

Box/Peanut Galaxies in the Near-IR

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1. Introduction

Galaxies with box/peanut-shaped (b/p) bulges have been known for some time (e.g., NGC 128 and NGC 7332 (Sandage 1961)). Observationally, b/p features are detected in edge-on systems, and are visible in images, contour maps, and brightness profiles as isophote sections that near minor axis are relatively flat and parallel to major axis (see Figure 1). Peanut-type bulges have isophotes indented at the intersection with the minor axis.

There have been several morphological surveys to date. The two most recent studies have found that about 20% of early-type galaxies and nearly 45% of all disk galaxies are b/p galaxies (see Shaw 1987, Dettmar 1989, and references therein) and that the b/p galaxy properties appear similar to normal spirals in the optical, radio, and infrared. A few kinematical studies have been done: b/p bulges are found to rotate more like disks than bulges (e.g., 150 km s⁻¹ up to 6 kpc above the plane in NGC 128 (Jarvis 1990) and the velocities remain constant up to large z , implying cylindrical rotation (e.g., NGC 3079 has v constant out to 1.6 kpc (Shaw et al. 1993)).

Several models have been suggested for b/p galaxies; one of these is that b/p galaxies may be barred galaxies seen edge-on: some models (Combes & Sanders 1981, Combes, et al. 1990) exhibit a p-shape when the bar is viewed perpendicular to its long axis and a b-shape when viewed edge-on. Vertical resonances in the bar may supply the heating to generate the b/p shape (Friedli & Pfenniger 1990, Pfenniger & Friedli 1991). In these models, a bar viewed end-on appears round and the b/p shape appears when the bar is viewed perpendicular to its long axis. A few b/p galaxies have been identified as possible edge-on SB galaxies, based on their surface brightness profiles (Hamabe & Wakamatsu 1989; Dettmar & Barteldrees 1990).

2. Data and Analysis

Optical CCD images were obtained at the KPNO 0.9m telescope using the TEK 1 CCD (512 × 512) with 0".7 pixels and 6'.5 total field of view. The galaxies observed were selected from lists of previously identified b/p galaxies (Shaw 1987; DeSouza & DosAnjos 1987). Near-IR images were obtained with the KPNO 1.3 m, using SQUID (Simultaneous Quad-color Infrared Imaging Device)

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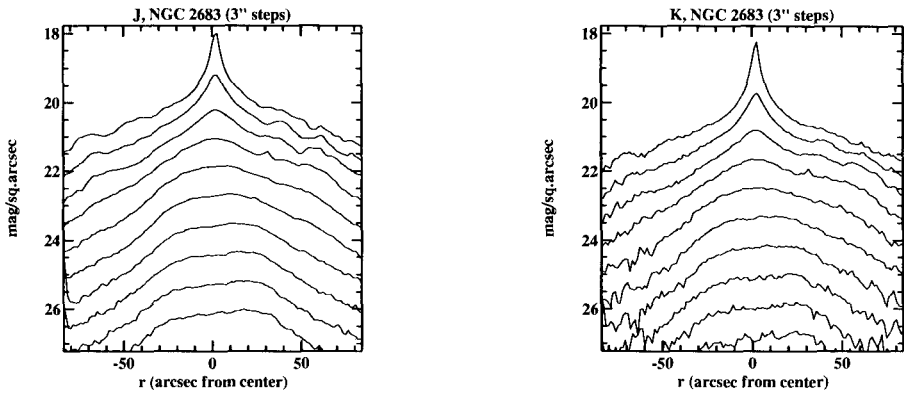


Figure 1. NGC 2683 *J* and *K*-band b/p cuts from southern side

camera equipped with PtSi detectors (256×256) with $1''.4$ pixels, total field of view $5''.5$.

Six galaxies have been studied in detail so far; four of the six are b/p while the other two appear to be normal edge-on galaxies. A striking result is that in the near-IR, each of the b/p galaxies is seen to possess 2 well-defined spiral arms, which appear to start in the b/p regions; the two non-b/p galaxies show no such arms. Contour and profile plots confirm the visual inspection results. As an example, the b/p galaxy NGC 2683 surface brightness profiles parallel to the major axis at increasing z are shown in Figure 1 and the *K*-band contour plot is shown in Figure 2. A quantitative measure of the b/p nature of the profiles parallel to the major axis was performed on all optical (Baggett 1993) and near-IR images (this study); these measurements confirm the results as well.

3. Conclusions

Results from recent SQUID *JHK* observations of edge-on galaxies were presented. Six highly inclined galaxies from the literature b/p lists have been examined in detail so far. Four galaxies exhibit obvious b/p features in the optical (Baggett 1993; Baggett & Anderson, in prep.) and near-IR (this study) and two lack b/p features.

As expected, the near-IR imaging provides unique information for edge-on galaxies, as the dust obscuration is greatly reduced. Four b/p galaxies show clear evidence of spiral arms emanating from the b/p region; these arms are not visible in the optical images and don't appear in the non-b/p galaxy images.

The near-IR data is suggestive of a highly-inclined bar viewed end-on, with the spiral arms extending outward from the bar's end. Question for model builders: As a bar is viewed from edge-on to more face-on, at what inclination would the b/p shape be expected to disappear?

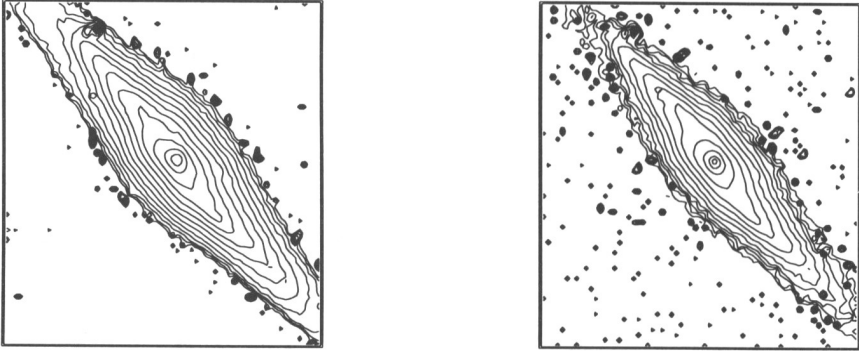


Figure 2. NGC 2683 *J* and *K*-band image contours in 0.5 mag steps; images are 4.6 square

References

- Baggett, S. M., Ph.D. Thesis 1993, New Mexico State University
- Combes, F. & Sanders, R. H. 1981, *A&A*, 96, 164
- Combes, F., Debbasch, F., Friedli, D., & Pfenniger, D. 1990, *A&A*, 233, 82
- Dettmar, R.-J. 1989, in *The World of Galaxies*, H.C. Corwin & L. Bottinelli, Berlin: Springer-Verlag, 229
- Dettmar, R.-J. & Barteldrees, A. 1990, in *ESO Bulges of Galaxies Conference and Workshop Proceedings*, No.35, 259
- de Souza, R.E. & dos Anjos, S. 1987, *A&AS*, 70, 465
- Hamabe, M. & Wakamatsu, K. 1989, *ApJ*, 339, 783
- Jarvis, B. 1990, in *Dynamics and Interactions of Galaxies*, Roland Wielen, Berlin: Springer-Verlag, 416
- Pfenniger, D. & Friedli, D. 1991, *A&A*, 252, 75
- Sandage, A. 1961, *The Hubble Atlas of Galaxies*, Washington, D. C.: Carnegie Institute of Washington, Publication 618
- Shaw, M. A. 1987, *MNRAS*, 229, 691
- Shaw, M., Wilkinson, A., & Carter, D. 1993, *A&A*, 268, 511