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SPIRAL GALAXIES: REQUIREMENTS FOR ACCURATE PHOTOMETRIC BULGE/DISK DECOMPOSITION

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Selected photometric bands, spatial resolution, disk dimension in the frame and the scanned sky background level are determined in order to establish galactic structural parameters. A crude analysis could lead to erroneous results. Possible causes of error, as well as the minimum requirements for a precise determination of parameters, will be discussed. Our main goal is to separate morphologically the dynamical components of galaxies in order to model their 3D structure and to estimate their gravitational potential. Also important is to study their stellar populations and histories. A population analysis of the different structures of the galactic components with OSIRIS tunable filters on the GTC is proposed.

1. INTRODUCTION

We have devised a method for analyzing the 2D and 3D structural components of spiral galaxies by modeling their mass distribution and gravitational potential. This methodology enables us to understand much of the nature of these galaxies. Now, with the advent of large telescopes, particularly the GTC, we shall proceed a step further to isolate the stellar populations and model each galactic component (bulge, disk, lens, rings, etc.). This will allow us in particular to understand better the present star formation in the galaxies, as well as bring to bear important new information on the problem of galactic evolution.

2. OBJECTIVES

Our main goal is to separate morphologically the dynamical components of the galaxies in order to study their stellar populations and histories. We wish to define a set of intermediate band filters specific to each galactic component that will enable us to characterize their star formation histories with the minimum of uncertainty. These filters should, at the very least, include the ultraviolet band and 1 micron in the infrared in order to characterize the youngest and oldest components. We need to reach a surface brightness of $\sim$26 mag/arcsec^2 in the visible in order to detect the outermost parts of a typical disk. OSIRIS would be the ideal instrument for this study.

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3. METHODOLOGY

Our methodology for 2D and 3D structural decomposition is described in Aguerri (1998) and Varela (1992).

The most important feature of the 2D decomposition method is the detailed study of the multicolor photometric information for each galaxy before performing the decomposition to determine the different structural components that form the galaxies and make an estimate of their scale lengths. One example of the results is shown in Figure 1. After the decomposition we consider whether the parameters obtained are physically meaningful (Prieto et al. 2001).

Once we have the 2D components, we tackle here the problem to obtaining the spatial source density.

The observational behavior of isophotes—generally concentric ellipses—of the majority of bulges of spirals and elliptical galaxies suggests that the corresponding distribution of sources consists of a family of concentric and coaxial ellipsoidal isodensity shells, with a rapidly decreasing luminosity profile with increasing size. Under these conditions of homology or of local homology (where the rate of variation of $\epsilon(\lambda)$ and $PA(\lambda)$, the semi-major axis of each isophote in arcseconds, is smaller than the rate of variation of their surface brightness distribution, $\sigma(\lambda)$), it is possible to perform the inverse process of determining the geometrical parameters of the emitting ellipsoids and their corresponding luminosity density from the geometrical and photometric properties of the observed isophotes, which will be identified as the corresponding projections of the same ellipsoids (Simonneau et al. 1998, and references therein). With these restrictive conditions we can perform the geometrical deprojection and the photometric inversion in the same way as described in references

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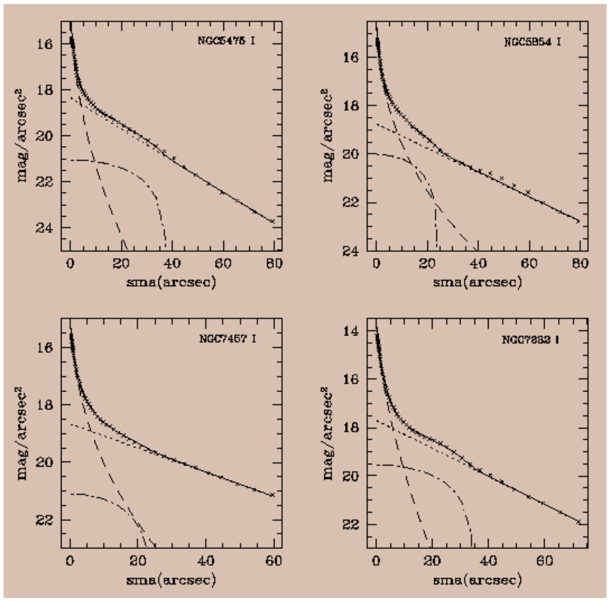

Fig. 1. Surface brightness distribution, in magnitudes per unit area vs. position on the semi-major axis, of each structural components of the four SO galaxies. The dotted line represent the disk, dashed line the bulge, the dot-dashed line the lens, and the solid line the total luminosity.

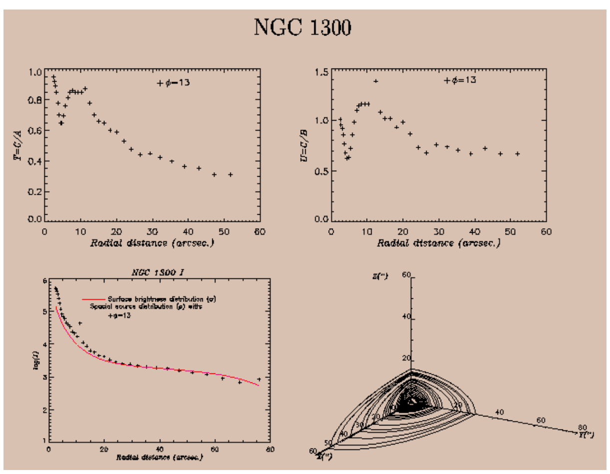

Fig. 2. $T = C/A$ (top left) and $U = C/B$ (top right) axial ratios of the bulge + bar structure of NGC 1300. Spatial source distribution associated with each ellipsoid (bottom-left). Three-dimensional representation of the bulge + bar structure of the galaxy (bottom right). Normalized to the scale factor, H which is the ratio of the volume of the emitting ellipsoids to the surface area of the corresponding projected ellipses.

above. As a general result, the axial ratios $T = C/A$ and $U = C/B$ (different for each free parameter Φ) are also now slightly different for different values of the λ parameter, which individualizes each isophote and the spectral source distribution for NGC 1300, as shown in Figure 2.

In the analysis and synthesis of galactic components with OSIRIS tunable filters some aspects must be taken into account in order to obtain reliable structural components of nearby galaxies and to study their stellar populations:

Disk dimension in the frame At least 1/3 of the galaxy luminosity profile must come from the disk without overlapping other components.

Photometric bands A well-spaced set of intermediate photometric bands reaching from U to, if possible, the NIR is necessary in order to study the stellar population of each component of the galaxy.

Dust The recognition and possible elimination of the effects of dust.

Star formation in the intermediate zone of galaxies This effect must be eliminated.

Spatial resolution Higher spatial resolution allows us to correct the above effects more accurately and discriminate better between the different components.

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