COOL AND CLOSE ENCOUNTERS OF THE HI KIND

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INTRAGROUP GAS

- Many examples of tidal streams detected in nearby systems (Mpc vs z) —see “HI Rogues” Gallery (Hibbard et al. 2001)

- Green Bank Telescope observations of 22 Hickson Compact Groups studies revealed a diffuse HI component missed by VLA observations (Borthakur, Yum & Verdes-Montenegro et al. 2010)
Gas dynamically similar to that mapped with the VLA
Spread over >1000 km/s
More consistent with tidal stripping than with ram-pressure
What is the spatial distribution of this gas?
This provides: kinematics, clues to past interactions, comparison to models etc.

Pilot Case: HCG 44
Westerbork Synthesis Radio Telescope (Serra et al. 2013)
OBSERVED WITH KAT-7: THE MEERKAT PATHFINDER

- 7 x 12m dishes
- Field of View: 1.08°
- Spatial Resolution: 3.5’
achieved sensitivity: \( N_{\text{HI}} < 2 \times 10^{18} \) cm\(^{-2}\)
KAT-7 ONLY: LOWEST CONTOUR IS $\sim 2\times10^{18}$ CM$^{-2}$

extended tail: KAT-7 recovers as much emission as Arecibo (ALFALFA) $\sim$450 kpc, $1.1\times10^9$ M$\odot$
Why is this interesting?

- neutral HI is detected below $2 \times 10^{18} \text{ cm}^{-2}$, but photoionization and radiative transfer models predict that HI cannot survive at column densities of $< 5 \times 10^{19} \text{ cm}^{-2}$ (Dove & Shull 1994) due to the lack of self-shielding against extragalactic ionizing photons.

- Proposed evolution of the group suggests neutral gas has survived at least 0.5-1 Gyr without being ionised (what mass has been lost? lack of hot, dense IGM and associated ram pressure stripping?)
Loose Group IC 1459

- Also detect similarly low column density gas with KAT-7 (down to $5 \times 10^{18} \text{ cm}^{-2}$)
- Age of the HI tail must be at least of order $\approx 2 \text{ Gyr}$
- reduced role for the intragroup medium in evaporating cold intragroup gas?

Osterloo et al. 2018
Low Column Density Gas

- Evidence suggesting radial column density profiles of nearby galaxies decline smoothly down to the sensitivity limit (no break due to ionization by extragalactic photons) Ianjamasimanana et al. (arXiv:1803.10291)

- Need sensitive HI observations in $10^{18}$ to $10^{20}$ cm$^{-2}$ regime

- QSO sightlines relatively insensitive in this “Lyman-Limit” regime due to HI self-shielding

- What is the fate of this gas? How does it effect the evolution of galaxies in groups?
64 x 15m dishes: compact core containing 70% of the dishes

extended array designed for high fidelity imaging performance over a range of resolutions

Better receivers (Gifford-McMahon (GM) cryogenic cooling)

Offset Gregorian dish configuration enhances sensitivity by providing high aperture efficiency, low spill-over temperature contribution, and a clean optical path

- Excellent Column Density sensitivity in L-band (comparable to eVLA-D)
- Field of View — 1 degree
- Better UV coverage at short baselines (compared to VLA) to recover diffuse emission
- Longest baseline — 8 km, shortest — 29m
- eVLA B, C, D array simultaneously
- M64 — July 2018
What role (if any) does group environment play in how galaxies evolve?

Combine

- sensitive gas observations — fuel/reservoir/tracer of interactions
- group properties
- stellar mass
- star formation
- bulge-disk ....

Complexity of studying dynamic physics and chemistry when limited to studying “snapshots” — simulations are key
GROUP GALAXIES IN GAMA

- G3C Catalogue - Robotham et al. (2011) — current gold standard due to high spectroscopic completeness of GAMA survey

- Use WISE mid-infrared as tracer of stellar mass (Cluver et al. 2014) and star formation (Cluver et al. 2017) — motivation?
WISE W3 luminosity tracks total infrared luminosity closely

scatter: 0.22 dex

Cluver et al. 2017
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- Combination of WISE-detected and LAMDAR photometry (Wright et al. 2016)

- $4 \leq N_{\text{fof}} \leq 10$, $z<0.2 \rightarrow 2311$ groups

- 82% success rate (11 797/14 529 galaxies with WISE)
Stellar Mass $>10^9 \, M_\odot$, $z<0.1$

Group galaxies form more higher mass systems.

Higher dynamical mass (proxy) of groups leads to fewer low mass systems.

Dyn. Mass $<10^{12} \, M_\odot$

distribution is strongly peaked at $10^{10.3}$
Stellar Mass $>10^{9.5} \, M_\odot$, $0.1<z<0.2$

Similar overall to $z<0.1$, but distribution peaks at $10^{10.8}$

Dyn. Mass $<10^{12} \, M_\odot$

distribution is strongly peaked
Stellar Mass >$10^9$ M$_\odot$, z<0.1

W2-W3err < 0.5 mag (S/N~2)
Folding in star formation

Stellar Mass $>10^9 \, M_\odot$

$z < 0.1$

Relative lack of high mass systems in non-group galaxies
Stellar Mass $>10^9 \, M_\odot$

$z < 0.1$

Higher dynamical mass groups have flatter W2-W3 distribution
At this redshift we don’t detect high mass systems unless they have some star formation.
Higher dynamical mass groups have flatter W2-W3 distribution, shift to lower sSFR
Wrapping Up

- Exciting times ahead for “nature vs nurture” studies: Taipan, DEVILS, WALLABY and DINGO on ASKAP, Medium-Deep Survey on Apertif, MeerKAT etc.

- Low column density gas, intragroup gas — what will the SKA pathfinders discover?

- Combine with CGM studies (Nikki Nielsen’s poster)

- More to come from GAMA-WISE group analysis