Role of H\text{\textsc{i}} in the Evolution of Radio Galaxies

Suma N. Murthy
Kapteyn Astronomical Institute/ASTRON

Raffaella Morganti (ASTRON/Kapteyn)
Nissim Kanekar (NCRA)
Tom Oosterloo (ASTRON/Kapteyn)
Outline

- Associated H\textsc{i} absorption.
- Low redshift studies.
- Scenario at high redshift.
- An associated H\textsc{i} absorption survey.
- Initial results.
- Summary.
H\textsc{i} Absorption in Radio AGNs

- Gas accretion on to SMBH $\Rightarrow$ AGN $\Rightarrow$ Host galaxy evolution.
- Cold gas plays a role too.
- H\textsc{i} absorption: Cold gas at high-$z$ and high spatial resolution.
- First detection of associated H\textsc{i} absorption in Centaurus-A. (Roberts 1970)
- Circumnuclar disks, turbulence, gas infall, outflow. (e.g. Taylor 1996, van Gorkom et al. 1989, Morganti et al. 2013)
- H\textsc{i} absorption in large samples $\Rightarrow$ hints on feedback, feeding. (e.g. Gereb et al. 2015)
Low-$z$ H\textsc{i} absorption studies: WSRT Survey

- 248 sources; $0.02 < z < 0.26$.
- Radio luminosity: $10^{22}$ to $10^{26}$ W Hz$^{-1}$.
- Detection rates:
  - Compact sources: $\sim$40%.
  - Old, extended sources: $\sim$13%.
  - Higher in hosts with dust.
- Overall detection rate of $\sim$30% across redshift and luminosity range.
- Supports earlier hypotheses.
  (e.g. Gupta et al. 2006)
- All detected outflows in young, high power sources.
- H\textsc{i} in extended (old) radio sources: rotating disks.
Scenario at High Redshifts

- ~130 searches at $z > 1$; 7 detections.
- Detection rate: ~ 5%:
  - Redshift evolution of cold gas?
  - High AGN Luminosity (UV and 1.4 GHz)?
- Uniform sample at all redshifts.
  (Aditya et al. 2016,17,18a,b)
- UV-faint objects at high redshifts.
  (Curran et al. 2013,16)
- Incidence of HI absorption in different AGN classes?
An Associated H\textsubscript{i} Absorption Survey: Sample

- 0.3 < z < 4.5; 1.4 GHz flux density > 70 mJy: 500 targets.
- SDSS, WiggleZ, VIPERS cross matched with FIRST at z < 2; ultra-steep spectrum sources at z > 2.
- 300 extended radio sources.
  (Gereb et al. 2015)
The Pilot Study

- 17 targets with the uGMRT; $z \sim 0.9 - 2.5$.
- 3 compact and 11 extended objects.
- 1 – 1.5 hours on source.
- $3\sigma$ optical depth limits: 0.3% – 1% per 100 km/s channel.
- Clean spectra for 14 objects.
- 1.4 GHz luminosity: $10^{26.5} - 10^{28.5}$ W Hz$^{-1}$.
- Low UV luminosity.
- 5 tentative detections of associated H$\text{I}$ absorption.
Results

- If confirmed, number of detections at $z > 2$ doubled!
- Overall detection rate $\sim 35\%$.
- Appears to be in agreement with low redshift studies!
- But the sample size needs to be increased.
Summary

- Associated H\textsubscript{i} absorption $\Rightarrow$ Interplay between gas and radio activity.
- Low redshift studies:
  - Overall detection rate: 30%.
  - Compact objects more likely to be detected (40% detection rate).
  - Outflows most likely in high power compact sources.
- Compact objects searched at high redshifts: not enough numbers and diversity.
- A huge heterogeneous sample at $z > 0.3$.
- Current focus on high-$z$ and (relatively) low luminosity targets.
- 17 observed with the uGMRT in the on-going cycle.
- 5 tentative detections and 9 non-detections: detection rate $\sim$36%.
- Present focus is on $z > 1$ and low luminosity objects.