03	0.04	0.02	0.01	0.02	0.01	
36.	58°606	3 29 30	59 24.4	9.76	2.38	1.87	1.28	0.55	0.22	0.50	1
				0.05	0.02	0.02	0.01	0.01	0.02	0.01	
37.	58°607	3 29 55	58 52.7	4.60	2.29	1.64	1.15	0.64	0.25	0.57	2
				0.03	0.04	0.02	0.02	0.02	0.02	0.01	
38.	57°726	3 30 02	58 22.5	9.98	4.70	3.93	2.76	1.12	0.46	1.00	2
				0.03	0.02	0.03	0.05	0.01	0.02	0.01	
39.	58°608	3 30 11	59 22.0	6.13	2.03	1.47	0.63	0.25	0.10	0.16	2
				0.03	0.03	0.02	0.02	0.01	0.02	0.01	
40.	56°815	3 30 38	57 12.2	10.36	2.81	2.39	1.63	0.64	0.27	0.64	3
				0.03	0.03	0.02	0.02	0.01	0.02	0.01	
41.	58°609	3 30 55	59 07.8	9.43	2.23	1.75	1.17	0.50	0.18	0.46	2
				0.03	0.02	0.02	0.01	0.01	0.02	0.01	
42.	58°610	3 30 58	59 14.6	9.60	1.60	1.27	0.89	0.50	0.20	0.42	2
				0.03	0.02	0.02	0.01	0.01	0.03	0.02	

Table 1 (continued)

No.	BD	α(2000) h m s	δ(2000) ° ′	V	U–V	P–V	X–V	Y–V	Z–V	V–S	n
43.	57°727	3 31 20	58 29.6	8.69	6.09	5.14	3.62	1.40	0.63	1.32	1
				0.03	0.04	0.03	0.02	0.02	0.02	0.01	
44.	58°612	3 31 25	58 42.3	9.13	4.02	3.40	2.36	0.97	0.37	0.88	4
				0.03	0.02	0.02	0.01	0.02	0.02	0.01	
45.	58°611	3 31 30	59 17.3	10.55:	3.77	2.59:	1.70:	0.96	0.30	0.80	2
				0.05	0.02	0.05	0.05	0.03	0.04	0.01	
46.		3 31 43	58 33.6	10.74:	2.35	1.71	0.86	0.40	0.17	0.31	4
				0.05	0.02	0.02	0.01	0.01	0.02	0.01	
47.	56°816	3 31 45	57 05.7	9.64	3.73	3.16	2.16	0.85	0.35	0.83	3
				0.03	0.02	0.03	0.01	0.01	0.02	0.01	
48.	58°613	3 31 49	59 00.9	9.86	2.40	1.95	1.34	0.57	0.22	0.52	2
				0.04	0.02	0.02	0.01	0.01	0.02	0.02	
49.		3 32 10	58 55.8	11.88:	2.60	1.96	1.04	0.46	0.21	0.28	2
				0.06	0.02	0.03	0.02	0.04	0.02	0.03	
50.		3 32 17	56 33.9	10.99	3.31	2.51	1.35	0.66	0.23	0.57	1
				0.03	0.03	0.02	0.02	0.02	0.02	0.01	
51.		3 32 18	58 43.3	11.89	2.04	1.60	1.00	0.53	0.21	0.42	2
				0.03	0.02	0.03	0.01	0.03	0.03	0.01	
52.	56°817	3 32 22	56 34.7	9.72	3.52	2.56	1.49	0.72	0.26	0.59	2
				0.03	0.03	0.02	0.02	0.01	0.02	0.02	
53.	56°818	3 32 30	57 03.2	10.56	2.66	2.10	1.42	0.65	0.24	0.57	2
				0.03	0.03	0.02	0.01	0.01	0.02	0.01	
54.		3 32 40	58 52.7	11.74	4.70	3.79:	2.63	1.07	0.42	0.95	5
				0.03	0.04	0.05	0.03	0.03	0.02	0.01	
55.		3 32 53	58 43.2	11.70	1.95	1.52	0.95	0.50	0.19	0.41	6
				0.03	0.02	0.02	0.03	0.02	0.02	0.01	
56.	58°614	3 32 53	59 19.0	10.93	2.64	1.88	0.99	0.50	0.19	0.36	2
				0.03	0.02	0.02	0.01	0.02	0.02	0.01	
57.	58°615	3 32 54	59 06.2	10.43	2.95	2.48	1.74	0.72	0.30	0.69	3
				0.04	0.02	0.02	0.02	0.02	0.03	0.02	
58.	58°616	3 32 54	58 50.1	9.48	2.45	1.89	1.21	0.54	0.20	0.48	8
				0.03	0.02	0.02	0.01	0.01	0.02	0.01	
59.	58°617	3 33 25	59 25.4	8.09	3.14	2.72	1.80	0.68	0.33	0.65	3
				0.03	0.02	0.03	0.02	0.02	0.02	0.01	
60.	58°618	3 33 30	58 45.8	7.93	2.11	1.64	1.03	0.44	0.17	0.40	6
				0.03	0.02	0.02	0.01	0.01	0.02	0.01	
61.	58°619	3 33 32	58 46.0	6.46	2.13	1.54	0.69	0.26	0.10	0.17	8
				0.04	0.02	0.02	0.02	0.01	0.02	0.02	
62.	57°729	3 33 36	58 15.8	8.39	2.20	1.63	0.82	0.32	0.10	0.31	1
				0.03	0.03	0.02	0.01	0.01	0.02	0.01	
63.	57°728	3 33 38	58 29.0	10.11	1.81	1.38	0.84	0.46	0.17	0.34	1
				0.03	0.02	0.02	0.02	0.01	0.02	0.01	

Table 1 (continued)

No.	BD	α(2000) h m s	δ(2000) ° ′	V	$U-V$	$P-V$	$X-V$	$Y-V$	$Z-V$	$V-S$	n
64.	56°819	3 33 39	57 22.8	11.13:	3.13	2.33	1.28	0.60	0.20	0.51	1
				0.09	0.02	0.02	0.02	0.01	0.02	0.02	
65.		3 33 40	58 39.5	13.16	2.82	2.25:	1.53	0.70	0.24	0.62	5
				0.04	0.02	0.07	0.04	0.03	0.04	0.03	
66.	57°730	3 33 40	57 51.7	6.37	2.27	1.78	1.20	0.51	0.20	0.48	1
				0.03	0.02	0.02	0.01	0.01	0.02	0.01	
67.		3 33 47	58 50.4	11.12	4.95	4.21	2.84	1.11	0.47	1.02	4
				0.03	0.04	0.03	0.03	0.02	0.02	0.02	
68.		3 33 51	58 45.2	12.63	2.79	2.24	1.54	0.65	0.24	0.65	9
				0.06	0.03	0.03	0.02	0.02	0.02	0.02	
69.		3 33 53	58 38.9	12.09	2.64	1.99	1.14	0.52	0.20	0.43	6
				0.06	0.02	0.02	0.01	0.03	0.02	0.02	
70.	56°820	3 33 54	56 57.0	9.09	5.51	4.69	3.25	1.32	0.54	1.14	5
				0.03	0.02	0.03	0.03	0.01	0.02	0.01	
71.		3 33 56	58 41.0	13.08	3.10	2.47	1.70	0.75	0.28	0.70	10
				0.03	0.03	0.04	0.03	0.02	0.02	0.02	
72.	56°821	3 33 58	57 15.2	10.05	3.07	2.13:	1.21	0.60	0.22	0.50	3
				0.04	0.04	0.06	0.01	0.01	0.02	0.01	
73.		3 33 59	58 35.9	11.15	4.47	3.87	2.72	1.01	0.64	1.14	6
				0.03	0.03	0.02	0.04	0.02	0.02	0.01	
74.		3 34 03	58 40.2	13.10	2.83	2.13	1.31	0.60	0.24	0.49	12
				0.03	0.03	0.03	0.03	0.02	0.03	0.02	
75.		3 34 08	58 41.5	12.20	2.73	2.16	1.48	0.68	0.26	0.58	7
				0.03	0.02	0.03	0.02	0.02	0.02	0.02	
76.		3 34 11	58 46.4	12.60			2.92:	1.42	0.58	1.36	9
				0.03			0.08	0.02	0.03	0.01	
77.	58°620	3 34 11	59 02.4	10.67:	2.52	1.91	1.18	0.51	0.19	0.50	3
				0.05	0.03	0.03	0.01	0.02	0.03	0.01	
78.		3 34 18	58 44.8	11.30	5.24	4.44:	3.06	1.24	0.50	1.12	5
				0.03	0.04	0.07	0.02	0.01	0.02	0.01	
79.		3 34 21	58 34.2	11.62	2.66	1.99	1.05	0.47	0.20	0.34	6
				0.03	0.02	0.03	0.01	0.01	0.02	0.02	
80.		3 34 27	58 32.0	12.00	3.57:	3.20	2.14	0.81	0.42	0.80	8
				0.04	0.08	0.05	0.02	0.02	0.03	0.02	
81.		3 34 37	58 42.4	12.40	3.67	2.98	2.19	0.94	0.35	0.84	6
				0.03	0.04	0.04	0.04	0.02	0.03	0.02	
82.	58°622	3 34 38	58 38.7	9.32	3.08	2.35	1.77	0.99	0.35	0.84	6
				0.03	0.03	0.02	0.02	0.01	0.02	0.01	
83.	58°621	3 34 40	59 21.6	8.90	4.83	4.10	2.81	1.08	0.46	1.02	2
				0.03	0.03	0.02	0.03	0.01	0.02	0.01	
84.	58°623	3 34 42	58 35.1	7.92	1.19	0.98	0.72	0.42	0.16	0.32	6
				0.03	0.02	0.02	0.02	0.03	0.03	0.01	

Table 1 (continued)

No.	BD	α(2000)	δ(2000)	V	U–V	P–V	X–V	Y–V	Z–V	V–S	n
		h m s	° ′								
85.		3 34 46	58 39.8	13.74			1.83:	0.75	0.25	0.76	7
				0.03			0.07	0.04	0.05	0.04	
86.		3 34 48	58 39.9	13.07	2.70	2.13	1.51	0.71	0.31	0.68	6
				0.05	0.04	0.03	0.04	0.02	0.02	0.04	
87.		3 34 49	58 43.7	12.92	2.89	2.21	1.57	0.74	0.29	0.59	6
				0.03	0.02	0.03	0.05	0.04	0.03	0.03	
88.		3 34 51	58 39.9	13.69	3.18:	2.87:	1.88	0.76	0.31	0.70	3
				0.04	0.07	0.07	0.04	0.02	0.06	0.04	
89.	59°675	3 35 01	60 02.5	6.47	2.07	1.62	1.05	0.46	0.17	0.41	1
				0.03	0.02	0.02	0.02	0.02	0.02	0.01	
90.		3 35 06	58 40.7	12.84:	2.73	2.00	1.15	0.50	0.18	0.37	1
				0.05	0.04	0.03	0.02	0.02	0.03	0.02	
91.	58°624	3 35 16	58 46.3	10.42	2.71	1.97	1.05	0.46	0.18	0.37	5
				0.03	0.02	0.02	0.01	0.01	0.02	0.01	
92.	56°822	3 35 28	56 48.5	10.67	2.60	1.90	1.05	0.56	0.20	0.41	2
				0.03	0.02	0.03	0.02	0.02	0.02	0.01	
93.	57°731	3 35 51	57 49.7	9.23	2.13	1.64	1.02	0.44	0.17	0.40	3
				0.03	0.03	0.02	0.01	0.01	0.02	0.01	
94.		3 35 54	58 31.5	12.11	2.65:	2.03	1.38	0.65	0.23	0.57	3
				0.04	0.06	0.03	0.02	0.05	0.04	0.03	
95.		3 35 55	58 33.8	11.15			2.82:	1.09	0.45	0.98	3
				0.03			0.06	0.02	0.03	0.01	
96.	58°625	3 36 03	58 44.3	11.07	2.76	2.06	1.11	0.50	0.21	0.37	9
				0.03	0.02	0.02	0.01	0.01	0.02	0.01	
97.	58°626	3 36 16	59 12.7	9.21:			2.99:	1.19	0.49	1.06	2
				0.05			0.05	0.01	0.02	0.02	
98.	58°627	3 36 21	59 16.3	10.09	4.05	3.34	2.38	1.01	0.38	0.88	3
				0.03	0.02	0.04	0.02	0.02	0.02	0.01	
99.	57°732	3 36 43	57 48.5	9.84:		4.77	3.38	1.36	0.59	1.25	2
				0.08		0.02	0.01	0.01	0.03	0.03	
100.	56°823	3 36 53	56 52.5	10.25	2.84	2.22	1.44	0.69	0.25	0.61	2
				0.03	0.02	0.02	0.01	0.01	0.02	0.01	
101.	58°628	3 37 25	58 40.1	8.34	4.74	4.05	2.80	1.08	0.44	0.98	4
				0.03	0.02	0.02	0.02	0.01	0.02	0.01	
102.	57°733	3 37 29	58 27.3	10.35	2.41	1.87	1.20	0.54	0.22	0.51	1
				0.04	0.03	0.03	0.02	0.01	0.02	0.01	
103.	58°629	3 37 30	58 34.4	10.51	2.33	1.70	0.83	0.35	0.13	0.27	2
				0.03	0.03	0.02	0.01	0.01	0.02	0.01	
104.	56°824	3 37 45	56 43.1	6.47	1.37	1.09	0.83	0.49	0.19	0.36	3
				0.03	0.02	0.02	0.01	0.01	0.02	0.01	
105.	56°825	3 37 54	57 06.9	9.32	2.04	1.52	0.93	0.50	0.19	0.41	3
				0.03	0.02	0.02	0.02	0.01	0.02	0.01	

Table 1 (continued)

No.	BD	α(2000) h m s	δ(2000) ° ′	V	$U-V$	$P-V$	$X-V$	$Y-V$	$Z-V$	$V-S$	n
106.	56°826	3 38 19	56 57.1	6.27	1.31	0.91	0.35	0.14	0.11	0.09	3
				0.03	0.02	0.02	0.01	0.01	0.02	0.01	
107.	57°734	3 38 19	57 41.2	8.78	2.24	1.70	1.15	0.61	0.21	0.50	2
				0.04	0.02	0.03	0.01	0.02	0.03	0.01	
108.	56°827	3 38 31	56 52.5	10.04	2.15	1.68	1.15	0.52	0.19	0.45	2
				0.03	0.02	0.02	0.02	0.01	0.02	0.01	
109.	56°828	3 39 09	56 40.9	9.91:	2.67	2.11	1.43	0.65	0.22	0.66	2
				0.05	0.02	0.04	0.04	0.02	0.02	0.01	
110.	58°631	3 39 22	59 15.9	7.78	4.34	3.70	2.52	0.95	0.44	0.87	2
				0.03	0.02	0.04	0.02	0.02	0.02	0.01	
111.	56°829	3 39 32	57 28.3	9.21		5.12	3.53	1.43	0.62	1.28	3
				0.03		0.04	0.02	0.01	0.02	0.01	
112.	58°633	3 39 37	59 22.2	8.22	2.14	1.71	1.18	0.51	0.19	0.49	6
				0.03	0.02	0.02	0.01	0.01	0.02	0.01	
113.	57°735	3 39 45	58 20.1	9.96	2.71	2.05	1.28	0.59	0.21	0.52	1
				0.04	0.02	0.02	0.01	0.01	0.02	0.01	
114.	57°736	3 40 13	58 18.1	9.13	2.13	1.67	1.08	0.47	0.16	0.42	1
				0.04	0.02	0.02	0.02	0.01	0.02	0.02	
115.	56°831	3 41 23	56 56.2	9.37	2.62	1.99	1.31	0.62	0.23	0.54	2
				0.03	0.02	0.02	0.01	0.02	0.03	0.01	
116.	56°830	3 41 24	57 09.9	9.20	2.16	1.56	0.88	0.47	0.18	0.35	2
				0.03	0.02	0.03	0.01	0.01	0.02	0.01	
117.	57°737	3 41 41	57 30.4	8.40	4.64	3.95	2.70	1.10	0.43	1.01	1
				0.04	0.03	0.02	0.02	0.01	0.02	0.01	
118.	56°833	3 41 52	56 56.1	10.38:	2.81	2.07	1.15	0.54	0.19	0.42	2
				0.05	0.03	0.02	0.03	0.01	0.02	0.01	
119.	56°832	3 41 53	57 20.7	9.94	2.71	1.90	1.02	0.52	0.21	0.40	2
				0.03	0.02	0.02	0.02	0.01	0.02	0.02	
120.		3 42 12	57 00.9	11.67	3.20:	2.29	1.35	0.63	0.23	0.51	2
				0.03	0.08	0.02	0.03	0.03	0.02	0.01	
121.	56°834	3 42 15	57 01.8	11.14	3.22:	2.34	1.46	0.71	0.27	0.51	2
				0.04	0.06	0.02	0.05	0.02	0.02	0.04	
122.	56°835	3 42 26	56 28.5	8.87	2.70	1.88	1.00	0.50	0.16	0.45	1
				0.03	0.02	0.03	0.03	0.02	0.03	0.02	
123.	57°739	3 42 59	57 33.9	8.35:	1.63	1.15	0.73	0.42	0.15	0.35	1
				0.05	0.02	0.02	0.01	0.01	0.02	0.01	
124.	57°738	3 43 00	58 00.3	10.08:	2.71	2.10	1.39	0.63	0.23	0.61	1
				0.05	0.03	0.03	0.02	0.02	0.02	0.01	
125.	59°708	3 45 21	60 21.1	8.04	2.33	1.88	1.30	0.57	0.20	0.51	1
				0.03	0.02	0.02	0.02	0.02	0.02	0.01	
126.	58°646	3 45 45	58 51.5	7.71	2.13	1.68	1.14	0.50	0.19	0.45	1
				0.03	0.02	0.02	0.02	0.02	0.02	0.01	

Table 2. Results of photometric quantification of stars

No.	BD	HD	l °	b °	Sp	M_V	E_{B-V}	A_V	r (pc)	σ_{Sp}
1.	57°708		141.641	0.568	G5 III	1.0	0.25	0.90	360	1
2.	57°709		141.672	0.597	B3 V	–1.5	0.73	2.42	640	1
3.	57°710		141.540	1.006	B4 III	–2.0	0.50	1.64	890	2
4.			141.442	1.318	A3 V	1.5	0.17	0.57	390	3
5.	57°711		141.553	1.197	K4.2 III	0.5	0.29	1.09	280	2
6.	57°712		141.465	1.336	F7 V	3.7	0.20	0.67	110	3
7.	57°713	20353	141.913	0.892	B9 V	0.4	0.37	1.23	310	2
8.	57°714	20417	141.714	1.332	B4 V	–1.1	0.42	1.38	620	2
9.	57°715	20524	142.098	1.004	K0.7 III	0.8	0.37	1.35	130	3
10.	57°716		141.850	1.516	G8 III	0.9	0.25	0.90	320	1
11.	56°806		142.798	0.122	B9 V	0.5	0.50	1.66	540	2
12.	56°807		142.940	-0.034	A1.5 III	0.4	0.42	1.41	560	1
13.			142.827	0.147	A4 V:	1.7:	0.38:	1.01:	520:	2
14.	57°717		142.055	1.399	F9 V:	4.1:	0.01:	0.04:	160:	7
15.	57°718		142.129	1.302	K1 III	0.8	0.37	1.35	220	3
16.	57°719		142.004	1.651	A2 V	1.3	0.38	1.30	270	1
17.	57°720	20787	142.097	1.716	F4 V	3.4	0.04	0.12	70	1
18.	56°808	20848	143.133	0.259	B8 V	0.1	0.56	1.85	260	1
19.	57°721	20847	142.187	1.730	B7 V	–0.2	0.51	1.68	390	2
20.	57°722		142.401	1.577	B7 IV	–0.6	0.50	1.67	440	2
21.	56°809		143.157	0.490	B6 V	–0.5	0.66	2.20	350	1
22.	56°810		143.010	0.723	K1.5 III	0.6	0.42	1.55	340	2
23.	56°811		143.388	0.277	F9.5 V	4.3	0.24	0.83	140	1
24.	58°601	21003	142.133	2.248	F6 V	3.7	0.00	0.00	110	1
25.	56°812	21059	142.986	1.049	G9.5 V	5.9	0.13	0.45	30	1
26.	57 723		142.663	1.592	B5 V	–0.8	0.52	1.72	500	1
27.	57 724	21084	142.537	1.776	F9 V	4.2	0.00	0.00	70	1
25.	56°812	21059	142.986	1.049	G9.5 V	5.9	0.13	0.45	30	1
26.	57°723		142.663	1.592	B5 V	–0.8	0.52	1.72	500	1
28.			143.343	0.658	A1.5 V	1.7:	0.72	2.44	310	2
29.	58°602	21116	142.070	2.575	B2.5 II	–4.9	0.48	1.58	1840	1
30.	56°813		143.374	0.680	B7 V	0.6	0.52	1.71	270	2
31.	58°603		142.216	2.447	B5 IV	–1.0	0.41	1.37	810	1
32.	56°814		143.672	0.431	B6 V	0.2	0.58	1.91	490	1
33.	58°604		142.528	2.125	F8 V	4.1	0.08	0.27	140	3
34.	57°725	21248	143.056	1.404	F5 V	3.6	0.04	0.12	100	4
35.	58°605		142.544	2.189	A1 V	1.1	0.36	1.23	380	1
36.	58°606		142.172	2.904	F8 V	3.8	0.06	0.22	140	1
37.	58°607	21389	142.519	2.501	B9 Ia	–7.2	0.58	1.93	90	1
38.	57°726		142.822	2.099	K0.7 III	0.8	0.40	1.45	350	1
39.	58°608	21427	142.267	2.920	A2 V	1.8	0.08	0.26	60	2
40.	56°815		143.560	1.185	G8 V	5.6	0.05	0.17	80	1
41.	58°609		142.480	2.780	F6 V	3.7	0.03	0.10	130	1

Table 2 (continued)

No.	BD	HD	l °	b °	Sp	M_V	E_{B-V}	A_V	r (pc)	σ_{Sp}
42.	58°610		142.420	2.877	B1.5 V	–2.9	0.62	2.07	1220	1
43.	57°727		142.893	2.293	K4.2 III	0.5	0.44	1.68	200	1
44.	58°612	21538	142.781	2.471	G8.5 III	0.9	0.29	1.03	280	1
45.	58°611	21538	142.449	2.953	A1 Ib:	–5.3:	0.95:	3.17:	3400:	4
46.			142.896	2.377	B9.5 V	1.6	0.33	1.12	400	1
47.	56°816		143.747	1.184	K0.5 IV	3.2	0.16	0.56	150	1
48.	58°613		142.642	2.753	F9.5 V	4.3	0.05	0.16	120	1
49.			142.728	2.710	A5 V:	2.3:	0.27:	0.92:	540:	5
50.			144.114	0.794	A2 V:	1.3:	0.60:	2.03:	340:	6
51.			142.862	2.551	B5 V	–0.1	0.59	1.94	1020	1
52.	56°817		144.115	0.812	A4 III:	0.4:	0.64:	2.16:	260:	5
53.	56°818		143.855	1.210	F5 V	3.7	0.24	0.81	160	1
54.			142.810	2.706	G9.5 II-III:	–0.7:	0.36:	1.31:	1600:	6
55.			142.925	2.594	B5 V	–0.1	0.54	1.79	1000	1
56.	58°614		142.578	3.079	B9.5 V	0.5	0.45	1.52	600	2
57.	58°615		142.704	2.906	G7 V	5.4	0.16	0.57	80	3
58.	58°616		142.860	2.688	F4 IV	2.5	0.14	0.48	200	1
59.	58°617	21742	142.570	3.205	K1 V	6.1	0.02	0.05	20	1
60.	58°618		142.965	2.676	F4 V	3.4	0.01	0.04	80	2
61.	58°619	21769	142.967	2.680	A5 V	1.9	0.00	0.00	80	2
62.	57°729	21784	143.270	2.279	A7 V	2.4	0.06	0.19	140	1
63.	57°728		143.144	2.460	B5 V	–0.8	0.46	1.53	750	1
64.	56°819		143.790	1.565	A3 V	1.5	0.49	1.67	390	3
65.			143.044	2.603	F6 V	3.8:	0.29	0.98	480	2
66.	57°730	21794	143.511	1.958	F6 V	3.7	0.05	0.18	30	2
67.			142.949	2.760	K2.2 III	1.0	0.30	1.11	640	3
68.			143.007	2.694	G1 IV	3.0	0.14	0.47	680	2
69.			143.073	2.611	A5 V	2.3	0.34	1.14	540	3
70.	56°820		144.071	1.236	K2.5 III	0.6	0.48	1.81	220	2
71.			143.057	2.644	F9 III	1.3	0.25	0.88	1520	1
72.	56°821		143.900	1.487	A0.5 III	0.0	0.58	1.97	410	1
73.			143.112	2.578	M1 V	9.4	0.05	0.16	20	3
74.			143.077	2.642	F0 V	2.8	0.33	1.11	690	3
75.			143.074	2.665	F6 V	3.8	0.27	0.92	310	2
76.			143.031	2.735	F9 II:	–2.5:	1.14:	4.04:	1620:	5
77.	58°620		142.874	2.952	F0 V	3.0	0.21	0.71	250	1
78.			143.059	2.722	K2 III	–0.3:	0.40	1.47	1060	2
79.			143.168	2.583	A5 V	1.9	0.27	0.93	570	3
80.			143.200	2.561	K2.2 V:	6.4:	0.17:	0.59:	100:	4
81.			143.115	2.715	G4 III	0.9:	0.34:	1.23:	1140:	4
82.	58°622		143.153	2.666	B7 Iab	–6.2	1.08	3.59	2400	2
83.	58°621		142.737	3.247	K2.2 III	0.7	0.25	0.94	280	1
84.	58°623	21894	143.196	2.623	B0.5 IV	–3.9	0.54	1.78	1000	1

Table 2 (continued)

No.	BD	HD	l °	b °	Sp	M_V	E_{B-V}	A_V	r (pc)	σ_{Sp}
85.			143.157	2.691	G2.5 III:	1.1:	0.16:	0.58:	2590:	2
86.			143.160	2.694	F8 V:	3.9:	0.27:	0.93:	450:	6
87.			143.124	2.747	F5 V:	3.4:	0.36:	1.22:	460:	4
88.			143.165	2.698	G9 V:	5.7:	0.18:	0.64:	300:	6
89.	59°675	21903	142.370	3.823	F5 V	3.6	0.00	0.00	40	2
90.			143.183	2.728	A7 V	2.3	0.30	1.03	800	3
91.	58°624		143.146	2.816	A4 V	1.7	0.29	0.98	350	1
92.	56°822		144.326	1.248	B8.5 V	0.8	0.55	1.82	410	3
93.	57°731	22020	143.766	2.102	F3 IV	2.5	0.01	0.02	220	1
94.			143.357	2.667	F3 V	3.2	0.27	0.90	400	1
95.			143.337	2.698	K2.2 III:	0.2:	0.23:	0.86:	1220:	1
96.	58°625		143.247	2.850	A5 V	2.0	0.32	1.08	400	3
97.	58°626		142.989	3.248	K2.2 III:	0.6:	0.36:	1.33:	290:	2
98.	58°627		142.962	3.303	G7 III	0.9	0.36	1.30	380	1
99.	57°732		143.871	2.154	K4 III-IV?					11
100.	56°823		144.444	1.416	F3 IV	2.5	0.33	1.12	210	1
101.	58°628	22191	143.432	2.900	K1.5 III	–0.3	0.26	0.97	340	1
102.	57°733		143.566	2.733	F3 V	3.2	0.16	0.52	210	1
103.	58°629		143.498	2.830	A2 V	1.8	0.21	0.72	400	1
104.	56°824	22253	144.631	1.361	B1 Iab	–6.3	0.52	1.70	1610	2
105.	56°825		144.411	1.691	B6 V	–0.5	0.52	1.73	420	1
106.	56°826	22316	144.554	1.594	B7 V	0.6	0.08	0.27	120	3
107.	57°734	22297	144.115	2.183	B5 V	–0.7	0.68	2.26	280	1
108.	56°827		144.623	1.549	F5 V:	3.4:	0.08:	0.28:	180:	7
109.	56°828		144.807	1.446	F6 V	3.7	0.22	0.75	120	2
110.	58°631	22400	143.276	3.528	K2.5 III-IV	1.9	0.10	0.39	120	1
111.	56°829		144.374	2.109	K4 III-IV:	1.7:	0.51:	1.95:	130:	8
112.	58°633	22439	143.238	3.630	F8 V:	3.6:	0.02:	0.08:	80:	6
113.			143.876	2.816	F0 V	3.0	0.31	1.06	150	1
114.	57°736	22508	143.945	2.825	F5 V	3.6	–0.01	0.00	130	1
115.	56°831		144.897	1.834	F3 IV	2.5	0.24	0.80	160	1
116.	56°830	22650	144.760	2.017	B7 V	–0.2	0.47	1.57	370	2
117.	57°737	22678	144.584	2.312	K0.7 III	0.7	0.37	1.34	180	2
118.	56°833		144.951	1.872	A1.5 V	1.7	0.46	1.56	270	1
119.	56°832		144.703	2.198	A0 V	–0.1	0.47	1.59	490	2
120.			144.938	1.964	A5 III	0.8	0.51	1.71	680	1
121.	56°834		144.934	1.979	A4 V:	1.7:	0.59:	2.01:	310:	6
122.	56°835	22777	145.292	1.555	A0 III	–0.1	0.44	1.47	320	1
123.	57°739	22830	144.687	2.464	B6 Ib	–5.8	0.32	1.05	4160	1
124.	57°738		144.418	2.813	F2 V	3.1	0.31	1.04	150	1
125.	59°708		143.208	4.847	F8 V	4.1	0.07	0.24	60	3
126.	58°646	23129	144.175	3.707	F8 V:	3.5:	0.01:	0.02:	70:	6