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Photometric parameters of edge-on galaxies from 2MASS observations

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Abstract. To analyze the vertical structure of edge-on galaxies, we have used images of a large uniform sample of flat galaxies that have been taken during the 2MASS all-sky survey. The photometric parameters, such as the radial scale length, the vertical scale height, and the deprojected central surface brightness of galactic disks have been obtained. We find a strong correlation between the central surface brightness and the ratio of the vertical scale height to the vertical scale length: the thinner the galaxy, the lower the central surface brightness of its disk. The vertical scale height does not increase systematically with the distance from the galaxy center in the frames of this sample.

Key words. galaxies: structure – galaxies: photometry

1. Introduction

The study of edge-on galaxies provides a unique possibility to obtain information about vertical structure in galactic disks. Beginning with the papers of Van der Kruit & Searle (1981a, 1981b, 1982) the investigation of edge-on galaxies continues today in optical bands (see Van der Kruit 2001 and references therein) as well as at radio wavelengths (Matthews et al. 1999; Van der Kruit et al. 2001). These studies help us to understand the laws governing the distribution of stellar and gaseous components of disks, and shed light on the role of dark halos in the evolution of spiral galaxies.

The main difficulty in studying edge-on disks in the optical is the need to take into account internal extinction by dust inside the disks. Extinction values can be enormous in the plane of a galaxy (of the order of a few tens of magnitudes for our Galaxy) and even far outside the plane they are substantial (see Xilouris et al. 1999). This is why it is preferable to use red and infrared data to investigate the structure of edge-on galaxies.

The 2MASS (Two Micron All Sky Survey) image library provides a sample of edge-on galaxies with near-infrared photometric data. Unfortunately the exposure time for 2MASS objects was too small to image the external parts of spiral galaxies, but it allows us to study the structures of their thin disks.

In this paper we use 2MASS data to obtain information about photometric parameters of stellar disks: their radial scale length, vertical scale height and deprojected central surface brightness for as many galaxies as possible. We choose the infrared photometric band $K_{\rm s}$ for this study as it is the 2MASS band least influenced by dust extinction.

2. Sample of galaxies

The data from the 2MASS Public Release Image Server were used (see Nikolaev et al. 2000 for details of the images). All images and calibration data were collected using the web-based interface provided by the NASA/IPAC Extragalactic Database (http://irsa.ipac.caltech.edu/applications/2MASS/ReleaseVis/). Image tiles containing objects from the Revised Flat Galaxy Catalog (Karachentsev et al. 1999, hereafter RFGC) were chosen for this analysis. This gives some guarantee that the galaxies chosen all have thin and highly-inclined disks.

Our initial sample included more than 700 objects from the RFGC catalog which had already been detected in 2MASS survey. An examination of these images shows that there are only 153 objects whose major axes, A, span more than $40''$ (in $K_{\rm s}$ filter). We note that this value is related to the visible size of objects shown in the 2MASS

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frames. Such a widely used value as the isophotal diameter D_{25} is generally about three times greater than the maximum size of the same objects in K_s frames. Flat galaxies that have a value of A close to $40''$ are marginally acceptable for the present analysis. The most critical parameter for the vertical structure analysis is the object size in the vertical direction i.e. parallel to the minor axis. Galaxies with $A < 40''$ do not allow us to analyze clearly the vertical cuts.

Finally, we refined this sample to a subsample consisting of 60 flat galaxies whose major axis size is more than $1'$. Galaxies in this subsample seem to be more reliable for our analysis due to bigger angular diameter and will be examined together with the main sample of 153 galaxies to look for a possible difference in photometric parameters between the main sample and the subsample. This allows us to estimate possible systematic errors caused by the small size of some objects.

3. A method for obtaining the radial scale length, the vertical scale height and the central surface brightness of stellar disks

We follow the classic way to investigate the vertical structure of edge-on disks in spiral galaxies (Van der Kruit & Searle 1981a, 1981b, 1982; de Grijs & Van der Kruit 1996). It allows us to trace the behavior of the scale height at different distances from the center of the galaxy analyzing each photometric cut separately. In previous studies roughly ten cuts were made parallel to the minor axis of each galaxy, and a few parallel to its major axis.

In this paper we analyze a few tens of cuts spaced at equal intervals parallel to the minor axis of the disk. To estimate the radial scale length and the central surface brightness we made two cuts parallel to the major axis located at a certain distance from the galactic plane, as in the plane the value of internal extinction remains relatively large even in the IR spectral range.

A preliminary inspection of each frame was made to make an initial guess at the position of galactic center, as well as at the approximate size and orientation of the ellipse outlining the visible size of a galaxy. The ellipse is drawn along the faintest isophote seen in the image. The cuts were done parallel to the major and the minor axes of the ellipse. The cuts parallel to the major axis were gradually shifted our away from the major axis (in both directions) by 12–15% of the minor axis size in order to examine the surface brightness profile along the major axis. The number of cuts parallel to the minor axis was chosen to be around 20–30, thus covering most of the disk. The 2MASS survey is not sensitive to the very faint parts of galaxies, so our results are related mostly to the thin stellar disks. Hence, emission from the thick stellar disk might be neglected near the galactic plane.

The equations used to fit the parameters of each cut assume an exponential law for the distribution of luminosity volume density in the radial direction $\rho_L(r)$ and an isothermal law for the distribution in the vertical direction. In this case a general form of surface brightness distribution I on the plane of a sky (X, Y) is

$$I(X,Y) = \int \rho_L(r,z) \mathrm{d}l, \quad (1)$$

where

$$\rho_L(r,z) = \rho_{L0} \exp\left(-\frac{|r|}{R_e}\right) \mathrm{sech}^2\left(\frac{|z|}{z_0}\right), \quad (2)$$

r is the radial distance from the center of a galaxy, z is the distance from the galactic plane, z_0 and R_e denote the vertical scale height and the radial scale length respectively. Integration of (1) proceeds along the line of sight. One can find the deprojected central surface brightness S_0 by integrating (2) along the vertical axis.

In the first-order approximation we assume z_0 to be independent of radius r, as has been previously noted by many authors (see e.g. Van der Kruit & Searle 1981a, 1981b; de Grijs & Peletier 1997). To take into account the radial variability of the vertical scale height, we must know a priori the form of $z_0(r)$. More generally, we can assume that z_0 is a monotonous function of r. Then, using our approximation we can determine whether z_0 varies significantly with radial distances or not.

We use Eq. (1) by fixing the Y coordinate and drawing two cuts parallel to the major axis to obtain the values of R_e and S_0. In a similar way, we fit the cuts drawn parallel to the minor axis to find the values of z_0. In this case we add a variable "shift term" δY to find the declination of the center of each cut from the galactic plane.

In this study we do not consider the possibility that some disks may not be 90° inclined, because we find that most objects from the RFGC catalog have inclinations that are close to 90°. A more detailed study that includes the non-90° inclined disks is problematic, since we usually do not see a dust layer on most of the 2MASS galactic images taken in the K_s-band.

While analyzing the radial surface brightness profiles, we exclude their central parts (typically 1/3–1/4 of the maximal extent of the radial profile) to decrease the influence of the bulge light on our results.

The smearing effect caused by the Earth's atmosphere affects the values of the measured scales by increasing the value of the scale height. To take this effect into account, we convolved the fitting functions with a Gaussian. The mean *FWHM* value of the PSF was about $3''$ during the survey so we have chosen $3''$ as the *FWHM* of the Gaussian. Finally the functions were fitted to the extracted profiles by the least-squares method.

The flux calibration of the central deprojected surface brightnesses S_0 is available from equations given by Nikolaev et al. (2000). Finally, we corrected the S_0 values for the Galactic extinction (using the data from LEDA, the Lyon-Meudon extragalactic database).

We analyzed the set of cuts parallel to the major and minor axes for each galaxy in our 2MASS sample and obtained the values of S_0, R_e, $z_0(r)$, and δY as the output.

The value of Y_0 was used to correct the position angle of the ellipse outlining the faintest isophote in the image of a galaxy, if it was needed, and to correct the final value of z_0 for each distance from the center r. Finally, we take the value of z_0 as the median value of all scale heights and the value of R_e as the average value of all scale lengths for each galaxy. The averaging of scale length/height allow us to avoid the influence of stars and bad pixels projected onto the images on the final values of R_e and z_0.

The output photometric parameters are presented in Table 1. It contains (1) the name of the galaxy according to RFGC catalog, (2) the distance in Mpc adopted in our paper, (3) the radial scale length in kpc, (4) the central surface brightness reduced to the face-on inclination in mag/□″, (5) the vertical scale height in kpc, and (6) the label "x" marking the galaxy that belongs to the subsample.

4. Results and discussion

Figure 1 shows the relation between the corrected central surface brightness S_0 and the ratio z_0/R_e of the scale height to the scale length of a disk. Open squares in Fig. 1 denote our main sample of galaxies. Filled squares show the subsample of galaxies. The linear fit gives the equation $z_0/R_e = 1.30-0.059 \times S_0$ for the subsample of 60 galaxies in Fig. 1.

As is seen in Fig. 1, there is a strong correlation between S_0 and z_0/R_e. Thicker disks have higher values of central surface brightness, and vice versa. The scatter in the points for the the main sample is larger than the scatter for the subsample. This indicates a typical uncertainty in z_0/R_e and S_0 due to the low quality of some images. A better correlation between these values for the more resolved galaxies gives us hope for even better results when the higher resolution photometric data will be available.

The systematic difference between galaxies of different sizes (open versus filled squares) is well seen in Fig. 1. It reflects the overestimation of z_0 for the faintest galaxies of the main sample.

As was noted by Gerritsen & de Blok (1999), the low surface brightness galaxies (LSB) must be relatively thinner than the normal (HSB) galaxies. The most natural explanation of this feature is that a dark halo does contribute a substantial part of the mass in LSB galaxies (de Blok & McGaugh 1997). A shallower central part of the rotation curve is a typical feature of LSB galaxies, which requires a large fraction of dark matter (van den Bosch et al. 2000). Figure 1 shows that the values of deprojected central surface brightness of disks span about 2.5 magnitudes (for the subsample of galaxies). This agrees well with the observational data published by de Jong (1996a), and Tully & Verheijen (1997) for almost face-on disks. These authors show that the typical difference in S_0 values between LSB and HSB galaxies is of the order of 2 magnitudes.

From the K_s-band central surface brightness of 18.2 mag/□″ and the B-band central surface brightness of 21.65 mag/□″ (Freeman 1970) we infer the $(B-K_s) \approx 3.5$

Table 1. Photometric parameters of disks of galaxies.

Name RFGC	D Mpc	R_e kpc	S_0 mag/□″	z_0 kpc	Note[1]
95	13.10	1.45	19.50	0.26	x
139	72.34	3.18	18.59	0.95	
176	72.01	5.66	18.78	1.00	x
183	69.80	8.11	19.43	0.92	x
206	62.16	1.94	16.47	0.77	
282	91.56	3.69	18.15	0.93	
355	74.42	4.79	18.96	0.85	
363	75.23	5.36	18.20	1.02	x
420	74.57	3.10	17.28	0.87	x
444	122.18	6.10	18.41	1.06	
485	110.64	5.45	19.13	1.16	
504	50.76	4.80	18.39	0.72	x
517	71.07	5.19	19.72	1.02	
507	53.84	2.38	17.81	0.63	x
538	26.71	1.66	18.73	0.48	x
544	84.44	3.33	17.91	0.85	
551	148.94	5.02	17.56	1.78	
561	145.61	4.70	17.56	1.39	
586	56.42	2.04	17.64	0.74	
603	70.77	2.24	16.79	0.98	
609	84.09	4.60	17.53	1.57	x
642	34.56	2.55	18.34	0.42	x
653	162.75	17.61	19.43	1.71	
671	143.69	8.18	18.13	1.92	
702	36.65	1.70	18.89	0.43	
722	24.11	2.23	18.92	0.41	x
744	124.66	4.96	18.12	1.14	
757	131.95	5.51	18.10	1.54	
765	121.79	6.06	17.68	1.69	x
826	115.75	7.66	19.05	1.67	
882	80.19	3.09	17.55	0.80	x
895	15.23	1.45	19.26	0.38	x
902	58.95	2.71	17.85	0.86	x
914	125.78	4.03	18.17	0.98	x
1047	36.33	1.82	18.74	0.51	
1049	13.39	0.96	17.18	0.22	x
1128	51.89	4.41	17.75	0.70	x
1135	63.82	2.30	18.45	0.53	
1140	63.88	3.32	17.53	0.78	
1143	58.62	3.73	18.90	0.76	x
1159	85.70	6.78	18.46	1.50	x
1167	52.15	3.37	18.59	0.71	x
1194	29.44	2.30	17.75	0.64	x
1206	32.57	1.84	17.69	0.39	
1244	41.43	4.79	18.64	1.09	x
1263	63.54	3.34	18.01	0.75	
1329	54.63	2.62	19.41	0.68	
1339	73.42	7.83	18.76	1.13	x
1349	56.14	2.69	17.15	0.79	
1421	19.98	1.76	17.68	0.40	x
1431	58.34	5.42	17.51	1.38	x
1459	102.94	3.14	17.89	0.88	
1499	65.25	2.09	17.12	0.85	
1500	22.07	3.03	17.02	0.85	x
1502	119.76	4.82	18.00	1.13	
1536	113.49	4.03	18.18	1.05	

[1] "x" means part of the more reliable subsample (see text).

Table 1. continued.

Name RFGC	D Mpc	R_e kpc	S_0 mag/□″	z_0 kpc	Note[1]
1548	55.37	2.34	18.46	0.66	
1624	60.63	3.59	18.95	0.79	
1627	96.27	3.35	18.23	0.88	
1670	99.85	8.41	18.73	1.06	x
1691	81.79	3.82	18.63	0.88	
1692	93.00	4.36	18.62	1.10	
1723	64.25	3.43	18.19	0.71	
1754	110.32	6.60	18.28	1.69	
1789	27.04	1.66	18.23	0.32	
1792	14.61	1.13	18.02	0.18	x
1872	103.64	3.76	17.59	1.20	
1901	83.97	3.92	18.14	0.90	
1904	129.33	7.13	18.75	1.45	
1906	13.72	1.32	18.91	0.24	x
1928	80.12	4.07	17.93	1.07	
1932	38.21	2.40	18.92	0.55	
1945	14.14	1.35	18.10	0.27	x
2026	101.81	4.12	17.97	1.13	
2044	51.01	2.65	18.14	0.61	
2068	75.97	3.39	18.97	0.83	
2097	68.96	5.10	19.58	0.77	
2100	86.45	4.21	18.15	1.26	
2162	21.70	1.42	19.24	0.29	
2171	47.64	2.72	19.28	0.77	
2174	100.18	3.68	18.26	0.96	
2239	11.40	1.42	18.88	0.20	x
2245	3.61	1.23	19.49	0.33	x
2246	10.00	1.73	20.25	0.20	x
2257	50.64	2.46	17.70	0.71	x
2296	106.92	7.53	19.90	1.19	
2312	83.28	3.31	17.41	0.94	
2315	13.81	8.40	19.78	0.80	x
2336	7.58	4.52	21.42	0.14	
2373	68.45	5.21	17.55	1.39	x
2376	90.16	4.06	18.17	1.24	
2380	47.61	3.93	18.52	0.80	x
2399	28.67	3.35	20.23	0.37	x
2418	117.08	8.44	19.08	1.19	
2425	36.76	1.70	17.76	0.64	
2473	146.73	3.89	17.80	1.31	
2477	95.17	4.75	17.53	1.37	x
2517	35.04	2.68	18.86	0.50	x
2528	35.18	5.50	18.74	0.84	x
2568	79.64	2.88	17.28	0.97	
2611	101.78	7.07	19.45	1.03	
2679	71.90	3.59	18.50	0.84	
2682	33.94	3.38	17.04	1.36	x
2715	136.69	6.47	18.07	1.50	
2747	39.53	6.22	18.38	0.88	x
2756	35.23	2.63	18.20	0.47	x
2826	31.39	2.46	17.92	0.56	x
2835	45.32	3.53	17.36	0.66	x
2860	28.59	1.93	17.57	0.56	x
2945	153.26	9.95	18.77	1.77	
2946	10.90	3.35	18.25	0.49	x
2966	92.63	4.74	18.46	0.95	

Table 1. continued.

Name RFGC	D Mpc	R_e kpc	S_0 mag/□″	z_0 kpc	Note[1]
2994	47.61	4.31	17.08	1.65	x
3004	127.28	6.29	18.11	1.75	
3006	43.30	3.04	18.79	0.58	
3085	62.95	2.55	17.80	0.67	
3094	120.43	8.03	18.15	1.56	x
3098	132.44	4.81	18.13	1.59	
3106	125.47	5.45	18.03	1.61	
3114	32.16	1.50	18.42	0.50	
3227	115.45	5.17	18.04	1.42	
3240	128.98	5.04	17.74	1.47	
3313	56.19	2.54	17.82	0.80	
3352	72.73	3.25	18.14	0.94	
3378	75.42	2.94	18.24	0.76	
3430	59.13	4.99	18.37	1.03	
3455	65.01	2.93	18.30	0.68	
3477	143.56	6.44	18.44	1.86	
3480	150.33	7.31	18.37	1.67	
3507	78.03	3.91	17.59	1.30	x
3580	72.82	5.30	18.86	1.01	x
3614	83.47	4.22	18.88	0.80	
3658	109.38	4.51	17.63	1.28	
3762	117.38	5.21	17.42	1.46	
3793	46.09	3.70	18.13	0.68	x
3863	77.13	5.96	18.07	1.07	x
3903	35.29	3.23	18.43	0.59	x
3926	67.84	5.05	18.11	0.90	x
3984	117.45	6.50	19.60	1.07	
3985	89.81	3.03	17.81	0.99	
4004	99.54	6.95	18.64	1.23	x
4013	43.43	11.09	20.69	0.51	
4043	99.73	3.54	17.21	1.13	
4051	90.88	3.03	18.29	0.97	
4076	97.13	4.46	17.83	0.93	x
4078	118.28	5.77	17.69	1.15	x
4092	93.99	2.56	17.55	0.83	
4103	145.16	5.91	17.60	1.46	
4106	98.73	4.11	17.60	1.22	
4110	82.41	15.53	16.35	4.18	
4136	70.31	2.32	17.71	0.89	
4165	92.36	3.89	17.38	1.10	
4171	101.53	5.39	17.87	1.24	

for the central parts of deprojected face-on disks. This is in good agreement with the values of S_0 in Fig. 1. Fainter disks in Fig. 1 have S_0 values that differ from the typical Freeman value in K_s-band by 1.5–2 magnitudes. These faint disks appear to be the LSB disks in our sample.

Using galactic distances based on radial velocities reduced for Galactic Standard of Rest movement (V_{GSR} taken from LEDA), we compare the linear values of z_0 and R_e for galaxies with different central surface brightnesses (see Fig. 2). We use a Hubble constant of 75 km s^{-1} Mpc^{-1} throughout this paper. As can be seen in Fig. 2, neither the linear value of R_e nor that of z_0 tends to show a systematic difference between LSB and HSB disks. Note that the errors in distances lead to additional

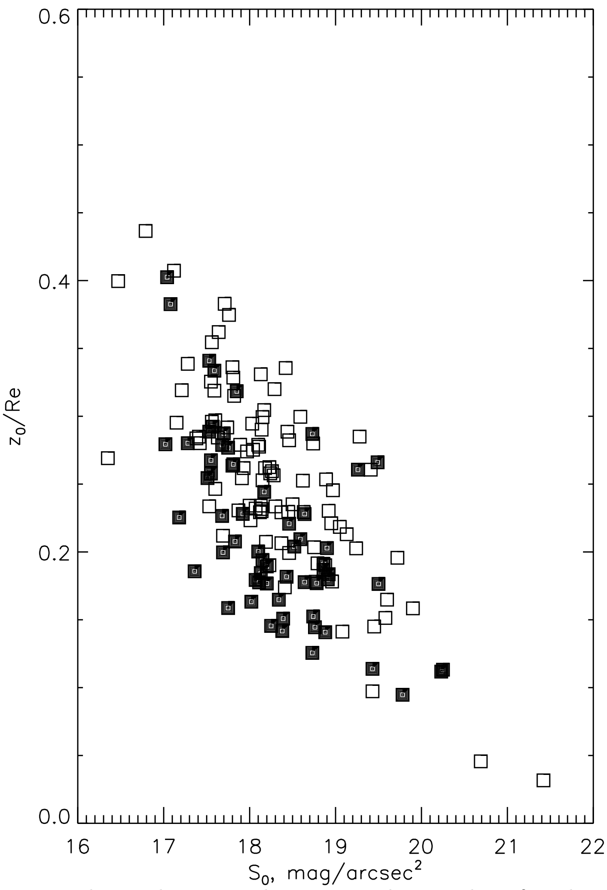

Fig. 1. Relation between the corrected central surface brightness, S_0, and the ratio of the vertical scale height to the radial scale length z_0/R_e for the sample of 153 galaxies. The subsample of galaxies is denoted by the filled squares.

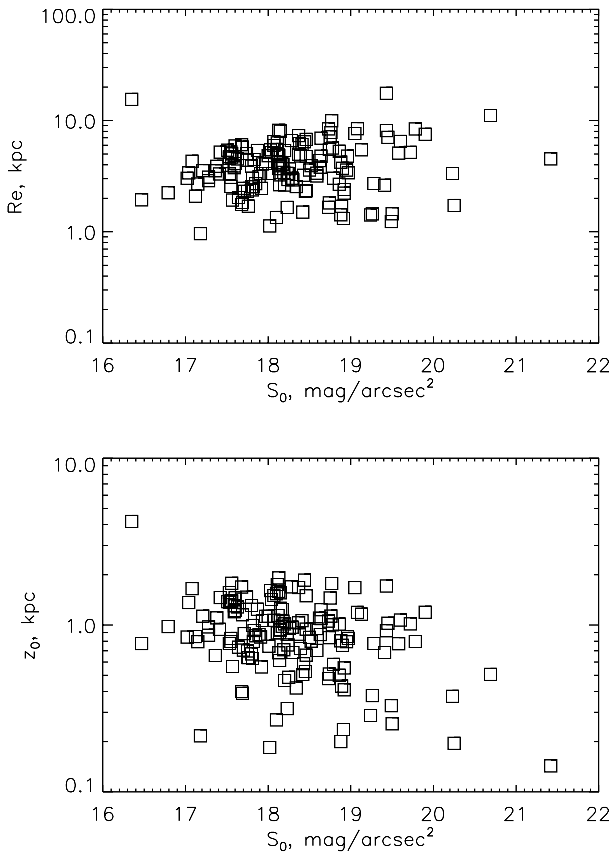

Fig. 2. The linear values of radial scale length R_e (upper figure) and vertical scale height z_0 (lower figure) for galaxies of different central surface brightnesses S_0.

scatter of the points in Fig. 2, especially for nearby galaxies. A more sophisticated analysis of distance-related values based on new distance estimates is needed. This question will be addressed in the next paper.

Nevertheless, the correlations between S_0 and each of scales z_0 and R_e (Fig. 2) are much worse than the correlation between S_0 and the ratio of scales z_0/R_e (Fig. 1). It implies that the latter correlation is based on a more significant physical foundation than the correlations between S_0 and each of scales z_0 and R_e. A pronounced correlation between S_0 and z_0/R_e implies the importance of dark halos in galaxies with low values of S_0. The gravity of the halo does not let the disk grow thicker in this case.

Eleven galaxies from our sample have the scales measured and published by Barteldrees & Dettmar (1994) and Schwarzkopf & Dettmar (2000). Four of them were observed in the K'-band, which is very close to K_s where our estimates have been done. Figure 3 shows a comparison of radial scale lengths (upper frame) and vertical scale heights (lower frame) made for these cases. Distance-dependent values for galaxies from other papers are corrected to our distance scale. Filled triangles denote the scales that have been obtained using the K'-band data. Open triangles are related mostly to the R-band observations. As Fig. 3 shows, scale lengths and scale heights are as a rule larger in the R-band and pretty close to our values in the K'-band. One of the galaxies, UGC 7321, was investigated by Matthews (2000) in the K-band. She found that the scale length and scale height are equal to 2.0 and 0.19 kpc respectively (here the scale height of the thin galactic disk is cited). Our values are 1.73 and 0.20 kpc, which do not differ significantly. Two other galaxies NGC 4244 and NGC 5907 were investigated by van der Kruit & Searle (1982) using photographic plates in the J-band (close to Johnson's B). Using distances to galaxies from the present paper (3.6 and 10.9 Mpc respectively) we can compare our scale lengths/scale heights. The published values are 1.87/0.41 kpc and 5.65/0.82 kpc after reducing to our distance scale, whereas our values are 1.23/0.33 kpc and 3.35/0.49 kpc respectively. The values are of the same order and a systematic difference is expected because of usually shorter scales in near-infrared filter bands. Finally, the scales for another galaxy, UGC 11194, were found using I-band observations and published by Bizyaev (2000). The scales are 4.48/0.98 kpc in contrast to 5.04/0.90 kpc found in this paper. The scales for the same galaxy were published by Reshetnikov & Combes (1997). After correcting to our distance scale they are 4.0/1.15 kpc.

In spite of the low accuracy achieved for each individual cut, we are able to estimate roughly the radial trend of $z_0(r)$. To do so, we exclude a few values of scale height

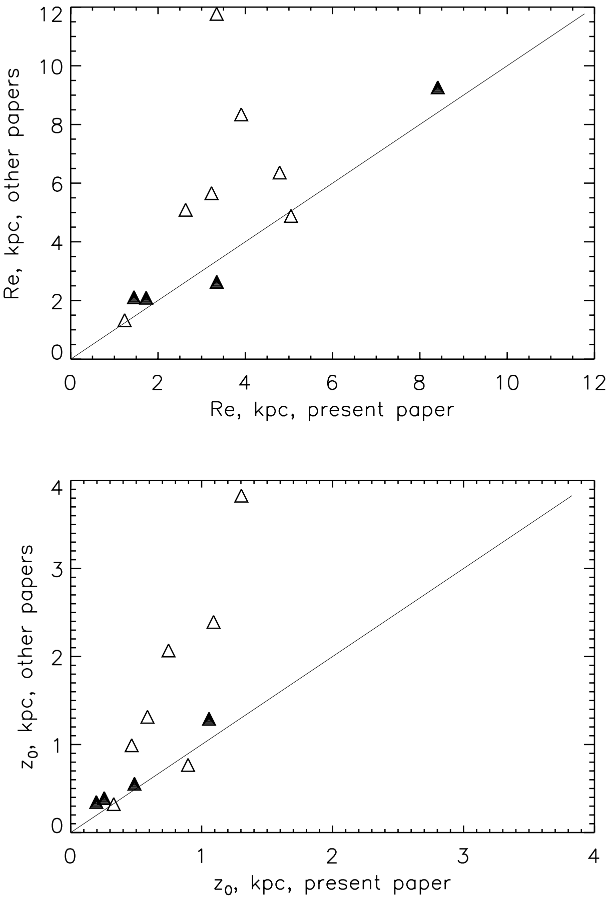

Fig. 3. The comparison of the radial scale lengths (upper frame) and the vertical scale heights (lower frame) between the published data and the data presented in this paper. Filled triangles denote the scales that were obtained using K' data. Open triangles are related mostly to R-band observations. Solid lines show the case of the equality of the scales.

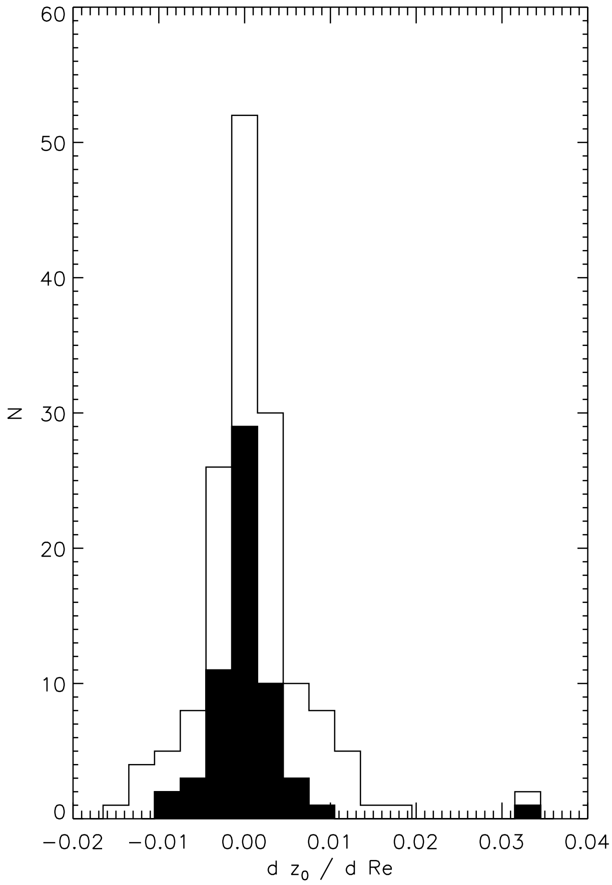

Fig. 4. The radial gradient of the vertical scale height $\mathrm{d}z_0/\mathrm{d}r$ for our sample of galaxies. The average value of $\mathrm{d}z_0/\mathrm{d}r$ is very close to zero. The standard deviation of $\mathrm{d}z_0/\mathrm{d}r$ is equal to 0.0063. The subsample of galaxies is highlighted by the filled part of histogram.

that deviate from the general trend by more than 3σ. We fit the values of z_0 to a linear function of r. The histogram in Fig. 4 shows the results of the fitting. The gradient $\mathrm{d}z_0/\mathrm{d}r$ is presented in dimensionless values. The subsample of galaxies is shown by the filled part of the histogram in Fig. 4.

As one can see in Fig. 4, the average value of $\mathrm{d}z_0/\mathrm{d}r$ is very close to zero (0.001), which is in agreement with the conclusions of many previous studies (see previously cited references). The subsample of galaxies has an average value of $\mathrm{d}z_0/\mathrm{d}r = 0.0003$ (i.e. zero). The standard deviation of $\mathrm{d}z_0/\mathrm{d}r$ in Fig. 4 is equal to 0.006 for the whole sample and 0.005 for the 60 largest galaxies in this sample. It gives a 10% change of the measured scale height on distances of 3.5 R_e from the center, i.e. at the very edge of a stellar disk adopting a typical value of z_0/R_e from Fig. 1. Note that the real change of z_0 along the radius needed to produce the 10% trend may be 2–3 times more significant due to projection of different parts of the disk on the line of sight.

5. Conclusions

We analyzed the vertical and the radial distributions of near-infrared surface brightness in disks of flat galaxies observed during the 2MASS survey. A strong dependence of the ratio z_0/R_e of the vertical scale heights to the radial scale lengths on the deprojected central surface brightness S_0 is inferred. Galaxies with lower central surface brightnesses look thinner and have lower values of z_0/R_e. The linear value of the radial scale length appear to be independent of the central surface brightness, the same conclusion is true for the vertical scale height. We can also conclude that the vertical scale height of thin stellar galactic disks is almost independent of radius for galaxies in our sample and has almost the same value over a wide range of distances from the center.

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References

Barteldrees, A., & Dettmar, R.-J. 1994, A&AS, 103, 475
Bizyaev, D. 2000, Soviet Astron. Lett., 26, 219
de Grijs, R., & van der Kruit, P. 1996, A&AS, 117, 19
de Grijs, R., & Peletier, R. 1997, A&A, 320, L21
de Blok, W., & McGaugh, S. 1997, MNRAS, 290, 533
de Jong, R. 1996, A&A, 313, 45
de Jong, R. 1996, A&A, 313, 377
Freeman, K. 1970, ApJ, 160, 811
Gerritsen, J., & de Blok, W. 1999, A&A, 342, 655
Karachentsev, I., Karachentseva, V., Kudrya, Y., et al. 1999, Bull. Special Astrophys. Obs., 47, 5
Matthews, L., Gallagher, J., & van Driel, W. 1999, AJ, 118, 2751
Matthews, L. 2000, AJ, 120, 1764
Nikolaev, S., Weinberg, M., Strutskie, M., et al. 2000, AJ, 120, 3340
Pohlen, M., Dettmar, R.-J., & Lutticke, R. 2000, A&A, 357, L1
Reshetnikov, V., & Combes, F. 1997, A&A, 324, 80
Schwarzkopf, U., & Dettmar, R.-J. 2000 A&AS, 144, 85
Tully, R., & Verheijen, M. 1997, ApJ, 484, 145
van den Bosch, F., Robertson, B., Dalcanton, J., & de Blok, W. 2000, AJ, 119, 1579
Van der Kruit, P., & Searle, L. 1981a, A&A, 95, 105
van der Kruit, P., & Searle, L. 1981b, A&A, 95, 116
Van der Kruit, P., & Searle, L. 1982, A&A, 110, 61
Van der Kruit, P. 2001 [`astro-ph/0109480`]
Van der Kruit, P., Jimenez-Vicente, J., Kregel, M., & Freeman, K. 2001, A&A, 379, 374
Xilouris, E., Byun, Y., Kylafis, N., et al. 1999, A&A, 344, 868