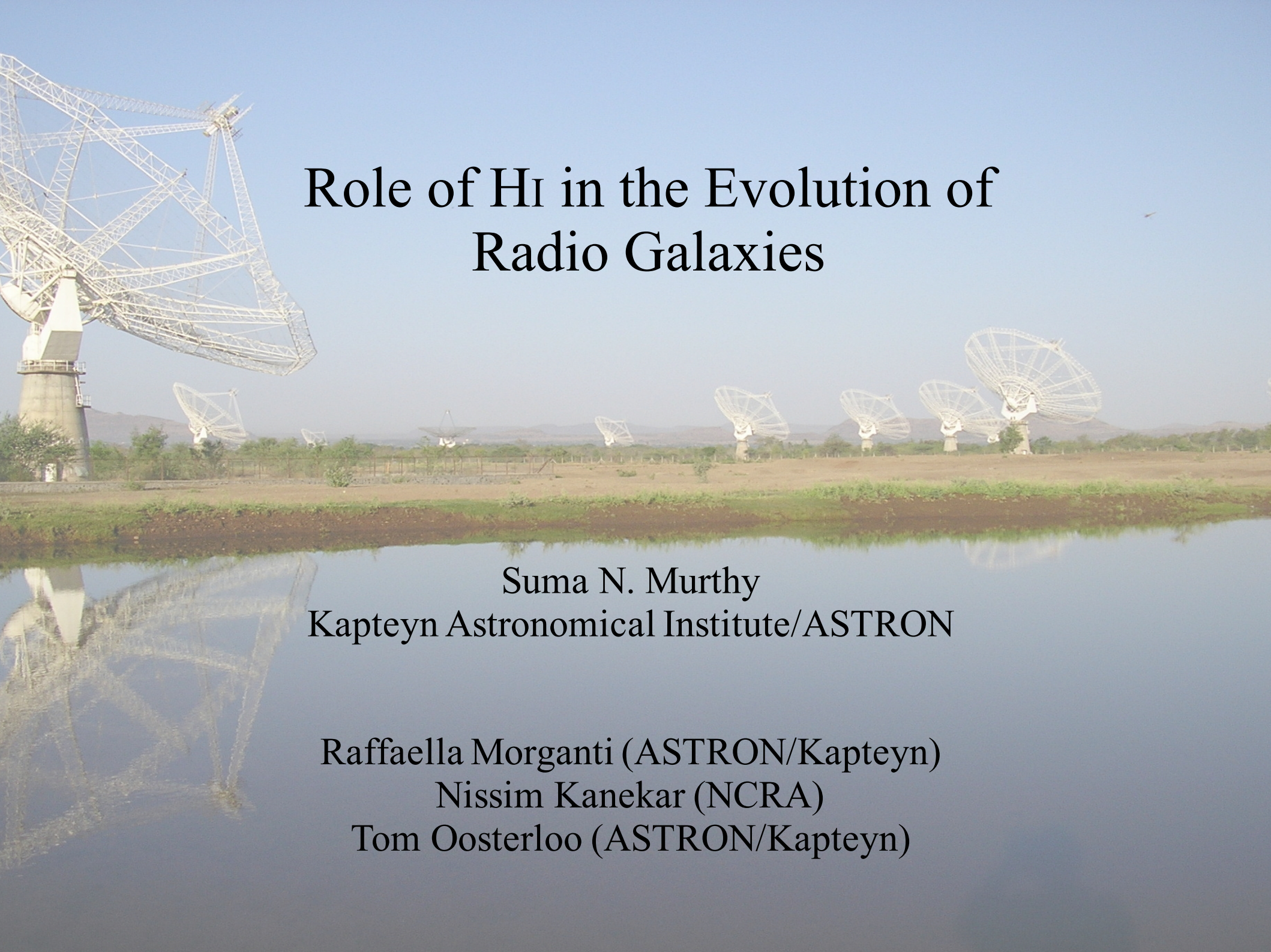


Role of HI in the Evolution of Radio Galaxies

Suma N. Murthy
Kapteyn Astronomical Institute/ASTRON

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

Outline

- Associated HI absorption.
- Low redshift studies.
- Scenario at high redshift.
- An associated HI absorption survey.
- Initial results.
- Summary.

HI Absorption in Radio AGNs

- Gas accretion on to SMBH ⇒ AGN ⇒ Host galaxy evolution.
- Cold gas plays a role too.
- HI absorption: Cold gas at high-z and high spatial resolution.
- First detection of associated HI 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)

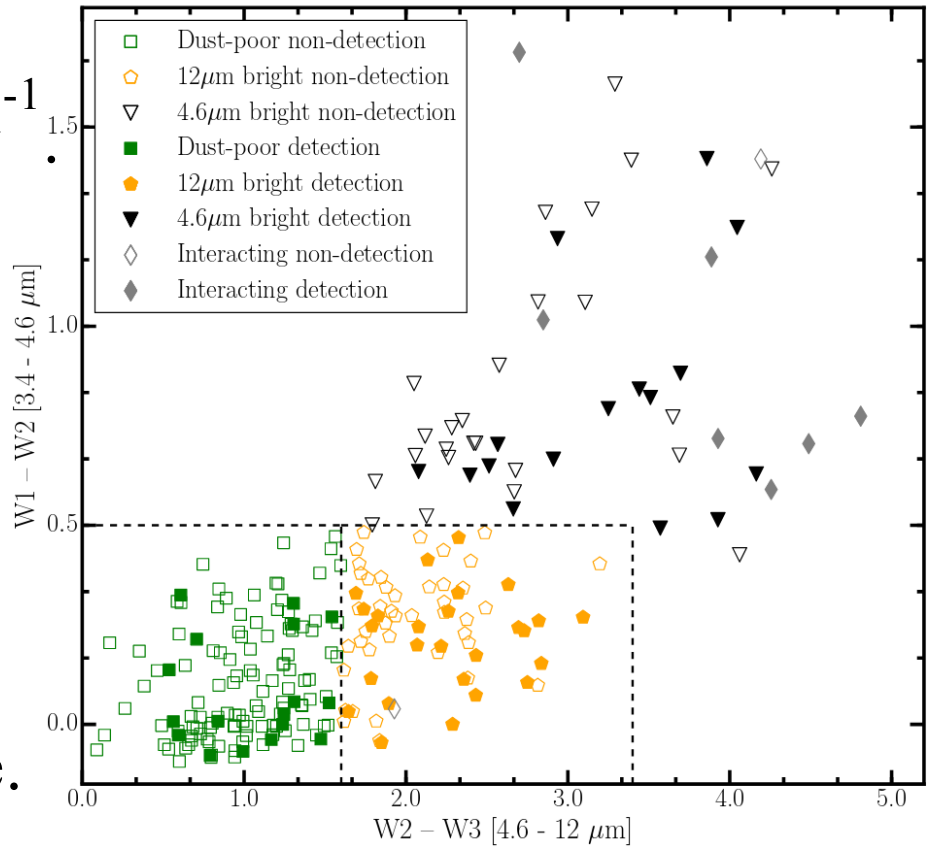
- HI absorption in large samples ⇒ hints on feedback, feeding.

(e.g. Gereb et al. 2015)

Low-z HI absorption studies: WSRT Survey

(Maccagni et al. 2017)

- 248 sources; $0.02 < z < 0.26$.
- Radio luminosity: 10^{22} to 10^{26} W Hz^{-1}.
- Detection rates:
  - Compact sources: ~40%.
  - Old, extended sources: ~13%.
  - Higher in hosts with dust.
- Overall detection rate of ~30% across redshift and luminosity range.
- Supports earlier hypotheses.

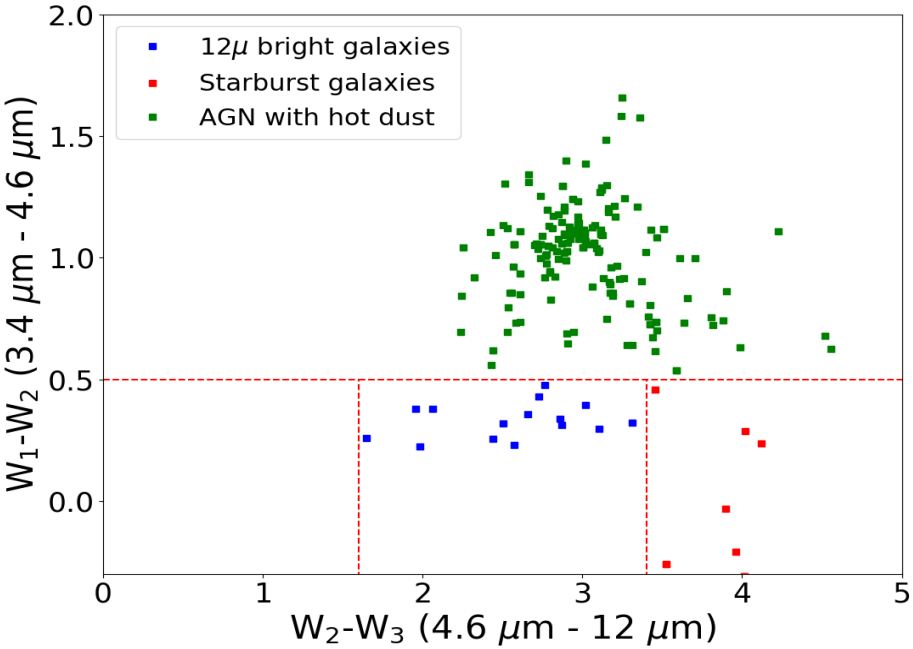


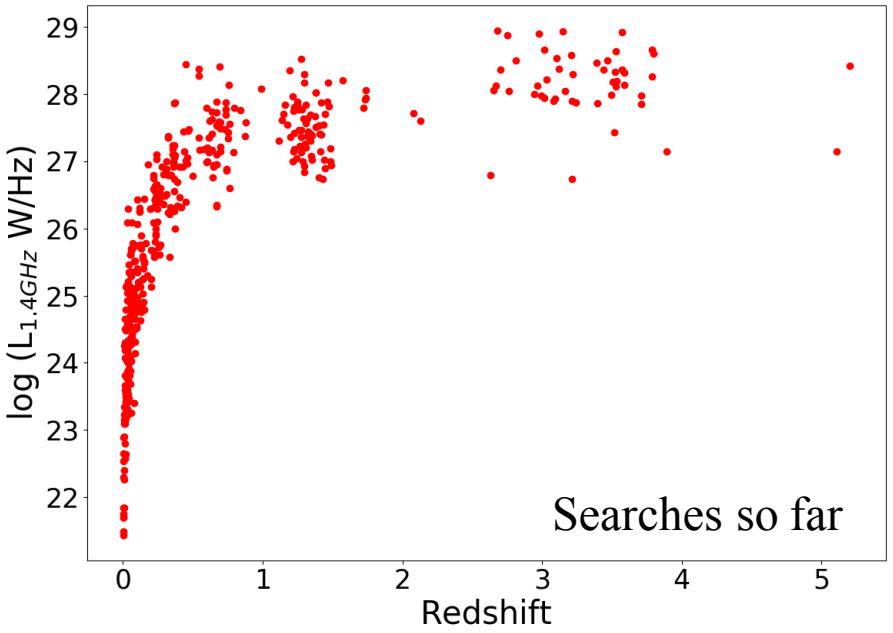
(e.g. Gupta et al. 2006)

- All detected outflows in young, high power sources.
- HI 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?





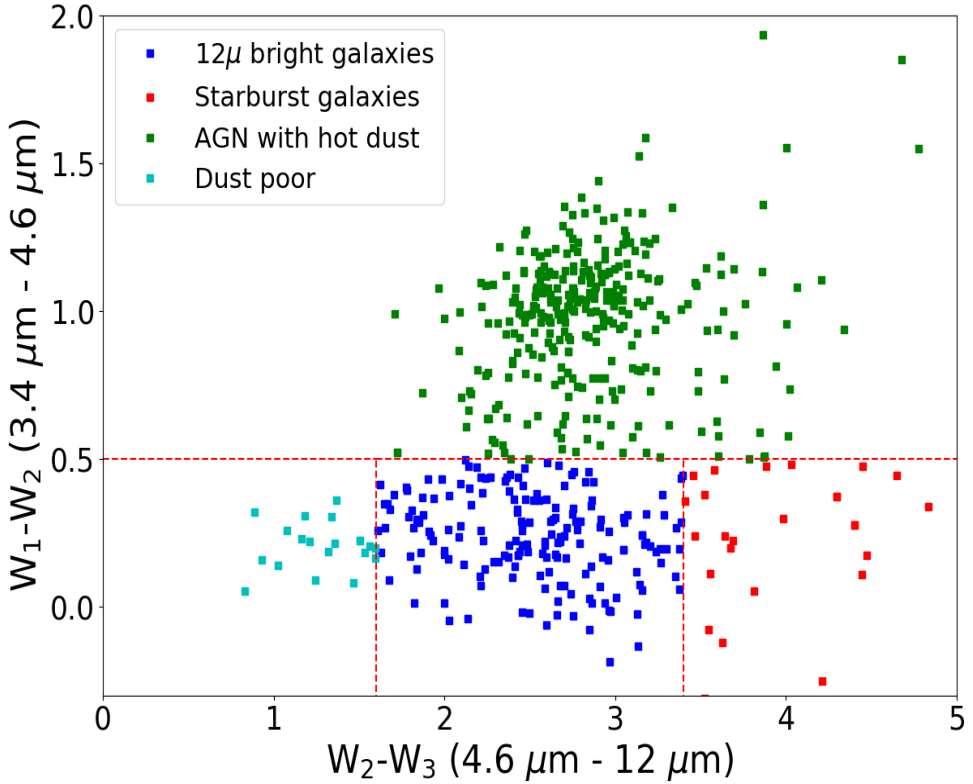
An Associated HI Absorption Survey: Sample

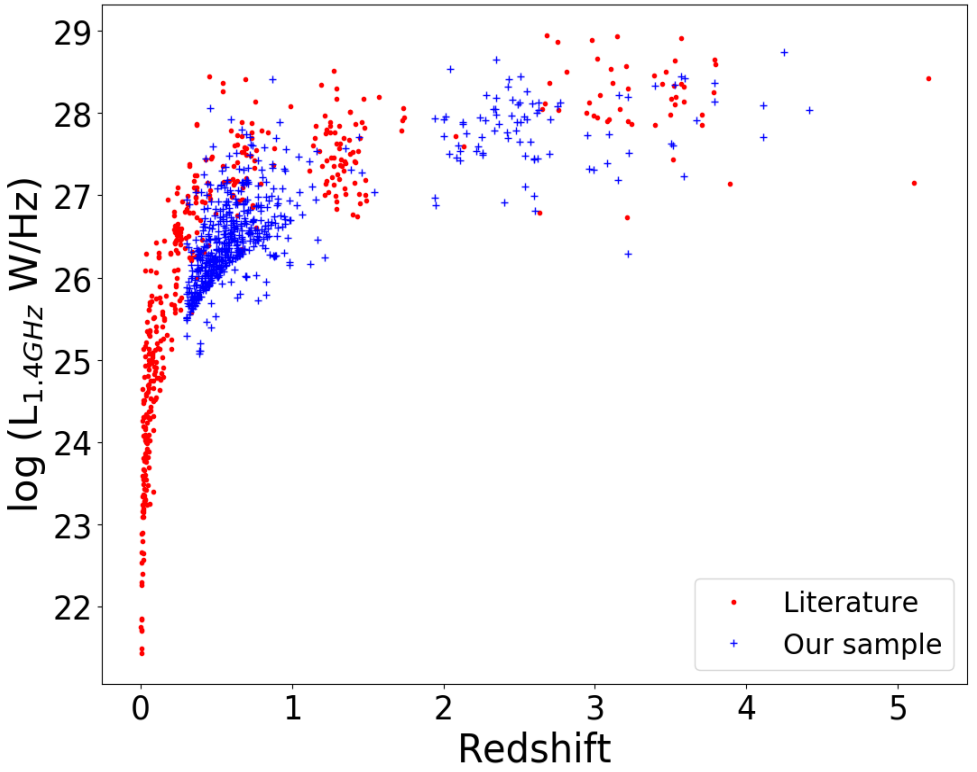
- $0.3 < z < 4.5$; 1.4 GHz flux density > 70 mJy: 500 targets.
- SDSS, WiggleZ, VIPERS cross matched with FIRST at $z < 2$; ultra-steep spectrum sources at $z > 2$.

(Alam et al. 2015, Parkinson et al. 2012, Guzzo et al. 2014, de Breuck et al. 2016)

- 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.
- 3σ 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 HI absorption.

Results

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

Summary

- Associated HI absorption ⇒ 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 ~36%.
- Present focus is on $z > 1$ and low luminosity objects.