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Vertical surface brightness profiles of boxy bulges

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Abstract. The thickening of the bar in barred disk galaxies has a strong influence in shaping the morphology in the inner regions of a disk galaxy above the galactic plane. The result of such a secular evolutionary process can be observed in galaxies with box/peanut shaped (b/ps) bulges. We have applied a one–dimensional fitting method to our sample of 30 edge–on disk galaxies using different fitting function approaches. A clear increase in scale height can be observed in the area of the most prominent b/ps isophotes compared to the neighbouring disk and bulge areas, in agreement with the predictions of the bar thickening model.

Keywords. infrared: galaxies, methods: data analysis, galaxies: photometry, galaxies: evolution, galaxies: structure, galaxies: spiral, galaxies: bulges, instabilities

1. Box/peanut shaped bulges

The work of Bureau & Freeman (1999) showed that box/peanut shaped (b/ps) bulges can be observed frequently ($\approx$ 71% of their sample) in barred edge–on disk galaxies. That result and the work of Bureau, Aronica, Athanassoula, *et al.* (2006) corroborated the view of a stellar bar as the primary driver for the formation of the b/ps structure. In fact, those structures can evolve from a vertical instability in the bar (bar buckling, e.g., Pfenniger & Friedli 1991) causing a vertical thickening of that component (e.g., Patsis, Skokos, & Athanassoula 2002, Athanassoula 2005) on secular timescales.

2. Analysis and results

In order to analyze the vertical surface brightness distribution we used K_n–band near infrared data of the sample galaxies described in Bureau & Freeman (1999) consisting of 30 galaxies. We have applied to the vertical surface brightness distribution of those galaxies a one–dimensional fitting approach based only on a thin disk component. The functions used were Sersic type functions, Gauss–Hermite polynomials, and the canonical exponential and sech type functions.

The innermost regions of the disk of galaxies with a b/ps structure are characterized by a global minimum in scale height (see Figure 1); a possible indication for a rather flat component like a compact cold disk. Further, the regions with the most prominent b/ps isophotes show higher values for the scale height compared to the neighbouring disk and bulge areas. Also, the shape parameters of all fitting functions used show rather flat–topped vertical surface brightness distributions, contrary to the outer disk regions. Both changes, the local maxima in scale height and the flat–topped shaped distributions in the region with the most prominent b/ps isophotes, are consistent with the model of b/ps bulge formation out of the thickening of the bar in those galaxies.

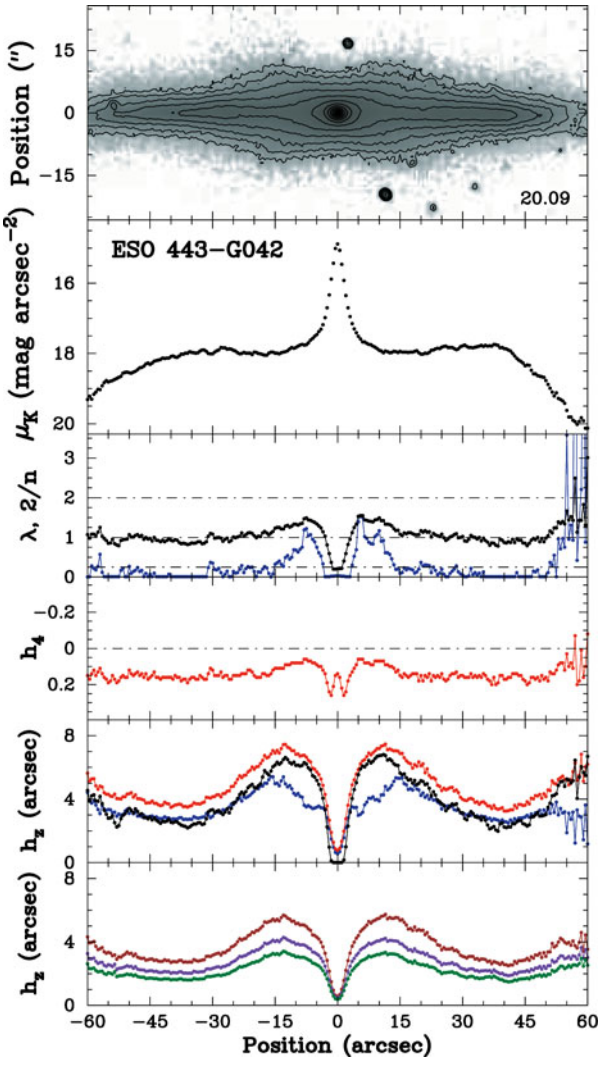

Figure 1. Results of the one–dimensional fitting approaches for the galaxy *ESO 443-G042*. In the first two panels, the grayscale K_n–band image with isocontours, respectively the radial surface brightness profile taken along the major axis of the galactic plane at $z = 0$ are plotted. The next two panels show the results for the shape parameters of a Sersic type (λ), a generalized sech type ($2/n$), and a Gauss–Hermite polynomial type (h_4) fitting approach. All those parameters are a measure for the peakiness of the fitted distribution. In the last two panels the fitted scale height for all fitting functions used is displayed; the upper one shows the results for the functions with varying shape, whereas the lower one the results for fixed shapes (e.g. an exponential function).

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