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B, *V*, *R*, *I*, *H* and *K* images of 86 face-on spiral galaxies

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Abstract

FITS images in the *B*, *V*, *R*, *I*, *H* and *K* passbands are presented of a sample of 86 face-on spiral galaxies. The galaxies were selected from the UGC to have a diameter of at least $2'$ and a minor over major axis ratio larger than 0.625. The selected galaxies have an absolute Galactic latitude $|b| > 25°$, to minimize the effect of Galactic extinction and foreground stars.

Nearly all *BVRI* data were obtained with the 1m Jacobus Kapteyn Telescope at La Palma and the *H* and *K* data were obtained at the 3.8m UK Infra-Red Telescope at Hawaii. The field of view of the telescope/camera combinations were often smaller than the observed galaxies, therefore driftscanning and mosaicing techniques were employed to image at least along the major axis of the galaxies. Most images were obtained during photometric nights and calibrated using standard stars. A small fraction of the images was calibrated from literature aperture photometry.

The azimuthally averaged radial luminosity profiles derived from these galaxy images (see de Jong and van der Kruit [1994], Paper I) are also made available in machine readable format, as are the results of the bulge/disk decompositions described in de Jong ([1996a], Paper II). A detailed statistical analysis of the bulge and disk parameters of this data set can be found in de Jong ([1996b], Paper III). The dust and stellar content of the galaxies as derived from the color profiles is described in de Jong ([1996c], Paper IV). Evidence for secular evolution as found in this sample is shown in Courteau, de Jong and Broeils ([1996]).

Keywords: surveys - galaxies: fundamental parameters - galaxies: photometry - galaxies: spiral - galaxies: structure

1 Introduction

A great deal about galaxy evolution can be learned by studying their broadband properties. Broadband observations give an immediate impression of the spectral energy distribution and thereby information on stellar and dust content. Even though integrated magnitudes of galaxies can be used to study global properties of galaxies, even more can be learned from examining the detailed distribution of their light and colors. The star formation history in galaxies seems to be related to their surface density properties (Kennicutt [1989]; Ryder and Dopita [1994]; de Jong [1996c]), and therefore it is imperative to have a statistical knowledge of surface brightness distributions in galaxies to understand galaxy evolution.

The image data set presented here was collected to study the surface brightness distribution of spiral galaxies. Of especial interest was the question whether disks in spiral galaxies have a preferred central surface brightness value as proposed by Freeman ([1970]). The observations were made in such a way that they were suitable to study this central surface brightness effect, but this might make the observations less useful for some other studies due to two limitations. (1) Disk central surface brightnesses are in general determined from one-dimensional (1D) luminosity profiles, constructed by some kind of azimuthal averaging of the light distribution. No effort was made to obtain images with high signal-to-noise per pixel, as large numbers of pixels were to be averaged in the process of creating luminosity profiles. Furthermore the “depth" of the optical images were matched to the near-IR observations, which are more limited by the high sky background level than by signal-to-noise ratios. A considerable fraction of the images have too low signal-to-noise per pixel to allow detailed morphological studies of non-axisymmetric structures (ie. bars and spiral arms) except in the highest surface brightness regions. (2) The used telescope/camera combinations had a limited field-of-view, especially in the near-IR. Often only the major axis was imaged of the larger galaxies, as this was sufficient to measure the radial luminosity distribution of the galaxy. This again limits the usefulness of the images to study non-axisymmetric light distributions in the outer part of galaxies.

The structure of this paper is as follows: the selection of the sample is described in Section 2 and the observations in Section 3. Section 4 explains the different data reduction techniques used. In Section 5 I describe the format of the FITS images on the CD-ROM, in Section 6 the format of the luminosity profiles and in Section 7 the format of the bulge/disk decomposition files. A more detailed description of the selection, observations and data reduction can be found in Paper I. The bulge/disk decomposition methods are explained in more detail in Paper II.

2 Selection

The galaxies were selected from the Uppsala General Catalogue of Galaxies (UGC, Nilson [1973]). Only spiral galaxies in the range S1-DWARF SP were selected, excluding galaxies with classifications as S0-S1, SB0-SB1, S3-IRR, IRR and DWARF IRR. Ideally one would like to have a volume-limited sample of galaxies for a statistical study of galaxy properties, but this is impossible due to selection effects. To create a sample that is correctable for selection effects, the galaxies were selected to have UGC red diameters of at least $2'$. The galaxies have red UGC minor over major axis ratios larger than 0.625 to reduce problems with projection effects and dust extinction. This axis ratio range corresponds to inclinations less than approximately $51°$. Only galaxies with an absolute Galactic latitude $|b| > 25°$ were selected, to minimize the effect of Galactic extinction and to reduce the number of foreground stars. These selection criteria resulted in a sample of 368 galaxies. The final sample of 86 galaxies observed was selected on the basis of hour angle and declination only, in such a way that we had about equal number of observable galaxies during the whole night in the granted observing time. The total selected areas cover about 12.5% of the sky. All global parameters of the observed galaxies are listed in Table 1.

3 Observations

Nearly all *BVRI* images were obtained with the 1m Jacobus Kapteyn Telescope (JKT) at La Palma, equipped with a 385x578 GEC CCD camera, in March and September 1991 and April 1992. The Kitt Peak *BVRI* filter set (RGO / La Palma Technical Notes [1987]) was used, the pixel size was

0.3″. The CCD camera was used in both its normal imaging mode as well as in its driftscan mode. In driftscan mode, optimal use is made of the way CCDs are designed: while the telescope is tracking the object, the CCD camera is shifted under the telescope at the same speed as the image is shifted down the columns of the CCD while it is read out. Typical exposure times were 600 s in *B* and 400 s for the other optical passbands. Twilight flatfields were obtained at the beginning or at the end of the night and globular cluster fields with standard stars were observed at regular intervals through the night for calibration. A small number of optical observations were obtained from the La Palma archive.

The near-IR *H* and *K* passband observations were made at the United Kingdom Infrared Telescope at Hawaii with IRCAM II containing a 58x62 InSb array. During the February 1992 run standard *H* and *K* filters were used, but a K' filter was used in September 1991. The pixel size was 1.2″. For accurate sky subtraction and flatfielding sky frames were obtained before and after every two object frames at a position offset a few arcmin from the object. Images were taken in a strip along the major axis of the galaxies, spending about twice as much time on the outer part of galaxies than on the central region to increase signal-to-noise in these low surface brightness regions. Calibration stars from the list of Elias et al. ([1982]) were imaged at regular intervals. Dark frames with exposure times equal to the object exposure times were also obtained at regular intervals.

The full observing log with observing method (driftscan, mosaic), exposure times, photometric quality and seeing estimates can be found in Paper I. These values are also store in the FITS headers of the images.

4 Data reduction

4.1 Optical data

The normal data reduction procedure for CCD data was followed to create calibrated images from the direct imaging data obtained with the JKT. A bias value was subtracted from the images using the average value in the overscan region. The images were divided by normalized flatfields created by averaging several twilight frames. No dark current was subtracted as this was found to be insignificant for this CCD. In general two observations at the same position of an object were made, which allowed cosmic-ray removal when they were averaged.

The data reduction of the driftscans was more elaborate. A driftscan image consists of a ramp up part (rows that were not exposed for a full chip length before being read out), a flat fully-exposed part and a ramp down part (rows that are read out after the shutter has closed). The first rows of the ramp up part showed a gradient in the bias level in the cross-scan direction. Therefore, the bias level was determined by fitting the first half of the ramp up part of each column, giving a bias level for each column at the first row. The images were flatfielded by flatlines created averaging normal flatfields in column direction. The ramp up and down parts were corrected for the shorter exposure times, extending the field-of-view beyond the area that was exposed to the sky for a full chip length.

4.2 Near-IR data

Careful attention had to be given to flatfielding of the near-IR images, as flux levels 5×10^4 times below the sky level were measured. We first subtracted the dark current from all near-IR images (object and sky) using the average of the two dark frames obtained nearest in time. A normalized flatfield image was created for each galaxy by taking the median of the 4-5 sky frames observed around the galaxy. After flatfielding, known “hot" and “dead" pixels were set to “undefined" by a bad pixel mask and remaining dubious pixels were set to “undefined’ by hand. These “undefined" pixels were not used in further analysis.

The different object frames of a galaxy were mosaiced together to create a full image along the major axis. The spatial offset between frames was determined by a cross-correlation technique or by using the telescope offsets if no structure was available to be used in the cross-correlation technique. The relative spatial offsets between all overlapping frame combinations were determined and a least-square-fit determined the relative offset of all frames with respect to the central frame. Zero point (due to sky fluctuations) and intensity scaling factors (only for non-photometric observations) were determined in a similar fashion. All zero point (and when necessary intensity) offsets between overlapping frames (using the just determined spatial offsets) were calculated and a least-squares-fit through all relative offsets provided the intensity offset with respect to the central frame. All frames were mosaiced together using these spatial and intensity offsets, taking the average in the overlapping areas.

4.3 Calibration

The images were calibrated using the standard star fields observed during each night under different airmasses. The optical standard star fields we used were calibrated to Landolt ([1983]) stars, and therefore our system response has been transformed to Johnson *B* and *V* and Kron-Cousins *R* and *I*. The near-IR was calibrated to *H* and *K* standard stars of Elias et al. ([1982]), using the corrections of Wainscoat and Cowie ([1992]) to transform the K' passband to the *K* passband. Instrumental magnitudes (-2.5 log(number of counts)) of the different stars in the calibration fields were measured with DAOphot (Stetson [1987]). All photometric calibration measurements of one observing run were combined to least-square-fit equations of the form:

$$\begin{aligned}
b &= B + c_{0,B} + c_{1,B}(B-V) + c_{2,B}X \\
v &= V + c_{0,V} + c_{1,V}(B-V) + c_{2,V}X \\
r &= R + c_{0,R} + c_{1,R}(V-R) + c_{2,R}X \\
i &= I + c_{0,I} + c_{1,I}(R-I) + c_{2,I}X \\
h &= H + c_{0,H} + c_{2,H}X \\
k &= K + c_{0,K} + c_{2,K}X \qquad (1)
\end{aligned}$$

where *B*, *V*, *R*, *I*, *H* and *K* are the standard star magnitudes, b, v, r, i, h and k the instrumental magnitudes per second, X the airmass of the observation and $c_{i,J}$ the unknown transformation coefficients. The results of these fits can be found in Tables 2 and 3 and in the FITS headers of the images.

Non-photometric observations were calibrated with aperture photometry from the literature when available. We first determined magnitudes in synthetic apertures of the size of the literature photometry using the calibration of a photometric night. If our magnitude differed more than the expected error from the literature value, all magnitude parameters were corrected for this difference (indicated by header item CORR in the FITS files).

The optical pixel size was determined to be 0.303±0.004″, using images of globular clusters which contained accurately known star positions. This pixel size agreed to within its uncertainty to the instrumental specification, and therefore a value of 0.30″ was adopted. The near-IR pixel size was derived from the scaling factor to align the near-IR images with the optical images (see next paragraph). The near-IR pixel size was 1.20″ per pixel.

4.4 Final reduction steps

We determined the sky background level on the fully reduced images using the box method. Average sky values were measured in small boxes around the galaxies. Sky level was set to the median value of these measurements. The uncertainty in the sky value was taken to be half the difference between the maximum and minimum average sky values found in these boxes. This uncertainty will reflect errors due to imperfect flatfielding and mosaicing.

We aligned the images in the different passbands using foreground stars in common between the different frames. Images obtained during the same observing run were only allowed to shift, between different runs also rotation and scaling was allowed. The near-IR data was regridded to the much smaller pixel scale of the optical images, which means that nothing smaller than the original pixel size ($1.2''$) should be trusted on these images. A linear interpolation was used for regridding and therefore the new smaller pixels contain values that are representative of the original surface brightness in the pixels of the original size. Total flux in the image is not conserved in this process, but the original number of counts in an area can easily be calculated by multiplying the new number of counts in an area with the ratio of the square of the pixel sizes, $(\mathrm{pixelsize}_{\mathrm{new}}/\mathrm{pixelsize}_{\mathrm{old}})^2$.

5 The image catalog

All aligned images are stored in FITS format on the CD-ROM in the directory `IMAGES/`, with a separate directory for each galaxy. The aligned near-IR images in these directories have been compressed with gzip, but the "raw" near-IR images (i.e. before aligning and regridding to the optical images) are available in uncompressed FITS format in the directory `IRIMAGES/`. The FITS headers contain all the essential information for analysis. The images are in analog-to-digital-units (ADU), which corresponds approximately to the number of detected photons for the optical images and to 50 detected photons in the near-IR images. Undefined pixels in the images contain the value -999. The header items of interest are as follows:

Basic FITS items

NAXIS1, NAXIS2 number of pixels in RA and DEC respectively

CTYPE1, CTYPE2 RA-TAN, DEC-TAN axis type and projection system

CRVAL1, CRVAL2 should contain the RA and DEC value at the reference pixel (CRPIX1,CRPIX2), but as the exact position of the galaxies was often unknown, the stored values have no meaning

CDELT1, CDELT2 the pixel size in *degrees*. The same value is stored in arcseconds in header item PIXSIZIM

Observation related

FILTER passband filter (*B, V, R, I, H, K* or K')

SEEING full-width-at-half-maximum (FWHM) of seeing estimate in arcsec

PHOT photometric quality estimate as in Paper I (1: photometric, 2: 0.0–0.2 mag, 3: 0.2–0.5 mag, 4: 0.5–1.0 mag and 5: $>$1.0 mag error)

QUAL quick look quality estimate, taking into account (in order of importance) flatfield quality, area to measure the sky level, signal-to-noise and seeing. The numbers mean, 1: excellent, 2: reasonable, but take into account some of the limitations such as limited sky area, 3: poor, do not use except in case of an emergency

Calibration

MAG0 zero point calibration constant for a 1 second exposure (-c_0 in Eq. 1)

CCOL color calibration constant, when not used 0 (c_1)

COL average color of this galaxy used for calibration

CAIR airmass calibration constant (c_2)

AIRMASS airmass during the observation (X)

CORR correction for non-photometric observation to put this image on literature photometry

PIXSIZE pixel size in arcsec of original image (before rebinning)

PIXSIZIM pixel size in arcsec of this image (after rebinning/aligning)

EXPTIME exposure time calibration constant (if several images were averaged, this contains the average exposure time)

SKYLEV estimate of the sky background level in ADU

SKYERR maximum uncertainty in sky background

MAGOFF for convenience, this constant gives the calibration to convert pixel ADU values into mag arcsec^{-2}. It is equal to

$$-\mathrm{MAG0} - \mathrm{CCOL} \times \mathrm{COL} - \mathrm{CAIR} \times \mathrm{AIRMASS} - \mathrm{CORR} + 2.5 \log(\mathrm{PIXSIZE}^2 \times \mathrm{EXPTIME}).$$

The surface brightness in mag arcsec^{-2} of a pixel with ADU counts in the galaxy is

$$\mathrm{MAGOFF} - 2.5 \log(\mathrm{pixel(ADU)} - \mathrm{SKYLEV}).$$

To use this constant to calculate the magitude in an area, take into acount that flux was not conserved per area in the rebinning/alligning proces. The magnitude in an area with total of ADU counts is

$$\mathrm{MAGOFF} - 2.5 \log(\mathrm{area(ADU)} - \mathrm{SKYLEV}) - 2.5 \log(\mathrm{PIXSIZE}^4/\mathrm{PIXSIZIM}^2)$$

6 Luminosity profiles

The radial luminosity distribution of each galaxy was determined in each passband and these are also present on the CD-ROM. The areas in the *R* passband images affected by foreground stars were masked using a polygon editor. This mask was transfered to the other passbands, thus making certain that the same area was used in all passbands. The center of the galaxy was determined by fitting an ellipse to the central peak in the *R* passband image. Next, with this center fixed, ellipses were fit to the isophotes at the 23.5, 24.0 and 24.5 *R*-mag arcsec^{-2} level. The median values found for the minor/major axis ratio (b/a) and position angle (PA) in the *R*-band were used in all passbands to determine the luminosity profiles. Average ADU values were determined in concentric elliptical annuli of increasing radius with the already determined center, b/a and PA fixed. For face-on galaxies this method gives a better estimate of the average luminostity at each radius than methods which freely fit ellipses at each isophote, if we assume that the galaxy is not strongly warped. Bars, spiral arms and HII regions make isophote fitting methods unreliable for face-on spiral galaxies.

The profiles are provided in ASCII in the directory `PROFILES/` and the graphs can be found in Paper I. The surface brightness profiles are in mag arcsec^{-2}, the radii in arcsec. Undefined values are indicated by an $*$. Note that the central regions of UGC 7540 were saturated in the *V*, *R* and *I* passband. Further header information in these files are

INCL inclination in degrees (actually $\cos^{-1}(b/a)$) used for profile extraction

PA position angle in degrees used for profile extraction, measured from north to east

EXPTIME exposure time in seconds of image used

MAGOFF magnitude calibration constant (see image catalog)

MAGSKY sky surface brightness in mag arcsec^{-2}

MAGSKYERR uncertainty in MAGSKY

MAGTOT total apparent magnitude of the galaxy derived from the surface brightness profile (see Paper I)

MAGERR uncertainty in apparent magnitude

SEEING FWHM of seeing estimate in arcsec

DATE date of observation

PHOTQ photometry quality estimate (see image catalog)

7 Bulge/disk decompositions

A number bulge/disk decomposition methods was applied to the data (see Paper II for details) and the results are stored in directory `B_Dratio/`. The results of the 1D profile decompositions with $R^{1/4}$, $R^{1/2}$ and exponential bulges can be found in the files `BD4QFPAR.DAT`, `BD4FFPAR.DAT` and `BD4EFPAR.DAT`, respectively. The results of the 2D decompositions with exponential bulges and disks and with Freeman bars can be found in `BD4FPAR.DAT`. Note that not all observations were photometric and that for non-photometric observations the listed numbers are the lower limits in surface brightness flux. Obviously the scale parameters are correct for the non-photometric observations. Check the file `PHT.DAT` for a listing of the photometric quality of the observations. The description of all the columns in these files can be found in file `BD4READ.ME`.

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Table 1: Global parameters of the galaxies in the observed sample. The positions and the $V_{\rm GSR}$ recession velocities (cz) are obtained from the RC3 catalog, $D_{\rm maj}$ is the red UGC major axis diameter, b/a is the red UGC minor over major axis diameter ratio

name		RA	DEC	classification		$D_{\rm maj}$	b/a	$V_{\rm GSR}$
		(1950)		UGC	RC3	($'$)		km/s
UGC 89	NGC 23	0 07 18.6	25 38 42	SB1	.SBS1..	2.2	0.68	4733
UGC 93		0 07 47.0	30 34 16	S IV	.SA.8..	2.0	0.85	5124
UGC 242		0 22 52.6	19 57 39	SB3	.SX.7..	2.1	0.86	4449
UGC 334	A 0031+31	0 31 16.6	31 10 33	DWRF SP	.S..9..	2.0	1.00	4800
UGC 438	NGC 214	0 38 48.9	25 13 33	S3	.SXR5..	2.2	0.77	4685
UGC 463	NGC 234	0 40 55.6	14 04 10	S3	.SXT5..	2.0	1.00	4577
UGC 490	NGC 251	0 45 12.0	19 18 00	S3	.S..5..	2.3	0.78	4732
UGC 508	NGC 266	0 47 05.6	32 00 23	SB1	.SBT2..	3.5	0.94	4823
UGC 628		0 58 18.0	19 13 00	DWRF SP	.S..9*.	2.0	0.80	5574
UGC 1305	NGC 691	1 47 55.8	21 30 45	S2/S3	.SAT4..	3.7	0.70	2769
UGC 1455	NGC 765	1 55 58.7	24 38 56	SB2/S3	.SXT4..	3.0	1.00	5224
UGC 1551		2 00 48.4	23 50 03	SB IV-V	.SB?...	3.0	0.67	2773
UGC 1559	IC 1774	2 01 12.0	15 04 00	S3/SB3	.SXS7..	2.1	0.81	3705
UGC 1577		2 02 32.3	30 56 14	SB2	.SB?...	2.3	0.70	5393
UGC 1719	IC 213	2 11 18.0	16 14 00	S2	.SXT3..	2.2	0.73	8297
UGC 1792		2 16 58.2	28 48 27	SB3	.SXR5..	2.2	0.64	5092
UGC 2064		2 32 18.0	20 38 00	SB2/S3	.SXS4..	2.1	0.71	4338
UGC 2081		2 33 27.1	0 12 08	S3	.SXS6..	2.5	0.72	2626
UGC 2124	NGC 1015	2 35 38.9	-1 32 00	SB1	.SBR1*.	3.0	1.00	2639
UGC 2125	IC 1823	2 35 36.9	31 51 14	SB3	.SBR5..	2.3	0.87	5288
UGC 2197		2 40 25.8	31 15 34	S3	.S..6*.	2.0	0.70	5195
UGC 2368	IC 267	2 51 06.1	12 38 43	SB2	PSBS3..	2.1	0.71	3610
UGC 2595	IC 302	3 10 13.9	4 31 06	SB2/SB3	.SBT4..	2.5	0.92	5907
UGC 3066		4 28 18.2	5 26 00	S3/SB3	.SXR7*.	2.0	0.75	4594
UGC 3080	A 0429+01	4 29 21.8	1 05 27	S3	.SXT5..	2.2	1.00	3481
UGC 3140	NGC 1642	4 40 20.1	0 31 35	S3	.SAT5*.	2.0	1.00	4564
UGC 4126	NGC 2487	7 55 19.0	25 17 08	SB2	.SB.3..	2.5	0.92	4771
UGC 4256	NGC 2532	8 07 03.2	34 06 20	S3	.SXT5..	2.2	0.82	5228
UGC 4308	A 0814+21	8 14 29.9	21 50 20	SB3	.SBT5..	2.2	0.77	3486
UGC 4368	NGC 2575	8 19 46.2	24 27 32	S3	.SAT6*.	2.5	0.80	3800
UGC 4375	A 0820+22	8 20 12.0	22 49 00	S3	.SX.5*.	2.5	0.68	1983
UGC 4422	NGC 2595	8 24 46.7	21 38 40	SB2/S3	.SXT5..	3.2	0.88	4250
UGC 4458	NGC 2599	8 29 15.4	22 44 00	S1	.SA.1..	2.0	1.00	4672
UGC 5103	NGC 2916	9 32 07.6	21 55 45	S	.SAT3$.	2.3	0.74	3649
UGC 5303	NGC 3041	9 50 22.5	16 54 53	S3	.SXT5..	3.8	0.63	1317
UGC 5510	NGC 3162	10 10 45.5	22 59 16	S3	.SXT4..	3.2	0.88	1231
UGC 5554	NGC 3185	10 14 53.2	21 56 20	SB1	RSBR1..	2.8	0.64	1159
UGC 5633	A 1021+15	10 21 54.0	15 00 00	SB IV-V	.SB.8..	2.5	0.64	1287
UGC 5842	NGC 3346	10 40 59.0	15 08 03	SB3	.SBT6..	3.0	0.87	1169
UGC 6028	NGC 3455	10 51 51.6	17 33 08	S2	PSXT3..	2.6	0.65	1029
UGC 6077	NGC 3485	10 57 24.0	15 06 43	SB2	.SBR3*.	2.3	1.00	1350
UGC 6123	NGC 3507	11 00 46.3	18 24 25	SB2	.SBS3..	3.4	0.82	906

Table 1: *Continued.*

name		RA	DEC	classification		$D_{\rm maj}$	b/a	$V_{\rm GSR}$
		(1950)		UGC	RC3	($'$)		km/s
UGC 6277	NGC 3596	11 12 27.9	15 03 38	S3	.SXT5..	3.6	0.78	1111
UGC 6445	NGC 3681	11 23 52.6	17 08 22	S2/S3	.SXR4..	2.3	1.00	1171
UGC 6453	NGC 3684	11 24 34.4	17 18 20	S3	.SAT4..	2.5	0.68	1097
UGC 6460	NGC 3686	11 25 07.3	17 29 56	SB2/SB3	.SBS4..	3.0	0.83	1089
UGC 6536	NGC 3728	11 30 36.0	24 43 00	S2	.S..3..	2.0	0.75	6941
UGC 6693	NGC 3832	11 40 54.0	23 00 00	SB3	.SBT4..	2.2	0.95	6869
UGC 6746	NGC 3884	11 43 37.0	20 40 11	S1	.SAR0..	2.1	0.81	6897
UGC 6754	NGC 3883	11 44 11.5	20 57 16	S2	.SAT3..	3.3	0.91	6979
UGC 7169	NGC 4152	12 08 04.6	16 18 42	S3	.SXT5..	2.2	0.86	2112
UGC 7315	NGC 4237	12 14 38.2	15 36 08	S2	.SXT4..	2.2	0.64	813
UGC 7450	NGC 4321	12 20 23.3	16 06 00	S3	.SXS4..	6.8	0.88	1540
UGC 7523	NGC 4394	12 23 24.7	18 29 30	SB2	RSBR3..	3.9	0.90	884
UGC 7594	NGC 4450	12 25 58.0	17 21 40	S2	.SAS2..	6.5	0.69	1918
UGC 7876	NGC 4635	12 40 09.5	20 13 12	S3	.SXS7..	2.0	0.80	938
UGC 7901	NGC 4651	12 41 12.5	16 40 05	S3	.SAT5..	4.0	0.68	772
UGC 8279	NGC 5016	13 09 42.6	24 21 42	S2-3	.SXT5..	2.0	0.75	2622
UGC 8289	NGC 5020	13 10 11.0	12 51 53	S2/SB3	.SXT4..	3.3	0.85	3331
UGC 8865	NGC 5375	13 54 40.7	29 24 26	SB2	.SBR2..	3.7	0.81	2435
UGC 9024		14 04 24.0	22 16 00	S	.S?....	2.0	1.00	2338
UGC 9061	IC 983	14 07 42.4	17 58 08	SB1/SB2	.SBR4..	4.5	0.78	5466
UGC 9481	NGC 5735	14 40 23.5	28 56 15	SB2	.SBT4..	2.2	0.82	3817
UGC 9915	NGC 5957	15 33 00.9	12 12 51	SB2	PSXR3..	2.8	1.00	1889
UGC 9926	NGC 5962	15 34 14.1	16 46 23	S3	.SAR5..	2.8	0.71	2034
UGC 9943	NGC 5970	15 36 08.1	12 20 53	SB3	.SBR5..	2.9	0.66	2030
UGC 10083	NGC 6012	15 51 54.6	14 44 55	SB1	RSBR2*.	2.0	0.65	1944
UGC 10437		16 29 36.0	43 27 00	S	.S?....	2.0	0.85	2759
UGC 10445		16 31 48.6	29 05 19	S3	.S..6?.	2.3	0.87	1102
UGC 10584	NGC 6246A	16 49 12.0	55 28 00	S3/SB3	.SXR5P*	2.3	0.91	5451
UGC 11628	NGC 6962	20 44 45.4	0 08 13	S1	.SXR2..	3.0	0.77	4370
UGC 11708	NGC 7046	21 12 24.1	2 37 38	SB	.SBT6..	2.0	0.65	4326
UGC 11872	NGC 7177	21 58 18.6	17 29 50	S2	.SXR3..	2.7	0.70	1343
UGC 12151		22 39 00.0	0 08 00	DWARF	.IBS9*.	3.0	0.67	1896
UGC 12343	NGC 7479	23 02 26.8	12 03 06	SB2	.SBS5..	4.0	0.83	2544
UGC 12379	NGC 7490	23 05 01.0	32 06 18	S2	.S..4..	2.3	1.00	6416
UGC 12391	NGC 7495	23 06 24.0	11 46 00	S3	.SXS5..	2.0	0.85	5050
UGC 12511	NGC 7610	23 17 09.8	9 54 40	S3	.S..6*.	2.5	0.84	3708
UGC 12614	NGC 7678	23 25 58.2	22 08 50	S3/SB3	.SXT5..	2.8	0.68	3665
UGC 12638	NGC 7685	23 28 00.2	3 37 31	S3	.SXS5*.	2.0	0.85	5775
UGC 12654	NGC 7691	23 29 53.0	15 34 28	SB2/S3	.SXT4..	2.0	0.80	4224
UGC 12732		23 38 09.1	25 57 30	DWRF SP	.S..9*.	3.0	1.00	929
UGC 12754	NGC 7741	23 41 22.7	25 47 53	SB3	.SBS6..	4.3	0.70	935
UGC 12776		23 43 41.4	33 05 26	SB2	.SBT3..	2.7	0.81	5127
UGC 12808	NGC 7769	23 48 31.5	19 52 25	S1-2	RSAT3..	2.5	0.84	4380
UGC 12845		23 53 11.0	31 37 23	S3	.S..7..	2.4	0.75	5064

Table 2: Calibration coefficients determined for the different observing runs on the JKT

passband	zero-point (c_0)	color coef. (c_1)	extinction coef. (c_2)
	April 3-9, 1991		
B	-22.251 ± 0.065	-0.062 ± 0.011	0.251 ± 0.027
V	-22.791 ± 0.032	-0.013 ± 0.007	0.216 ± 0.030
R	-22.883 ± 0.030	-0.001 ± 0.010	0.179 ± 0.020
I	-22.060 ± 0.045	-0.012 ± 0.015	0.058 ± 0.058
	September 7-10, 1991		
B	-21.757 ± 0.111	-0.161 ± 0.044	0.238 ± 0.065
V	-22.215 ± 0.067	-0.048 ± 0.024	0.135 ± 0.025
R	-22.438 ± 0.073	-0.016 ± 0.046	0.141 ± 0.020
I	-21.709 ± 0.081	-0.034 ± 0.057	0.081 ± 0.082
	September 13-16, 1991		
B	-21.977 ± 0.122	-0.161 ± 0.044	0.279 ± 0.052
V	-22.322 ± 0.072	-0.048 ± 0.024	0.121 ± 0.030
R	-22.558 ± 0.064	-0.016 ± 0.046	0.126 ± 0.026
I	-21.833 ± 0.068	-0.034 ± 0.057	0.023 ± 0.027
	March 4-9, 1992		
B	-22.157 ± 0.041	-0.067 ± 0.013	0.294 ± 0.011
V	-22.697 ± 0.019	-0.033 ± 0.005	0.198 ± 0.005
R	-22.768 ± 0.036	-0.002 ± 0.018	0.170 ± 0.010
I	-22.063 ± 0.038	-0.008 ± 0.027	0.118 ± 0.012

Table 3: Calibration coefficients determined for the different observing runs on the UKIRT

color	zero point (c_0)	extinction coefficient (c_2)
	September 28-30, 1991	
H	-20.500±0.200	—
K'	-20.018±0.040	0.087±0.032
	February 20-22, 1992	
H	-20.704±0.032	0.147±0.048
K	-20.497±0.032	0.119±0.047