Mass Profiles and Shapes of Cosmological Structures
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DENSITY PROFILES OF GALAXY BULGES AND NUCLEI

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Abstract. The bulge contribution to the inner density profile of a galaxy is well traced by the bulge's NIR surface brightness profile. We map the surface brightness profiles of bulges using HST/NICMOS imaging. Most bulges show nuclear components of 20-200 pc scales, and frequently also unresolved nuclear star clusters (< 20 pc). These nuclear components are the densest parts of bulges, and gave bulges the 'reputation' of having high stellar concentration. Actually, the Sérsic $r^{1/n}$ bulges typically have low concentrations, $1 < n < 2.5$. We cannot confirm the bi-modal distribution of bulge profile slopes reported by others, and suggest that the alleged bi-modality is related to selectively excluding/including nuclear components in low/high-n bulges.

1 Data

HST/NICMOS F160W and *HST/WFPC2 F450W, F814W* images, together with ground-based *UKIRT* J, K imaging, and *INT/PFC UBRI* imaging, for 19 inclined S0-Sbc galaxies (Peletier et al. 1999). We link the NIR surface brightness profiles from *HST* and *UKIRT* hence profiles cover from ∼20 pc to several kpc, sampling from the innermost nuclei to the disk region. This allows for a reliable bulge-disk decomposition. See Balcells et al. (2003).

2 Densities: Often, bulges are less dense than their nuclei

Both the surface brightness profile analysis and the nuclear isophotes concur in showing that bulge nuclei often (∼60%) contain flattened, dusty, high-surface brightness components of 20-200 pc size. These provide an excess light with respect to the bulge, and are well modeled with an exponential profile with an optional

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unresolved source (likely a star cluster). Our early-type disk galaxies typically have bulges with $1 < n < 2.5$ Sérsic indices. Including the nuclear components with the bulge would yield Sérsic fits with $1 < n < 5$ (Andredakis, Peletier & Balcells 1995), and would 'fool' ground-based observers into believing that many bulges are $r^{1/4}$ (Balcells et al. 2003): only few bulges do (e.g., Graham et al. 2001). We suggest, from isophotes and from the profile shapes, that nuclei may be best described as separate components (Balcells, Graham & Peletier 2006).

Of obvious interest is to discern the roles of the known bulge formation processes (primordial collapse; merging; bar-driven disk inflow) in the growth of bulges and nuclei, and to address questions such as which formed first, the extended bulge or the inner components. We note that such components break the frequently-used paradigm that dense galaxian components are spheroids, as they are flattened structures, most likely disks, bars or rings.

3 Two families of bulges?

We find that nuclear components are easy to discern from the underlying bulge when the latter has an exponential surface brightness profile; but nuclear components can easily be confused into the bulge profile when the bulge has $n > 2$. When computing nuclear profile slopes, selectively excluding/including light from the nuclear components in low/high n bulges tends to polarize inferred slopes toward low and high values, perhaps explaining the claims for a bi-modal distribution of nuclear profile slopes that have been attributed to trace two families of bulges (e.g., Carollo & Stiavelli 1998). We find negative logarithmic nuclear profile slopes $\gamma \equiv -d \log I(r)/d \log r$ following a continuous distribution $0 < \gamma < 1$ when only the Sérsic-bulge component is taken into account, and γ clustering around $\gamma \sim 0.5$ when we including the light of nuclear components with the bulge.

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