# A photometric analysis of Abell 1689: two-dimensional multistructure decomposition, morphological classification and the Fundamental Plane

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## ABSTRACT

We present a photometric analysis of 65 galaxies in the rich cluster Abell 1689 at $z = 0.183$, using the *Hubble Space Telescope* Advanced Camera for Surveys archive images in the rest-frame $V$ band. We perform two-dimensional multicomponent photometric decomposition of each galaxy adopting different models of the surface-brightness distribution. We present an accurate morphological classification for each of the sample galaxies. For 50 early-type galaxies, we fit both a de Vaucouleurs law and a Sérsic law; S0s are modelled by also including a disc component described by an exponential law. Bars of SB0s are described by the profile of a Ferrers ellipsoid. For the 15 spirals, we model a Sérsic bulge, exponential disc and, when required, a Ferrers bar component. We derive the Fundamental Plane (FP) by fitting 40 early-type galaxies in the sample, using different surface-brightness distributions. We find that the tightest plane is that derived by Sérsic bulges. We find that bulges of spirals lie on the same relation. The FP is better defined by the bulges alone rather than the entire galaxies. Comparison with local samples shows both an offset and rotation in the FP of Abell 1689.

**Key words:** galaxies: clusters: individual: Abell 1689 – galaxies: elliptical and lenticular, cD – galaxies: fundamental parameters – galaxies: photometry – galaxies: spiral.

## 1 INTRODUCTION

The discovery of the Fundamental Plane (FP) three decades ago (Djorgovski & Davis 1987; Dressler et al. 1987; Faber et al. 1987) constituted an important milestone on understanding galaxy evolution. Stellar velocity dispersion, $\sigma_\star$, effective radius, $r_e$, and average surface brightness within $r_e$, $\langle I \rangle_e$, of early-type galaxies (ETGs) define a remarkably tight plane in the form $r_e \propto \sigma_\star^b \langle I \rangle_e^c$. Under the assumptions of structural homology and uniform mass-to-light ratio, the virial theorem predicts $b = 2$ and $c = -1$; because the best-fitting values of $b$ and $c$ deviate from this prediction, the FP is said to be 'tilted' (Burstein et al. 1997; Trujillo, Burkert & Bell 2004). The FP remains a potentially powerful tool to investigate galaxy mass assembly and luminosity evolution with redshift, by comparing the values of the FP coefficients over time. However, there is little uniformity in the details of how the observables are measured, which makes direct comparisons difficult or inappropriate. Differences in the derived FP coefficients can be due to the algorithm used, whether the fit is direct or orthogonal, choice of the dependent variable (e.g. Sheth & Bernardi 2012), passband (e.g. Bernardi et al. 2003) and sample selection (e.g. Nigoche-Netro, Ruelas-Mayorga & Franco-Balderas 2008). In this contribution, we will focus on the photometric parameters that enter the FP and investigate whether or not possible discrepancies can arise with the change of photometric models. Indeed, originally $r_e$ and $\langle I \rangle_e$ of galaxies were measured by fitting a de Vaucouleurs law to the growth curve (see Paper I for a description). Later on Sérsic profile to the growth curve was adopted (e.g. Caon, Capaccioli & D'Onofrio 1993; La Barbera et al. 2002). A de Vaucouleurs bulge plus exponential disc decomposition has also been used (e.g. Saglia et al. 1997; Fritz et al. 2005), as have two-dimensional surface-brightness decompositions (e.g. Simard et al. 2002; Tran et al. 2003; Fritz, Böhm & Ziegler 2009; Fernández Lorenzo et al. 2011).

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Abell 1689 (Abell [1958]) is a richness class 4 cluster at redshift $z = 0.183$ (Struble & Rood [1999]). As a Coma cluster analogue, it provides an opportunity to study the evolution of galaxies in dense environments over the last 2.26 Gyr. It is a dynamically active, merging system with discrete mass components as revealed by substructure in X-ray, lensing and near-infrared maps of this cluster (Haines et al. [2010]). The galaxy alignment appears to be stronger towards the centre and is mostly present among the fainter galaxies, whereas bright galaxies are unaligned (Hung et al. [2010]). The luminosity function shows a steep red faint end upturn, suggesting that the least massive galaxies are just being quenched at this epoch (Bañados et al. [2010]). Moreover, the cluster population shows two distinct populations: two-thirds are unremarkable blue, late-type spirals; the remainder, found only in the cluster outskirts, are dusty red-sequence galaxies whose star formation is heavily obscured. There is also an excess of 100-µm-selected galaxies that extend ∼6 Mpc in length along an axis that runs NE–SW through the cluster centre (Balogh et al. [2002]; Haines et al. [2010]).

This is the third paper in a series on Abell 1689, and a fourth one is in preparation. Houghton et al. ([2012], hereafter Paper I) present the imaging and spectroscopy of the cluster and analyse the Faber–Jackson, Kormendy and colour–magnitude relations, based on data from the Advanced Camera for Surveys (ACS) on the *Hubble Space Telescope (HST)* and the Gemini Multi-Object Spectrograph on the Gemini North telescope (GMOS-N). D'Eugenio et al. ([2013], hereafter Paper II) present integral field spectroscopy of a sample of galaxies observed with the Fibre Large Array Multi Element Spectrograph (FLAMES) at the Very Large Telescope, European Southern Observatory (ESO), and investigate their internal kinematics. In this paper, we analyse the photometry of 65 galaxies at the centre of Abell 1689, perform two-dimensional multicomponent surface-brightness decompositions, provide a morphological classification and derive the FP relationship for the ETGs (i.e. ellipticals or lenticulars) using different photometric models. In Paper IV (in preparation), we will provide a deep interpretation of the FP by measuring accurate dynamical masses of the sample galaxies observed with FLAMES and ACS.

This work is organized as follows. The sample selection is presented in Section 2. The photometric analysis is described in Section 3. The morphological classification is discussed in Section 4. In Section 5, the FP is derived, and the results are compared to the local FP. In Section 6, we draw our conclusions. We assume $H_0 = 71 \, \mathrm{km \, s^{-1} \, Mpc^{-1}}$, $\Omega_\mathrm{m} = 0.27$ and $\Omega_\Lambda = 0.73$, following the seven-year *Wilkinson Microwave Anisotropy Probe* (WMAP7) cosmology (Komatsu et al. [2011]), as in Paper I.

## 2 SAMPLE

In this investigation, we used images from *HST* ACS. We downloaded the data, originally obtained for program GO-9289 (PI: H. Ford), from MAST.[1] The images are from the Wide Field Channel (WFC) with the *F625W* filter, which approximates the Sloan Digital Sky Survey (SDSS)-*r* filter and is nearly equivalent to rest-frame *V* band at the redshift of Abell 1689 ($z = 0.183$). Our data reduction procedures are described in Paper I.

We performed a photometric analysis of 65 galaxies, i.e. 54 galaxies from the spectroscopic sample and 11 from the ancillary sample, as described below.

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[1] Mikulsi Archive for Space Telescopes at the Space Telescope Science Institute.

The primary sample we selected are galaxies from Paper I that were observed with GMOS-N plus those that were observed with FLAMES from Paper II. The field of view of the ACS/WFC/*F625W* image contains 43 galaxies from Paper I and 29 galaxies from Paper II. The two samples have 18 galaxies in common, so our entire spectroscopic sample consists of 54 individual galaxies.

We performed a two-dimensional photometric decomposition of the spectroscopic sample. This also required photometric analysis of 11 additional galaxies that affect the surface-brightness distribution of some of the spectroscopic sample galaxies on account of their proximity (Section 3.2). These 11 galaxies were therefore modelled with the aim of subtracting their two-dimensional surface-brightness distributions to improve the fits for the primary sample. We provide the derived parameters of our photometric decomposition as ancillary data.

Visual inspection of the images of the spectroscopy sample reveals that 41 are ETGs and 13 are late-type galaxies (LTGs; i.e. spirals). We list galaxy names, coordinates, morphological classification and central stellar velocity dispersions $\sigma_\star$ (see Section. 5.1) of the spectroscopic sample in Table 1. Our visual inspection of the contaminating galaxies forming the ancillary sample reveals that nine galaxies are ETGs and two are LTGs (Table 2).

## 3 TWO-DIMENSIONAL SURFACE-BRIGHTNESS FITS

To perform a photometric decomposition of each galaxy, we used the code GASP2D, which is described in detail by Méndez-Abreu et al. ([2008], [2014]). Briefly, GASP2D assumes that the surface-brightness distribution of elliptical galaxies consists of a single bulge component, and that disc galaxies are the sum of a bulge, a disc and, if necessary, a bar component. Each structure has elliptical and concentric isophotes with constant ellipticity, $\epsilon = 1 - q$, and constant position angle (PA). This algorithm has been used successfully to model ellipticals and brightest cluster galaxies (e.g. Ascaso et al. [2011]), unbarred and barred disc galaxies (e.g. Morelli et al. [2012]), active galaxies with an unresolved component (e.g. Benítez et al. [2013]), high-*z* galaxies (Zanella et al. [2016]) and, more recently, the large sample of galaxies from the Calar Alto Legacy Integral Field Area Data Release 3 (CALIFA-DR3, Méndez-Abreu et al. [2017]).

### 3.1 Photometric model

For ellipticals and bulge components, we adopt the Sérsic ([1963]) law, i.e.

$$I_\mathrm{b}(r) = I_\mathrm{e} \, e^{-b_n\left[(r/r_\mathrm{e})^{1/n} - 1\right]}, \tag{1}$$

where $r_\mathrm{e}$, $I_\mathrm{e}$ and $n$ are the effective (or half-light) radius, the surface brightness at $r_\mathrm{e}$ and a shape parameter describing the curvature of the surface-brightness profile, respectively. The value of $b_n$ is coupled to $n$ so that half of the total luminosity of the bulge is within $r_\mathrm{e}$ and can be approximated as $b_n = 2n - 0.324$ (Ciotti [1991]). The total luminosity of the bulge is

$$L_\mathrm{bulge} = 2\pi I_{0,\mathrm{bulge}} \, n \, r_\mathrm{e}^2 \frac{\Gamma(2n)}{b_n^{2n}} \, q_\mathrm{bulge}, \tag{2}$$

where $I_{0,\mathrm{bulge}} = I_\mathrm{e} \, 10^{b_n}$ is the central surface brightness of the bulge, $q_\mathrm{bulge}$ is the bulge axial ratio and $\Gamma$ is the Euler gamma function.

We consider as a special case the de Vaucouleurs ([1948]) law, which is essentially equation (1) with a fixed value of the Sérsic index $n = 4$.

**Table 1.** Spectroscopic sample.

| | Galaxy ID | RA (h m s) | Dec. (° ′ ″) | Type | Data | $\sigma_\star$ (km s$^{-1}$) | FP sample |
|---|---|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| S01 | 286, – | 13 11 23.09 | −1 21 17.1 | Late | G | 150.7 ± 2.9 | No |
| S02 | 341, 28 | 13 11 24.47 | −1 21 10.9 | Early | G,F | 190.5 ± 3.6 | Yes |
| S03 | 368, – | 13 11 25.39 | −1 20 36.8 | Late | G | 167.1 ± 3.3 | No |
| S04 | 371, – | 13 11 25.41 | −1 20 17.0 | Early | G | 166.9 ± 6.5 | Yes |
| S05 | 390, 30 | 13 11 25.96 | −1 19 51.7 | Early | G,F | 171.5 ± 3.3 | Yes |
| S06 | 398, 14 | 13 11 26.24 | −1 19 56.3 | Early | G,F | 280.2 ± 4.7 | Yes |
| S07 | 433, – | 13 11 26.93 | −1 19 40.5 | Early | G | 67.7 ± 11.8 | Yes |
| S08 | 435, 16 | 13 11 26.94 | −1 19 36.6 | Early | G,F | 151.7 ± 4.1 | Yes |
| S09 | 463, 13 | 13 11 27.43 | −1 20 2.3 | Early | G,F | 182.7 ± 3.6 | Yes |
| S10 | 476, – | 13 11 27.86 | −1 20 7.5 | Early | G | 260.4 ± 5.1 | Yes |
| S11 | 481, – | 13 11 27.94 | −1 21 36.5 | Early | G | 143.8 ± 4.1 | Yes |
| S12 | 501, – | 13 11 28.25 | −1 20 43.3 | Late | G | 149.1 ± 4.8 | No |
| S13 | 508, – | 13 11 28.39 | −1 19 58.3 | Late | G | 126.9 ± 5.5 | No |
| S14 | 514, 29 | 13 11 28.48 | −1 20 24.9 | Early | G,F | 179.5 ± 2.3 | Yes |
| S15 | 531, – | 13 11 28.78 | −1 19 2.4 | Late | G | 101.5 ± 6.8 | No |
| S16 | 549, 10 | 13 11 29.04 | −1 21 16.6 | Early | G,F | 220.3 ± 2.9 | Yes |
| S17 | 567, 17 | 13 11 29.35 | −1 19 16.4 | Early | G,F | 250.4 ± 3.8 | No |
| S18 | 584, 12 | 13 11 29.52 | −1 20 27.8 | Early | G,F | 270.2 ± 5.0 | Yes |
| S19 | 593, – | 13 11 29.79 | −1 21 0.5 | Early | G | 131.9 ± 3.2 | Yes |
| S20 | 601, – | 13 11 29.91 | −1 20 14.9 | Early | G | 109.3 ± 6.7 | Yes |
| S21 | 610, 9 | 13 11 30.02 | −1 20 39.9 | Late | G,F | 122.1 ± 2.3 | No |
| S22 | 635, – | 13 11 30.42 | −1 20 45.2 | Early | G | 255.0 ± 3.6 | Yes |
| S23 | 636, – | 13 11 30.43 | −1 20 34.7 | Early | G | 152.6 ± 5.5 | Yes |
| S24 | 645, – | 13 11 30.62 | −1 20 43.5 | Early | G | 175.9 ± 4.5 | Yes |
| S25 | 655, – | 13 11 30.84 | −1 20 30.5 | Early | G | 151.5 ± 3.4 | Yes |
| S26 | 670, 25 | 13 11 31.14 | −1 21 27.6 | Early | G,F | 240.9 ± 4.4 | Yes |
| S27 | 677, – | 13 11 31.17 | −1 21 24.9 | Early | G | 185.8 ± 5.9 | Yes |
| S28 | 690, 5 | 13 11 31.45 | −1 19 32.5 | Early | G,F | 285.0 ± 2.4 | Yes |
| S29 | 698, – | 13 11 31.57 | −1 19 24.4 | Late | G | 94.0 ± 5.6 | No |
| S30 | 717, 18 | 13 11 32.04 | −1 19 24.1 | Early | G,F | 182.5 ± 3.9 | Yes |
| S31 | 723, 24 | 13 11 32.14 | −1 21 37.9 | Early | G,F | 183.4 ± 3.8 | Yes |
| S32 | 724, – | 13 11 32.14 | −1 19 36.0 | Late | G | 37.2 ± 13.1 | No |
| S33 | 726, – | 13 11 32.16 | −1 19 46.5 | Late | G | 218.0 ± 2.6 | No |
| S34 | 753, 6 | 13 11 32.71 | −1 19 58.3 | Early | G,F | 312.6 ± 2.6 | Yes |
| S35 | 755, – | 13 11 32.72 | −1 20 58.2 | Early | G | 92.8 ± 6.5 | Yes |
| S36 | 756, 19 | 13 11 32.76 | −1 19 31.4 | Early | G,F | 266.9 ± 3.1 | Yes |
| S37 | 814, – | 13 11 34.10 | −1 21 1.7 | Late | G | 130.1 ± 3.9 | No |
| S38 | 816, – | 13 11 34.13 | −1 21 18.4 | Early | G | 114.8 ± 3.4 | Yes |
| S39 | 848, 22 | 13 11 34.81 | −1 20 59.0 | Early | G,F | 185.7 ± 3.4 | Yes |
| S40 | 852, 21 | 13 11 34.91 | −1 20 4.2 | Early | G,F | 116.7 ± 3.1 | Yes |
| S41 | 874, – | 13 11 35.40 | −1 21 33.0 | Early | G | 205.9 ± 2.7 | Yes |
| S42 | 883, – | 13 11 35.65 | −1 20 12.0 | Late | G | 49.2 ± 8.2 | No |
| S43 | 906, – | 13 11 36.68 | −1 19 42.5 | Late | G | 37.2 ± 9.3 | No |
| S44 | –, 1 | 13 11 28.14 | −1 19 31.4 | Early | F | 236.8 ± 6.6 | Yes |
| S45 | –, 2 | 13 11 28.07 | −1 18 43.6 | Early | F | 93.8 ± 4.8 | Yes |
| S46 | –, 3 | 13 11 29.44 | −1 18 34.4 | Early | F | 198.9 ± 5.6 | Yes |
| S47 | –, 4 | 13 11 31.92 | −1 18 53.5 | Early | F | 101.5 ± 6.3 | Yes |
| S48 | –, 7 | 13 11 34.82 | −1 19 24.3 | Early | F | 129.1 ± 4.3 | Yes |
| S49 | –, 8 | 13 11 30.32 | −1 20 29.0 | Early | F | 223.7 ± 3.3 | Yes |
| S50 | –, 11 | 13 11 27.88 | −1 21 12.7 | Late | F | 112.3 ± 4.0 | No |
| S51 | –, 15 | 13 11 25.14 | −1 19 30.8 | Early | F | 161.1 ± 5.9 | Yes |
| S52 | –, 23 | 13 11 31.12 | −1 20 52.4 | Early | F | 181.4 ± 5.6 | Yes |
| S53 | –, 26 | 13 11 30.10 | −1 20 42.6 | Early | F | 250.0 ± 5.9 | Yes |
| S54 | –, 27 | 13 11 30.07 | −1 20 28.3 | Early | F | 231.7 ± 6.1 | Yes |

*Note.* Column (1): galaxy ID from this paper. Column (2): galaxy ID from Paper I and/or from Paper II. Column (3): right ascension (J2000.0). Column (4): declination (J2000.0). Column (5): Early-/late-type classification. Column (6): spectroscopic data available, GMOS-N (G) and/or FLAMES (F). Column (7): central stellar velocity dispersion and its $1\sigma$ error. Column (8): sample adopted in FP analysis.

**Table 2.** Ancillary sample.

| Galaxy ID | RA (h m s) | Dec. (° ′ ″) | Type |
|---|---|---|---|
| (1) | (2) | (3) | (4) |
| A01 | 13 11 27.27 | −1 20 09.7 | Late |
| A02 | 13 11 30.26 | −1 20 51.6 | Early |
| A03 | 13 11 31.03 | −1 21 27.6 | Early |
| A04 | 13 11 28.38 | −1 18 44.6 | Early |
| A05 | 13 11 28.08 | −1 19 28.1 | Early |
| A06 | 13 11 24.21 | −1 21 07.4 | Late |
| A07 | 13 11 30.95 | −1 20 27.6 | Early |
| A08 | 13 11 30.05 | −1 20 17.1 | Early |
| A09 | 13 11 29.81 | −1 20 19.6 | Early |
| A10 | 13 11 28.65 | −1 20 26.3 | Early |
| A11 | 13 11 29.20 | −1 21 20.5 | Early |

*Note.* Column (1): galaxy ID (Fig. 1). Column (2): right ascension (J2000.0). Column (3): declination (J200.0). Column (4): Early-/Late-type classification.

We describe the surface brightness of the disc component by an exponential law (Freeman 1970),

$$I_{\mathrm{d}}(r) = I_{0,\mathrm{disc}}\, e^{-r/h}, \tag{3}$$

where $I_{0,\mathrm{disc}}$ and $h$ are the central surface brightness and scalelength of the disc, respectively. The total luminosity of the disc is

$$L_{\mathrm{disc}} = 2\pi I_{0,\mathrm{disc}}\, h^2\, q_{\mathrm{disc}}, \tag{4}$$

where $q_{\mathrm{disc}}$ is the disc axial ratio.

We adopt the radial surface-brightness profile of a Ferrers (1877) ellipsoid to describe bar components,

$$I_{\mathrm{bar}}(r) = \begin{cases} I_{0,\mathrm{bar}}\left[1 - \left(\frac{r}{r_{\mathrm{bar}}}\right)^2\right]^{n_{\mathrm{bar}}+0.5} & r \le r_{\mathrm{bar}} \\ 0 & r > r_{\mathrm{bar}}, \end{cases} \tag{5}$$

where $I_{0,\mathrm{bar}}$, $r_{\mathrm{bar}}$ and $n_{\mathrm{bar}}$ are the central surface brightness, length and shape parameter of the surface-brightness profile of the bar, respectively. The total luminosity of the bar is

$$L_{\mathrm{bar}} = \pi\, I_{0,\mathrm{bar}}\, r_{\mathrm{bar}}^2\, \frac{\Gamma(n_{\mathrm{bar}}+1.5)}{\Gamma(n_{\mathrm{bar}}+2.5)}\, q_{\mathrm{bar}}, \tag{6}$$

where $q_{\mathrm{bar}}$ is the bar axial ratio. We chose to fix the $n_{\mathrm{bar}}$ parameter at $n_{\mathrm{bar}} = 2$, following Laurikainen, Salo & Buta (2005). The total luminosity of the bar for $n_{\mathrm{bar}} = 2$ is

$$L_{\mathrm{bar}} = \pi\, I_{0,\mathrm{bar}} r_{\mathrm{bar}}^2\, \frac{\Gamma(7/2)}{\Gamma(9/2)}\, q_{\mathrm{bar}}. \tag{7}$$

### 3.2 Fitting procedure

We performed multiple fits of the sky-subtracted images of the galaxies. Specifically, each ETG was fitted as follows:

(i) as a single bulge component following a de Vaucouleurs profile (fits hereafter referred to as `deVauc`);

(ii) as a single bulge component following a Sérsic profile, (hereafter `Sérsic`);

(iii) as a sum of a bulge following a Sérsic profile, and a disc component (hereafter `SeDisc`);

(iv) when a bar is present, also as a sum of a bulge following a Sérsic profile, a disc and a bar component (hereafter `SeDiBar`).

Each LTG was fitted with a `SeDisc` model, or a `SeDiBar` model in cases where a bar was detected.

Since GASP2D accounts for seeing effects, for each galaxy we used an appropriate PSF, whose details are given in Paper I.

The choice of the region in which we perform the $\chi^2$ minimization (see Méndez-Abreu et al. 2008 for details on the minimization algorithm) is a crucial issue. After extensive testing with mock galaxies, we concluded that the most-suitable maximum fitting radius, $r_{\mathrm{max}}$, is where $I(r_{\mathrm{max}}) = 1.5\,\sigma_{\mathrm{sky}}$. Indeed, we created artificial galaxies as described in Section 3.3, and performed photometric decompositions to a limit surface brightness of $0.1\,\sigma_{\mathrm{sky}}$, $0.25\,\sigma_{\mathrm{sky}}$, $0.50\,\sigma_{\mathrm{sky}}$, $0.75\,\sigma_{\mathrm{sky}}$, $1.0\,\sigma_{\mathrm{sky}}$,..., and $4.5\,\sigma_{\mathrm{sky}}$. We then analysed the distribution of the errors on the parameters (as in Section 3.3). Extending the fitting area to pixels where the sky noise dominates over the surface brightness of the galaxy leads to significant systematic errors in the fitted photometric parameters. In particular, it leads to an overestimate of $r_{\mathrm{e}}$ and Sérsic index $n$, if a single Sérsic component is fitted, and an overestimate of $r_{\mathrm{e}}$, $n$, and also the scalelength $h$, if a sum of Sérsic and exponential components are fitted. In both cases, the size of the galaxy is overestimated. On the other hand, if the fit is performed within a region that is too restricted, the size of the galaxy derived from the photometric decomposition is underestimated. We find that thorough testing to identify the optimal maximum fitting radius is essential for avoiding potentially severe systematic errors in scaling relations involving galaxy sizes.
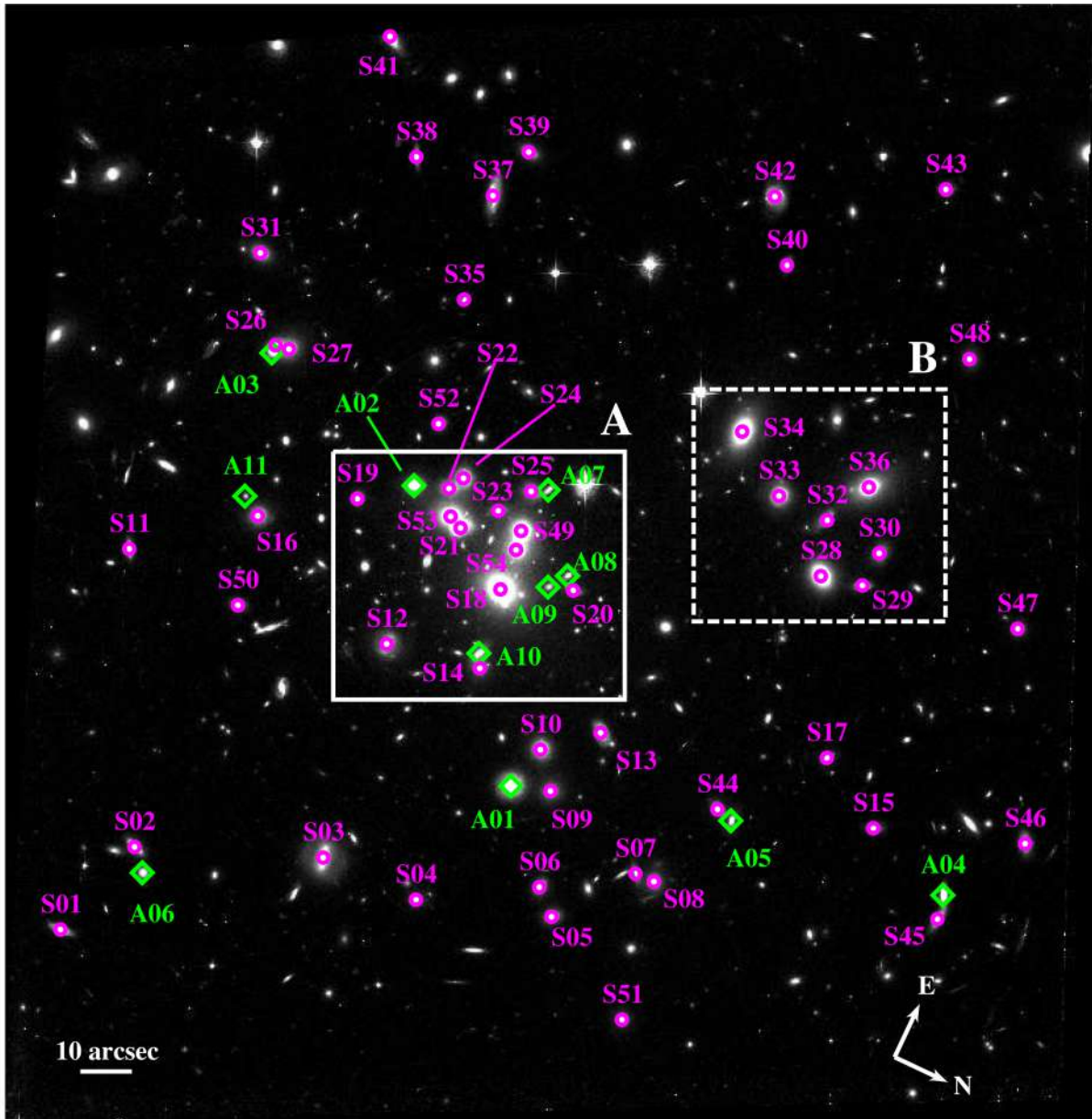
It is challenging to fit the surface-brightness distributions of galaxies that overlap. Each of these galaxies consequently has an underlying surface-brightness gradient that is due to its neighbours, and cannot be neglected. It must be treated as extra background light that must be removed. Although GASP2D is able to fit multiple galaxies simultaneously, dealing with more than two galaxies at once leads to degeneracy in the fit parameters. Therefore, for each galaxy, we took into account contamination due to the neighbours by subtracting their surface-brightness models in an iterative way.

The proximity problem is particularly onerous in two dense regions of the cluster, marked 'A' and 'B' in Fig. 1. Region A, which is the centre of the cluster with a surface area of $\sim 0.5$ arcmin$^2$, includes 13 of our galaxies. As noted in Section 2, we fitted 11 ancillary galaxies in the field of view whose surface brightness affects the sample galaxies and whose photometric decomposition is presented in this paper. Five of these additional galaxies are in region A. We thus modelled the central 18 galaxies in the following iterative fashion:
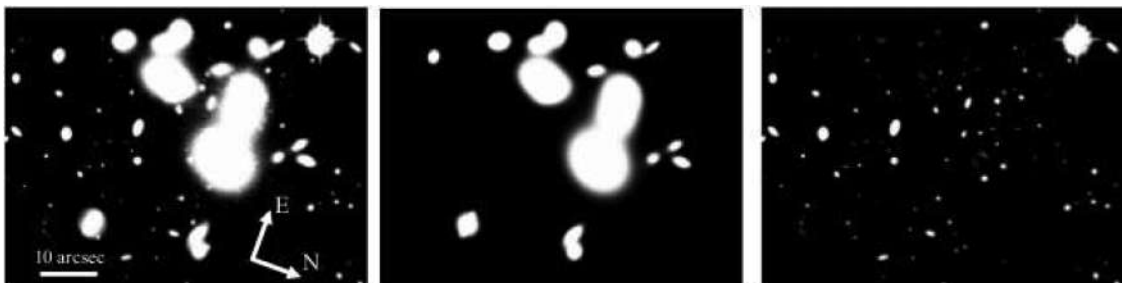
(i) Fit the central cD galaxy (galaxy S18) and subtract its model.

(ii) Fit the outer less contaminated galaxies and subtract their models.

(iii) Proceeding inwards, fit the less contaminated galaxies and subtract their models.[2]

(iv) Repeat the previous step until the sample is complete.

(v) Repeat steps (i)–(iv) for each galaxy. Each fit is performed on the observed image from which the models of the surrounding galaxies from the most recent iteration are subtracted, leaving a final image that contains only the galaxy currently being modelled.

Step (v) is repeated until consistent values of fitted parameters for the whole central sample are obtained. For region A, we performed step (v) six times to obtain convergence. The comparison between the observed surface-brightness distributions of the 18 galaxies in the centre of Abell 1689 and their models is shown in Fig. 2.

[2] For each galaxy, we fitted a `Sérsic`, `SeDisc`, and, in cases where a bar is present, `SeDiBar`, and then chose the model that best describes the surface-brightness distribution of the galaxy, particularly in its outer regions, by visual inspection of the residuals images.

**Figure 1.** ACS/WFC/*F625W* image of Abell 1689. The white continuous and dashed frames highlight the regions A and B where the photometric decomposition was particularly challenging due to the light contamination of the crowded galaxies. Magenta circles mark the spectroscopic sample and green diamonds mark the ancillary sample. The linear scale and orientation are shown.



**Figure 2.** Left-hand panel: centre of Abell 1689, corresponding to region A of Fig. 1. Centre panel: synthetic image of region A, resulting from the composition of the modelled surface-brightness distribution of the 18 brightest galaxies. Right-hand panel: residual (observed − modelled) image of region A. The grey-scale, linear scale and orientation used for the panels are kept the same. Linear scale and orientation are shown on the left-hand panel.

We then subtracted from the whole observed ACS/WFC/*F625W* image the models of the 18 galaxies and used the resulting image to fit the seven galaxies in region B. We used the same iterative method described above, starting with the most extended galaxy (galaxy S34).

Finally, we subtracted from the original observed image the models of the 25 galaxies fitted in regions A and B, and used the resulting image to fit the rest of the sample galaxies. We adopted the iterative method described above for a few sub-groups of three or four galaxies. When the iterative process converged, we cut a frame for each sample galaxy and used it for the final fits. In all cases, the individual frames were large enough to include the entire region defined by $r_{max}$.

We were able to fit all the galaxies with the exception of S17. In this case, inspection reveals the presence of an edge-on disc, for which a thick-disc model is required. GASP2D is not yet able to fit a thick-disc model, so only deVauc and Sérsic fits of S17 were performed.

### 3.3 Error estimates

To estimate the errors on the fitted parameters, we ran a series of Monte Carlo simulations. For every fit type – deVauc, Sérsic, SeDisc and SeDiBar – we created 250 artificial galaxies characterized by parameters appropriate to the specific model. Simulations were carried out in one-magnitude bins, and five bins were required to cover the luminosity range of our sample. Thus, for each fit type, about 1250 artificial galaxies were created. Each parameter $p_i$ was randomly chosen in the range $p_{min} - 0.3 p_{min} < p_i < p_{max} + 0.3 p_{max}$, where $p_{min}$ and $p_{max}$ are the minimum and maximum values of the fitted parameter on the real images in that particular magnitude bin.

The size of each artificial frame is $700 \times 700$ pixel$^2$, equivalent to $21 \times 21$ arcsec$^2$ (pixel scale $= 0.03$ arcsec pixel$^{-1}$). This is large enough to enclose $r_{max}$ for all fits. We separately produced 250 mock galaxies in frames of $1600 \times 1600$ pixel$^2$, equivalent to $48 \times 48$ arcsec$^2$, to run simulations for the central cD galaxy. All the synthetic galaxies were convolved with a PSF that was randomly chosen from those produced for the fits to the observed image. The pixel scale, CCD gain and read-out-noise of the artificial images match those of the real *HST*/ACS/*F625W* image. In addition, we added photon noise in order to obtain a signal-to-noise ratio consistent with that of the original image.

We then ran the GASP2D two-dimensional parametric decomposition as described above to analyse the images of the mock galaxies. We studied the distribution of the relative errors on the parameters as $(p_{output}/p_{input} - 1)$. For PAs and axis ratios, we derived the absolute errors, $(p_{output} - p_{input})$. All the distributions appear to be nearly Gaussian. We measured the median and absolute deviation of each distribution and applied $5\sigma$-clipping to reject outliers. Median values were used to detect the possible presence of systematic errors, and the absolute deviations were used to derive the errors on the single parameters. We did not identify any systematic errors, as all median values are consistent with zero.

In Table A1, we present the best-fitting observed parameters with their errors for the whole sample, adopting Sérsic, SeDisc and SeDiBar models according to the morphological classification presented in Section 4. In Figs A1–A64, we show the corresponding GASP2D fits. We give the results of the photometric decomposition of the ETGs of the spectroscopic sample with deVauc and Sérsic models in Tables A2 and A3, respectively.

## 4 MORPHOLOGICAL CLASSIFICATION

We were able to distinguish between ETGs and LTGs by visual inspection, as mentioned in Section 2, because the presence of spiral arms is clearly detectable, given the high signal-to-noise ratio and spatial resolution of the data.

Nevertheless, on the basis of visual inspection alone, it is not always possible to distinguish among ellipticals (E), unbarred lenticulars (S0) and possibly barred lenticulars (SB0), or to distinguish between spirals (S) and barred spirals (SB). This necessitates a more sophisticated and quantitative approach. We therefore made use of the multicomponent photometric decompositions and use the isophotal parameters derived in our fits to check for signatures of bars and discs. Barred galaxies are characterized by the presence of a local maximum in the ellipticity radial profile and constant PA in the bar region (e.g. Aguerri, Méndez-Abreu & Corsini 2009). A disc component is characterized by an exponential surface-brightness radial profile with constant ellipticity and PA.

By the combination of visual inspection and analysis of the isophotal parameters, we are able to detect with confidence the presence of a bar and therefore classify a galaxy as spiral (S), barred spiral (SB) or barred lenticular (SB0).

A more difficult problem arises when we need to distinguish between an E and S0, i.e. detect the presence of a disc. We note that for an E or S0, a Sérsic model is always a poorer fit than a SeDisc model, as the former has seven free parameters (i.e. $I_e$, $r_e$, $n$, $\epsilon_b$, PA$_b$, and the centre $x_0$, $y_0$) and the latter has four more ($I_0$, $h$, $\epsilon_d$, PA$_d$). We therefore conservatively classify a galaxy as an S0 only if we can associate the fitted exponential component to a real structure of the galaxy and not use it just as a mathematical expedient (see also Fritz et al. 2005; Méndez-Abreu et al. 2017).

For each candidate E or S0 galaxy, we visually examined the ellipse-averaged radial profile of the surface brightness, ellipticity and PA. We also compared the Sérsic and SeDisc fits, and closely inspected the modelled and residual images, as the latter are particularly useful for detection of any structured residual of the galaxy. If an outer exponential component is present, the galaxy is classified as S0. If no outer exponential is detected or the result is ambiguous, the galaxy is classified as S0 if both the ellipticity and PA radial profiles are better fitted with a SeDisc, otherwise the galaxy is classified as E. No additional spiral galaxies were detected from the analysis of the residuals of the photometric decomposition.

The method used to classify the galaxies is shown in the flowchart in Fig. 3. We further subclassified the ellipticals as E$n$, where $n$ is the integer approximating the value $10 \times (1 - q_{bulge})$ and $0 < n < 6$, following the van den Bergh (1976) classification. For unbarred and barred S0s and spirals, we also used the subclasses 'a, b and c' (van den Bergh 1976) on the basis of the disc-to-bulge luminosity ratio (Kormendy & Bender 2012, Kormendy, private communication).

Galaxy S18 is a cD, a giant elliptical with a typical extended envelope that is very well fit by an exponential component. Thus, its total surface-brightness distribution is best fitted by a SeDisc model.

The morphological classification of the galaxies and the features that allow us to discriminate among the different classes are shown in Table 3. Ellipticals are better fitted by a Sérsic model, S0s and Ss by a SeDisc model, and SB0s and SBs by a SeDiBar model. The deVauc model provides poorer fits of our ETGs than the Sérsic model, given that typically, Sérsic indices $n \neq 4$.
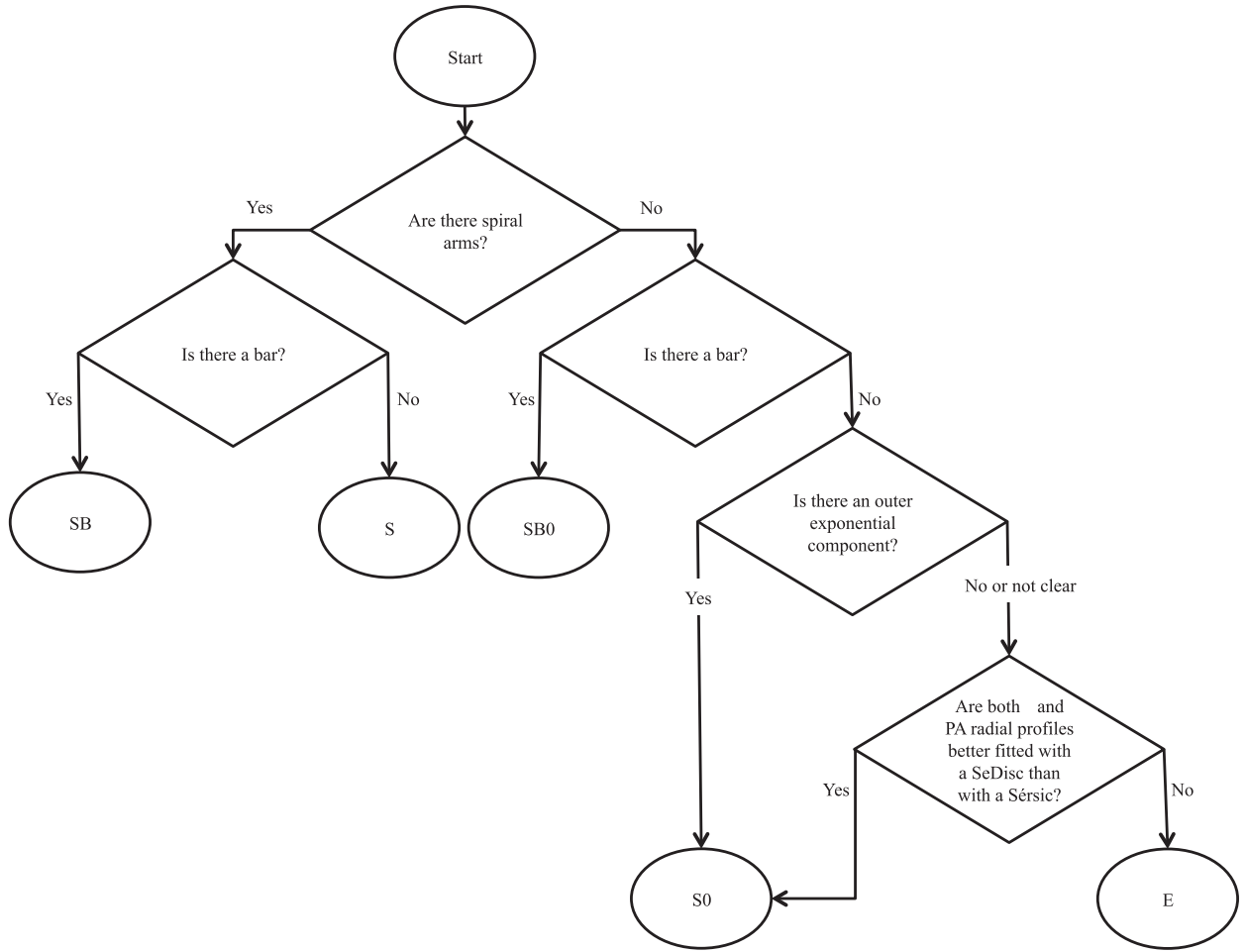
**Figure 3.** Flowchart describing the method applied to classify the galaxies.

## 5 FP ANALYSIS

The sample analysed to determine the FP coefficients for Abell 1689 is composed of the ETGs of the spectroscopic sample with successful photometric decomposition. Only galaxy S17 is excluded from this analysis on account of its edge-on disc component (Section 3.2), so the total sample used in the FP analysis consists of the 40 galaxies listed in Table 1.

### 5.1 Central stellar velocity dispersions

We use central stellar velocity dispersions $\sigma_\star$ from Paper I, which are already corrected to a standard projected aperture of 1.62 kpc, equivalent to 3.4 arcsec at the distance of the Coma galaxy cluster (Jorgensen, Franx & Kjaergaard 1995b). Stellar velocity dispersions of the sample galaxies from Paper II were re-extracted for this study from the FLAMES/GIRAFFE spectra using a synthetic circular aperture that projects to 1.62kpc and adjusting the seeing to that of the GMOS-N data (FWHM $\approx$ 1 arcsec). For the 18 galaxies for which we have both GMOS-N and re-extracted FLAMES measurements, we take $\sigma_\star$ to be the weighted mean of the two values. The comparison between GMOS-N, re-extracted FLAMES, and mean velocity dispersions is shown in Fig. 4. The average difference between GMOS-N and FLAMES stellar velocity dispersion values, $\langle \sigma_{\text{GMOS-N}, i} - \sigma_{\text{FLAMES}, i} \rangle = 4.3 \, \text{km s}^{-1}$, that is within the mean $1\sigma$ error in the velocity dispersion ($\langle 1\sigma_{\text{FLAMES}} \rangle = 5.9 \, \text{km s}^{-1}$

and $\langle 1\sigma_{\text{GMOS-N}} \rangle = 4.4 \, \text{km s}^{-1}$). For this reason, we conclude that the two sets of data are consistent. The values of $\sigma_\star$ adopted for this analysis are given in Table 1.

### 5.2 FP fits of Abell 1689 ETGS

We use the fitting algorithm `LTS_PLANEFIT` described by Cappellari et al. (2013), which combines the robust Least Trimmed Squares technique of Rousseeuw & van Driessen (2006) with a least-squares fitting algorithm that allows for errors in all variables as well as intrinsic scatter. The best-fitting plane is defined as $z = a + b(x - x_0) + c(y - y_0)$, where $x_0$ and $y_0$ are the median of the measured values $x_j$ and $y_j$, respectively. The intrinsic scatter, $\epsilon_z$, is in the $z$-coordinate and defined in section 3.2.1 of Cappellari et al. (2013, equation 7 and following paragraph). The observed scatter, $\Delta$, is defined as the standard deviation of $[a + b(x_j - x_0) + c(y_j - y_0) - z_j]$, where $x_j$, $y_j$ and $z_j$ are the fitted data values. In all our fits, we set the clipping parameter to $5\sigma$, which results in no rejections of galaxies. Our choice of a large clipping parameter is driven by two considerations: (i) we have carefully checked each individual galaxy while performing the photometric decomposition and find no physical reason to exclude any galaxy, and (ii) for a direct comparison of the FP fits for different photometric models, we want the sample of galaxies to be the same in each case. The central cD galaxy S18 could be considered an 'outlier' for

**Table 3.** Morphological classification of the sample galaxies.

| Galaxy ID | Type | Spiral arms | Bar | Exp. component | $\varepsilon$ | PA |
|---|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| *Spectroscopic sample* | | | | | | |
| S01 | Sb | Y | N | | | |
| S02 | S0b | N | N | Y | | |
| S03 | SBbc | Y | Y | | | |
| S04 | E2 | N | N | N | N | N |
| S05 | E2 | N | N | N | N | N |
| S06 | E4 | N | N | N | Y | N |
| S07 | S0b | N | N | Y | | |
| S08 | S0ab | N | N | not clear | Y | Y |
| S09 | S0ab | N | N | Y | | |
| S10 | S0ab | N | N | Y | | |
| S11 | S0b | N | N | Y | | |
| S12 | SBb | Y | Y | | | |
| S13 | Sb | Y | N | | | |
| S14 | S0ab | N | N | Y | | |
| S15 | SBbc | Y | Y | | | |
| S16 | S0ab | N | N | Y | | |
| S17 | S0 | N | N | Y | | |
| S18 | cD | N | N | Y | | |
| S19 | S0ab | N | N | Y | | |
| S20 | SB0bc | N | Y | | | |
| S21 | SBbc | Y | Y | | | |
| S22 | S0ab | N | N | Y | | |
| S23 | S0ab | N | N | not clear | Y | Y |
| S24 | S0b | N | N | Y | | |
| S25 | SB0ab | N | Y | | | |
| S26 | S0ab | N | N | Y | | |
| S27 | E1 | N | N | not clear | Y | N |
| S28 | E2 | N | N | N | N | N |
| S29 | Sbc | Y | N | | | |
| S30 | S0a | N | N | Y | | |
| S31 | E3 | N | N | N | N | N |
| S32 | Sb | Y | N | | | |
| S33 | Sb | Y | N | | | |
| S34 | S0ab | N | N | Y | | |
| S35 | S0ab | N | N | Y | | |
| S36 | S0ab | N | N | Y | | |
| S37 | SBc | Y | Y | | | |
| S38 | S0ab | N | N | Y | | |
| S39 | SB0ab | N | Y | | | |
| S40 | S0b | N | N | Y | | |
| S41 | S0b | N | N | Y | | |
| S42 | Sc | Y | N | | | |
| S43 | SBc | Y | Y | | | |
| S44 | S0b | N | N | Y | | |
| S45 | S0b | N | N | Y | | |
| S46 | S0ab | N | N | Y | | |
| S47 | S0ab | N | N | Y | | |
| S48 | SB0ab | N | Y | | | |
| S49 | S0ab | N | N | not clear | Y | Y |
| S50 | SBb | Y | Y | | | |
| S51 | S0a | N | N | not clear | Y | Y |
| S52 | S0b | N | N | Y | | |
| S53 | S0b | N | N | Y | | |
| S54 | S0b | N | N | not clear | Y | Y |
| *Ancillary sample* | | | | | | |
| A01 | Sc | Y | N | | | |
| A02 | S0b | N | N | Y | | |
| A03 | S0ab | N | N | not clear | Y | Y |
| A04 | S0bc | N | N | Y | | |
| A05 | E5 | N | N | N | N | N |
| A06 | Sab | Y | N | | | |
| A07 | S0b | N | N | Y | | |
| A08 | S0ab | N | N | Y | | |
| A09 | E2 | N | N | not clear | N | N |
| A10 | S0ab | N | N | Y | | |
| A11 | S0bc | N | N | Y | | |

*Note.* Column (1): galaxy ID (Fig. 1). Column (2): morphological type. Column (3): presence of spiral arms. Column (4): presence of a bar. Column (5): presence of an outer exponential component. Column (6): $\epsilon$ radial profile better fitted with a `SeDisc` rather than a `Sérsic`. Column (7): PA radial profile better fitted with a `SeDisc` rather than a `Sérsic`.

**Figure 4.** Central stellar velocity dispersions from GMOS-N (red open circles) and FLAMES (black filled circles) versus the adopted $\sigma_\star$ values. The continuous line defines the one-to-one relation.

its peculiar surface-brightness distribution, but we find consistent results regardless of whether or not S18 is included in the sample.

*5.2.1 $\log \mathcal{R}_e$ as the dependent variable*

We first fitted the FP in the classical form (Djorgovski & Davis 1987),

$$\log \mathcal{R}_e = a + b \log \sigma_\star + c \log \langle I \rangle_e, \qquad (8)$$

where $\mathcal{R}_e = r_e(q_{bulge})^{1/2}$ is the circularized effective radius in kpc, $\sigma_\star$ is the central stellar velocity dispersion in km s$^{-1}$ (Section 5.1) and $\langle I \rangle_e = I_e \exp(b_n) \, n \, \Gamma(2n) \, b_n^{-2n}$ is the average surface brightness within the effective radius, in L$_\odot$ pc$^{-2}$. The conversion to L$_\odot$ pc$^{-2}$ is obtained from $I = 10^{-0.4(\mu - \mu_\odot)}$, where $\mu_\odot = 26.222$ mag arcsec$^{-2}$ is a constant depending on the absolute magnitude of the Sun in the observed passband. Each magnitude and surface brightness is corrected for Galactic extinction following Schlegel, Finkbeiner & Davis (1998), adopting an absorption $A = 0.073$ mag for the coordinates of Abell 1689 in the SDSS-*r* band. In each case, the surface brightness is also corrected for cosmological $(1 + z)^4$ dimming (Tolman 1930).

With the aim of comparing the FP coefficients derived by using different fits for the surface-brightness distributions of the galaxies, we perform the following fits, in which $\mathcal{R}_e$ and $\langle I \rangle_e$ are derived from the following:

(1) a `deVauc` model for all the galaxies;
(2) a `Sérsic` model for all the galaxies; and
(3) a Sérsic model for all galactic bulges, i.e. taken from a `Sérsic` model for Es, a `SeDisc` model for S0s and a `SeDiBar` model for SB0s.

We present FP coefficients along with intrinsic and observed scatter for the three fits in Table 4, and the corresponding plots are shown in Fig. 5. We note that the FP coefficients for different photometric models are not consistent.

We specify that we derived the FP corresponding to a `deVauc` model because it is usually done in literature, but with the warning that the `deVauc` model is not a good representation of the ETGs and does not provide very reliable values of $\mathcal{R}_e$ and $\langle I \rangle_e$. The FP derived by using a Sérsic model for all galactic bulges is the tightest, having a smaller intrinsic and observed scatter than the FP derived by adopting a `Sérsic` model.[3] From this, we conclude that the FP

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[3] We exclude from this comparison the FP derived by using a `deVauc` model, for the reasons explained above.

**Table 4.** FP COEFFICIENTS OF ABELL 1689 FOR DIFFERENT DEPENDENT VARIABLES AND PHOTOMETRIC MODELS.

| $z = a + b\,(x - x_0) + c\,(y - y_0)$ | | | | | | |
|---|---|---|---|---|---|---|
| a | b | c | $\epsilon_z$ | $\Delta$ | $x_0$ | $y_0$ |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| $\log \mathcal{R}_e = a + b\,(\log \sigma_\star - \log \sigma_{\star,0}) + c\,(\log \langle I \rangle_e - \log \langle I \rangle_{e,0})$ | | | | | $\log \sigma_{\star,0}$ | $\log \langle I \rangle_{e,0}$ |
| | | `deVauc` $\mathcal{R}_e$ | | | | |
| $0.468 \pm 0.012$ | $1.092 \pm 0.084$ | $-0.817 \pm 0.039$ | 0.072 | 0.073 | 2.262 | 2.576 |
| | | `Sérsic` $\mathcal{R}_e$ | | | | |
| $0.532 \pm 0.015$ | $1.057 \pm 0.104$ | $-0.680 \pm 0.033$ | 0.091 | 0.091 | 2.262 | 2.475 |
| | | `Sérsic` $\mathcal{R}_e$ of bulges | | | | |
| $0.065 \pm 0.013$ | $1.239 \pm 0.089$ | $-0.714 \pm 0.024$ | 0.070 | 0.079 | 2.262 | 3.054 |
| $\log \sigma_\star = a + b\,(\log \mathcal{R}_e - \log \mathcal{R}_{e,0}) + c\,(\log \langle I \rangle_e - \log \langle I \rangle_{e,0})$ | | | | | $\log \mathcal{R}_{e,0}$ | $\log \langle I \rangle_{e,0}$ |
| | | `deVauc` $\mathcal{R}_e$ | | | | |
| $2.209 \pm 0.010$ | $0.756 \pm 0.060$ | $0.635 \pm 0.054$ | 0.060 | 0.060 | 0.3996 | 2.576 |
| | | `Sérsic` $\mathcal{R}_e$ | | | | |
| $2.243 \pm 0.012$ | $0.704 \pm 0.069$ | $0.490 \pm 0.051$ | 0.074 | 0.076 | 0.5064 | 2.475 |
| | | `Sérsic` $\mathcal{R}_e$ of bulges | | | | |
| $2.227 \pm 0.010$ | $0.705 \pm 0.050$ | $0.504 \pm 0.039$ | 0.053 | 0.059 | 0.01504 | 3.054 |

*Note.* Column (1), column (2), and column (3): FP coefficients. Column (4): intrinsic scatter. Column (5): observed scatter (dex). Column (6) and column (7): median of the fitted $x_i$ and $y_i$ values, respectively. Values of $\mathcal{R}_e$ used to fit the FP are in kpc, $\sigma_{\star,0}$ in km s$^{-1}$, and $\langle I \rangle_{e,0}$ in L$_\odot$ pc$^{-2}$.

is defined by the bulges alone, rather than by the entire galaxies. This conclusion is strengthened by adding the bulges of the LTG sample; they all lie on the FP, with the exception of three galaxies (namely S32, S42, and S43) out of 13. These outliers are the galaxies with the lowest value of $\sigma_\star \sim 40$ km s$^{-1}$. According to Kormendy & Kennicutt (2004), they could be pseudo-bulges, which are similar to small discs (and therefore rotation supported) and made by slow evolution internal to galaxy discs. Indeed, the FP relation for elliptical and classical bulges holds till very low values of velocity dispersion (Costantin et al. 2017) and refers to pressure supported systems.

### 5.2.2 $\log \sigma_\star$ as the dependent variable

In the FP fits to the three models described above, only $\sigma_\star$ is a fixed parameter common to all three. We therefore repeat the fits using $\log \sigma_\star$ as the dependent variable, to see whether the minimization process leads to consistent best-fitting planes. We present the results in Table 4 and show the results in Fig. 6. Only the fits obtained by using `Sérsic` photometric models and Sérsic models of bulges are consistent. We confirm that, with $\log \sigma_\star$ as the dependent variable, the tightest FP is that derived by the Sérsic bulges. Again, the bulges of LTGs also lie on the FP, with the exception of the three galaxies with $\sigma_\star < 50$ km s$^{-1}$.

### 5.3 Comparison with local FPs

#### 5.3.1 Coma cluster

We first compare the FP we find for Abell 1689 with that derived for the Coma cluster by Jorgensen, Franx & Kjaergaard (1996, hereafter JFK96), which is based on an orthogonal fit. This is a classic comparison generally found in literature. For the sake of uniformity, we fit the Coma data with `LTS_PLANEFIT` and use $\log \mathcal{R}_e$ as the dependent variable, as in JFK96. We take $\sigma_\star$ from Jorgensen et al. (1995b) and photometric parameters in the Gunn-$r$ from Jorgensen, Franx & Kjaergaard (1995a) that were derived from fitting a de Vaucouleur's law to the observed growth

curve. Our best-fitting FP is

$$\log \mathcal{R}_e = 0.432\,(\pm 0.012) + 1.263\,(\pm 0.073) \log \sigma_\star$$
$$- 0.810\,(\pm 0.037) \log \langle I \rangle_e , \tag{9}$$

which has $a$, $b$ and $c$ values consistent with those of JFK96 to within $1\sigma$ (we note that the zero-point of the FP in JFK96 corresponds to $(a - b \log \sigma_{\star,0} - c \log \langle I \rangle_{e,0})$.

The ACS/WFC/*F625W* image of Abell 1689 at $z = 0.183$ corresponds approximately to the rest-frame $V$ band. We compute an average colour within the effective radius $(V - R)_{\text{Gunn}} = 1.22$ mag from a sample of 14 Coma cluster galaxies from Jorgensen et al. (1995a) and use this value to derive $\langle \mu \rangle_e$ in $V$ band. We verified that we could use a common colour within the effective radius for E and S0 galaxies, deriving $(V - R)_{\text{Gunn}}$ for the two classes of galaxies (the morphological type was taken from Dressler 1980). We found consistent values. As a further test to increase the sample, we derived the average colour within the effective radius $(B_{\text{Johnson}} - R_{\text{Gunn}}) = 1.15$ mag for 31 ETGs (from Jorgensen et al. 1995a) and again colours for Es and S0s were in agreement. We then fit the Coma data to obtain the FP in the $V$ band (hereafter FP$_{\text{Coma}}$), which is consistent with the Gunn-$r$ FP. We present all our derived FP$_{\text{Coma}}$ values in Table 5. We compare FP$_{\text{Coma}}$ with our derived FP for Abell 1689 by adopting a `deVauc` model for $\mathcal{R}_e$ and $\langle I \rangle_e$ and adopting $\log \mathcal{R}_e$ as the dependent variable, for the sake of consistency. We find that from the local Coma cluster to Abell 1689, there is a decrease in the parameter $b$, from $1.279 \pm 0.012$ for Coma to $1.092 \pm 0.084$ for Abell 1689. The parameter $c$ is consistent for the two clusters. We show the edge-on view of FP$_{\text{Coma}}$ together with the Abell 1689 data in Fig. 7. We also plot the values of parameters $b$ and $c$ for the two clusters.

#### 5.3.2 WINGS survey

We can also compare our FP with that derived from the WIde-field Nearby Galaxy-cluster Survey (WINGS, Fasano et al. 2006; D'Onofrio et al. 2008). We took spectroscopic and $V$-band photometric data of the 'WINGS/W+S' sample of 282 galaxies

**Figure 5.** Edge-on view of the FP with $\log \mathcal{R}_e$ as dependent variable and using $\mathcal{R}_e$ and $\langle I \rangle_e$ from deVauc photometric model (top panel); Sérsic model (middle panel) and Sérsic model of bulges (bottom panel), as described in the text. Blue filled circles: ETG sample; red filled squares: bulges of the LTG sample. The LTG sample is not used for the fit and plotted to show how it lies on the FP. The dark- and light-pink shaded regions enclose the $1\sigma$ (equivalent to 68 per cent of the values for a Gaussian distribution) and $2.6\sigma$ (99 per cent) observed scatter, respectively.

**Figure 6.** Edge-on view of the FP with $\log \sigma$ as dependent variable and using $\mathcal{R}_e$ and $\langle I \rangle_e$ from different photometric models. For a description of panels and symbols see Fig. 5.

(D'Onofrio et al. 2008, private communication[4]), which are ETGs belonging to 13 nearby clusters in the redshift range $0.04 < z < 0.07$. We obtain values for $\mathcal{R}_e$ and $\langle I \rangle_e$ by fitting a Sérsic law to a growth curve.

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[4] We note that the values of $\sigma_\star$ are corrected to the uniform aperture $\mathcal{R}_e/8$.

**Table 5.** Coma and WINGS FP coefficients.

| $\log \mathcal{R}_e = a + b\,(\log \sigma_\star - \log \sigma_{\star,0}) + c\,(\log \langle I \rangle_e - \log \langle I \rangle_{e,0})$ | | | | | | |
|---|---|---|---|---|---|---|
| a | b | c | $\epsilon_z$ | $\Delta$ | $\log \sigma_{\star,0}$ | $\log \langle I \rangle_{e,0}$ |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| | | Coma $-$ $\mathcal{R}_e$ from de Vaucouleurs law | | | | |
| $0.432 \pm 0.012$ | $1.279 \pm 0.068$ | $-0.804 \pm 0.034$ | 0 | 0.081 | 2.219 | 2.645 |
| | | WINGS $-$ $\mathcal{R}_e$ from Sérsic law | | | | |
| $0.4262 \pm 0.0056$ | $1.345 \pm 0.050$ | $-0.769 \pm 0.020$ | 0.076 | 0.100 | 2.166 | 2.408 |

*Note.* Column (1), column (2) and column (3): FP coefficients. Column (4): intrinsic scatter. Column (5): observed scatter (dex). Column (6) and column (7): median of the fitted $x_i$ and $y_i$ values, respectively. Values of $\mathcal{R}_e$ used to fit the FP are in kpc, $\sigma_{\star,0}$ in km s$^{-1}$, and $\langle I \rangle_{e,0}$ in L$_\odot$/pc$^{-2}$.



**Figure 7.** Top left-hand panels: edge-on-view of FP$_{Coma}$ (black line) obtained for the Coma galaxies (orange squares); the Abell 1689 ETGs sample, whose photometric parameters are obtained with a `deVauc` model, is shown (purple circles). Top right-hand panel: *b* and *c* FP parameters obtained for the Coma (orange square) and Abell 1689 ETGs (purple circle) samples, both shown in the top left-hand panel. Bottom left-hand panels: edge on view of FP$_{WINGS}$ (black line) obtained for the WINGS galaxies (light-blue squares); the Abell 1689 ETGs sample, whose photometric parameters are obtained with a `Sérsic` model, is shown (magenta circles). Bottom right-hand panels: *b* and *c* FP parameters obtained for the WINGS (light-blue square) and Abell 1689 ETGs (magenta circle) samples, both shown in the bottom left-hand panel; the FP parameters are plotted also for the sample of di Serego Alighieri et al. (2005) (black diamond).

For a more appropriate comparison, we fit the WINGS data with `LTS_PLANEFIT`, and use $\log \mathcal{R}_e$ as the dependent variable, as did D'Onofrio et al. (2008). The derived FP coefficients (hereafter, FP$_{WINGS}$) are presented in Table 4. They are in agreement with those of D'Onofrio et al. (2008), which are based on an orthogonal fit. We compare the FP$_{WINGS}$ with that derived for Abell 1689 with $\mathcal{R}_e$ as the dependent variable and use a `Sérsic` photometric model. The edge-on view of the WINGS FP and Abell 1689 data is shown in Fig. 7. We see a decrease in the value of the parameter *b* and an increase in the parameter *c* from the local WINGS FP to the that of

Abell 1689.[5] The parameters *b* and *c* for the two samples are plotted in Fig. 7.

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[5] As a second caveat, the WINGS sample has values of $\sigma_\star < 95$ km s$^{-1}$. In our Abell 1689 analysis, only three galaxies do not strictly obey this selection criterion, since S07, S35 and S45 have $\sigma_\star = 67.7$, 92.8 and 93.8 km s$^{-1}$, respectively. However, if we derive the Abell 1689 FP excluding these galaxies, our conclusions do not change.

## 6 DISCUSSION AND CONCLUSIONS

We perform a careful photometric analysis of 65 galaxies, specifically 50 ETGs and 15 LTGs, in the cluster Abell 1689 using rest-frame *V*-band ACS images. A two-dimensional multistructure photometric decomposition of each galaxy provides a complete morphological classification. For our sample, a `Sérsic` model of Es provides a better fit than a `deVauc` model, as on average, Sérsic indices $n \neq 4$. This is true also for the bulges of S0s, which are also well fit by a Sérsic profile, and S0s are well represented by a `SeDisc` model. For Ss, we present `SeDisc` models, and for SBs and SB0s, we provide `SeDiBar` models.

We use a sample of 40 ETGs to derive the FP by adopting $\mathcal{R}_e$ and $\langle I \rangle_e$ from different photometric models, i.e. a `deVauc` model, a `Sérsic` model and a Sérsic model for galaxy bulges. We find that the corresponding FP coefficients are not consistent within $1\sigma$ if we choose $\log \mathcal{R}_e$ as the dependent variable. This is partially confirmed if we choose $\log \sigma_\star$ as the dependent variable, in which case only FPs derived from `Sérsic` models and Sérsic models of bulges are in agreement. In both cases, the bulges of LTGs follow the FP, with the exception of 3 galaxies, out of 13, all with $\sigma_\star < 50 \, \mathrm{km \, s^{-1}}$. The tightest FP is the one derived by using a Sérsic model of the galactic bulges, thus the FP is better defined by the bulges alone rather than the entire galaxies.

Similar studies have already been published, e.g. Kelson et al. (2000a) compare the photometric parameters derived by fitting their sample, at $z = 0.33$, with a pure de Vaucouleurs law, a Sérsic law and a combination of a de Vaucouleurs bulge plus exponential disc; while they find large uncertainties on $\mathcal{R}_e$, they conclude that this does not affect the FP analysis (in Kelson et al. 2000b), because the product $\mathcal{R}_e \langle I \rangle_e^{-c}$, which enters the FP, remains stable. This result was confirmed by Fernández Lorenzo et al. (2011), who analysed ETGs in the redshift range $0.2 < z < 1.2$. Our investigation differs in that we perform a Sérsic bulge plus exponential disc (plus a Ferrers ellipsoid, in case a bar is present) decomposition, and discriminate between Es and S0s (Section 5.2.1).

We compare the FP for Abell 1689 with the FP derived for local samples. We first perform the classic comparison with FP$_\mathrm{Coma}$, where $\mathcal{R}_e$ and $\langle I \rangle_e$ are based on a de Vaucouleurs law fitting procedure. We find a hint of evolution in the *b* parameter, in the sense of decreasing with redshift. The evolution is more evident if we make the comparison with FP$_\mathrm{WINGS}$, where the photometric parameters were derived with a Sérsic model. The FP of Abell 1689 shows both an offset and rotation, given that *b* decreases and *c* increases with redshift. Interestingly enough, this trend is in agreement with di Serego Alighieri et al. (2005), who studied a sample of galaxies in the range $0.88 < z < 1.3$, in the rest-frame *B* band, and adopting a two-dimensional Sérsic model for the surface-brightness distribution. This study is based on field galaxies, but di Serego Alighieri, Lanzoni & Jørgensen (2006a,b) show that ETGs are the same in the field (using the sample of di Serego Alighieri et al. 2005) and in the clusters (using two clusters at $z = 0.8$–0.9 from Jørgensen et al. 2006, 2007). We use the comparison with di Serego Alighieri et al. (2005) for consistency in adopting a Sérsic model to derive the photometric parameters that enter the FP. We show their result in Fig. 7 (bottom right-hand panel). In our two comparisons, two things diverge: (i) the photometric model, and (ii) the local sample. As for (i), we find in our analysis that a `deVauc` model is poorer than a `Sérsic` model in reproducing the surface-brightness distribution of ETGs; as for (ii) we think that the WINGS survey, including data for thirteen clusters, is more representative of the global behaviour of local galaxies than the Coma cluster alone. For

these reasons, we conclude that the FP of Abell 1689 shows an evolution in both the *b* and *c* coefficients, in the sense described above. A comparison with a local sample in which Es, S0s and SB0s are fitted with multiple component surface-brightness distributions will be required to confirm this.

For 29 galaxies in our sample, we measure spatially resolved kinematics from FLAMES data (Paper II). In a future paper (Paper IV, in preparation), we will use the two-dimensional kinematic maps, alongside ACS photometry to fit dynamical models and measure accurate dynamical masses (Cappellari et al. 2007). We will therefore investigate the systematic variation of the stellar and dynamical mass-to-light ratios, and compare these measurements to the prediction of the FP.

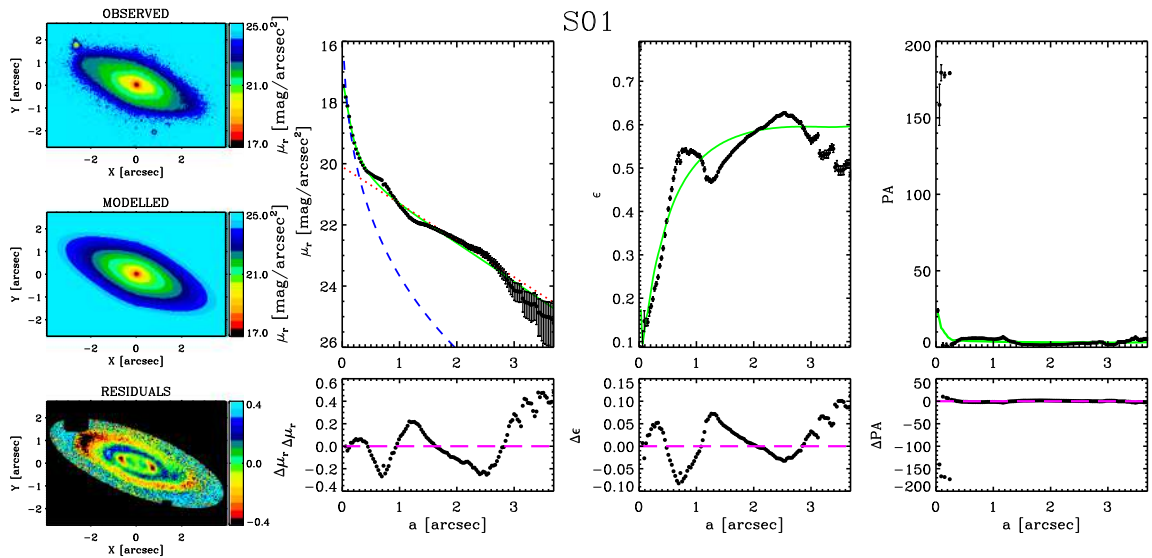## REFERENCES

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# APPENDIX A: ADDITIONAL FIGURES AND TABLES



**Figure A1.** Two-dimensional photometric decomposition of the spiral galaxy S01 fitted with a SeDisc. Left-hand maps from top to bottom: observed, modelled and residual (observed–modelled) surface-brightness distribution of the galaxy. The mask applied to the image, containing the pixels rejected in the fit, is highlighted in black. Images are oriented as in Fig. 1, i.e. PA of *Y*-axis is 115°.12. Right-hand panels from left- to right-hand side and top to bottom: ellipse-averaged radial profile of surface-brightness, ellipticity and PA, measured in the observed (black dots with error-bars) and modelled image (green solid line). The dashed blue and dotted red lines represent the intrinsic surface-brightness radial profiles of the bulge and disc, respectively, along their semi major axis. The difference between the ellipse-averaged radial profiles extracted from the modelled and observed images is also shown.

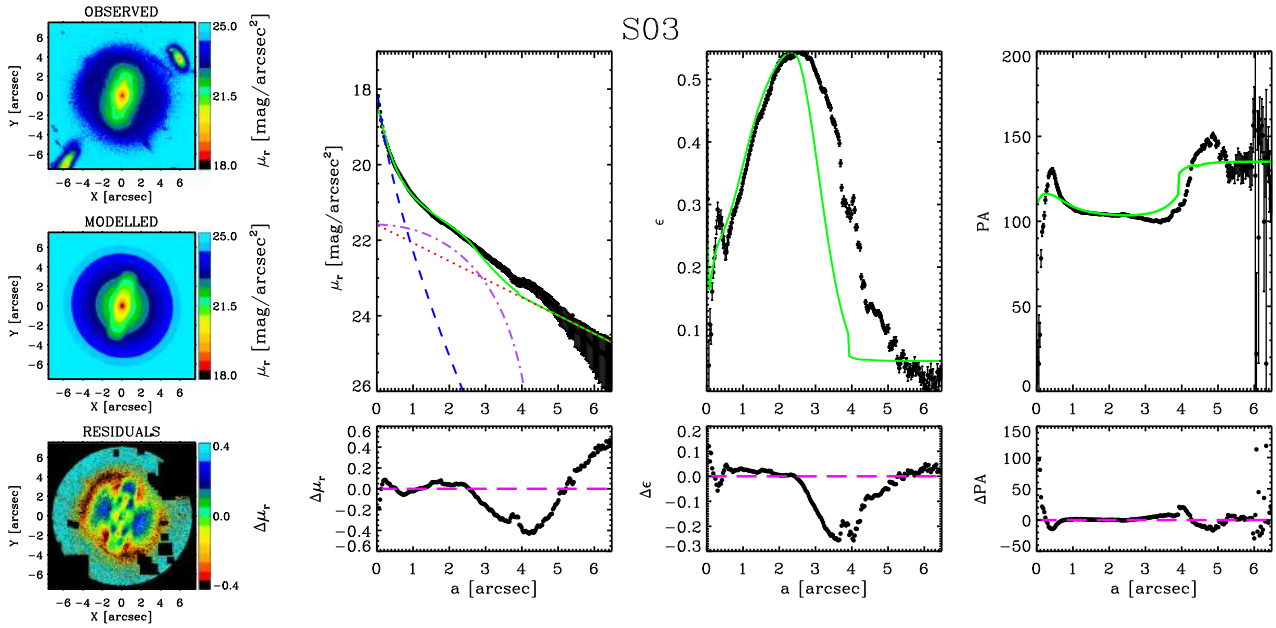**Figure A2.** As in Fig. A1 but for galaxy S02 (`SeDisc` model).



**Figure A3.** As in Fig. A1 but for galaxy S03 fitted with a `SeDiBar` model. The dash-dotted purple line represents the intrinsic surface-brightness radial profile of the bar along its semi major axis.
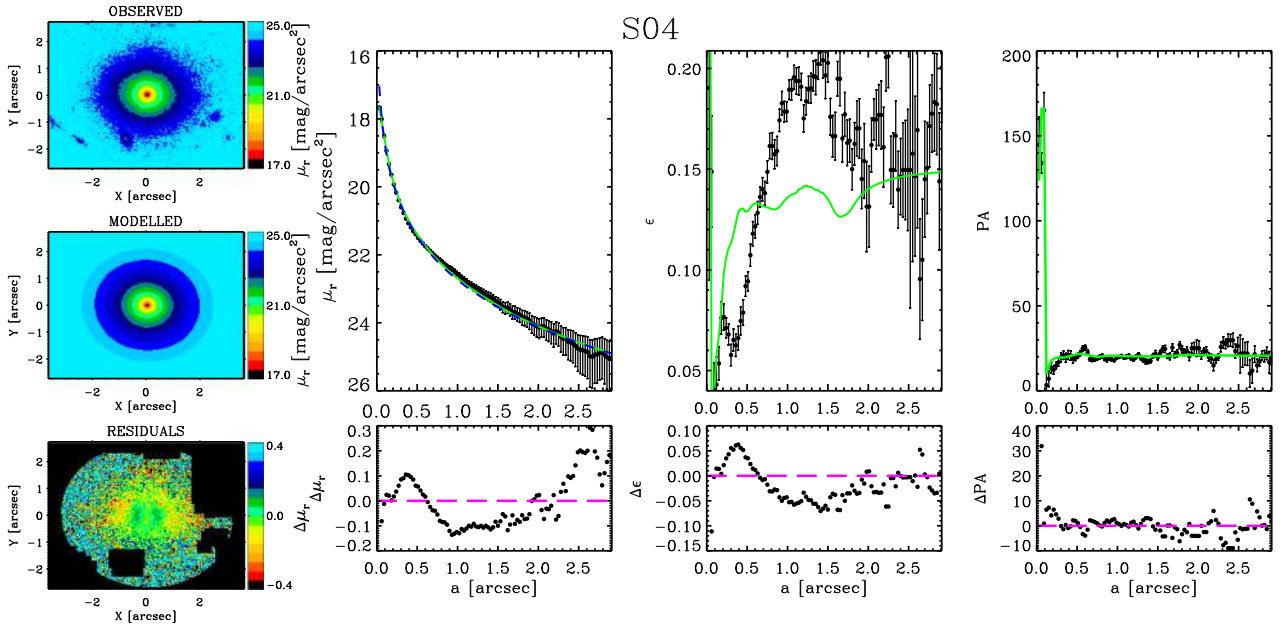
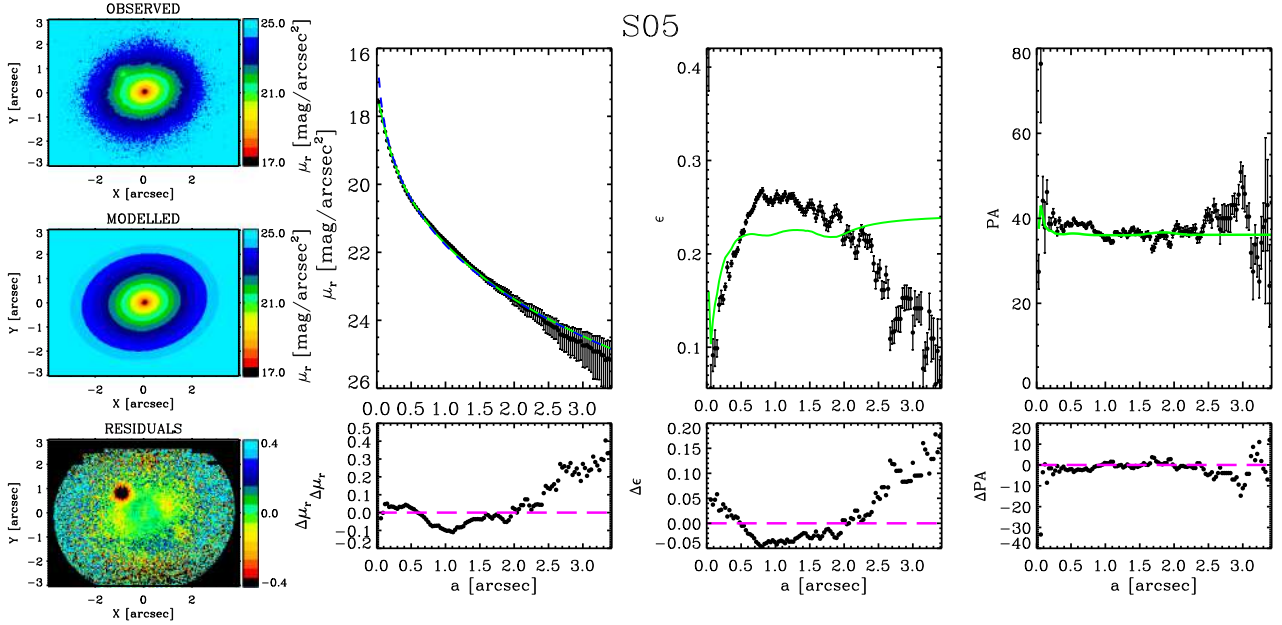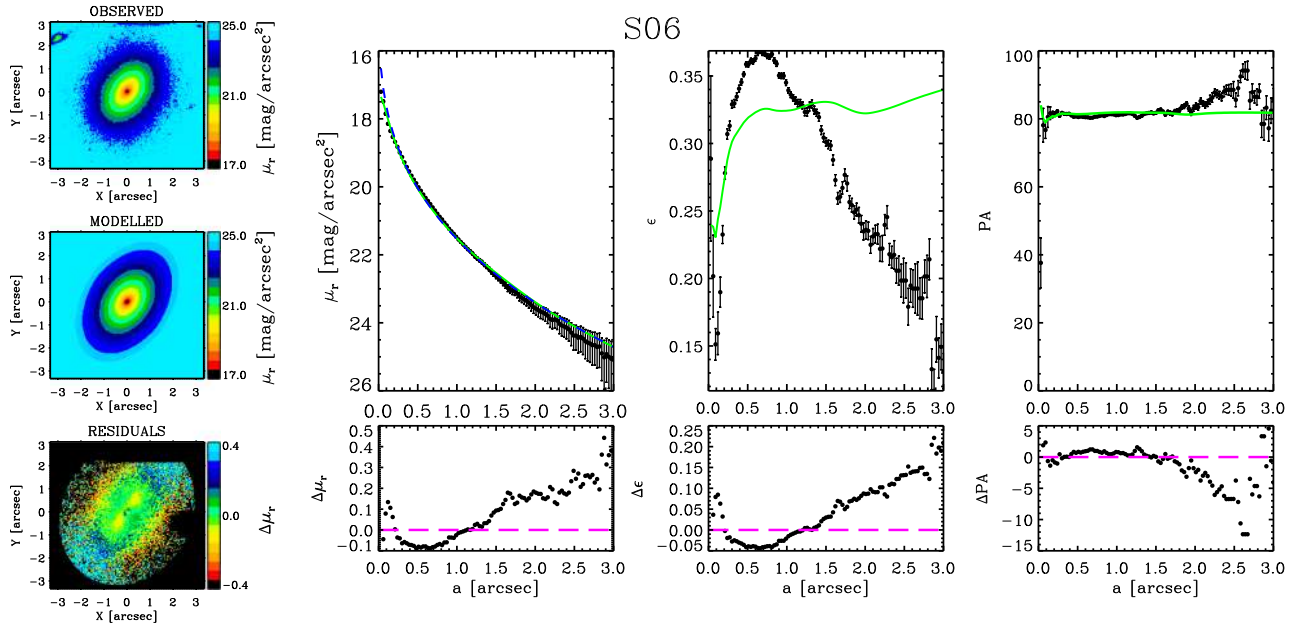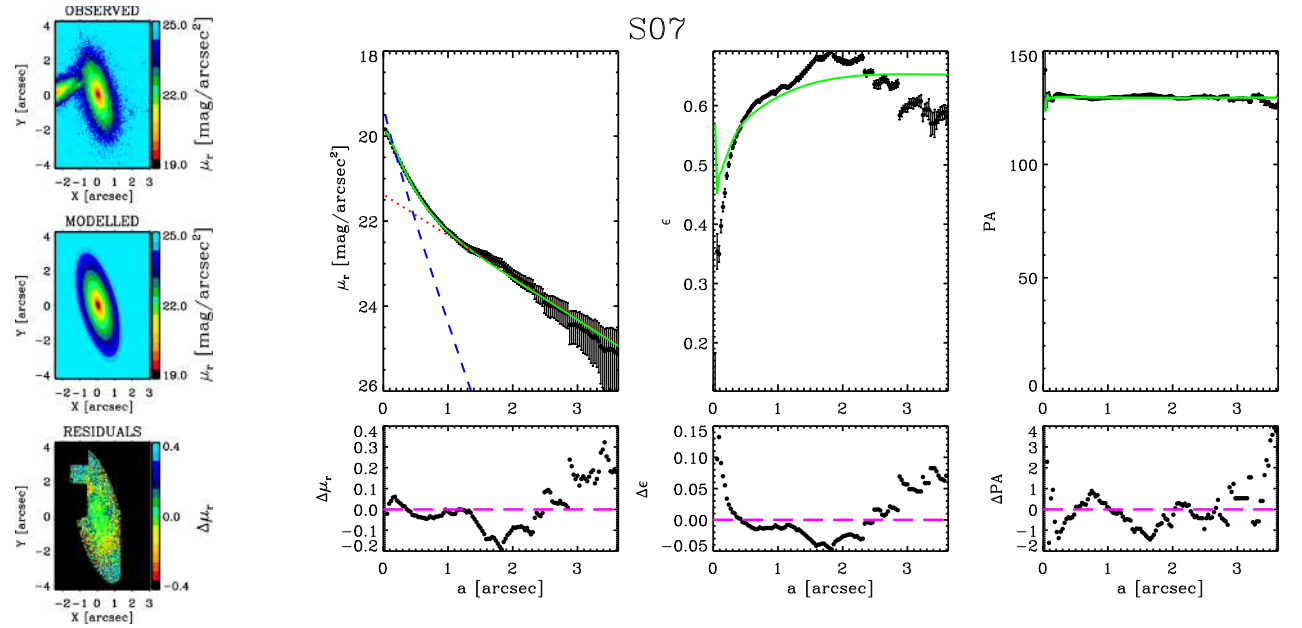**Figure A4.** As in Fig. A1 but for galaxy S04 fitted with a Sérsic model.
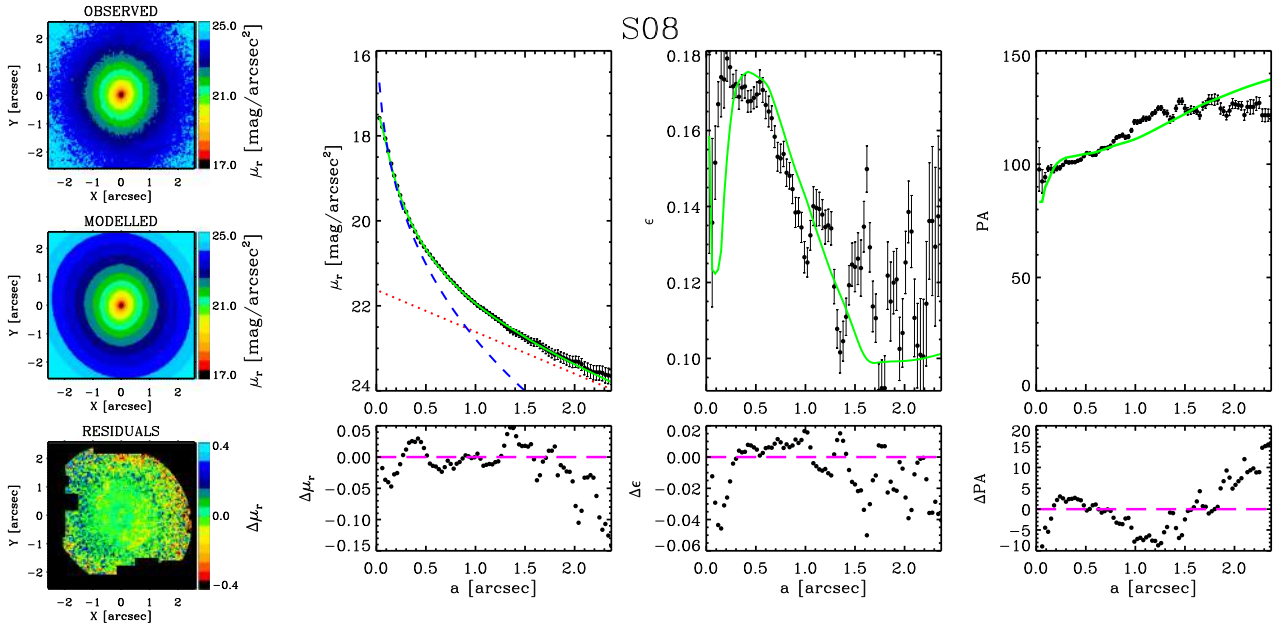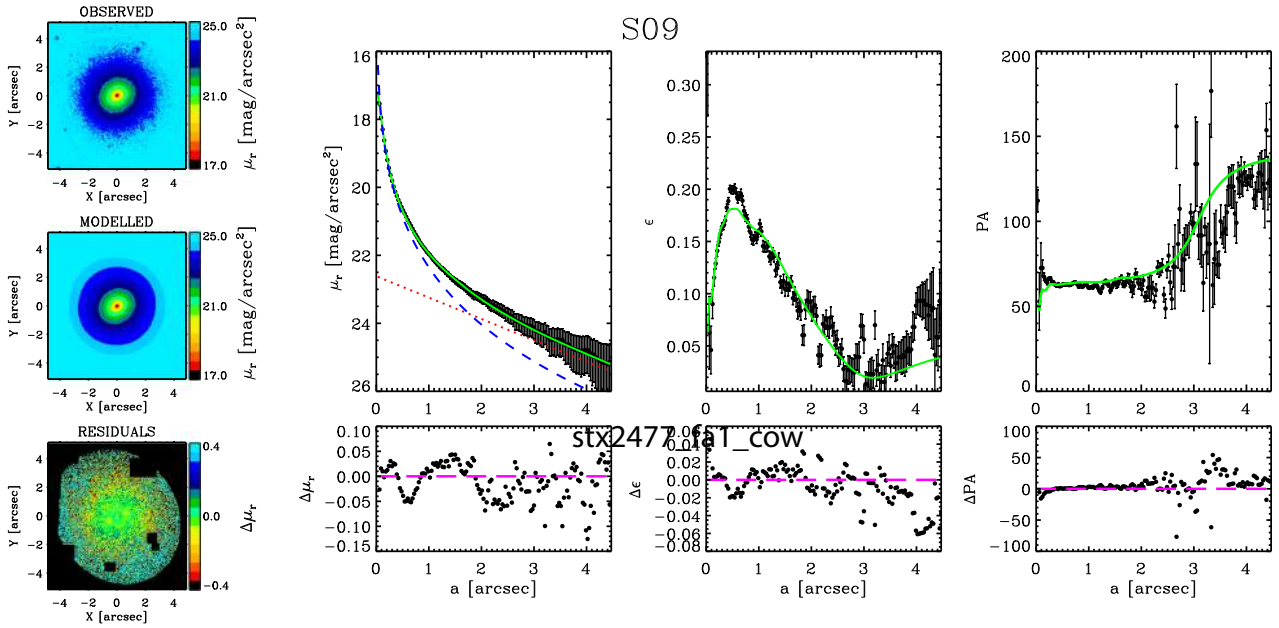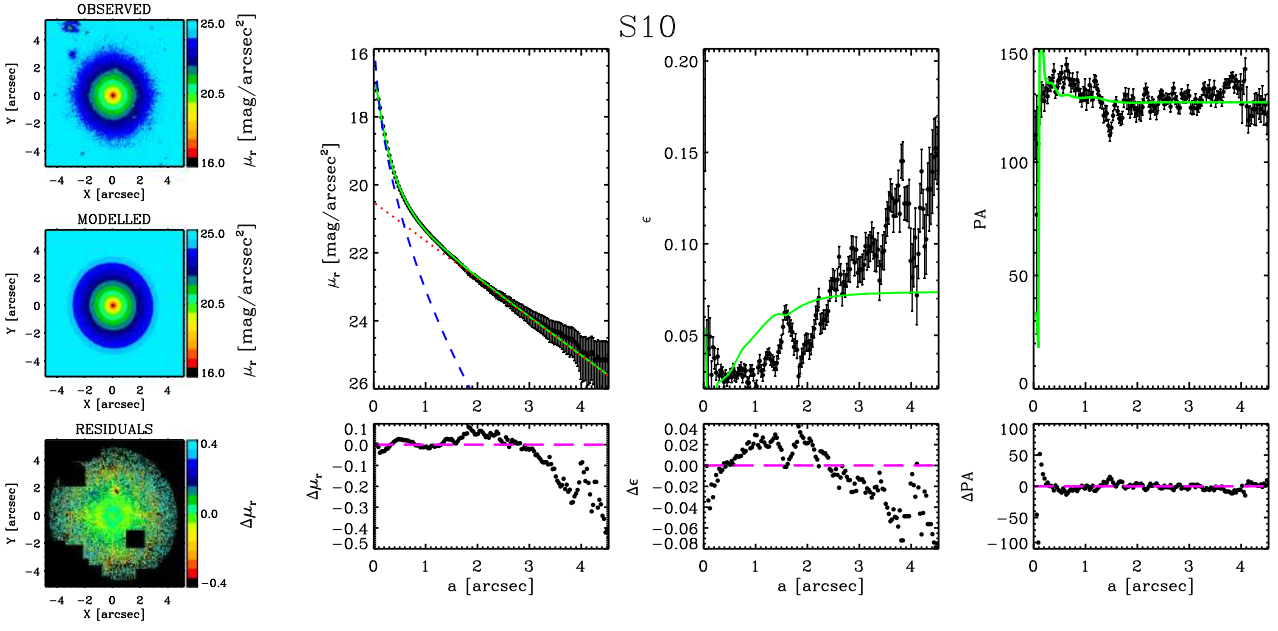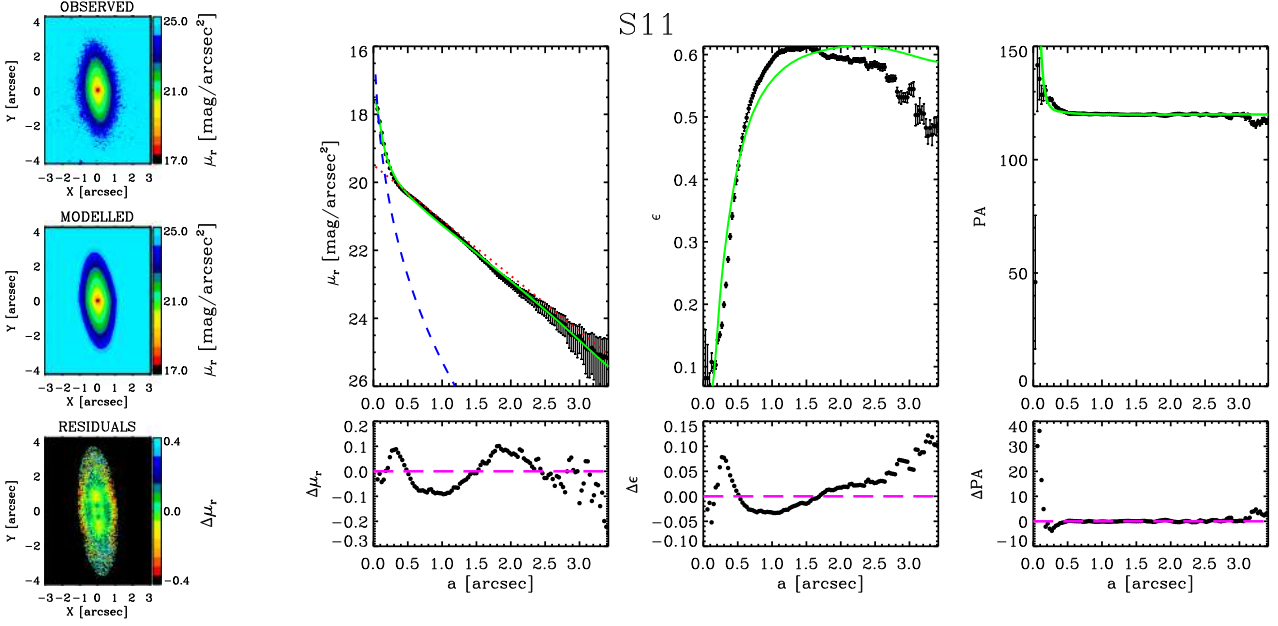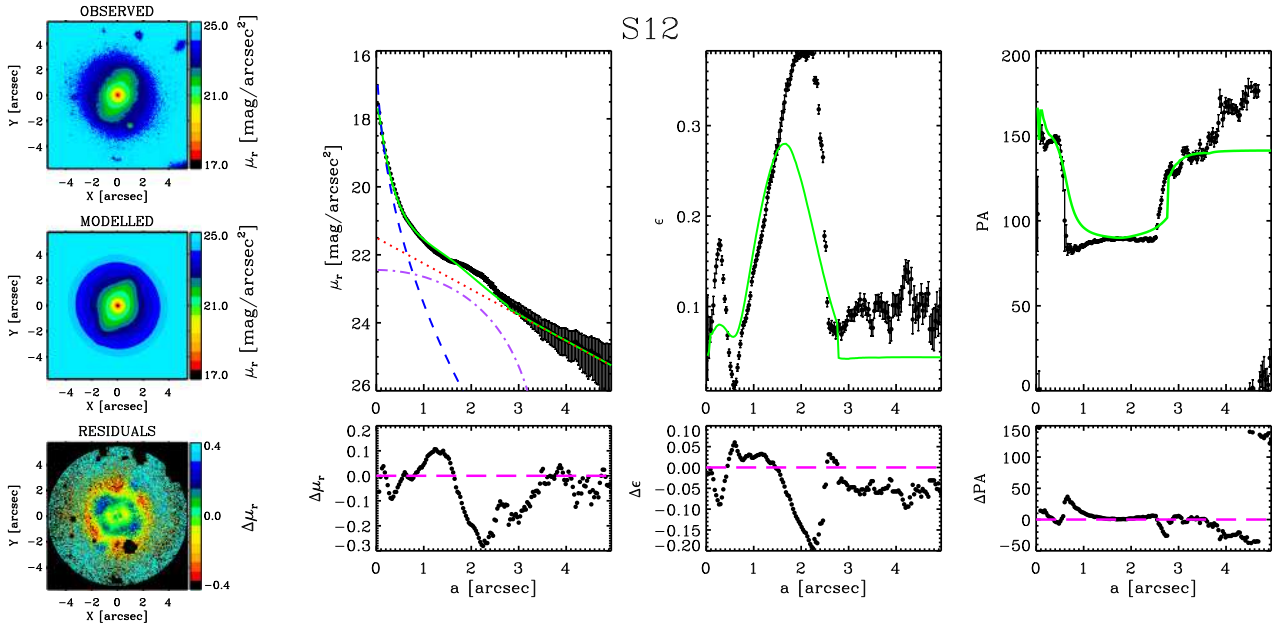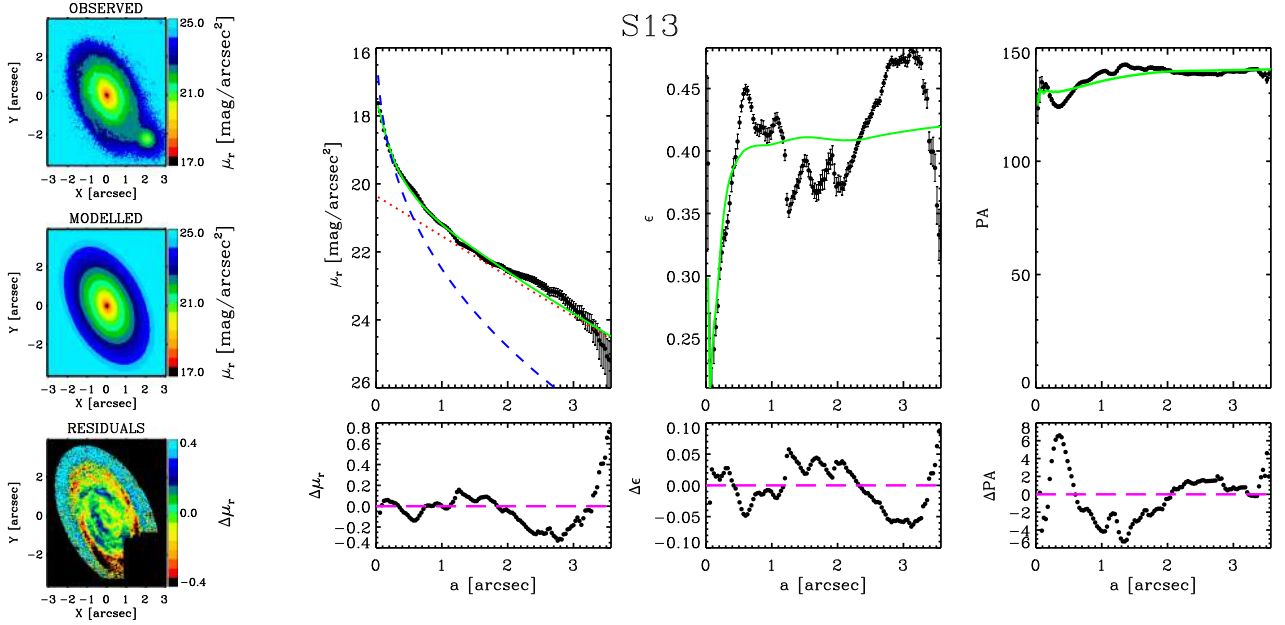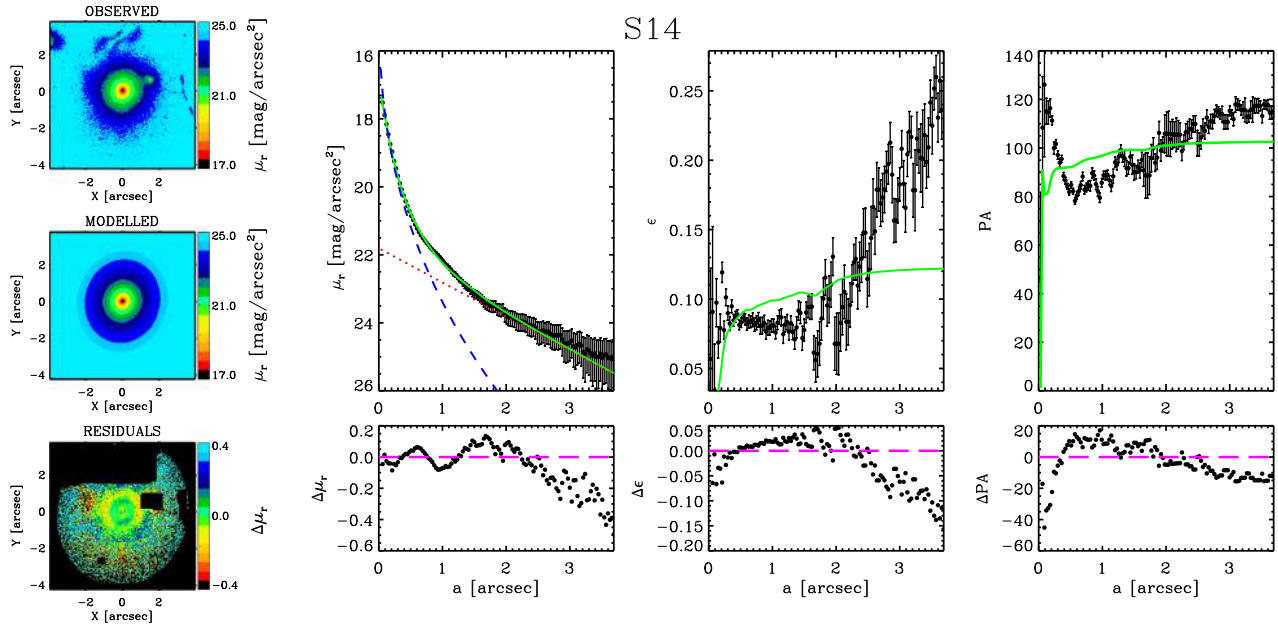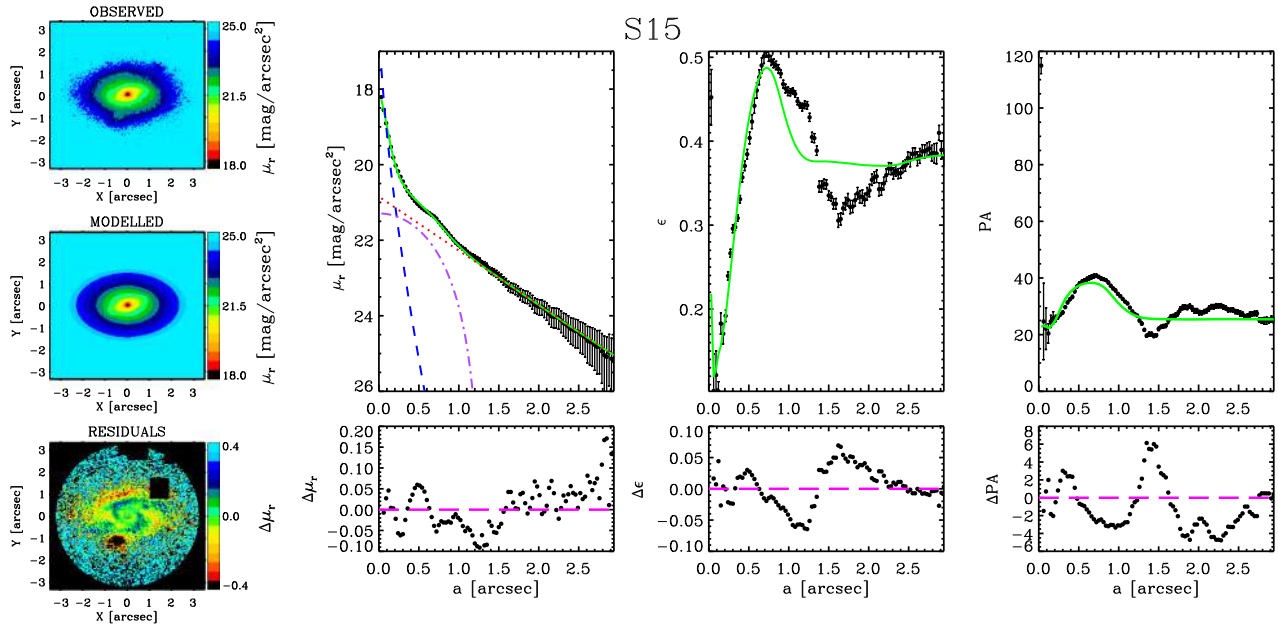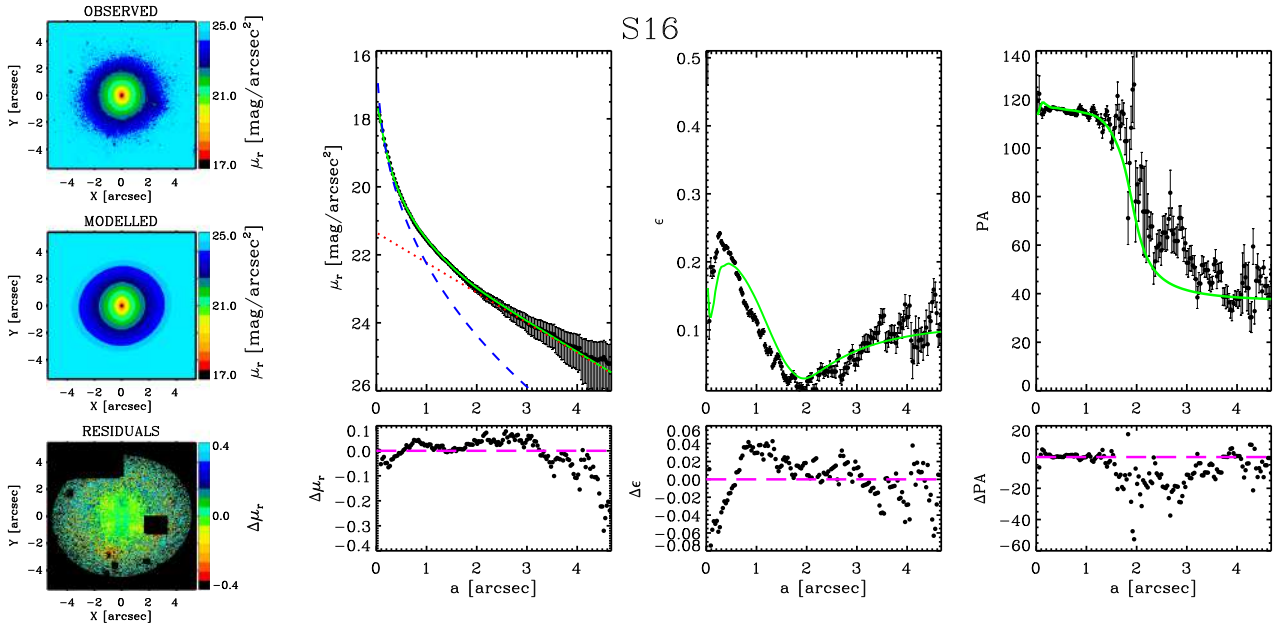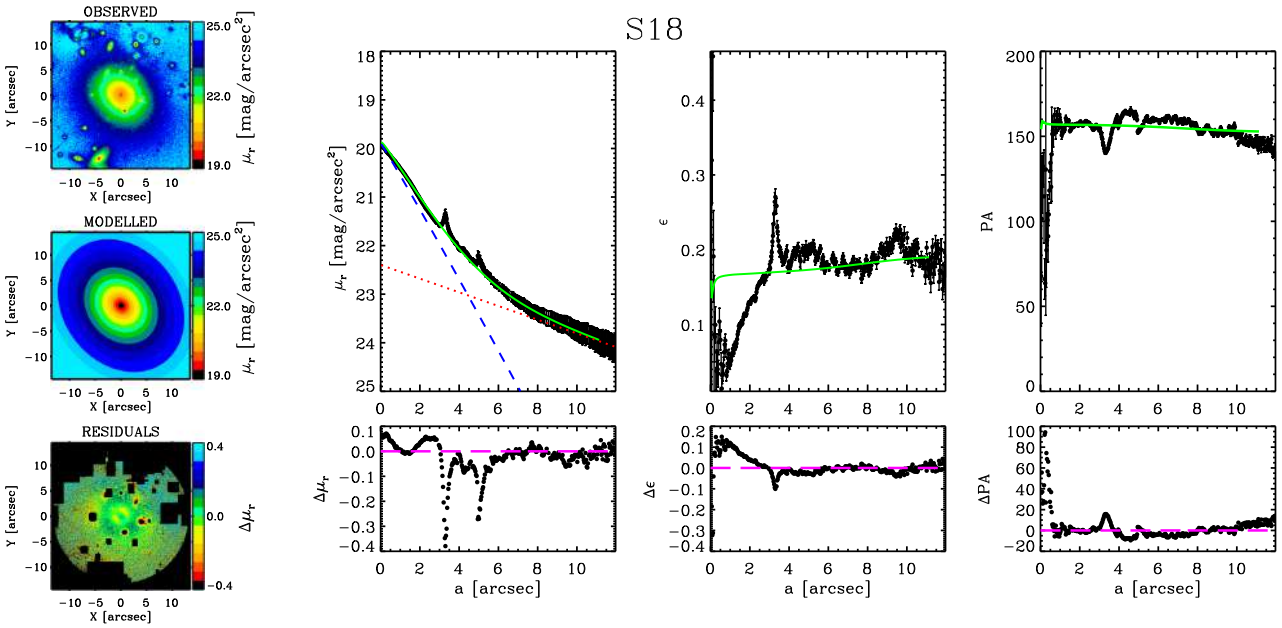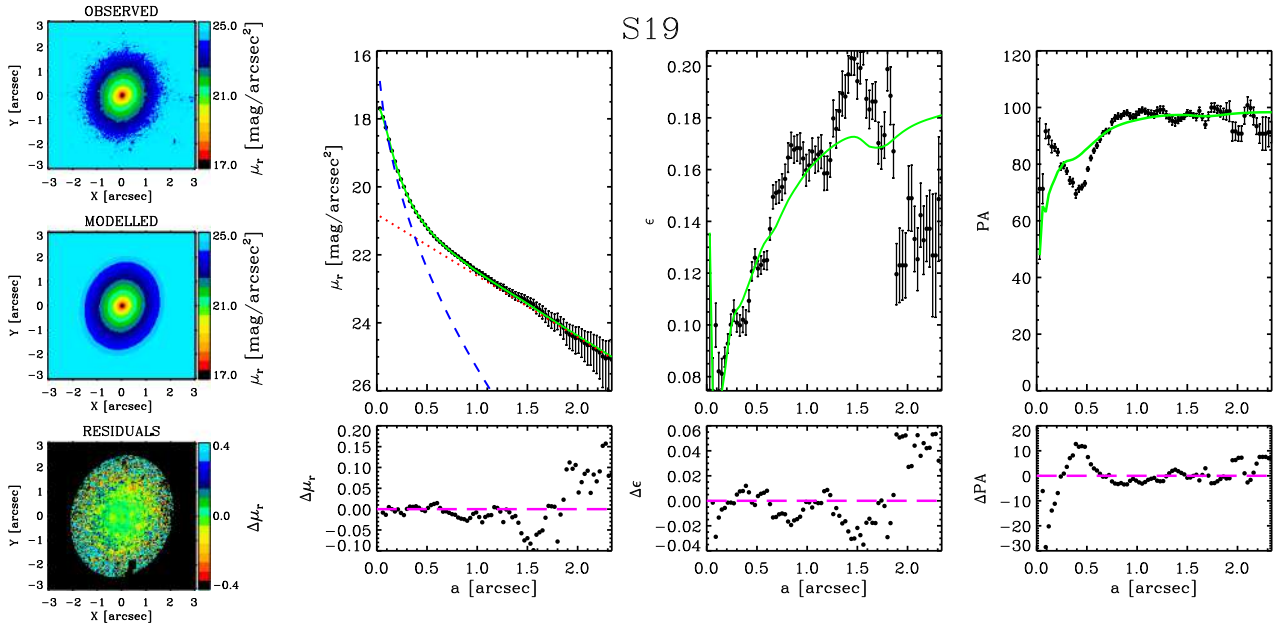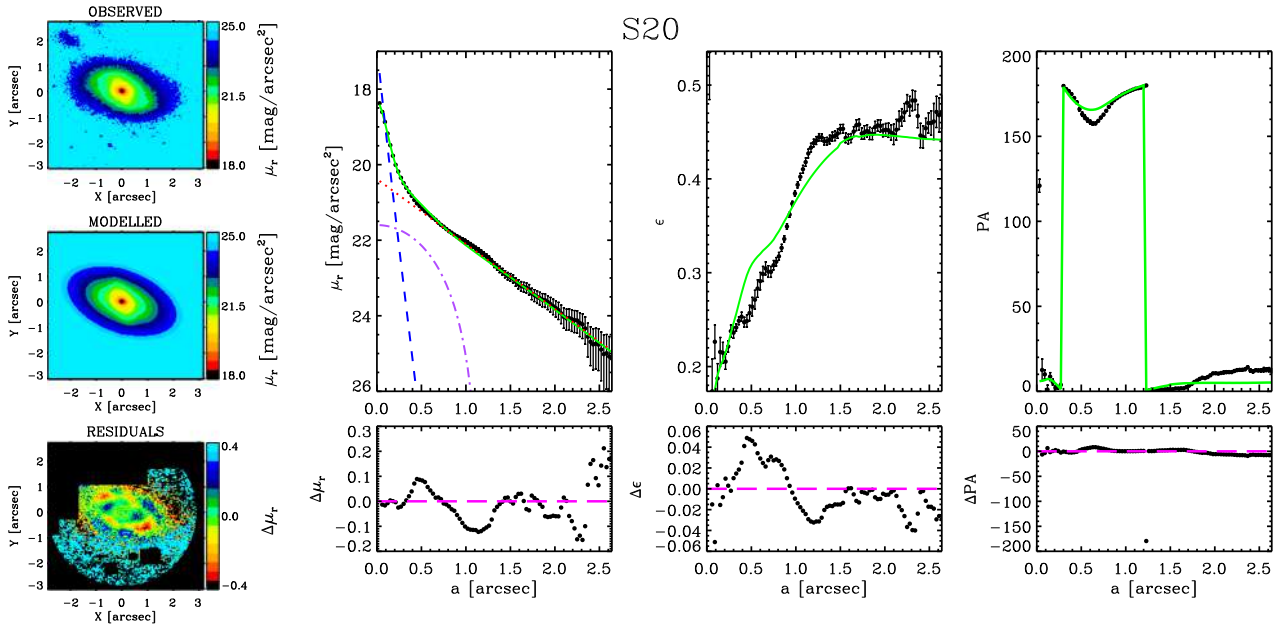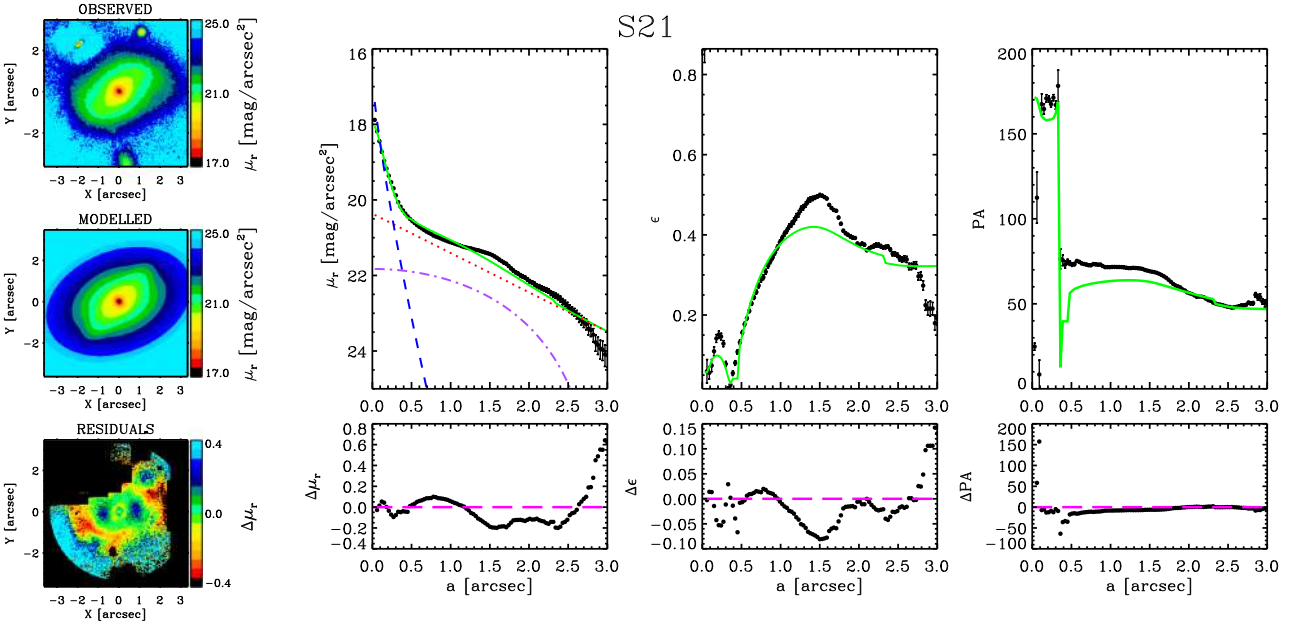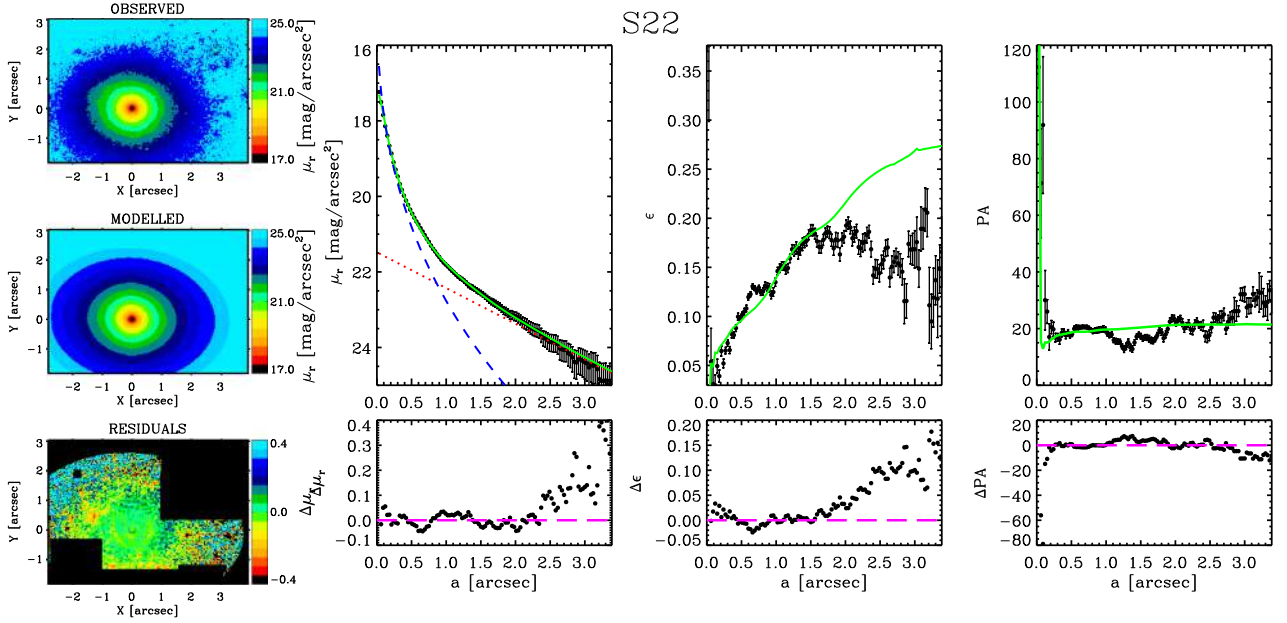


**Figure A5.** As in Fig. A1 but for galaxy S05 fitted with a Sérsic model.

**Figure A6.** As in Fig. A1 but for galaxy S06 fitted with a `Sérsic` model.



**Figure A7.** As in Fig. A1 but for galaxy S07 (`SeDisc` model).

**Figure A8.** As in Fig. A1 but for galaxy S08 (`SeDisc` model).



**Figure A9.** As in Fig. A1 but for galaxy S09 (`SeDisc` model).

**Figure A10.** As in Fig. A1 but for galaxy S10 (`SeDisc` model).



**Figure A11.** As in Fig. A1 but for galaxy S11 fitted with a `SeDisc` model.

**Figure A12.** As in Fig. A1 but for galaxy S12 fitted with a `SeDiBar` model. The dash-dotted purple line represents the intrinsic surface-brightness radial profile of the bar along its semi major axis.



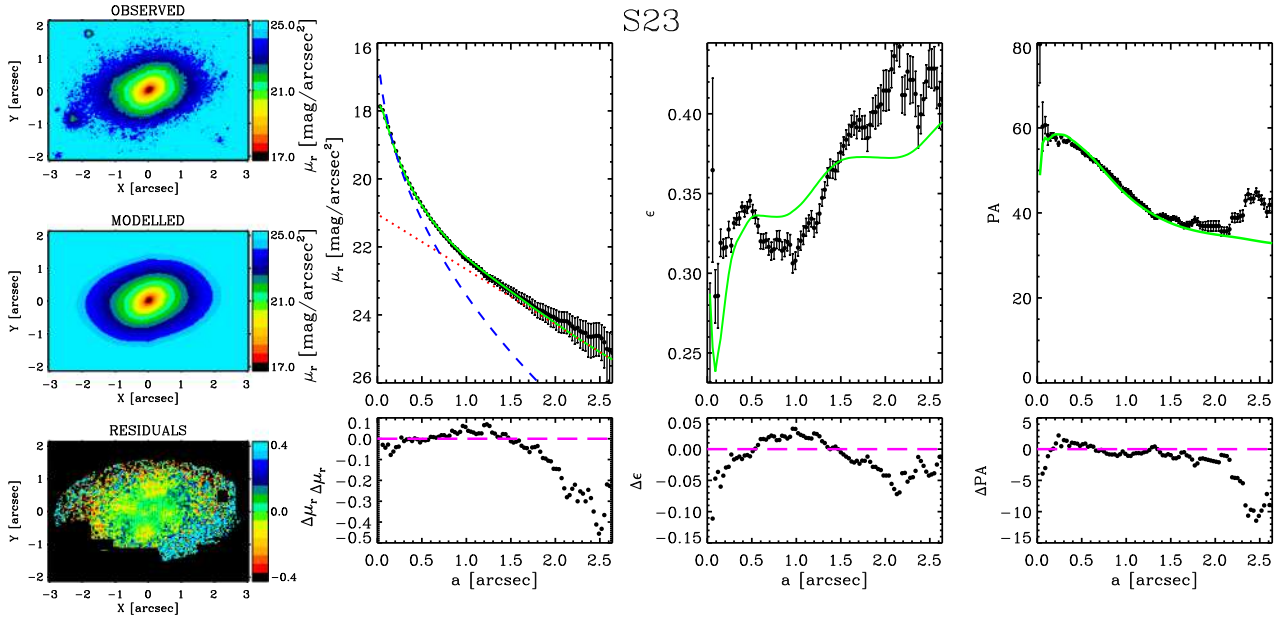**Figure A13.** As in Fig. A1 but for galaxy S13 (`SeDisc` model).
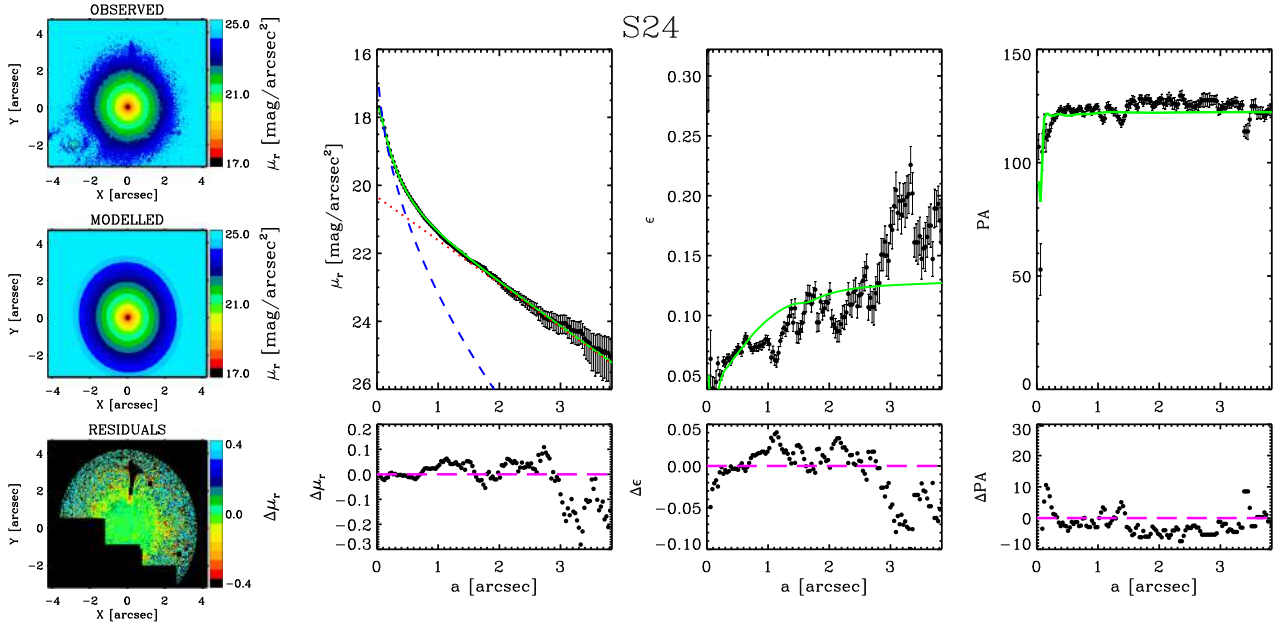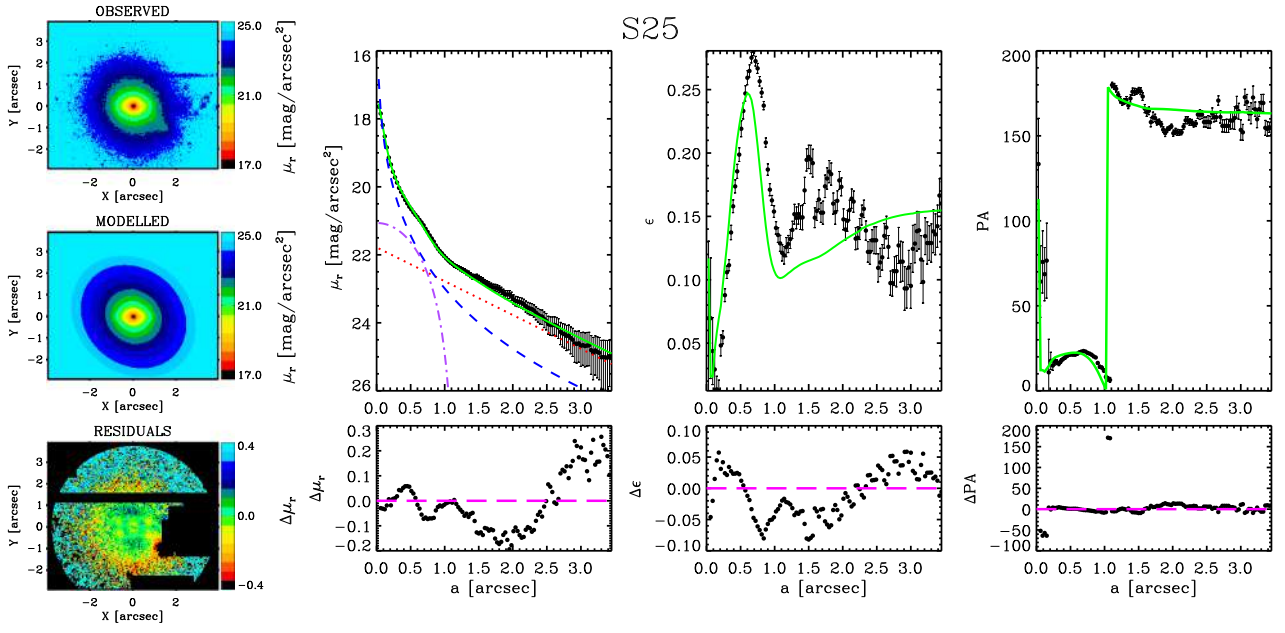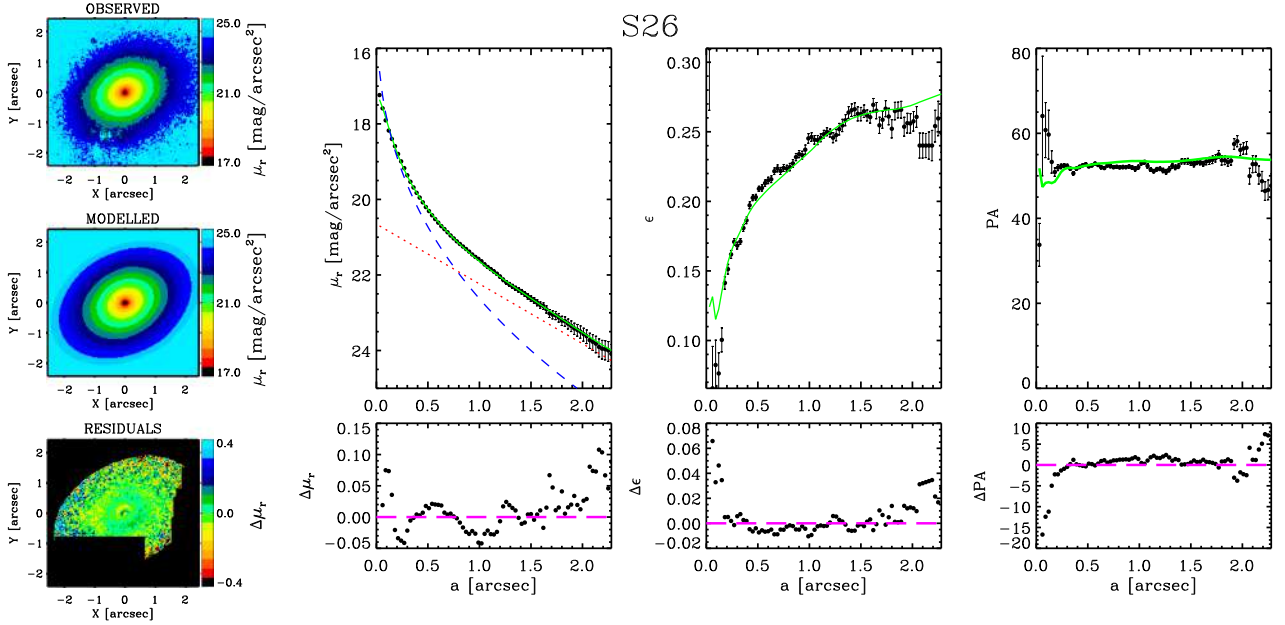
**Figure A14.** As in Fig. A1 but for galaxy S14 (`SeDisc` model).



**Figure A15.** As in Fig. A1 but for galaxy S15 (`SeDiBar` model). The dash-dotted purple line represents the instrinsic surface-brightness radial profile of the bar along its semi major axis.

S16



**Figure A16.** As in Fig. A1 but for galaxy S16 (`SeDisc` model).

S18



**Figure A17.** As in Fig. A1 but for galaxy S18 (`SeDisc` model).

**Figure A18.** As in Fig. A1 but for galaxy S19 (`SeDisc` model).



**Figure A19.** As in Fig. A1 but for galaxy S20 fitted with a `SeDiBar` model. The dash-dotted purple line represents the intrinsic surface-brightness radial profile of the bar along its semi major axis.

**Figure A20.** As in Fig. A1 but for galaxy S21 fitted with a `SeDiBar` model. The dash-dotted purple line represents the intrinsic surface-brightness radial profile of the bar along its semi major axis.



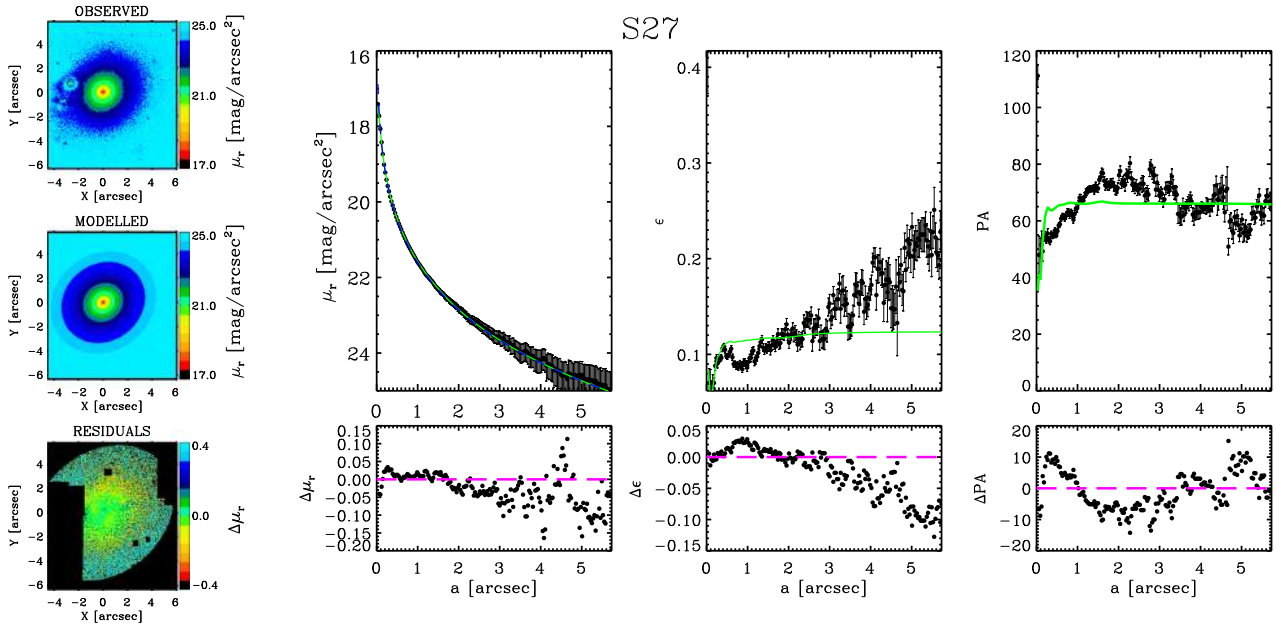**Figure A21.** As in Fig. A1 but for galaxy S22 (`SeDisc` model).
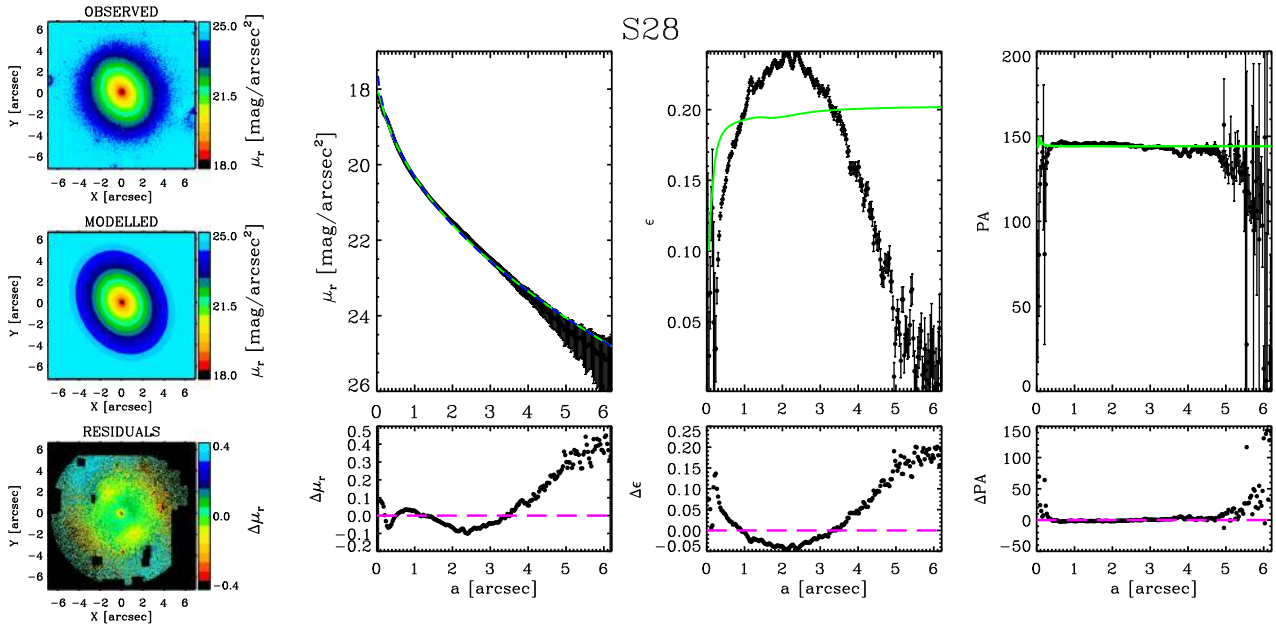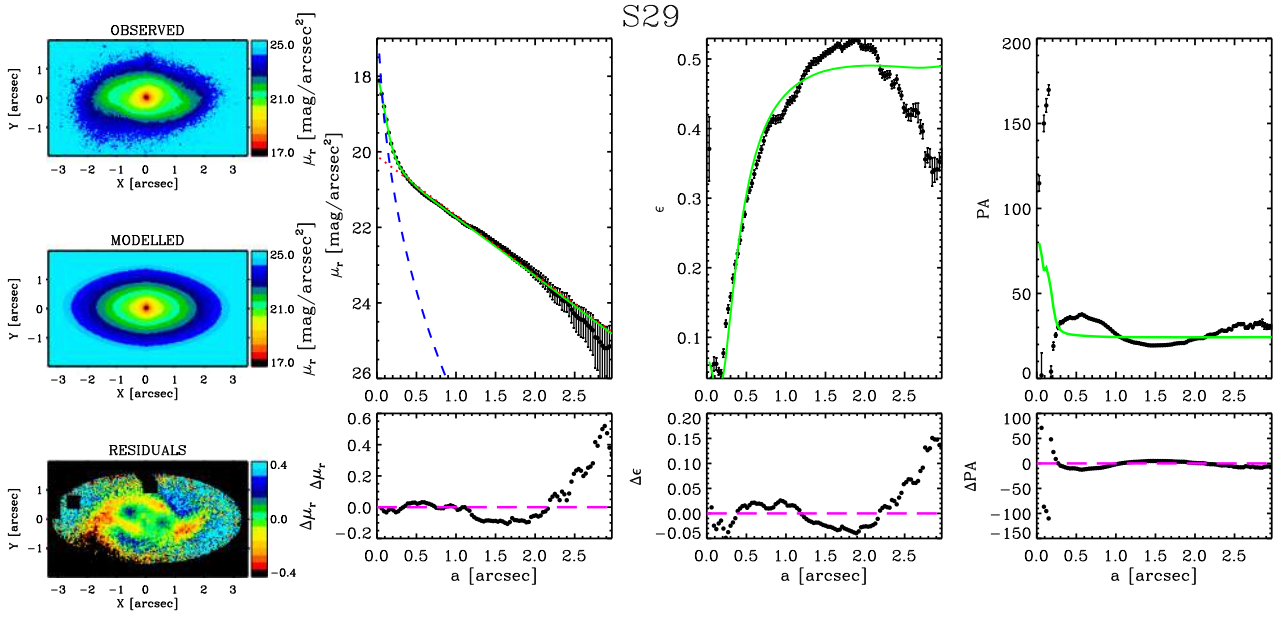
**Figure A22.** As in Fig. A1 but for galaxy S23 (`SeDisc` model).



**Figure A23.** As in Fig. A1 but for galaxy S24 (`SeDisc` model).

**Figure A24.** As in Fig. A1 but for galaxy S25 fitted with a `SeDiBar` model. The dash-dotted purple line represents the intrinsic surface-brightness radial profile of the bar along its semi major axis.



**Figure A25.** As in Fig. A1 but for galaxy S26 (`SeDisc` model).

**Figure A26.** As in Fig. A1 but for galaxy S27 (Sérsic model).



**Figure A27.** As in Fig. A1 but for galaxy S28 fitted with a Sérsic model.

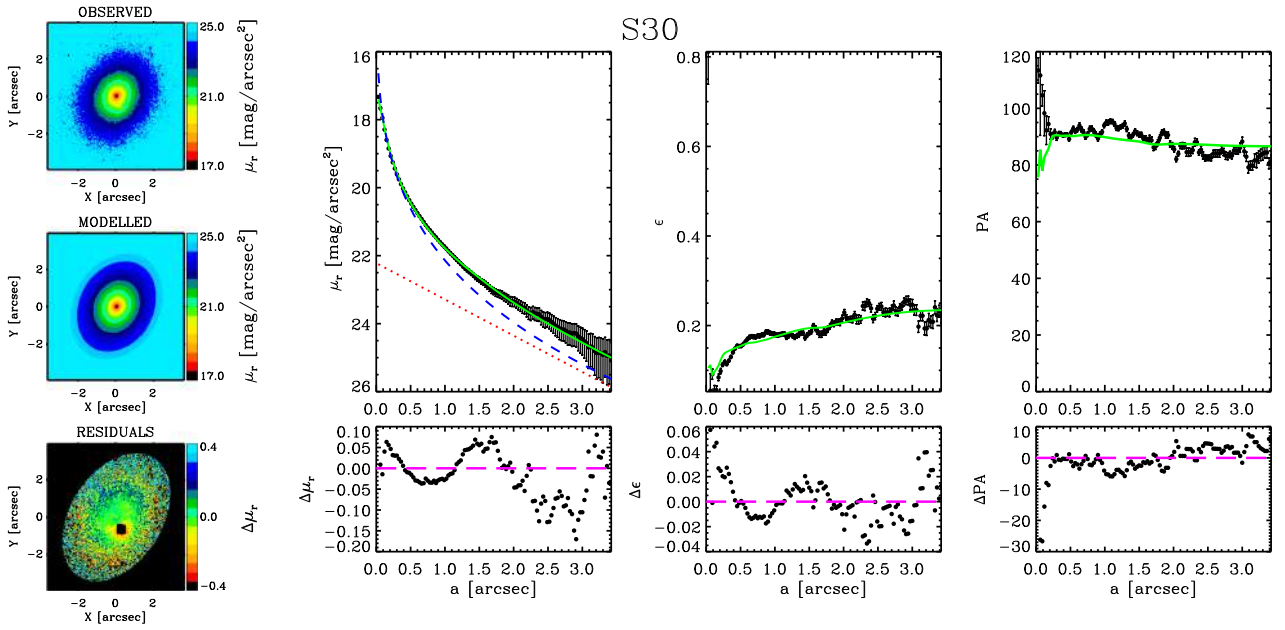**Figure A28.** As in Fig. A1 but for galaxy S29 (`SeDisc` model).



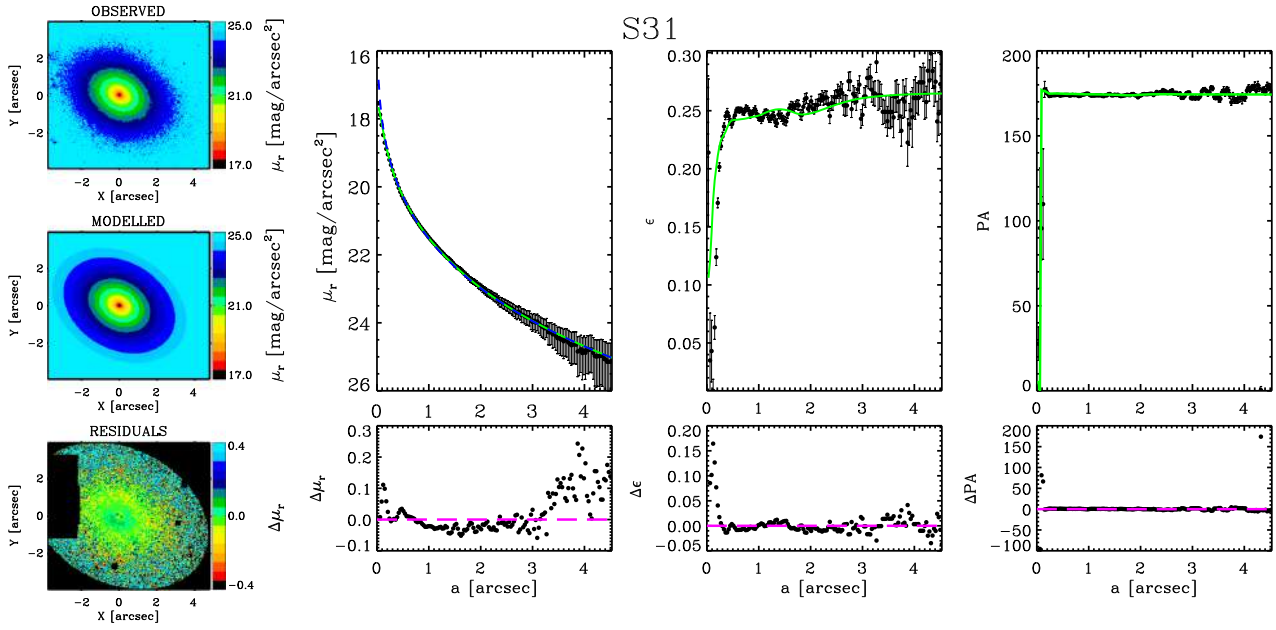**Figure A29.** As in Fig. A1 but for galaxy S30 (`SeDisc` model).

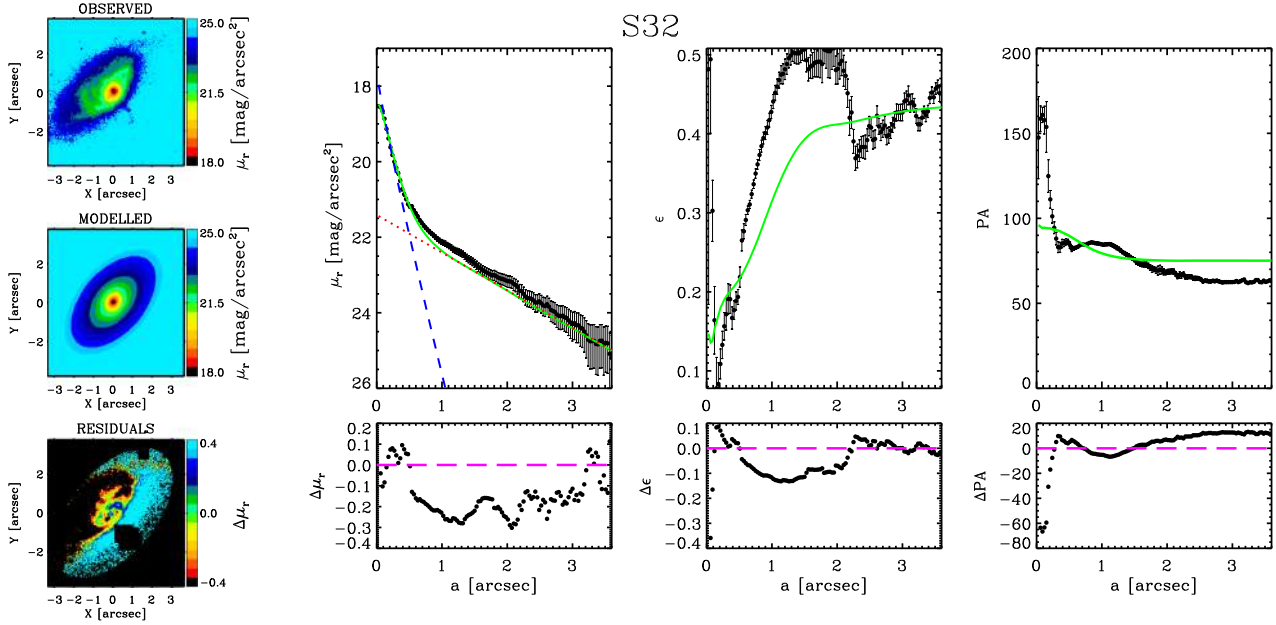**Figure A30.** As in Fig. A1 but for galaxy S31 fitted with a `Sérsic` model.


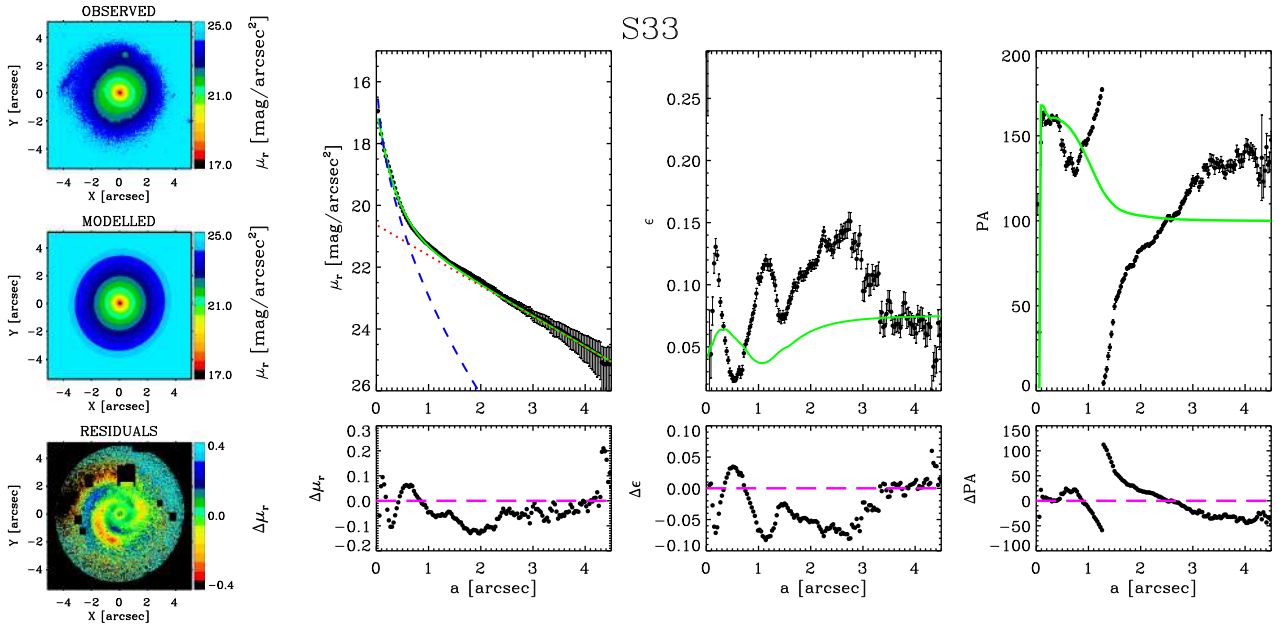
**Figure A31.** As in Fig. A1 but for galaxy S32 (`SeDisc` model).

## S33



**Figure A32.** As in Fig. A1 but for galaxy S33 (`SeDisc` model).
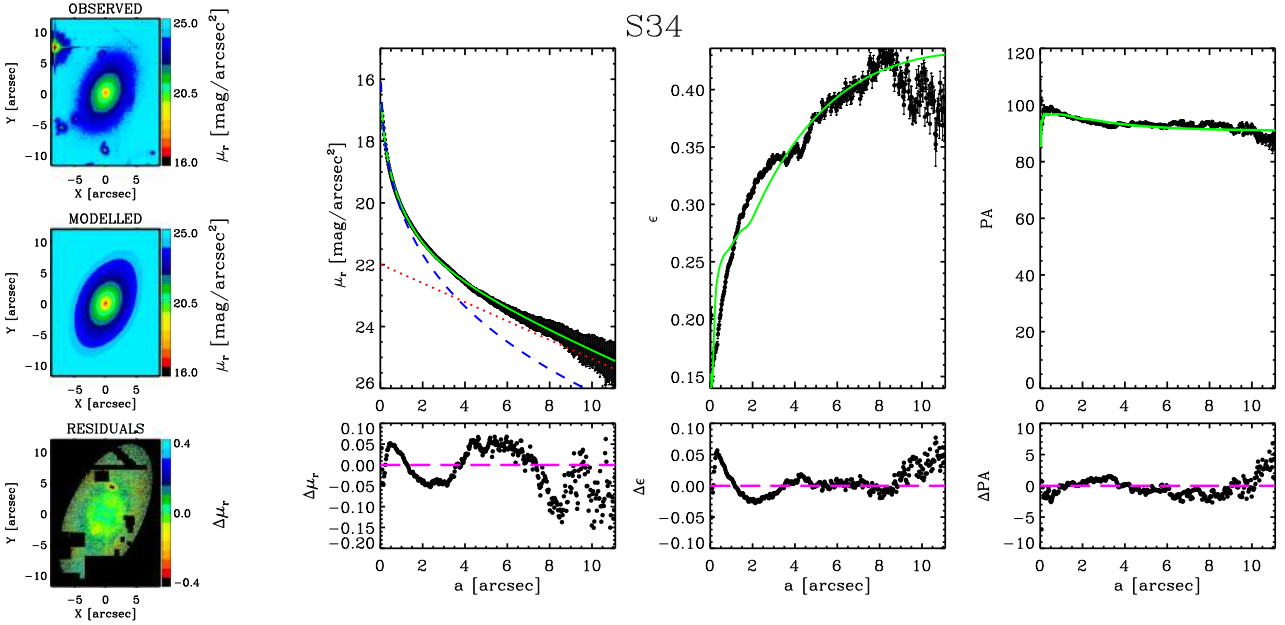
## S34



**Figure A33.** As in Fig. A1 but for galaxy S34 (`SeDisc` model).

**Figure A34.** As in Fig. A1 but for galaxy S35 (`SeDisc` model).



**Figure A35.** As in Fig. A1 but for galaxy S36 (`SeDisc` model).

**Figure A36.** As in Fig. A1 but for galaxy S37 (SeDiBar model). The dash-dotted purple line represents the intrinsic surface-brightness radial profile of the bar along its semi major axis.
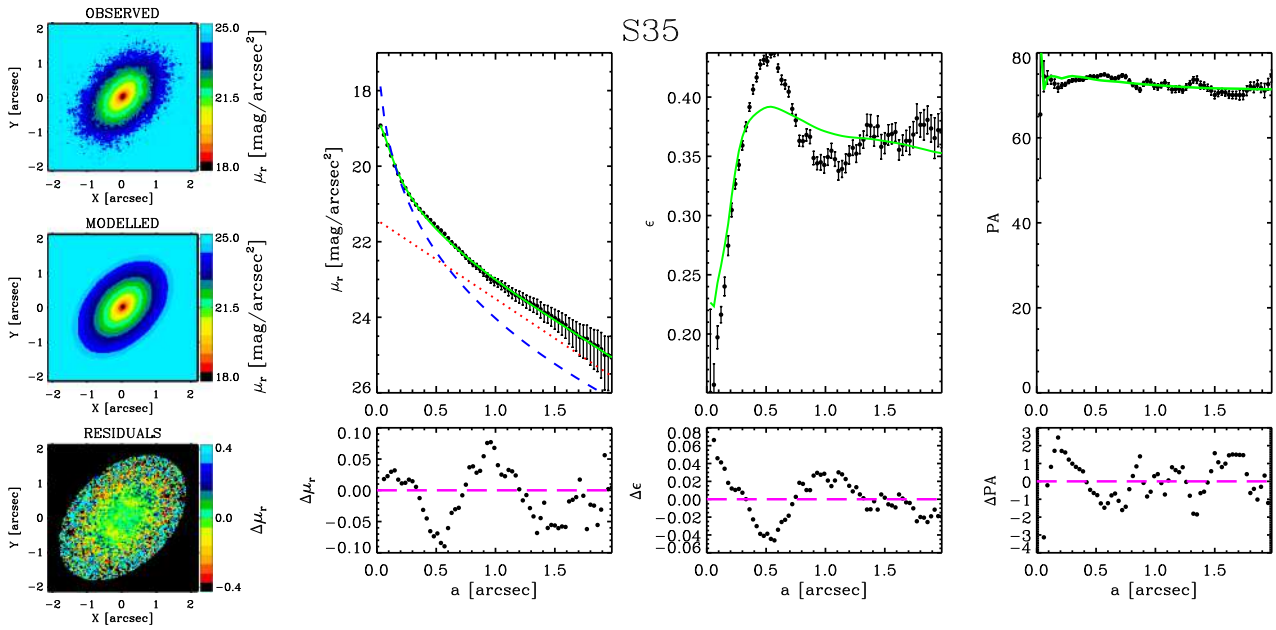


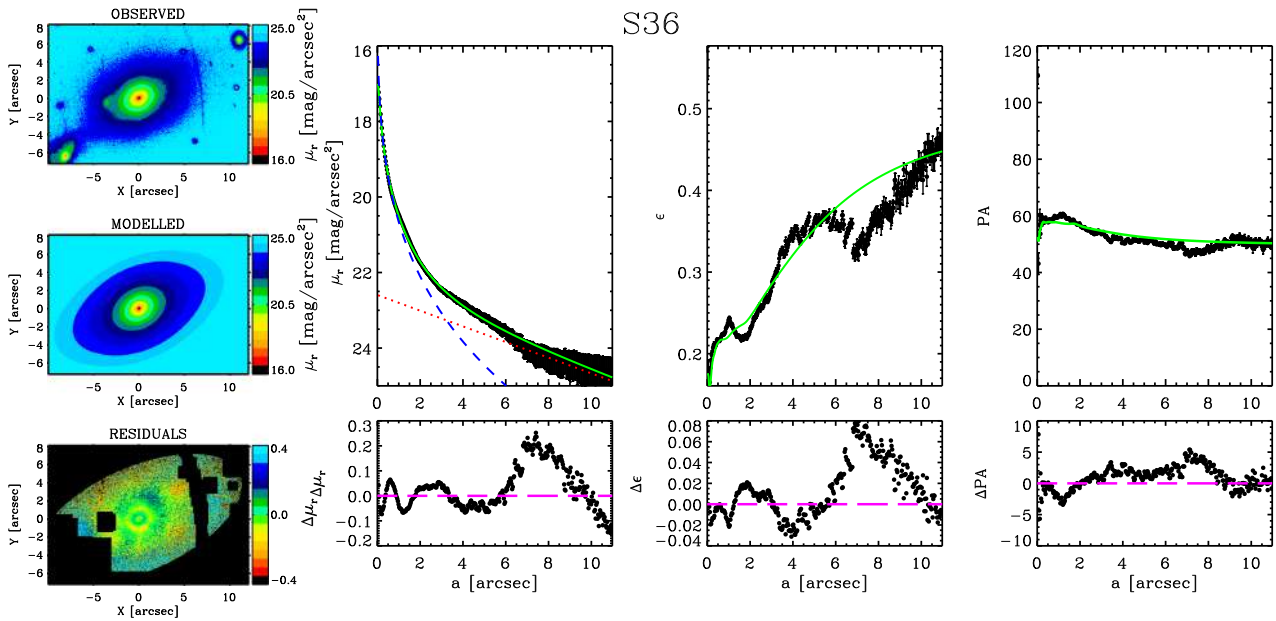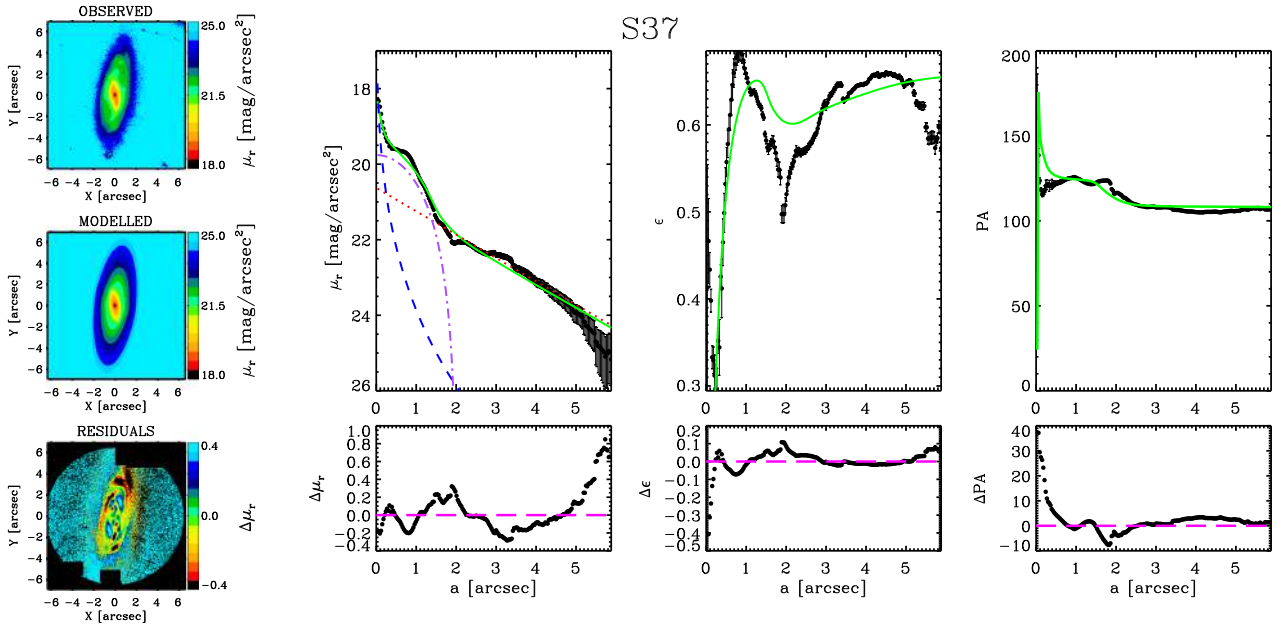**Figure A37.** As in Fig. A1 but for galaxy S38 (SeDisc model).

**Figure A38.** As in Fig. A1 but for galaxy S39 fitted with a `SeDiBar` model. The dash-dotted purple line represents the intrinsic surface-brightness radial profile of the bar along its semi major axis.



**Figure A39.** As in Fig. A1 but for galaxy S40 (`SeDisc` model).

**Figure A40.** As in Fig. A1 but for galaxy S41 (`SeDisc` model).



**Figure A41.** As in Fig. A1 but for galaxy S42 (`SeDisc` model).

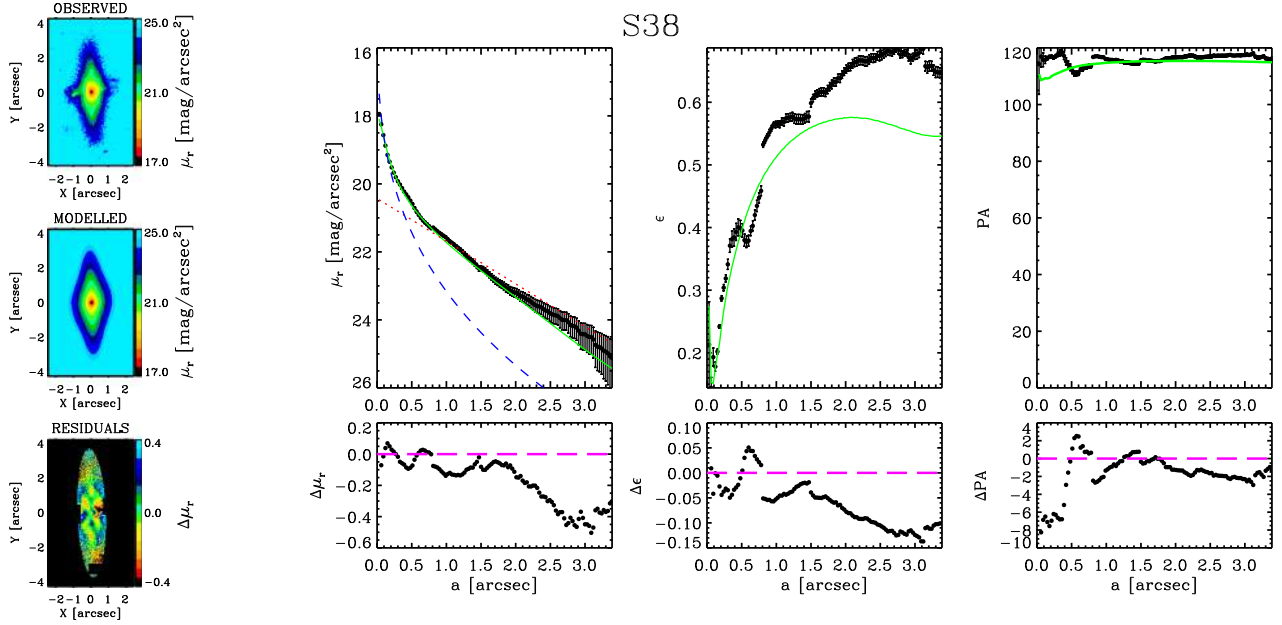**Figure A42.** As in Fig. A1 but for galaxy S43 fitted with a `SeDiBar` model. The dash-dotted purple line represents the intrinsic surface-brightness radial profile of the bar along its semi major axis.



**Figure A43.** As in Fig. A1 but for galaxy S44 (`SeDisc` model).
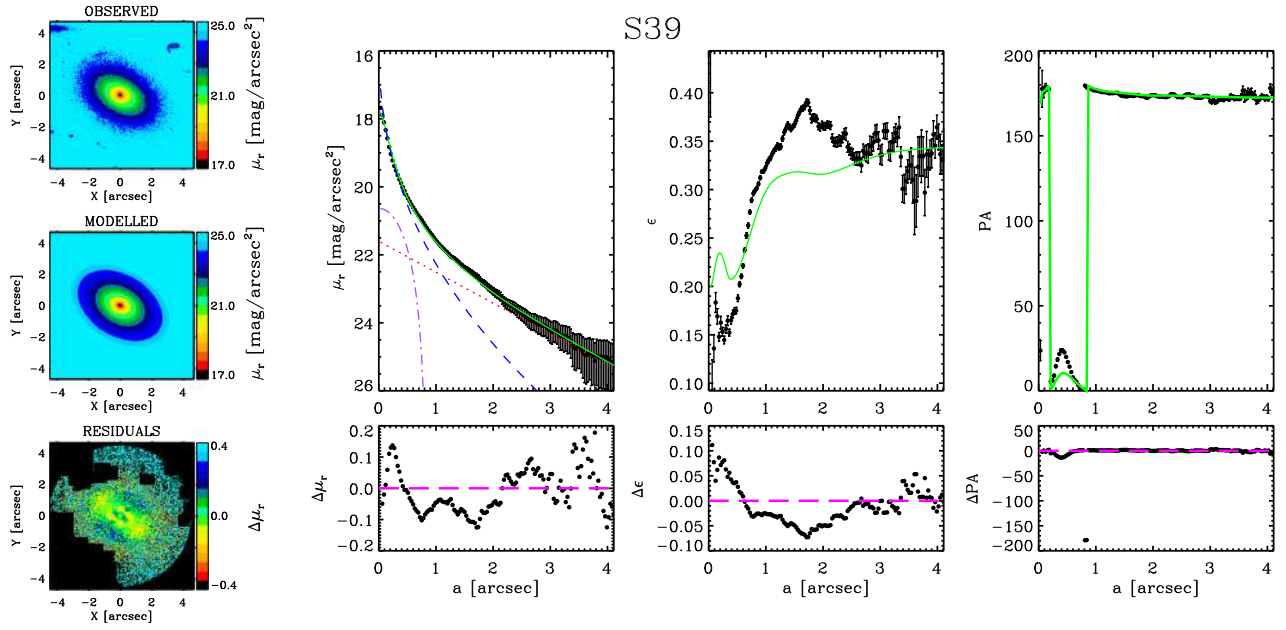
**Figure A44.** As in Fig. A1 but for galaxy S45 (`SeDisc` model).
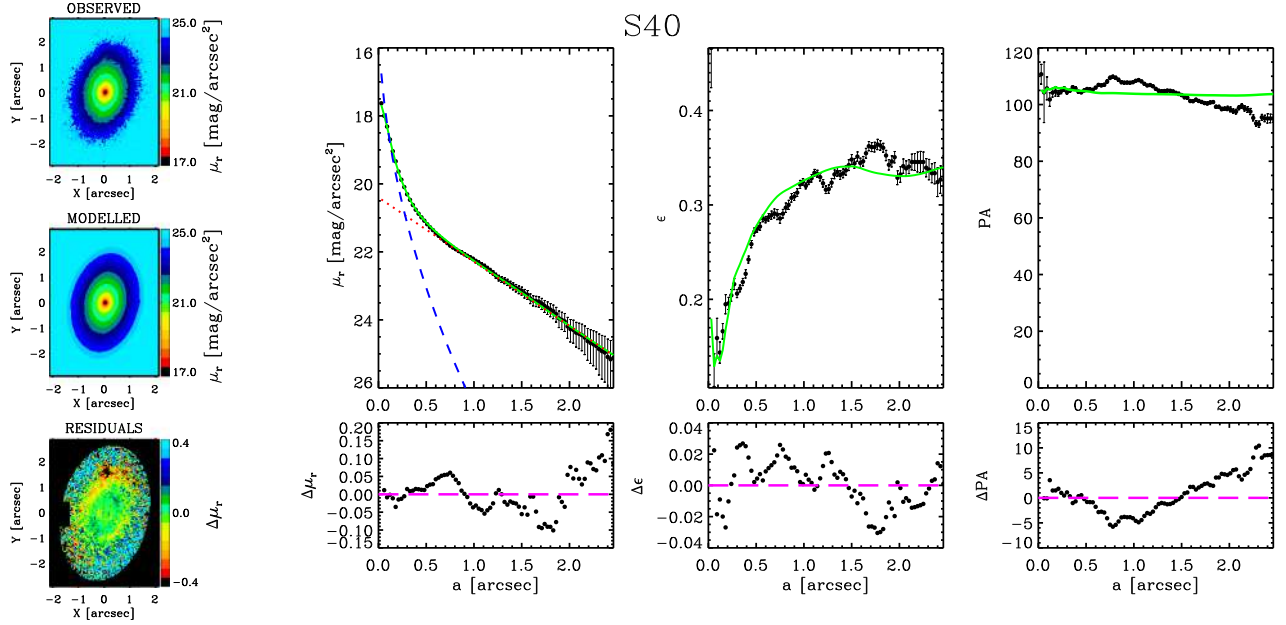


**Figure A45.** As in Fig. A1 but for galaxy S46 (`SeDisc` model).

**Figure A46.** As in Fig. A1 but for galaxy S47 (`SeDisc` model).



**Figure A47.** As in Fig. A1 but for galaxy S48 fitted with a `SeDiBar` model. The dash-dotted purple line represents the intrinsic surface-brightness radial profile of the bar along its semi major axis.

**Figure A48.** As in Fig. A1 but for galaxy S49 (`SeDisc` model).



**Figure A49.** As in Fig. A1 but for galaxy S50 fitted with a `SeDiBar` model. The dash-dotted purple line represents the intrinsic surface-brightness radial profile of the bar along its semi major axis.

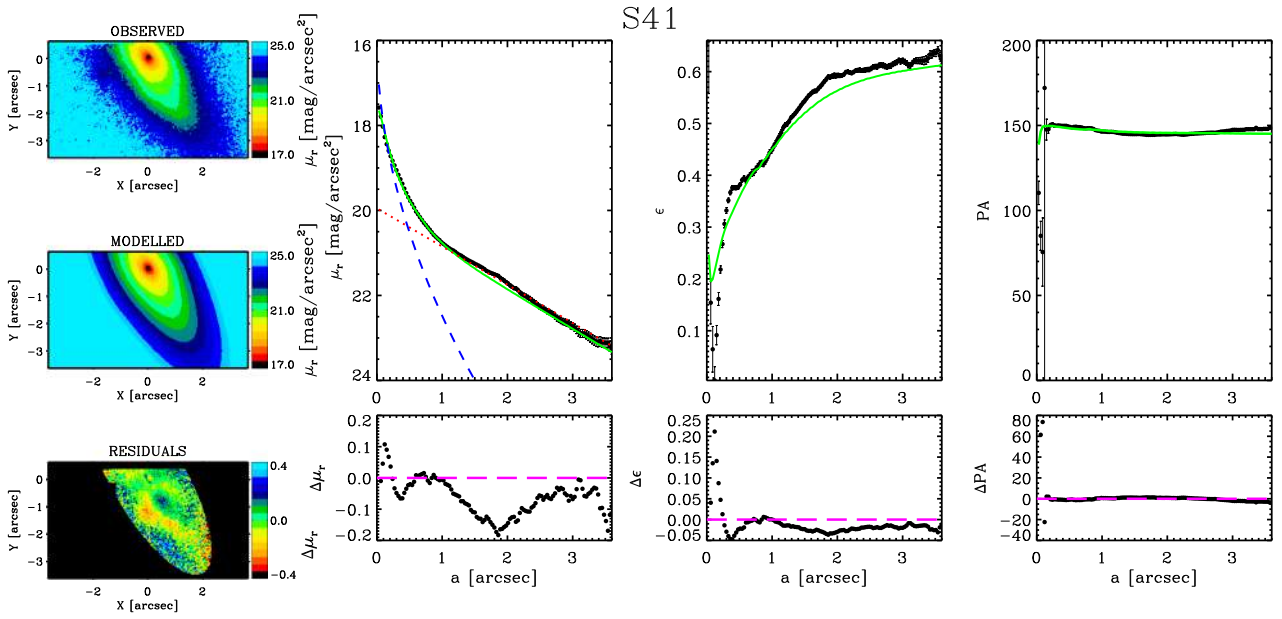**Figure A50.** As in Fig. A1 but for galaxy S51 (`SeDisc` model).



**Figure A51.** As in Fig. A1 but for galaxy S52 (`SeDisc` model).

**Figure A52.** As in Fig. A1 but for galaxy S53 (`SeDisc` model).



**Figure A53.** As in Fig. A1 but for galaxy S54 (`SeDisc` model).

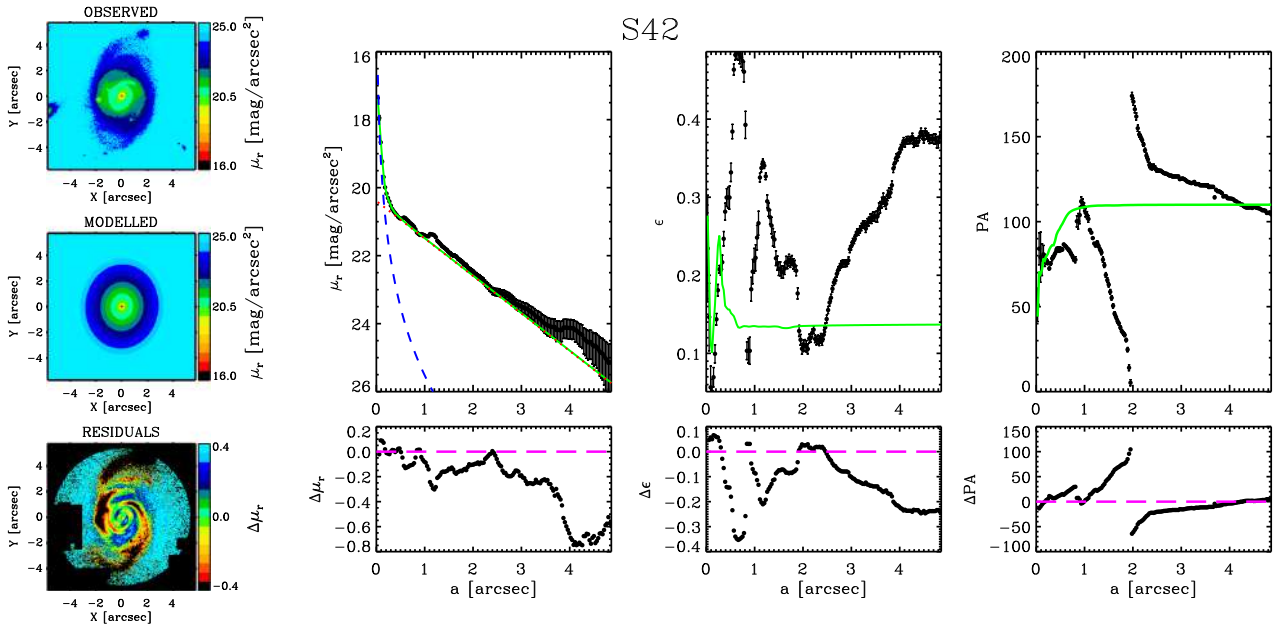**Figure A54.** As in Fig. A1 but for galaxy A01 (`SeDisc` model).



**Figure A55.** As in Fig. A1 but for galaxy A02 (`SeDisc` model).

**Figure A56.** As in Fig. A1 but for galaxy A03 (`SeDisc` model).



**Figure A57.** As in Fig. A1 but for galaxy A04 (`SeDisc` model).

**Figure A58.** As in Fig. A1 but for galaxy A05 fitted with a `Sérsic` model.



**Figure A59.** As in Fig. A1 but for galaxy A06 (`SeDisc` model).
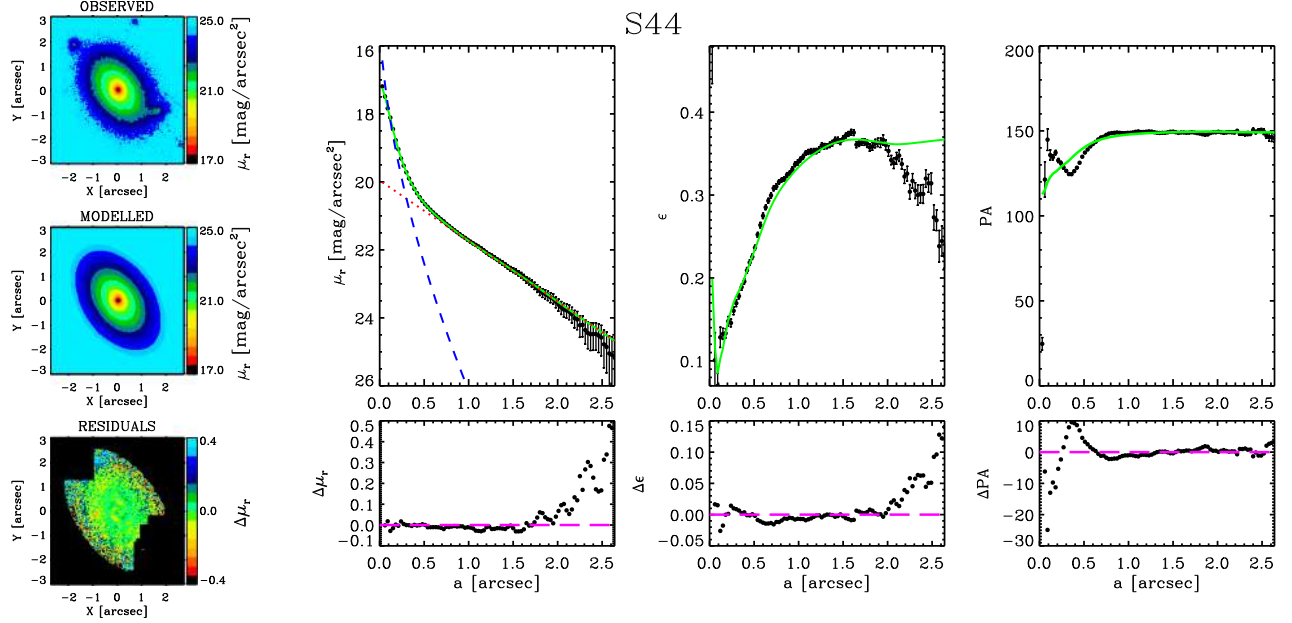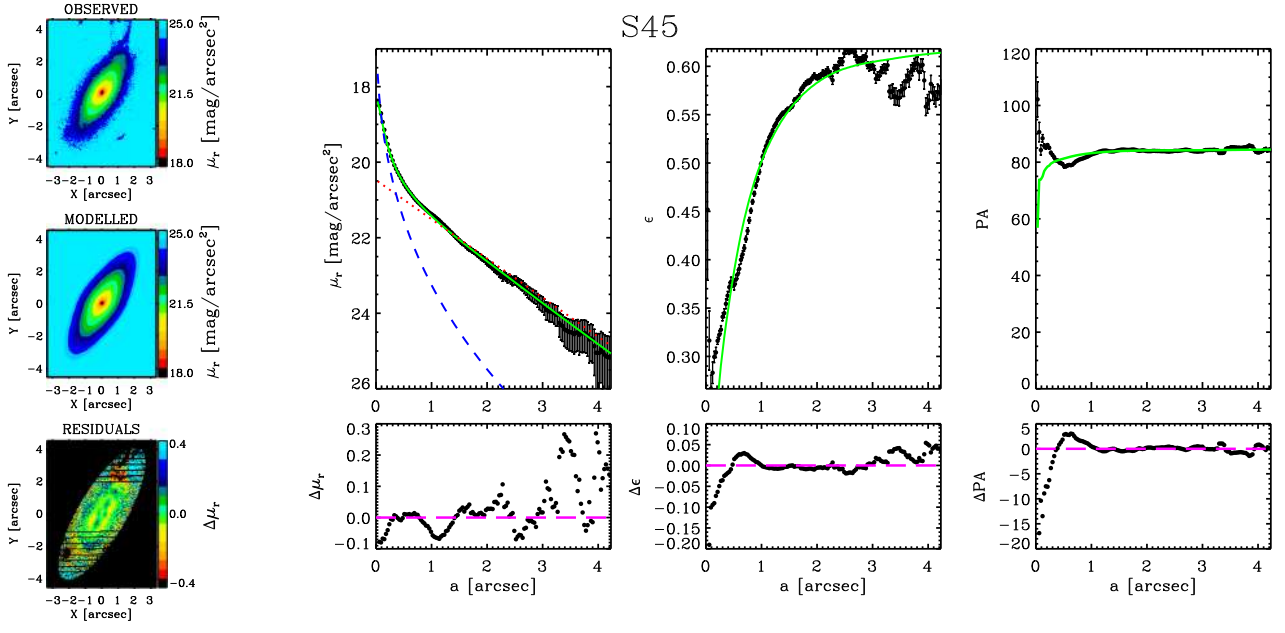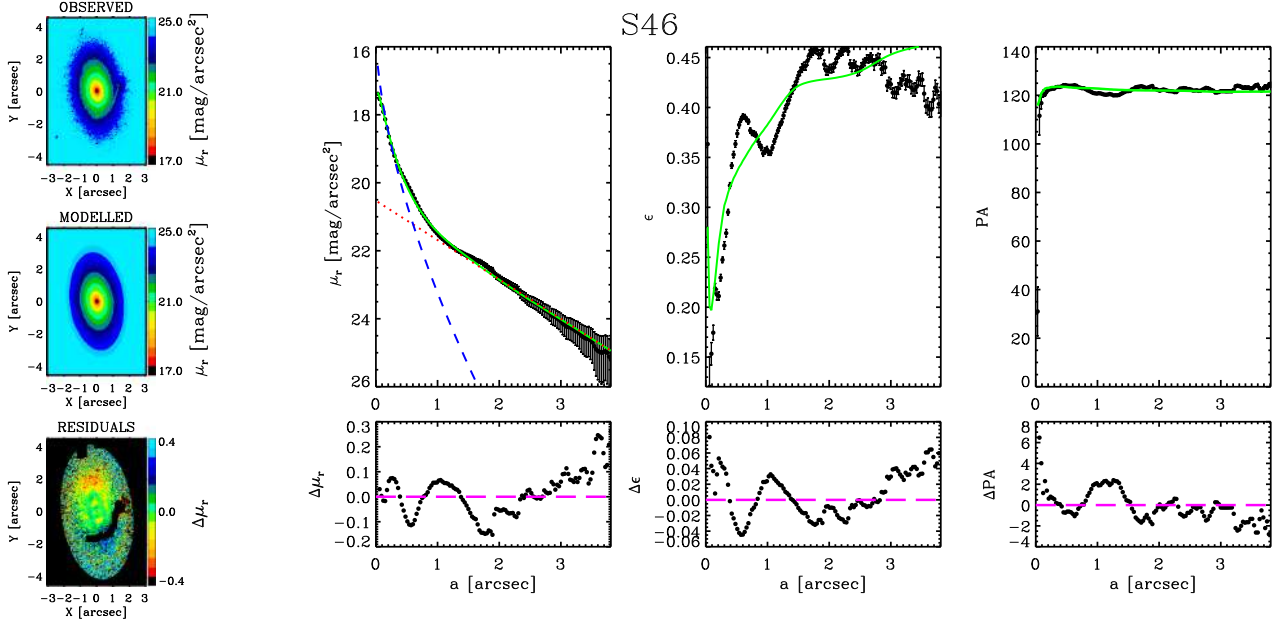
**Figure A60.** As in Fig. A1 but for galaxy A07 (`SeDisc` model).



**Figure A61.** As in Fig. A1 but for galaxy A08 (`SeDisc` model).

**Figure A62.** As in Fig. A1 but for galaxy A09 fitted with a `Sérsic` model.



**Figure A63.** As in Fig. A1 but for galaxy A10 (`SeDisc` model).

**Figure A64.** As in Fig. A1 but for galaxy A11 (`SeDisc` model).

**Table A1.** Structural photometric parameters of the sample galaxies.

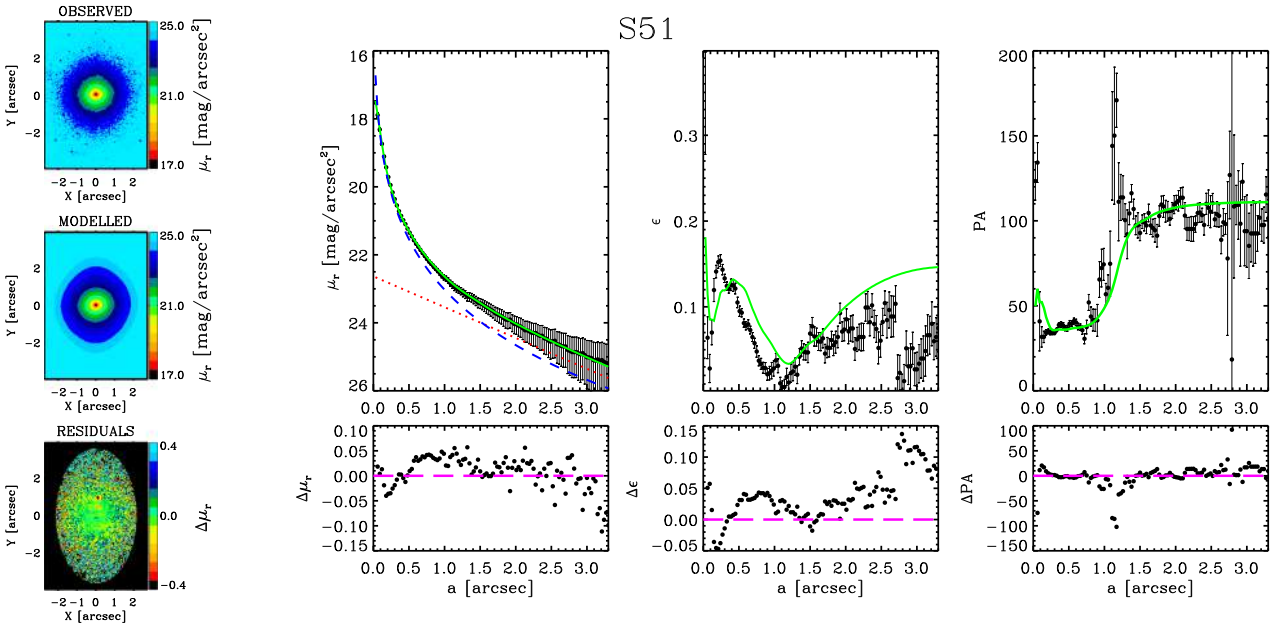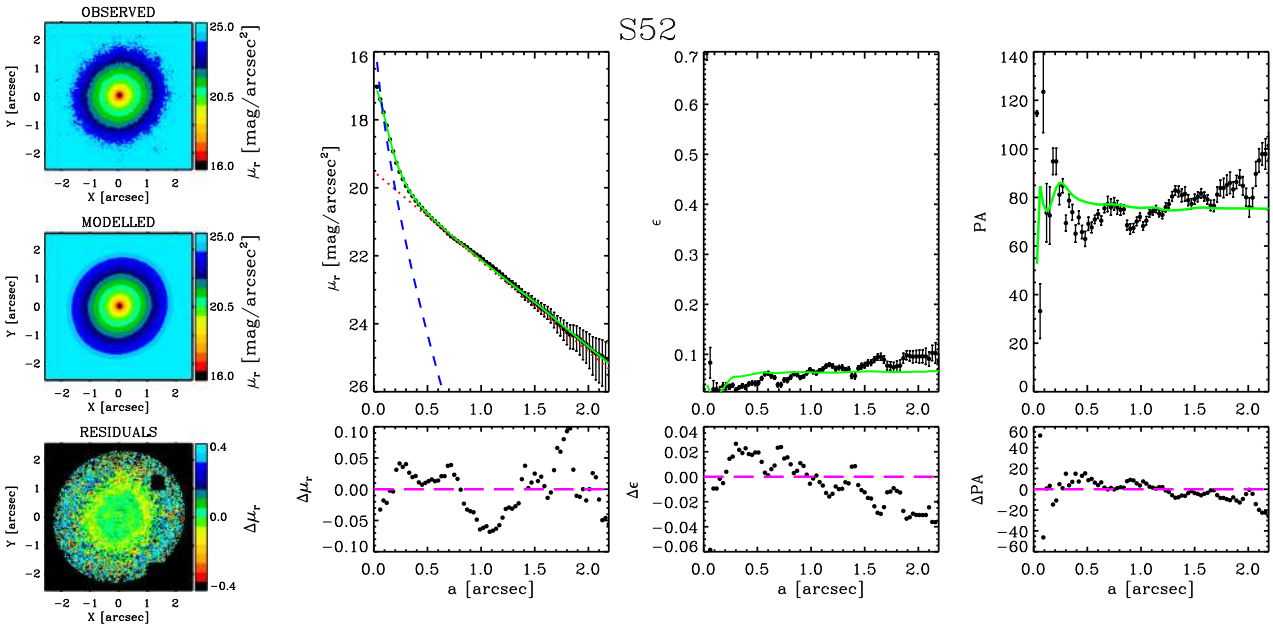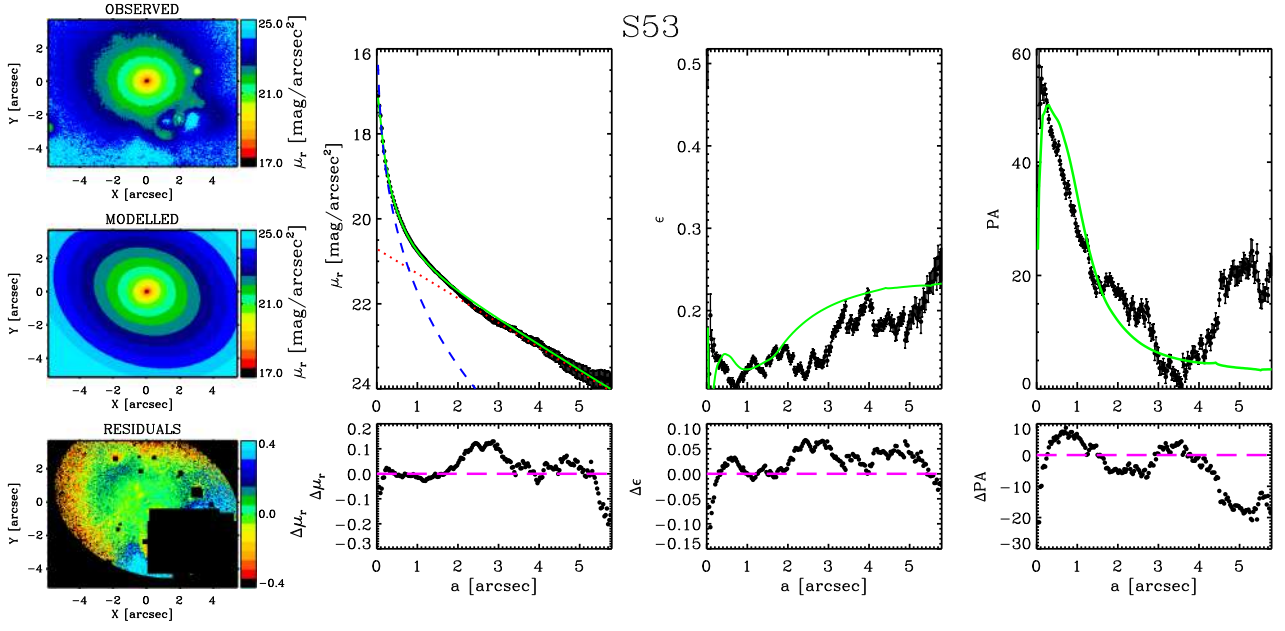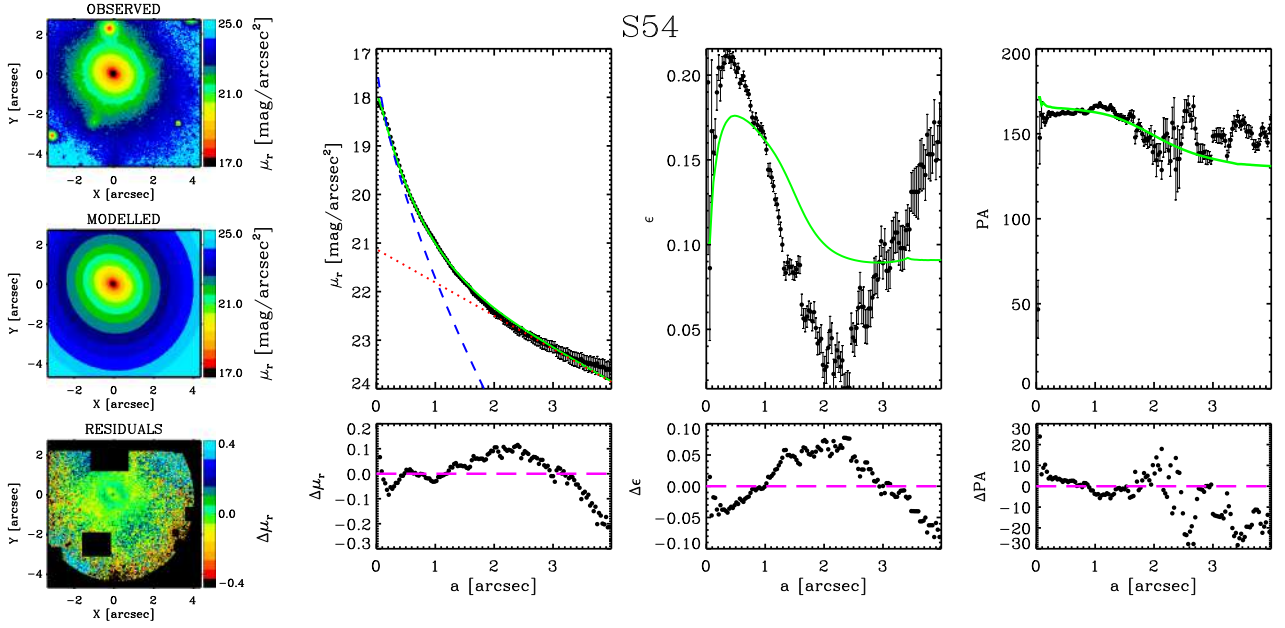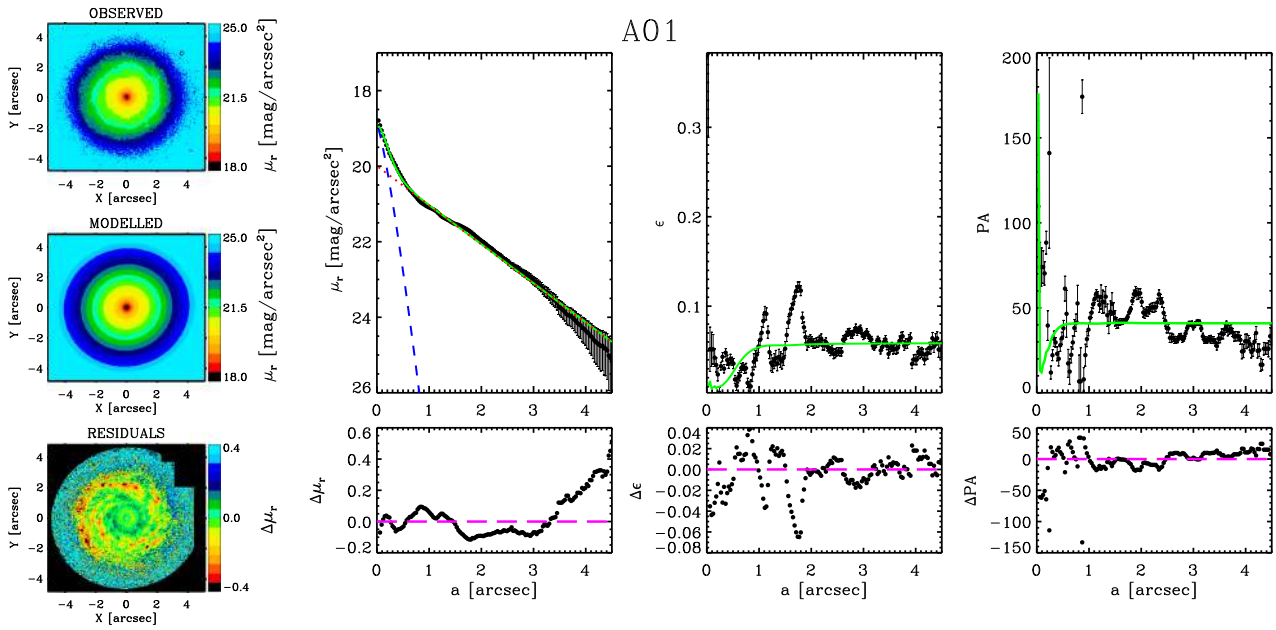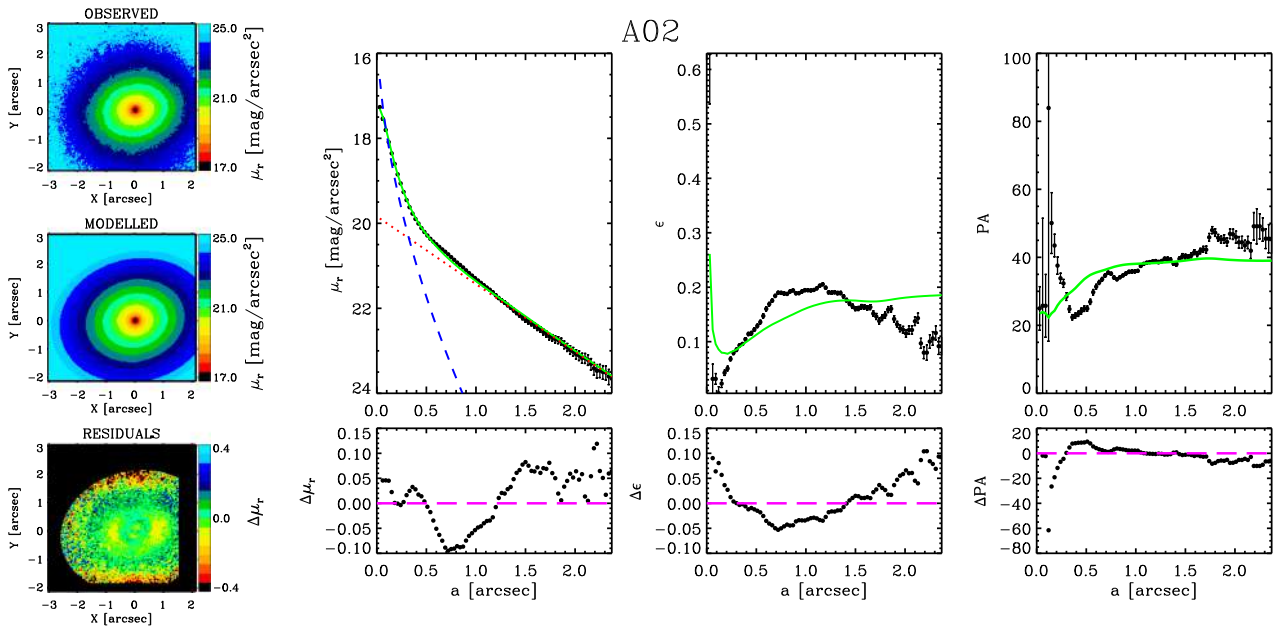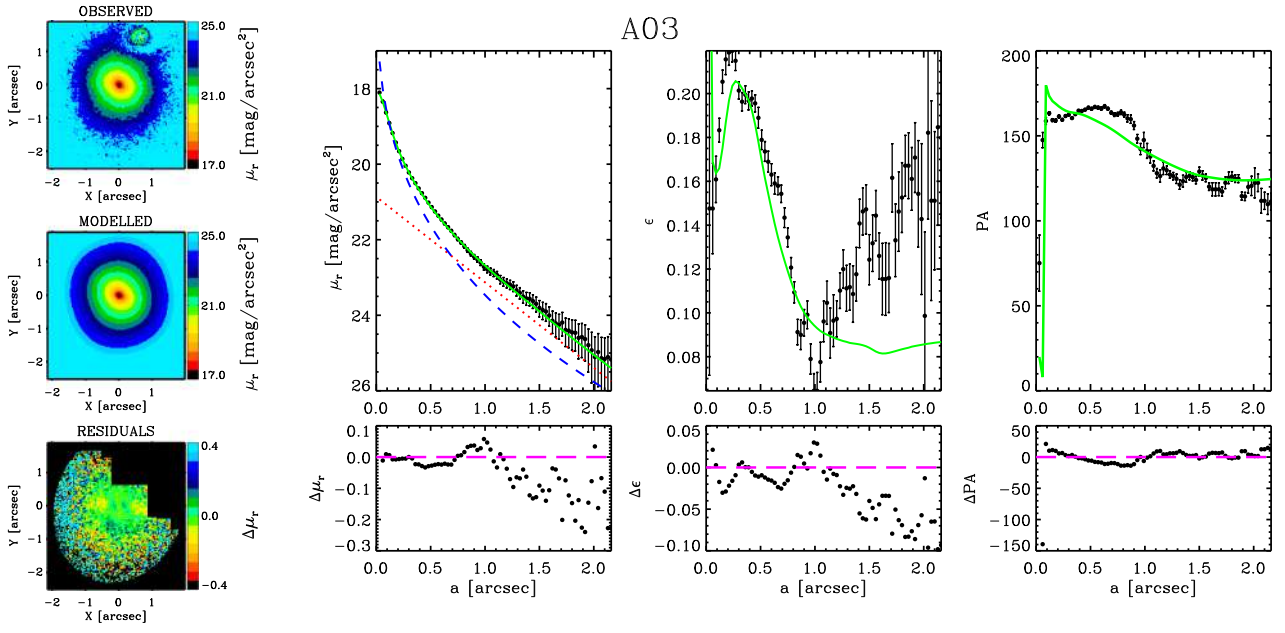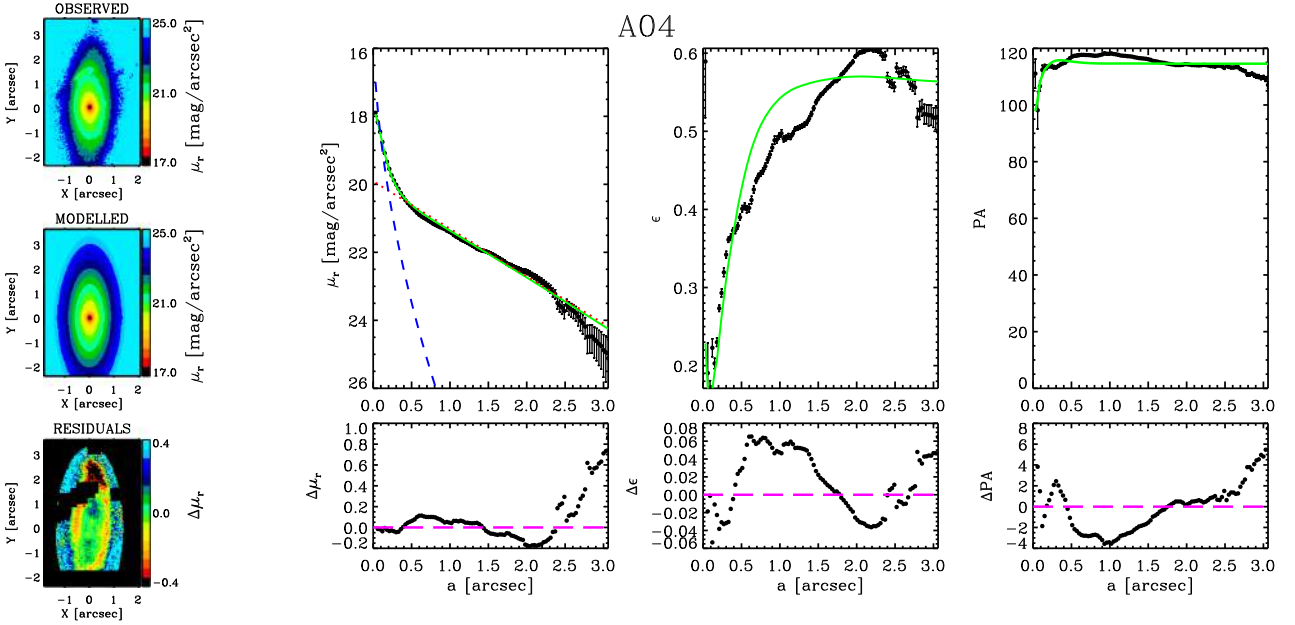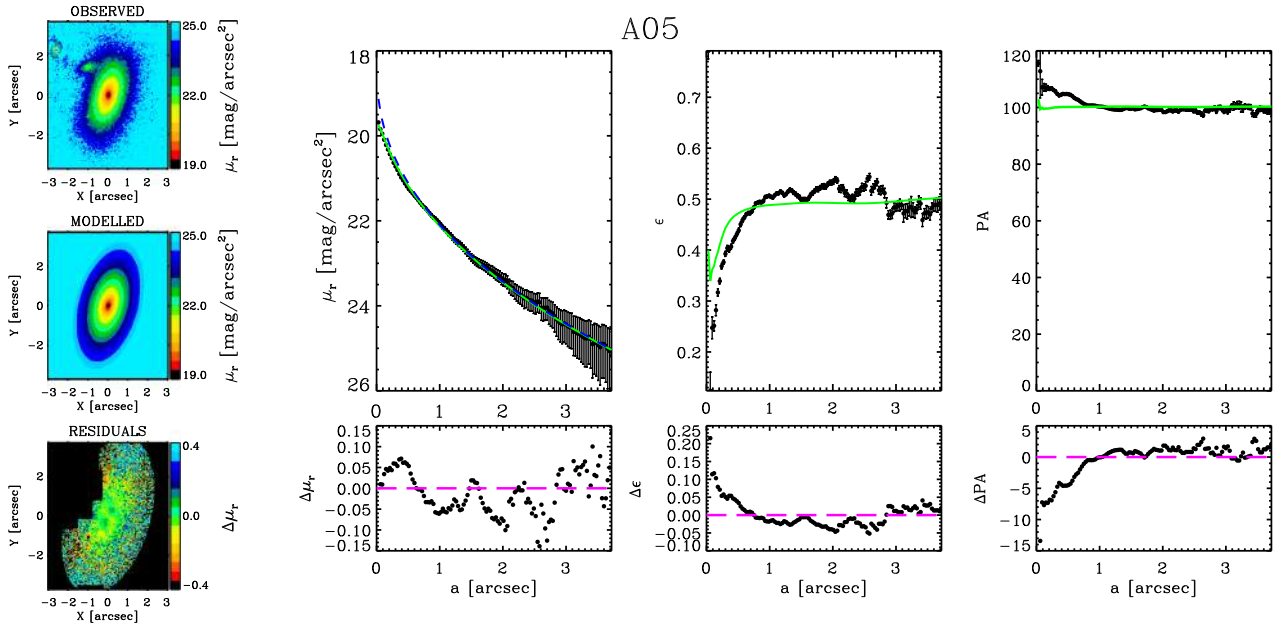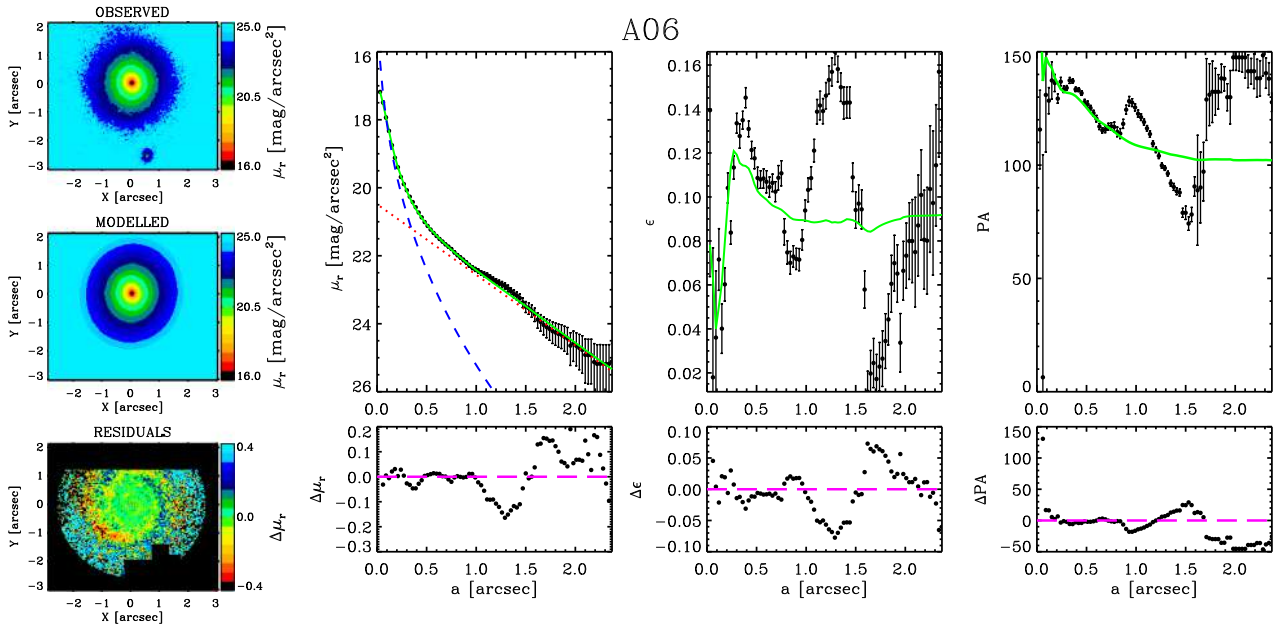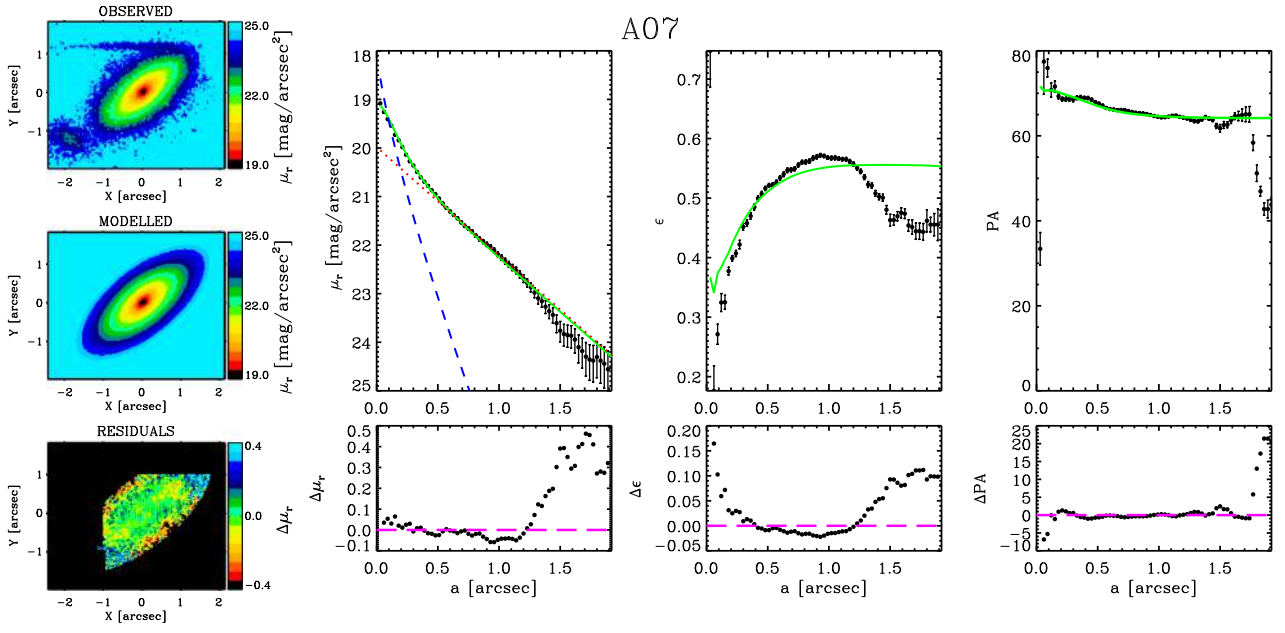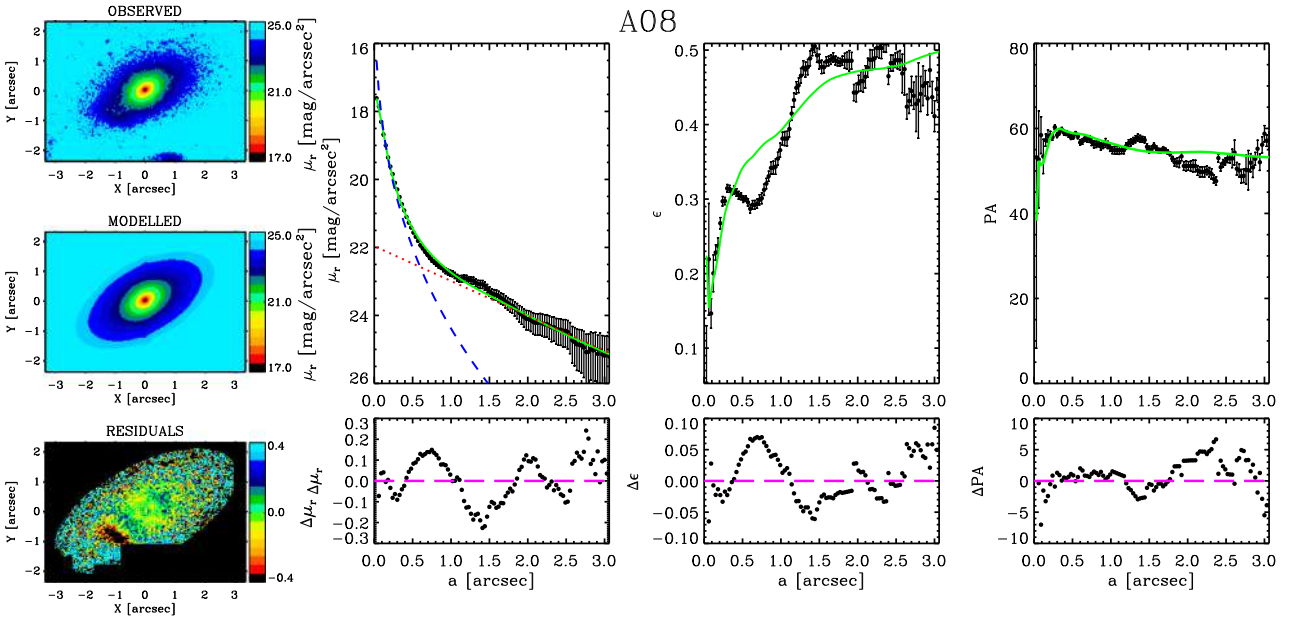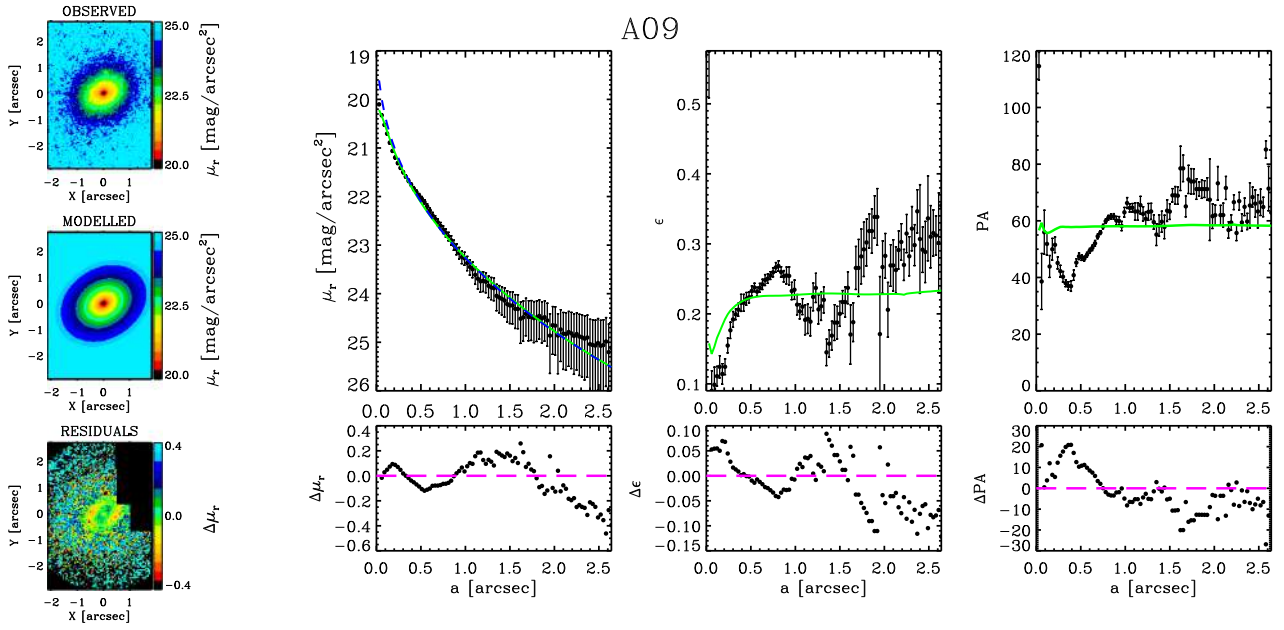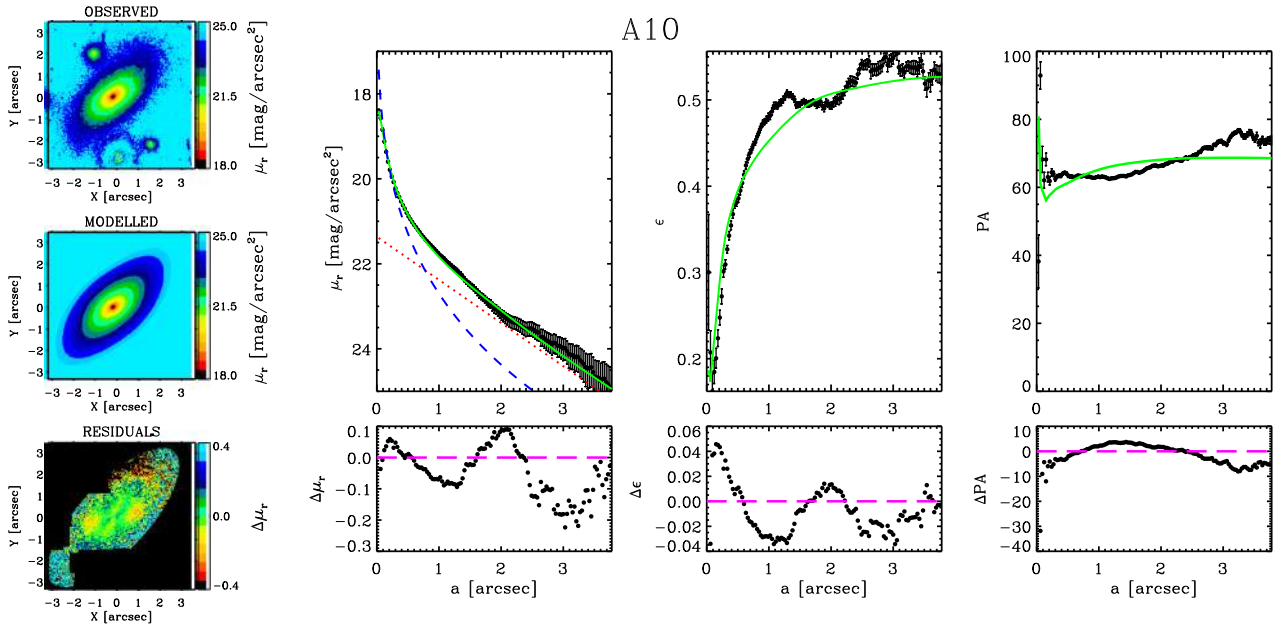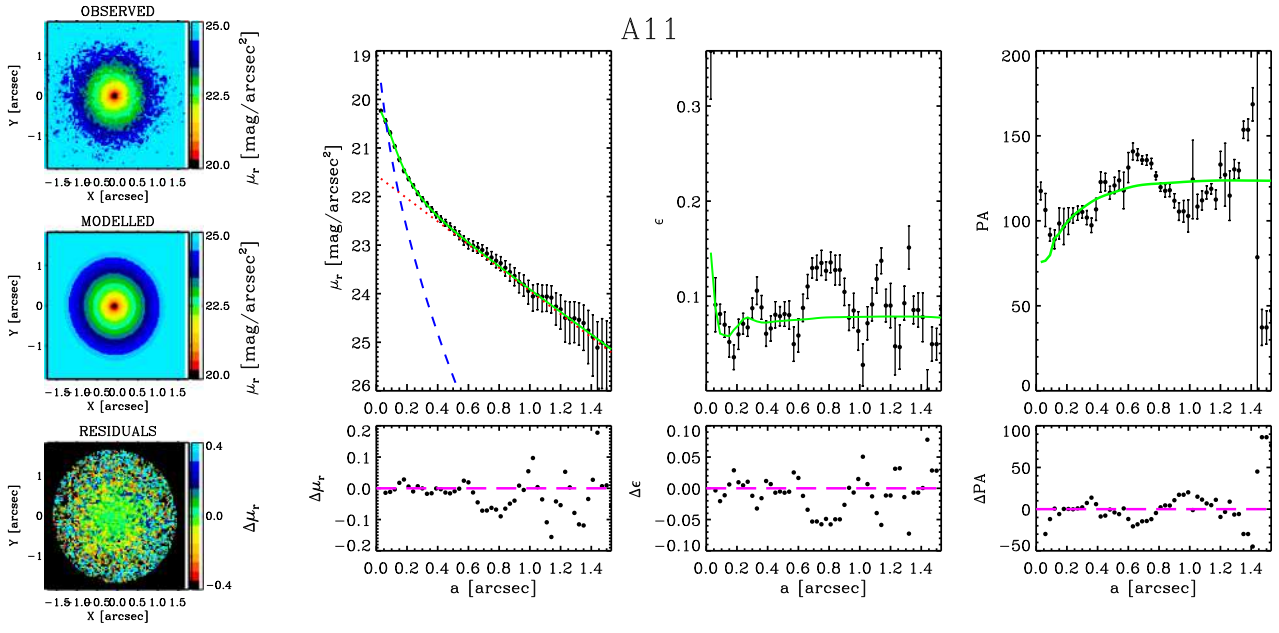| ID (1) | Model (2) | mag (mag) (3) | $\mu_e$ ($\frac{mag}{arcsec^2}$) (4) | $r_e$ (arcsec) (5) | $n$ (6) | $q_{bulge}$ (7) | $PA_{bulge}$ (°) (8) | $\mu_{0,disc}$ ($\frac{mag}{arcsec^2}$) (9) | $h$ (arcsec) (10) | $q_{disc}$ (11) | $PA_{disc}$ (°) (12) | $\mu_{0,bar}$ ($\frac{mag}{arcsec^2}$) (13) | $r_{bar}$ (arcsec) (14) | $q_{bar}$ (15) | $PA_{bar}$ (°) (16) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Spectroscopic sample | | | | | | | |
| S01 | SeDisc | 19.01 | 19.83 ± 0.12 | 0.22 ± 0.017 | 3.59 ± 0.12 | 0.71 ± 0.003 | 5.45 ± 0.38 | 20.10 ± 0.06 | 0.90 ± 0.019 | 0.34 ± 0.009 | 3.18 ± 0.27 | – | – | – | – |
| S02 | SeDisc | 18.77 | 18.22 ± 0.12 | 0.13 ± 0.010 | 1.28 ± 0.04 | 0.76 ± 0.003 | 147.28 ± 0.38 | 19.36 ± 0.06 | 0.73 ± 0.015 | 0.37 ± 0.009 | 160.10 ± 0.27 | – | – | – | – |
| S03 | SeDiBar | 17.54 | 20.55 ± 0.12 | 0.50 ± 0.037 | 1.45 ± 0.07 | 0.73 ± 0.001 | 117.68 ± 0.28 | 21.59 ± 0.05 | 2.26 ± 0.033 | 0.95 ± 0.006 | 135.12 ± 0.47 | 21.59 ± 0.05 | 4.62 ± 0.069 | 0.26 ± 0.006 | 101.82 ± 0.47 |
| S04 | Sérsic | 18.88 | 24.92 ± 0.05 | 2.94 ± 0.069 | 10.21 ± 0.11 | 0.85 ± 0.001 | 20.64 ± 0.12 | – | – | – | – | – | – | – | – |
| S05 | Sérsic | 18.71 | 21.62 ± 0.05 | 0.92 ± 0.022 | 3.93 ± 0.04 | 0.76 ± 0.001 | 36.11 ± 0.12 | – | – | – | – | – | – | – | – |
| S06 | Sérsic | 18.74 | 20.46 ± 0.05 | 0.62 ± 0.015 | 3.06 ± 0.03 | 0.64 ± 0.001 | 81.61 ± 0.12 | – | – | – | – | – | – | – | – |
| S07 | SeDisc | 20.10 | 21.33 ± 0.09 | 0.36 ± 0.020 | 1.11 ± 0.04 | 0.38 ± 0.004 | 129.93 ± 0.47 | 21.37 ± 0.05 | 1.13 ± 0.021 | 0.32 ± 0.008 | 129.38 ± 0.51 | – | – | – | – |
| S08 | SeDisc | 18.79 | 20.31 ± 0.12 | 0.36 ± 0.027 | 3.21 ± 0.11 | 0.78 ± 0.003 | 104.17 ± 0.38 | 21.63 ± 0.06 | 1.10 ± 0.023 | 0.88 ± 0.009 | 153.04 ± 0.27 | – | – | – | – |
| S09 | SeDisc | 18.53 | 21.37 ± 0.12 | 0.64 ± 0.049 | 5.62 ± 0.19 | 0.79 ± 0.003 | 63.50 ± 0.38 | 22.61 ± 0.06 | 1.73 ± 0.036 | 0.86 ± 0.009 | 147.45 ± 0.27 | – | – | – | – |
| S10 | SeDisc | 18.11 | 18.95 ± 0.10 | 0.24 ± 0.013 | 2.05 ± 0.06 | 0.97 ± 0.002 | 132.62 ± 0.28 | 20.52 ± 0.05 | 0.96 ± 0.014 | 0.93 ± 0.006 | 126.46 ± 0.47 | – | – | – | – |
| S11 | SeDisc | 19.23 | 19.17 ± 0.07 | 0.13 ± 0.004 | 3.05 ± 0.12 | 0.87 ± 0.004 | 129.27 ± 0.57 | 19.49 ± 0.01 | 0.67 ± 0.002 | 0.33 ± 0.001 | 119.78 ± 0.12 | – | – | – | – |
| S12 | SeDiBar | 18.28 | 19.76 ± 0.12 | 0.26 ± 0.020 | 2.18 ± 0.11 | 0.91 ± 0.002 | 146.62 ± 0.28 | 21.50 ± 0.05 | 1.43 ± 0.021 | 0.96 ± 0.006 | 141.21 ± 0.47 | 22.45 ± 0.05 | 3.78 ± 0.056 | 0.35 ± 0.006 | 87.04 ± 0.47 |
| S13 | SeDisc | 18.65 | 20.18 ± 0.12 | 0.39 ± 0.029 | 2.71 ± 0.09 | 0.54 ± 0.003 | 129.33 ± 0.38 | 20.35 ± 0.06 | 0.92 ± 0.019 | 0.57 ± 0.009 | 141.66 ± 0.27 | – | – | – | – |
| S14 | SeDisc | 18.88 | 19.33 ± 0.12 | 0.23 ± 0.018 | 2.44 ± 0.08 | 0.89 ± 0.003 | 93.02 ± 0.38 | 21.81 ± 0.06 | 1.08 ± 0.023 | 0.88 ± 0.009 | 102.83 ± 0.27 | – | – | – | – |
| S15 | SeDiBar | 19.65 | 18.95 ± 0.11 | 0.09 ± 0.007 | 1.52 ± 0.09 | 0.76 ± 0.004 | 15.53 ± 0.47 | 20.85 ± 0.05 | 0.76 ± 0.014 | 0.60 ± 0.008 | 25.32 ± 0.52 | 21.29 ± 0.05 | 1.32 ± 0.025 | 0.32 ± 0.008 | 43.58 ± 0.52 |
| S16 | SeDisc | 18.39 | 20.50 ± 0.10 | 0.47 ± 0.026 | 2.74 ± 0.08 | 0.75 ± 0.002 | 116.49 ± 0.28 | 21.35 ± 0.05 | 1.23 ± 0.018 | 0.87 ± 0.006 | 35.48 ± 0.47 | – | – | – | – |
| S18 | SeDisc | 15.82 | 21.63 ± 0.00 | 2.52 ± 0.014 | 0.96 ± 0.01 | 0.83 ± 0.001 | 157.06 ± 0.17 | 22.40 ± 0.03 | 7.70 ± 0.169 | 0.81 ± 0.002 | 152.35 ± 0.26 | – | – | – | – |
| S19 | SeDisc | 19.50 | 19.12 ± 0.12 | 0.15 ± 0.011 | 2.08 ± 0.07 | 0.87 ± 0.003 | 79.39 ± 0.38 | 20.81 ± 0.06 | 0.60 ± 0.013 | 0.81 ± 0.009 | 98.27 ± 0.27 | – | – | – | – |
| S20 | SeDiBar | 19.75 | 18.80 ± 0.11 | 0.09 ± 0.006 | 1.07 ± 0.06 | 0.70 ± 0.004 | 7.80 ± 0.47 | 20.38 ± 0.05 | 0.63 ± 0.012 | 0.52 ± 0.008 | 5.31 ± 0.52 | 21.60 ± 0.05 | 1.20 ± 0.023 | 0.50 ± 0.008 | 136.78 ± 0.52 |
| S21 | SeDiBar | 18.42 | 19.11 ± 0.12 | 0.14 ± 0.011 | 1.27 ± 0.06 | 0.82 ± 0.002 | 154.07 ± 0.28 | 20.36 ± 0.05 | 1.04 ± 0.015 | 0.67 ± 0.006 | 46.45 ± 0.47 | 21.83 ± 0.05 | 3.09 ± 0.046 | 0.31 ± 0.006 | 74.02 ± 0.47 |
| S22 | SeDisc | 18.63 | 19.66 ± 0.12 | 0.30 ± 0.023 | 2.61 ± 0.09 | 0.91 ± 0.003 | 16.50 ± 0.38 | 21.48 ± 0.06 | 1.15 ± 0.024 | 0.69 ± 0.009 | 21.69 ± 0.27 | – | – | – | – |
| S23 | SeDisc | 19.55 | 19.66 ± 0.09 | 0.26 ± 0.014 | 2.15 ± 0.07 | 0.60 ± 0.004 | 60.44 ± 0.47 | 21.04 ± 0.05 | 0.67 ± 0.013 | 0.54 ± 0.008 | 29.34 ± 0.51 | – | – | – | – |
| S24 | SeDisc | 18.38 | 19.82 ± 0.10 | 0.29 ± 0.016 | 2.01 ± 0.06 | 0.93 ± 0.002 | 121.71 ± 0.28 | 20.34 ± 0.05 | 0.85 ± 0.013 | 0.87 ± 0.006 | 122.38 ± 0.47 | – | – | – | – |
| S25 | SeDiBar | 18.82 | 21.42 ± 0.15 | 0.50 ± 0.051 | 5.32 ± 0.31 | 0.92 ± 0.003 | 13.49 ± 0.38 | 21.78 ± 0.06 | 1.09 ± 0.023 | 0.80 ± 0.009 | 159.84 ± 0.27 | 21.06 ± 0.06 | 1.17 ± 0.025 | 0.44 ± 0.009 | 25.24 ± 0.27 |
| S26 | SeDisc | 18.81 | 19.78 ± 0.12 | 0.33 ± 0.025 | 2.61 ± 0.09 | 0.80 ± 0.003 | 52.62 ± 0.38 | 20.65 ± 0.06 | 0.69 ± 0.014 | 0.66 ± 0.009 | 54.01 ± 0.27 | – | – | – | – |
| S27 | Sérsic | 17.72 | 24.27 ± 0.04 | 4.03 ± 0.092 | 6.79 ± 0.06 | 0.88 ± 0.001 | 66.02 ± 0.09 | – | – | – | – | – | – | – | – |
| S28 | Sérsic | 17.29 | 21.28 ± 0.03 | 1.72 ± 0.026 | 2.13 ± 0.01 | 0.80 ± 0.000 | 144.20 ± 0.06 | – | – | – | – | – | – | – | – |
| S29 | SeDisc | 19.48 | 19.46 ± 0.12 | 0.11 ± 0.008 | 2.57 ± 0.09 | 0.86 ± 0.003 | 106.13 ± 0.38 | 20.11 ± 0.06 | 0.69 ± 0.015 | 0.48 ± 0.009 | 24.19 ± 0.27 | – | – | – | – |
| S30 | SeDisc | 18.74 | 20.90 ± 0.12 | 0.58 ± 0.044 | 3.81 ± 0.13 | 0.83 ± 0.003 | 91.84 ± 0.38 | 22.22 ± 0.06 | 1.02 ± 0.021 | 0.65 ± 0.009 | 82.89 ± 0.27 | – | – | – | – |
| S31 | Sérsic | 18.38 | 22.17 ± 0.04 | 1.38 ± 0.032 | 4.36 ± 0.04 | 0.73 ± 0.001 | 174.35 ± 0.09 | – | – | – | – | – | – | – | – |
| S32 | SeDisc | 19.39 | 19.70 ± 0.12 | 0.22 ± 0.017 | 1.13 ± 0.04 | 0.77 ± 0.003 | 94.29 ± 0.38 | 21.41 ± 0.06 | 1.09 ± 0.023 | 0.56 ± 0.009 | 75.04 ± 0.27 | – | – | – | – |
| S33 | SeDisc | 18.03 | 19.20 ± 0.10 | 0.27 ± 0.015 | 2.01 ± 0.06 | 0.92 ± 0.002 | 160.54 ± 0.28 | 20.63 ± 0.05 | 1.10 ± 0.016 | 0.92 ± 0.006 | 99.91 ± 0.47 | – | – | – | – |
| S34 | SeDisc | 16.77 | 21.15 ± 0.06 | 1.57 ± 0.057 | 3.73 ± 0.06 | 0.73 ± 0.001 | 97.05 ± 0.19 | 21.98 ± 0.06 | 3.54 ± 0.082 | 0.47 ± 0.009 | 89.18 ± 0.36 | – | – | – | – |
| S35 | SeDisc | 20.50 | 21.52 ± 0.09 | 0.35 ± 0.019 | 3.41 ± 0.12 | 0.51 ± 0.004 | 75.34 ± 0.47 | 21.42 ± 0.05 | 0.52 ± 0.010 | 0.66 ± 0.008 | 69.32 ± 0.51 | – | – | – | – |

**Table A1** – *continued*

| ID (1) | Model (2) | mag (mag) (3) | $\mu_e$ $\left(\frac{mag}{arcsec^2}\right)$ (4) | $r_e$ (arcsec) (5) | $n$ (6) | $q_{bulge}$ (7) | $PA_{bulge}$ (°) (8) | $\mu_{0,disc}$ $\left(\frac{mag}{arcsec^2}\right)$ (9) | $h$ (arcsec) (10) | $q_{disc}$ (11) | $PA_{disc}$ (°) (12) | $\mu_{0,bar}$ $\left(\frac{mag}{arcsec^2}\right)$ (13) | $r_{bar}$ (arcsec) (14) | $q_{bar}$ (15) | $PA_{bar}$ (°) (16) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S36 | SeDisc | 16.90 | 21.35 ± 0.06 | 1.41 ± 0.051 | 3.89 ± 0.07 | 0.77 ± 0.001 | 58.05 ± 0.19 | 22.60 ± 0.06 | 5.23 ± 0.122 | 0.47 ± 0.009 | 49.10 ± 0.36 | ... | – | – | – |
| S37 | SeDiBar | 18.19 | 21.74 ± 0.12 | 0.41 ± 0.030 | 3.71 ± 0.18 | 0.70 ± 0.002 | 152.99 ± 0.28 | 20.63 ± 0.05 | 1.76 ± 0.026 | 0.32 ± 0.006 | 107.62 ± 0.47 | 19.76 ± 0.05 | 2.06 ± 0.031 | 0.28 ± 0.006 | 125.65 ± 0.47 |
| S38 | SeDisc | 19.47 | 20.91 ± 0.12 | 0.39 ± 0.030 | 3.05 ± 0.11 | 0.72 ± 0.003 | 107.05 ± 0.38 | 20.43 ± 0.06 | 0.86 ± 0.018 | 0.21 ± 0.009 | 117.22 ± 0.27 | ... | – | – | – |
| S39 | SeDiBar | 18.74 | 20.26 ± 0.15 | 0.44 ± 0.045 | 2.25 ± 0.13 | 0.66 ± 0.003 | 177.61 ± 0.38 | 21.60 ± 0.06 | 1.19 ± 0.025 | 0.65 ± 0.009 | 171.71 ± 0.27 | 20.63 ± 0.06 | 0.86 ± 0.018 | 0.44 ± 0.009 | 63.01 ± 0.27 |
| S40 | SeDisc | 19.62 | 18.69 ± 0.02 | 0.11 ± 0.001 | 1.97 ± 0.03 | 0.70 ± 0.003 | 106.99 ± 0.47 | 20.40 ± 0.01 | 0.58 ± 0.003 | 0.64 ± 0.002 | 103.54 ± 0.24 | ... | – | – | – |
| S41 | SeDisc | 18.27 | 19.81 ± 0.10 | 0.36 ± 0.020 | 1.93 ± 0.06 | 0.68 ± 0.002 | 150.16 ± 0.28 | 19.95 ± 0.05 | 1.21 ± 0.018 | 0.34 ± 0.006 | 145.07 ± 0.47 | ... | – | – | – |
| S42 | SeDisc | 18.52 | 17.01 ± 0.07 | 0.04 ± 0.001 | 9.93 ± 0.39 | 0.35 ± 0.004 | 78.42 ± 0.57 | 20.39 ± 0.01 | 0.98 ± 0.003 | 0.86 ± 0.001 | 110.87 ± 0.12 | ... | – | – | – |
| S43 | SeDiBar | 19.68 | 18.70 ± 0.11 | 0.08 ± 0.006 | 0.50 ± 0.03 | 0.75 ± 0.004 | 99.52 ± 0.47 | 20.55 ± 0.05 | 0.56 ± 0.011 | 0.96 ± 0.008 | 43.90 ± 0.52 | 21.63 ± 0.05 | 1.18 ± 0.022 | 0.25 ± 0.008 | 65.39 ± 0.52 |
| S44 | SeDisc | 19.06 | 18.34 ± 0.12 | 0.13 ± 0.010 | 1.69 ± 0.06 | 0.78 ± 0.003 | 126.51 ± 0.38 | 19.96 ± 0.06 | 0.61 ± 0.013 | 0.61 ± 0.009 | 149.46 ± 0.27 | ... | – | – | – |
| S45 | SeDisc | 19.14 | 21.10 ± 0.12 | 0.41 ± 0.031 | 2.74 ± 0.09 | 0.69 ± 0.003 | 77.11 ± 0.38 | 20.47 ± 0.06 | 1.05 ± 0.022 | 0.32 ± 0.009 | 84.92 ± 0.27 | ... | – | – | – |
| S46 | SeDisc | 18.68 | 18.86 ± 0.12 | 0.24 ± 0.019 | 1.63 ± 0.06 | 0.62 ± 0.003 | 123.56 ± 0.38 | 20.53 ± 0.06 | 0.94 ± 0.020 | 0.53 ± 0.009 | 121.53 ± 0.27 | ... | – | – | – |
| S47 | SeDisc | 19.58 | 21.90 ± 0.09 | 0.49 ± 0.026 | 4.07 ± 0.14 | 0.87 ± 0.004 | 134.40 ± 0.47 | 21.79 ± 0.05 | 0.76 ± 0.014 | 0.94 ± 0.008 | 67.34 ± 0.51 | ... | – | – | – |
| S48 | SeDiBar | 19.14 | 20.79 ± 0.15 | 0.36 ± 0.037 | 4.12 ± 0.24 | 0.89 ± 0.003 | 114.25 ± 0.38 | 22.00 ± 0.06 | 1.02 ± 0.021 | 0.79 ± 0.009 | 133.57 ± 0.27 | 21.96 ± 0.06 | 1.09 ± 0.023 | 0.64 ± 0.009 | 85.30 ± 0.27 |
| S49 | SeDisc | 17.39 | 19.98 ± 0.06 | 0.50 ± 0.018 | 2.72 ± 0.05 | 0.95 ± 0.001 | 0.73 ± 0.19 | 20.77 ± 0.06 | 1.55 ± 0.036 | 0.88 ± 0.009 | 141.83 ± 0.36 | ... | – | – | – |
| S50 | SeDiBar | 19.43 | 18.92 ± 0.15 | 0.10 ± 0.011 | 1.98 ± 0.12 | 0.93 ± 0.003 | 60.03 ± 0.38 | 20.78 ± 0.06 | 0.67 ± 0.014 | 0.77 ± 0.009 | 9.30 ± 0.27 | 21.59 ± 0.06 | 1.26 ± 0.026 | 0.61 ± 0.009 | 38.02 ± 0.27 |
| S51 | SeDisc | 19.21 | 22.11 ± 0.12 | 0.66 ± 0.050 | 7.62 ± 0.26 | 0.82 ± 0.003 | 33.77 ± 0.38 | 22.63 ± 0.06 | 1.20 ± 0.025 | 0.62 ± 0.009 | 115.75 ± 0.27 | ... | – | – | – |
| S52 | SeDisc | 19.11 | 17.75 ± 0.07 | 0.08 ± 0.003 | 1.57 ± 0.06 | 0.93 ± 0.004 | 93.39 ± 0.57 | 19.52 ± 0.01 | 0.41 ± 0.001 | 0.93 ± 0.001 | 75.64 ± 0.12 | ... | – | – | – |
| S53 | SeDisc | 17.27 | 20.87 ± 0.06 | 0.68 ± 0.025 | 3.97 ± 0.07 | 0.82 ± 0.001 | 51.20 ± 0.19 | 20.71 ± 0.06 | 1.87 ± 0.044 | 0.74 ± 0.009 | 1.38 ± 0.36 | ... | – | – | – |
| S54 | SeDisc | 17.76 | 20.03 ± 0.10 | 0.50 ± 0.028 | 1.49 ± 0.04 | 0.80 ± 0.002 | 164.95 ± 0.28 | 21.13 ± 0.05 | 1.59 ± 0.024 | 0.91 ± 0.006 | 130.19 ± 0.47 | ... | – | – | – |
| | | | | | | | | Ancillary sample | | | | | | | |
| A01 | SeDisc | 17.90 | 20.28 ± 0.10 | 0.22 ± 0.012 | 0.80 ± 0.02 | 1.00 ± 0.002 | 115.12 ± 0.28 | 20.00 ± 0.05 | 1.05 ± 0.016 | 0.94 ± 0.006 | 40.83 ± 0.47 | ... | ... | ... | ... |
| A02 | SeDisc | 18.51 | 18.82 ± 0.12 | 0.17 ± 0.013 | 1.84 ± 0.06 | 0.91 ± 0.003 | 25.88 ± 0.38 | 19.84 ± 0.06 | 0.68 ± 0.014 | 0.81 ± 0.009 | 39.06 ± 0.27 | ... | ... | ... | ... |
| A03 | SeDisc | 19.70 | 20.69 ± 0.09 | 0.33 ± 0.018 | 3.06 ± 0.11 | 0.70 ± 0.004 | 164.59 ± 0.47 | 20.87 ± 0.05 | 0.48 ± 0.009 | 0.82 ± 0.008 | 96.97 ± 0.51 | ... | ... | ... | ... |
| A04 | SeDisc | 19.22 | 18.84 ± 0.07 | 0.11 ± 0.003 | 1.84 ± 0.07 | 0.67 ± 0.004 | 119.12 ± 0.57 | 19.91 ± 0.01 | 0.78 ± 0.003 | 0.40 ± 0.001 | 114.58 ± 0.12 | ... | ... | ... | ... |
| A05 | Sérsic | 19.62 | 22.92 ± 0.02 | 1.57 ± 0.013 | 2.29 ± 0.02 | 0.49 ± 0.001 | 100.25 ± 0.15 | – | – | – | – | ... | ... | ... | ... |
| A06 | SeDisc | 19.33 | 18.41 ± 0.07 | 0.12 ± 0.004 | 2.66 ± 0.10 | 0.81 ± 0.004 | 133.35 ± 0.57 | 20.48 ± 0.01 | 0.52 ± 0.002 | 0.90 ± 0.001 | 101.06 ± 0.12 | ... | ... | ... | ... |
| A07 | SeDisc | 20.28 | 20.44 ± 0.09 | 0.20 ± 0.011 | 1.29 ± 0.04 | 0.46 ± 0.004 | 72.81 ± 0.47 | 19.98 ± 0.05 | 0.49 ± 0.009 | 0.41 ± 0.008 | 64.09 ± 0.51 | ... | ... | ... | ... |
| A08 | SeDisc | 19.80 | 19.10 ± 0.09 | 0.16 ± 0.009 | 2.96 ± 0.10 | 0.61 ± 0.004 | 60.99 ± 0.47 | 21.96 ± 0.05 | 1.06 ± 0.020 | 0.46 ± 0.008 | 53.08 ± 0.51 | ... | ... | ... | ... |
| A09 | Sérsic | 20.37 | 23.58 ± 0.02 | 1.18 ± 0.010 | 2.58 ± 0.02 | 0.76 ± 0.001 | 58.05 ± 0.15 | – | – | – | – | ... | ... | ... | ... |
| A10 | SeDisc | 19.31 | 22.14 ± 0.12 | 0.77 ± 0.059 | 4.19 ± 0.14 | 0.58 ± 0.003 | 58.38 ± 0.38 | 21.36 ± 0.06 | 1.07 ± 0.023 | 0.38 ± 0.009 | 72.36 ± 0.27 | ... | ... | ... | ... |
| A11 | SeDisc | 21.19 | 21.62 ± 0.19 | 0.13 ± 0.017 | 1.84 ± 0.22 | 0.88 ± 0.013 | 99.74 ± 3.63 | 21.56 ± 0.06 | 0.46 ± 0.010 | 0.92 ± 0.006 | 124.17 ± 1.80 | ... | ... | ... | ... |

*Note.* Best-fitting observed parameters of the sample galaxies resulting from the photometric decomposition. Column (1): galaxy ID. Column (2): fit-type according to morphological classification (see Table 3). Column (3): total magnitude. Columns (4)–(8): bulge parameters, i.e. effective surface brightness $\mu_e$ and radius $r_e$, Sérsic index $n$, axis ratio $q_{bulge}$, and position angle $PA_{bulge}$. Columns (9)–(12): disc parameters, i.e. central surface brightness $\mu_0$, scalelength $h$, axis ratio $q_{disc}$, and position angle $PA_{disc}$. Columns (13)–(16): bar parameters, i.e. central surface brightness $\mu_{0,bar}$, bar radius $r_{bar}$, axis ratio $q_{bar}$, and position angle $PA_{bar}$. The PA are measured counterclockwise from north to east.

**Table A2.** Structural photometric parameters of the ETGs spectroscopic sample fitted with a `deVauc` model.

| Galaxy ID (1) | mag (mag) (2) | $\mu_e$ (mag/arcsec$^2$) (3) | $r_e$ (arcsec) (4) | $q_{bulge}$ (5) | PA$_{bulge}$ (°) (6) |
|---|---|---|---|---|---|
| S02 | 18.59 | 21.04 ± 0.01 | 0.98 ± 0.007 | 0.44 ± 0.001 | 159.34 ± 0.11 |
| S04 | 19.57 | 21.79 ± 0.01 | 0.63 ± 0.005 | 0.86 ± 0.002 | 19.01 ± 0.14 |
| S05 | 18.71 | 21.65 ± 0.01 | 0.94 ± 0.006 | 0.76 ± 0.001 | 36.11 ± 0.11 |
| S06 | 18.65 | 20.85 ± 0.01 | 0.72 ± 0.005 | 0.64 ± 0.001 | 81.89 ± 0.11 |
| S07 | 19.59 | 24.24 ± 0.01 | 3.10 ± 0.027 | 0.33 ± 0.002 | 129.97 ± 0.14 |
| S08 | 18.76 | 21.80 ± 0.01 | 0.92 ± 0.006 | 0.85 ± 0.001 | 109.79 ± 0.11 |
| S09 | 18.69 | 21.88 ± 0.01 | 0.99 ± 0.007 | 0.85 ± 0.001 | 63.68 ± 0.11 |
| S10 | 18.02 | 21.16 ± 0.01 | 0.92 ± 0.005 | 0.95 ± 0.001 | 125.60 ± 0.06 |
| S11 | 19.02 | 21.44 ± 0.01 | 0.99 ± 0.007 | 0.41 ± 0.001 | 119.99 ± 0.11 |
| S14 | 18.95 | 20.79 ± 0.01 | 0.52 ± 0.003 | 0.90 ± 0.001 | 93.01 ± 0.11 |
| S16 | 18.24 | 22.27 ± 0.01 | 1.42 ± 0.008 | 0.89 ± 0.001 | 111.74 ± 0.06 |
| S17 | 19.12 | 20.12 ± 0.01 | 0.51 ± 0.003 | 0.43 ± 0.001 | 59.14 ± 0.11 |
| S18 | 15.23 | 24.92 ± 0.19 | 20.05 ± 2.033 | 0.82 ± 0.001 | 153.36 ± 0.08 |
| S19 | 19.43 | 21.17 ± 0.01 | 0.51 ± 0.003 | 0.85 ± 0.001 | 90.00 ± 0.11 |
| S20 | 19.42 | 22.64 ± 0.01 | 1.17 ± 0.008 | 0.62 ± 0.001 | 178.19 ± 0.11 |
| S22 | 18.61 | 21.03 ± 0.01 | 0.70 ± 0.005 | 0.84 ± 0.001 | 17.20 ± 0.11 |
| S23 | 19.42 | 21.07 ± 0.01 | 0.57 ± 0.004 | 0.63 ± 0.001 | 49.23 ± 0.11 |
| S24 | 18.14 | 21.99 ± 0.01 | 1.30 ± 0.008 | 0.90 ± 0.001 | 115.12 ± 0.06 |
| S25 | 18.83 | 21.80 ± 0.01 | 0.90 ± 0.006 | 0.84 ± 0.001 | 12.57 ± 0.11 |
| S26 | 18.64 | 20.98 ± 0.01 | 0.71 ± 0.005 | 0.75 ± 0.001 | 53.86 ± 0.11 |
| S27 | 18.17 | 22.55 ± 0.01 | 1.68 ± 0.010 | 0.89 ± 0.001 | 69.72 ± 0.06 |
| S28 | 17.00 | 22.50 ± 0.01 | 2.97 ± 0.020 | 0.79 ± 0.001 | 143.86 ± 0.05 |
| S30 | 18.68 | 21.31 ± 0.01 | 0.78 ± 0.005 | 0.80 ± 0.001 | 89.05 ± 0.11 |
| S31 | 18.43 | 21.99 ± 0.01 | 1.26 ± 0.008 | 0.73 ± 0.001 | 174.21 ± 0.06 |
| S34 | 16.69 | 21.91 ± 0.01 | 2.83 ± 0.019 | 0.67 ± 0.001 | 94.05 ± 0.05 |
| S35 | 20.26 | 22.73 ± 0.01 | 0.86 ± 0.007 | 0.57 ± 0.002 | 73.32 ± 0.14 |
| S36 | 17.00 | 22.24 ± 0.01 | 2.73 ± 0.018 | 0.73 ± 0.001 | 54.81 ± 0.05 |
| S38 | 19.29 | 21.79 ± 0.01 | 1.00 ± 0.007 | 0.44 ± 0.001 | 115.63 ± 0.11 |
| S39 | 18.64 | 21.56 ± 0.01 | 0.98 ± 0.007 | 0.68 ± 0.001 | 177.53 ± 0.11 |
| S40 | 19.54 | 21.34 ± 0.01 | 0.59 ± 0.005 | 0.67 ± 0.002 | 104.43 ± 0.14 |
| S41 | 17.92 | 22.01 ± 0.01 | 2.03 ± 0.012 | 0.47 ± 0.001 | 145.60 ± 0.06 |
| S44 | 18.98 | 20.74 ± 0.01 | 0.57 ± 0.004 | 0.69 ± 0.001 | 143.60 ± 0.11 |
| S45 | 18.83 | 22.66 ± 0.01 | 1.89 ± 0.013 | 0.43 ± 0.001 | 83.90 ± 0.11 |
| S46 | 18.60 | 20.86 ± 0.01 | 0.78 ± 0.005 | 0.57 ± 0.001 | 122.33 ± 0.11 |
| S47 | 19.40 | 22.87 ± 0.01 | 1.07 ± 0.007 | 0.94 ± 0.001 | 127.17 ± 0.11 |
| S48 | 19.11 | 21.66 ± 0.01 | 0.73 ± 0.005 | 0.87 ± 0.001 | 114.89 ± 0.11 |
| S49 | 17.21 | 21.98 ± 0.01 | 1.95 ± 0.013 | 0.93 ± 0.001 | 157.07 ± 0.05 |
| S51 | 19.40 | 21.74 ± 0.01 | 0.62 ± 0.004 | 1.00 ± 0.001 | 41.66 ± 0.11 |
| S52 | 19.01 | 20.62 ± 0.01 | 0.46 ± 0.003 | 0.94 ± 0.001 | 79.36 ± 0.11 |
| S53 | 16.95 | 22.90 ± 0.01 | 3.55 ± 0.024 | 0.83 ± 0.001 | 17.19 ± 0.05 |
| S54 | 17.55 | 22.54 ± 0.01 | 2.25 ± 0.013 | 0.87 ± 0.001 | 158.90 ± 0.06 |

*Note.* Best-fitting observed `deVauc` parameters. Column (1): galaxy ID. Column (2): total magnitude. Column (3): effective surface brightness. Column (4): effective radius. Column (5): axis ratio. Column (6): PA, measured counterclockwise from north to east.

**Table A3.** Structural photometric parameters of the ETGs spectroscopic sample fitted with a Sérsic model.

| Galaxy ID (1) | mag (mag) (2) | $\mu_e$ (mag/arcsec$^2$) (3) | $r_e$ (arcsec) (4) | $n$ (5) | $q_{bulge}$ (6) | PA$_{bulge}$ ($^\circ$) (7) |
|---|---|---|---|---|---|---|
| S02 | 18.56 | 21.16 ± 0.05 | 1.03 ± 0.024 | 4.27 ± 0.04 | 0.44 ± 0.001 | 159.35 ± 0.12 |
| S04 | 18.88 | 24.92 ± 0.05 | 2.94 ± 0.069 | 10.21 ± 0.11 | 0.85 ± 0.001 | 20.64 ± 0.12 |
| S05 | 18.71 | 21.62 ± 0.05 | 0.92 ± 0.022 | 3.93 ± 0.04 | 0.76 ± 0.001 | 36.11 ± 0.12 |
| S06 | 18.74 | 20.46 ± 0.05 | 0.62 ± 0.015 | 3.06 ± 0.03 | 0.64 ± 0.001 | 81.61 ± 0.12 |
| S07 | 19.87 | 23.33 ± 0.02 | 1.94 ± 0.016 | 2.78 ± 0.02 | 0.34 ± 0.001 | 129.57 ± 0.15 |
| S08 | 18.38 | 23.32 ± 0.04 | 1.96 ± 0.045 | 6.73 ± 0.06 | 0.84 ± 0.001 | 110.97 ± 0.09 |
| S09 | 17.86 | 25.56 ± 0.04 | 6.09 ± 0.140 | 11.57 ± 0.11 | 0.85 ± 0.001 | 64.64 ± 0.09 |
| S10 | 17.92 | 21.60 ± 0.04 | 1.12 ± 0.026 | 4.97 ± 0.05 | 0.95 ± 0.001 | 126.45 ± 0.09 |
| S11 | 19.00 | 21.59 ± 0.05 | 1.07 ± 0.025 | 4.16 ± 0.04 | 0.41 ± 0.001 | 119.98 ± 0.12 |
| S14 | 18.80 | 21.44 ± 0.05 | 0.69 ± 0.016 | 5.51 ± 0.06 | 0.90 ± 0.001 | 93.80 ± 0.12 |
| S16 | 18.14 | 22.65 ± 0.04 | 1.71 ± 0.039 | 4.71 ± 0.04 | 0.89 ± 0.001 | 112.26 ± 0.09 |
| S17 | 19.16 | 19.89 ± 0.05 | 0.47 ± 0.011 | 3.31 ± 0.03 | 0.43 ± 0.001 | 59.16 ± 0.12 |
| S18 | 16.06 | 22.74 ± 0.02 | 6.01 ± 0.083 | 1.86 ± 0.02 | 0.83 ± 0.001 | 157.18 ± 0.07 |
| S19 | 19.30 | 21.71 ± 0.05 | 0.65 ± 0.015 | 5.26 ± 0.05 | 0.84 ± 0.001 | 90.62 ± 0.12 |
| S20 | 19.44 | 22.58 ± 0.05 | 1.14 ± 0.027 | 3.91 ± 0.04 | 0.62 ± 0.001 | 178.20 ± 0.12 |
| S22 | 18.52 | 21.39 ± 0.05 | 0.82 ± 0.019 | 4.72 ± 0.05 | 0.84 ± 0.001 | 18.18 ± 0.12 |
| S23 | 19.48 | 20.78 ± 0.05 | 0.50 ± 0.012 | 3.33 ± 0.03 | 0.63 ± 0.001 | 49.26 ± 0.12 |
| S24 | 18.23 | 21.65 ± 0.04 | 1.11 ± 0.025 | 3.41 ± 0.03 | 0.90 ± 0.001 | 123.29 ± 0.09 |
| S25 | 18.53 | 23.02 ± 0.05 | 1.62 ± 0.038 | 6.31 ± 0.06 | 0.84 ± 0.001 | 11.51 ± 0.12 |
| S26 | 18.72 | 20.64 ± 0.05 | 0.61 ± 0.014 | 3.30 ± 0.03 | 0.75 ± 0.001 | 53.24 ± 0.12 |
| S27 | 17.72 | 24.27 ± 0.04 | 4.03 ± 0.092 | 6.79 ± 0.06 | 0.88 ± 0.001 | 66.02 ± 0.09 |
| S28 | 17.29 | 21.28 ± 0.03 | 1.72 ± 0.026 | 2.13 ± 0.01 | 0.80 ± 0.001 | 144.20 ± 0.06 |
| S30 | 18.65 | 21.47 ± 0.05 | 0.84 ± 0.020 | 4.29 ± 0.04 | 0.80 ± 0.001 | 89.22 ± 0.12 |
| S31 | 18.38 | 22.17 ± 0.04 | 1.38 ± 0.032 | 4.36 ± 0.04 | 0.73 ± 0.001 | 174.35 ± 0.09 |
| S34 | 16.58 | 22.37 ± 0.03 | 3.54 ± 0.053 | 4.86 ± 0.03 | 0.67 ± 0.001 | 94.19 ± 0.06 |
| S35 | 20.30 | 22.57 ± 0.02 | 0.80 ± 0.007 | 3.72 ± 0.03 | 0.58 ± 0.001 | 73.32 ± 0.15 |
| S36 | 16.62 | 23.71 ± 0.03 | 5.76 ± 0.087 | 6.53 ± 0.04 | 0.72 ± 0.000 | 54.64 ± 0.06 |
| S38 | 19.42 | 21.27 ± 0.05 | 0.80 ± 0.019 | 2.93 ± 0.03 | 0.44 ± 0.001 | 115.59 ± 0.12 |
| S39 | 18.70 | 21.27 ± 0.05 | 0.86 ± 0.020 | 3.41 ± 0.04 | 0.68 ± 0.001 | 177.77 ± 0.12 |
| S40 | 19.35 | 22.23 ± 0.05 | 0.89 ± 0.021 | 5.65 ± 0.06 | 0.66 ± 0.001 | 104.85 ± 0.12 |
| S41 | 18.05 | 21.51 ± 0.04 | 1.59 ± 0.036 | 3.25 ± 0.03 | 0.46 ± 0.001 | 145.57 ± 0.09 |
| S44 | 18.87 | 21.20 ± 0.05 | 0.70 ± 0.017 | 5.07 ± 0.05 | 0.68 ± 0.001 | 144.44 ± 0.12 |
| S45 | 19.02 | 21.95 ± 0.05 | 1.35 ± 0.032 | 2.76 ± 0.03 | 0.43 ± 0.001 | 83.73 ± 0.12 |
| S46 | 18.60 | 20.87 ± 0.05 | 0.79 ± 0.019 | 4.03 ± 0.04 | 0.57 ± 0.001 | 122.33 ± 0.12 |
| S47 | 19.21 | 23.63 ± 0.05 | 1.57 ± 0.037 | 5.19 ± 0.05 | 0.94 ± 0.001 | 129.38 ± 0.12 |
| S48 | 18.93 | 22.45 ± 0.05 | 1.05 ± 0.025 | 5.65 ± 0.06 | 0.87 ± 0.001 | 115.44 ± 0.12 |
| S49 | 16.94 | 22.99 ± 0.03 | 3.25 ± 0.049 | 5.63 ± 0.04 | 0.93 ± 0.001 | 154.97 ± 0.06 |
| S51 | 18.68 | 25.12 ± 0.05 | 3.26 ± 0.077 | 11.79 ± 0.12 | 0.92 ± 0.001 | 42.38 ± 0.12 |
| S52 | 18.91 | 21.21 ± 0.05 | 0.59 ± 0.014 | 5.11 ± 0.05 | 0.93 ± 0.001 | 79.88 ± 0.12 |
| S53 | 16.55 | 24.37 ± 0.03 | 7.58 ± 0.114 | 6.26 ± 0.04 | 0.83 ± 0.001 | 18.11 ± 0.06 |
| S54 | 17.65 | 22.17 ± 0.04 | 1.87 ± 0.043 | 3.49 ± 0.03 | 0.87 ± 0.001 | 160.09 ± 0.09 |

*Note.* Best-fitting observed Sérsic parameters. Column (1): galaxy ID. Column (2): total magnitude. Column (3): effective surface brightness. Column (4): effective radius. Column (5): Sérsic index. Column (6): axis ratio. Column (7): PA, measured counterclockwise from north to east.

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