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The Nature of High H I Mass-to-Light Ratio Galaxies

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Abstract. We present here the preliminary results of a multi-wavelength investigation into high H I mass-to-light ratio dwarf galaxies identified in the *HIPASS Bright Galaxy Catalog.*

One way to investigate aspects of star formation and galaxy evolution is to study galaxies which appear to have done little of either, those with excessive quantities of neutral hydrogen compared to their stellar content. How could such galaxies, generally low luminosity dwarf galaxies, maintain such a high relative proportion of gas, where as others have processed most of their gas into stars? Could the star formation have been impaired or halted in some way? Have they lacked internal or external stimulation or only recently begun star formation?

The H I Parkes All-Sky Survey (*HIPASS*) has provided the largest blind survey of extragalactic neutral hydrogen over the southern sky to date. One of its first products is the *HIPASS Bright Galaxy Catalog* (*BGC*, Koribalski et al. 2003, AJ submitted) listing the 1000 apparently strongest extragalactic H I sources in the southern hemisphere. A comparison of the *BGC* H I data with preliminary optical properties (from *LEDA*, the Lyon-Meudon Extragalactic Database, Paturel et al. 1997, A&AS, 124, 109, http://cismbdm.univ-lyon1.fr/∼leda/) of the *BGC* galaxies (Jerjen et al. 2003 in preparation) revealed numerous sources, mostly intrinsically faint dwarf galaxies, with high H I mass-to-light ratios; three with $\mathcal{M}_{\rm HI}/L_B > 20\ \mathcal{M}_\odot/L_\odot$ (ESO505-G007, ESO215-G?009 and IC4212).

Figure 1(a) shows a plot of $\mathcal{M}_{\rm HI}/L_B$ for 789 *BGC* galaxies as a function of their absolute photographic B magnitude. The plot shows that there is a much larger spread in $\mathcal{M}_{\rm HI}/L_B$ for low luminosity (dwarf) galaxies, with some dwarf galaxies (in the top right corner) having unusually high ratios. We have undertaken extensive multi-wavelength observations (optical, near-infrared, radio) of a sample of 20 high and 20 low $\mathcal{M}_{\rm HI}/L_B$ dwarf galaxies on this plot (filled circles) using the ANU 2.3m telescope and the Australia Telescope Compact Array (ATCA). We present here preliminary results from this investigation, some of the optical (B band photometry) and radio (H I flux and rotation) properties from three of the objects classified as high $\mathcal{M}_{\rm HI}/L_B$ galaxies in our initial sample. Optical VRI and infrared JHK bands have also been taken, along with optical spectra for some galaxies.

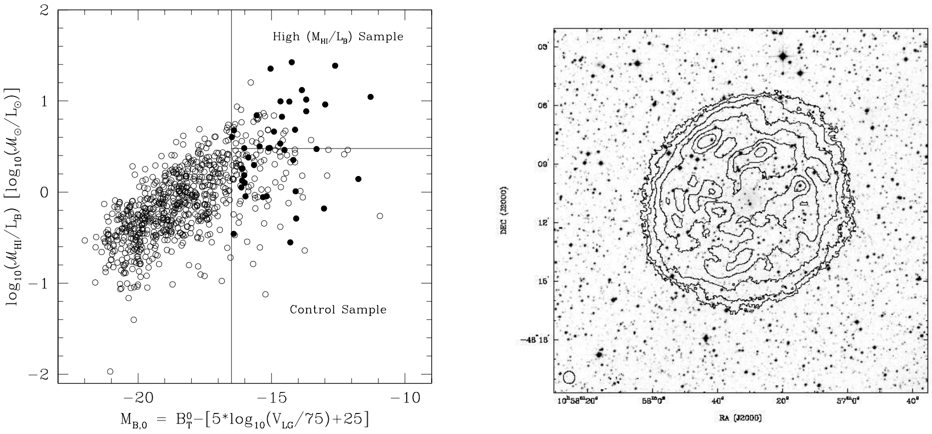

Figure 1. (a) The $\log(\mathcal{M}_{\rm HI}/L_B)$ of 789 *BGC* galaxies as a function of absolute B magnitude. Our sample (filled circles) is drawn from all galaxies with $M_{B,0} >$ -16.5 (mostly dwarf galaxies). The high $\mathcal{M}_{\rm HI}/L_B$ sample was drawn from galaxies with $\mathcal{M}_{\rm HI}/L_B > 3\ \mathcal{M}_\odot/L_\odot$ (top right). A control sample has been drawn from galaxies with $\mathcal{M}_{\rm HI}/L_B < 3\ \mathcal{M}_\odot/L_\odot$ (bottom right). (b) H I line intensity contour map for ESO215–G?009 overlaid on a DSS2 red image. Contours levels are at 0.08, 0.16, 0.32, 0.56, 0.88, 1.20 and 1.60 Jy beam^{-1} km s^{-1}.

Our measured apparent B magnitudes from CCD imaging for all three galaxies, ESO215–G?009 (16.13 ± 0.07 mag), ESO348–G009 (14.82 ± 0.07 mag) and MCG–04–02–003 (15.27 ± 0.07 mag), were brighter than those stated in *LEDA* (16.43, 16.71, 15.84 mag respectively) based on photographic plates. The integrated H I flux densities of the three example galaxies are $F_{\rm HI} = 104 \pm 12$, 13.4 ± 2.2, and 16.0 ± 2.5 Jy km s^{-1} (*BGC*). With the ATCA we obtain $F_{\rm HI} = 121.6 \pm 0.3$, 11.3 ± 0.5, and 16.1 ± 1.8 Jy km s^{-1}. Using the ATCA H I flux and correcting the B magnitudes for galactic extinction (Schlegel et. al. 1998, ApJ, 500, 525) we obtain H I mass-to-light ratios of 21.3 ± 1.4, 1.36 ± 0.15 and 2.9 ± 0.5 $\mathcal{M}_\odot/L_\odot$ respectively, compared to the previous photographic plate estimates of 24.4, 9.2 and 4.8 $\mathcal{M}_\odot/L_\odot$.

A study of H I envelopes around low luminosity galaxies on Arecibo by van Zee, Haynes, & Giovanelli (1995, AJ, 109, 990) claimed to have found numerous high $\mathcal{M}_{\rm HI}/L_B$ galaxies, including the galaxy H I 0542+05 (the Orion dwarf galaxy) at 84.1 $\mathcal{M}_\odot/L_\odot$. However, Karachentsev & Musella (1996, A&A, 315, 348) using CCD photometry and a better estimate of the high galactic extinction for this galaxy produced a $\mathcal{M}_{\rm HI}/L_B$ of just 2.6 $\mathcal{M}_\odot/L_\odot$. Similarly two of our sample galaxies have dropped into the low $\mathcal{M}_{\rm HI}/L_B$ regime, but ESO215–G?009 is confirmed as a very high $\mathcal{M}_{\rm HI}/L_B$ galaxy. A detailed discussion of this galaxy will appear in an upcoming paper (Warren, Jerjen and Koribalski 2003 in preparation). Figure 1(b) shows the H I intensity map for ESO215–G?009, the H I cloud extending to several times the radius of the faint stellar component.