Gas rich galaxies from the FIGGS survey

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1 Introduction

The FIGGS (Faint Irregular Galaxy GMRT Survey) is aimed at creating a multi-wavelength observational data base for a volume limited sample of the faintest gas rich galaxies. As described in more detail in the contribution by Begum et al. in these proceedings, the galaxies form an HI flux and optical diameter limited subsample of the Karachentsev et al.(2004) catalog of galaxies within 10 Mpc. The sample consists of 65 galaxies with $M_B \widetilde{>} -14.5$ with median $M_B \sim -13$ and a median HI mass $\sim 3\times10^7$ $M_\odot$. HI aperture synthesis data (from the Giant Meterwave Radio Telescope - GMRT) has been obtained for all galaxies in the sample. Because the GMRT has a hybrid configuration (see Swarup et al. (1991)) images at a variety of spatial resolutions (ranging from $\sim 40''$ to $\sim 3''$) can be made from a single GMRT observation run. Galaxies in the FIGGS survey have substantially lower M_{HI} and L_B that typical of galaxies in earlier aperture synthesis surveys. The GMRT observations also used a velocity resolution ($\sim$1.6 kms^{-1}), that is $\sim$ 4 times better than most earlier interferometric studies of such faint dwarf galaxies. This high velocity resolution is crucial to detect large scale velocity gradients, which cannot be clearly distinguished in lower velocity resolution observations (see e.g. Begum et al. 2003a, 2003b, 2004a, 2004b, and for contrast Lo et al. 1993). In this paper we discuss two very gas rich galaxies that were observed as part of the FIGGS survey, viz. NGC 3741 and AndIV.

2 Two extremely gas rich galaxies

NGC 3741 ($M_B \sim -13.13$) has $M_{HI}/L_B \sim 5.8$. GMRT observations of this galaxy have been presented in Begum et al. (2005). And IV, was originally thought to be a satellite of the Andromeda (M31) galaxy. However, based on HST imaging Ferguson et al. (2000) argue that it is likely to be a background galaxy that happens to lie in projection close to the disk of M31. Consistent with this interpretation, they derive a distance of 6.11 Mpc for it (using the Tip of the Red Giant Branch technique) – this places And IV beyond the confines of the local group. The HI velocity measured for this galaxy (i.e. 234 km/s; Braun et al. (2003)) is also substantially different from that of the nearest portion of the disk of M31. The galaxy has blue magnitude of ~ -12.37, which implies that $M_{HI}/L_B \sim 13$.

3 HI in NGC 3741 and And IV

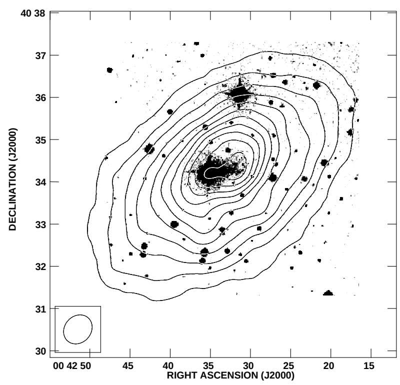

Fig. 1. The GMRT moment 0 image of And IV (at $\sim 44''$ resolution), overlayed on the DSS image.

The GMRT observations (Begum et a. 2005) showed that NGC 3741 had an HI disk that extends to $\sim$ 8.3 times its Holmberg radius. This makes it probably the most extended gas disk known. Our observations allowed us to derive the rotation curve (which is flat in the outer regions) out to $\sim$38 optical scale lengths. NGC 3741 has a dynamical mass to light ratio of $\sim$107 and is one of the "darkest" irregular galaxies known. Follow up WSRT observations are presented in Gentile et al. (2007).

For AndIV, the GMRT observations show that its gas disk extends out to $\sim$ 6 Holmberg radii. Fig. 1 shows the integrated HI emission from AndIV at $44'' \times 38''$ resolution, overlayed on the digitised sky survey (DSS) image. Fig. 2 shows the velocity field of AndIV at $26'' \times 23''$ resolution. The velocity field is regular and a large scale velocity gradient, consistent with systematic rotation, is seen across the galaxy. From the rotation curve Fig. 3 the ratio of the dynamical mass to the blue luminosity is $M_{\rm dyn}/L_B \sim 237$!.

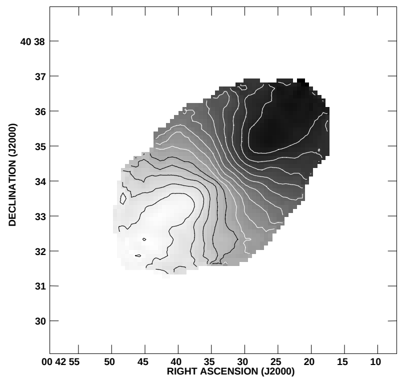

Fig. 2. The GMRT moment 1 image of (velocity field) And IV (at $\sim 26''$ resolution).

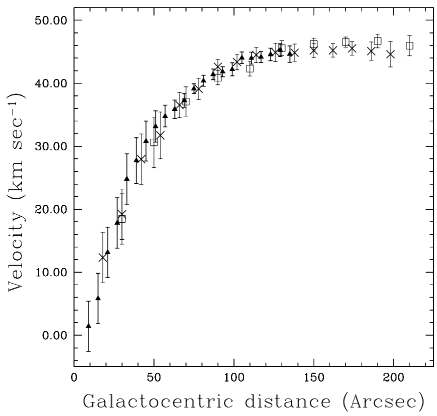

Fig. 3. Rotation curve of AndIV as derived from the GMRT data.

These very large dynamical mass to blue luminosity ratios naturally lead one to ask whether extremely gas rich dwarf galaxies have abnormally small baryon fractions, i.e. have they just been inefficient at forming stars, or did they end up with less than the typical baryon fraction? The ratio of baryonic to dark matter is expected to systematically vary with halo mass, since small halos are both inefficient at capturing hot baryons (for e.g. during the epoch of reionization) and also because small halos are less able to prevent energy input from star bursts from leading to escape of baryons (see e.g. Gnedin et al. 2002). In Fig. 4 we show the baryon fraction (as determined at the last measured point of the rotation curve) for a sample of galaxies with well measured rotation curves. The average cosmic baryon fraction is shown as a horizontal line. As can be seen, there is a large scatter in baryon fraction, and there is no systematic trend for a lower baryon fraction in smaller galaxies. In particular although gas rich galaxies (shown as solid points in the figure), have somewhat extreme baryon fractions, they lie within the range of that observed for galaxies in general. As such these galaxies have got their "fair share" of baryons, but for some reason have been unable to convert them into stars.

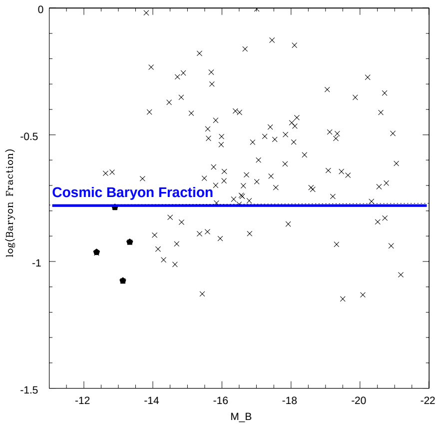

Fig. 4. Baryon fraction (within the last measured point of the rotation curve) as a function of blue luminosity for a sample of galaxies with well measured rotation curves. The cosmic baryon fraction is shown as a horizontal line. Four gas rich galaxies, viz. DDO154, NGC3741, ESO 215 G? 009 (Warren et al. 2004) and And IV are shown as solid points.

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