Morphological classification and structural parameters of galaxies in the Coma and Perseus clusters

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Accepted, February, 2, 1997

Abstract. We present the results of an isophotal shape analysis of galaxies in the Coma and Perseus clusters. These data, together with those of two previous papers, provide two complete samples of galaxies with reliable Hubble types in rich clusters:

1) all galaxies brighter than $m_0 = 16.5$ falling within one degree (=2.3 Mpc) from the center of the Coma cluster (187 galaxies),

2) all galaxies brighter than $m_{\text{Zwicky}} = 15.7$ in a region of 5\textdegree \times 30\textdegree around the center of the Perseus cluster (139 galaxies).

These two complete samples cover 5 orders of magnitude in galaxy density and span areas of 91 and 17 Mpc\textsuperscript{2}, cluster-centric radii up to 2.3 and 6.4 Mpc, for Perseus and Coma respectively. They will be used in subsequent papers to study the dependence of galaxy types on cluster environment and as reference samples in comparisons with distant clusters.

Key words: Galaxies: clusters: individual: Coma (Abell 1656) – individual: Perseus (Abell 426) – Galaxies: elliptical and lenticular, cD – Galaxies: fundamental parameters

1. Introduction

In two previous papers, we presented an isophotal shape analysis with morphological type estimates for a large number of galaxies in two clusters of galaxies. Our analyses, based on CCD images and photographic plates, concerned more than 200 galaxies in three regions of Coma (Andreon et al. 1996, hereafter Paper I) and about 100 galaxies in the Perseus cluster (Poulain, Nieto & Davoust 1992). The aim of both works was to collect as many galaxies as possible in these two clusters for subsequent studies of galaxy properties (e.g. Michard 1996; Andreon 1994, 1996; Andreon, Davoust & Heim 1997). The galaxies observed with a CCD were selected mainly because they had previously been classified as early-type.

Once the data accumulate and the samples grow to a reasonable size, it becomes possible to trace some notable properties of the Hubble types, but we convinced ourselves that slight differences among the properties of the morphological types were not properly measured with incomplete samples. Using samples with various degrees of completeness, different authors have in fact reached different conclusions on many galaxy properties: on the galaxy mean surface brightness of the types (Andreon 1996), on the optical luminosity function of boxy Es and disky Es (Andreon 1994 and 1996), on the radio luminosity function of boE and diE (Lowen & Owen 1995). The two previously available samples of galaxies in Coma and Perseus, although large in size and almost complete in (small) selected areas and within restricted magnitude ranges, were not quite complete in magnitude. Therefore we decided to observe the galaxies unobserved in these previous surveys. We also observed some galaxies whose detailed morphological type was unsatisfactory.

Since it was beyond our observing capabilities to complete the two samples down to the magnitude of the faintest observed galaxy and out to the distance of the most peripheral galaxy, we set the more limited goal of completing our samples within an area and down to a magnitude limit that does not exclude too many faint galaxies already observed by our team and at the same time does not include an unreasonable number of new galaxies to be observed.

In order to complete the observation of the samples rapidly, we gave up the idea of obtaining independent morphologies from images in different passbands (e.g. $V$ and $r$) and from different observing material (CCD images and small-scale plates), properties characterizing the two previous surveys. Furthermore, since high resolution conditions are not necessary for classifying spiral galaxies with obvious spirals arms, we also made use of Schmidt plates, thus innovating with respect to our two other papers.

The availability of a thinned CCD at the 2-meter Telescope Bernard Lyot (hereafter TBL), with a good quantum efficiency in blue and the fact that spiral galaxies are easier to classify
in visible than in red, prompted us to observe the program galaxies in Johnson $V$, instead of Gunn $r$. The increased CCD quantum efficiency largely compensates for the decrease in luminosity of early-type galaxies from $r$ to $V$, allowing us to image the program galaxies in $V$ within the allocated telescope time.

The paper is organized as follows. We present the data completing the two samples of galaxies in Coma and in Perseus in Sect. 2. The techniques of analysis used in the present study are briefly summarized in Sect. 3. The results are given in the form of tables (Tables 2, 3, 4 and 5) and presented only in electronic form; the tables include global photometric and geometrical parameters as well as detailed morphological information, but not the photometric and geometrical profiles as a function of radius. Notes on individual galaxies are included in the Tables. An estimate of the quality of our measures is presented in Sect. 5.

We adopt a Hubble constant of $H_0 = 50$ km s$^{-1}$ Mpc$^{-1}$.

2. The sample

2.1. Coma

This sample of galaxies was taken from the catalogue of Godwin et al. (1983; hereafter GMP), which lists all galaxies down to magnitude $m_b = 20.0$ in a 2.63 degree square area, centered on the Coma cluster. We selected all the galaxies down to magnitude $m_b = 16.5$, within one degree from the cluster center whose morphological type is not published in Paper I. Furthermore we reobserved all SAB0 galaxies (i.e. S0s for which the presence of a bar is uncertain) and unE (i.e. Es where boxiness or diskiness is undetermined) observed under mediocre seeing conditions by Andreon et al. (1996), as well as other galaxies of borderline type between two classes. We discarded from the observations 3 galaxies (GMP 978, 1646, 1741) which do not belong to the Coma cluster, as they have velocities$^1$ of more than 4000 km s$^{-1}$ relative to the cluster center. Figure 1 (only available in electronic form) shows the spatial distribution of the Coma galaxies. With the present sample, all (187) galaxies brighter than $M_b = -19.2$ mag in the surveyed area have been observed.

The galaxies of this sample were first inspected on two Schmidt plates, OCA #2849 and OCA #2842, taken at the Calern Observatory and kindly provided by C. Pollas. These plates were digitized at the MAMA$^2$ with a 5 and 10 micron (= 0.33" and 0.65") step respectively, and with an aperture of 10 microns. The digitization produces image files with pixel readings proportional to plate density.

All galaxies with evident asymmetric or irregular isophotes or with spiral arms were classified as S and eliminated from further observations with CCDs. We nevertheless already had CCD images for half of them, because they were published by other authors or in the field of view of other program galaxies. The CCD images confirm the type estimates based on our Schmidt plates for all galaxies; this confirms the reliability of this method for classifying obvious spiral galaxies, even at the distance of the Coma cluster.

Finally, we found 5 galaxies in our CCD-image archives which had not been classified in Paper I; these 5 were not reobserved.

Three suspected spiral galaxies were observed in December 1994 with the TBL, and the remaining 28 galaxies were observed during one observing run in February 1995 with the same instrument and setup. The CCD was a Tektronics 1024 × 1024, with a pixel size of 24 µ corresponding to 0.30 arcsec on the sky. The seeing was 1.0–1.1 arcsec (FWHM) and the nights were photometric. The exposure time was 20 minutes for all galaxies. With the present observations, the median seeing of the complete sample reduces from 1.48 arcsec in Paper I to 1.2 arcsec, which is a large improvement since less than one third of the sample had been observed. This corresponds to a restframe resolution of 0.75 Kpc, not very different from the resolution that the Hubble Space Telescope offers for distant ($z \sim 0.4$) galaxies.

2.2. Perseus

The sample is composed of all (141) galaxies listed in the Zwicky catalogue (Zwicky 1961-1968) in a box of $5^\circ 3' \times 5^\circ 27'$ centered on $3^\circ 14' 42'', 41^\circ 13' 30''$ to which we added two Tiff (1977) galaxies. NGC 1233 is listed twice in the Zwicky catalogue (Zw 525-6, Zw 524-65). Three galaxies (Zw 525-21, Zw 540-65 and Zw 541-19) certainly do not belong to the cluster because their velocity relative to the cluster center is larger than 4000 km s$^{-1}$; they were eliminated from the list of galaxies to be observed, together with all galaxies whose morphological type is listed in Poulain, Nieto, Davoust (1992). Note however that some of the observed galaxies might still be foreground objects, in particular some of the galaxies for which the radial velocity is unknown or some galaxies in the outskirts of the studied region and with intermediate relative velocities with respect to the cluster center. Figure 2 (only available in electronic form) shows the spatial distribution of the galaxies in the studied region.

54 of these galaxies were first inspected on Schmidt plate OCA #2977 taken at the Calern Observatory in December 1992 and digitized, as the preceding one, at the MAMA with a 5 micron (= 0.33") step and with an aperture of 0.65". The remaining galaxies are outside the region covered by our plate. All the galaxies were further inspected on the Digitized Palomar Sky Survey$^3$. Obvious spiral galaxies were classified as such and eliminated from the list of galaxies to be observed in CCD.

We found images of 3 galaxies in our CCD-image archives which had not been classified by Poulain, Nieto & Davoust (1992); they were not reobserved.

Finally, we observed in CCD almost all galaxies not classified as S. Five observing runs (35 nights) at TBL were used for completing this sample, since bad weather, technical problems with the filter wheel and with data acquisition, and the pear-shaped PSF of many images, made the completion of the program very slow, largely compensating the good luck of Poulain, Nieto & Davoust (1992). During the first 3 runs (February

$^1$ Velocities of the program galaxies in Coma and Perseus were mainly collected from public databases, such as NED and LEDA, and by a survey of the literature.

$^2$ MAMA (Machine Automatique à Mesurer pour l’Astronomie) is operated by CNRS/INSU.

$^3$ The Digitized Sky Survey was produced at the Space Telescope Science Institute under US Government grant NAG W-2166.
1993, December 1993, February 1994) we used a 1024 × 1024
Thompson CCD with a pixel size of 19µ corresponding to 0.24
arcsec on the sky and the galaxies were observed in the Gunn
r filter and calibrated in the Cousin R filter, to make the mea-
sures consistent with those of Paper I. During the last two
runs (December 1994 and February 1995) the CCD was the
same Tektronics 1024 × 1024 as for the Coma sample and we
observed the galaxies in Johnson V.

Thanks to the fact that the sample is largely composed of
obvious spirals, whose large-scale spiral structure is visible
even on defective images (missing pixels, pear-shaped PSF,
unidentified filter), we were able to collect images of sufficient
quality for the morphological classification of all but 4 galaxies
(Zw 540-73, 540-80, 540-83 and 525-36).

For the first three galaxies, we only used our Calern plates,
whose densities had been transformed into intensities by means
of a contour to contour correspondence between plate-image
output and CCD-image intensity for a set of galaxies, as we did
in Paper I. Plate OCA #2977, like those used for Coma galax-
ies, is a Kodak panchromatic 4415 emulsion sensitive from the
near UV to 6000–7000 ˚
ie, is a Kodak panchromatic 4415 emulsion sensitive from the

3. Results of the photometric and isophotal shape
analyses

3.1. Spirals

Table 2 presents the parameters of 31 galaxies in Coma clas-
ified as spirals from visual inspection of the two plates OCA
#2842 and OCA #2849, with our notes and from the morpho-
logical appearance on CCD data when available. In that Table,
we also list separately three Coma galaxies classified as S from
CCD data taken on December 27 and 28, 1994, and two Coma
galaxies classified as spirals from images in our archives.

Table 3 presents the parameters of 36 galaxies in Perseus
classified as spiral or peculiar, from their visual appearance
on plate OCA #2977, on the Digitized Palomar Sky Survey
and/or on our CCD images.

3.2. Early-type galaxies

The data presented in Tables 4 and 5, for early-type galaxies
in Coma and Perseus respectively, include the usual photomet-
ric parameters in Cousin’s R or Johnson V band, namely the
asymptotic magnitude, the effective radius, the corresponding
isophotal major axis, and the average surface brightness (here-
after SuBr) inside the effective isophote. Geometrical param-
eters are given next, the minimum axis ratio (or alternatively its
value at the effective isophote), the representative e4 coefficient
(see Paper I for the definition of e4 and f4), the axis ratio in the
envelope, i.e. at the isophote \( \mu_R = 24 \text{ mag arcsec}^{-2} \) or \( \mu_V =
24.85 \text{ mag arcsec}^{-2} \), and a representative value for the isopho-
tal twist. Next is a coded description, indicating the detection
or absence of components such as bar, disk, spiral pattern, and
the classification of disks and envelopes.

We emphasize that the units of angular measures in this paper
and in Paper I are arcsec, not 0.1 arcmin as incorrectly
stated in Paper I.

Table 4 lists the parameters of 28 early-type galaxies in
Coma. The first 4 columns concern the catalogue data, the
others list the measured data.

Table 5 lists the parameters of 27 early-type galaxies in
Perseus. The first 2 columns concern the catalogue data, the
others list the measured data.

In the notes to Table 4 and 5, we give qualitative remarks
for galaxies which present either peculiar morphological prop-
erties or practical problems for classification.

4. Quality of the parameters and types

A detailed comparison of the morphological types of the whole
Coma sample of galaxies with other published studies is pre-
sented in Andreon & Davoust (1997). It shows that the main
objective of this work and of Paper I, reliable estimates of mor-
phological types, has been reached, since these types are at least
as good as the traditional ones, because less subjective, more
reproducible and based on images of adequate quality.

The quality of the parameters listed in Tables 4 and 5 (mag-
nitudes, effective radii, representative ellipticities, etc.) does
not differ from that of the parameters presented in Paper I,
because of the close similarity of the data and of the analyses.

Some discrepancies have been found between our values of
representative quantities (such as ellipticity or e4) and pub-
lished ones, but we stress that they are largely due to differ-
ences in the definition of what is a “representative” quantity,
whether it is an intensity averaged quantity, or the quantity at
the galaxy effective radius, at its maximum or at the extremum,
and of what is its value when not just an extremum is present
or when we only measure an incomplete range of galaxy radii
(i.e. always because of seeing or sky brightness limitations). In
Paper I, the comparison of these “representative” quantities
shows that the typical errors are of 0.06 on ellipticity (and our
ellipticities are systematically larger than the others by 0.05)
and of 1.3 (%) on e4 (and our e4 are larger than the others by
0.7 %). These figures, based on more than 200 comparisons,
are also valid for the data presented in this paper.

Aside from errors on sky determination, the effective radii
suffer from the existence of two definitions, the radius contain-
hing half the light, measured by extrapolating the luminosity
growth curve and taking the radius where the integrated mag-
nitude is 0.75 mag fainter than the total one, or the slope of the
SuBr profile, measured by the best fit of the SuBr profile with
a de Vaucouleurs’ law. Adopting the former method, the sub-
jective extrapolation of the growth curve implies a typical error
of 0.02 in $\log(r_e)$ and $\log(l_e)$ for galaxies of range 0.5 to 1.0 in $\log(r_e)$ (where $r_e$ is in units of arcsec), or, more precisely, this is the typical scatter between estimates of different observers, all using the same growth curves. Much larger differences have sometimes been found for galaxies whose growth curves differ from the standard ones listed in RC3 (de Vaucouleurs et al. 1991), used by us as standards.

5. Summary

We present morphological type estimates, together with a detailed coded description for 59 galaxies in Coma and 80 in Perseus. The material for the morphological type estimates is adapted to the difficulty of morphological classification, ranging from Schmidt plates for obvious Ss to CCD data with a median restframe resolution of 0.65-0.75 Kpc for early-types.

In the present paper and in two previous ones (Paper I; Poulain, Nieto & Davoust 1992) we classify two magnitude complete samples of galaxies: all (187) galaxies in Coma brighter than $M_b =-19.2$ mag within 1 degree from the cluster center and all (139) galaxies in Perseus brighter than $M_{Zwicky} =-19.5$ mag in a box of $5''3 \times 5''2'$. At the distance of these two clusters, we sample an area of 17 and 91 Mpc$^2$ and distances of up to 2.3 and 6.4 Mpc from the cluster center, for Coma and Perseus respectively, and 4 to 5 orders of magnitude in galaxy density. The ranges of explored clustercentric distances and galaxy densities allow us to study how the cluster affects the galaxy properties. The results for Coma, based on these data, are presented in Andreon (1996). For Perseus, work is in progress.

Acknowledgements. We thank Christian Pollas (Observatoire de Calern) for taking three Schmidt plates for this project, and Jean Guibert and his staff (MAMA) for digitizing the plates. We thank Bénédicte Rougeaux for her visual inspection of the OCA #2849 plate. This research made use of the NASA/IPAC Extragalactic Database (NED) which is operated by the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration and of the Lyon-Meudon Extragalactic Database (LEDA) supplied by the LEDA team at the CRAL-Observatoire de Lyon (France). Skyeye (http://terra.ira.bo.cnr.it/ira/skyeye) greatly helped giving a quick and easy access to the Digitized Palomar Sky Survey.

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Figure 1. The galaxies of the Coma sample. Full and open circles represent galaxies whose morphological type is presented in this paper and in Paper I, respectively. The size of the circles is proportional to the magnitude of the galaxy. The radius of the field is one degree. There are 187 galaxies in this field. The morphological types of 59 of them are presented in this paper, and the others can be found in Paper I.
Figure 2. The galaxies of the Perseus sample. Full and open circles represent galaxies whose morphological types are presented in this paper and in Poulain, Nieto & Davoust (1992), respectively. The size of the circles is proportional to the magnitude of the galaxy. The size of the studied region is 5°3′ × 5°27′. There are 139 galaxies in this field. The morphological types of 80 of them are presented in this paper, and the others can be found in Poulain, Nieto & Davoust (1992).
Table 1. Observing log of Perseus galaxies

| name  | run   | filter | exp. time (min) | seeing (arcsec) | notes                                      |
|-------|-------|--------|-----------------|-----------------|--------------------------------------------|
| 525-19| dec94 | V      | 15              | 1.7             |                                            |
| 525-29| dec94 | x      | 15              | 1.6             |                                            |
| 525-31| feb95 | V      | 15              | 1.5             |                                            |
| 525-6 | dec94 | x      | 15              | 1.6             |                                            |
| 540-32| feb95 | V      | 15              | 1.3             |                                            |
| 540-33| feb95 | V      | 15              | 1.3             |                                            |
| 540-35| dec94 | V      | 15              | 1.6             |                                            |
| 540-36| dec94 | V      | 15              | 1.7             |                                            |
| 540-41| feb95 | V      | 15              | 1.6             |                                            |
| 540-42| dec94 | x      | 15              | 1.6             |                                            |
| 540-43| dec94 | x      | 15              | 1.6             |                                            |
| 540-45| dec94 | V      | 15              | 1.7             |                                            |
| 540-46| sep93 | r      | 15              | 1.3             | archive, PIC, CCD=RCA1 F/10 pixel size=0.324|
| 540-48| feb94 | V      | 15              | 1.2             |                                            |
| 540-51| feb95 | V      | 15              | 1.4             |                                            |
| 540-54| dec94 | x      | 15              | 1.5             |                                            |
| 540-56| dec93 | r      | 20              | 2.6             |                                            |
| 540-57| feb95 | V      | 15              | 1.3             |                                            |
| 540-59| dec93 | r      | 20              | 3.7             |                                            |
| 540-60| dec94 | x      | 15              | 1.6             |                                            |
| 540-62| feb95 | V      | 15              | 1.2             |                                            |
| 540-67| dec93 | r      | 20              | 2.6             |                                            |
| 540-68| dec94 | V      | 15              | 1.7             |                                            |
| 540-70| dec94 | x      | 15              | 1.6             |                                            |
| 540-73| plate |        |                 | OCA #2977       |                                            |
| 540-74| feb94 | r      | 20              | 1.0             |                                            |
| 540-76| feb94 | r      | 20              | 1.2             |                                            |
| 540-80| plate |        |                 | OCA #2977       |                                            |
| 540-81| dec93 | r      | 10              | 0.7             | archive, CFH, CCD=RCA2 (see Paper I)       |
| 540-82| dec94 | V      | 15              | 1.6             |                                            |
| 540-83| plate |        |                 | OCA #2977       |                                            |
| 540-85| feb95 | V      | 15              | 1.3             |                                            |
| 540-85| feb95 | V      | 15              | 1.6             |                                            |
| 540-89| feb95 | V      | 15              | 1.4             |                                            |
| 540-97| dec93 | r      | 20              | 2.5             |                                            |
| 540-104| plate|        |                 | OCA #2977       |                                            |
| 540-106| feb94| V      | 15              | 1.5             |                                            |
| 540-114| dec93| r      | 20              | 2.7             |                                            |
| 540-114| plate|        |                 | OCA #2977       |                                            |
| 540-115| dec94| V      | 15              | 1.5             |                                            |
| 541-3 | dec93 | r      | 2               | 1.7             |                                            |
| 541-12| dec93 | r      | 20              | 1.8             |                                            |
| 541-14| dec93 | r      | 20              | 1.9             |                                            |
| 541-15S| sep90| r      | 30              | 1.1             | archive, PIC, CCD=Tho F/10 pixel size=0.2?  |
| 541-16N| feb95| V      | 15              | 1.4             |                                            |
| 541-16S| feb95| V      | 15              | 1.4             |                                            |
| 541-112N| dec93| r      | 20              | 2.7             |                                            |
| BGP41| feb94 | r      | 15              | 1.1             |                                            |
| T40  | feb95 | V      | 15              | 1.4             |                                            |
| T40  | feb95 | V      | 15              | 1.3             |                                            |
| T04  | dec93 | r      | 20              | 1.8             | Not analyzed, bright star at 14”           |

Notes:
- feb93: CCD Thompson 1024x1024, pixel size=0.24
- dec93: CCD Thompson 1024x1024, pixel size=0.48 (0.24 2x2 binned)
- feb94: CCD Thompson 1024x1024, pixel size=0.24 (the observations in the x filter were done with an unknown filter, because of a mechanical fault).
- dec94: CCD Tektronics 1024x1024, pixel size=0.30
- feb95: CCD Tektronics 1024x1024, pixel size=0.30
Table 2. Galaxies classified as S from visual inspection of the plates OCA2842 and OCA2849 (all but two not presented in Paper I)

| GMP | characteristics | other observations | notes |
|-----|-----------------|--------------------|-------|
| 0315 | irr             | run 10, S         |       |
| 0433 | asym            |                    |       |
| 0440 | irr, asym       |                    |       |
| 0507 | irr, asym       | run 9, S          | Irr   |
| 0510 | irr, asym, low SuBr |                | Irr   |
| 0686 | arms            | run 7, S, GavIII, S |       |
| 0689 | asym, irr       |                    |       |
| 0790 | irr, arms       | run 10, S         |       |
| 0804 | irr, arms       | GavI, S, GavIV, S | beautiful S |
| 0834 | irr?, spiP?     |                    | uncertain type, classified S by D80, BO |
| 0837 | arms            | GavI, S           | beautiful barred S |
| 0867 | irr             | run 9, SA0/a      | strange shape on plate |
| 0875 | irr, asym       |                    | late type spiral or Irr |
| 0892 | asym            |                    | dust, no bulge |
| 0897 | irr             |                    | Irr   |
| 0914 | asym, arms      | run 10, S         |       |
| 0978 | asym, irr       |                    |       |
| 1001 | irr             | run 10, S         | outside the redshift limits |
| 1193 | irr, asym       |                    |       |
| 1203 | asym            |                    |       |
| 1420 | irr, asym       | GavIV, S          |       |
| 1555 | irr             | GavIV, S          | Irr   |
| 1566 | irr, asym       |                    | Irr   |
| 1576 | arms            |                    |       |
| 1675 | irr, asym       | GavIII, S         | beautiful barred S |
| 1711 | spiP            |                    |       |
| 1744 | spiP            |                    | uncertain type, classified S by BO |
| 2156 | irr             |                    | Irr   |
| 2172 | irr, asym, spiP?|                    | late type spiral |
| 2275 | asym            |                    | dust   |
| 0315 | asym            |                    |       |
| 0790 | spiP            |                    |       |
| 1001 | irr, asym       |                    |       |
| 0507 | arms, irr       | march 94          | Irr, not in the published list |
| 0518 | S in kp1608     | run 7, S          | not published in Paper I |

Notes:
BO= Butcher & Oemler 1985
GavI = Gavazzi, Garilli & Boselli 1990
GavIII = Gavazzi & Randone 1994
GavIV = Gavazzi, Boselli & Carrasco 1994
D80 = Dressler 1980
kp1608 = KPNO photographic plate (see Paper I)
run 7 = CCD observations in March 1993 (see Paper I)
Table 3. Morphological description of spiral galaxies in Perseus

| Name         | Palomar dig     | OCA #2977 | Notes OCA #2977                 | CCD   | Run n. & Notes |
|--------------|-----------------|-----------|---------------------------------|-------|----------------|
| Zw 525-6     |                 |           |                                 | S     | dec94          |
| Zw 525-11    |                 | S         | very low SuBr                   |       |                |
| Zw 525-19    |                 |           | (r)S barred                     |       | dec94          |
| Zw 525-29    |                 | S         |                                 |       | dec94          |
| Zw 525-31    |                 |           | too close to bright star        | S     | feb95          |
| Zw 525-33    | Irr             |           |                                 |       |                |
| Zw 525-39    | S               |           |                                 |       |                |
| Zw 540-34    | S arms          |           |                                 | S     | dec94          |
| Zw 540-35    |                 |           |                                 | S     | dec94          |
| Zw 540-36    |                 |           | S flocculent                    |       | dec94          |
| Zw 540-37    | S late          |           |                                 |       |                |
| Zw 540-42    |                 |           |                                 | S     | dec94          |
| Zw 540-43    |                 |           | S asymm                         |       | dec94          |
| Zw 540-45    |                 |           |                                 | S     | dec94          |
| Zw 540-49    | S dust          |           |                                 | S     | dec94          |
| Zw 540-54    |                 |           |                                 | S barred | dec94       |
| Zw 540-58    | S irr           |           | Pec                             |       | Interact       |
| Zw 540-60    |                 |           |                                 | S late | dec94          |
| Zw 540-67    |                 |           |                                 | Irr   | dec93          |
| Zw 540-68    |                 |           |                                 | S     | dec94          |
| Zw 540-70    | late type?      |           |                                 | S dusty | dec94      |
| Zw 540-71    | S               | low SuBr, asym                   |       |                |
| Zw 540-77    | S               |                                 |       |                |
| Zw 540-82    |                 | S                                 |       | dec94          |
| Zw 540-84    | Irr             |           |                                 |       |                |
| Zw 540-90    | S late          |           |                                 | S     |                |
| Zw 540-91    | S arms          |           |                                 | S     |                |
| Zw 540-93    | S               | low SuBr, elongated, ->dust      |       |                |
| Zw 540-97    |                 | S two faint arms, bar, disk      |       | dec93          |
| Zw 540-106   | S               | disk                              |       |                |
| Zw 540-115   |                 | other galaxy at 6"                |       | S dusty        | dec94    |
| Zw 540-118   | S               |                                 |       |                |
| Zw 540-121   | S               | disk, irr                         |       |                |
| Zw 541-3     | Irr             |           |                                 |       |                |
| Zw 541-19    | S arms, III reg. |                                   |       |                |
| Zw 541-112N  |                 | Pec (Interact?)                   |       | dec93          |
Description of Table 4 (Coma galaxies)

(1) and (2) Number in the abridged and unabridged versions of the Godwin, Metcalf & Peach (GMP) catalogue.
(3) Number in Dressler’s catalogue (Dressler 1980).
(4) Usual designation, such as NGC, IC (Dreyer 1888), and RB (Rood & Baum 1967) numbers.
(5) Asymptotic magnitude, in V (Johnson’s system).
(6) Logarithm of the effective radius, in units of arcsec (log(r_e)).
(7) Logarithm of the semi major axis of the effective isophote, in units of arcsec (log(l_e)).
(8) Mean SuBr inside the effective isophote, in V mag arcmin^{-2}.
(9) Photometric evidence for a disk, coded as st (strong), cl (clear), ft (faint), or no (none).
(10) Typical axis ratio, either its minimum value, if clearly defined, or its value at the effective isophote otherwise.
(11) Location where the axis ratio was estimated, coded as ex (at its extremum), re (at the effective isophote), or co (if the value is the same at both locations).
(12) Typical e_4 parameter, either its extremum value, if clearly defined, or its value at the effective isophote otherwise. The estimates are in %.
(13) Location where the e_4 parameter was estimated, coded as ex (at its extremum), re (at the effective isophote), or co (if the value is the same at both locations).
(14) Axis ratio in the envelope, i.e. at the isophote \( \mu_V = 24.85 \) mag arcsec^{-2}.
(15) Amplitude of isophotal twist in the range of reliable measurements, in degrees.
(16) Detection of a bar, coded as follows : bar (bar seen), bar? (bar suspected), -no (no bar seen).
(17) Detection and classification of a disk, coded as follows: emDi (embedded disk), miDi (mixed disk), exDi (extended disk), -?Di (detected but unclassified disk), -no- (no disk seen).
(18) Detection of a spiral pattern, coded as follows: spiP (spiral pattern seen), spiP? (spiral pattern suspected), -no- (no spiral pattern seen).
(19) Classification of an envelope, coded as follows: spH (spheroidal halo), thD (thick disk), exD (extended disk), pec (peculiar envelope), -?- (unclassified envelope).
(20) Our morphological classification, coded as follows: boE (boxy E), unE (undetermined E), diE (disky E), SA0, SAB0, SB0, Sa, etc., S... (spiral of unknown stage).
(21) An asterisk refers to a note in Sect. 5 about specific features such as important dust pattern, ring or lens, low SuBr, \( f_4 \)-asymmetry, etc., and about uncertainties of various sources.

Note that, when a parameter has not been measured, or when a specific morphological component has not been studied, the relevant code is replaced by a dash.
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) | (18) | (19) | (20) | (21) |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|------|------|------|------|------|------|
| 0552 | 1715 | 141 NGC 4927 | 13.56 | 0.93 | 1.02 | 11.31 | no | 0.70 | co | 1.2 | co | 0.73 | 3 | -no | miDi | -no | thD | diE | * |
| 0607 | 1853 | 190 | -- | -- | -- | st | 0.26 | ex | 8.0 | ex | 0.29 | 2 | -no | miDi | -no | thD | SA0 | * |
| 0718 | 2157 | 79 NGC 4919 | 13.73 | 0.71 | 0.80 | 10.39 | st | 0.72 | re | 2.2 | ex | 0.49 | 4 | -no | -?Di | -no | pec | SA0 | * |
| 0750R | 2237 | 80 | 14.63 | 0.55 | 0.65 | 10.47 | st | 0.59 | ex | 3.0 | co | 0.99 | 2 | -no | emDi | -no | spH | SA0 | * |
| 0750 | 2237 | 80 | 15.06 | 0.55 | 0.65 | 10.91 | st | 0.59 | ex | 3.0 | co | 0.92 | 30 | -no | emDi | -no | spH | SA0 | * |
| 0754 | 2259 | 229 | 15.01 | 0.59 | 0.64 | 11.03 | no | 0.80 | re | 1.8 | co | 0.71 | 10 | -no | miDi | -no | exD | diE | * |
| 0828 | 2417 | 167 NGC 4908 | 13.77 | 0.70 | 0.78 | 10.39 | ft | 0.67 | ex | -0.8 | ex | 0.65 | 8 | -no | -no | -no | -? | unE | * |
| 0857 | 2495 | 231 | 14.55 | 0.42 | 0.54 | 9.73 | cl | 0.50 | ex | 4.0 | ex | 0.60 | 0 | -no | miDi | -no | spH | SA0 | * |
| 0908 | 2629 | 232 NGC 4896 | 13.77 | 0.87 | 1.00 | 11.20 | ft | 0.52 | ex | 0.0 | re | 0.55 | 3 | -no | -no | -no | -? | unE | * |
| 0924 | 2670 | 27 | 15.26 | 0.51 | 0.57 | 10.90 | ft | 0.80 | ex | 1.6 | ex | 0.82 | 3 | -no | -?Di | -no | -? | diE | * |
| 0967 | 2776 | 39 | 14.91 | 0.54 | 0.58 | 10.73 | no | 0.78 | ex | 0.0 | co | 0.78 | 2 | -no | -no | -no | -? | unE | * |
| 1109 | 3073 | 175 NGC 4883 | 14.24 | 0.61 | 0.64 | 10.44 | cl | 0.71 | ex | -1.0 | re | 0.82 | 45 | bar | -?Di | -no | -? | SB0 | * |
| 1154 | 3165 | 57 | 13.85 | 0.65 | 0.81 | 10.22 | st | 0.25 | ex | 8.0 | ex | 0.34 | 4 | -no | emDi | -no | spH | SA0 | * |
| 1232 | 3328 | 242 | 15.01 | 0.36 | 0.44 | 9.91 | cl | 0.50 | ex | 2.5 | ex | 0.52 | 2 | -no | miDi | -no | thD | SA0 | * |
| 1432 | 3818 | 218 | 14.18 | 0.60 | 0.70 | 10.26 | no | 0.45 | ex | 2.5 | co | 0.45 | 11 | -no | -? | spiP | exD | S.. | * |
| 1560 | 4147 | | 14.27 | 0.64 | 0.74 | 10.59 | st | 0.50 | ex | 3.2 | co | 0.61 | 1 | -no | emDi | -no | spH | SA0 | * |
| 1564 | 4156 | 43 NGC 4853 | 13.49 | 0.54 | 0.58 | 9.29 | st | 0.78 | ex | 0.0 | re | 0.82 | 10 | -no | -no | -no | -? | SAB0p | * |
| 1594 | 4230 | 161 RB 241 | 13.98 | 0.76 | 0.80 | 10.89 | no | 0.87 | co | -0.8 | co | 0.91 | 20 | -no | -no | -no | -? | boE | * |
| 1625 | 4315 | 137 NGC 4850 | 14.23 | 0.58 | 0.65 | 10.24 | cl | 0.74 | co | 3.1 | co | 0.93 | 30 | bar | -?Di | -no | -? | SB0 | * |
| 1844 | 4849 | 211 | 14.31 | 0.78 | 1.01 | 11.30 | st | 0.31 | ex | 7.1 | co | 0.44 | 5 | -no | emDi | -no | spH | SA0 | * |
| 1852 | 4866 | 212 | 14.88 | 0.67 | 0.77 | 11.32 | cl | 0.50 | ex | 1.4 | co | 0.56 | 12 | bar | -?Di | -no | thD | SAB0 | * |
| 1925 | 5038 | 16 | 15.11 | 0.67 | 0.73 | 11.54 | cl | 0.72 | co | 4.1 | co | 0.89 | 60 | -no | emDi | -no | pec | SA0 | * |
| 2047 | 5341 | 221 | 14.98 | 0.47 | 0.55 | 10.44 | cl | 0.64 | ex | 4.9 | co | 0.95 | 74 | bar | -?Di | -no | -? | SB0 | * |
| 2085 | 5478 | | 14.46 | 0.64 | 0.66 | 10.74 | no | 0.91 | co | -0.8 | co | 0.90 | 9 | -no | -no | -no | -? | boE | * |
| 2109 | 5495 | | 14.51 | 0.47 | 0.51 | 9.94 | no | 0.79 | ex | 1.0 | ex | 0.88 | 15 | -no | -?Di | -no | -? | unE | * |
| 2134 | 5568 | NGC 4816 | 12.66 | 1.40 | 1.44 | 12.74 | no | 0.79 | re | -1.0 | ex | 0.74 | 20 | -no | -no | -no | -? | boEp | * |
| 2220 | 5799 | | 15.14 | 0.38 | 0.44 | 10.13 | cl | 0.69 | ex | 2.9 | co | 0.81 | 30 | bar | -?Di | -no | -? | SB0 | * |
| 2283 | 5999 | | 14.03 | 1.00 | 1.09 | 12.13 | no | 0.78 | ex | 0.0 | co | 0.80 | 0 | -no | -no | -no | -? | unE | * |
Notes to Table 4 (Coma galaxies)

0552: dust along the major axis. Type given in Paper I confirmed.
0718: two bumps on the major axis profile. Inner ring and lens. Type given in Paper I confirmed.
0750R: image of run 9 (see Paper I).
0750: 30 degree twist at r ~ 10 arcsec on the V image. Same twist in R, but image not deep enough for full confirmation. Type given in Paper I confirmed.
0754: type given in Paper I fully confirmed.
0828: E boxy outside r_e and possibly disky inside. In Paper I it is classified diE because the boxiness of the outer region is not detected with certainty, partly because of the presence of a companion galaxy at 15 arcsec in the minor axis direction.
0857: the bar suspected in Paper I is detected.
0908: slightly boxy isophotes out to r_e, then slightly disky isophotes. Uncertain detailed classification.
1109: the bar suspected in Paper I is detected.
1154: asymmetric with respect to its major axis.
1432: classified SA0/a by morphologists, probably because of the low contrast spP.
1564: ellipticity and e_4 profile unusual for a lenticular galaxy. It seems to be asymmetric.
1594: the better data with respect to Paper I allow us to classify it elliptical.
1625: the bar suspected in Paper I is detected.
1844: isophote twist toward GMP 1852. Type given in Paper I confirmed.
1852: isophote twist opposite to GMP 1844, bar suspected but nearby star slightly elongated in the same direction. Type given in Paper I confirmed.
1925: large isophote twist at low SuBr.
2085: rich in globular clusters. The better data with respect to Paper I allow us to classify it elliptical.
2109: focus problems made the PSF slightly elongated in a direction orthogonal to the galaxy major axis. Data inside 4 arcsec are not usable. Also classified unE with CFH data of Paper I.
2134: rich in globular clusters. Its intensity profile obeys the r^{-1.44} law from 1 arcsec out to 60 arcsec, putting this galaxy in the D class following Schombert (1987) and Tonry (1987). Classified as unE in Paper I from a slightly shallower image.
2283: the analysis is made difficult by the crowded field and a nearby saturated star.

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4 The expression “globular cluster” here and hereafter does not imply a group of dynamically bound stars, but a clump of light.
Description of Table 5 (Perseus galaxies)

(1) Zwicky name.
(2) Usual designation, such as NGC, UGC (Nilson 1976), T (Tiff 1976), BGP (Bucknell, Godwin & Peach 1979) and CR (Chincarini and Rood 1977) numbers.
(3) Flag for filter or observational material.
(4) Asymptotic magnitude.
(5) Logarithm of the effective radius, in units of arcsec.
(6) Logarithm of the semi major axis of the effective isophote, in units of arcsec.
(7) Mean SuBr inside the effective isophote, in mag arcmin$^{-2}$.
(8) to (12) Same as columns (9) to (13) of Table 4.
(13) Axis ratio in the envelope, i.e. at the isophote $V=24.85$ or $R=24$ mag arcsec$^{-2}$.
(14) to (20) Same as columns (15) to (21) of Table 4.

Note that a “(1)” in the table means that the parameter has not been computed because the night was not photometric, or because of the pan-chromaticity of the plate.

Table 5. Morphological description of early-type galaxies in Perseus

| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) | (18) | (19) | (20) |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 540-32 | NGC 1175 | V | 13.81 | 0.90 | 0.92 | 11.41 | no | no | 0.92 | ex | -0.8 | ex | 0.92: | 15: | -no | -no- | -no- | -no boE | * |
| 540-33 | NGC 1177 | V | 12.52 | 1.04 | 1.19 | 10.79 | st | 0.27 | ex | -7.2 | co | 0.30: | 0 -no emDi | -no- | thD | SA0 | * |
| 540-41 | V | 14.28 | 0.86 | 0.94 | 11.66 | st | 0.62 | co | 5.3 | co | 1.0 | 20 | bar | emDi | -no- | spH | SB0 | * |
| 540-46 | UGC 2559 | R (1) | 0.95 | 1.03 | (1) | st | 0.39 | ex | 5.0 | ex | (1) | 10 | bar | -?Di | -no- | -? SB0 | * |
| 540-48 | V | 14.41 | 0.56 | 0.66 | 10.31 | st | 0.52 | ex | 3.0 | ex | 0.63 | 9 | -no miDi | -no- | thD | SA0 | * |
| 540-51 | V | 14.10 | 0.77 | 0.83 | 11.06 | st | 0.58 | ex | 0.0 | re | 0.65 | 25 | bar | -?Di | -no- | thD | SB0 | * |
| 540-56 | R (1) | - | - | (1) | st | 0.39 | ex | 7.0 | ex | (1) | 3 | -no miDi | -no- | thD | SA0 | * |
| 540-57 | V | 15.55 | 0.78 | 0.84 | 10.54 | no | 0.62 | ex | -2.0 | ex | 0.70 | 10 | -no- | -no- | -? boE | * |
| 540-59 | R (1) | 0.72 | 0.78 | (1) | st | 0.46 | ex | 5.6 | ex | (1) | 12 | bar | -?Di | -no- | thD | SB0 | * |
| 540-62 | V | 13.40 | 0.74 | 0.82 | 10.22 | no | 0.67 | ex | -1.0 | co | 0.76: | 0 | -no- | -no- | spH boE | * |
| 540-73 | CR 6 | plate (1) | - | - | (1) | SA0 | * |
| 540-74 | BGP 37 | R (1) | 0.75 | 0.80 | (1) | st | 0.75 | co | 0 | co | (1) | 3 | -no- | -no- | thD SA0 | * |
| 540-74 | BGP 37 | plate (1) | 0.76 | 0.83 | (1) | ft | 0.85 | co | 0 | co | (1) | 10 | -no- | -no- | -?- SA0 | * |
| 540-76 | R | SA0 | * |
| 540-80 | plate | 14.38 | 0.81 | 0.89 | 11.55 | st | 0.75 | ex | 0 | co | 0.75 | 25 | bar | -?Di | -no- | -?- SB0 | * |
| 540-81 | R | SA0 | * |
| 540-83 | BGP 34 | plate (1) | - | - | (1) | cl | 0.23 | ex | 9.0 | ex | (1) | 0 | -no emDi | -no- | thD SA0 | * |
| 540-85 | CR 15 | 2 V images | 13.91 | 0.68 | 0.73 | 10.40 | no | 0.72 | co | 0.3 | co | 0.76 | 3 | -no- | -no- | xsi | eDi | * |
| 540-89 | CR 22 | V | 14.06 | 0.88 | 1.03 | 11.54 | cl | 0.42 | ex | 3.0 | ex | 15 | no | 1 | 1 | -no- | -?- SA0 | * |
| 540-106 | V | 14.24 | 0.58 | 0.73 | 10.25 | st | 0.32 | ex | 6.1 | ex | 10 | -no emDi | spP | -?- S | * |
| 540-114 | R (1) | - | - | (1) | st | 0.31 | ex | 8.3 | ex | (1) | 0 | -no miDi | -no- | exD SA0 | * |
| 540-114 | plate (1) | 0.72 | 0.88 | (1) | st | 0.35 | ex | 6.9 | ex | (1) | 0 | -no miDi | -no- | exD SA0 | * |
| 541-12 | R (1) | 0.71 | 0.86 | (1) | st | 0.31 | ex | 8.1 | ex | (1) | 2 | -no emDi | -no- | spH SA0 | * |
| 541-14 | R (1) | 0.93 | 1.04 | (1) | st | 0.56 | ex | 5.2 | ex | (1) | 25 | bar | -?Di | -no- | spH SB0 | * |
| 541-15S | UGC 2755 | V (1) | 0.97 | 0.99 | 1 | ft | 0.75 | ex | 2.0 | ex | (1) | 60 | bar | -?Di | -no- | -?- SB0 | * |
| 541-16N | V | 14.19 | 0.90 | 1.08 | 11.79 | cl | 0.42 | ex | 0.5 | ex | 3 | -no miDi | -no- | thD SA0 | * |
| 541-16S | V | 14.10 | 0.60 | 0.62 | 10.19 | no | 0.75 | ex | -1.8 | co | 40 | bar | -?Di | -no- | -?- SB0 | * |
| BGP 41 | R (1) | 0.74 | 0.81 | (1) | cl | 0.70 | ex | 2.0 | ex | (1) | 12 | bar | -?Di | -no- | spH SB0 | * |
| T 40 | 2 V images | 14.31 | 0.75 | 0.80 | 11.17 | st | 0.78 | ex | 1.7 | co | 0.86 | 5 | -no emDi | -no- | spH SA0 | * |
Notes to Table 5 (Perseus galaxies)

**T40**: the identification of Tiff 40 is doubtful. The observed galaxy is the nearest one to the Tiff 40 coordinates. A brighter (spiral) galaxy is 4 arcmin SE, which is more likely Tiff 40, if we believe Kent & Sargent’s (1983) classification (S).

**540-32**: companion of NGC 1177; roundish.

**540-33**: peanut shaped SA0.

**540-41**: face on.

**540-46**: the small field of view did not allow us to image the whole envelope.

**540-57**: there is a bump on the major axis SuBr profile at $V=23$ mag arcsec$^2$.

**540-73**: this galaxy is 19 arcsec from a very bright star, preventing the detailed structural analysis. However, bulge and disk are clearly visually detected as a change of axis ratio and as a bump on the major axis profile, leading to our estimated type. The galaxy is edge-on.

**540-74**: our morphological type fully confirms that of Poulain, Nieto & Davoust (1992).

**540-76**: strong, but smooth, dust lane on major axis. A second faint dust lane is present with an inclination of about 10 degrees with respect to the galaxy major axis 10 arcsec Southward.

**540-81**: dust just in the inner part of this galaxy observed near the CCD’s edge.

**540-89**: a very bright star 20 arcsec from the galaxy center perturbs the isophotal analysis at that radius. $e_4$ never dominates the Fourier terms, $f_4$ asymmetry.

**540-106**: almost edge-on, a bit S-shaped, asymmetric.

**540-114**: the c/a profile starts to rise at fainter SuBr than sampled by plate, thus explaining the difference in the envelope classification.

**541-15S**: face on.

**541-16N**: the galaxy Zw 540-16S and nearby stars prevented us from measuring the shape of this galaxy’s envelope.

**541-16S**: the galaxy 540-16N makes it impossible to measure the SuBr profile at $r > 12$ arcsec.