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# The multicomponent structure of bulges

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## *Introduction*

The morphology of disk galaxies is usually described by two major components, the centrally concentrated spheroidal component, called the bulge, and an oblate disk. The ratio of there contribution to the total luminosity – the bulge-to-disk ratio – is one of the parameters characterizing the Hubble sequence. Following de Vaucouleurs (1948), for most galaxies the radial distribution of the outer spheroid is fairly well described by the $r^{1/4}$ law: $I(r)=I_0 \cdot \exp(-\alpha r^{1/4})$, whereas the radial luminosity distribution of the disk follows an exponential law: $I(r)=I_0 \exp(-\alpha r)$ (Freeman 1970), with r the radial distance from the center. $I_0$ and $\alpha$ are characteristic constants for each individual galaxy.

Parameters for the structural properties of these components give important constraints for models of the formation and evolution of galaxies. Therefore we have tried to decompose disk and bulge components from high S/N CCD observations of a sample of edge-on disk galaxies.

A common procedure for the decomposition is to model one component in a region where it dominates and subtract it from the combined light distribution. This technique was successfully carried out e.g. by van der Kruit&Searl (1981, 1982) and Wakamatsu&Hamabe (1984, 1989).

Here we present two more examples of bulge-dominated edge-on S0 galaxies, namely ESO 506-G33 and NGC 7123, which show an additional small and concentrated central component besides disk and "bulge" .

## *Observations and reduction*

We have investigated a sample of 10 bulge-dominated early-type disk galaxies (S0-Sa). The objects were selected by inspecting the ESO/SRC sky survey plates to insure that the inclination $i \approx 90°$ . This "edge-on" geometry guarantees that the projected intensities of the components have the smallest overlap. The surface photometry observations were carried out with the 2.2m telescope at ESO/La Silla using a RCA CCD.

Preliminary results in the decomposition process indicated that in two cases, ESO 506-G33 and NGC 7123, there is a more complex structure. Plotting log(I) vs. $r^{1/4}$ for the minor axes of these galaxies clearly revealed a two component structure, resembling the minor axis profile of NGC 4565.

## *Results*

While the outer spheroid of these two galaxies is successfully modelled with a de Vaucouleurs $r^{1/4}$ law, the remaining disks after subtracting the best-fit bulge models still show additional concentrated bulge-like central structures. With the bulge-to-disk of the residuum images, these galaxies could be classified as Sb/Sbc. The inner nuclear structure in NGC 7123 even resembles a box- or peanut-shaped bulge. The presence of these inner bulges is not very critically depend on the parameters chosen for the outer spheroids. This suggests that the additional structures are real and not just artifacts. However, our observations can not distinguish whether the remaining bulges are independent additional components or parts of more complex spheroids.

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A possible explanation for the presence of this additional structure is based on resent theoretical work e.g. by Combes et al. (1990). They found from N-body simulations that a bar can mimic the presence of a bulge. Depending on the projection direction of this "bulge" could be box-, or peanut-shaped, or round.

## *Conclusions*

Our results corroborates the suggested relation between box- and peanut-shaped bulges and bars. This scenario has significant implications for any theory of galaxy evolution and formation: If (at least) some bulges, especially in later-type disk galaxies, developed as a resonance phenomenon or instability caused by a bar, they are an evolutionary structure rather than a relict of the galaxy formation process.

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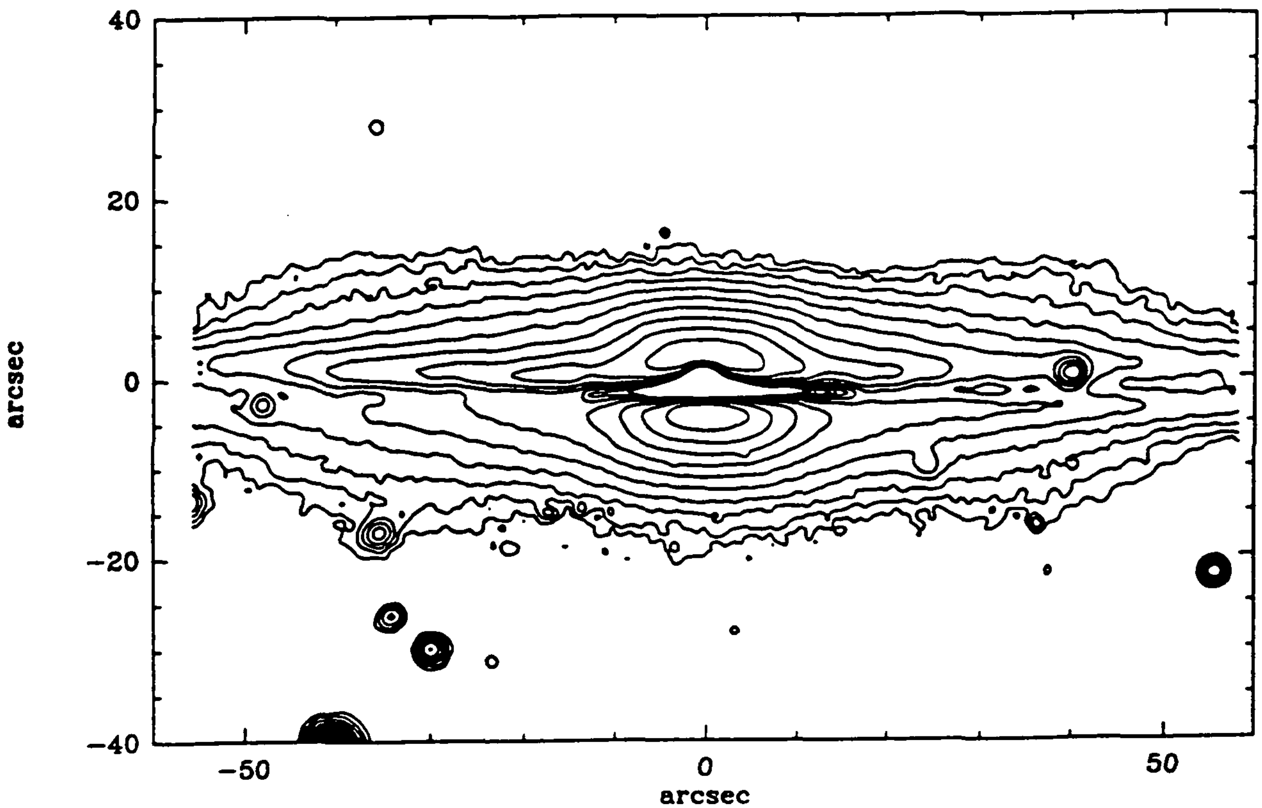


**Figure 1:** Resulting intensity distribution for NGC 7123 after subtraction of the dominant outer spheroid.

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