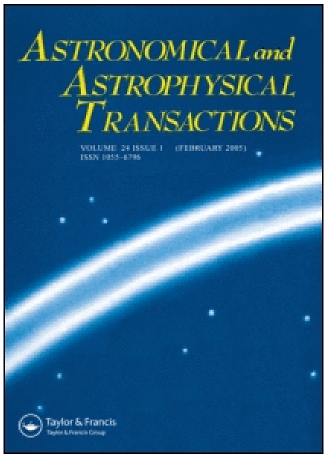

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DISTANCES TO THREE NEARBY DWARF GALAXIES FROM PHOTOMETRY OF THEIR BRIGHTEST STARS

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For dwarf galaxies Holmberg II, Holmberg I and UGCA 105 located in the NGC 2403 neighbourhood, the photographic photometry of their bright stellar population with an account for photoelectric standards has been made. Over the three brightest red, and three brightest blue supergiants, the following distance moduli are obtained: $27^m_.78$ for HoII, $29^m_.11$ for HoI and $27^m_.60$ for UGCA 105. An essential discrepance between our estimate of distance to HoI and the previous estimates is discussed.

KEY WORDS Dwarf galaxies, Nearby galaxies, Distances to galaxies

1. INTRODUCTION

Nearby galaxies resolved into stars give an opportunity to use separate brightest stars (cepheids or supergiants) to determine their distances. Here, a neighbouring group of galaxies, M81 + NGC 2403, enables us to compare various methods of distance determination. In these galaxies cepheids were found and supergiants brightness have been determined (Freedman, Madore, 1988, Humphreys *et al.*, 1986). Besides the bright galaxies, in the neighbourhood of M81 group, there are irregular dwarf galaxies, also resolved into stars, and the question arises on their belonging to the M81 system. Not far from the M81 + NGC 2403 group there is an insufficiently explored group around IC 342. Both groups are likely to form a common filament structure. To corroborate this hypothesis one should know, for all the galaxies, their distance moduli, which is very indefinitely known to date.

To determine the distance moduli based on cepheid luminosity curves is more reliable, but cepheid are not searched for in all the galaxies, and long-time observations are needed to obtain the cepheids' period. Use of the brightest supergiants may be applied for all the galaxies resolved on stars but it has its shortcomings caused by uncertainty of supergiant luminosity, that is, its dependence on the luminosity of parent galaxy. Furthermore, both methods are subject to uncertainty because of light absorption inside the studied galaxy.

The galaxies HoI (DDO 63, UGC 5139, K 57, MCG 12–9–59) and HoII (DDO 50, UGC 4305, Arp 268, VII Zw 225) are located in the boundaries of M81 + NGC 2403 group and have corrected radial velocities, respectively, +310 km/s and +332 km/s. Photometry of bright stars in these galaxies allowed Sandage and Tamman (1974) (here and further ST) to consider them be the members of the group. Later in the galaxies HoI and HoII, mass photometry of stars was provided in the GRI system by Hossel, Danielson (1984), (HD). But the work was aimed to study stellar luminosity function, without taking the distance modulus problem into consideration. To somewhat smaller distance modulus than that in ST paper was obtained for HoII by Moss and Irwin (1988). We must note, that the small scale of the plates used by them hampers the separation of stellar objects from diffuse or multiple ones.

The UGCA 105 galaxy is usually associated with giant spiral galaxy IC 342 only because of their mutual location in the sky. But the distance to IC 342 itself is accepted to be from 1.5 Mpc (Ables, 1971) to 8 Mpc (Sandage, Tammann, 1974b), which caused considerable uncertainty in understanding the spatial geometry of this group. There was not any direct attempt to determine the distance moduli for UGCA 105.

Using the large scale plates for galaxies in M81 group obtained with the 6-m telescope and also new photoelectric data for reliable standards, we fulfilled the search and photometry of bright stellar population in these galaxies. This allowed us to produce independent estimates of their distances.

2. OBSERVATIONS AND DATA REDUCTION

For the search and photometry of supergiants in the studied galaxies, we used B (IIaO + GG13) and V (IIaD + GG14) plates obtained with the scale 8″192/mm

Table 1 Photoelectric sequences near HoI, HoII and UGCA105

Galaxy	*Star*	B_{phe}	V_{phe}	B_{phg}	V_{phg}
	a	16.62	16.00	16.64	16.23
HoI	b	17.94	17.25	17.72	17.03
	c	18.85	17.62	19.03	17.61
	B	16.96	16.27	17.05	16.49
	C[a]	17.58	16.80	17.60	16.95
	D[a]	19.06	18.61	19.10	18.55
	E[a]	19.78	18.77	19.75	18.72
HoII	F[a]	19.93	18.38	19.90	18.45
	G[b]	19.94	19.25	20.55	19.86
	H[a]	20.20	18.33	19.97	18.45
	I	21.15	20.37	21.09	19.61
	J[a]	20.77	19.80	20.78	19.48
	a	16.89	16.06	—	—
UGCA105	b	18.90	18.20	18.91	18.26
	c	20.62	19.17	20.62	19.12

a[a] Photoelectric standarts from ST (1974).
[b] Variable.

in the prime focus of the 6 m telescope in 1982–84. Atmospheric seeing on the plates was about 1".5, and limiting apparent magnitudes correspond to 24^m in B and 23^m in V systems. The comparison of B and V plates allowed us to reveal in each galaxy several dozens of blue and red stars. Their photometry was then fulfilled using the automatic microdensitomer AMD-1. Details of photometry are described by Tikhonov *et al.* (1991). The zero-point calibration was based on photoelectric observations of several stars in the plates framework made in December, 1986. The equipment used for photoelectric photometry at the 6 m telescope is described by Neizvestnyi and Pimonov (1978). As initial photoelectric standards during the same night some stars in the regions of the NGC 6946, IC 2574, NGC 2403 and HoIX were being observed. Their intercomparison demonstrates a good mutual convergence. All the photoelectric data for stars in the galaxies HoII, HoI and UGCA 105 are presented in Table 1. For each galaxy a designation of standard stars is shown on blue colour prints. Note, by the way, that our photoelectric measurements for B and I stars in HoII with the results by ST, revealed their significant difference. Perhaps these stars are really variable, since the zero-point of our photoelectric measurements differs very little from the one obtained at our plates based on the measurements of all the ST photoelectric sequence. For HoI and UGCA 105, we did not find in the literature any indications to photoelectric standards existing.

As for the standards, relatively bright stars of 18^m–20^m were used, and photographic photometry was carried out up to 23^m–24^m, we must be sure in a linearity of our photometric scale. In Figure 1 our photographic B-magnitudes for single isolated stars in HoI and HoII are compared with the results of CCD photometry made by Hoessel and Danielson (1984). Here is a good agreement of two photometric scales over the interval $\Delta m \simeq 4^m$. A similar situation is observed also for V-magnitude scale.

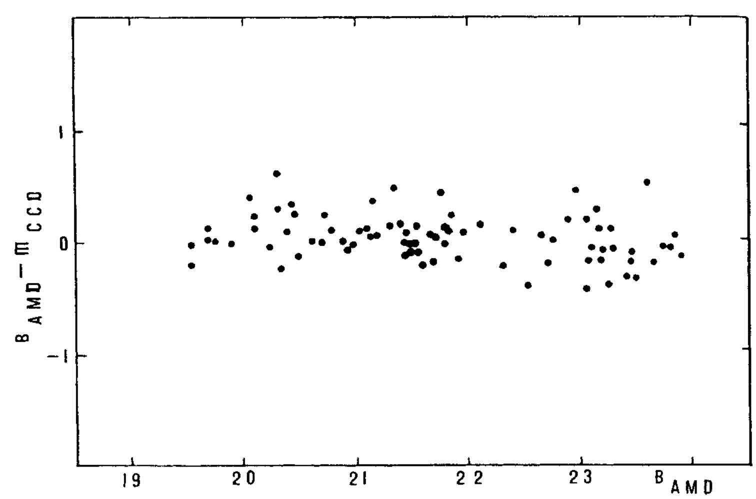

Figure 1 Comparison of photographic magnitudes (AMD) with the CCD-measurements for the stars in HoI and HoII.

3. COLOUR-MAGNITUDE DIAGRAMS

(*a*) *Holmberg II*

Search of candidates for red and blue supergiants was carried out by blinking B and V plates. After the photometry of more than two hundred stars in the galaxian body and its neighbourhood, we selected the objects with the colour index $B-V>1.4$ and $B-V<+0.4$ inside of visible boarders of HoII. (Fig. 2) The results are shown in Table 2. In the first column the ordinal number of the

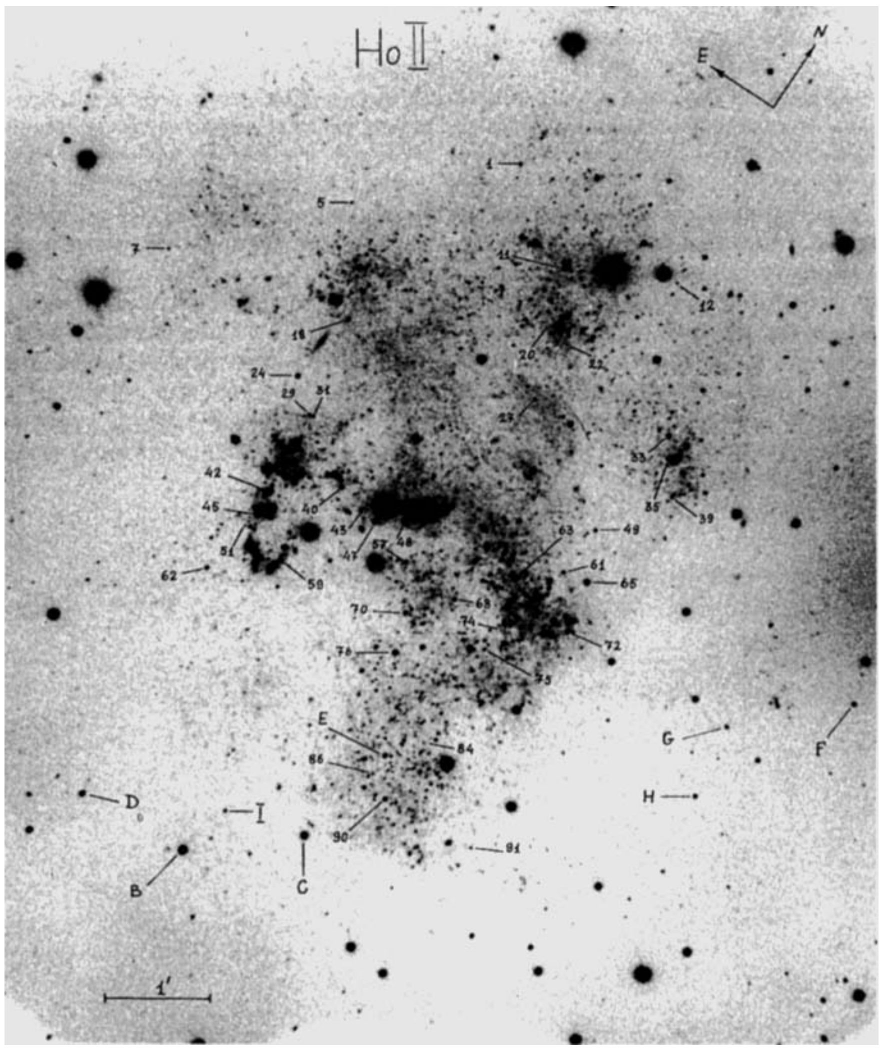

Figure 2 HoII reproduction from the blue plate obtained at the 6 m telescope. Orientation and scale are given in corners. Numbers mark brightest blue and red stars, and letters mark photoelectric standards.

Table 2 The brightest blue and red stars in Holmberg II.

n° (1)	*x* (2)	*y* (3)	*V* (4)	*B−V* (5)	*Notes* (6)
1	24.66	48.29	19.49	1.50	178
2	24.75	53.70	21.27	1.41	117
3	26.14	87.74	21.87	0.08	—
4	27.28	39.97	21.46	−0.11	B27
5	27.76	60.23	20.12	1.53	102
6	31.13	39.75	21.35	−0.02	—
7	31.43	73.17	20.15	1.96	—
8	31.49	59.04	21.24	0.23	108
9	31.82	44.05	21.60	1.40	251
10	31.89	48.36	21.75	−0.31	B30
11	32.03	44.98	20.48	0.25	B18, 237
12	32.99	36.91	20.71	1.57	R1, 397
13	33.77	39.75	21.49	1.61	349
14	34.00	59.33	21.62	1.98	115
15	34.53	44.76	21.22	1.70	264
16	34.55	46.81	21.73	1.97	234
17	35.46	39.65	21.09	0.39	373
18	36.20	60.22	20.15	−0.04	B6, 120
19	36.48	43.52	20.62	0.05	B13, 300
20	36.50	46.17	20.84	2.15:	R7, 260
21	36.81	45.74	21.26	−0.52	B19, 270
22	37.65	44.60	20.80	2.20:	R3, 293
23	38.12	52.18	21.38	0.07	215
24	40.40	63.71	19.37	0.34	B3, 111
25	40.41	37.18	22.19	−0.36	490
26	40.68	47.29	22.28	−0.39	286
27	41.61	46.82	19.52	1.68	296
28	42.28	36.98	21.48	−0.08	518
29	43.16	62.79	19.70	1.47	135
30	43.18	85.90	22.39	−0.35	—
31	43.31	62.53	19.63	1.67	140
32	43.71	46.09	21.80	1.50	332
33	43.96	37.16	19.94	−0.03	B4, 524
34	44.21	34.83	21.23	−0.29	551
35	45.57	37.07	20.03	0.03	B8, 539
36	46.72	34.64	20.85	0.17	B24, 562
37	47.47	35.64	21.71	0.05	558
38	48.09	63.58	20.86	0.25	162
39	48.31	36.78	20.70	−0.35	B16, 555
40	48.31	60.38	20.46	−0.35	B7, 201
41	48.33	65.32	21.70	−0.25	—
42	48.75	65.52	16.94	1.58	—
43	49.42	58.52	20.40	1.88	219
44	49.77	36.83	22.34	−0.31	—
45	50.46	66.32	20.36	−0.09	B14, 146
46	50.51	48.45	21.30	−0.12	B29
47	50.51	57.91	20.58	−0.40	—
48	50.76	55.81	20.33	−0.03	242
49	50.89	42.18	20.43	0.07	B12, 516
50	51.07	50.09	20.86	−0.08	B23, 341
51	51.24	67.20	20.26	2.31	136
52	51.31	66.79	20.92	−0.11	147
53	51.46	50.53	21.04	1.56	334
54	51.67	63.98	21.69	−0.32	B31, 179
55	52.18	69.54	21.56	−0.26	121
56	52.79	47.98	21.35	−0.57	B17, 416
57	53.51	55.63	18.80	1.59	267
58	53.58	61.07	20.66	0.01	B15, 216
59	53.64	64.47	20.70	−0.28	189
60	53.82	48.95	20.79	1.77	404
61	53.99	44.40	19.03	1.57	506
62	54.32	69.76	20.13	0.30	131
63	54.45	47.85	20.00	−0.31	B1, 439
64	54.62	48.18	21.08	1.79	435
65	54.65	42.72	19.52	0.03	B2, 535
66	55.03	53.38	21.68	1.72	317
67	55.55	66.72	20.84	0.30	200
68	56.14	52.08	20.54	−0.19	B11, 368
69	57.08	58.15	21.30	1.85	261
70	57.19	55.55	20.43	−0.11	303
71	57.22	48.68	21.30	2.00	453
72	58.23	44.00	20.12	0.08	B9, 544
73	58.30	49.50	21.55	−0.12	448
74	59.38	48.45	20.76	2.30	473
75	59.70	49.84	19.70	1.51	459
76	60.10	56.20	18.96	−0.06	B5, 322
77	60.21	43.77	21.54	0.02	554
78	60.26	50.38	22.11	−0.33	456
79	61.33	57.58	21.84	−0.09	—
80	61.80	56.77	21.70	2.00	330
81	62.37	51.36	21.08	−0.09	B25, 462
82	64.42	52.80	21.58	−0.45	B26, 455
83	66.33	53.13	20.96	−0.06	B20, 474
84	66.55	54.01	20.93	1.54	R4, 457
85	68.75	52.98	20.81	0.23	507
86	68.88	57.49	20.82	1.53	R8, 410
87	69.51	54.24	21.51	1.98	—
88	69.89	58.11	20.67	0.01	409
89	69.97	53.68	21.63	−0.08	511
90	70.68	56.61	20.63	−0.26	B10
91	74.01	50.43	20.10	1.46	—
92	74.86	66.14	21.46	0.05	—
93	75.31	51.29	22.19	−0.26	—
94	75.42	36.75	21.67	−0.34	—
95	77.05	55.97	21.94	0.10	
96	77.46	39.07	21.78	−0.14	
97	86.01	58.01	22.20	−0.31	
98	92.27	68.51	21.38	0.32	

star is given, in the second and third—rectangular coordinates in an arbitrary system, in the fourth—apparent yellow magnitude, in the fifth—the colour index. The last column contains identifications with the numbers of blue (B) and red (R) stars by ST, and also the three-digit numbers according to the HD list.

Star arrangement according to their luminosities and comparison to the brightest blue and red stars from the list by ST, shows that some stars are variable. In particular, the star B5 has increased its brightness by $1^m.2$. Note, that a variability of supergiants is an additional source of scattering in Figure 1.

The "colour-magnitude" diagram for the brightest stars in HoII is presented in Figure 3. Stars measured by us are shown by filled circles. Fifteen red stars from the HD list are drawn by points. The three brightest blue stars (65 = B2, 63 = B1, 33 = B4), and three red ones (7, 51, 43), were chosen by us as distance indicators. The star B5 was excluded as being variable in its outburst stage, and B3—being yellowish. Opposite to the blue stars, the appearance of HoII over the surrounding background is not too large in the case of red stars. It is caused by rather low galactic latitude of HoII, $b = 32^\circ.7$. According to red star counts outside the main body of the galaxy, the expected number of background stars with the index B–V > 1.6 is ~5 in its boarders. Accounting for this consideration, we excluded brighter and less red stars in Figure 3 as background objects. Thus, for the three brightest red supergiants, we obtained the mean apparent magnitude $\langle V(3)\rangle_R = 20^m.27$, which yields the distance modulus $\mu_0^R = 27^m.29$ with the absolute magnitude $\langle M_3^v\rangle_R = -7.7$ and the correction for absorption $A_v = 0.28$ (de Vaucouleurs, 1978).

The mean apparent magnitude for three brightest blue supergiants is $\langle B(3)\rangle_B = 19^m.72$. According to de Vaucouleurs, (1978) for a galaxy with the integral absolute magnitude $M_T^B = -16^m.8$, the mean absolute magnitude of its

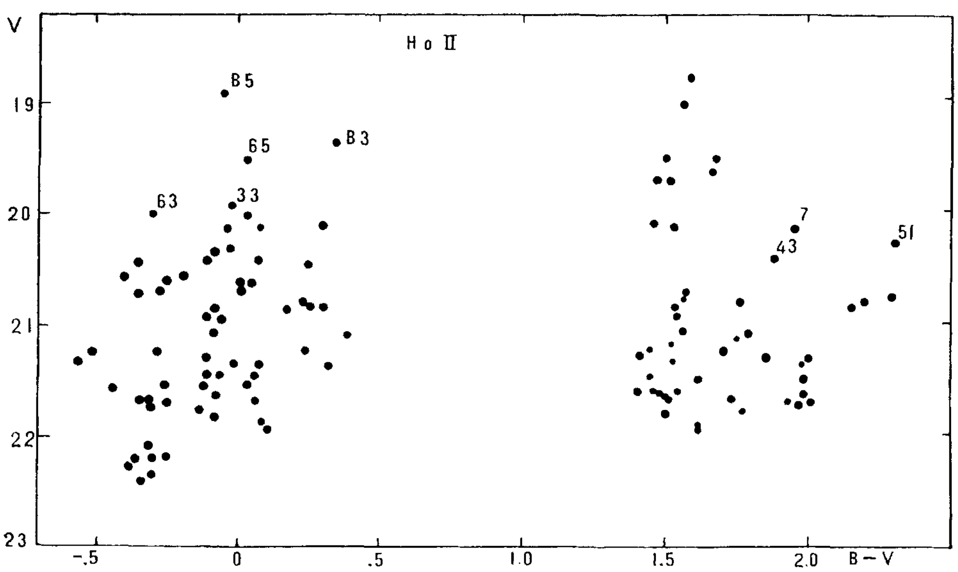

Figure 3 The colour-magnitude diagram for Holmberg II.

three brightest blue stars is $\langle M_3^B \rangle_B = -8^{\mathrm{m}}.6$. After applying the correction for extinction ($A_B = 0.36$) this may be used to obtain another estimate for the distance modulus: $\mu_0^B = 27^{\mathrm{m}}.96$. Note, good mutual agreement of these estimates.

(*b*) *Holmberg I*

The structure of this galaxy looks less contrast as compared to HoII. Its reproducton made from one of our two blue plates is shown in Figure 4. Basing on our photoelectric standards, we fulfilled the seach and photometry of blue and

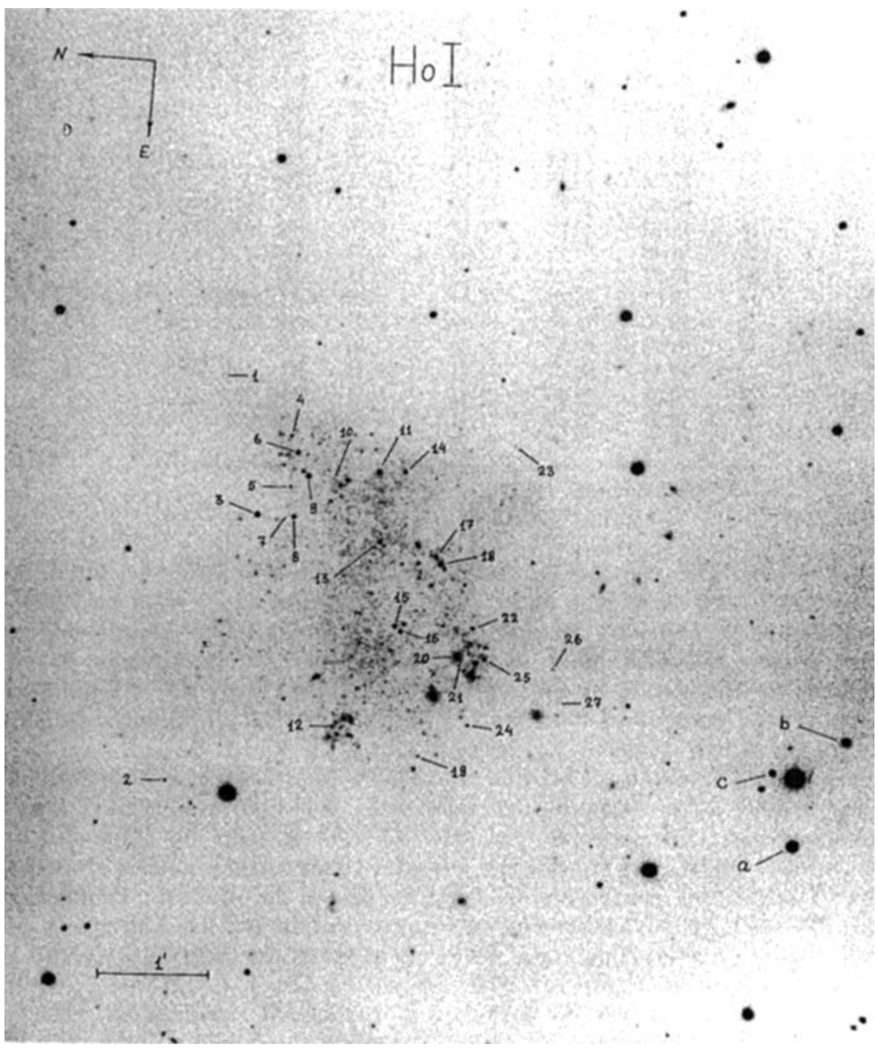

Figure 4 HoI reproduction from the blue plate. Letters represent standard stars; numbers mark the brightest blue and red stars.

Table 3 The brightest blue and red stars in Holmberg I.

$n°$ (1)	x (2)	y (3)	V (4)	$B-V$ (5)	*Note* (6)
1	38.10	60.64	21.97	1.80	—
2	40.35	88.35	21.78	−0.12	113
3	42.62	69.65	18.92	0.63	B1
4	43.79	64.06	22.11	−0.35	367
5	44.37	67.35	22.21	−0.16	335
6	44.41	65.05	20.46	0.05	B3, 358
7	44.58	69.07	22.14	1.60	327
8	45.00	69.27	19.59	0.83	B4
9	45.40	66.42	20.16	0.06	B2, 344
10	47.15	66.52	21.85	1.61	345
11	49.90	65.14	21.05	0.09	B7, 356, (D)
12	50.40	82.48	22.19	−0.35	B12, 139
13	50.93	69.69	20.41	0.31	B6, 311
14	51.60	64.78	21.98	−0.49	359, (D:)
15	53.07	74.99	19.34	1.65	251
16	53.52	75.26	21.55	0.25	244
17	54.81	69.91	21.33	0.22	B9, 307, (D:)
18	55.23	70.27	20.37	0.50	B8, 304, (D)
19	56.40	83.21	20.42	1.53	130
20	57.57	76.30	21.25	−0.15	227
21	57.87	76.33	21.51	2.00	R1, 225
22	58.30	74.00	21.66	−0.31	263
23	58.73	62.68	21.34	1.69	378:
24	59.19	80.47	21.81	−0.12	B11, 169
25	59.34	75.95	21.65	0.11	B10, 233
26	63.93	75.57	21.31	1.62	240, (D)
27	64.72	77.68	21.75	2.00	—

D—diffuse image.

red stars in HoI. The photometry results are presented in Table 3. The data are organized there the same way as in Table 2. Marking of 27 stars in Table 3 is given in Figure 4. The stars measured by us are shown in the colour-magnitude diagram (Figure 5) with filled circles. Accounting for the results of CCD-photometry for this galaxy by Hoessel and Danielson (1984), we did not seek to measure a large number of faint stars. The data of HD photometry for fainter blue stars are shown by points in Figure 5.

Sandage and Tammann (1974) had no reliable photometric sequence for HoI. For this reason their selection of candidates for blue supergiants was not successful enough. For example, the stars B1, B4 of their list appeared to be rather yellow objects, and we did not consider them further. Other objects (B7, B8) are of non-stellar appearance. Among the rest of the stars, the brightest stars B2 and B3 seem to be background stars, accounting for the luminosity break between them and other blue stars. Thus, we adopted the stars #20, 22 and 14 as three brightest blue supergiants in HoI. They have $\langle B(3) \rangle_B = 21^{m}.31$.

It was somewhat easier to select red supergiant candidates. Based on neighbouring star photometry we expect the number of background stars to be $N \sim 3$ in galaxian borders among the stars with B–V >1.5. Having excluded the stars #15 and #19 being too bright, and the object #26 as a probable distant

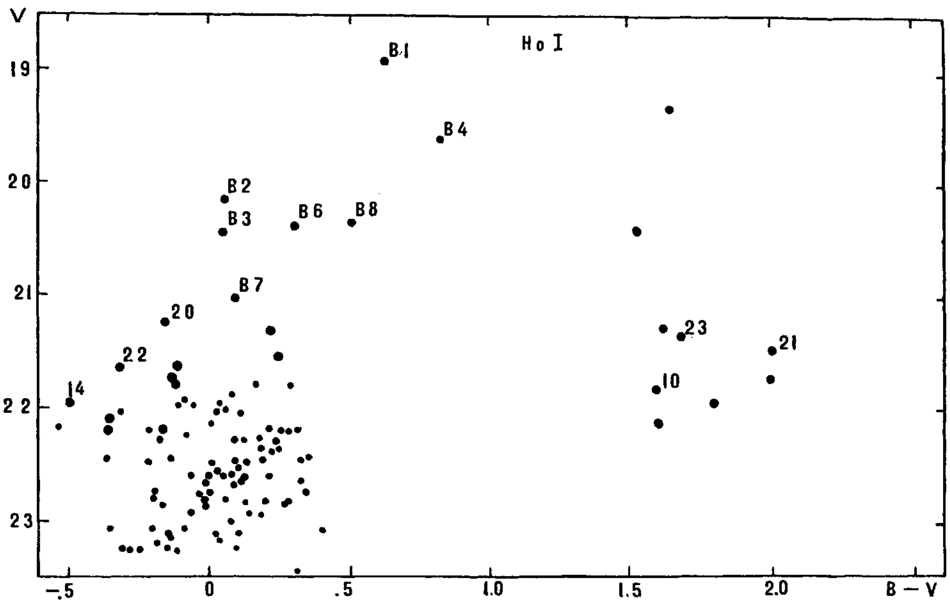

Figure 5 Colour-magnitude diagram for Holmberg I. Filled circles correspond to our data, points—to HD measurements.

galaxy, we obtain for the stars #23, 21 and 10, the average $\langle V(3)\rangle_R = 21^m\!.57$. With $\langle M_3^V\rangle_R = -7.7$ and $A_v = 0.25$ (de Vaucouleurs, 1978), we obtain the distance modulus $\mu_0^R = 29^m\!.02$.

This value may be compared with the distance modulus according to the three brightest blue stars. Using $\langle M_3^B\rangle_B = -8.6$ for the galaxy with the absolute magnitude $M_T^B = -16.0$, and $A_B = 0.36$, we obtain $\mu_0^B = 29^m\!.29$. Both estimates also agree well enough here.

(c) *UGCA 105*

This galaxy with the radial velocity $V_0 = +305$ km/s is located at the low galactic latitude ($b = 13.7$) and because of absorption it looks at Palomar Prints like a pallid spot with faint spiral features. As far as we know, it was first resolved on stars at our plates. UGCA 105 reproduction from a blue negative is presented in Figure 6. We carried out the photometry of more than 300 blue and red stars in the galaxian body and in its neighbourhood. Most blue (B–V < 0.4) and most red (B–V > 1.8) objects are gathered in Table 4. Column designations in it are the same as in the previous tables. The colour-magnitude diagram for the stars inside the apparent galaxian boundary is shown in Figure 7. Three red and three blue stars selected as brightest supergiants are marked with their numbers. According to Burstein and Heiles (1982, 1984), galactic absorption in the direction of UGCA 105 is $A_B = 1^m\!.36$ and $A_v = 1^m\!.03$. Colour excess CE = 0.33 is clearly seen when one compare Figure 7 with Figures 3 and 5. A number of Milky Way red stars is projected on the galactic body. Their expected number is estimated by us

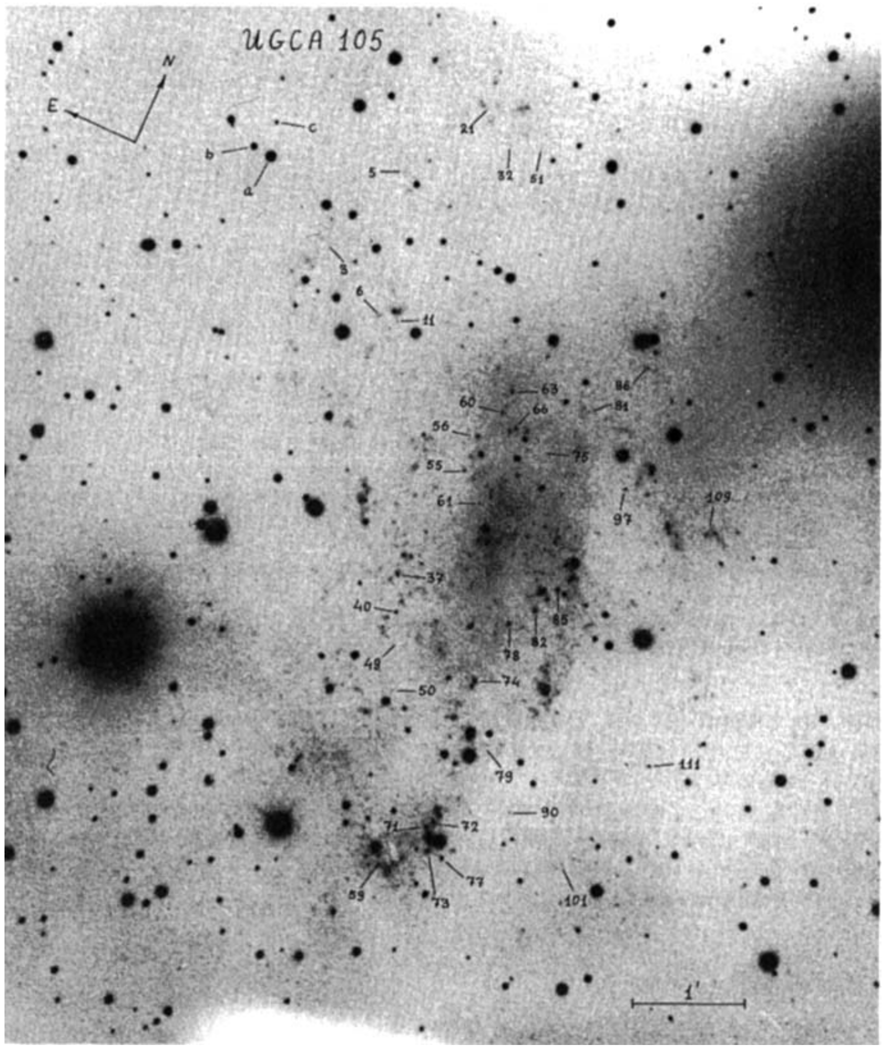

Figure 6 UGCA 105 reproduction from the blue plate. Star designations are analogous to the previous figures. The north-west corner is lighted up by a bright star.

to be 10. For this reason, we were selecting red supergiant candidates mostly in the central region of the galaxy.

Thus, with mean apparent magnitudes of brightest supergiants $\langle V(3)\rangle_R = 20.88$ and $\langle B(3)\rangle_B = 20.87$, the above-mentioned corrections for absorption A_B, A_v and mean absolute magnitudes $\langle M_3^v\rangle_R = -7.7$, $\langle M_3^B\rangle_B = -8.2$ the distance moduli of the galaxy are $\mu_0^R = 27^{\mathrm{m}}.55$ and $\mu_0^B = 27^{\mathrm{m}}.71$. Hence, UGCA 105 has the distance typical for the M81 group members.

Table 4 The brightest blue and red stars in UGCA 105.

$n°$ (1)	x (2)	y (3)	V (4)	$B-V$ (5)	*Note* (6)	$n°$ (1)	x (2)	y (3)	V (4)	$B-V$ (5)	*Note* (6)
1	54.36	35.08	21.90	0.23		58	69.12	37.79	21.65	0.26	D
2	55.92	31.06	22.27	0.10		59	70.12	71.81	21.55	0.18	
3	56.25	32.69	20.98	1.89		60	70.14	40.51	21.85	−0.28	M?
4	58.87	42.44	22.41	−0.23		61	70.23	46.72	20.78	2.01	
5	59.89	26.29	21.05	2.07		62	70.26	56.97	22.49	−0.17	
6	60.62	35.46	21.61	0.06	E	63	70.37	39.08	21.34	0.31	M?
7	60.69	34.20	22.21	0.38		64	70.90	41.66	22.02	−0.09	
8	61.15	34.65	21.86	0.38		65	71.02	70.61	21.77	2.23	
9	61.29	46.87	21.68	0.25		66	71.25	41.32	21.45	−0.13	
10	61.82	49.32	22.02	0.35		67	71.28	45.28	21.79	0.22	D
11	61.91	36.50	20.76	2.05		68	71.95	46.54	21.94	0.04	B
12	62.66	21.52	21.74	1.96		69	71.99	41.34	21.99	−0.11	D?
13	62.99	49.37	22.77	−0.21		70	72.42	62.32	21.73	0.16	
14	63.34	20.91	22.86	0.20		71	72.56	68.54	20.91	0.03	
15	63.55	48.53	22.25	0.36		72	72.83	68.07	21.09	0.18	D
16	63.59	21.14	22.46	−0.12		73	73.01	70.04	21.25	0.05	D?
17	63.66	60.70	22.06	0.30		74	73.03	58.33	20.47	0.18	
18	63.88	64.68	22.74	0.03		75	73.40	42.47	21.09	2.21	
19	63.88	58.86	22.50	0.20		76	73.76	48.09	22.18	0.15	
20	63.92	19.53	21.80	0.06	D	77	74.03	70.27	20.90	0.15	
21	63.93	21.24	21.19	1.82		78	74.19	54.06	20.88	0.13	E
22	64.20	22.11	22.24	0.09		79	74.89	62.19	21.36	1.94	
23	64.33	63.78	22.26	−0.03		80	75.11	48.62	22.23	0.32	
24	64.87	46.35	21.52	1.91		81	75.57	39.13	21.15	2.15	
25	64.92	53.22	22.82	−0.27		82	75.62	52.77	21.13	0.02	D?
26	64.93	43.83	22.46	−0.17		83	75.79	47.62	21.59	0.25	
27	65.03	52.66	22.78	−0.18		84	76.53	58.79	22.50	−0.01	
28	65.68	60.86	22.29	−0.03		85	76.66	51.02	21.25	0.12	D?
29	65.71	50.89	22.76	0.11		86	76.99	56.36	21.74	0.30	
30	65.90	53.15	21.92	0.21		87	77.12	48.08	22.48	−0.09	
31	66.01	50.08	22.95	−2.06		88	77.33	56.53	21.85	0.36	
32	66.03	23.19	20.83	2.05		89	77.33	56.11	22.15	0.14	
33	66.05	47.34	21.90	0.26		90	77.51	66.18	20.66	2.07	
34	66.15	53.45	23.00	0.11		91	77.61	60.46	22.58	−0.06	
35	66.23	56.36	21.52	0.37		92	77.81	58.63	22.07	0.26	
36	66.25	50.56	22.90	−0.23		93	78.06	51.85	22.24	0.31	
37	66.29	52.71	20.87	0.28	D	94	78.26	46.63	22.26	0.10	
38	66.39	20.60	21.83	0.12	B	95	78.46	57.59	21.81	0.40	
39	66.39	33.44	21.76	0.36	D?	96	78.50	35.25	21.54	−0.17	
40	66.84	55.21	21.00	0.27		97	79.21	43.36	21.47	0.03	
41	66.89	63.09	22.73	−0.17		98	79.91	42.32	22.18	0.08	
42	67.00	54.43	21.58	0.28		99	81.48	56.72	22.38	0.31	
43	67.22	46.45	22.00	0.32		100	81.62	50.53	22.21	0.11	
44	67.22	74.61	22.69	−0.10		101	81.76	68.68	21.27	1.93	D
45	67.36	63.78	22.52	0.16		102	82.01	42.23	22.05	1.95	
46	67.52	62.42	22.79	−0.21		103	82.06	46.34	22.26	0.13	
47	67.63	51.61	21.93	0.08		104	83.25	57.04	22.07	0.23	
48	67.85	63.41	22.18	0.12		105	84.00	51.78	21.96	0.22	
49	67.87	57.20	21.43	2.07		106	84.53	50.23	22.50	0.03	
50	67.96	60.31	21.22	1.84		107	85.05	55.92	22.48	0.33	
51	67.98	22.86	20.74	2.26		108	85.38	44.91	21.87	2.13	
52	68.33	67.71	22.17	0.36		109	85.41	44.34	21.47	2.53	
53	68.45	73.23	22.34	0.01		110	85.46	68.46	22.36	0.26	
54	68.66	70.29	21.96	0.33		111	85.53	60.87	21.05	0.08	
55	68.70	44.92	21.12	0.38		112	85.69	44.75	22.15	−0.10	
56	68.97	42.49	21.55	−0.16		113	87.35	55.62	21.77	0.16	D
57	69.08	35.92	22.89	0.16		114	88.32	55.24	22.32	0.06	

E—elongated image, D—diffuse, B—inhomogeneous background, M—multiple image.

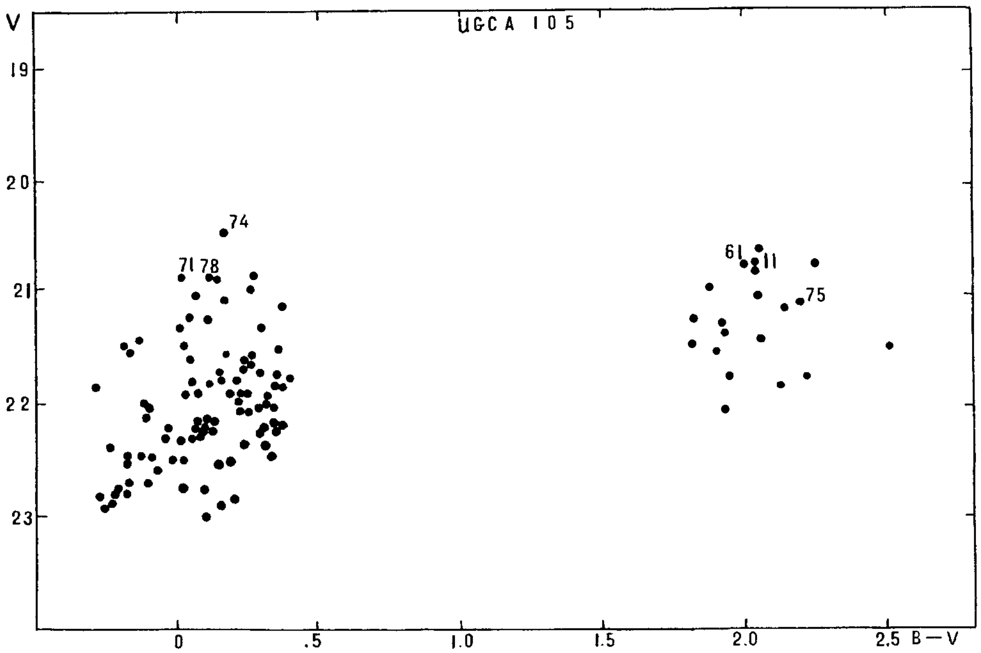

Figure 7 Colour-magnitude diagram for the dwarf spiral galaxy UGCA 105.

4. DISCUSSION

A summary of distance moduli determinations for the discussed galaxies is presented in Table 5. As it follows from these data, various methods give good mutual agreement for HoII. Maximum scatter of its distance estimates is no more than ±20%. The situation with HoI is quite different. Both module estimates obtained by us exceed its other estimates by $1^m.5$–$2^m.0$. This fact needs some comments. Note first of all that de Vaucouleurs' (1978) data are not independent. The difference between our estimate of HoI module and the original ST estimate over the bright stars is caused not by photometry reasons as much as by essentially different selection of brightest supergiant candidates. According to ST, the mean ratio of angular sizes for HII region in HoI and HoII lies in the interval (1.5 ÷ 1.8), which agrees well with the module difference $\mu_0(\text{HoI}) - \mu(\text{HoII}) = 1^m.31$ according to our measurements. Another indication of the distance difference being real in these dwarf galaxies is found in observational data by Hoessel and Danielson (1984). The colour-magnitude diagrams for HoI and HoII (see Figures 5–8 of these authors) demonstrate systematic shift at $\Delta m = 1^m.2 \pm 0^m.3$. Hoessel and Danielson explained it by a difference in star formation stages in these galaxies. But it might as well be caused by a simple geometric reason.

With the module $29^m.11$ or the distance $\Delta = 6.6$ Mpc HoI cannot belong to the galaxian complex M81 + NGC 2403 + IC 342. The next step in solving this problem will apparently be the search and measurements of Cepheids in HoI.

Table 5 Distance moduli for the studied galaxies.

Distance modulus		*Indicator and data*		*Reference*
HoII	*HoI*	*UGCA105*		
27.22	27.16	—	HII regions	Sandage, Tammann, 1974
27.82	27.65	—	Brightest stars	Sandage, Tammann, 1974
28.00	27.18[a]	—	Brightest blue stars	de Vaucouleurs, 1978
27.52	—	—	Brightest red stars	de Vaucouleurs, 1978
27.32	—	—	Luminosity function	Moss, Irwin, 1988
27.28	—	—	Largest HII rings	Moss, Irwin, 1988
27.69	29.02	27.55	Brightest red stars	present paper
27.96	29.29	27.72	Brightest blue stars	present paper
27.78	29.11	27.60	Weighted (2:1) mean for BRS and BBS	present paper

[a] With a correction of erronous value for M_3^* have been adopted by de Vaucouleurs (1978).

5. CONCLUSIONS

1. For three dwarf galaxies HoII, HoI and UGCa 105 located in a broad neighbourhood of NgC 2403, photoelectric zero-points in B, V systems were determined, and mass photometry of their stellar population accomplished.

2. Using photographic photometry of the brightest red and blue stars the distance moduli are determined for each galaxy.

3. In a good agreement with the previous estimates we obtained the module $\bar{\mu}_0 = 27^m.78$ for HoII, which corresponds to the distance $\Delta = 3.6$ Mpc.

4. The module $\bar{\mu}_0 = 29^m.11$ (or $\Delta = 6.6$ Mpc), obtained here for HoI, is in a sharp difference with the previous estimates published by Sandage and Tammann (1974). The data by ST on the size ratio for HII-regions in HoI and HoII, and also the HD data on the luminosity functions of these dwarfs are reinterpreted by us in favour of a new estimate.

5. We resolved the dwarf spiral galaxy UGCA 105 on stars and determined its distance module $\bar{\mu}_0 = 27.60$ for the first time. Having the distance $\Delta = 3.3$ Mpc, this dwarf is a real member of the group around NGC 2403.

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