Barred Galaxies
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Multicolor Photometry of Barred Spiral Galaxies

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1. Observations

$B - V$ and $R - I$ color maps (from CCD imagery obtained at Cerro Tololo Inter-American Observatory) of six barred spiral galaxies have been used (Horst 1992) to investigate stellar populations within the bars and nuclei. Two-color diagrams show that the distribution of pixel colors largely parallels the expected locus for normal unreddened stars. If the "reddening" law is assumed to remain fairly constant, and if the slope of the vector associated with this reddening law is additionally assumed to be commensurate with that derived from models which take into account both absorption and scattering (Witt et al. 1992), one concludes that the overall effects of internal extinction are remarkably uniform along the bars and within the nuclei of all six galaxies. It thus appears reasonable as a first approximation to shift the observed data along the assumed reddening vector to estimate the spectral types of stars that are present and to investigate differences between bar and bulge populations. Nevertheless, to correct surface brightness distributions for the effects of internal extinction, and hence to proceed with more detailed attempts to model the various luminosity components (i. e., the bulge, bar, etc.), is a complex problem which must be addressed through numerical models explicitly designed to reproduced barred systems.

2. Results

In all the galaxies of the present sample (NGC 613, 1300, 1433, 1566, 1672, and 7479), surface brightness profiles suggest star formation activity is occurring near the ends of the bars. In addition, color indices in the central regions (within the central 5 arc seconds, both $B - V$ and $R - I$ color indices become bluer than surrounding regions) for all but one galaxy (NGC 7479) suggest active star formation within the nucleus. This is a testament to the efficiency of the bar mechanism which dynamically funnels interstellar gas and dust toward the nucleus, resulting in active star formation. This same mechanism is also likely responsible for the observed bar-end star formation in the surface brightness profiles along the bar. Integrated color is very much a function of the position along the bar.

The surface photometry suggests a difference between the nuclear and bar populations as determined by shifting the observed distribution of pixel colors along the assumed reddening vector towards the unreddened locus. Two effects are present which account for this:

1. The spheroidal populations of the central regions of galaxies are typically composed of older, redder Population II objects, whereas surface brightness profiles along the bars strongly suggest active bar-end star formation. Older, redder stars associated with the nucleus and younger, bluer stars associated with the bar ends likely produces the first-order effect which accounts for the majority of the observed radial color trend.

2. A more subtle effect is believed also to be present and from which it actually appears possible to discriminate between bulge and bar populations. In two galaxies, NGC 1300 and NGC 1433, in bar regions which are largely unaffected by either bulge light or bar-end star formation and thus where the colors are indicative of the dominant population of the stellar bars, de-reddening suggests populations corresponding to late G-type stars. For both of these galaxies this appears to be distinguished clearly from the bulge light (discounting the nuclear bluing) which corresponds to early K-type stars.

3. Conclusion

Though this sample base is too small to draw a global inference, nevertheless it would seem there is reason to believe the bar and bulge populations are indeed separate and that both correspond to relatively old populations. In order to investigate possible differences between the disk and bulge populations one needs further deep exposures of these low surface brightness features. Until this is accomplished it is not considered feasible to discriminate between bars as density wave enhancements of the disk or bars as a dynamically distinct population separate from the disk.

References

Horst, W. D. 1992, Ph.D. Thesis, University of Missouri – Columbia
Witt, A. N., Thronson, H. A., & Capuano, J. M., Jr. 1992, ApJ, 393, 611