The effects of dust extinction on galaxy image decompositions

Dimitri Gadotti (ESO) & Maarten Baes (Univ. of Ghent)
dgadotti@eso.org

The short version

The effects of dust on galaxy structural parameters derived from 2D fits, or image decompositions, are more complex than those on pure disks or pure spheroidals, due to the complex relation between bulge and disk structural parameters in such fits. Dust effects are more significant for the bulge parameters, and lead to a strong underestimation of the bulge-to-total ratio, which can reach a factor of 3 in the *V* band, even at relatively low galaxy inclinations and dust opacities.

The longer (but still short) version

The goal of this study is to evaluate how dust extinction affects the direct output of 2D bulge/disc decompositions. Thus, we have created several realistic, dusty disc galaxy models, with different dust opacities and at various inclination angles, and carried out sophisticated 2D bulge/disc decompositions on these models, using BUDDA (de Souza et al. 2004; Gadotti 2008). The dust-affected galaxy images are constructed with the 3D Monte Carlo radiative transfer code SKIRT (Baes et al. 2003; Baes, Dejonghe & Davies 2005). **Figure 1** shows that the attenuation of the disc luminosity due to dust, as derived from the decompositions, is less important than the actual attenuation of the disc, calculated from the input model. It also shows that the disc scalelength is overestimated when dust effects become important. **Figure 2** shows that the attenuation of the bulge luminosity, as derived from the decompositions, is, contrary to what happens to the disc, more important than its actual attenuation. It is remarkable that the bulge attenuation is much stronger than the attenuation of the disc at identical optical depths and inclinations. It also shows that, generally, the bulge effective radius and Sérsic index are underestimated when dust effects are important. **Figure 3** shows that the bulge-to-disc luminosity ratio, as measured through the decompositions, can be significantly smaller than the corresponding ratio in the input, SKIRT models, at fixed optical depth and inclination.

Our results show that the decomposition minimises the attenuation of the disc. The outer regions of the disc are hardly affected by dust, but have a strong weight in the fitting of the disc model, given that they contain a larger number of pixels than the disc inner regions. As a result, the outer regions will tend to push the fitted disc parameters to their optically thin value, in spite of the much larger attenuation at smaller radii, making the apparent attenuation weaker than the actual one. In order to compensate such discrepancy at small radii, the bulge model is affected in such a way that the bulge contribution to the total model is significantly reduced.

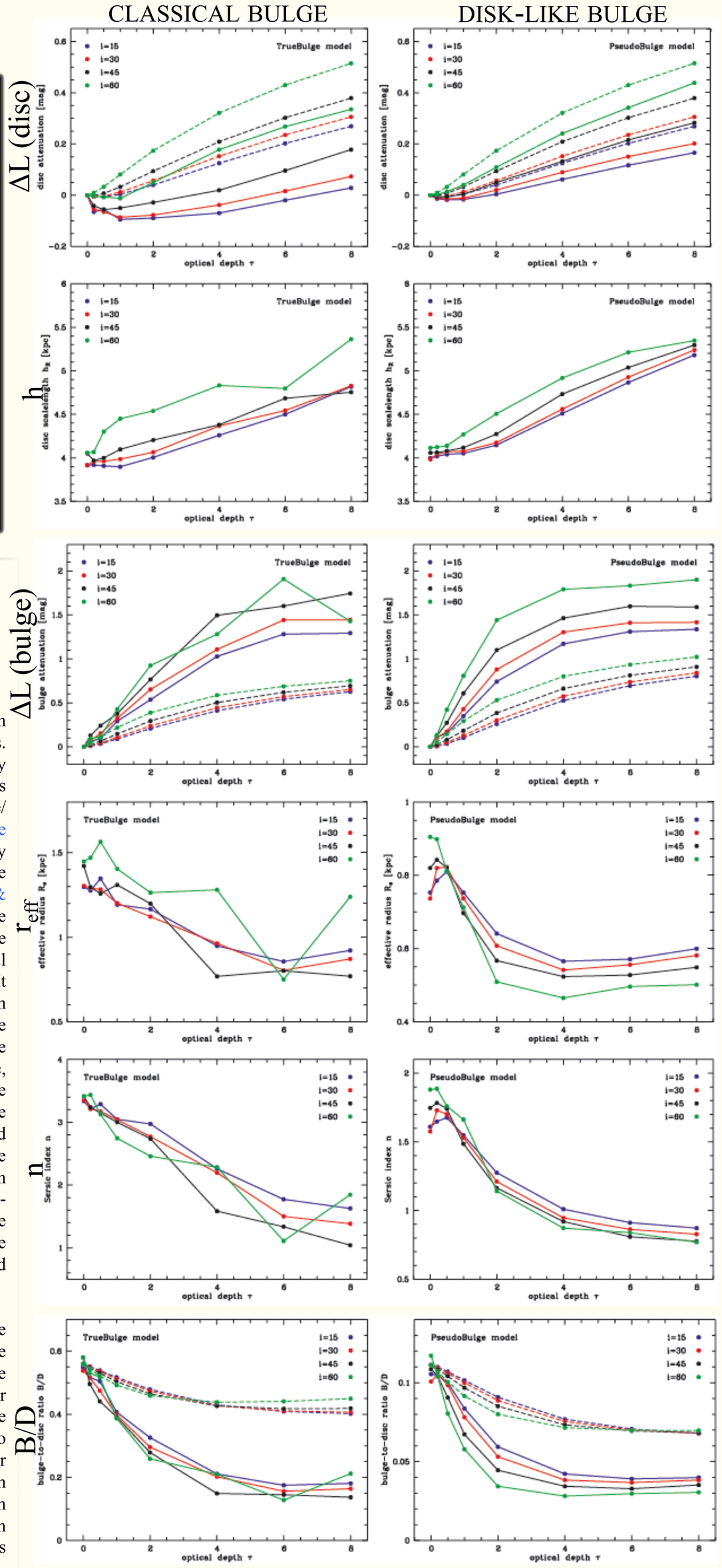

Fig. 1. Dependence of the apparent disc parameters on the V-band optical depth τ, as derived from the BUDDA bulge/disc decompositions of the dust-affected images. The panels on the top and bottom rows respectively show the apparent attenuation of the disc total luminosity, and the disc scalelength. The dashed lines in the top panels show the actual attenuation of the disc as a function of the optical depth. Results for the different inclination angles and models are shown, as indicated.

Fig. 2. Dependence of the apparent bulge parameters on the V-band optical depth τ, as derived from the BUDDA bulge/disc decompositions of the dust-affected images. The panels on the top, central and bottom rows show, respectively, the apparent attenuation of the bulge total luminosity, the bulge effective radius and Sérsic index. The dashed lines in the top panels show the actual attenuation of the bulge as a function of the optical depth. Results for the different inclination angles and models are shown, as indicated.

Fig. 3. Dependence of the bulge-to-disc ratio on the V-band optical depth τ. The solid lines represent the apparent bulge-to-disc ratio as derived from the BUDDA bulge/disc decompositions of the dust-affected images. The dashed lines represent the actual (dust affected) bulge-to-disc ratio as determined from the ratio of the input bulge and disc integrated fluxes.

Radiative transfer in disc galaxies – IV. The effects of dust attenuation on bulge and disc structural parameters
(Gadotti et al. 2010, MNRAS 403, 2053)