STRUCTURAL PARAMETERS of EDGE-ON GALAXIES from SDSS DATA

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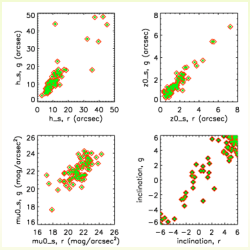
- *Context*: SDSS has imaged about a thousand edge-on galaxies (from Revised Flat Galaxies Catalog, RFGC) in u,g,r,I,z bands. The SDSS data are useful in studying the vertical structure of stellar disks. It will allow to estimate parameters of dark haloes around the galaxies.
- *Aims*: To estimate the structural parameters as free as possible of internal extinction for all available edge-on galaxies from the SDSS data.
- *Methods*: 1) We develop 3D modeling of stellar components with embedded dust disk. 2) For the comparison with previous results, 1D analysis of photometric vertical and radial profiles is run for the same objects. 3) The 1D and 3D routines were run on a set of artificial images to find out how well both methods work for SDSS data.

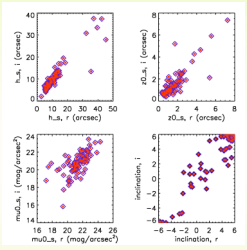
3-D modeling of broad-band images of edge-on galaxies

1. Calibrated SDSS g,r,i images from last public release (Adelman-McCarthy, 2008) were cleaned of foreground stars, rotated, and aligned.
2. Volume brightness of model images:
   Stellar disk: $\rho_s(z,r) = \rho_{s,0} \exp(-r / h_s) \operatorname{sech}^2(z / z_{0,s})$ (1)
   Bulge: $\rho_b = \rho_{b,0} (1 + B^2)^{-3/2}$, $B^2=(r^2+z^2(b/a)^2)/R_b^2$ (2)
   Dust disk: $\kappa_\lambda(z,r) = \tau_\lambda/(2z_{0,d}) \exp(-r / h_d) \exp(-|z| / z_{0,d})$ (3)
   (Bianchi, 2007, Xilouris et al, 1998)
   The volume brightness of the components (disk + bulge - dust extinction) was integrated along the line-of-sight to obtain the 2D surface brightness maps. The non-edge-on inclination angle was taken into account. Then the maps were adjusted by (dx,dy) center displacement and pa during the fitting.
3. Model parameters: $\rho_{s,0}$, h_s, $z_{0,s}$, $\rho_{b,0}$, (b/a), R_b, τ_λ, $z_{0,d}$, h_d, inclination, dx, dy, pa. AMOEBA downhill simplex algorithm of optimization is found to be the best for the problem solution.

Results of the modeling

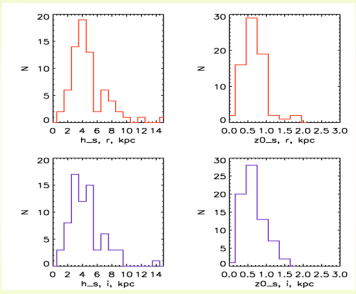


The comparison of the structural parameters of stellar disks (scale length h_s, scale height z0_s, central surface brightness mu0_s, and inclination) estimated from the *g* and *r* band images.



The same comparison with the the *r* and *i* band images. Only large galaxies (semimajor axis > 0.7 arcmin) are used to plot both figures.

Results of the modeling

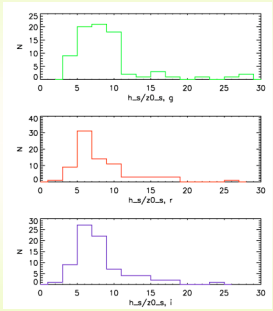


Stellar disk's scale length and scale height in the *r* and *i* bands.

Results of the modeling

The radial-to-vertical scale length ratio in the stellar disks for our galaxies in the SDSS *g,r,* and *i* bands.

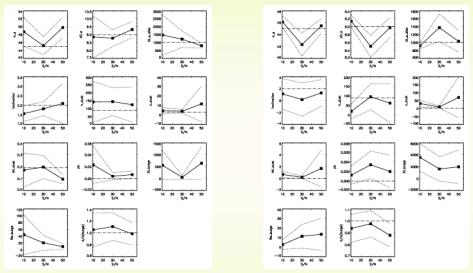
Band	Mean (h/z0)	Median (h/z0)
g	9.0	7.7
r	8.2	7.0
i	8.0	7.1



Structural Parameters from Artificial Images

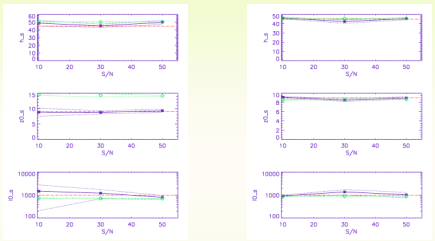
- To verify the reliability of our estimation of the structural parameters, we run our modeling for a set of artificial images.
- The 3-D model galaxies are constructed according to formulae (1) - (3). The corresponding artificial images are results of the line-of-sight integration. Realistic Poisson and Gaussian noise maps are added, different values of S/N are considered. A set of images (~30) with random noise is created for each considered set of model parameters.
- Typical parameters for the artificial disks and bulges are accepted.
  $h_d = 2\ h_s$
  $z_{0,d} = 1/3\ z_{0,s}$
  A set of $z_{0,s}$/FWHM(seeing) is considered.
  Moderate face-on extinction in the centers of the galaxies is accepted: $A_V \sim 0.3$ mag.
  The extinction was converted to $A_{g,r,i}$.
- In addition, K-band artificial images are evaluated with the same structural parameters.

Results of the Artificial Modeling



Mean structural parameters (squares and solid lines) and their r.m.s (dashed lines) of the artificial galaxies are estimated with the 3D code in the *i* (left panel) and *K* bands (right panel) for different of S/N. The dash-doted lines designate the true (I.e. input) values of the structural parameters.

Results of the Artificial Modeling



The scale length, height, and central surface brightness (in arbitrary linear units) from 1D and 3D modeling for different S/N (in the center of the galaxies). Blue squares and solid lines show the mean values of the parameters obtained with our 3-D modeling; dashed lines designate their r.m.s.
Red lines show the true values of the parameters.
Green diamonds and lines designate the same parameters and their r.m.s. estimated from 1-D profile modeling (like in Bizyaev & Mitronova, 2002).

CONCLUSIONS

- We develop 3D photometric modeling of edge-on galaxies observed by SDSS taking into account embedded dust disks and bulges. The structural parameters of stellar disks, bulges, and dust disks are estimated. Independent analysis of *g, r,* and *i* images yields comparable parameters of the galactic components for large enough images. For the comparison, we analyze 1D vertical and radial photometric profiles.
- We create a set of artificial images of edge-on galaxies and apply our modeling to study how well we can restore the structural parameters of galactic components. We also test how the S/N, extinction, inclination, and presence of a bulge affect the estimated structural parameters. The radial scale height and central surface brightness can be obtained easily from the *r* and *i* band SDSS images in both models (3D and 1D). The vertical scale height is ~1.5 times overestimated in 1D modeling if SDSS *i* images are used. Our 3D modeling helps to get more realistic values for the vertical scale even in the optical bands.

- NIR bands, like K, would help to estimate $z_{0,s}$ well with both 1D analysis of the vertical profiles and 3D modeling.
- We consider how the pixel resolution and seeing affect the parameters obtained with our 3D and 1D modeling. The resulting structural parameters of stellar disks in our 3D modeling are almost independent of the pixel size of the images unless the vertical scale height $z_{0,s}$ is greater than the FWHM of PSF.
- The structural parameters of bulges in our modeling are the least reliable.
- The mean radial-to-vertical scales ratio in the stellar disks for galaxies with well estimated parameters is ~ 8.

This project was partly supported by the Small Research Grant of the American Astronomical Society (given in 2008).

REFERENCES

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