The effects of Dust on the Derived Photometric Parameters of Disks and Bulges in Spiral Galaxies

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Abstract

Here we present preliminary results of a study to quantify the effects of dust on the derived photometric parameters of disks and bulges: disk scalelengths, axis-ratios, central surface-brightness and bulge effective radii. The effects of dust are derived for both broad-band and narrow line (Balmer lines) images. The changes in the derived photometric parameters from their intrinsic values (as seen in the absence of dust) were obtained by fitting simulated images of disks and bulges produced using radiative transfer calculations and the model of Popescu et al (2011). This study follows on the analysis of Möllenhoff et al. (2006), who quantified the effects of dust on the photometry of old stellar disks seen at low and intermediate inclination. Here we extend the study to disks at all inclinations and we also investigate the changes in the photometry of young stellar disks and bulges.

Motivation

- dust corrected scalelengths of disks are needed to investigate the predicted change in disk sizes with cosmic epoch
- dust corrected scalelengths of disks are needed for accurate scaling of flux densities when modelling the integrated SEDs of galaxies using radiative transfer methods
- dust corrected scalelengths of Hα and UV emission is essential in studies of the distribution of star-formation in galaxies
- dust corrected axial-ratios are needed to derive accurate inclinations of galaxies
- dust corrected surface-brightnesses of disks and bulges are critical for resolved studies of stellar populations

Simulated images

- we used simulated images of disks and bulges produced using radiative transfer calculations and the model of Popescu et al. (2011)
- a schematic representation of the geometrical model used to create the simulated images is shown in Fig.1
- simulated images were created using double exponential distributions (in radial and vertical directions) for stellar emissivity and dust in the disks, and the de-projection of a de Vaucouleurs distribution for the stellar emissivity in the bulge

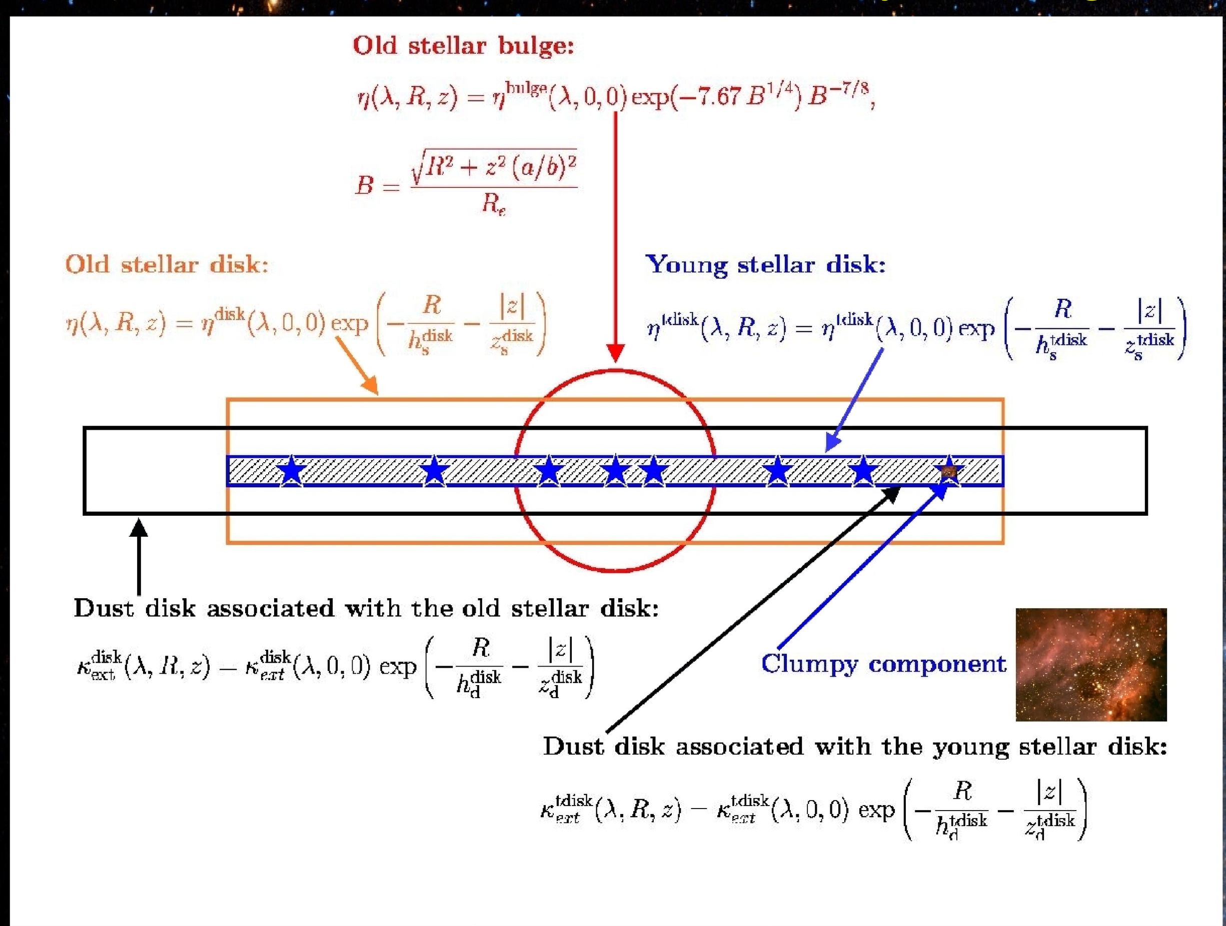

Fig.1 Schematic representation of the geomterical model used to create the simulated images (taken from Popescu et al.(2011))

Methods

- to quantify the dust effects on the photometric parameters of disks and bulges, simulated images were fitted with ideal (dustless) templates: infinite thin exponential disks and de Vaucouleurs/Sersic functions, respectively
- for the fitting procedure, the GALFIT data analysis algorithm was used
- this study is for pure disks and pure bulges, seen through the same distribution of dust in the disk; we will extend the present analysis to quantify the effects of dust on the bulge/disk decomposition of spiral galaxies

Conclusions

- systematic deviations of fitted photometric parameters from the intrinsic values can be substantial for typical local Universe spiral galaxies
- particularly for bulges, the distortions in morphology induced by the dust attenuation can be so extreme that is impossible to obtain meaningful fits with dustless templates
- it is interesting to note that the effect of dust attenuation on bulges can be mimicked by a variable Sersic index

References

1. Popescu, C. C., Tuffs R. J. et al., A&A 527, A109 (2011)
2. Möllenhoff C., Popescu C. C., Tuffs R. J., A&A 456, 941 (2006)

Results

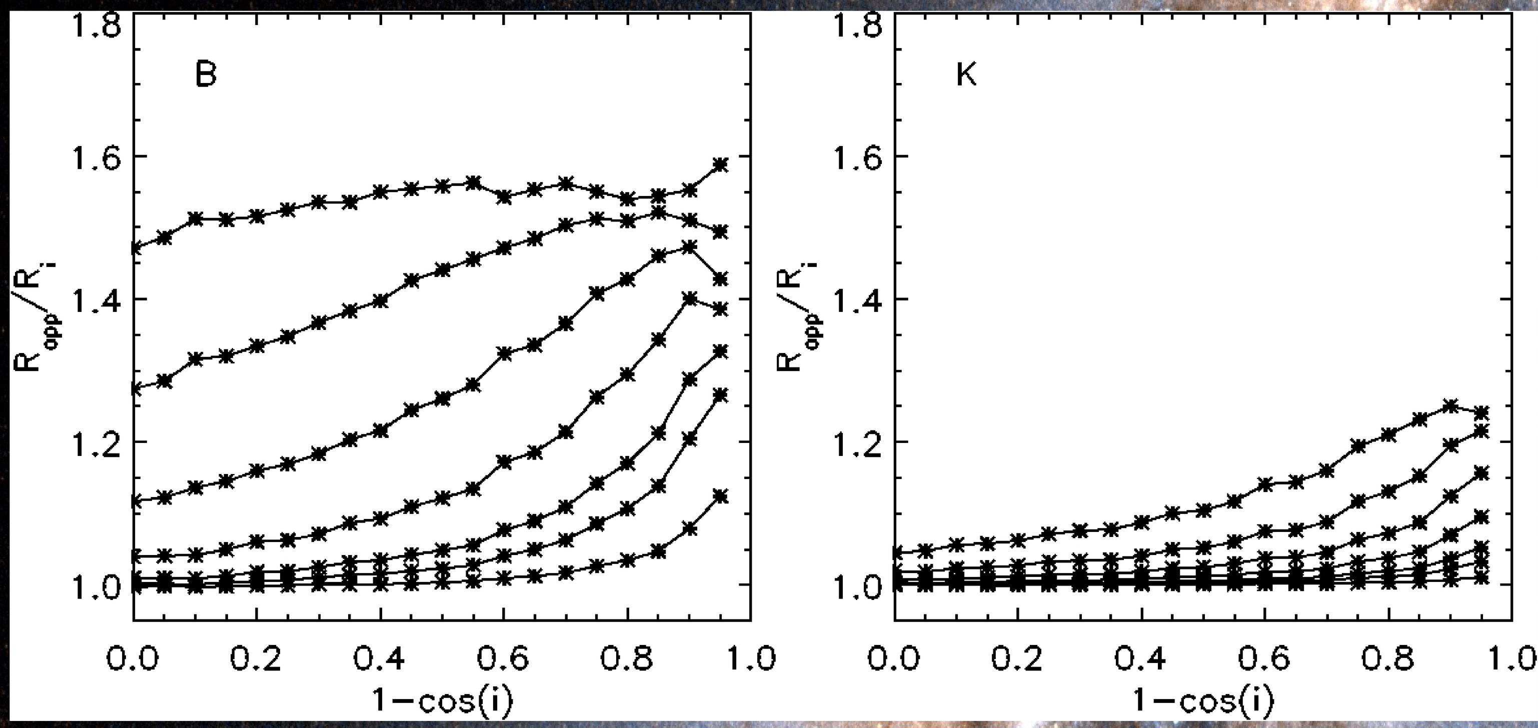

Fig.2 The ratio between the apparent (with dust) scalelength, R_app, and the intrinsic (dustless) scalelength, R_i, of the disk images, as a function of inclination (1-cos(i)), for B and K optical bands. From bottom to top the curves are for central face-on B band opacity values of 0.1,0.3,0.5,1.0,2.0,4.0,8.0.

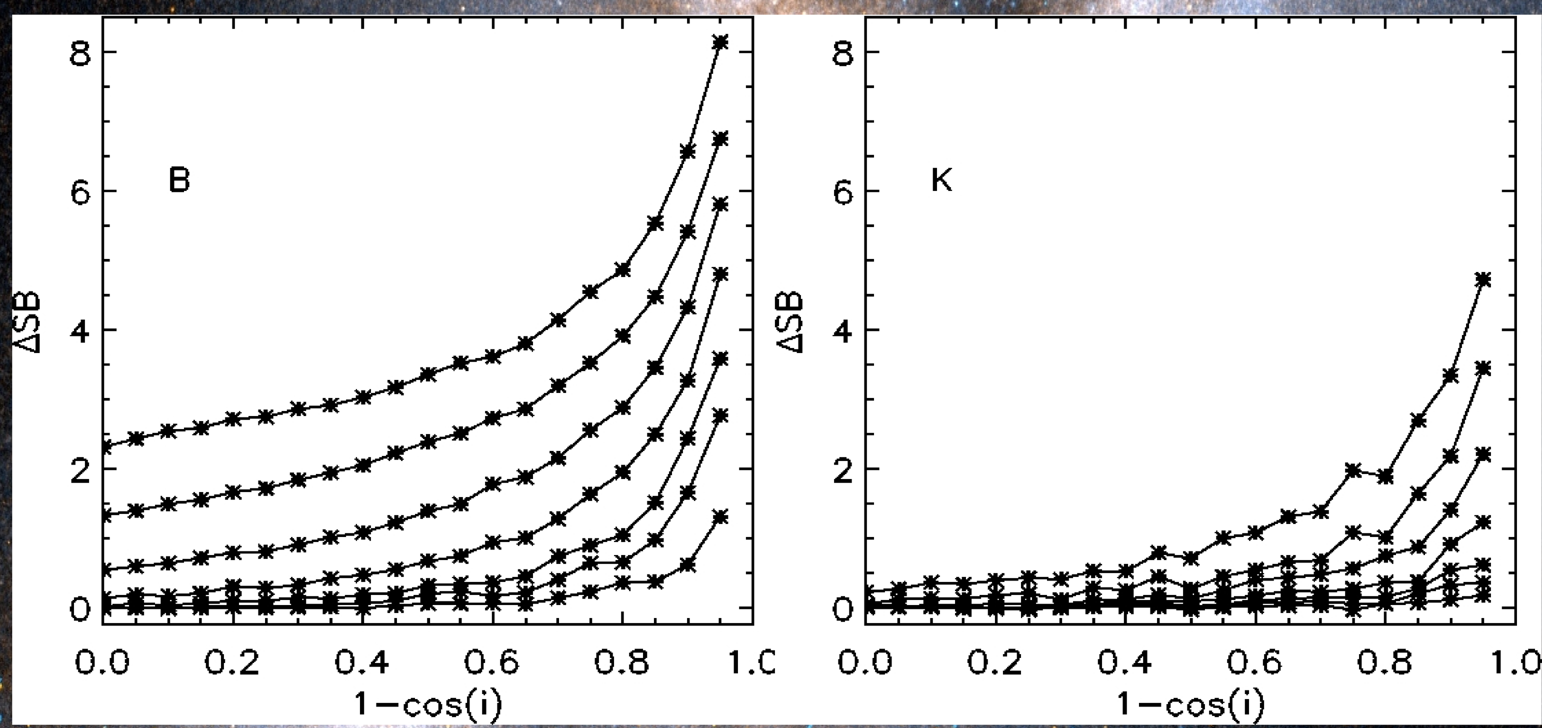

Fig.3 The ratio between the apparent (with dust) and intrinsic (dustless) central surface brightnesses of disk images, ΔSB, expressed in magnitudes, versus inclination (1-cos(i)), for B and K optical bands. From bottom to top the curves are for central face-on B band opacity values of 0.1,0.3,0.5,1.0,2.0,4.0,8.0.

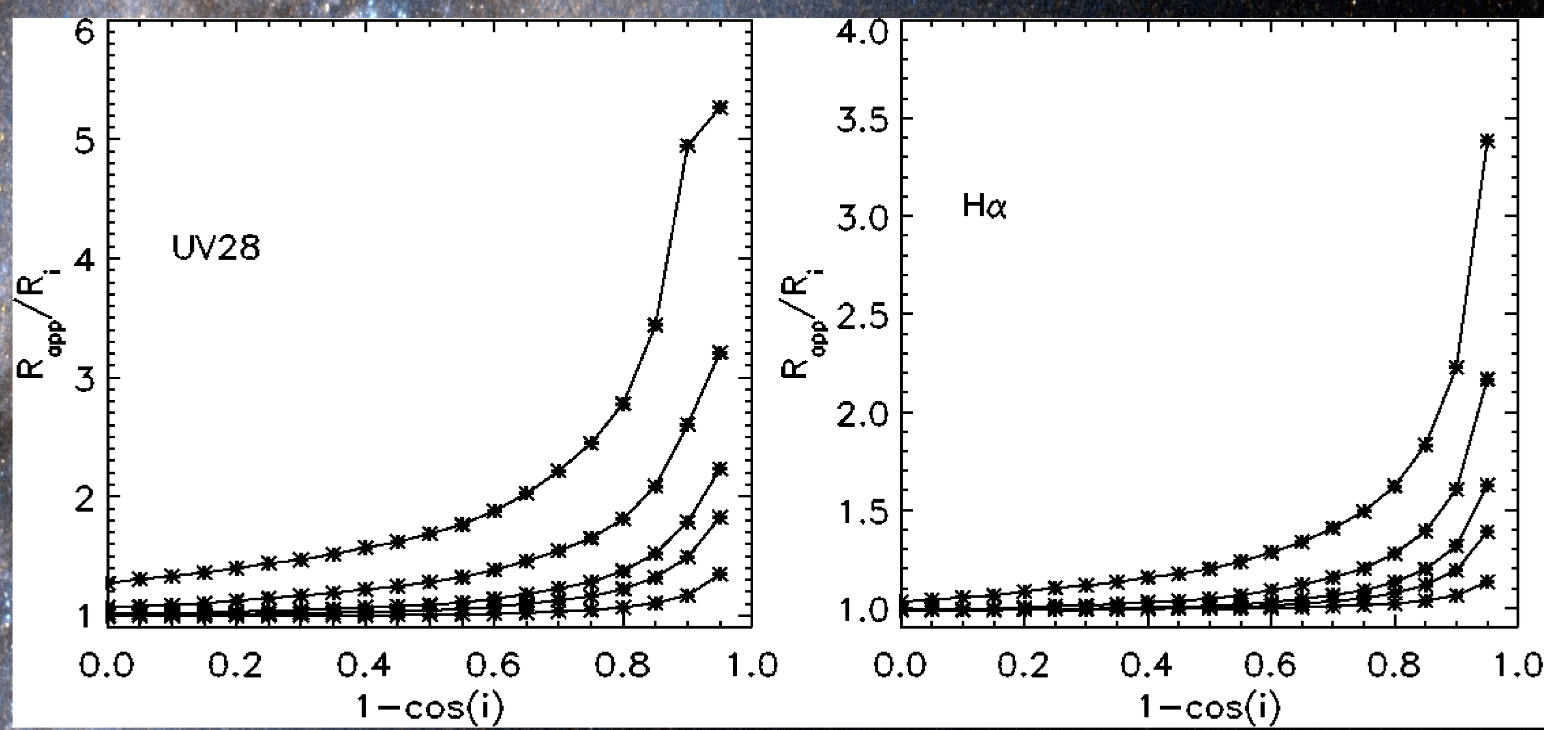

Fig.4 The ratio between the apparent (with dust) scalelength, R_app, and the intrinsic (dustless) scale-length, R_i, versus inclination (1-cos(i)), for the 280 nm wavelength and the Hα line. From bottom to top, the curves are plotted for central face-on B band opacity values of 0.1,0.3,0.5,1.0,2.0.

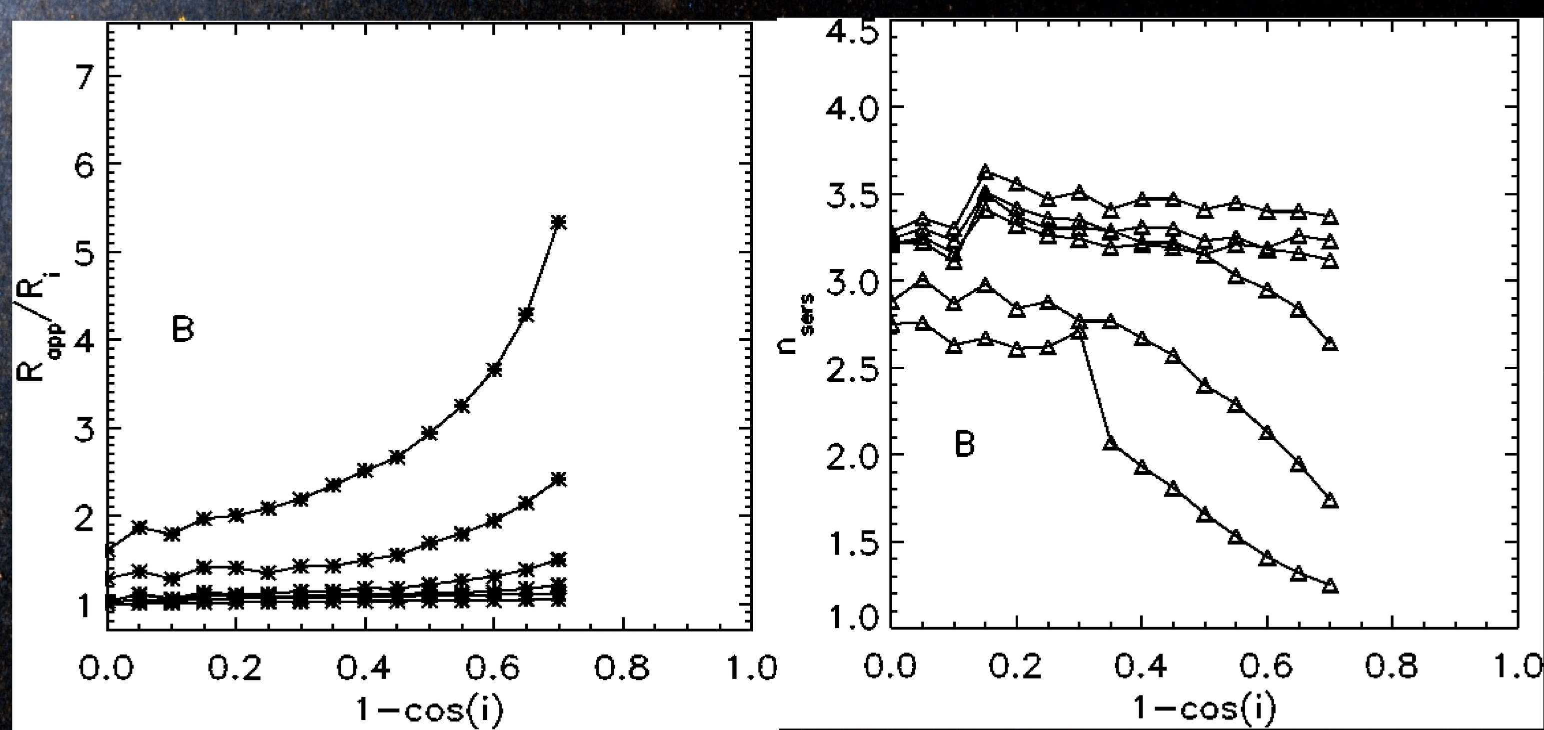

Fig.5 The ratio between the apparent (with dust) effective radius, R_app, and the intrinsic (dustless) effective radius, R_i, of the bulge images, versus inclination (left panel). The inclination dependence of the Sersic-index *n* for the dusty images of the bulge, for the case that the images are fitted with a general Sersic function having *n* as a free parameter (right panel). The different curves correspond to central face-on B band opacity values of 0.1,0.3,0.5,1.0,2.0,4.0.

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