1.65 μm (H-band) surface photometry of galaxies. IV: observations of 170 galaxies with the Calar Alto 2.2m telescope.

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Abstract. We present near-infrared (H band) surface photometry of 170 galaxies, obtained in 1997 using the Calar Alto 2.2m telescope equipped with the NICMOS3 camera MAGIC. The majority of our targets are selected among bright members of the Virgo cluster, however galaxies in the A262 and Cancer clusters and in the Coma/A1367 supercluster are also included. This data set is aimed at complementing the NIR survey in the Virgo cluster discussed in Boselli et al. (1997) and in the Coma Supercluster, presented in Papers I, II and III of this series. Magnitudes at the optical radius, total magnitudes, isophotal radii and light concentration indices are derived.

Key words: Galaxies: fundamental parameters; Galaxies: photometry; Infrared: galaxies

1. Introduction

This work presents H-band (1.65 μm) observations of 170 galaxies in the regions of the Virgo cluster, of the A262 and Cancer clusters and in the Coma Supercluster obtained in 1997 with the Calar Alto 2.2m telescope equipped with the NICMOS3 camera MAGIC. This is an accompanying paper of Paper III (Gavazzi et al. 1999, this issue) where similar observations of 558 galaxies obtained with the TIRGO 1.5m telescope are reported. Since most considerations are in common between the two papers, we preferred to give them in Paper III to avoid unnecessary duplications. Only informations which depend on the Calar Alto instrumentation and telescope are given in full details here. The paper is organized as follows: Section 2 describes the stud-
ied sample, and the observations are outlined in Section 3. Image analysis strategies are discussed in Section 4. Preliminary results are given in Section 5 and summarized in Section 6.

2. Sample definition, observations and data reduction

The present paper contains the observation of 170 galaxies, primarily selected among late-type objects belonging to the Virgo cluster. Out of the 99 observed Virgo (12\(^h\) \(\leq\) RA \(\leq\) 13\(^h\), 0\(^o\) \(\leq\) dec \(\leq\) 18\(^o\)) galaxies, 84 belong to the Virgo Cluster Catalogue (VCC) of Binggeli et al. (1985) and 15, in the outskirts of the cluster, were selected from the CGCG (Zwicky et al. 1961-68). These galaxies have velocities V \(<\) 3000 km/sec, and can thus be considered bona-fide cluster members. Observations of 73 filler objects are also given, so subdivided:

- 20 are CGCG galaxies in the A262 cluster (1\(^h\)43\(^m\) \(\leq\) RA \(\leq\) 2\(^h\)1\(^m\), 34\(^o\)31\(^\prime\) \(\leq\) dec \(\leq\) 38\(^o\)33\(^\prime\)),
- 23 are CGCG objects in the Cancer cluster (8\(^h\)11\(^m\) \(\leq\) RA \(\leq\) 8\(^h\)25\(^m\), 20\(^o\)30\(^\prime\) \(\leq\) dec \(\leq\) 23\(^o\)),
- 28 are CGCG galaxies in the region 11\(^h\)30\(^m\) \(\leq\) RA \(\leq\) 13\(^h\)30\(^m\), 18\(^o\) \(\leq\) dec \(\leq\) 32\(^o\)) containing the Coma supercluster, which includes the Coma and the Abell 1367 clusters and relatively isolated galaxies in the bridge between these two clusters.

By themselves these observations do not form a complete sample in any sense. However, combined with data published in Paper I (Gavazzi et al. 1996c), II (Gavazzi et al. 1996b) (which were devoted to observations of disk galaxies), III of this series and in Boselli et al. (1997: B97) (containing mainly measurements of Virgo galaxies taken with the Calar Alto 2.2 m telescope), the present survey contains a complete set of NIR observations as follows:

- out of the 646 galaxies, of both early and late-types in the CGCG (m\(_P\) \(\leq\) 15.7) which are members to the Coma supercluster (18\(^o\) \(\leq\) \(\delta\) \(\leq\) 32\(^o\); 11.5\(^h\) \(\leq\) \(\alpha\) \(\leq\) 13.5\(^h\)) according to Gavazzi et al. (1999), i.e. 5000 \(<\) V \(\leq\) 8000 km s\(^{-1}\), 625 (97 \%) have a NIR image available. Moreover the survey contains 221 out of 248 (89 \% complete) VCC galaxies brighter than m\(_P\)=14.0. Thus the giant members of the Virgo cluster (excluding VCC galaxies which are found in the background of the Virgo cluster) are sampled in a quasi-complete manner. A less complete coverage is at m\(_P\) \(\leq\) 16.0: 277/587 objects were observed (47 \% complete). However, we have observed all but one the 88 late-type VCC galaxies selected as part of the central program of the Infrared Space Observatory (ISO) (see B97) brighter than m\(_P\)=16.0. These are objects lying either within 2 degrees of projected radial distance from M87 or in the corona between 4 and 6 degrees. Thus the H band survey contains a complete (m\(_P\) \(\leq\) 16.0) sample of late-type dwarf members of the Virgo cluster, restricted however to a region smaller than the VCC.

2.1. Observations

The observations were carried out in three photometric nights of February 26, 27 and 28, 1997 with the Calar Alto
2.2-m telescope. The Cassegrain focus of the telescope was equipped with the MAGIC 256 × 256 pixel NICMOS3 infrared array (Herbst et al. 1993). In order to observe galaxies with large apparent sizes, the optical configuration of the detector was chosen to give the largest possible field of view, i.e. 6.8 × 6.8 arcmin$^2$, with a pixel size of 1.61 arcsec. The observational technique and the data reduction procedures, here just briefly summarized, are similar to the one described in B97 and in Paper III.

The seeing ranged between 2 and 3 arcsec with an average of 2.4 arcsec, as shown in Fig. 1. These seeing conditions are mostly due to the large pixels in the selected optical configuration, and as such represent a necessary disadvantage, because they also provide the large field-of-view fundamental for our observations.

At H the sky brightness (typically 13.8 mag) varied over the time scale of an observation by typically 3% in photometric conditions, by up to 8% in the worst conditions encountered. Reaching a brightness limit 8 mag arcsec$^{-2}$ fainter than the sky requires a careful subtraction of the sky, necessitating mosaicing techniques.

As in B97 we used three types of mosaic maps, obtained by programming the telescope pointing along different patterns.

Galaxies with optical diameter larger than half of the size of the field of view of the array were observed using a mosaic in which 50% of the time is devoted to the target of interest and 50% to the surrounding sky (“A” mosaic, Fig 2a in B97). This pattern was obtained alternating 8 fields centred on the target with 8 observations of the sky chosen along a circular path around the galaxy (off-set by a field of view from the centre). The 8 on-target fields were dithered by 10 arcsec in order to help the elimination of bad pixels.

Galaxies with optical diameter smaller than half of the size of the field of view of the array were observed with a mosaic consisting of 9 pointings along a circular path and displaced from one-another by 2 arcmin such that the target galaxy is always in the field (“B” mosaic; Fig 2b in B97). To avoid saturation each pointing was split into 32 elementary integrations of 1 sec which were added by the on-line MAGIC software. There were 7 galaxies with angular sizes larger than the dimension of the detector;
these were mapped using mosaics prepared according to the shape and orientation of the galaxy in the sky in order to cover the entire surface of the target. In order to get a higher signal-to-noise two observation cycles were secured for the low surface brightness galaxies. Some galaxies were serendipitously observed in the sky frames of other targets. For these objects the number of available frames is generally \( \leq 8 \) (see Table 1), thus their signal to noise is lower than the average value obtained for pointed galaxies.

The observations were calibrated and the fluxes transformed into the H photometric system using standard stars (Elias et al. 1982), observed hourly throughout the night. Calibration stars were observed with a third mosaic (“C”, Fig 2c in B97). This is composed of 5 pointings, starting with the target star near to the centre of the array followed by pointings in each of the 4 quadrants of the array. The observations of the standard stars were obtained with a defocused telescope to avoid saturation.

The typical uncertainty on the photometric calibration is \( \leq 0.05 \) mag.

2.2. Image analysis

The reduction of two-dimensional IR frames follows procedures identical to those reported in B97 and in Paper III. These procedures are based on the IRAF data reduction package developed by NOAO and on the SAOIMAGE and PROS packages developed at the Center for Astrophysics and on STSDAS: 2.

To remove the detector response, two sets of flat-field exposures were obtained on the telescope dome with (lamp-on) and without (lamp-off) illumination with a quartz lamp. The response of the detector is then contained in the normalized frame
\[
FF = \frac{\langle \text{lamp-on} \rangle - \langle \text{lamp-off} \rangle}{\langle \text{lamp-on} \rangle - \langle \text{lamp-off} \rangle}
\]
(per pixel).

Specific reduction strategies were used for the various mosaics, according to the stability of the sky during the observations. When the sky was stable to within a few percent during the observation of a galaxy (the large majority of the observations), the 8 SKY exposures (SKY\( _i \)) were combined using a median filter to obtain (SKY) for type “A” mosaics. For type “B” mosaics (SKY) was obtained by combining the 9 frames containing target+SKY with a median filter.

The mean counts \( \langle c_T \rangle_i \) and \( \langle c_{\text{sky}} \rangle \) were respectively determined for the \( i \)th target observation and the median sky. Individual “normalized” SKY\( _i \) frames were then produced such that
\[
\text{SKY}_i = \langle \text{SKY} \rangle \times \langle c_T \rangle_i / \langle c_{\text{sky}} \rangle\]
This removed the time variations of the sky level, but, due to the source emission, introduced an (additive) offset; this was subsequently removed (see below). Occasionally, when the average response of the detector to the sky changed by more than 3\% during an observation, significant temporal variations in the spatial response of the detector to the sky became discernable. Under these circumstances, only the

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2 IRAF is the Image Analysis and Reduction Facility made available to the astronomical community by the National Optical Astronomy Observatories, which are operated by AURA, Inc., under contract with the U.S. National Science Foundation. STSDAS is distributed by the Space Telescope Science Institute, which is operated by the Association of Universities for Research in Astronomy (AURA), Inc., under NASA contract NAS5-26555.
| Galaxy  | R.A.1950  | Dec.  | Type | Seeing | Date | $H_{B25}$ | $H_{r25}$ | $r_{25} - r_{33}$ | C3   |
|---------|-----------|-------|------|--------|-------|-----------|-----------|----------------|------|
| VC0025  | 120804.40 | 161841.0 | VComet | 12.6 | 3.16 | 1.6 | 3.14 | Sc | 9 | 2 | 2.0 | 32.0 | 1.2 | 9.6 | 3.30 |
| VC0058  | 709     | 120859.30 | 122407.0 | VCM | 13.1 | 3.16 | 1.2 | 16.9 | Sc | 9 | 3 | 2.0 | 32.0 | 1.2 | 9.6 | 3.30 |
| VC0073  | 7180 | 121039.70 | 071200.0 | VCV | 13.3 | 3.14 | 1.6 | 16.9 | Sc | 9 | 3 | 2.0 | 32.0 | 1.2 | 9.6 | 3.30 |
| VC0089  | 7180 | 121114.50 | 134213.0 | VCM | 12.5 | 3.28 | 2.0 | 16.9 | Sc | 9 | 3 | 2.0 | 32.0 | 1.2 | 9.6 | 3.30 |
| VC0097  | 7180 | 121280.80 | 132703.0 | VCM | 13.2 | 3.28 | 1.7 | 16.9 | Sc | 9 | 3 | 2.0 | 32.0 | 1.2 | 9.6 | 3.30 |
| VC0120  | 7180 | 121305.10 | 060857.0 | VComet | 13.4 | 4.47 | 0.81 | Sed | 8 | 3 | 2.0 | 32.0 | 1.2 | 9.6 | 3.30 |
| VC0145  | 7180 | 121306.60 | 141046.0 | VCA | 12.7 | 3.31 | 1.0 | 3.14 | Sc | 9 | 3 | 2.0 | 32.0 | 1.2 | 9.6 | 3.30 |
| VC0187  | 7180 | 121312.50 | 125240.0 | VCA | 10.9 | 11.22 | 2.69 | 3.14 | Sc | 9 | 3 | 2.0 | 32.0 | 1.2 | 9.6 | 3.30 |
| VC0199  | 7180 | 121405.50 | 074424.0 | VCV | 12.8 | 3.63 | 1.36 | Sc | 9 | 3 | 2.0 | 32.0 | 1.2 | 9.6 | 3.30 |
| VC0222  | 7180 | 121436.70 | 072800.0 | VCV | 12.6 | 3.37 | 0.89 | Sc | 9 | 3 | 2.0 | 32.0 | 1.2 | 9.6 | 3.30 |
| VC0226  | 7180 | 121438.90 | 133607.0 | VCA | 12.5 | 2.51 | 1.45 | Sc | 9 | 3 | 2.0 | 32.0 | 1.2 | 9.6 | 3.30 |
| VC0234  | 7180 | 121452.60 | 063500.0 | VCV | 12.9 | 4.17 | 2.34 | Sc | 9 | 3 | 2.0 | 32.0 | 1.2 | 9.6 | 3.30 |
| VC0267  | 7180 | 121539.70 | 065533.0 | VComet | 13.8 | 2.51 | 2.5 | Sc | 18 | 3 | 2.0 | 32.0 | 1.2 | 9.6 | 3.30 |
| VC0307  | 7180 | 121617.00 | 144139.0 | VCA | 10.4 | 3.59 | 6.92 | Sc | 8 | 3 | 2.0 | 32.0 | 1.2 | 9.6 | 3.30 |
| VC0324  | 7180 | 121635.80 | 040738.0 | VCV | 14.7 | 3.56 | 1.33 | BCD | 18 | 3 | 2.0 | 32.0 | 1.2 | 9.6 | 3.30 |
| VC0403  | 7180 | 121668.90 | 061117.0 | VCV | 14.4 | 3.21 | 0.5 | BCD | 9 | 3 | 2.0 | 32.0 | 1.2 | 9.6 | 3.30 |
| VC0411  | 7180 | 121669.60 | 062010.0 | VCV | 12.7 | 4.37 | 2.5 | Sc | 9 | 3 | 2.0 | 32.0 | 1.2 | 9.6 | 3.30 |
| VC0445  | 7180 | 121650.60 | 060612.0 | VCV | 11.3 | 4.90 | 3.6 | Sc | 9 | 3 | 2.0 | 32.0 | 1.2 | 9.6 | 3.30 |
| VC0558  | 7180 | 121702.50 | 060672.0 | VCV | 12.8 | 1.75 | 1.2 | Sc | 9 | 3 | 2.0 | 32.0 | 1.2 | 9.6 | 3.30 |
| VC0593  | 7180 | 121703.60 | 053810.0 | VCom | 14.8 | 1.21 | 0.87 | Sc | 1 | 3 | 2.0 | 32.0 | 1.2 | 9.6 | 3.30 |
| VC0671  | 7180 | 121713.60 | 053713.0 | VCV | 13.7 | 2.0 | 0.63 | Sc | 2 | 3 | 2.0 | 32.0 | 1.2 | 9.6 | 3.30 |
| VC0823  | 7180 | 121727.60 | 053713.0 | VCV | 12.5 | 2.1 | 1.62 | Sc | 9 | 3 | 2.0 | 32.0 | 1.2 | 9.6 | 3.30 |
| VC0866  | 7180 | 121730.50 | 053707.0 | VCV | 14.4 | 1.75 | 1.19 | Sc | 6 | 9 | 3 | 2.0 | 32.0 | 1.2 | 9.6 | 3.30 |
| VC0933  | 7180 | 121754.50 | 053707.0 | VCV | 12.3 | 2.1 | 1.62 | Sc | 9 | 3 | 2.0 | 32.0 | 1.2 | 9.6 | 3.30 |
| VC0965  | 7180 | 121845.30 | 114730.0 | VCA | 12.6 | 3.90 | 1.55 | Sc | 9 | 3 | 2.0 | 32.0 | 1.2 | 9.6 | 3.30 |
| VC0983  | 7180 | 121900.50 | 143501.0 | VCA | 12.8 | 4.47 | 2.51 | Sc | 8 | 3 | 2.0 | 32.0 | 1.2 | 9.6 | 3.30 |
| VC0992  | 7180 | 121908.30 | 053043.0 | VCV | 13.7 | 2.69 | 0.89 | Sc | 9 | 3 | 2.0 | 32.0 | 1.2 | 9.6 | 3.30 |
| VC0997  | 7180 | 121910.10 | 145320.0 | VCA | 12.5 | 3.92 | 2.00 | Sc | 8 | 3 | 2.0 | 32.0 | 1.2 | 9.6 | 3.30 |
three sky frames closest in time to each target frame were used to determine the sky. After sky removal, each target frame ($T_i$) was processed to obtain a flat-field, sky-subtracted, corrected frame: $T_{i,\text{corr}} = [T_i - \text{SKY}_i] / \text{FF}$.

Sky-subtracted and flat-fielded frames were then registered using field stars and combined together with a median filter. This provided a satisfactory removal of the bad pixels in the final combined image. Tests on the data showed that the photometry obtained from this use of a median filter was identical to that obtained with averaging techniques.

Star-subtracted frames were produced by a manual “editing” of the contribution from pointlike sources which are clearly not associated with the target galaxies.

The residual sky background and its rms noise ($\sigma$) (in the individual pixels) were determined in each star-subtracted frame in concentric object-free annuli around the objects of interest.

We checked the quality of the final images on large and small scales. On small scales the measured noise was always consistent with the expected statistical fluctuations in the photon count from the sky background accumulated over the total integration time. The typical pixel to pixel fluctuations are $\sim 22\text{mag arcsec}^{-2}$, i.e. 0.05% of the sky (see Fig. 2).

Fig. 2. The distribution of the sky rms as a function of integration time.

3. Results

The main results of this paper are given in Table 1 (with structure identical to Table 1 in Paper III) as follows:

Column 1: CGCG (Zwicky et al. 1961-68) or VCC (Binggeli et al. 1985) denomination.

Column 2: NGC/IC names.

Column 3, 4: adopted (1950) celestial coordinates, measured by us or taken from NED\(^3\), with few arcsec uncertainty.

Column 5: “aggregation” parameter. This parameter defines the membership to a group/cluster/supercluster: CSisol, CSPairs, CSgroups indicate members of the Coma

\(^3\) NASA-IPAC Extragalactic Databasa (NED) is operated by the Jet Propulsion Laboratory, California Institute of Technology, under contract with NASA
Supercluster (5000 < V < 8000 km s\(^{-1}\)); CSforeg means objects in the foreground of the Coma Supercluster (V < 5000 km s\(^{-1}\)) and CSbackg means objects in the background of the Coma Supercluster (V > 8000 km s\(^{-1}\)).

Galaxies in the Virgo region are labelled following the membership criteria given by Binggeli et al. (1993): VCA, VCB, VCM, VCW, VCW', VCSE, VCmem, are members to the cluster A or B, to the M, W, W' or South-East clouds or are not better specified members to the Virgo cluster respectively. NOVCC are galaxies taken from the CGCG in the outskirts of Virgo, but outside the area covered by the VCC. VCback are galaxies in the background of the Virgo cluster (V > 3000 km/sec). Members to the A262 and Cancer clusters are indicated.

Column 6: photographic magnitude as given in the CGCG or in the VCC.

Column 7,8: for CGCG galaxies these are the major and minor optical diameters (\(a_{25}, b_{25}\)) (in arcmin) derived as explained in Gavazzi & Boselli (1996). These diameters are consistent with those given in the RC3. For VCC galaxies the diameters are measured on the du Pont plates at the faintest detectable isophote, as listed in the VCC.

Column 9: morphological type.

Column 10: number of frames \(N_f\) combined to form the final image (depending on the adopted mosaic).

Column 11: number of elementary observations (coadds) \(N_c\). The total integration time (in seconds) is the product of the number of coadds \(N_c\) times the number of combined frames \(N_f\) times the on-chip integration time \(t_{int}\) which was set to 1 sec.

Column 12: seeing (in pixels, with 1.61 arcsec per pixel).

Column 13: adopted zero point (mag / sec).

Column 14: observing date (day-month-1997);

Column 15: \(H_{B25}\) magnitude obtained extrapolating the present photometric measurements to the optical diameter along circular apertures as in Gavazzi & Boselli (1996).

Column 16: \(H_{B25}^o\) magnitude computed at the optical diameter (see Column 15) corrected for galactic and internal extinction following Gavazzi & Boselli (1996).

The adopted internal extinction correction is \(\Delta m = -2.5 D \log(b/a)\) where \(D=0.17\), as determined in Boselli & Gavazzi (1994).

Column 17: \(H_T\) total H magnitude extrapolated to infinity (see Paper V, Gavazzi et al. 1999a).

Column 18: galaxy observed major (\(r_H(20.5)\)) radius (in arcsec) determined in the elliptical azimuthally–integrated profiles as the radii at which the surface brightness reaches 20.5 H–mag arcsec\(^{-2}\). Galaxies which require an extrapolation larger than 0.5 mag to reach the 20.5\(^{\text{th}}\) magnitude isophote are labelled -1.

Column 19: the model–independent concentration index \(C_{31}\) as defined in de Vaucouleurs (1977) is the ratio between the radii that enclose 75% and 25% of the total light \(H_T\).
The present data were compared with aperture photometry available in the literature by integrating the counts in concentric circular rings around the galaxy centres to provide curves of growth up to the diameter of the reference photometry. This comparison provided a general check of the intrinsic photometric accuracy of the current work.

The virtual photometry measurements obtained in this work are compared with the aperture photometry available in the literature (200 measurements) in Fig. 3: on the average we find:

$$H_{\text{this work}} - H_{\text{literature}} = -0.013 \pm 0.107 \, \text{mag.}$$

A conservative estimate of the overall photometric accuracy of our data, including systematic errors on the zero point, is thus

$$\leq 0.1 \, \text{mag.}$$

The measurements taken through the individual "virtual circular apertures" are given in Table 2 (available only in digital format) as follows:

| Galaxy | Ap. \( \text{arcsec} \) | \( \log \text{Ap}/a_{25} \) | \( H \) |
|--------|----------------|----------------|-------|
| (1)    | (2)            | (3)            | (4)   |
| VCC 25 | 19.00          | -1.00          | 10.95 |
| VCC 25 | 19.30          | -0.99          | 10.94 |
| VCC 25 | 29.00          | -0.82          | 10.55 |
| VCC 25 | 38.60          | -0.69          | 10.30 |
| VCC 25 | 48.30          | -0.59          | 10.14 |
| VCC 25 | 58.00          | -0.51          | 10.06 |
| VCC 25 | 67.60          | -0.45          | 10.01 |
| VCC 25 | 77.30          | -0.39          | 9.99  |
| VCC 25 | 86.90          | -0.34          | 9.97  |
| VCC 25 | 96.60          | -0.29          | 9.95  |
| VCC 25 | 106.30         | -0.25          | 9.94  |
| VCC 25 | 115.90         | -0.21          | 9.94  |
| VCC 25 | 125.60         | -0.18          | 9.93  |
| VCC 25 | 135.20         | -0.15          | 9.93  |
| VCC 58 | 19.30          | -0.99          | 12.39 |
| VCC 58 | 29.00          | -0.82          | 11.82 |
| VCC 58 | 38.60          | -0.69          | 11.49 |
| VCC 58 | 48.30          | -0.59          | 11.24 |
| VCC 58 | 58.00          | -0.51          | 11.04 |
| VCC 58 | 67.60          | -0.45          | 10.90 |
| VCC 58 | 77.30          | -0.39          | 10.80 |
| VCC 58 | 86.90          | -0.34          | 10.73 |
| VCC 58 | 96.60          | -0.29          | 10.66 |
| VCC 58 | 106.30         | -0.25          | 10.61 |
| VCC 58 | 115.90         | -0.21          | 10.56 |
| VCC 58 | 125.60         | -0.18          | 10.52 |
| VCC 58 | 135.20         | -0.15          | 10.48 |
| VCC 58 | 144.90         | -0.12          | 10.46 |
| VCC 58 | 154.60         | -0.09          | 10.45 |
| VCC 58 | 164.20         | -0.06          | 10.44 |
| VCC 58 | 173.90         | -0.04          | 10.43 |
| VCC 73 | 12.90          | -1.00          | 10.60 |
| VCC 73 | 19.30          | -0.82          | 10.19 |
| VCC 73 | 25.80          | -0.70          | 9.95  |
| VCC 73 | 27.00          | -0.68          | 9.91  |
| VCC 73 | 31.60          | -0.61          | 9.81  |
| VCC 73 | 32.20          | -0.60          | 9.80  |
| VCC 73 | 35.10          | -0.56          | 9.76  |
| VCC 73 | 38.60          | -0.52          | 9.71  |
| VCC 73 | 45.10          | -0.45          | 9.64  |
| VCC 73 | 51.50          | -0.40          | 9.59  |
| VCC 73 | 58.00          | -0.35          | 9.55  |

The lowest surface brightness reached in each image is given as a function of the integration time in Fig. 4 (see Pa-
The comparison between the present photometric measurements and those available from the literature as a function of the normalized aperture.

Although the present observations are deeper on average than the ones obtained at TIRGO, we decided for consistency to measure the H band radii at the same isophotal radius as in Paper III: i.e. at the 20.5 mag arcsec\(^{-2}\) isophote.

The comparison between the isophotal B band radii and the infrared \(r_H(20.5)\) isophotal radii determined in this work is shown in Fig. 5. The B radii are those measured on the du Pont plates at the faintest detectable isophote, as listed in the VCC. These are on average larger by 25\% than the standard \(r_B(25.0)\) (Binggeli et al. 1985). Thus it is not surprising that the relation \(r_H(20.5) = 0.7\ r_B\) used in Paper III (and reproduced as a solid line in Fig. 5) does not hold with the present data-set.

3.3. Magnitudes \((H_T, H_{B25})\)

\(H_{B25}\) magnitudes listed in Column 15 of Table 1 are obtained by extrapolating the circular aperture measurements to the optical \(r_B(25.0)\) radius using standard growth curves (as in Gavazzi & Boselli 1996). \(H_T\) mag instead are obtained by extrapolating to infinity the magnitude integrated along elliptical isophotes using combinations of exponential and de Vaucouleurs laws (see Gavazzi 1996). For VCC galaxies the optical radius is not determined at the 25 mag arcsec\(^{-2}\) isophote, but at the faintest detectable isophote (see Section 3.2).
Fig. 5. The relation between the apparent major radius $r_H(20.5)$ as determined in the infrared (this work) and the optical $r_B$ determined in the VCC at the faintest detectable isophote. The solid line represents the relation $r_H(20.5) = 0.7 r_B(25.0)$. As expected, $H_T$ are brighter than $H_{B25}$ by $0.05 \pm 0.15$ mag on average.

Fig. 6. The dependence of the near–infrared concentration index $C_{31}$ on H band luminosity.

3.4. Concentration index ($C_{31}$)

The concentration index $C_{31}$ is a measure of the shape of light profiles in galaxies, independent of a (model–dependent) bulge–disk decomposition. Values larger than $C_{31} > 2.8$ indicate the presence of substantial bulges.

We confirm the presence in our sample of a general correlation between $C_{31}$ and the H band (total or $H_{25}$) luminosity (computed from the redshift distance). We find that $C_{31}$ generally increases toward higher absolute magnitudes (Fig. 6). High $C_{31}$ are found only among high luminosity systems, but the reverse is not true: there are several high luminosity systems (namely late type spirals) with no or little bulge ($C_{31} \sim 3$).

4. Summary

We obtained images in the near-infrared H bandpass for an optically selected ($m_p \leq 15.7$) sample of 170 nearby ($z < 0.02$) galaxies. As in previous papers we derive H magnitudes at the optical radius, total H magnitudes, isophotal radii at the 20.5 mag arcsec$^{-2}$ isophote and light concentration index $C_{31}$. As mentioned in the Introduction, the observations presented in this paper do not cover
by themselves a complete sample, but they represent the last step of our extensive NIR survey. Papers I, II, III, IV of this series and B97 contain all the data gathered so far. A comprehensive analysis of the NIR properties of galaxies will be the subject of forthcoming papers of this series. Paper V will report on the profile decomposition.

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