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

Roelof S. de Jong(1,2)

(1) University of Durham, Dept. of Physics, South Road, Durham DH1 3LE, United Kingdom
[R.S.deJong@durham.ac.uk]
(2) Kapteyn Astronomical Institute, P.O.box 800, 9700 AV Groningen, The Netherlands

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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, Nilsson 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. Typically 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 $5 \times 10^4$ 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 ($-2.5 \log(\text{number of counts})$) 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-squares-fit equations of the form:

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

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 $0.303 \pm 0.004''$, 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
regidded 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 inter-
polation 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, \((\text{pixelsize}_{\text{new}}/\text{pixelsize}_{\text{old}})^2\).

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 (ie. 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 (CR-
  PIX1, 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 (-c0 in Eq. 1)
- **CCOL** color calibration constant, when not used 0 (c1)
- **COL** average color of this galaxy used for calibration
- **CAIR** airmass calibration constant (c2)
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 \(-MAG0–CCOL×COL–CAIR×AIRMASS–CORR+2.5\log(PIXSIZE^2×EXPTIME)\). The surface brightness in mag arcsec\(^{-2}\) of a pixel with ADU counts in the galaxy is \(MAGOFF–2.5\log\text{(pixel(ADU)}–\text{SKYLEV})\). To use this constant to calculate the magnitude in an area, take into account that flux was not conserved per area in the rebinning/aligning process. The magnitude in an area with total of ADU counts is \(MAGOFF–2.5\log\text{(area(ADU)}–\text{SKYLEV})–2.5\log\text{(PIXSIZE}^4/\text{PIXSIZIM}^2)\)

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 transferred 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 luminosity 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 a *. 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\(^{-2}\)
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 \( V_{\text{GSR}} \) recession velocities (\( c_z \)) are obtained from the RC3 catalog, \( D_{\text{maj}} \) is the red UGC major axis diameter, \( b/a \) is the red UGC minor over major axis diameter ratio.

| name          | RA    | DEC   | classification | \( D_{\text{maj}} \) | \( b/a \) | \( V_{\text{GSR}} \) |
|---------------|-------|-------|----------------|----------------------|----------|---------------------|
| 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 | 0.00 | 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..7.. | 3.0 | 0.67 | 2773 |
| UGC 1559 IC 1774 | 2 01 12.0 | 15 04 00 | S3/SB3 .SX5..  | 2.1 | 0.81 | 3705 |
| UGC 1577       | 2 02 32.3 | 30 56 14 | SB2 .SB..7..  | 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 .SB1..  | 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 .SBS3..  | 2.1 | 0.71 | 3610 |
| UGC 2595 IC 302 | 3 10 13.9 | 4 31 06 | SB2/SB3 .SBR4.. | 2.5 | 0.92 | 5907 |
| UGC 3066       | 4 28 18.2 | 5 26 00 | S3/SB3 .SX7..  | 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 .SBR5..  | 2.2 | 0.77 | 3486 |
| UGC 4308 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 .SA1..  | 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 .SBR7..  | 3.0 | 0.87 | 1169 |
| UGC 6028 NGC 3455 | 10 51 51.0 | 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 |
| name     | RA (1950) | DEC | classification | $D_{maj}$ | $b/a$ | $V_{GSR}$ 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 6745 NGC 3884 | 11 44 11.5 | 20 57 16 | S2 .SAT3.. | 3.3 | 0.91 | 6979 |
| UGC 6754 NGC 3883 | 11 44 13.6 | 20 57 16 | S2 .SXT4.. | 2.2 | 0.64 | 613 |
| UGC 6865 NGC 3975 | 12 08 04.6 | 16 18 42 | S3 .SXT.. | 2.0 | 0.75 | 6979 |
| UGC 6902 | 13 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 | SB3/SB3 .SXR5P* | 2.3 | 0.91 | 5451 |
| UGC 11628 NGC 6962 | 20 44 45.4 | 08 13 | S1 .SXR2.. | 3.0 | 0.77 | 4370 |
| UGC 11708 NGC 7046 | 21 12 24.1 | 2 37 38 | SB .SBR6.. | 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 | SB3/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 | DWARF 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 46 23.2 | 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** | | | |
| $B$ | $-22.251 \pm 0.065$ | $-0.062 \pm 0.011$ | $0.251 \pm 0.027$ |
| $V$ | $-22.791 \pm 0.032$ | $-0.013 \pm 0.007$ | $0.216 \pm 0.030$ |
| $R$ | $-22.883 \pm 0.030$ | $-0.001 \pm 0.010$ | $0.179 \pm 0.020$ |
| $I$ | $-22.060 \pm 0.045$ | $-0.012 \pm 0.015$ | $0.058 \pm 0.058$ |
| **September 7-10, 1991** | | | |
| $B$ | $-21.757 \pm 0.111$ | $-0.161 \pm 0.044$ | $0.238 \pm 0.065$ |
| $V$ | $-22.215 \pm 0.067$ | $-0.048 \pm 0.024$ | $0.135 \pm 0.025$ |
| $R$ | $-22.438 \pm 0.073$ | $-0.016 \pm 0.046$ | $0.141 \pm 0.020$ |
| $I$ | $-21.709 \pm 0.081$ | $-0.034 \pm 0.057$ | $0.081 \pm 0.082$ |
| **September 13-16, 1991** | | | |
| $B$ | $-21.977 \pm 0.122$ | $-0.161 \pm 0.044$ | $0.279 \pm 0.052$ |
| $V$ | $-22.322 \pm 0.072$ | $-0.048 \pm 0.024$ | $0.121 \pm 0.030$ |
| $R$ | $-22.558 \pm 0.064$ | $-0.016 \pm 0.046$ | $0.126 \pm 0.026$ |
| $I$ | $-21.833 \pm 0.068$ | $-0.034 \pm 0.057$ | $0.023 \pm 0.027$ |
| **March 4-9, 1992** | | | |
| $B$ | $-22.157 \pm 0.041$ | $-0.067 \pm 0.013$ | $0.294 \pm 0.011$ |
| $V$ | $-22.697 \pm 0.019$ | $-0.033 \pm 0.005$ | $0.198 \pm 0.005$ |
| $R$ | $-22.768 \pm 0.036$ | $-0.002 \pm 0.018$ | $0.170 \pm 0.010$ |
| $I$ | $-22.063 \pm 0.038$ | $-0.008 \pm 0.027$ | $0.118 \pm 0.012$ |

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** | | |
| $H$ | $-20.500 \pm 0.200$ | — |
| $K'$ | $-20.018 \pm 0.040$ | $0.087 \pm 0.032$ |
| **February 20-22, 1992** | | |
| $H$ | $-20.704 \pm 0.032$ | $0.147 \pm 0.048$ |
| $K$ | $-20.497 \pm 0.032$ | $0.119 \pm 0.047$ |