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KiDS collaboration

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Chapter 21

Early Type Galaxies and Structural Parameters from ESO Public Survey KiDS

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Abstract The Kilo Degree survey (KiDS) is a large-scale optical imaging survey carried out with the VLT Survey Telescope (VST), which is the ideal tool for galaxy evolution studies. We expect to observe millions of galaxies for which we extract the structural parameters in four wavebands (u, g, r and i). This sample will represent the largest dataset with measured structural parameters up to a redshift $z = 0.5$. In this paper we will introduce the sample, and describe the 2D fitting procedure using the 2DPHOT environment and the validation of the parameters with an external catalog.

21.1 Introduction

The Kilo Degree Survey (KiDS) is a ESO public survey (PI. K. Kuijken) carried out with the VLT Survey Telescope (VST), at the ESO Paranal Observatory. It will cover $1,500 \text{ deg}^2$ of the night sky in four optical bands (*ugri*). The large area covered, the depth, the good seeing and pixel scale make the VST the ideal tool to investigate the evolution of galaxies across the last billions of years. KiDS possess upper hand in different aspects compared to the previous surveys. E.g., with respect to the Sloan Digital Sky Survey (SDSS), which is the most successful survey in the galaxy evolution studies [4], KiDS has two major improvements that are crucial for its science goals: it is much deeper (by about 2 mag), and it has better image quality, particularly in the r-band with respect to SDSS.

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We will study the structural properties of early-type galaxies, which, being the oldest and most massive systems in the universe, provide a unique way to trace the galaxy evolution and formation, and important physical processes like galaxy mergings.

21.2 The Sample

For the current study we are using a galaxy catalog extracted from the first 158 deg² of the KiDS Survey. Single band sourcelist have been extracted with a stand-alone procedure for the catalog extraction optimized for KiDS whose backbone is constituted by S-Extractor [1] software for the source detection and extraction which is fed with KiDS image, weighting maps (from Astro-Wise pipeline, [10]) and external masks for bad pixels, saturated stars and stars haloes obtained with an automated procedure (i.e., an evolution of the ExAM software, see [3]). Star/galaxy separation is based on the CLASS_STAR (star classification) and S/N (signal-to-noise ratio) parameters provided by S-Extractor [1, 6]. From the whole galaxy population extracted within the KIDS DR2 (~7 million), we have selected those galaxies with r-band signal-to-noise ratio (S/N) > 50. This criterion allows one to obtain reliable structural parameters [7]. Using this cut on S/N ratio we ended up with a sample of ~38,000 galaxies. For further details, see the contribution from Tortora et al.

21.3 Structural Parameter Extraction

The structural parameter extraction is performed by 2DPHOT [6], which is an automated software environment which accomplishes several tasks such as catalog extraction (using S-extractor, [1]), star/galaxy separation and surface photometry, for the selected galaxies. Galaxy images were fitted with a PSF convolved Sérsic models [2] having elliptical isophotes plus a local background value.

In Fig. 21.1 we show the 2DPHOT output stamps for few example galaxies. Ninety-three percent of our galaxy sample were fitted by a Sérsic profile with a small reduced χ^2 value (see left panels in Fig. 21.1) without any residuals. However, we found galaxies with $\chi^2 > 1.5$, not perfectly fitted, and leaving in the residual maps signs of substructures, as spiral arms. 2DPHOT model fitting will provide structural parameters like surface brightness μ_e , effective radius R_e , Sérsic index n , model magnitude, axial ratio, position angle, etc.

Because our sample consists of both early-type (ETGs) and late-type (LTGs) galaxies, we have selected ETGs on the base of the following criteria: (1) Sérsic index $n > 2.5$, since LTGs are found to have lower Sérsic indices (e.g. [8]), (2) $R_e > 0.2$ arcsec (since the VST pixel scale is 0.21 arcsec/pixel), and (3) $\chi^2 < 1.5$, to take the galaxies best-fitted by the Sérsic profile and remove those systems with a clear sign of spiral arms in the fit residuals (see right panels in Fig. 21.1).

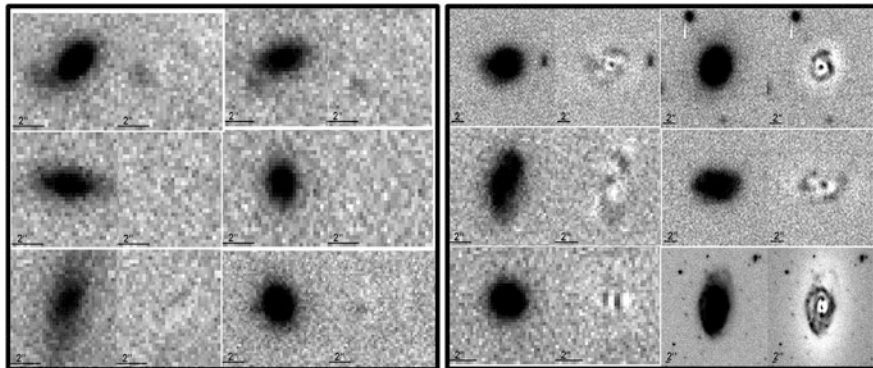


Fig. 21.1 2D fit results for 12 example galaxies in r-band. Each frame shows the galaxy stamp (*left*) and the residual map (*right*) after model subtraction. *Left panels* are for $\chi^2 < 1.5$, while *right panels* for $\chi^2 > 1.5$

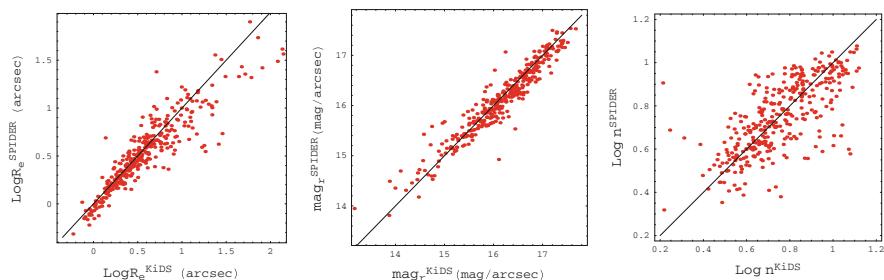


Fig. 21.2 Comparison of KiDS structural parameters with the ones derived within the SPIDER survey. The SPIDER dataset consists of ETGs with redshifts in the range $0.05 < z < 0.095$, selected from SDSS; the structural parameters are derived using 2DPHOT. We show the relationship for effective radius (R_e), model magnitude (mag_r) and Sèrsic index (n) respectively from left to right. Data are shown as *red points*. The *diagonal lines* are the one-to-one relations, corresponding to the perfect agreement

21.4 Comparison with Literature Data

To study the reliability and consistency of the derived structural parameters we made a comparison of our results with an external datasample from the SPIDER survey [7]. This dataset, extracted from SDSS, consists of $\sim 39,000$ ETGs with redshifts $0.05 < z < 0.095$, with structural parameters determined by fitting a Sérsic profile and the fitting procedure is performed using 2DPHOT. We found 345 shared sources by cross-matching the two catalogs.

The comparisons of R_e , magnitudes and Sérsic index are shown in Fig. 21.2. There is a good agreement in the parameters from two catalogs, which confirm the reliability of our extracted parameters in the KiDS survey.

21.5 Conclusions

KiDS, being a large scale survey with good image quality, provides a great platform for the study of galaxy evolution. With the extraction of structural parameters we are about to start the analysis of scaling relations, as the relationship between the extracted structural parameters (e.g. R_e and n) as a function of luminosity or stellar mass [9], or the correlation of surface brightness with R_e or magnitude [5]. KiDS will allow to analyze these correlations at different cosmic epochs up to redshift 0.5. Galaxy size and mass evolution with cosmic time provide fundamental details about the physical mechanisms which drive the galaxy evolution, including the effect of mergings or other phenomena related to the galaxy environment.

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