Neutral Hydrogen in Galaxy Groups

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Abstract. We present preliminary results from a study of the neutral hydrogen (H\textsubscript{i}) properties of an X-ray selected sample of nearby loose galaxy groups. This forms part of a multi-wavelength investigation (X-ray, optical and radio) of the formation and evolution of galaxies within a group environment. Some initial findings of an ATNF Parkes Multibeam wide-area neutral hydrogen (H\textsubscript{i}) imaging survey of 17 nearby galaxy groups include two new, potentially isolated clouds of H\textsubscript{i} in the NGC 1052 and NGC 5044 groups and significant amounts of H\textsubscript{i} within the group virial radii of groups NGC 3557 and IC 1459 - two groups with complex X-ray structures that suggest they may still be in the act of virialisation. Here we present ATCA high-resolution synthesis-imaging follow-up observations of the distribution and kinematics of H\textsubscript{i} in these four groups.

Keywords: Galaxy groups, Neutral Hydrogen

1. Introduction

Neutral hydrogen is a valuable tracer of galactic structure and dynamics. It is the most spatially extended component of a galaxy’s disk, and is particularly sensitive to tidal interactions and mergers between galaxies, retaining the imprint of an encounter out to large galactic radii (Mundell et al., 1995). It is therefore an ideal tool for probing the morphology and dynamics of galaxies in groups, with the aim of unravelling the processes driving galaxy evolution in a group environment.

This study is part of the GEMS project - a multi-wavelength (X-ray, optical and radio) investigation of the formation and evolution of galaxies within groups. We have conducted a wide-area (5.5° × 5.5° per target) neutral hydrogen (H\textsubscript{i}) imaging survey of 17 nearby galaxy groups (distance < 40 Mpc) using the ATNF Parkes Radiotelescope Multibeam System, at an angular resolution of 17 arcminutes.

Initial results of this survey include the detection of H\textsubscript{i} within the X-ray virial radius in the IC 1459 and NGC 3557 groups. Additionally, new group members previously uncatalogued at optical wavelengths were detected at the edges of the groups NGC 1052 and NGC 5044.
High angular resolution (\(\sim 35\) arcsec) synthesis followup observations of a targeted 33 arcmin region in each of these four groups were subsequently obtained, using the Australia Telescope Compact Array, with the goal of determining the precise location, distribution and kinematics of the HI in these regions.

2. NGC 1052 Group

The loose group NGC 1052 (Garcia, 1993) has 14 catalogued member galaxies and is located at a distance of 19.3 Mpc, with a systemic velocity of 1438 km s\(^{-1}\). In addition to HI detection of group members, the Parkes wide-field observations of this group reveal HI emission from a source located \(\sim 2^\circ\) (690 kpc) from the centre of the group, and 14 arcmin (100 kpc) south of the edge-on galaxy NGC 1110. The ATCA followup observation, with spatial resolution of \(42'' \times 30''\) and spectral resolution of \(3\) km s\(^{-1}\), confirms the HI-emitting region to be \(\sim 10 \times 50\) kpc in extent, approximately 90 kpc south of, and spatially distinct from, NGC 1110 (see Figure 1, left). This object, to which we refer as J0249-0806, has a mean velocity of 1450 km s\(^{-1}\), a derived HI mass of \(M_{\text{HI}} = 1.2 \times 10^9\ M_\odot\) and a mean \(\sigma_{\text{HI}} = 3\ M_\odot\ \text{pc}^{-2}\) (cf. \(\sigma_{\text{HI}(\text{LSBgal})} \sim 2\ M_\odot\ \text{pc}^{-2}\) (de Block et al., 1996)). The DSS2-red optical image at the position of J0249-0806 shows uncatalogued faint emission spatially coincident with the HI gas (see Figure 1, left), and optical data now in hand will allow us to better determine the nature of his object.
3. NGC 5044 Group

The NGC 5044 group has 9 catalogued member galaxies (Garcia, 1993), a systemic velocity of 2379 km s\(^{-1}\) and a distance of 19.3 Mpc. A previously uncatalogued source of HI emission was discovered by the Parkes wide-field survey, and confirmed by a targeted ATCA followup observation (spatial resolution \(41'' \times 32''\), spectral resolution 3 km s\(^{-1}\)) (see Figure 1). This new group member, designated J1320-1426, lies \(\sim 2.5^\circ\) (1.4 Mpc) north-east of the group centre and has velocity gradient north-west to south-east centred at a velocity of 2750 km s\(^{-1}\). At the assumed distance we derive an HI mass of \(M_{\text{HI}} = 1.3 \times 10^9\) M\(_\odot\) and a projected size of 35 \(\times\) 20 kpc. The DSS1 optical image of the region reveals two peaks straddling the HI peak, and a faint halo of optical emission spatially coincident with the HI source. This, together with a surface density of \(\sigma_{\text{HI}} = 1.2\) M\(_\odot\) suggests that this may be a low surface brightness galaxy (de Block et al., 1996). We have obtained optical images of J1320-1426, which will give us a better understanding of its nature.

4. IC 1459 Group

The Parkes wide-field data reveal HI emission within the X-ray virial radius of the IC 1459 group, where extended, potentially non-virialised, X-ray gas is known to exist. The centre of the group was imaged in ATCA followup observations (spatial resolution \(36'' \times 33''\), spectral resolution 10 km s\(^{-1}\)) to determine the distribution and kinematics of the HI within the virial radius. We detected HI associated with the galaxies IC 5269B (\(M_{\text{HI}} = 1.1 \times 10^9\) M\(_\odot\)), IC 5264 (\(M_{\text{HI}} = 0.2 \times 10^9\) M\(_\odot\)) which exhibited two lobes of emission, and NGC 7418A (\(M_{\text{HI}} = 1.6 \times 10^9\) M\(_\odot\)) whose HI emission is tidally distorted. In addition, three low HI-mass clouds are tentatively detected near IC 1459, IC 5264 and NGC 7418A. \(\lambda\)-21 cm radio continuum emission was also detected from IC 1459.

5. NGC 3557 Group

The Parkes survey observations of this group detected little HI gas outside the X-ray virial radius, but a substantial amount within this region, where X-ray studies have detected complex emission. The ATCA followup observation (spatial resolution \(97'' \times 60''\), spectral resolution 7 km s\(^{-1}\)) detected HI and radio continuum emission from the galaxy NGC 3568 (\(M_{\text{HI}} = 3.8 \times 10^9\) M\(_\odot\)). HI emission from NGC 3557_17
(Zabludoff and Mulchaey, 2000) was also detected ($M_{\text{HI}} = 0.1 \times 10^9 M_\odot$), and two tentative HI detections were made, near NGC 3557 and NGC 3557_17.

6. Conclusion

In combination with forthcoming results from the remaining 13 groups in this study, and in parallel with the work being carried out on this sample at X-ray and optical wavelengths, these results will help us to understand how the neutral hydrogen gas in loose galaxy groups, through its interactions with other group elements, contributes to the evolution of the galaxies and the groups they inhabit.

References

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