The Discovery of New Galaxy Members in the NGC 5044 and NGC 1052 Groups

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ABSTRACT

We present the results of neutral hydrogen (HI) observations of the NGC 5044 and NGC 1052 groups, as part of a GEMS (Group Evolution Multiwavelength Study) investigation into the formation and evolution of galaxies in nearby groups. Two new group members have been discovered during a wide-field HI imaging survey conducted using the ATNF Parkes telescope. These results, as well as those from followup HI synthesis and optical imaging, are presented here. J1320 – 1427, a new member of the NGC 5044 Group, has an HI mass of $M_{\text{HI}} = 1.05 \times 10^9 M_\odot$ and $M_{\text{HI}}/L_B = 1.65 M_\odot/L_\odot$, with a radial velocity of $v = 2750 \text{km} \text{s}^{-1}$. The optical galaxy is characterised by two regions of star formation, surrounded by an extended, diffuse halo. J0249 – 0806, the new member of the NGC 1052 Group, has $M_{\text{HI}} = 5.4 \times 10^8 M_\odot$, $M_{\text{HI}}/L_R = 1.13 M_\odot/L_\odot$ and $v = 1450 \text{km} \text{s}^{-1}$. The optical image reveals a low surface brightness galaxy. We interpret both of these galaxies as irregular type, with J0249 – 0806 possibly undergoing first infall into the NGC 1052 group.

Key words: galaxies: clusters: individual: NGC 5044, NGC 1052 – radio lines: galaxies

1 INTRODUCTION

Galaxy groups are the most common form of galaxy association, and also the most common environment in which galaxies are found (Tully 1987). The size scales of groups lie between those of galaxy pairs and rich clusters. As such, they are an ideal environment in which to study the relationship between the formation and evolution of galaxies, and large scale structure.

Studies of galaxy groups and clusters at optical and infrared wavelengths select against low surface brightness and low luminosity objects (Impey & Bothun 1997), which are predicted to be numerous in these environments (e.g. Moore et al. 1999). These optically-faint objects are often gas-rich and are thus more likely to be detected in neutral hydrogen (HI) surveys. HI is also a sensitive tracer of gravitational disturbances, such as tidal interactions and galaxy mergers, with the kinematic imprint of such encounters often being retained to distances larger than several galactic radii (Mundell et al. 1995; Hibbard 2004). Studies of the content, distribution and kinematics of HI in galaxy groups therefore provide an important probe of ongoing galaxy interactions and mergers and, in combination with X-ray and optical studies, provide a key indicator of the group’s evolutionary state and that of its constituent galaxies.

The Group Evolution Multiwavelength Study (GEMS) is a multi-wavelength investigation of the evolution of nearby galaxy groups. It compares the X-ray, HI and optical properties of a sample of groups, selected on the availability of high-quality X-ray (ROSAT) data, with the aim of building up a comprehensive view of their evolutionary state and, ultimately, furthering our understanding of the processes which drive galaxy evolution within a group environment.

As part of GEMS we have completed a sensitive, wide-area HI imaging survey of 17 nearby galaxy groups, using the Multibeam System on the ATNF Parkes Radiotelescope¹. Full details of this survey will be given in a later paper. With its long integration times and wide-area mapping, the GEMS HI survey complements deep targeted studies of small areas of the sky (e.g. de Blok et al. 2002) and less sensitive HI all-sky surveys, for example the southern HIPASS (Staveley-Smith et al. 1996) and northern HIJASS

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In addition to emission from known group members, HI emission was detected from two positions which do not correspond to any previously catalogued galaxies. The location of each newly detected object, relative to its group centre, is shown in Fig. 1 and Fig. 2.

2.2 ATCA observations

In order to characterise the properties and determine the more precise locations of the newly discovered HI emission regions in the NGC 5044 and NGC 1052 groups, high-resolution λ21-cm follow-up observations were carried out on 2002 January 8–9, using the Australia Telescope Compact Array\(^2\) in its 750A configuration, which has baselines in the range 76.5–3750.0 m. The correlator was configured to provide two orthogonal linear polarisations, each with a bandpass of 8 MHz and divided into 1024 spectral channels, with the central observing frequency tuned to the known redshifted HI frequency of the target source, yielding a velocity resolution of 1.5 km s\(^{-1}\) per channel. The pointing centre of each observation was chosen to be the location of the new HI emission regions detected in the Parkes observations. These are listed in Table 2 along with a summary of other observing parameters.

The observing strategy followed the standard phase referencing technique, consisting of alternate observations of the target source (25 min) and a nearby phase calibrator (5 min), with this cycle repeated over each 12 hour run. PKS B1934 – 638 was observed at least once during the observation of each target, to determine the bandpass correction and calibrate the absolute flux scale, assuming a flux density for this source of 14.9 Jy at 1384 MHz [Reynolds (1994)].

The data reduction was carried out using the NRAO Astronomical Image Processing System (AIPS), with the calibration following the standard procedure outlined in the AIPS Cookbook (1994). The editing and calibration of the data were carried out using a “channel 0” dataset, generated by averaging the visibilities in the central 75% of the bandpass.

The NGC 5044 Group dataset suffered from narrow-band interference at 1.408 GHz, due to the 11th harmonic of the telescope’s 128 MHz sampler clock [Killeen (1995)]. This interference was limited to a single channel and was excised by flagging the affected channel, prior to creation of the “channel 0” dataset.

Calibration of the NGC 5044 Group dataset used PKS B1934 – 638 and the phase calibrator PKS B1308 – 220. Gain and phase solutions for the calibrators were derived and applied to the spectral-line dataset. After bandpass correction, the pure continuum dataset was extracted (by averaging together line-free channels 100–450 and 630–950), imaged and used to further self-calibrate the target field. The final corrections were then applied to the spectral line data.

Similar data editing and calibration methods were used for the NGC 1052 Group dataset. However, due to instrumental problems, data from antenna CA06 had to be discarded, resulting in an usable uv-range of 0 – 3.5 kλ for this dataset.

On-line Doppler tracking is not used by ATCA, so calibrated spectral line datasets were corrected for the Earth’s motion using the task cvel. Finally, the emission in the line-free channels (100–450 and 630–950) for the NGC 5044 dataset and 200–430 and 605–

2 The Australia Telescope is funded by the Commonwealth of Australia for operation as a National Facility managed by CSIRO.

### Table 1. Observing parameters for the Parkes wide-field imaging survey and properties of the resulting image cubes.

|                         | NGC 5044 | NGC 1052 |
|-------------------------|----------|----------|
| Date of observation     | 2001-Jan-07–10 | 2001-Jan-07–10 |
|                        | 2001-Jul-15–17 | 2001-Jul-14–18 |
| Centre of scanned field : |          |          |
| Right Ascension (J2000) | 13\(^{h}\)15\(^{m}\)00\(\alpha\)0 | 02\(^{h}\)40\(^{m}\)00\(\alpha\)0 |
| Declination (J2000)     | −10\(^{\circ}\)22\('')48'' | −08\(^{\circ}\)08\('')00'' |
| Angular area imaged     | 5.5\(^{\circ}\) × 5.5\(^{\circ}\) | 5.5\(^{\circ}\) × 5.5\(^{\circ}\) |
| Frequency of observation (MHz) | 1409.0 | 1413.5 |
| Bandwidth (MHz)         | 8        | 8        |
| Spectral channels       | 2048     | 2048     |
| Spectral channel width (kHz) | 3.8     | 3.8     |
| Integration time (s)    | 5        | 5        |
| Data cube properties:   |          |          |
| Linear dimensions (pixels) | 105 × 104 | 103 × 105 |
| Velocity channels       | 1024     | 1024     |
| Velocity range (km s\(^{-1}\)) | 1565–3252 | 615–2302 |
| Spatial resolution      | 15.5\(^{\prime}\) | 15.5\(^{\prime}\) |
| Pixel size              | 4\(^{\prime}\) | 4\(^{\prime}\) |
| Spectral resolution (km s\(^{-1}\)) | 1.6     | 1.6     |
| RMS noise level (mJy beam\(^{-1}\)) | 53.8     | 54.0     |
Table 2. ATCA observing parameters and spectral line cube properties.

|                        | NGC 5044 | NGC 1052 |
|------------------------|----------|----------|
| Date of observation    | 2002-Jan-08 | 2002-Jan-09 |
| Field pointing centre: | Right Ascension (J2000) | 13\(^h\)20\(^m\)24.4\(^s\) | 02\(^h\)19\(^m\)20.8\(^s\) |
|                        | Declination (J2000) | −14\(^\circ\)26'40'' | −08\(^\circ\)03'48'' |
| Primary beam (arcmin)  | 33'       | 33'       |
| Antenna efficiency     | 68%       | 68%       |
| Frequency of observation (MHz) | 1408 | 1414 |
| Bandwidth (MHz)        | 8         | 8         |
| Spectral channels      | 1024      | 1024      |
| Spectral channel width (kHz) | 7.8   | 7.8       |
| Effective time on source (h) | 8.49 | 7.30       |
| Flux calibrator        | PKS B1934 – 638, PKS B1934 – 638 |
|                        | PKS B0823 – 500 |
| Phase calibrator       | PKS B1308 – 220 | PKS B0310 – 150 |
| Data cube properties:  | Linear dimensions (pixels) | 1024 × 1024 | 1024 × 1024 |
|                        | Velocity channels | 90 | 102 |
|                        | Velocity range (km s\(^{-1}\)) | 2538 – 2837 | 1174 – 1510 |
|                        | Channels imaged | 451 – 630 | 401 – 605 |
|                        | Spatial resolution | 41'×32'' | 420''×50'' |
|                        | Pixel size | 3''×3'' | 15''×15'' |
|                        | Spectral resolution (km s\(^{-1}\)) | 3.3 | 3.3 |
|                        | RMS Noise (mJy beam\(^{-1}\)) | 2.6 | 3.8 |

850 for the NGC 1052 dataset) was used, with the task UVLIN, to model and subtract the continuum, in the u-v plane.

An image cube of each target field, employing 2-channel spectral averaging (resulting in a velocity resolution of 3.3 km s\(^{-1}\)) was then generated using IMAGR, to Fourier transform and deconvolve the calibrated, spectral-line datasets. Natural weighting (Briggs’ robustness parameter 5) was used, to maximise sensitivity to low surface-brightness, extended structure (Briggs 1995), and line-free channels (i.e. those chosen to produce the continuum dataset) were excluded from the imaging process. Finally, a correction was applied to the image cubes, using PBCOR, to account for primary beam attenuation. Spectral-line cube properties are given in Table 2.

The minimum detectable HI mass per channel in the NGC 5044 cube (3σ detection), of an object of angular size equal to that of the synthesised beam and located at the pointing centre, is \(9 \times 10^6\) M\(_\odot\). Similarly, a 3σ detection of an object with the largest angular extent imageable by the array (\(\sim 4\) arcmin) is \(4 \times 10^8\) M\(_\odot\).

For the NGC 1052 dataset, the minimum detectable HI mass per channel is \(5 \times 10^6\) M\(_\odot\), assuming a 3σ detection at the pointing centre, of an object the size of the synthesised beam. Similarly, a 3σ detection of an object with the largest angular extent imageable by the array (\(\sim 4\) arcmin) is \(1 \times 10^7\) M\(_\odot\).

2.3 Optical observations

Examination of images from the Second Digitized Sky Survey (DSSII – Lasker & McLean 1994) revealed faint optical emission coincident with the HI-detected objects in the NGC 5044 and NGC 1052 groups (see Section 3). Subsequently, follow-up broadband images were obtained using the Wide Field Imager (WFI) on the MPG/ESO 2.2-m telescope in 2001 August 7-10. Conditions were photometric with \(\sim 1\) arcsec seeing. The exposure times were \(5 \times 120\) s and \(4 \times 300\) s respectively, for the B- and R-band observations of the NGC 5044 group, and \(5 \times 120\) s for the R-band observation of the NGC 1052 group.

Data were taken at several dither positions, in order to eliminate the gaps between the individual CCD chips of the WFI instrument, when mosaicing the dithered images together after basic reduction of the individual images. The data reduction was carried out using IRAF software as well as dedicated IDL scripts, and galaxy photometry was performed using SExtractor (Bertin & Arnouts 1996; see Miles et al. 2004 for further details). The SExtractor detection threshold for galaxies detected in the mosaiced R-band image of the NGC5044 field was \(R = 22.85\).

3 RESULTS

Regions of HI emission from positions previously uncatalogued in both optical and radio positional databases (e.g. the NASA-IPAC Extragalactic Database (NED)) are detected in the NGC 5044 and NGC 1052 groups. In the NGC 5044 Group, HI is detected \(\sim 2.5\)° North-East of the group centre, whilst in the NGC 1052 Group HI emission is detected 14 arcmin South of the edge-on galaxy NGC 1110, itself located 2° from the group centre. Optical emission is also detected from these two HI-emission regions.

3.1 NGC 5044 Group: J1320–1427

HI emission

Fig. 4 shows the Parkes spectrum of the previously uncatalogued source of HI emission, discovered \(\sim 2.5\)° North-East of...
the NGC 5044 Group centre (see Table 3), to which we refer as “J1320 − 1427” after its refined position. The spectrum was extracted using a spatial box width of 5 pixels and Hanning smoothening over 7 channels; a second-order polynomial was fitted to line-free channels and subtracted to correct the non-zero baseline. The line has a width, at 50% intensity, of $W_{1/2} = 47$ km s$^{-1}$. The integrated H$\alpha$ flux is $\int S \ dV = 4.1 \pm 0.1$ Jy km s$^{-1}$ which, assuming optically thin emission and a distance to J1320 − 1427 of 33 Mpc (the adopted distance to the NGC 5044 Group), implies a total H$\alpha$ mass of $(1.05 \pm 0.03) \times 10^6$ $M_{\odot}$.

ATCA imaging of J1320 − 1427 reveals H$\alpha$ emission from a region centred on $\alpha_{2000.0} = 13^h 20^m 13^s$, $\delta_{2000.0} = -14^\circ 27' 32''$, with a deconvolved size of $65'' \times 125''$ and a velocity range of 2716–2773 km s$^{-1}$. Channel maps for this object are shown in Fig. 4.

Maps of line intensity integrated over velocity ($\sigma^3$ moment, Fig. 5) and intensity-weighted velocity (1$\sigma$ moment, Fig. 6) were produced using the Brinks “conditional blank” method (Taylor et al. 1993) where a mask, created by excluding fluxes below 2$\sigma$, was applied to each spatially smoothed channel map, was used to filter noise from the full resolution image cube, prior to calculating the moments with XMOM. The total HI intensity map (Fig. 5) shows the emission to be elongated in the north-south direction, with emission extending to the north-east. The $\sigma^3$ contour of this map was used to define the spatial area over which the average spectrum, shown in Fig. 4, was taken.

We measure a peak HI column density of $1.1 \times 10^{21}$ atoms cm$^{-2}$ (9.0 $M_{\odot}$ pc$^{-2}$), which is a lower limit of this quantity, due to the large beam size. The integrated total HI intensity is $\int S \ dV = 4.3 \pm 0.2$ Jy km s$^{-1}$, from which we calculate an HI mass $M_{HI} = (1.10 \pm 0.05) \times 10^7$ $M_{\odot}$. The projected size of the HI emission, measured to a column density of 1.6 $M_{\odot}$ pc$^{-2}$ ($3\sigma$), is $11 \times 20$ kpc.

Despite the narrow range in velocity covered by the HI emission ($W_{1/2} = 47$ km s$^{-1}$; see Fig. 2), the velocity field (Fig. 5) is relatively well-ordered, showing a smooth change in velocity of $\sim 30$ km s$^{-1}$ over $\sim 1.5$ arcmin (14 kpc) from the north-west to south-east.

Several background radio continuum sources lie within the field of view but no continuum emission above the $3\sigma$ level of 0.3 mJy beam$^{-1}$ was detected at the position of J1320 − 1427.

### Optical data

Our follow-up B and R-band images (see Fig. 8) reveal knots of optical emission; two spatially-extended sources straddle the position of HI maximum, while two further bright regions lie, one south and one west of the main peaks. The two main optical components (labelled 2 and 4 in Fig. 8) are very blue, with $(B-R)$ values of 0.32 and 0.16 magnitudes respectively, suggesting that star formation is occurring within these regions.

 Applying a filter to remove the high surface-brightness objects in the R-band image and convolving the result with an exponential kernel, revealed a very low-surface brightness halo extending north-east of the two main optical components, towards the extended HI emission. Fig. 9 shows the R-band image with the four main optical components identified, and the convolved image showing the LSB halo. The extent of the faint halo is illustrated with an ellipse. The mean sky background level in the R-band mosaic image was 20.24 mag arcsec$^{-2}$, while the peak surface brightness of the LSB component was 23.77 mag arcsec$^{-2}$. In general, the convolution of the image with an appropriate exponential kernel allowed us to detect galaxies with peak surface brightnesses of about 4.25 magnitudes below the background. The detection of the LSB component is therefore significant, being 0.75 mag brighter than the detection limit.

The measured and derived optical properties of the system are shown in Table 4. Columns numbered (1 − IV) refer to the four bright optical components, and column (V) to the low surface brightness halo (LSB). Column (VI) shows the combined optical properties of all objects within the extent of the halo (components 2, 4 and LSB). The Galactic extinction corrections in B and R, $A_B$ and $A_R$, were obtained as per Schlegel et al. (1998).

The upper limit for the extinction intrinsic to J1320 − 1427 was calculated from the average HI column density over each component, using the relations $A_B = 8.62 \times 10^{-22}$ $N_{HI}$ (Staveley-Smith & Davies 1987) and $A_R = A_B / 1.770$ (Binney & Merrifield 1998). The surface brightnesses ($\mu_B$ and $\mu_R$) of the LSB component only, and the total surface brightness of the optical object were calculated assuming that the optical extent is defined by the ellipse shown in Fig. 8.

### 3.2 NGC 1052 Group: J0249 − 0806

#### HI emission

Inspection of the Parkes cube for the NGC 1052 Group revealed HI emission from a number of known galaxies. In particular, our spectrum of the edge-on galaxy NGC 1110 (ID 463 in Tiffit & Cocker 1988; RFGC 600 in Karachentsev et al. 1993), which lies $\sim 2'$ from the group centre, shows a classic line profile of a rotating disk (Fig. 8). However, an additional emission component distinct in velocity from NGC 1110 was detected, offset by approximately one beamwidth south. The spectrum taken at this position, of the object hereafter named “J0249 − 0806”, is shown in Fig. 9. A box width of 3 pixels and Hanning smoothing over 5 channels were used to produce this spectrum, and a fourth-order polynomial was fitted and subtracted to correct the non-zero baseline. The intensity integrated over velocity of J0249 − 0806 is $\int S \ dV = 5.7 \pm 0.2$ Jy km s$^{-1}$, implying an HI mass of $M_{HI} = (5.4 \pm 0.1) \times 10^6$ $M_{\odot}$, assuming a distance to the source of 20 Mpc.

The angular resolution of the Parkes data was not sufficient to determine the spatial relationship between NGC 1110 and the newly-discovered HI emission. We therefore used ATCA to image the region with an improved angular resolution ($420'' \times 50''$), which confirmed the new detection and established this HI emission as spatially and kinematically distinct from that of NGC 1110.

Fig. 10 shows the distribution of HI emission from the two galaxies, overlaid on our R-band optical image. J0249 − 0806 lies 17 arcmin ($\sim 95$ kpc) south of the edge-on galaxy NGC 1110, and is associated with faint diffuse optical emission. The HI is...
centred on $\delta_{J2000.0} = 02^h49^m14^s$, $\delta_{J2000.0} = -08^\circ06'51''$, and has a velocity range 1404–1490 km s$^{-1}$. The rms noise level is 3.8 mJy beam$^{-1}$ per channel, with a 3σ detection corresponding to an H$\alpha$ column density of $N_{H\alpha} = 3.0 \times 10^{20}$ cm$^{-2}$ (0.02 M$_\odot$ pc$^{-2}$) per channel. The H$\alpha$ emission from NGC 1110 is spatially and kinematically distinct from this, being centred on $\alpha_{J2000.0} = 02^h49^m09^s$, $\delta_{J2000.0} = -07^\circ49'17''$, with velocity range 1237–1424 km s$^{-1}$.

The total intensity map of J0249 − 0806 is shown in Fig. 11. This source is essentially unresolved in H$\alpha$ at the resolution of our observations, so little may be determined about its morphology. The (lower limit) peak H$\alpha$ flux is $2.2 \times 10^{20}$ atoms cm$^{-2}$ (equivalent to 1.8 M$_\odot$ pc$^{-2}$) and lies close to the optical peak. The H$\alpha$ velocity structure shows a smooth change in velocity of $\sim 40$ km s$^{-1}$ over $\sim 5$ arcmin, with marginal evidence of a north-east to south-west velocity gradient with position angle $\sim 30^\circ$.

The H$\alpha$ intensity of J0249 − 0806, integrated over velocity, is $\int S dV = 2.3 \pm 0.1$ Jy km s$^{-1}$. This corresponds to a total H$\alpha$ mass $M_{H\alpha} = (2.2 \pm 0.1) \times 10^8$ M$_\odot$, assuming the source to be at the distance of the NGC 1052 Group.

The difference between the Parkes and ATCA velocity-integrated H$\alpha$ intensities for J0249-0806 (see Fig. 9) implies the presence of extended emission, not detected by the ATCA observations due to the lack of very short antenna spacings, or the presence of a significant amount of H$\alpha$ with column densities below the detection limit of the ATCA observations. The map shown in Fig. 10a maximises the sensitivity to extended structure (by only including data with uv-distance $< 3.5k\lambda$) available with the chosen array configuration. This does not show any evidence of extended emission, for example tidal tails, connecting bridge or common envelope surrounding J0249 − 0806 and NGC 1110, which one might expect if the two objects were strongly interacting. This lack of tidal features is consistent with the current strength of the interaction, as defined by the Dahari Q parameter (Dahari 1984), being very small. We conclude that the additional H$\alpha$ emission detected in the Parkes spectrum of J0249-0806 must be smoothly extended on scales larger than 4 arcmin (the largest angular scale imageable by the array), possibly distributed as a diffuse halo.

### Table 4. J1320 − 1427 in NGC 5044 Group: Measured and derived optical properties. The columns are as follows: (i) - each of the bright components labelled 1 – 4 in Fig 4 (V) - the low surface-brightness (LSB) component only; (vi) - the combined properties of all five components (i.e. 1, 2, 3, 4 and LSB). Absolute magnitudes, $M_R$ and $M_B$, and luminosities, $L_R$ and $L_B$, are corrected for extinction. Estimates of Galactic extinction, $A_B$ and $A_R$, have been derived as per Schlegel et al. [1998]. $A_B$(intrinsic) and $A_R$(intrinsic) are the extinction, for the B and R bands respectively, derived from the total H$\alpha$ content of J1320 − 1427. The surface brightness calculation uses the ellipse shown in Fig. 4 as the definition of the extent of the LSB component.

| Component       | Component | Component | Component | LSB       | Total       |
|-----------------|-----------|-----------|-----------|-----------|-------------|
|                 | 1         | 2         | 3         | 4         |             |
| $m_R$ (mag)     | 20.15     | 18.42     | 24.39     | 18.66     | 18.27       | 17.17       |
| $B - R$ (mag)   | 1.42      | 0.32      | 3.90      | 0.16      | 1.89        | 1.22        |
| $A_B$(Galactic) (mag) | 0.37      | 0.37      | 0.37      | 0.37      | -           |
| $A_B$(intrinsic) (mag) | 0.23      | 0.23      | 0.23      | 0.23      | -           |
| $A_R$(intrinsic) (mag) | 0.68      | 0.85      | 0.57      | 0.82      | -           |
| $M_B$ (mag)     | −13.49    | −15.39    | −9.14     | −15.12    | −15.32      | −16.54      |
| $M_R$ (mag)     | −14.47    | −15.20    | −12.65    | −14.78    | −16.79      | −17.25      |
| $\mu_B$ (mag arcsec$^{-2}$) | -         | -         | -         | -         | 25.91       | 25.81       |
| $\mu_R$ (mag arcsec$^{-2}$) | -         | -         | -         | -         | -           |             |
| $L_R$ ($L_{\odot}$) | $3.84 \times 10^7$ | $2.21 \times 10^8$ | $6.98 \times 10^5$ | $1.72 \times 10^6$ | $2.07 \times 10^8$ | $6.39 \times 10^8$ |
| $L_B$ ($L_{\odot}$) | $3.16 \times 10^7$ | $6.19 \times 10^7$ | $5.92 \times 10^6$ | $4.21 \times 10^7$ | $2.68 \times 10^8$ | $4.10 \times 10^8$ |
| $M_{\text{49}}/L_B$ ($M_\odot/L_{\odot}$) | -         | -         | -         | -         | 1.37        | 1.64        |
| $M_{\text{49}}/L_R$ ($M_\odot/L_{\odot}$) | -         | -         | -         | -         | 1.05        | 2.56        |

### Optical data

The MPG/ESO 2.2-m WFI R-band follow-up image of the region clearly shows NGC 1110, and an uncatalogued low surface brightness source, spatially coincident with the J0249 − 0806 neutral hydrogen detection. The image also shows a number of other galaxies (see Figs 10 and 11) however those with published velocities clearly lie outside the NGC 1052 group. The derived optical properties of J0249 − 0806 are listed in Table 5.

### Table 5. J0249 − 0806 in NGC 1052 Group: Measured and derived optical properties. The estimate of Galactic extinction, $A_R$, has been derived as per Schlegel et al. [1998]. $A_B$(intrinsic) and $A_R$(intrinsic) are the extinction correction derived from the H$\alpha$ content of J0249 − 0806. Extinction corrections have been applied to the absolute magnitude and luminosity. Surface brightness, $\mu_R$, has been calculated for the region within $D_{25}$.

|          |          |          |          |          |          |
|----------|----------|----------|----------|----------|----------|
|          |          |          |          |          |          |
| $m_R$ (mag) | 14.27    |          |          |          |          |
| $A_B$(Galactic) (mag) | 0.084    |          |          |          |          |
| $A_B$(intrinsic) (mag) | 0.09     |          |          |          |          |
| $D_{25}$ (arcsec) | 13.6     |          |          |          |          |
| $M_R$ (mag) | -17.41   |          |          |          |          |
| $\mu_R$ (mag arcsec$^{-2}$) | 22.1      |          |          |          |          |
| $L_R$ ($L_{\odot}$) | $4.8 \times 10^8$ |          |          |          |          |
| $M_{\text{49}}/L_R$ ($M_\odot/L_{\odot}$) | 1.13      |          |          |          |          |

### 4 DISCUSSION

#### 4.1 Group membership

J1320−1427 and the NGC 5044 Group

Early classification by Huchra & Geller [1982] of this galaxy group, using the percolation method to determine group membership to a limiting magnitude of $m_B = 13.2$, suggested a membership of three galaxies, concentrated around the brightest group member, NGC 5044. Garcia [1993] subsequently used percolation.
and hierarchical clustering (Matern, 1978) methods to identify 9 group members to a magnitude limit of $m_B = 14.0$, and catalogued the group as LGG 338. In a study of the central 2.3° sq. of the group, which used the visual inspection of optical plates to find dwarf group members, Ferguson & Sandage (1990) identified 80 definite and a further 82 likely or possible members of the NGC 5044 Group, with 69% of the total classified as dwarf galaxies (Cellone, 1999).

As part of the GEMS project, Osmond & Ponman (2004) have recalculated the optical membership of the NGC 5044 Group, using NED as the parent catalogue. Their criteria for group membership require that members lie within the $r_{500}$ overdensity radius of the group (calculated from the group's X-ray temperature) and have a velocity which differs by no more than $3\sigma$ from the group velocity. Using this method Osmond & Ponman found 18 members of the NGC 5044 Group and determined several group parameters, in- cluding the heliocentric velocity $v = 2518 \pm 100 \text{ km s}^{-1}$, resulting in a corrected distance to the group of 33 Mpc. The velocity dispersion, $\sigma_v = 426 \pm 74 \text{ km s}^{-1}$, is high for galaxy groups. These, and other group parameters from Osmond & Ponman (2004) relevant to this paper are given in Table 3.

The position of J1320 - 1427 within the NGC 5044 Group is shown in Fig. 1. It lies on the outskirts of the group, 137 arc- min (2.3°) north-west of the group centre. This corresponds to a projected distance of 1.3 Mpc, or 2.1$r_{500}$. Despite its distance from the group centre, the velocity of J1320 - 1427 matches well with those of other group members. The velocity distribution of all known group members, as a function of angular distance from the group centre, is shown in Fig. 12. The velocity of J1320 - 1427 (2750 km s$^{-1}$) is 1.1σ from the mean group velocity of 2518 ± 100 km s$^{-1}$. We therefore suggest that J1320 - 1427 is likely to be a member of the NGC 5044 Group, rather than a chance superposition of the group and an unrelated field galaxy.

J0249–0806 and the NGC 1052 Group

The NGC 1052 group of galaxies, also known as LGG 71, was first identified by Huchra & Geller (1982) with a membership of 6 galaxies, with this later extended to 14 galaxies by Tully (1988) and Geller (1992), using the membership determination methods described above (see Figs 2 and 13 for the position and velocity distribution of the group members). Using the same criteria employed for NGC 5044, Osmond & Ponman (2004) have catalogued this group with 4 galaxy members, a group radial velocity $v = 1366 \pm 41 \text{ km s}^{-1}$ (implying a distance to the system of 20 Mpc) and velocity dispersion $\sigma_v = 91 \pm 35 \text{ km s}^{-1}$ (see Table 3).

The brightest galaxy in the group is NGC 988 (Giuricin et al. 2000), an SB(s)c/d galaxy with $m_B = 10.60$. The galaxy which gives the group its common name, NGC 1052, is classified as an E4 elliptical (Reif et al. 1978) and is found to have an asymmetrical HI spectrum. van Gorkom et al. (1984) suggest that the HI gas was captured from a gas-rich dwarf or spiral galaxy about 10$^9$ years ago.

The radial distance of 2.1° between J0249 – 0806 and the group centre corresponds to a projected distance of 747 kpc, or 2.1$r_{500}$. The radial velocity of this galaxy, 1450 km s$^{-1}$, is 1.8σ from the mean group velocity of 1366 ± 41 km s$^{-1}$. Fig. 13 shows the velocity distribution of members of the NGC 1052 Group as a function of radial distance from the group centre. From this, and the diagram showing the positions of the group members on the sky (Fig. 4) we suggest that J0249 – 0806 is a physical member of the NGC 1052 Group.

4.2 The nature of J1320–1427 and J0249–0806

The measured properties (HI emission and optical photometry) of J1320–1427 and J0249–0806 are consistent with those exhibited by irregular galaxies.

 Morphologically, a smooth diffuse halo enveloping bright star forming regions, akin to what we see in J1320 – 1427, is a feature occasionally seen in high sensitivity observations of irregular galaxies (Gallagher & Hunter, 1984). The absolute magnitude of this galaxy, measured here to be $M_B = -16.54$, is in the range accepted for irregulars, tending somewhat towards the dwarf end of that scale ( Binggeli et al. 1988; Gallagher & Hunter, 1984).

The mean HI surface densities of the two galaxies, measured to a radius where the HI column density drops to 1 M$_{\odot}$pc$^{-2}$, are $\sigma_{HI} = 2.11$ M$_{\odot}$pc$^{-2}$ for J1320–1427 and $\sigma_{HI} = 0.89$ M$_{\odot}$pc$^{-2}$ for J0249–0806, with peak column densities of 9.0 M$_{\odot}$pc$^{-2}$ and 1.8 M$_{\odot}$pc$^{-2}$ respectively. These values are higher than the Kennicutt star-formation threshold (Kennicutt, 1989), and consistent with the surface density of late-type spiral and irregular galaxies (Roberts & Haynes, 1994).

The neutral hydrogen mass-to-light ratios of J1320 – 1427 and J0249 – 0806 are $M_{HI}/L_R = 2.56$, $M_{HI}/L_R = 1.64$ and $M_{HI}/L_R = 1.13$, respectively while for the low surface brightness halo in J1320 – 1427 $M_{HI}/L_R = 1.05$ M$_{\odot}$/L$_{\odot}$ and $M_{HI}/L_B = 1.37$ M$_{\odot}$/L$_{\odot}$. The $M_{HI}/L_R$ values are higher than the median values calculated by Roberts & Haynes (1994) ($M_{HI}/L_B = 0.36$ M$_{\odot}$/L$_{\odot}$ for Scd and Sd galaxies and $M_{HI}/L_B = 0.66$ M$_{\odot}$/L$_{\odot}$ for Sm and Im galaxies) and others (eg. Roberts, 1969, Broeils & Rhee, 1997, etc.), but they are consistent with several individual Sm and Im galaxies in their samples, at the high end of the $M_{HI}/L_R$ scale. The $M_{HI}/L_B$ values are consistent with the average for Im galaxies, $M_{HI}/L_B = 1.92 \pm 0.71$, calculated from HI masses and photometry by Swaters & Balcells (2002). In comparison, the isolated HI cloud J1712–64, found by the HIPASS survey (Kilborn et al. 2000), has $M_{HI}/L_B = 24$ M$_{\odot}$/L$_{\odot}$, a further indication, in addition to the fact that we do detect a stellar component in both our objects, that J1320 – 1427 and J0249 – 0806 are not primordial gas clouds left over from the formation of the groups.

Although not a primordial cloud, J0249 – 0806 might be on its first infall into the NGC 1052 group. As discussed in Section 4 this galaxy lies approximately 2$r_{500}$ from the group centre, but has a velocity consistent with group membership. More indicative of first infall, however, is its high $M_{HI}/L_R$ ratio, implying an absence of tidal stripping. Additionally, we have detected greater HI emission with the single-dish than in the synthesis observation, suggesting the presence of gas extended on scales larger than 4 arcmin. This gas does not appear to be in the form of tidal tails and therefore might exist as a smooth diffuse halo, as is seen in, for example, Sextans A (Wilcots & Hunter, 2002). Existence of such halos would confirm that the galaxy is on its first infall into the group potential well, as otherwise such a halo would easily have been stripped (eg. Acreman et al. 2003; Gottlober et al. 2002). In particular, simulations by Marcolini et al. (2003), of dwarf galaxies moving through a low density IGM typical of galaxy groups, indicate that the galaxies are completely stripped by the group IGM within timescales as short as 1-2 Myr. An extended HI halo, as may exist around J0249 – 0806, is less likely to survive in the inner region of the group, as it will be much less strongly bound than the disc gas sim-
ultated by Marcolini et al. (2003). Conversely, we see no evidence for first infall of the NGC 5044 group galaxy, J1320 — 1427.

5 CONCLUSIONS

We have presented high angular resolution radio synthesis and optical observations of new galaxy members, discovered in the groups NGC 5044 and NGC 1052, as part of the GEMS survey of galaxy groups.

J1320–1427, in the NGC 5044 Group, has $M_{B,H} = 1.05 \times 10^9 \ M_\odot$ (single dish measurement), $M_B = -16.54$, $M_R = -17.25$ and $M_{B,L}/L_B = 1.64 \ M_\odot/L_\odot$, $M_{B,L}/L_R = 2.56 \ M_\odot/L_\odot$. J0249 — 0806, in the NGC 1052 Group, has $M_{B,H} = 5.4 \times 10^8 \ M_\odot$ (single dish measurement), $M_R = -17.41$ and $M_{B,L}/L_B = 1.13 \ M_\odot/L_\odot$. Both of these galaxies are at a distance equivalent to just over 2$r_{2500}$ from their group centres. This and the possible presence of an extended HI halo suggests that J0249 — 0806 may be on its first infall into the NGC 1052 group.

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REFERENCES

Acreman D. M., Stevens I. R., Ponman T. J., Sakelliou I., 2003, MNRAS, 341, 1333

AIPS Group, 2000, AIPS Cookbook. National Radio Astronomy Observatory

Barnes D. G., de Blok W. J. G., 2001, AJ, 122, 825

Barnes D. G., Staveley-Smith L., de Blok W. J. G., Oosterloo T., Stewart I. M., Wright A. E., Banks G. D., Bithal R., Boyce P. J., Calabretta M. R., Disney M. J., Drinkwater M. J., Ekers R. D., Freeman K. C., Gibson B. K., Henning, P. A., Jerjen, H., Knezev, P. M., Koribalski, B., Minchin, R. F., Mould, J. R., Oosterloo, T., Price, R. M., Putman, M. E., Ryder, S. D., Sadler, E. M., Stewart, I., Stootman, F., Wright, A. E., 2000, AJ, 120, 1342

Killeen N. E. B., 1995, Technical report, ATNF ATCA Data Information Report 17. Australia Telescope National Facility

Lang R. H., Boyce P. J., Kilborn V. A., Minchin R. F., Disney M. J., Jordan C. A., Grossi M., Garcia D. A., Freeman K. C., Phillipps S., Wright A. E., 2003, MNRAS, 342, 738

Lasker B. M., McLean B. J., 1994, ST ScI Newsletter, 11, 39

Marcolini A., Brighteni F., D’Ercole A., 2003, MNRAS, 345, 1329

Materne J., 1978, A&A, 63, 401

Meyer et al. 2004, submitted

Miles T., Raychaudhury S., Forbes D., Goudfrooij P., 2004, MNRAS, submitted

Moore B., Ghigna S., Governato F., Lake G., Quinn T., Stadel J., Tozzi P., 1999, ApJ, 524, L19

Mundell C. G., Pedlar A., Axon D. J., Meaburn J., Unger S. W., 1995, MNRAS, 277, 641

Osmond J. P. F., Ponman T. J., 2004, MNRAS

Reif K., Mebold U., Goss W. M., 1978, A&A, 67, L1

Reynolds J., 1994, Technical report, A Revised Flux Scale for the AT Compact Array. Australia Telescope National Facility

Roberts M. S., 1969, AJ, 74, 859

Roberts M. S., Haynes M. P., 1994, Ann. Rev. Astron. Astrophys., 32, 115

Sault R. J., Teuben P. J., Wright M. C. H., 1995, in Shaw R., Payne H. E., eds, ASP Conf. Ser. 77: Astronomical Data Analysis Software and Systems IV Vol. 77 of ASP Conf. Ser., A Retrospective View of MIRIAD. pp 433–436

Schlegel D. J., Finkbeiner D. P., Davis M., 1998, ApJ, 500, 452

Staveley-Smith L., Davies R. D., 1987, MNRAS, 224, 953

Staveley-Smith L., Wilson W. E., Bird T. S., Disney M. J., Ekers R. D., Freeman K. C., Haynes R. F., Sinclair M. W., Vaile R. A.,
Webster R. L., Wright A. E., 1996, Proc. Astr. Soc. Aust., 13, 243
Swaters R. A., Balcells M., 2002, A&A, 390, 863
Taylor C. L., Brinks E., Skillman E. D., 1993, AJ, 105, 128
Tifft W. G., Cocke W. J., 1988, ApJS, 67, 1
Tully R. B., 1987, ApJ, 321, 280
Tully R. B., 1988, Nearby galaxies catalog. Cambridge University Press
van Gorkom J. H., Knapp G. R., Raimond E., Faber S. M., Gallagher J. S., 1986, AJ, 91, 791
Wilcots E. M., Hunter D. A., 2002, AJ, 123, 1476
Figure 1. Member positions in the NGC 5044 Group. Solid symbols show the position of previously identified group members, whilst open circles denote the positions of other probable members (catalogued by NED) within the same projected area and with velocities close to that of the group. The symbol representing each member denotes the first group catalogue to list the galaxy: pentagon–Huchra & Geller (1982), square–Ferguson & Sandage (1990), triangle–Garcia (1993), circle–Osmond & Ponman (2004). The position coordinates for each source are those listed by NED. The centre of the group, at \( \alpha_{\text{J2000.0}} = 13^\mathrm{h}15^m09^s.1, \delta_{\text{J2000.0}} = -16^\circ26'31'' \), lies very close to the galaxy NGC 5044. The extent of the \( r_{500} \) overdensity radius is denoted by a dashed circle centred on this point. The new group member reported in this paper, J1320 – 1427, is in the upper left corner of the diagram, marked "∗", and surrounded by a circle indicating the field of view of the ATCA observation.
Figure 2. Member positions in the NGC 1052 Group. Solid symbols show the position of previously identified group members, whilst open circles denote the positions of other probable members (catalogued by NED) within the same projected area and with velocities close to that of the group. The symbol representing each member denotes the first group catalogue to list the galaxy: pentagon—Huchra & Geller (1982), square—Tully (1988), triangle—García (1993). The position coordinates are as given by NED. The centre of the group lies close to the galaxy NGC 1052 itself, at $\alpha_{2000.0} = 02^h40^m35^s3, \delta_{2000.0} = -08^\circ13'08''$. The extent of the $r_{500}$ overdensity radius is shown with a dashed circle centred on this point. The new group member reported in this paper, J0249−0806, is in the centre left of the diagram (marked *) and is surrounded by a circle indicating the size of the ATCA field of view. The position of the early galaxy, NGC 1110 is also labelled.
Figure 3. NGC 5044 Group: Parkes (solid) and ATCA (dashed) H\textsc{i} spectra of J1320−1427. The Parkes spectrum was produced by averaging over a spatial box of width 3 pixels (12 arcmin) and Hanning smoothing over 7 velocity channels. A second-order polynomial has been used to correct the non-zero baseline.

The ATCA spectrum was taken over a spatial region whose boundaries are defined by the 3σ detection level (a column density of $2.0 \times 10^{20}$ atoms cm$^{-2}$).
Figure 4. NGC 5044 Group: Channel maps showing HI emission from the new group member J1320 − 1427. The peak of the emission is 33 mJy beam$^{-1}$, at a velocity of 2736.3 km s$^{-1}$. The contour levels represent flux levels of $−3\sigma$ (dashed), $3\sigma$, $6\sigma$ and $12\sigma$, where the noise level $\sigma = 2.6$ mJy beam$^{-1}$. A $3\sigma$ detection corresponds to an HI column density of $N_{\text{HI}} = 3.3 \times 10^{19}$ cm$^{-2}$ (or 0.26 M$_\odot$ pc$^{-2}$) per channel. The central velocity (heliocentric, optical definition) of each channel is shown in the top right of each map, and the size of the synthesised beam ($41'' \times 32''$) is shown in the bottom-left of the map of the lowest velocity channel.
Figure 5. J1320 − 1427 in the NGC 5044 Group: Total H\textsubscript{I} intensity contours superimposed on to the MPG/ESO 2.2 m WFL\textit{R}-band optical image. The peak column density of the source is $1.1 \times 10^{21}$ atoms cm\(^{-2}\) (9.0 M\(_\odot\) pc\(^{-2}\)) and contour levels are set to 3$\sigma$, 6$\sigma$, 9$\sigma$, 12$\sigma$, 15$\sigma$. These represent column densities of 1, 2, 3, 4, and 5 times $2.0 \times 10^{20}$ atoms cm\(^{-2}\) (equivalent to 1, 2, 3, 4, and 5 times 1.6 M\(_\odot\) pc\(^{-2}\)). The H\textsubscript{I} map has been rescaled to the same pixel size and coordinate grid as the optical data. The ellipse in the lower-left of the image indicates the size of the synthesised beam (41" × 32") and the scale bar at the top-right shows the linear scale of the image (1 arcsec = 160 pc at a distance of 33 Mpc). At least 3 other galaxies can be seen in the optical image, but none of these is identified in the standard catalogues.
Figure 6. J1320 − 1427 in NGC 5044 Group: H\(\text{I}\) isovelcity contours superimposed on to the greyscale H\(\text{I}\) intensity map. As indicated in the figure, the velocity contours cover the range 2731 − 2761 km s\(^{-1}\) in regular 3 km s\(^{-1}\) increments. The ellipse in the lower-left of the image indicates the size of the synthesised beam (41\(''\) × 32\(''\)).
Figure 7. J1320 − 1427 in NGC 5044 Group: Left — MPG/ESO 2.2 m WFI $R$-band image. The ellipse illustrates the extent of the low surface brightness component, with its centre marked C. The brightest components are numbered 1 – 4. Right — Convolved image showing the low surface brightness (LSB) component, with the SExtractor ellipse overlaid. The apparent emission to the south-west of the LSB component is a residue of imperfect masking of features caused by the nearby saturated star, clearly visible in the left panel.
Figure 8. NGC 1052 Group: Parkes (left) and ATCA (right) HI spectra of galaxy NGC 1110. The Parkes spectrum was produced using a spatial box of width 5 pixels (20 arcmin) and Hanning smoothing over 5 velocity channels. A fourth-order polynomial has been used to correct the non-zero baseline. The vertical lines indicate the spectral region over which the integral has been taken (see text, Section 3.2). The ATCA spectrum was taken over a spatial region whose boundaries are defined by an HI column density of $1.57 \times 10^{20}$ atoms cm$^{-2}$. 
Figure 9. NGC 1052 Group: Parkes and ATCA H\textsc{i} spectra of new group member J0249 − 0806. The Parkes spectrum was produced using a spatial box of width 3 pixels (12 arcmin) and Hanning smoothing over 5 velocity channels. A fourth-order polynomial has been used to correct the non-zero baseline. The vertical lines indicate the spectral region over which the integral has been taken (see text, Section 3.2). The ATCA spectrum was taken over a spatial region whose boundaries are defined by an H\textsc{i} column density of $1.57 \times 10^{20}$ atoms cm$^{-2}$. 
Figure 10. NGC 1052 Group: HI total intensity contours of known galaxy NGC 1110 (top) and new group member J0249−0806 (bottom), superimposed on the MPG/ESO 2.2 m WFI R-band optical image. The peak column densities of the two sources are $5.4 \times 10^{21}$ atoms cm$^{-2}$ (NGC 1110) and $1.1 \times 10^{21}$ atoms cm$^{-2}$ (J0249−0806). The contour levels are 2, 4, 8, 16 and 32 times $1.3 \times 10^{20}$ atoms cm$^{-2}$ (2, 4, 8, 16 and 32 M$_\odot$ pc$^{-2}$). For presentation purposes the HI map has been rescaled to the same pixel size and coordinate grid as the optical data. The increase in the background noise level at the top edges of the map are due to the decrease in sensitivity of the primary beam with increasing distance from the phase centre. Because the RMS noise is not uniform across the field, due to the primary beam correction, noise measurements local to NGC1110 were used for the moment analysis. The ellipse in the lower-left of the image indicates the size of the synthesised beam ($420'' \times 50''$). The R-band image includes a number of background galaxies, 2MASS galaxies with unknown velocities and uncatalogued galaxies. At the calculated group distance of 20 Mpc, the projected linear scale of the image is 1 arcsec = 97 pc, represented by the scale bar at the top-left of the figure.
Figure 11. J0249−0806 in the NGC 1052 Group: Total HI intensity contours of the new group member superimposed onto the MPG/ESO 2.2 m WFI $R$-band optical image. This is the same as Fig. 10 zoomed in on the area around J0249−0806, and with background noise measured local to this source. The peak column density of the source is $2.2 \times 10^{20}$ atoms cm$^{-2}$ (1.8 M$_{\odot}$pc$^{-2}$), with contours representing HI column density levels of 1, 2, 3, 4, 5, 6 and 7 times $1.3 \times 10^{20}$ atoms cm$^{-2}$ (1, 2, 3, 4, 5, 6 and 7 M$_{\odot}$pc$^{-2}$). The HI map has been rescaled to the same pixel size and coordinate grid as the optical data. The ellipse in the lower-left of the image indicates the size of the synthesised beam (420$''$ × 50$''$). At the calculated group distance of 20 Mpc, the scale of the image is 1 arcsec = 97 pc, indicated by the scale bar at the top-right of the figure. Other objects in the field have been labelled, but none of these is known to be associated with the group.
Figure 12. Velocity distribution of previously identified NGC 5044 Group members (solid symbols) and other probable group members within the same projected area (open circles), as a function of angular distance from the centre of the group. Symbols denote the galaxies in the group in the same manner as in Fig. 1. The new group member reported in this paper, J1320 – 1427, is located in the right of the diagram and is marked *. The group velocity is shown with a solid horizontal line at \( v = 2518 \) km s\(^{-1}\), while the dotted lines parallel to this indicate the velocity dispersion of \( \sigma = 426 \) km s\(^{-1}\). The dashed vertical line shows the extent of \( r_{500}\). Position and velocity data are from NED.
Figure 13. Velocity distribution of previously identified NGC 1052 Group members (solid symbols) and other probable group members within the same projected area (open circles), as a function of angular distance from the centre of the group. Symbols denote the galaxies in the group in the same manner as in Fig.2. The new group member reported in this paper, J0249−0806, is located just above centre in the diagram and is labelled and marked $\ast$. The nearby galaxy NGC 1110 is also labelled and marked with a filled square, for comparison. The group velocity is shown with a solid horizontal line at $v = 1366$ km s$^{-1}$, while the dotted lines parallel to this indicate the velocity dispersion of $\sigma = 91$ km s$^{-1}$. The dashed vertical line represents the extent of $r_{500}$. Position and velocity data are from NED.