A WIYN Survey of Early-Type Barred Galaxies: Double 
Bars and Central Structures

Peter Erwin and Linda S. Sparke
Astronomy Department, University of Wisconsin–Madison, 475 N.
Charter St., Madison, WI 53703

1. Introduction

We present results from a preliminary analysis of a recently-completed, multi-
color imaging survey of nearby, early-type barred galaxies in the field, carried 
out with the WIYN telescope and supplemented with archival HST images. This 
forms a reasonably complete sample of nearby, bright, barred S0 and Sa galaxies 
in the field. The excellent seeing provided by WIYN allows us to examine the 
galaxies for central features such as circumnuclear rings and secondary bars; we 
find some evidence for dust lanes within secondary bars.

The most striking results is the high frequency of double bars: our analysis 
suggests that at least $\sim 20\%$ of barred S0–Sa galaxies possess secondary bars. We 
also find an excellent candidate triply barred galaxy: NGC 2681.

2. The Sample and Observations

Our sample was designed to address questions about the frequency of multiple 
central structures in barred galaxies. To minimize confusion due to dust, we 
concentrated on early type (S0 and Sa) galaxies. Using the UGC, we chose all 
barred S0 and Sa galaxies north of $-10^\circ$ meeting these criteria: $z \leq 2000$ km/s, 
major axis $\geq 2$ arcmin, and axis ratio (major : minor) $\leq 2$. Galaxies in the 
Virgo Cluster were excluded, resulting in a total of 38 galaxies. Although there 
is a bias towards luminous, high surface brightness galaxies, this is a reasonable 
complete set of galaxies.

All but two of the galaxies were observed in the B and R bands between 
December, 1995, and March, 1998, at the 3.5m WIYN telescope in Tucson, 
Arizona. Seeing ranged from 0.6–1.3$''$; the majority of galaxies were observed 
in sub–arc second seeing. Archival HST data was also consulted for some of the 
galaxies. For the two galaxies not observed, excellent ground-based and HST 
data were available in the literature.

3. Analysis

We search for secondary bars in our galaxies by fitting ellipses to isophotes. Bars 
are indicated by a peak in the ellipticity, accompanied by a plateau or stationary 
point in the position angles of the ellipses at roughly the same semi-major axis. 
We also inspect the B band images and color maps to ensure that dust lanes 
and star formation do not create spurious bar-shaped isophotes.
Figure 1. Isophote fits for two galaxies from our sample. NGC 2950 is a typical double-barred galaxy; NGC 2681 is a triple-barred galaxy, with an inner ring around the middle bar.

4. Preliminary Results

Of the 22 galaxies we have analyzed so far, there are:

- 5 galaxies with clear secondary bars (NGC 2681, NGC 2859, NGC 2950, NGC 3945, NGC 4314 — note that NGC 2681 has three bars!);
- 5 more with possible secondary bars (NGC 2880, NGC 3185, NGC 3412, NGC 3941, NGC 4643);
- 6 galaxies with no secondary bar, and 6 galaxies too dusty to determine their central stellar structure.

At least 26% of our galaxies have clear or possible secondary bars. We tentatively conclude that the fraction of barred S0 and Sa galaxies in the field with secondary bars is at least 20%.

We can construct a similar sample of galaxies in the southern sky (matching our sample criteria, but with $\delta \leq -10^\circ$ and excluding the Fornax cluster). A search of the literature reveals 6 known double bars, out of the 28 galaxies in the sample. The minimum fraction of double bars in that sample is thus 21%. This strengthens our belief that our (northern) sample is not unusual in its frequency of double bars. Double bars are surprisingly common in field S0 and Sa galaxies.