INTERSTELLAR EXTINCTION IN THE DARK CLOUD KHAVTASSI 217 IN CASSIOPEIA

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Abstract. The Vilnius photometric system has been applied for the investigation of interstellar extinction in the area of dark cloud Khavtassi 217 in Cassiopeia. On the ground of photoelectric photometry of 152 stars, their photometric spectral types, absolute magnitudes, color excesses, interstellar extinctions and distances were determined. The area is divided into two regions with different extinction versus distance run. Distances of the dark clouds are determined.

Key words: interstellar medium: extinction – methods: observational – techniques: photometric

1. INTRODUCTION

The investigated area with the coordinates $\alpha(2000) = 0^{\text{h}}50^{\text{m}} - 1^{\text{h}}30^{\text{m}}$, $\delta(2000) = 65^{\circ}40' - 67^{\circ}40'$, close to the bright star ψ Cas, is situated slightly above the galactic plane (galactic coordinates of the center: $l = 124.5^{\circ}$, $b = 3.9^{\circ}$). On photographs of the area, a complex of dark clouds is seen. In the Khavtassi (1960) atlas of the galactic dark clouds, the area coincides with the dark cloud 217. In the Lynds (1962) catalog of dark clouds the identification is very uncertain: the L1305 and L 1307 have similar galactic coordinates. This region is almost uninvestigated photometrically. Only a few stars of specific spectral types have been measured in the *UBV* (Neckel 1974, Haupt & Schroll 1974, Pesch 1963, Oja 1991) and *uvby* (Perry & Johnston 1982, Olsen 1983) photometric systems. The spectral types and interstellar extinction are also known only for some stars.

Fig. 1. Identification chart of stars in the investigated area. The line separates two regions with different extinction. The approximate northern border of the Dark Cloud is marked by dashed line.

A new catalogue of extinction data (Guarinos 1995) includes just one star from the investigated area. To fill this gap, the photometric investigation of this area has been started. All the brightest stars with BD numbers in a selected field of $2^\circ \times 4^\circ$ size were measured. Trying to penetrate deeper into the dark cloud and to determine the dependence of interstellar extinction on distance, about 30 fainter stars down to $V = 12.5$ mag were measured additionally in a smaller area of about 1 square degree size.

2. PHOTOMETRIC OBSERVATIONS AND CLASSIFICATION OF STARS

The observations were obtained in September 1992 with the 1 meter telescope of the Institute of Theoretical Physics and Astronomy at the Maidanak Observatory in Uzbekistan. A standard set of filters of the Vilnius photometric system has been used. The observed magnitudes and color indices were transformed to outside the atmosphere by Nikonov's method modified by Zdanavičius (1975). The extinction star HD 189796 (G0 V, $V = 7.82$) has been used. Transformation equations from the instrumental to the standard system have been determined from observations of 29 stars of various spectral types and luminosities from the Cygnus Standard Region (Zdanavičius & Černienė 1985).

The results of photometry of 152 stars are presented in Table 1 which contains: star numbers identified in Fig. 1, BD numbers, coordinates, V magnitudes and color indices $U-V$, $P-V$, $X-V$, $Y-V$, $Z-V$ and $V-S$ in the Vilnius system, the number of independent observations. 90 % of the stars were measured twice. The typical mean square errors of the magnitudes and color indices are of the order of ± 0.01 to ± 0.02 mag (for stars fainter than $V = 11$ mag). Some red stars were observed with lower accuracy in the ultraviolet passbands due to insufficient photon statistics. If the errors are greater than ± 0.05 mag, the indices are not given. If the errors are between ± 0.03 and ± 0.05 mag, the indices are marked by colons.

Photometric spectral classes, luminosity classes and absolute magnitudes of the stars have been determined from the photometric data by using the computer program CLASS written by Vansevičius & Bridžius (1994). The quantification of stars is based on a three-dimensional (spectral class, absolute magnitude and color excess) fitting of the observed color indices of the program star with those from the bank of standard stars. This program gives also the stan-

dard deviation σ of color indices between the program star and the closest standard star; this can be used as a measure of the classification accuracy. On the other hand, σ values depend on spectral classes and luminosity classes: if $\sigma = \pm 0.03$ is a good accuracy for K-type stars, it is too bad for B-type stars. To control the accuracy of the presented classification, three more methods have been applied: (a) the method of comparison of ten reddening-free Q -parameters of the program star with those of about 7000 stars from the General Photometric Catalogue of Stars Observed in the Vilnius System (Straizys & Kazlauskas 1993); (b) Q, Q -diagrams calibrated in terms of spectral class and absolute magnitude by Straizys et al. (1982); (c) the probability method proposed by Zdanavičius et al. (1994).

All four methods give very similar results if the accuracy of color indices is of the order of 0.01 mag. Comparing the results of the classification obtained by different methods and taking into account the values of σ from the CLASS program, the results of two-dimensional classification were divided into three groups according to their weight. $W = 3$ means that the classification is good, i.e. all methods give very similar results and σ is of the order of $\pm(0.01 - 0.02)$ mag. For $W = 2$ the classification is reliable, i.e. spectral classes obtained by different methods may differ by 2–3 spectral subclasses and σ is of the order of $\pm(0.02 - 0.03)$ mag. For $W = 1$ the classification is uncertain. When σ is greater than ± 0.03 mag, spectral classes and absolute magnitudes may contain significant errors.

For stars Nos. 1, 91 and 93 the classification failed. Star No. 1 probably is a peculiar or an unresolved binary. Stars Nos. 91 and 93 were measured with insufficient accuracy.

The color excesses E_{Y-V} were calculated as differences between the observed color indices $Y-V$ and the intrinsic color indices $(Y-V)_0$ of the corresponding spectral class and luminosity (Straizys 1992).

Table 1. Results of photometry.

No.	BD	$\alpha(2000)$ h m s	$\delta(2000)$ ° ' "	V	U-V	P-V	X-V	Y-V	Z-V	V-S	n
1.	+66° 61	0 49 02	+67 19.5	10.31	4.05:	3.37	2.43	1.01	0.44	0.97	2
2.	+66° 97	0 49 10	+66 03.1	9.74	2.44	1.79	1.05	0.43	0.18	0.36	2
3.	+66° 62	0 49 14	+67 34.2	9.72	6.20:	5.31:	3.74	1.47	0.61	1.29	2
4.	+66° 63	0 49 20	+67 30.3	9.19	5.46	4.62	3.19	1.23	0.52	1.11	2
5.	+65°100	0 49 55	+66 03.3	10.01	2.27	1.74	1.17	0.49	0.18	0.48	2
6.	+66° 64	0 50 18	+67 10.6	9.55	2.65	1.77	1.00	0.50	0.18	0.41	2
7.	+66° 65	0 51 15	+66 49.8	10.08	2.27	1.72	1.11	0.48	0.18	0.43	2
8.	+65°101	0 51 26	+65 58.8	8.03	4.18	3.55	2.42	0.89	0.39	0.84	2
9.	+66° 66	0 51 33	+67 34.8	8.61	6.45	5.51	3.85	1.49	0.66	1.37	2
10.	+65°102	0 51 58	+66 31.2	9.63	2.24	1.60	0.87	0.36	0.14	0.32	2
11.	+65°103	0 52 36	+65 53.5	8.32	2.00	1.41	0.61	0.24	0.09	0.16	2
12.	+66° 67	0 53 15	+66 54.6	9.94	1.99	1.56	1.09	0.57	0.19	0.46	2
13.	+65°104	0 53 30	+66 35.9	10.52	4.24:	3.66	2.54	1.01	0.39	0.91	2
14.	+66° 68	0 53 49	+66 55.6	10.12	2.43	1.96	1.39	0.56	0.21	0.56	2
15.	+65°105	0 54 01	+66 44.1	8.97	2.95	2.10	1.31	0.59	0.22	0.53	2
16.	+65°106	0 54 06	+66 26.1	7.04	2.19	1.61	1.00	0.42	0.17	0.39	2
17.	+65°107	0 54 38	+65 57.2	10.04	2.55	1.99	1.34	0.57	0.23	0.55	2
18.	+66° 69	0 54 42	+67 21.9	9.02	2.36	1.86	1.29	0.53	0.21	0.51	2
19.	+65°108	0 55 28	+66 02.3	9.38	2.28	1.71	1.11	0.47	0.17	0.45	2
20.		0 55 33	+66 47.1	10.38	2.56	1.98	1.36	0.60	0.22	0.54	2
21.	+66° 70	0 56 00	+66 50.1	10.04	2.74	2.00	1.25	0.57	0.20	0.52	2
22.	+65°109	0 56 02	+65 46.8	11.37			2.89:	1.10:	0.46	1.01	2
23.	+66° 72	0 56 04	+66 53.1	9.73	2.47	1.91	1.31	0.55	0.23	0.52	2
24.	+66° 71	0 56 04	+67 22.6	9.35	2.70	1.92	1.21	0.63	0.21	0.49	2
25.	+65°110	0 56 15	+66 24.8	8.31	1.35	1.01	0.56	0.29	0.10	0.20	2
26.	+65°111	0 56 18	+66 01.9	9.28	3.50	2.73	1.88	0.88	0.32	0.81	1
27.	+65°112	0 56 32	+66 12.3	9.09	2.56	1.70	0.86	0.42	0.14	0.33	2
28.	+66° 73	0 56 32	+66 55.6	9.45	4.36	3.67	2.52	0.99	0.39	0.89	2
29.	+65°113	0 57 41	+66 12.5	10.27	4.09:	3.37:	2.41	1.05	0.41	0.97	2
30.	+66° 74	0 57 56	+67 44.4	9.10	2.22	1.59	0.91	0.39	0.15	0.35	2
31.	+66° 75	0 58 04	+67 41.9	8.51	6.66	5.52	3.93	1.57	0.66	1.46	2
32.	+66° 76	0 58 15	+67 29.0	9.89	2.24	1.73	1.17	0.50	0.19	0.47	2
33.	+66° 77	0 58 16	+66 57.4	9.67	2.35	1.68	0.91	0.39	0.13	0.32	2
34.	+65°114	0 58 21	+66 03.2	9.65	2.46	1.74	0.87	0.39	0.14	0.28	2
35.	+65°115	0 58 31	+66 21.1	5.95	1.66	1.16	0.45	0.18	0.07	0.12	2
36.	+66° 78	0 58 35	+66 49.4	10.10	2.34	1.67	0.94	0.40	0.15	0.34	2
37.	+66° 79	0 58 40	+67 26.4	8.34	2.25	1.66	1.02	0.44	0.17	0.40	2
38.		0 58 51	+67 07.3	11.45	3.09	2.27	1.43	0.67	0.25	0.55	2
39.	+66° 80	0 59 03	+67 33.4	10.46	4.00	3.33	2.35	0.99	0.40	0.93	2
40.		0 59 06	+67 04.2	10.94	2.39	1.91	1.32	0.56	0.23	0.54	2

Table 1 (continued)

No.	BD	$\alpha(2000)$ h m s	$\delta(2000)$ ° ' "	V	$U-V$	$P-V$	$X-V$	$Y-V$	$Z-V$	$V-S$	n
41.		0 59 28	+67 18.2	12.47	2.55:	2.08:	1.48	0.66	0.26	0.58	2
42.		0 59 31	+67 16.6	12.29			3.22:	1.35	0.51	1.19	2
43.	+65° 116	0 59 47	+66 16.3	8.93		5.08:	3.53	1.41	0.61	1.31	2
44.	+66° 81	1 00 07	+67 42.6	10.69	3.35:	2.42	1.54	0.73	0.27	0.61	2
45.	+66° 82a	1 00 12	+66 59.0	9.84	2.21	1.63	1.00	0.44	0.15	0.41	2
46.	+66° 82b	1 00 16	+66 58.6	11.04	2.83	2.07	1.19	0.53	0.18	0.41	2
47.	+66° 84	1 00 29	+66 55.8	9.93	3.92	3.27	2.31	0.98	0.36	0.87	2
48.		1 00 31	+66 49.1	11.28	2.27	1.76	1.21	0.53	0.20	0.50	2
49.	+65° 117	1 00 34	+66 06.6	9.90	4.40	3.71	2.57	1.00	0.41	0.91	2
50.		1 00 37	+66 43.2	11.95	4.15	3.55	2.44	1.02	0.42	0.89	2
51.		1 00 38	+67 15.7	11.54	2.75	2.08:	1.41	0.63	0.23	0.62	2
52.	+65° 118	1 00 42	+66 35.8	9.70	4.12	3.46	2.35	0.91	0.37	0.86	2
53.		1 01 07	+67 0 .5	12.59	2.60:	2.16	1.54	0.65	0.29	0.59	2
54.	+65° 119	1 01 11	+65 49.6	9.81	4.46	3.73	2.57	1.02	0.40	0.90	2
55.	+66° 85	1 01 16	+67 10.4	9.88	2.72	1.97	1.06	0.50	0.18	0.36	2
56.	+65° 121	1 01 18	+65 55.0	10.63	3.61	2.59	1.76	0.92	0.31	0.77	2
57.	+66° 86	1 01 25	+66 56.3	9.24	4.62	3.83	2.76	1.20	0.44	1.03	2
58.	+65° 122	1 01 25	+66 26.3	9.47	1.95	1.42	0.85	0.44	0.17	0.36	2
59.	+66° 87	1 01 41	+67 37.5	10.55	2.20	1.66	1.10	0.47	0.17	0.43	2
60.	+65° 123	1 01 46	+66 13.4	8.42	2.26	1.77	1.22	0.52	0.20	0.49	2
61.		1 02 01	+66 46.4	11.60	3.51	3.05:	2.04	0.75:	0.40	0.73	2
62.	+65° 124	1 02 08	+66 05.2	9.63	3.49	2.99	2.00	0.75	0.35	0.70	2
63.		1 02 15	+67 03.3	11.23	2.46	1.88	1.25	0.55	0.21	0.52	2
64.		1 02 35	+66 51.9	12.53	3.13	2.45	1.68	0.85	0.32	0.68	2
65.		1 02 35	+66 51.0	11.03	2.63	1.92	1.05	0.53	0.19	0.39	2
66.		1 02 42	+66 58.2	10.79	2.27	1.72	1.13	0.49	0.19	0.46	2
67.		1 02 45	+66 32.1	10.60	4.32	3.65	2.53	1.01	0.42	0.93	2
68.	+66° 88p	1 02 53	+67 19.1	10.27	2.32	1.80	1.24	0.52	0.20	0.51	2
69.		1 02 54	+67 02.8	10.98	2.87	2.28	1.60	0.67	0.26	0.63	2
70.		1 02 56	+66 35.3	12.02	3.23	2.35	1.47	0.74	0.26	0.59	2
71.	+66° 88	1 02 59	+67 19.0	9.98	4.38	3.70	2.54	0.95	0.42	0.90	2
72.	+65° 125	1 03 07	+66 28.9	9.76	2.37	1.79	1.19	0.56	0.22	0.51	2
73.	+66° 89	1 03 10	+66 56.6	9.19	4.09	2.93	1.97	1.02	0.36	0.86	2
74.		1 03 16	+67 31.0	11.46	3.12	2.32	1.35	0.64	0.23	0.50	2
75.	+65° 126	1 03 21	+66 04.8	10.33	2.45	1.86	1.24	0.55	0.20	0.53	2
76.	+66° 90	1 03 34	+66 54.6	9.27	2.18	1.64	1.06	0.45	0.17	0.43	2
77.	+65° 127	1 04 05	+66 29.4	10.47	2.58	1.86	0.99	0.43	0.16	0.32	2
78.		1 04 11	+67 21.2	11.08	2.21	1.71	1.23	0.56	0.22	0.53	2
79.	+66° 91	1 04 38	+66 54.8	10.39	2.62	2.08	1.64	0.93	0.31	0.73	2
80.		1 04 38	+67 29.3	11.47	2.83	2.08	1.35	0.70	0.26	0.55	2

Table 1 (continued)

No.	BD	$\alpha(2000)$ h m s	$\delta(2000)$ ° ' "	V	U	V	P-V	X-V	Y-V	Z-V	V-S	n
81.		1 04 46	+67 03.1	11.33	2.55	2.05	1.47	0.62	0.25	0.61	2	
82.		1 05 03	+67 06.5	12.21	3.09	2.27	1.42	0.66	0.25	0.57	2	
83.		1 05 09	+67 34.8	12.31	3.19	2.36	1.55	0.79	0.28	0.66	2	
84.		1 05 34	+67 05.6	12.11	2.75	2.22	1.54	0.63	0.26	0.66	2	
85.		1 05 38	+67 08.0	12.71			3.28:	1.47	0.54	1.30	2	
86.		1 05 40	+67 10.3	12.24	3.85	3.07	2.26:	0.99	0.36	0.93	2	
87.	+66° 92	1 05 49	+67 18.7	10.24	2.36	1.86	1.33	0.58	0.23	0.57	2	
88.	+65° 129	1 05 53	+65 58.3	7.24	1.70	1.17	0.62	0.31	0.12	0.29	2	
89.	+65° 128	1 05 56	+65 53.7	9.35	2.12	1.44	0.69	0.32	0.11	0.27	2	
90.		1 06 11	+67 04.1	10.78	2.99	2.17	1.25	0.63	0.22	0.49	2	
91.		1 06 25	+66 32.7	10.98			4.09	1.86	0.70	1.64	2	
92.	+65° 130	1 06 26	+66 26.8	8.51	2.27	1.56	0.77	0.37	0.14	0.29	2	
93.		1 06 57	+67 06.7	11.10		4.52:	3.20	1.27	0.54	1.13	2	
94.		1 07 30	+67 09.2	12.06	2.86	2.21	1.57	0.72	0.26	0.62	2	
95.	+66° 93	1 08 11	+67 18.1	10.44	2.40	1.78	1.13	0.50	0.20	0.45	2	
96.	+66° 94b	1 08 14	+67 28.4	11.73	3.21:	2.45:	1.70:	0.78	0.26	0.70	1	
97.	+66° 94a	1 08 17	+67 29.0	8.57	5.16	4.32	3.08	1.33	0.54	1.18	2	
98.	+66° 95	1 08 25	+66 48.9	10.03	2.84	2.35	1.60	0.63	0.25	0.61	2	
99.	+65° 131	1 08 40	+66 12.8	10.53	2.91	2.17:	1.47	0.80	0.28	0.63	2	
100.		1 08 58	+67 02.9	11.80	3.65	2.72:	1.81	0.89	0.32	0.72	2	
101.	+66° 96	1 09 32	+67 42.7	10.88	2.38	1.83	1.24	0.54	0.22	0.50	1	
102.	+65° 132	1 09 42	+66 16.4	9.83	2.11	1.54	0.88	0.44	0.16	0.34	2	
103.		1 09 45	+66 51.3	11.74	2.46	1.94	1.36	0.61	0.23	0.57	2	
104.	+65° 133	1 10 04	+65 46.4	10.81	2.36	1.71	0.83	0.40	0.15	0.28	1	
105.	+65° 134	1 10 24	+66 08.0	8.85	3.91	3.33	2.36	0.94	0.37	0.83	2	
106.	+65° 135	1 10 23	+65 46.4	9.08	2.33	1.69	1.05	0.46	0.17	0.42	2	
107.	+65° 136	1 10 31	+66 44.5	9.11	2.45	1.96	1.36	0.55	0.22	0.55	2	
108.	+65° 137	1 10 49	+65 49.0	10.48	2.39	1.75	1.04	0.46	0.17	0.41	2	
109.	+65° 138	1 11 26	+66 24.0	10.45	2.67	2.12	1.48	0.64	0.26	0.58	2	
110.	+65° 139	1 11 30	+66 03.5	9.72	2.31	1.67	0.94	0.38	0.14	0.37	2	
111.		1 11 39	+67 03.3	11.48	3.31	2.43	1.62	0.83	0.27	0.66	2	
112.	+65° 140	1 11 49	+65 52.4	8.50	4.22	3.57	2.43	0.91	0.38	0.86	2	
113.	+65° 141	1 12 27	+66 25.6	10.19	4.50	3.78:	2.62	1.05	0.42	0.94	2	
114.	+65° 142	1 12 40	+66 09.8	9.49	2.95	2.10	1.37	0.73	0.25	0.57	2	
115.	+66° 97	1 13 01	+67 38.1	9.74	2.44	1.79	1.05	0.43	0.18	0.36	2	
116.	+65° 143	1 14 25	+66 43.3	10.60	2.39	1.87	1.32	0.54	0.21	0.52	2	
117.	+65° 144	1 14 28	+65 47.1	8.94	4.08	3.41	2.36	0.91	0.38	0.83	2	
118.	+66° 99	1 15 01	+67 19.0	10.38	2.40	1.87	1.31	0.56	0.22	0.54	2	
119.	+66° 98	1 15 03	+67 14.2	10.12	2.29	1.71	1.10	0.49	0.19	0.45	2	
120.	+65° 145	1 16 12	+66 07.8	8.57	2.24	1.65	1.03	0.44	0.17	0.41	2	

Table 1 (continued)

No.	BD	$\alpha(2000)$ h m s	$\delta(2000)$ ° ' "	V	U-V	P-V	X-V	Y-V	Z-V	V-S	n
121.	+66°100	1 16 45	+67 30.1	10.46	3.15	2.33	1.62	0.83	0.29	0.69	2
122.	+66°101	1 17 00	+67 33.0	10.91	2.41	1.95	1.37	0.55	0.21	0.55	2
123.	+65°146	1 17 23	+65 57.9	10.25	4.31	3.62	2.52	1.01	0.41	0.90	2
124.	+66°102	1 17 36	+67 42.9	9.86	2.21	1.65	1.02	0.43	0.16	0.40	2
125.	+65°147	1 17 47	+65 49.7	9.66	2.43	1.78	1.14	0.51	0.19	0.46	2
126.	+65°148	1 17 57	+65 49.9	10.32	2.48	1.83	1.08	0.46	0.17	0.43	2
127.	+65°149	1 18 36	+66 21.0	10.62	2.39	1.77	1.11	0.50	0.20	0.42	2
128.	+65°150	1 18 40	+66 06.4	11.44	2.51	1.91	1.23	0.53	0.20	0.48	1
129.	+65°152	1 19 38	+66 31.4	11.07	2.29	1.75	1.21	0.53	0.19	0.49	2
130.	+66°103	1 19 48	+67 12.1	9.22	2.13	1.54	0.77	0.32	0.12	0.24	2
131.	+66°104	1 20 27	+67 26.8	10.53	2.66	2.00	1.30	0.68	0.23	0.51	2
132.	+66°105	1 20 37	+67 14.0	8.44	2.29	1.67	0.97	0.39	0.15	0.35	2
133.	+65°153	1 20 50	+65 47.4	9.78	2.68	1.97	1.24	0.55	0.21	0.50	2
134.	+66°106	1 20 54	+67 41.9	9.41	2.44	1.91	1.31	0.55	0.21	0.53	2
135.	+66°107	1 21 41	+67 14.0	10.22	2.30	1.76	1.18	0.50	0.19	0.47	2
136.	+66°108a	1 21 44	+67 19.6	10.89	2.64	2.11	1.46	0.60	0.22	0.58	2
137.	+66°108b	1 21 45	+67 19.1	11.75	2.62	2.11	1.45	0.58	0.22	0.59	2
138.	+65°154	1 21 51	+65 58.3	10.61	2.64	1.92	1.11	0.55	0.18	0.41	2
139.	+66°109	1 22 19	+67 29.2	10.62	2.79	2.01	1.15	0.57	0.21	0.45	1
140.	+65°155	1 22 29	+66 06.4	8.81	5.58	4.73	3.28	1.23	0.58	1.13	2
141.	+65°156	1 23 32	+65 50.4	9.35	2.29	1.74	1.18	0.52	0.20	0.50	2
142.	+65°157	1 23 43	+66 20.5	10.47	2.36	1.84	1.24	0.52	0.20	0.51	1
143.	+65°158	1 23 55	+66 06.2	10.06	2.44	1.84	1.24	0.54	0.20	0.50	2
144.	+66°111	1 24 02	+67 26.9	9.15	2.62	1.85	1.14	0.60	0.21	0.48	1
145.	+66°112	1 24 03	+67 08.9	10.19			4.16:	1.67	0.69	1.50	1
146.	+65°159	1 24 13	+66 21.6	10.70	2.26	1.76	1.22	0.56	0.21	0.48	1
147.	+66°114	1 26 49	+67 04.1	8.77	2.29	1.64	0.94	0.39	0.15	0.36	1
148.	+66°113	1 26 50	+67 13.4	10.55	2.11	1.61	1.04	0.46	0.18	0.42	1
149.	+66°116p	1 27 05	+66 57.7	9.89	2.91	2.00	1.13	0.56	0.21	0.46	1
150.	+66°116	1 27 06	+66 58.5	9.28	2.56	1.81	1.09	0.57	0.21	0.44	1
151.	+66°118	1 27 57	+67 07.0	9.45		4.96:	3.42:	1.28	0.58	1.21	1
152.	+66°119	1 28 14	+67 10.3	8.92	2.21	1.67	1.09	0.55	0.19	0.46	1

To obtain the interstellar monochromatic extinction A_V at the wavelength $\lambda = 544$ nm, which is the effective wavelength of the Vilnius system's V passband, the ratio $R_{YV} = A_V/E_{Y-V}$ has been used. The ratio R_{YV} depends slightly on the spectral type and the luminosity of star. Table 2 gives the values of R_{YV} for various spectral types and luminosities. These values were obtained by calculating the synthetic color excesses E_{Y-V} for the amount of interstellar matter $x = 1$ ($E_{B-V} = 1$) from energy distribution of normal stars (Sviderskienė 1988), response functions of the Vilnius system and the mean extinction law, normalized to $R_{BV} = 3.15$, given by Straižys (1992). It is evident that the mean value $R_{YV} = 4.15$ is good approximation for all spectral types and luminosities excluding only very late M-type stars.

Table 2. The ratios of interstellar extinction A_V to color excess E_{Y-V} .

Sp			Sp		
R_{YV}			R_{YV}		
B0-A5	V-III	4.14	K0	III	4.17
A7-F8	V-III	4.15	K2-M1	III	4.18
G0-G5	V-III	4.16	M2-M3	III	4.19
K0	V	4.16	M4	III	4.20
K2	V	4.15	M5	III	4.25
K3	V	4.14	M7	III	4.29
K4	V	4.13	B0-F0	I	4.15
K5-M0	V	4.11	F5	I	4.16
M2	V	4.13	F8-G5	I	4.17
M3	V	4.14	G8	I	4.19
M5	V	4.16	K2-K4	I	4.20
M7	V	4.22	M2	I	4.26

For a comparison with the BV system, in Table 3 we give color excesses E_{B-V} , calculated with the relations given by Kurilienė & Sūdžius (1974). The distance was found by the equation

$$\log r = \frac{V - M_V + 5 - A_V}{5}.$$

The results of photometric classification, interstellar extinction and distance determination are given in Table 3, which contains: identification number, HD number, spectral class from the PPM Star Catalogue (1992), photometric spectral type, M_V , E_{Y-V} , E_{B-V} , A_V , distance r in parsecs, rounded to the nearest number multiple to 10 for $r > 150$ pc, and the weight of the two-dimensional quantification.

The maximum expected errors of A_V do not exceed 0.15 mag, the typical errors of absolute magnitudes M_V are ± 0.5 mag.

3. INTERSTELLAR EXTINCTION IN THE AREA

Fig. 2 shows the dependence of extinction on distance for the investigated area, plotted from the data of Table 3. Two regions with different run of extinction with distance may be separated: one of them is the Dark Cloud shown in Fig. 1 and the second one is more transparent region surrounding the cloud. The northern boundary of the Dark Cloud is not well defined due to small number of stars observed in this area. The slightly reddened stars start to appear at a distance of 160 pc in both regions. In the Dark Cloud region at $r = 250$ pc, the interstellar extinction begins to grow up very fast; in the surrounding region it starts to grow only at ~ 400 pc. A possible explanation is that we have here two dark clouds: the more distant cloud covers both regions and the nearer one covers only the Dark Cloud region. The inclined rise of extinction with distance in the Dark Cloud region may indicate that the ratio R_{YV} is larger than the normal value of 4.15. To get the vertical rise of extinction at $r = 400$ pc, this ratio should be of the order of 6 (or $R_{BV} \approx 4.5$).

Several stars from the Dark Cloud region (Nos. 42, 57, 70, 71, 113, 136, 137) show the extinction run with distance, which is more typical for the surrounding field. It may be caused either by the absolute magnitude errors or by transparent windows in the dust cloud. The presence of such windows is confirmed by star counts in small areas where these stars were observed. Three stars, i.e. No. 42 (K0 II, $M_V = -2.0$), No. 57 (BD+66°86, G4 II, $M_V = -3.9$) and No. 79 (BD+66°91, B2 II, $M_V = -4.7$) seem to be situated behind the dark cloud complex, but their absolute magnitudes are not very reliable. There is no indication at which distance the dark cloud ends. If the cloud extends to $r = 1$ kpc, as Fig. 2 seems to indicate, then it should be rather high (about 100 pc) above the galactic plane. To verify, more distant stars should be measured.

Fig. 2. Dependence of interstellar extinction on distance in the investigated area. Dots are stars situated in the Dark Cloud area, circles are for more transparent area. Different sizes of dots and circles correspond to different accuracy of classification.

Fig. 3. Dependence of interstellar extinction on distance in the galactic belt with the coordinates $l = 120^\circ - 130^\circ$, $b = +2^\circ - +10^\circ$.

Table 3. Results of quantification, extinction and distance determination.

No.	HD	PPM sp. type	Photom. sp. type	M_V	E_{Y-V}	E_{B-V}	A_V	r pc	W
1.*			K0 IV?	3.4:					
2.	4625	G5	F2 III	1.4	0.02	0.03	0.08	450	1
3.		K2	K4 III	-1.7	0.48	0.55	2.17	740	1
4.		K0	K3 III	0.1	0.32	0.36	1.34	360	2
5.			F5 V	3.7	0.03	0.04	0.12	170	3
6.		A0	A0 III	-1.6	0.34	0.44	1.41	890	3
7.			F4 IV	3.0	0.04	0.05	0.17	240	3
8.	4829	K0	K2 III	0.7	0.04	0.05	0.17	270	3
9.	4828	K5	M0 III	-0.6	0.38	0.42	1.59	340	1
10.		A5	F0 IV	2.2	0.03	0.03	0.11	290	3
11.	4948	A2	A1 V	1.5	0.05	0.07	0.21	210	3
12.		B5	B3 V	-1.9	0.50	0.66	2.07	900	1
13.			K0 III	-0.6	0.24	0.29	1.00	1060	1
14.			G1 V	4.8	0.01	0.02	0.04	110	2
15.			F3 III	-0.4	0.17	0.22	0.71	540	3
16.	5110	F0	F2 IV	2.9	0.02	0.03	0.08	65	3
17.			F8 IV	2.7	0.07	0.09	0.29	260	3
18.	5162	G5	F8 V	4.7	0.02	0.03	0.08	71	3
19.	5257	F5	F3 IV	2.9	0.05	0.07	0.21	180	3
20.			F6 V	3.7	0.12	0.16	0.50	170	2
21.		F8	F2 III	1.4	0.17	0.22	0.71	390	3
22.			K3 III	0.4	0.19	0.22	0.79	1080	1
23.		G0	F8 IV	3.0	0.05	0.06	0.21	200	3
24.		B8	B9 III	-1.1	0.49	0.64	2.03	480	2
25.	5326	A0	B4 V	-0.9	0.21	0.28	0.87	470	3
26.		F8	G1 III	0.9	0.41	0.51	1.71	910	1
27.	5352	A2	A1 III	-0.9	0.25	0.32	1.03	620	3
28.		K0	K0 III	0.0	0.22	0.26	0.92	510	3
29.			G5 III	0.7	0.38	0.46	1.59	400	1
30.	5476	F5	F1 IV	2.0	0.04	0.06	0.17	240	2
31.*		M0	M1 III	-1.6	0.44	0.49	1.84	450	1
32.		F8	F5 V	3.6	0.04	0.05	0.17	170	3
33.		A5	A8 III	1.5	0.08	0.10	0.33	370	3
34.	5535	A0	A1 V	1.3	0.20	0.26	0.83	320	3
35.*	5550	B9	B9 V	1.3	0.04	0.05	0.17	80	3
36.		A5	F0 III	1.5	0.05	0.07	0.21	480	3
37.	5563	F2	F2 IV	2.5	0.04	0.04	0.17	140	3
38.			F1 III	0.8	0.30	0.38	1.24	760	2
39.			G8 IV	2.0	0.34	0.42	1.42	260	2
40.			F8 V	4.1	0.05	0.06	0.21	210	3
41.			F9 V	4.3	0.15	0.19	0.62	320	2
42.			K0 II	-2.0	0.48	0.56	2.01	2850	1
43.		M0	M2 III	-0.5	0.26	0.29	1.09	460	1
44.			F1 III	-0.1	0.36	0.46	1.49	720	2
45.		F5	F2 V	3.0	0.04	0.05	0.17	220	3

Table 3 (continued)

No.	HD	PPM sp. type	Photom. sp. type	M_V	E_{Y-V}	E_{B-V}	A_V	r pc	W
46.			A5 V	1.8	0.27	0.35	1.12	420	2
47.			G7 III	1.0	0.28	0.34	1.17	360	3
48.			F5 V	3.6	0.07	0.09	0.29	300	3
49.			K1 III	-0.4	0.19	0.23	0.79	800	3
50.			K1 IV	3.7	0.25	0.30	1.04	280	1
51.			F6 V	3.8	0.15	0.20	0.62	260	3
52.			K1 III	1.1	0.10	0.12	0.42	430	3
53.			G2 V	4.5	0.09	0.12	0.37	350	1
54.		K2	K0 III	-0.7	0.25	0.30	1.04	780	2
55.		A0	A3 V	1.5	0.28	0.36	1.16	280	2
56.			B9 III	-1.7	0.78	1.02	3.23	660	1
57.		K2	G4 II	-3.9	0.46	0.56	1.92	1750	3
58.	5849	B9	B6 IV	-1.0	0.33	0.43	1.37	660	3
59.			F5 V	3.6	0.01	0.02	0.04	240	3
60.	5889	G0	F8 V	4.1	0.01	0.01	0.04	72	3
61.			K2 V	5.8	0.07	0.08	0.29	130	2
62.		K0	K1 IV	4.4	0.00	0.00	0.00	110	2
63.			F4 V	3.3	0.11	0.14	0.46	310	3
64.			F3 V	3.4	0.43	0.54	1.78	300	2
65.			A0 V	1.2	0.36	0.48	1.49	460	3
66.			F3 V	3.3	0.07	0.09	0.29	270	3
67.			K1 III	1.4	0.20	0.23	0.83	470	3
68.		F5	F6 V	4.1	0.05	0.06	0.21	160	3
69.			G0 III	1.7	0.10	0.12	0.42	590	3
70.			A0 V	0.6	0.57	0.75	2.36	650	3
71.		K2	K2 III	0.9	0.10	0.12	0.42	540	2
72.		F5	F4 V	3.3	0.12	0.15	0.50	160	1
73.		G5	F1 II	-4.0	0.68	0.87	2.82	1180	1
74.			A5 V	1.8	0.38	0.49	1.57	410	3
75.			F5 IV	3.0	0.09	0.11	0.37	250	3
76.	6091	F8	F4 V	3.2	0.01	0.02	0.04	160	3
77.			A5 IV	1.4	0.17	0.21	0.70	470	3
78.			F5 V	3.6	0.10	0.12	0.41	260	1
79.			B2 I	-4.7	0.81	1.09	3.36	2220	2
80.			B8 III	-0.6	0.57	0.75	2.36	870	2
81.			G0 V	4.4	0.09	0.11	0.37	210	1
82.			A8 V	2.9	0.36	0.47	1.49	370	1
83.			B8 III	-0.6	0.66	0.87	2.73	1080	2
84.			G3 V	4.8	0.07	0.08	0.29	250	1
85.			G8 III	-1.1	0.75	0.91	3.13	1370	1
86.			F5 IV	3.1	0.53	0.68	2.20	240	1
87.			F8 V	4.2	0.07	0.08	0.29	140	1
88.*	6343	B8	B7 III	-1.3	0.19	0.26	0.79	360	3
89.		A	A0 III	-0.1	0.16	0.21	0.66	570	3
90.			A0 V	0.7	0.47	0.61	1.94	420	1

Table 3 (continued)

No.	HD	PPM sp. type	Photom. sp. type	M_V	E_{Y-V}	E_{B-V}	A_V	r pc	W
91.*			K-M?						
92.	6415	A0	A0 III	0.0	0.21	0.27	0.87	340	3
93.*			K-M?						
94.			F6 IV	3.3	0.24	0.30	1.00	350	2
95.		F0	F3 IV	2.3	0.08	0.10	0.33	360	2
96.*			F7 III	1.7	0.29	0.37	1.20	580	1
97.*	6599	K0	K0 III	-0.5	0.56	0.67	2.34	220	1
98.			G5 IV	3.4	0.04	0.05	0.17	200	3
99.			B7 III	-1.6	0.68	0.89	2.82	730	2
100.			F1 III	1.6	0.52	0.66	2.16	410	2
101.			F5 V	3.6	0.08	0.11	0.33	250	3
102.		F8	B8 V	0.1	0.32	0.43	1.33	480	3
103.			F8 V	4.1	0.10	0.12	0.42	280	3
104.*			A1 V	1.5	0.20	0.27	0.83	500	2
105.	6821	K0	K0 III	1.0	0.17	0.20	0.71	270	1
106.	6831	F2	F3 III	1.8	0.04	0.05	0.17	260	2
107.	6830	G0	G0 V	4.5	0.02	0.03	0.08	80	2
108.			F1 IV	2.2	0.11	0.15	0.46	370	3
109.			G0 IV	2.9	0.11	0.13	0.46	260	2
110.		A5	F1 III	1.7	0.01	0.01	0.04	390	3
111.*			B8 III	-0.6	0.70	0.92	2.90	690	1
112.	6985	K0	K1 III	0.7	0.10	0.11	0.42	300	3
113.		G5	K0 III	0.0	0.28	0.34	1.17	640	2
114.		B5	B9 III	-1.7	0.59	0.78	2.44	560	2
115.		A5	F2 III	1.4	0.02	0.03	0.08	450	1
116.			F8 V	4.2	0.03	0.04	0.12	180	1
117.	7263	K0	K0 III	-0.4	0.14	0.17	0.58	560	3
118.			F8 V	4.2	0.05	0.06	0.21	160	2
119.		F0	F4 IV	2.9	0.05	0.06	0.21	250	3
120.	7443	F5	F3 IV	2.5	0.02	0.02	0.08	160	3
121.*			B7 III	-2.3	0.71	0.94	2.94	920	1
122.			G1 V	4.7	0.01	0.02	0.04	170	2
123.			K0 III	-0.3	0.24	0.29	1.00	810	2
124.			F2 V	2.9	0.03	0.03	0.12	230	3
125.		F5	F5 III	1.6	0.06	0.07	0.25	360	2
126.			F0 IV	2.3	0.13	0.17	0.54	320	3
127.			F3 IV	2.4	0.08	0.10	0.33	380	2
128.			F2 V	3.0	0.13	0.17	0.54	380	3
129.			F5 V	3.6	0.07	0.09	0.29	270	1
130.*	7842	A0	A5 V	2.3	0.06	0.07	0.25	220	3
131.			B7 IV	-0.5	0.56	0.74	2.32	550	3
132.	7901	A3	F1 III	2.0	0.02	0.02	0.08	190	3
133.			F3 III	1.2	0.13	0.17	0.54	410	2
134.	7940	K0	F8 V	3.7	0.04	0.05	0.17	130	3
135.			F5 V	3.6	0.04	0.05	0.17	190	3

Table 3 (continued)

No.	HD	PPM sp. type	Photom. sp. type	M_V	E_{Y-V}	E_{B-V}	A_V	r pc	W
136.			G0 IV	2.6	0.07	0.09	0.29	400	3
137.			G1 IV	3.4	0.05	0.06	0.21	420	3
138.			B9 V	0.7	0.41	0.54	1.70	440	1
139.			A0 IV	0.3	0.41	0.54	1.70	530	2
140.	8123	K2	K5 III	0.9	0.16	0.18	0.67	280	2
141.		F8	F5 V	3.7	0.06	0.08	0.25	120	2
142.			F7 V	3.9	0.03	0.04	0.12	190	3
143.*			F5 IV	3.0	0.08	0.11	0.33	220	3
144.		B5	B9 III	-1.0	0.46	0.60	1.90	440	3
145.			K0 II	-2.6	0.80	0.94	3.36	770	2
146.			F5 V	3.6	0.10	0.13	0.41	220	2
147.	8607	F0	F1 III	1.6	0.02	0.02	0.08	260	3
148.			F4 V	3.6	0.02	0.02	0.08	240	3
149.		A	A0 III	-0.9	0.40	0.53	1.66	670	2
150.	8633	B8	B9 III	-0.8	0.43	0.56	1.78	460	3
151.*		K5	K0 III	0.9	0.51	0.61	2.13	190	1
152.	8756	A3	B5 IV	-1.2	0.10	0.13	0.41	870	3

Notes to Table 3:

1. Photometric classification uncertain; interstellar extinction seems to be too high for this distance; unresolved binary?
31. Buscombe (1984) gives M2 III;
35. Jashek (1978) gives A0 III;
88. Buscombe (1984) gives B5 Vne;
91. Photometric classification uncertain due to low accuracy of the short wavelength indices;
93. Photometric classification uncertain due to low accuracy of the short wavelength indices;
96. ADS 927C at 37.7" from the components A+B;
97. Close binary ADS 927AB; the faint component of 12.5 mag is at 2.8"; both stars were measured together;
104. Binary; the faint component of 12.9 mag is at 15"; only the bright component was measured;
111. Binary; only the bright component was measured;
121. Buscombe (1984) gives A0 Ib;
130. Binary; the faint component of 14.3 mag is at 20"; only the bright component was measured;
143. Binary; the faint component of 14.2 mag is at 17"; only the bright component was measured;
151. Photometric classification uncertain, interstellar extinction seems to be too high for this distance; unresolved binary?

Fig. 3 shows the run of interstellar extinction in a wide belt with the galactic coordinates $l = 120^\circ - 130^\circ$ and $b = +2^\circ - +10^\circ$. The data are taken from the catalogue of Guarinos (1992), now accessible on Internet. One can see that the main rise of interstellar extinction takes place between 200 and 1000 pc. The mean value of interstellar extinction at larger distances is about 2.5 mag and does not grow up with distance. A comparison of Figs. 2 and 3 shows that the investigated area is covered by more opaque clouds than the surrounding region: in our area the maximum value of extinction is 3.4 mag.

Some stars in the foreground, closer than 200 pc, exhibit too large extinction for their distance. Probably, these stars are either unresolved binaries of close spectral types or peculiar objects. They are marked by asterisks in Table 3 and are not plotted in Fig. 3.

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