Barred Galaxies
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HI Observations of Barred Magellanic Type Galaxies

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Abstract. We present the results of a VLA D-configuration survey of a sample of Barred Magellanic type (SBm/IBm) galaxies. The data show that: (1) the HI is extended well beyond the optical diameter; (2) the HI distribution often has a different position angle than the optical distribution; (3) the bar morphology is typically manifested in the HI kinematics; (4) these galaxies not only tend to have gaseous companions, but they also tend to be strongly interacting systems; and (5) the companions have no obvious optical counterparts.

1. Introduction

Contrary to popular opinion irregular galaxies such as the LMC are not, in fact, irregular. Barred Magellanic type galaxies (SBm/IBm) are larger and more organized than dwarf irregulars. They are also the most massive of the irregular galaxies and tend to have strong stellar bars. In addition to their stellar bars they are characterized by well-defined structure and rotation as well as nascent spiral arms. SBm/IBm systems are seen as transitional objects between true dwarfs and spiral galaxies. In addition to these properties Magellanic irregulars are well-represented in the local universe and they are among the most abundant of the active star-forming galaxies. While the star formation activity in SBm/IBm galaxies is more widely distributed than in amorphous galaxies, it is often dominated by a single giant HII region complex located at one end of the bar.

This study is based on D-array VLA observations of five galaxies classified as either SBm or IBm by de Vaucouleurs & Freeman (1972): NGC 1507, NGC

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3264, NGC 3432, NGC 4288, and NGC 4861. An additional criterion was that the galaxies be closer than 10 Mpc.

2. Results

The quantitative results of this study are summarized in Table 1.

Table 1: HI Properties

Galaxy	R	V_{max}	M_{HI}	M_{kin}
-	kpc	km s^{-1}	$M_\odot$	$M_\odot$
Primary Galaxies				
N1507A	7.0	114	4.8×10^8	1.1×10^{10}
N3264	8.0	95.0	4.5×10^8	8.3×10^9
N3432A	16.0	150.0	2.4×10^9	4.2×10^{10}
N4288A	13.6	109.0	3.4×10^8	1.9×10^{10}
N4861A	19.8	81.0	7.8×10^8	1.5×10^{10}
Neighboring Clouds				
N1507B	5.4	57.0	2.6×10^7	2.0×10^9
N3432B	6.4	59.0	5.9×10^7	1.3×10^9
N4288B	11.8	29.0	1.4×10^7	5.5×10^8
N4861B	7.4	19.0	4.0×10^6	1.6×10^8

The physical properties of the primary galaxies are quite consistent with the properties of typical irregular galaxies (Hunter & Gallagher 1986). The properties of the neighboring clouds are quite consistent with detections of intergalactic HI clouds (Taylor et al. 1993; Wilcots et al. 1995b) and high-velocity clouds (van der Hulst & Sancisi 1988). In comparing the HI properties of these galaxies with their optical properties we find that the HI extends far beyond the optical limits of each galaxy. For NGC 1507, NGC 3432, and NGC 4288 the major axes of the optical and HI distributions are not aligned. We also find that there are no obvious optical counterparts to any of the HI clouds detected in this study. The velocity fields of these galaxies show: 1) the inner parts are generally characterized by solid body rotation coincident with the optical bar; 2) the outer isovelocity contours are twisted; and 3) the major and minor axes of the velocity fields are not perpendicular. These properties are the manifestation of a barred potential. The rotational velocities of the primary galaxies are typical of giant irregular and extreme late-type spiral galaxies.

3. Discussion: The Interactions

A major result of this study is the detection of neighboring HI clouds found to be interacting with 4 of the 5 galaxies in this sample. This is consistent with what is seen around HII galaxies (Taylor et al. 1993) and IC 10 (Wilcots et al. 1995b). The major question this raises is whether or not the interactions with these HI clouds are the cause of the barred morphology and kinematics in these galaxies. There is an increasing amount of evidence both observational and numerical that barred structure in galaxies is related to gravitational interactions with their neighbors (Elmegreen et al. 1990; Noguchi 1987, 1988; Gerin et al. 1990; Salo 1991; Odewahn 1994). Quantitatively, we find that these interactions are quite weak and, based on numerical simulations, may not be able to trigger bar formation (Salo 1991). On the other hand these systems fit into the scenario proposed by Noguchi (1987) that the interaction of two gaseous systems first leads to bar formation and then to the formation of an amorphous galaxy. Few conclusions can be reached until these data can be compared with more appropriate numerical simulations (i.e. interactions between irregulars and dwarfs). Additionally, we cannot appreciate the full implications of these results until we can establish whether or not there are barred Magellanic irregulars that do not seem to be interacting with neighboring clouds. We can conclude that these data are consistent with the notion that barred structure and kinematics in irregular galaxies is triggered by gravitational interactions. Secondly, if the neighboring HI clouds detected here prove to be purely gas as have the ones detected by Taylor et al. (1993), we may be witnessing a stage in the formation of these galaxies.

4. Summary

This survey of a small sample of IBm/SBm galaxies has yielded the following results:
[1] The optical barred morphology is typically manifested in the distribution and kinematics of the neutral hydrogen.
[2] The physical properties of these galaxies are consistent with being transitional objects between dwarfs and large spirals.
[3] These galaxies tend to be interacting with small, neighboring HI clouds.
A complete description, analysis, and discussion of these data can be found in Wilcots et al. (1995a).

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