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High Resolution Surface Photometry of Rich ISM Early-type Galaxies

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Abstract.

We have used high resolution HST multicolor images of a sample of early-type galaxies to study the photometric properties of the central region. The effect of a central mass concentration were investigated decomposing the luminosity profiles. The profiles were fitted with two different components: a Sérsic law for the stellar bulge and a cuspy law for the central region. A model image, builded by ellipse fitting, were subtracted from the original image to reveal the dust extinction and the core structure. A detailed analysis of the isophotal parameters lead us to determine the gradients in the position angle, ellipticity and Fourier coefficients, which indicate disturbing effects due to the presence of the dust or past merger events.

1. Sample and data reduction

The galaxies studied in this work are luminous early-type galaxies selected from a sample in which we have previously detected ionized gas (Macchetto em et al. 1996) and dust (Ferrari em et al. 1999) We have collected WFPC2 public data from Hubble Data Archive in order to perform photometric analysis and investigate the dust properties in this galaxies.

The images were reduced following the steps described in the HST Data Handbook V.3. The HST pipeline calibration has proven to be good enough for our purposes, so no further bias, dark current and flat field correction needed to be made. The final science images were calibrated with up to date calibration constant for each filter (`PHOTFLAM`).

2. Color and Extinction Maps

With the purpose to investigate the dust extinction, we build a model image fitting ellipses to the isophotes of the galaxy using the *isophote* STSDAS routines within IRAF[1]. This model image represents the light distribution not affected by

[1]IRAF is distributed by the National Optical Astronomy Observatories, which is operated by the Association of Research in Astronomy, Inc., under cooperative agreement with the National Science Foundation, U.S.A.

local intensity irregularities caused by dust absorption and scattering. With this model image is possible to construct extinction maps in each filter, subtracting the model image from the observed image

$$A_\lambda = -2.5 \log \left[\frac{F_{\lambda,\mathrm{obs}}}{F_{\lambda,\mathrm{model}}} \right] \quad (1)$$

Figure 2a, 2b and 2c shows the model images and the extinction map in filter F555W for the galaxy IC 4889.

We have also builded color maps to study the characteristics of the dust distribution. Since the visible extinction effect is greater the shorter the wavelength (Goudfrooij *et al.* 1994, Ferrari *et. al* 1999) we can use the ratio of images in different filters to map the dust distribution. Figures 3f and 2g shows the color maps for two of the galaxies of the sample, NGC 5845 and NGC 3862.

3. Some Individual Cases

IC 4889 - In order to analyze the dust morphology, we build a model image (Fig. 2b) by fitting ellipses to the light distribution of the galaxy (Fig. 2a). This model represents the light not affected by the dust. When the model is subtracted from the image we have the extinction in the respective passband. Figure 2c shows the extinction in the F555W. The dust here are distributed in a regular and extended cloud. Both filters (F814W not shown) present the same overall morphology, although the models were independently builded and the F555W image is much more affected by the dust. F555W image and model contours are 18.81, 18.25, 17.89, 17.61, 17.40 mags. The extinction maps contour levels (flux ratios) are 1 and 1.03.

NGC 5845 - The nuclear dust disk can be seen directly in the F555W image (Fig. 2d). The longer wavelengths are less affected by the dust extinction, as can be seen in Fig. 2e. If we build a color map from the ratio of F555W and F814W images, it's possible to map the dust extinction (Fig. 2f) which shows the dust disk nearly edge on. The dust cloud extends a little longer to the Southwest side, as can be seen from the absorption features in darker colors. Together with this dust disk, there is a stellar core associated with the break in the luminosity profile μ (Fig. 1). The profile is measured in the ellipse fitting with the dust masked out. This break has been observed in many elliptical galaxies observed with high resolution imaging, for example NGC 3379 (Pastoriza *et al.* 2000). This core is also produces the gradients in the ellipticity ϵ, in the position angle PA and in the diskness (Cos 4^{th} coef. > 0) of the isophotes (Fig 1).

NGC 3862 - Figure 2g is the color map builded from the ratios of the F547 (Strömgrem y) to F791W (wide I) filters, which shows the jet in the nucleus of this galaxy. It can be inferred an absorption disk around the nucleus, extending more to the North side. Contour values (flux ratios) are 0.8 to 0.98, 0.03 interval.

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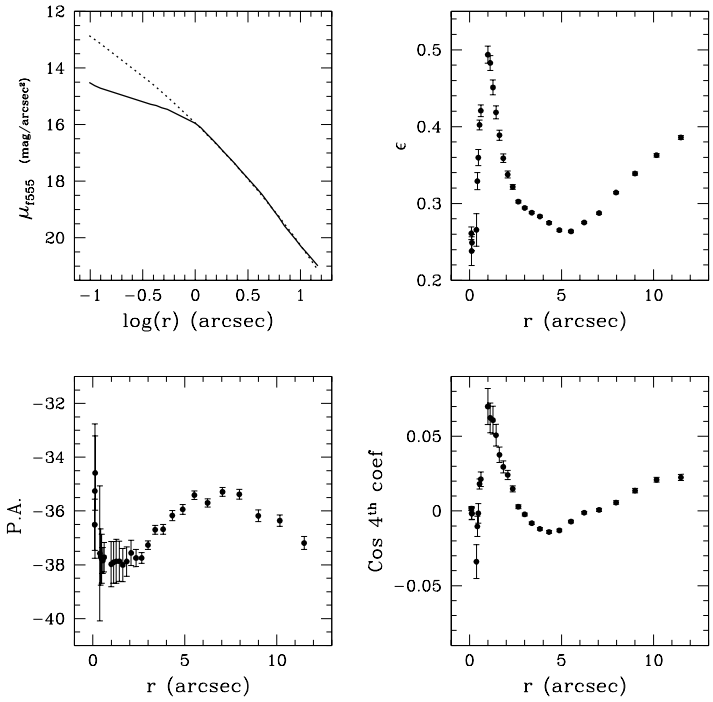

Figure 1. Luminosity profile, elipticity, position angle and Fourier 4^{th} coefficient for the galaxy NGC 5845.

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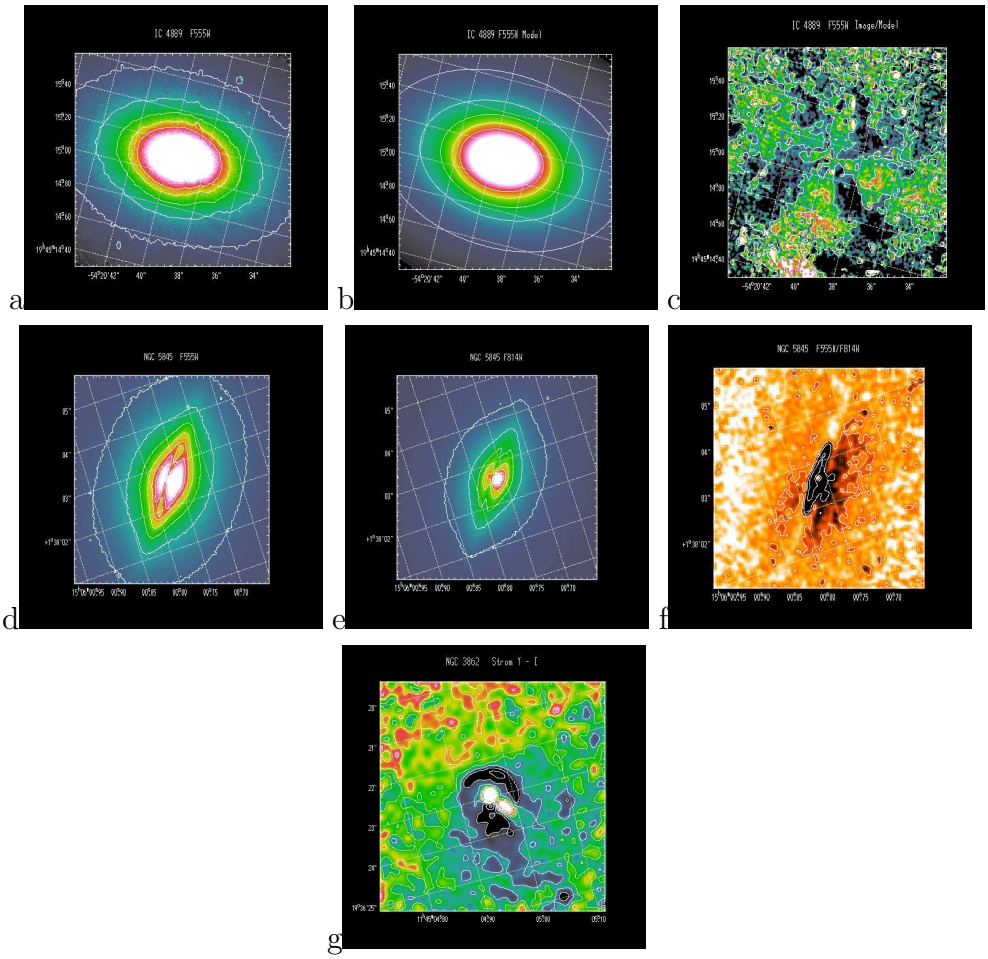

Figure 2. **IC 4889:** *a)* V (555 nm) image; *b)* the V model builded with the ellipse fitting; *c)* the ratio image/model which results in the extinction map A_V. **NGC 5845:** *d)* the V image; *e)* the I image (814 nm); *f)* the ratio V/I which shows the dust absorption. **NGC 3862:** *g)* the color map between the Strömgrem (547 nm) and I filters revealing the dust absorption as well as a nuclear jet.