Multi-colour photometry of nearby dwarf galaxies^{*,**}

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Abstract. Observations of 39 nearby, mostly dwarf galaxies are presented. The observations were carried out at the 1.2-m telescope of Observatoire de Haute-Provence (France) with B , V and I Cousins filters. Based on surface and integrated photometry of the obtained images we derived total B , V and I magnitudes and integrated $B - V$, $V - I$ colours as well as radii and magnitudes at the 25^m isophotal level.

Azimuthally averaged surface brightness profiles were derived for 33 galaxies in each photometric band. Most of the profiles can be well fitted by an exponential intensity law of brightness distribution. The best-fitting exponential parameters are also given for the galaxies.

Key words: galaxies: fundamental parameters — galaxies: photometry — galaxies: irregular — galaxies: structure

Cousins filter), where extinction is less, can make it possible to investigate in detail the galaxy morphology and structure (Heraudeau & Simien 1996).

A sample of nearby, mostly dwarf irregular galaxies with significant uncertainty of total magnitude B_T was selected from the Principal Galaxy Catalogue (Paturel et al. 1996). CCD observations of galaxies from this list are presented in this paper. The observations were carried out at the 1.2-m telescope of Observatoire de Haute-Provence (OHP), France with B , V and I Cousins filters (see Sect. 3). Total magnitudes of observed galaxies were derived in each photometric band and azimuthally averaged surface brightness profiles were also constructed (see Sect. 5). The profiles were fitted by an exponential intensity law or by a combination of two such functions. The best-fitting parameters are given in Sect. 6.

1. Introduction

Nearby dwarf galaxies are well recognized now as central objects under study for many areas of extragalactic astronomy, such as star formation, galaxy evolution and structure (Stetson et al. 1998; Greggio et al. 1998). Many nearby galaxies are also well resolved into individual stars, which allows one to estimate photometric galaxy distances (see, for example, Karachentsev et al. 1994; Makarova & Karachentsev 1998). Nevertheless, the main photometric parameters, such as total magnitudes and colours, remain poorly known for a number of nearby dwarf galaxies. A study of these galaxies not only in visual bands (B and V Johnson-Cousins filters), but also in the near infrared (I

2. The sample

The galaxies for our sample were extracted mostly from the PGC catalogue (Paturel et al. 1996). The northern ($\delta > 0^\circ$) objects with radial velocities $< 500 \text{ km s}^{-1}$ and with an uncertainty of total magnitude $B_T > 0.2^m$ were included in the list. Some objects from the list of nearby galaxies by Karachentsev (1994) were also added to the sample. General parameters of 61 chosen galaxies are given in Table 1. The columns of the table are:

Column 1: NGC, IC or UCG name of the galaxy.

Column 2: PGC name.

Columns 3 and 4: 1950 coordinates.

Column 5: galaxy type according to RC3 system, as given in PGC catalogue.

Column 6: angular diameter at the 25^m isophotal level (in arcmin) from PGC.

Column 7: total magnitude B_T according to PGC.

Columns 8, 9 and 10: values of galactic absorption (in mag) in B , V and I filters, respectively, taken from IRAS/DIRBE maps (Schlegel et al. 1998).

Column 11: radial velocity in km s^{-1} .

* Based on observations made at Observatoire de Haute-Provence (CNRS), France.

** Table 3 is only available in electronic form at the CDS via anonymous ftp to cdsarc.u-strasbg.fr (130.79.128.5) or via <http://cdsweb.u-strasbg.fr/Abstract.html>

Table 1. General parameters of the sample

Ident.	PGC id.	α (1950)	δ (1950)	Type	D_{25} (arcmin)	B_T	A_B	A_V	A_I	$V_\odot$ (km s ⁻¹)	Dist. (Mpc)
IC 10	PGC 0001305	00 ^h 17 ^m 41. ^s 5	59°00′52″	9.8	6.8	12.20	4.01	3.08	1.80	−345	0.8
Cas 1	LEDA0100169	020205.0	684618				4.44	3.42	2.00	35	2.8
UGCA 39	PGC 0010217	023807.9	592324	3.9	3.3		5.73	4.40	2.58	−2	2.7
Dwingeloo 2	LEDA0101304	025021.7	584807				5.11	3.93	2.30	93	4.5
Dwingeloo 1	LEDA0100170	025306.4	584238				5.94	4.57	2.67	110	4.8
NGC 1156	PGC 0011329	025646.8	250221	9.8	3.3	12.04	1.06	0.82	0.48	380	7.8
UGC 2684	PGC 0012514	031742.0	170800	9.9	1.8		0.58	0.45	0.26	349	6.5
UGC 2716	PGC 0012719	032117.2	173442	7.9	1.6	15.13	0.61	0.47	0.27	379	6.7
UGC 2773	PGC 0013115	032835.3	473728		1.2	15.04	2.37	1.82	1.06	242	5.6
UGCA 86	PGC 0014241	035500.0	665900	10.0	0.9		4.22	3.24	1.90	68	2.6
NGC 1569	PGC 0015345	042605.8	644418	9.8	3.6	11.70	3.40	2.61	1.53	−86	1.7
UGCA 92	PGC 0015439	042724.0	633000	10.0	2.0		3.58	2.75	1.61	−99	1.8
UGCA 105	PGC 0016957	050936.0	623100	10.0	5.5	15.25	1.38	1.06	0.62	111	3.2
KK 49	PGC 0017603	053900.0	064000			15.36	2.90	2.23	1.30	441	5.4
Orion	PGC 0017716	054222.0	050230				2.84	2.18	1.28	365	6.4
UGC 3676	PGC 0019162	062711.9	332013	9.9	1.0	15.67	1.00	0.76	0.45	469	7.0
UGC 3600	PGC 0019871	065212.0	390918	10.0	1.1		0.40	0.31	0.18	403	7.3
UGC 3698	PGC 0020264	070541.4	442742	10.0	1.0	15.43	0.45	0.34	0.20	423	7.2
NGC 2337	PGC 0020298	070637.1	443220	9.9	2.0	13.05	0.40	0.31	0.18	434	7.9
UGC 3755	PGC 0020445	071106.3	103618	9.9	1.6	14.64	0.38	0.29	0.17	323	4.1
UGC 3817	PGC 0020852	071906.0	451200	10.0	1.8		0.41	0.32	0.18	438	8.6
	LEDA0093088	072312.0	691700	8.0	1.1		0.17	0.13	0.08	135	
NGC 2366	PGC 0021102	072336.5	691900	9.7	7.3	11.43	0.16	0.12	0.07	99	3.4
UGC 3974	PGC 0021600	073902.7	165517	9.8	3.8	13.71	0.15	0.12	0.07	270	4.3
K 52	PGC 0023521	081843.0	711125	10.0	1.3	16.5	0.11	0.08	0.05	113	3.0
UGC 4459	PGC 0024050	082933.0	662101	9.8	1.6	14.5	0.15	0.12	0.07	18	3.1
UGC 4483	PGC 0024213	083207.0	695716	9.9	1.1	15.51	0.14	0.11	0.06	156	3.6
F464-v3	LEDA 086668	090003.0	201619	10.0	0.9	15.9	0.13	0.10	0.06	481	5.2
UGC 5086	PGC 0027115	092959.1	214112	8.4	0.9	15.73	0.14	0.11	0.06	498	7.4
Holmberg I	PGC 0027605	093600.0	712447	9.8	3.6	13.20	0.18	0.14	0.08	136	6.7
UGC 5288	PGC 0028378	094838.5	080343	7.9	0.8	14.22	0.15	0.12	0.07	555	6.8
BK3N	PGC 0028529	094942.0	691218	10.0	0.5	18.6	0.38	0.29	0.17	−40	2.8
Holmberg IX	PGC 0028757	095328.0	691653	9.8	2.6	14.41	0.34	0.26	0.16	47	3.4
UGC 5423	PGC 0029284	100125.3	703627	9.9	1.0	15.52	0.36	0.28	0.16	342	5.3
UGC 5692	PGC 0030997	102648.0	705233	8.6	3.4	13.49	0.20	0.15	0.09	180	4.5
UGC 5918	PGC 0032405	104617.0	654740	9.8	2.4	15.13	0.05	0.04	0.02	338	7.4
K 73	PGC 0032667	104928.2	694842	10.0	0.6	18.2	0.09	0.07	0.04	115	4.0
UGC 6817	PGC 0037050	114816.8	390931	9.9	4.2	13.44	0.11	0.09	0.05	245	3.9
NGC 4068	PGC 0038148	120129.7	525201	9.8	3.2	13.21	0.08	0.06	0.04	210	5.2
NGC 4144	PGC 0038688	120728.3	464407	6.0	6.2	12.01	0.07	0.05	0.03	267	9.8
NGC 4163	PGC 0038881	120937.6	362651	9.8	1.7	14.48	0.09	0.07	0.04	163	3.6
KK 127	PGC 0038998	121051.1	301159		1.0	15.61	0.08	0.06	0.04	152	16.0
UGC 7298	PGC 0039316	121400.0	523200	9.8	1.2		0.11	0.08	0.05	170	8.6
UGC 7321	PGC 0039432	121502.3	224901	6.5	5.6	14.11	0.11	0.08	0.05	409	4.9

Table 1. continued

Ident.	PGC id.	α (1950)	δ (1950)	Type	D_{25} (arcmin)	B_T	A_B	A_V	A_I	$V_\odot$ (km s ⁻¹)	Dist. (Mpc)
IC 3308	PGC 0040495	122248.0	265931	7.3	1.4	15.17	0.09	0.07	0.04	315	3.9
UGC 7577	PGC 0040904	122515.4	434613	9.7	4.2	12.87	0.08	0.06	0.04	195	4.8
NGC 4449	PGC 0040973	122545.2	442215	9.7	6.2	9.83	0.07	0.05	0.03	202	4.5
UGC 7698	PGC 0041636	123026.2	314902	9.9	6.5	13.06	0.06	0.05	0.03	332	6.1
IC 3687	PGC 0042656	123950.9	384633	9.8	3.5	13.72	0.08	0.06	0.04	358	3.0
IC 4182	PGC 0045314	130330.0	375223	8.7	6.0	12.41	0.06	0.05	0.03	315	5.0
UGC 8201	PGC 0045372	130439.4	675816	9.9	3.4	12.85	0.11	0.08	0.05	34	4.9
UGC 8308	PGC 0045939	131111.9	463457	9.8	1.1	14.91	0.05	0.04	0.02	164	3.7
UGC 8320	PGC 0046039	131216.6	461101	9.9	3.6	12.73	0.06	0.04	0.02	194	4.0
UGC 8331	PGC 0046127	131320.3	474537	9.8	2.5	14.59	0.03	0.02	0.02	259	8.2
UGC 8508	PGC 0047495	132846.8	551003	9.8	1.7	14.64	0.06	0.04	0.03	62	3.7
NGC 5229	PGC 0047788	133158.5	481016	6.6	3.3	14.51	0.06	0.05	0.03	364	5.1
Holmberg IV	PGC 0049448	135255.2	540858	9.7	4.2	13.59	0.06	0.05	0.03	142	8.3
NGC 5474	PGC 0050216	140315.3	535405	6.0	5.0	11.23	0.05	0.04	0.02	276	7.2
NGC 6503	PGC 0060921	174958.7	700926	5.9	7.1	10.74	0.15	0.11	0.06	44	5.2
NGC 6946	PGC 0065001	203348.8	595850	5.9	11.2	9.58	1.48	1.14	0.66	52	6.0
Pegasus	PGC 0071538	232602.8	142816	9.8	5.1	12.82	0.27	0.20	0.12	-183	0.8

Column 12: galaxy distance in Mpc taken from Karachentsev (1994), recently revised by D. Makarov and I. Karachentsev (private communications).

The majority of the galaxies from our list have small diameters (1 – 4 arcmin) and type around 9.5 – 10. The distribution of their total magnitudes B_T shows a maximum near 13 and 15 magnitudes. Therefore, most of the sample galaxies are dwarf irregular objects.

3. Observations

39 of the galaxies from our sample were observed on April, 1995 at the 1.2-m telescope of Observatoire de Haute-Provence (OHP), France. A CCD camera No. 2 Tektronix 1024×1024 pix provided a field of view of $11.8' \times 11.8'$ with a resolution of $0.69''$ per pixel. B , V and I Cousins filters were used (see the equipment description on <http://www.obs-hp.fr>). The list of the galaxy exposures is presented in Table 2, where the columns are:

Column 1: galaxy name.

Column 2: date of the observation.

Columns 3, 4 and 5: exposure time (in s) in B , V or I filter, respectively.

Some bias and dark exposures were made every night. Flat fields (twilight sky) were also exposed every evening and every morning.

4. Data reduction

4.1. Initial processing

Reduction of the obtained images was done with the MIDAS package developed by ESO. Initial processing

of the data contained usual steps such as bias and dark frame subtraction and flat-fielding. Cosmic rays were then removed from each galaxy image with the FILTER/COSMIC procedure. The galaxy frames of the same band were summed, if several exposures were made. Images of the observed galaxies in B band are presented in Fig. 1.

4.2. Sky background determination

Background stars were removed from the frames by fitting a second-degree surface in circular pixel-area. The sky background was then approximated by a tilted plane, created from a 2-dimension polynomial, using the least-squares method (FIT/FLAT_SKY). The accuracy of the sky background determination is about 0.3% of the original sky level. A typical value of the sky surface brightness is near $22^m/\text{sq s}$ in B band. Therefore, the mean error of sky determination must not exceed 0.07 mag.

The center coordinates for about 1/3 of all the observed galaxies were determined by ellipse fitting of outer parts of the galaxy (FIT/ELL3). Most of other galaxy centers were determined interactively, because a significant part of the sample consists of the galaxies of irregular morphology. For some galaxies with a star-like center the coordinates of the center were determined using first moment of the intensity pixel values.

4.3. Photometric calibration

For the calibration, the photometric standard stars from Landolt's (1992) list were observed during the observational run after every two galaxies. Due to extinction

Fig. 1. The images of the sample galaxies in *B* band, which were obtained at the 1.2-m telescope of Observatoire de Haute-Provence (France). The field size of the images is $11.8' \times 11.8'$. For all the images North is top and East is left

Fig. 1. continued

Fig. 1. continued

Fig. 1. continued

Fig. 1. continued

Fig. 1. continued

Fig. 1. continued

present on some nights, a number of the galaxies were exposed once more with short exposures under better photometric conditions (see Table 2). Deeper images were then calibrated using these short-exposure data.

Zero-point errors of the transformation to the standard Johnson-Cousins system are estimated to be about 0.15^m in each filter.

5. Results

5.1. Total magnitudes and surface brightness profiles

For estimation of total galaxy magnitudes in each band, integrated photometry was performed in increasing circular apertures from a prechosen center (see above) to faint outskirts of the galaxies. Aperture photometry of the observed galaxies is presented in Table 3, which is available

only in electronic form in the CDS. The total magnitude was estimated as asymptotic value of the obtained radial growth curve. The asymptotic extrapolation was done by eye. The errors of the total magnitude determination are 0.06^m in B band, 0.08^m in V and 0.10^m in I . The results of our measurements are presented in Table 4, where the columns represent:

Column 1: galaxy name.

Columns 2, 3 and 4: total magnitudes in B , V and I band, respectively (not corrected for galactic absorption).

Columns 5 and 6: total colour $B - V$ and $V - I$, respectively (not corrected for galactic absorption).

Column 7: radius (arcsec) at the surface brightness level of $25^m/\text{sq s}$ in B band.

Column 8: total B -magnitude at this level (not corrected for galactic absorption).

Table 2. Observational log

Ident.	Date	<i>B</i> expos.(sec)	<i>V</i> expos.(sec)	<i>I</i> expos.(sec)
UGC 3755	11.04.1997	2×400	2×400	2×500
NGC 2366	05.04.1997	600	500	600
UGC 3974	11.04.1997	2×500	2×500	2×600
K 52	10.04.1997	2×600	2×600	2×900
UGC 4459	05.04.1997	2×600	2×500	2×600
UGC 4483	09.04.1997	2×400	2×400	2×600
F464-v3	12.04.1997	3×600	3×600	3×900
UGC 5086	11.04.1997	2×400	2×400	2×600
Holmberg I	02.04.1997	600+1200	1000	800
UGC 5288	12.04.1997	2×400	2×400	2×600
BK3N	12.04.1997	3×600	3×600	3×900
Holmberg IX	06.04.1997	2×800	2×800	2×1000
UGC 5423	07.04.1997	2×600	2×600	2×800
UGC 5692	03.04.1997	3×400	2×300	2×300
	09.04.1997	400	60	60
UGC 5918	09.04.1997	3×500	3×500	3×600
K 73	12.04.1997	2×600	2×600	2×900
UGC 6817	02.04.1997	2×600	2×500	2×450
NGC 4068	04.04.1997	600	2×300	2×300
	10.04.1997	100	100	100
NGC 4144	04.04.1997	2×300	300	300
	10.04.1997	100	100	100
NGC 4163	05.04.1997	600	500	700
PGC 38998	09.04.1997	2×300	2×300	2×500
UGC 7298	07.04.1997	3×600	3×600	3×800
UGC 7321	04.04.1997	1000	800	600
	10.04.1997	100	100	100
IC 3308	09.04.1997	2×300	2×300	2×500
UGC 7577	06.04.1997	2×400	2×400	2×500
NGC 4449	02.04.1997	100	100	100
UGC 7698	10.04.1997	600	600	2×900
IC 3687	04.04.1997	2×400	2×400	2×400
	10.04.1997	100	100	100
IC 4182	02.04.1997	600	500	2×300
UGC 8201	10.04.1997	400	400	2×600
UGC 8308	02.04.1997	2×1200	1000	1000+900
UGC 8320	04.04.1997	2×400	2×400	2×500
	10.04.1997	100	100	100
UGC 8331	05.04.1997	2×500	2×500	2×600
UGC 8508	06.04.1997	2×400	2×400	2×500
NGC 5229	07.04.1997	600	600	900
Holmberg IV	08.04.1997	2×600	2×600	3×800
	10.04.1997	100	100	100
NGC 5474	06.04.1997	500	500	600
NGC 6503	02.04.1997	100	100	120
NGC 6946	05.04.1997	3×100	100	100

Columns 9 and 10: same as 7 and 8, but for *V* band.

Columns 11 and 12: same as 7 and 8, but for *I* band.

Column 13: absolute *B* magnitude corrected for galactic absorption.

The blanks in Cols. 7–12 are due to the lack of surface brightness profiles for these galaxies (see below). The magnitude values for the galaxy UGC 5086 are uncertain because of extinction and marked with a colon.

Obtaining of the galaxy growth curves allows us also to trace the integrated colour changes with radius. *B* – *V* and *V* – *I* total colours versus galaxy radius from center are given in Fig. 2 for 33 galaxies of the sample. The growth curves were not determined for the six dwarf galaxies (K 52, UGC 4483, F464-v3, UGC 5086, BK3N, K 73) because of significant measurement errors caused by the extremely low surface brightness of the object or by bright nearby background stars, which affects photometry

Fig. 2. The total $B - V$ colour (solid line) and the total $V - I$ colour (dashed line) with respect to the radius from the galaxy center (arcsec)

Fig. 2. continued

Fig. 2. continued

results. For these six objects total magnitude and colour estimations were made only in one large circular aperture.

Note that most observed galaxies show a slow increase in the total $B - V$ colour value from the center to the outer parts of the galaxy. Some spiral galaxies show the reverse colour gradient. For the most galaxies the $V - I$ total colours follow $B - V$ variations.

$(V - I)_0$ vs. $(B - V)_0$ (the total colours corrected for galactic absorption) are plotted in Fig. 3 for the measured galaxies (filled squares). For comparison, the integrated colours from the papers by Reshetnikov & Combes (1996) (circles) and Heraudeau & Simien (1996) (crosses) are also given in the figure. The galaxies from all the three works are well fitted by the following distribution:

$(B - V)_0 = 0.85 \times (V - I)_0 - 0.20$. This line is also plotted in Fig. 3.

Obtaining of azimuthally averaged surface brightness profiles was the next step of the reduction of the observed galaxies. These profiles have an advantage for dwarf galaxies of very low surface brightness and irregular structure (Karachentseva et al. 1996; Papaderos et al. 1996; Bremnes et al. 1998), because they allow the accuracy of the photometry in such galaxies to be improved. Azimuthally averaged surface brightness profiles for our galaxies were obtained by differentiating the galaxy growth curves with respect to radius (Bremnes et al. 1998). The resulting profiles are shown in Fig. 4. Most of the galaxies are calculated till the level of 27–28 mag/sq s in B band. Mean errors of the measurements

Table 4. Total magnitudes of the observed galaxies

Ident.	B_T	V_T	I_T	$(B - V)_T$	$(V - I)_T$	$R_{25}(B)$	B_{25}	$R_{25}(V)$	V_{25}	$R_{25}(I)$	I_{25}	M_B
UGC 3755	14.07	13.52	12.64	0.55	0.88	42.5	14.26	46.0	13.68	54.2	12.74	-14.39
NGC 2366	11.68	11.26	10.74	0.42	0.53	123.5	12.18	150.9	11.54	180.4	10.88	-16.17
UGC 3974	13.62	13.14	12.54	0.48	0.60	41.8	15.13	57.6	14.25	67.9	13.53	-14.69
K 52	16.35	16.11	15.55	0.24	0.56							-11.11
UGC 4459	14.55	14.14	13.49	0.45	0.65	33.6	15.35	41.8	14.66	52.1	13.87	-13.05
UGC 4483	14.95	14.51	14.02	0.44	0.49							-12.99
F464-v3	16.90	16.63	16.00	0.27	0.63							-11.81
UGC 5086	16.45:	15.89:	15.17:	0.56:	0.72:							-13.05:
Holmberg I	13.64	13.22	12.68	0.42	0.54	41.8	15.51	71.3	14.11	89.2	13.21	-15.66
UGC 5288	14.62	14.06	13.22	0.56	0.84	30.2	14.90	38.4	14.21	44.6	13.30	-14.71
BK3N	18.78	18.27	17.08	0.51	1.19							-8.83
Holmberg IX	14.53	14.31	13.49	0.22	0.82	29.5	15.95	32.2	15.61	56.9	14.30	-13.48
UGC 5423	14.42	13.90	13.48	0.52	0.42	33.6	14.68	38.4	14.08	53.5	13.53	-14.55
UGC 5692	13.57	12.66	11.36	0.90	1.30	53.5	14.10	80.3	12.95	122.1	11.46	-14.89
UGC 5918	15.00	14.58	13.78	0.42	0.80	21.3	16.62	30.9	15.65	56.9	14.16	-14.41
K 73	17.09	16.66	15.69	0.43	0.97							-11.03
UGC 6817	13.70	13.35	12.30	0.35	1.04	52.1	14.49	63.1	13.90	106.3	12.58	-14.38
NGC 4068	13.19	12.77	12.01	0.42	0.76	65.2	13.44	73.4	12.95	87.8	12.09	-15.49
NGC 4144	12.16	11.63	10.74	0.53	0.89	90.6	12.48	118.0	11.81	154.4	10.80	-17.86
NGC 4163	13.63	13.07	12.22	0.56	0.85	46.0	13.80	56.3	13.18	67.2	12.26	-14.21
PGC 38998	15.37	14.82	14.10	0.55	0.73	21.3	15.53	24.7	14.95	29.5	14.13	-15.73
UGC 7298	15.95	15.66	15.17	0.29	0.48	19.9	16.29	21.3	15.95	24.7	15.30	-13.83
UGC 7321	13.90	13.29	12.41	0.61	0.88	40.5	14.84	58.3	13.85	83.7	12.59	-14.65
IC 3308	15.41	14.96	13.94	0.45	1.02	20.6	15.80	22.6	15.33	36.4	14.31	-12.64
UGC 7577	12.95	12.36	11.36	0.59	1.00	76.1	13.41	94.7	12.69	142.7	11.51	-15.55
NGC 4449	10.06	9.65	8.85	0.42	0.79	164.6	10.10	187.3	9.66	222.0	8.80	-18.28
UGC 7698	13.53	13.18	12.49	0.35	0.69	55.6	14.71	65.9	14.02	91.9	12.98	-15.46
IC 3687	13.79	13.37	12.77	0.42	0.60	50.1	14.28	57.6	13.73	69.3	12.98	-13.68
IC 4182	12.02	11.60	10.72	0.42	0.88	123.5	12.31	140.6	11.78	173.6	10.73	-16.56
UGC 8201	13.31	12.97	12.27	0.34	0.70	66.5	13.69	77.5	13.24	101.5	12.39	-15.24
UGC 8308	15.45	15.10	14.34	0.39	0.70	26.8	15.85	28.1	15.39	36.4	14.46	-12.45
UGC 8320	12.97	12.53	11.99	0.44	0.54	72.0	13.40	85.8	12.88	100.2	12.18	-15.10
UGC 8331	14.46	14.17	13.62	0.29	0.55	35.7	15.03	41.8	14.49	46.6	13.79	-15.15
UGC 8508	14.12	13.67	12.88	0.45	0.79	41.8	14.42	52.1	13.83	61.7	12.99	-13.77
NGC 5229	14.33	13.85	13.05	0.48	0.80	39.1	14.68	43.9	14.02	43.9	13.15	-14.28
Holmberg IV	13.76	13.31	12.57	0.45	0.74	46.0	14.51	61.1	13.79	78.9	12.84	-15.90
NGC 5474	11.60	11.08	10.23	0.52	0.85	110.4	11.78	125.5	11.18	142.7	10.27	-17.73
NGC 6503	11.05	10.31	9.20	0.73	1.10	116.6	11.14	140.6	10.37	198.9	9.21	-17.68
NGC 6946	10.00	9.11	7.46	0.89	1.65	264.8	10.06	269.6	9.15	475.0	6.80	-20.38

were estimated by intercomparison of individual profiles for the same objects obtained from different frames in the same passband and they are of about 0.05^m at the 22 mag/sq s isophotal level and about $0.3 - 0.4$ at the 27 mag/sq s isophotal level in each photometric band.

5.2. Photometric errors

Summing up all internal errors given above, we obtain the resulting errors of the total magnitude estimation to be about 0.18^m in B band, 0.18^m in V band and 0.19^m in I

band and the resulting errors of surface brightness estimation to be about 0.17^m at the 22 mag/sq s isophotal level and about $0.35 - 0.45$ at the 27 mag/sq s isophotal level in each photometric band.

External photometric errors can be estimated by a comparison of the total magnitudes of the observed galaxies with the published magnitudes of these galaxies. The comparison of the total B -magnitudes estimated in the present work with those given in the article of Bremnes et al. (1998) for seven galaxies in common, yields an agreement of 0.18 ± 0.04 . A considerable systematic deviation may be caused by the uncertainty

Fig. 3. $(B - V)_0$ versus $(V - I)_0$ for our sample galaxies (filled squares) and for the galaxies from the article of Heraudeau & Simien (1996) (crosses) and Reshetnikov & Combes (1996) (circles). The line of the regression for all galaxies is presented

in the photometric calibration in the work of Bremnes et al., where they give information about the problems due to atmospheric extinction. A second similar work of the same authors has recently become available. A comparison of our data with those obtained by Bremnes et al. (1999), for seven common galaxies shows a good agreement of 0.07 ± 0.16 .

Total magnitude estimates for some galaxies of our sample can be found in a number of papers. A comparison of these magnitudes with our data is given in Table 5, where the columns are:

Column 1: galaxy name.

Columns 2, 3 and 4: total magnitude difference in B , V and I band respectively.

Column 5: total $B - V$ colour difference.

Column 6: reference to the work, where magnitudes for the comparison were taken. Here

- 1: work of Tikhonov & Karachentsev (1998), where galaxies were observed at the 6-m telescope of Special Astrophysical Observatory, Russia, and CCD field contained only $120'' \times 80''$.
- 2: article of Makarova & Karachentsev (1998).
- 3: article of Makarova et al. (1998) (in [2] and [3] the observations were carried out at the Nordic Optical Telescope with the CCD of $3' \times 3'$ field).
- 4: paper of Gavazzi, Boselli (1996).
- 5: article of Patterson & Thuan (1996) (note that, unlike for other works, there is no good agreement of our data with the magnitudes given in this paper).

Table 5. Comparison with magnitudes of other authors (see text)

Ident.	ΔB	ΔV	ΔI	$\Delta(B - V)$	Reference
K 52	0.63		2.61		[5]
UGC 4459	-0.17				[6]
UGC 4483	-0.39				[6]
UGC 5086		0.66	1.08		[2]
Holmberg I	-0.13				[6]
BK3N	-0.18				[6]
UGC 5423	-1.00		-0.86		[5]
UGC 5692	-0.01				[6]
UGC 5918	-0.21				[6]
K 73	-0.17				[6]
NGC 4163	-0.30			0.11	[1]
UGC 7321	0.05	0.21			[4]
UGC 7577				0.14	[1]
UGC 7698	0.38			0.00	[3]
IC 3687	0.04			0.04	[3]
UGC 8308	-0.05				[7]
UGC 8320	-0.08				[7]
UGC 8331	0.19				[7]
UGC 8508	0.24				[7]
NGC 5229	0.23				[7]
Holmberg IV	0.11				[7]
NGC 5474	-0.17				[7]

6: work of Bremnes et al. (1998).

7: work of Bremnes et al. (1999).

The comparison of our blue total magnitudes and $B - V$ colours with those given in the PGC yields a poor agreement: 0.63 ± 0.69 mag. The large scatter shows that the PGC magnitudes are considerably inhomogeneous. It is possible that the PGC total magnitudes used in photometric investigations may not provide good reliability.

The comparison directly of the aperture magnitudes in each photometric band, which are available for 26 of our galaxies in Prugniel & Heraudeau (1998), yields a good agreement: 0.00 ± 0.15 in B , 0.04 ± 0.14 in V , 0.09 ± 0.16 in I . Mean difference for each galaxy was found for the apertures (at least three) available. The results were then averaged for the all galaxies.

6. Fitting of surface brightness profiles

It is well known that surface brightness profiles of dwarf galaxies (both irregular and spheroidal) and also disks of spiral galaxies can be fitted by an exponential intensity law of brightness distribution (de Vaucouleurs 1959)

$$I(r) = I_0 * \exp(-r/h)$$

or, in magnitudes per sq s

$$\mu(r) = \mu_0 + 1.086 * (r/h),$$

where μ_0 is the central surface brightness and h is the exponential scale length. Most of the measured galaxies are

Fig. 4. The azimuthally averaged surface brightness profiles for the measured galaxies in B band (bottom lines), those in V band (middle lines) and those in I band (upper lines). The model profiles are shown by the dashed lines

Fig. 4. continued

Fig. 4. continued

well-fitted by an exponential law in the whole profile or in its outer parts. Some galaxy profiles show a prominent surface brightness central peak, which may be formed by the star formation regions near the center of the galaxy. The best result for these cases is given by decomposition of the profiles into contributions from the two exponential components.

Profile parameters estimation for UGC 4459 in I band has not been made because there is not any significant part of the profile which followed to exponential law of brightness distribution.

Finally, one galaxy of our sample, namely the late type spiral NGC 6946, is well decomposed into bulge and exponential disk components. Among the most commonly

used bulge fitting functions is the “ $r^{1/4}$ law” proposed by de Vaucouleurs (1948). This is written as

$$I(r)/I_e = 10^{-3.33*((r/r_e)^{1/4}-1)}$$

or, in magnitudes per sq s

$$\mu(r) = \mu_e + 8.33 * ((r/r_e)^{1/4} - 1),$$

where r_e is the effective radius that contains half of the total luminosity, and μ_e is the effective surface brightness at this radius.

The exponential fits to the surface brightness profiles were done by a least-squares fitting procedure. Decomposition of profiles into two components was performed using the algorithm by Kormendy (1977).

Table 6. Derived photometric parameters

Ident.	μ_0^B	h_B (")	μ_0^{B1}	h_{B1} (")	μ_0^V	h_V (")	μ_0^{V1}	h_{V1} (")	μ_0^I	h_I (")	μ_0^{I1}	h_{I1} (")
UGC 3755	21.64	12.62			21.25	14.04			20.44	14.51		
NGC 2366	22.65	59.75			22.20	59.61			21.42	56.72		
UGC 3974	24.52	62.91	23.81	15.22	24.52	79.36	23.32	20.61	22.40	28.03		
UGC 4459	24.08	28.69			23.63	28.18						
Holmberg I	22.95	33.43			22.72	36.31			22.01	32.65		
UGC 5288	21.54	9.16			20.92	8.84			20.12	9.39		
Holmberg IX	24.85	49.45	23.45	11.35	24.08	36.75	23.20	8.14	24.18	90.66	23.34	14.46
UGC 5423	21.81	11.91			21.33	12.37			20.90	13.33		
UGC 5692	22.47	23.00			21.88	27.58			20.85	31.45		
UGC 5918	24.00	27.66			23.48	24.45			22.74	26.74		
UGC 6817	23.19	31.06			22.87	32.25			22.41	44.14		
NGC 4068	21.84	22.22			21.36	21.91			20.11	19.15		
NGC 4144	22.72	42.60	21.08	13.42	22.38	45.95	20.47	13.80	21.52	45.88	19.56	14.07
NGC 4163	21.37	13.91			21.02	15.42			20.21	15.80		
P38998	21.50	6.67			20.94	6.50			20.22	6.66		
UGC 7298	22.33	7.68			21.95	7.51			20.76	6.25		
UGC 7321	24.01	39.85	22.33	8.14	23.32	37.78	21.67	8.35	21.96	29.90	20.50	6.99
IC 3308	21.86	7.11			21.44	7.09			20.65	7.07		
UGC 7577	22.74	36.82			22.26	38.00			21.48	42.48		
NGC 4449	19.46	29.51	17.72	2.05	19.09	29.79	17.12	1.66	18.39	30.99	16.21	1.41
UGC 7698	23.99	55.42			23.38	46.01			22.65	44.21		
IC 3687	22.74	25.05			22.29	24.74			21.59	22.35		
IC 4182	21.22	35.51			21.02	38.31			20.33	42.76		
UGC 8201	22.28	26.82			22.04	28.09			21.57	31.19		
UGC 8308	23.26	16.59			23.26	25.94			22.71	26.75		
UGC 8320	22.36	30.17			22.13	32.72			21.39	30.51		
UGC 8331	22.59	16.02			22.17	15.70			21.46	14.69		
UGC 8508	22.05	15.86			21.67	16.54			20.84	16.35		
NGC 5229	22.08	13.61			21.39	12.65			20.27	10.93		
Holmberg IV	22.82	25.74			22.37	25.72			21.61	24.06		
NGC 5474	22.64	50.53			22.03	45.81			21.09	40.86		
NGC 6503	20.05	24.32			19.35	22.57			18.19	22.16		
NGC 6946	22.15	142.08	26.10	63.19	21.10	125.55	24.00	41.00	19.41	113.12	22.18	59.82

The rms deviation of the derived model profiles from the original ones does not exceed 0.02 mag.

The results of the fitting are presented in Table 6. The columns of the table are:

Column 1: galaxy name.

Columns 2 and 3: best-fitting parameters of the exponential disk in B filter (the central surface brightness μ_0 (mag/sq s) and exponential scale length h (arcsec)).

Columns 4 and 5: best-fitting parameters of the second exponential disk in B filter, or, for NGC 6946 are best-fitting bulge parameters (effective surface brightness μ_e (mag/sq s) and effective radius r_e (arcsec)).

Columns 6, 7, 8 and 9: same as 2, 3, 4 and 5, but in V filter.

Columns 10, 11, 12 and 13: same as 2, 3, 4 and 5, but in I filter.

The central surface brightnesses in the table are not corrected for galactic absorption.

In Fig. 5 the absolute B -magnitudes for the measured galaxies are shown versus the model central surface brightnesses (μ_0^B) in B band (left) and scale lengths in kpc (right). All the magnitudes are corrected for galactic absorption. For comparison, these distributions for spiral galaxies studied by Binggeli & Cameron (1993) and van der Kruit (1987), and also for dwarf and low surface brightness galaxies (LSB) from Vennik et al. (1996) are given in the figure. As seen from Fig. 5 the absolute B -magnitudes of the studied galaxies span over a wide range from -12^m to -20.5^m and the exponential disk central surface brightnesses are distributed mostly in the range from 21 to 24.5 mag/sq s, except some bright spiral galaxies, the central surface brightnesses of which are higher. The mean value of the central SB in B band is about 22.4 ± 0.8 for the measured galaxies (and the mean value in V band is about 22.1 ± 0.9 and in I band is about 21.3 ± 0.9). Near the same area is occupied in the figure by the nearby dwarf

Fig. 5. The model central surface brightnesses (left) and logarithm of the scale lengths (right) in B band versus the absolute B -magnitudes. The filled squares are the measured galaxies, the squares are the galaxies from the article of Vennik et al. (1996), the crosses (+) are the spiral galaxies from the work of Binggeli & Cameron (1993), and the crosses (x) are the spiral galaxies from the work of van der Kruit (1987)

galaxies studied in the paper by Vennik et al. (1996). Some distant LSB galaxies from this work have higher absolute B -magnitudes and lower central surface brightnesses. The plotted spiral galaxies are on average of higher absolute magnitudes and also of higher central SB. Note that absolute magnitudes are only slightly correlated with central surface brightnesses for the galaxies plotted in the Fig. 5. On the contrary, the disk scale lengths in B band are closely correlated with absolute B -magnitudes. The scale lengths are distributed over a wide range, $-0.7 < \log h < +0.7$ and the area of nearby dwarf galaxies and the area of bright spiral (and LSB) galaxies are well-separated in the figure. The mean scale length value for the measured nearby dwarf galaxies is about 0.68 ± 0.40 kpc in B band.

7. Notes to individual galaxies

NGC 2366. The galaxy has an irregular, clumpy structure. The clump in the lower right part of the galaxy has a separate number in the PGC catalogue, LEDA 93088. However, it may also be a star formation region belonging to NGC 2366. Both of the objects are measured together in the present work.

UGC 4459. A light from a bright foreground star appears at the upper left corner of the image (see Fig. 1).

UGC 4483. The estimates of the total magnitudes for this galaxy contain large uncertainties due to a bright nearby foreground star.

UGC 5086. The galaxy measurements have poor calibration because of atmospheric extinction.

BK 3N. The M 81 boundary appears at the upper left corner of the image (see Fig. 1).

Holmberg IX. According to our measurements, this is one of the bluest galaxies of the sample with $B - V = 0.22$. However, it is possible that the result is affected by the bright neighbor M 81.

UGC 7321. This is an edge-on galaxy of big diameter. For the case of this object the method of obtaining an azimuthally averaged profile can probably yield satisfactory results only in the central parts of the galaxy.

NGC 5229. This is also an edge-on object of big diameter. The same notes as for UGC 7321 can be given.

NGC 5474. This bright spiral galaxy has a very asymmetric structure. The geometric center of the galaxy was used when measuring total magnitudes and surface brightness profiles.

NGC 6946. The CCD field is probably too small for this galaxy. Therefore, the given total magnitudes should be taken as lower limits.

8. Conclusion

Observations of 39 nearby, mostly dwarf galaxies are presented in this work. The observations were carried out at the 1.2-m telescope of Observatoire de Haute-Provence (France) with B , V and I Cousins filters. The sample of nearby galaxies with significant uncertainties in the total magnitude B_T was selected from the Principal Galaxy Catalogue.

Based on surface and integrated photometry of the observed galaxies we derived total B , V and I magnitudes and integrated $B - V$, $V - I$ colours and also radii and magnitudes at the 25^m isophotal level.

It should be noted that $B - V$, $V - I$ colours of the measured galaxies (corrected for galactic absorption)

are well fitted by the following distribution: $(B - V)_0 = 0.85 \times (V - I)_0 - 0.20$.

Azimuthally averaged surface brightness profiles were derived for 33 galaxies in each photometric band. Most of the measured galaxies can be well fitted by an exponential intensity law of brightness distribution in the whole profile or in its outer parts. The best-fitting exponential parameters are given for the galaxies.

The relations between absolute B -magnitudes and model central surface brightnesses in B band and scale lengths in B band are also presented. For comparison, similar data are given for spiral galaxies, nearby dwarf galaxies and low surface brightness galaxies from articles of different authors. Our sample galaxies span over a wide range of absolute B -magnitudes from -12^m to -20.5^m and the exponential disk central surface brightnesses are distributed mostly in the range from 21 to 24.5 mag/sq s , except some bright spiral galaxies. Note that absolute magnitudes are weakly correlated with central surface brightnesses for the given data. The mean value of the central SB in B band is about 22.4 ± 0.8 for the measured galaxies (and the mean value in V band is about 22.1 ± 0.9 and in I band is about 21.3 ± 0.9). The scale lengths in B band are closely correlated with absolute B -magnitudes, and the area of nearby dwarf galaxies and the area of bright spiral (and LSB) galaxies are well-separated in the figure. The mean scale length value for the measured nearby dwarf galaxies is about $0.68 \pm 0.40 \text{ kpc}$ in B band.

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