HI absorbers at intermediate redshifts

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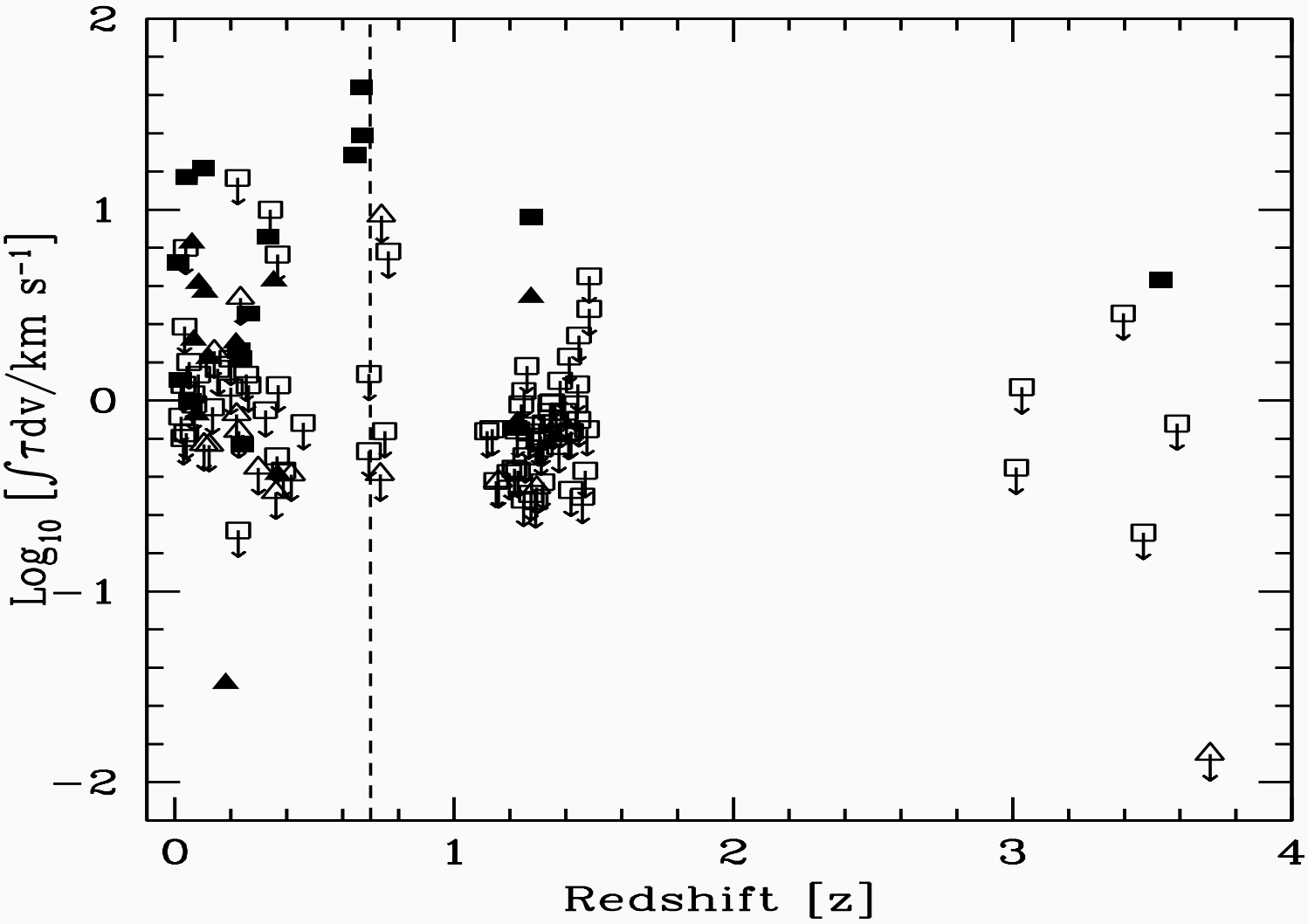
The Metre Wavelength Sky - II

HI at high redshifts

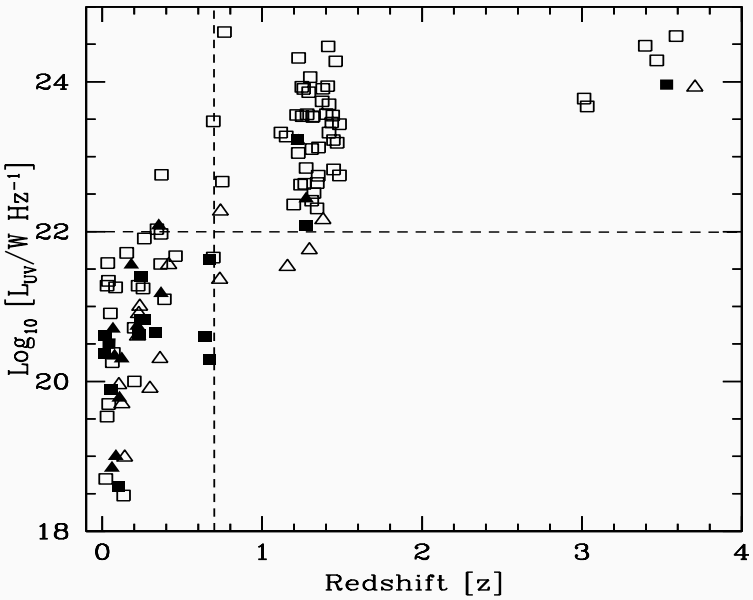
- Neutral hydrogen (HI) is a dominant component of the gaseous ISM.
- Probing HI can lead us to the understanding of AGN-host galaxy co-evolution; fuelling of AGN and 'feedback' processes.
- HI in the high-z AGNs can be probed through HI 21 cm absorption technique.
- Advantage: Kinematical properties can be investigated.
- Over 650 searches have been done, with $\approx$ 120 detections. Mostly at at low z.

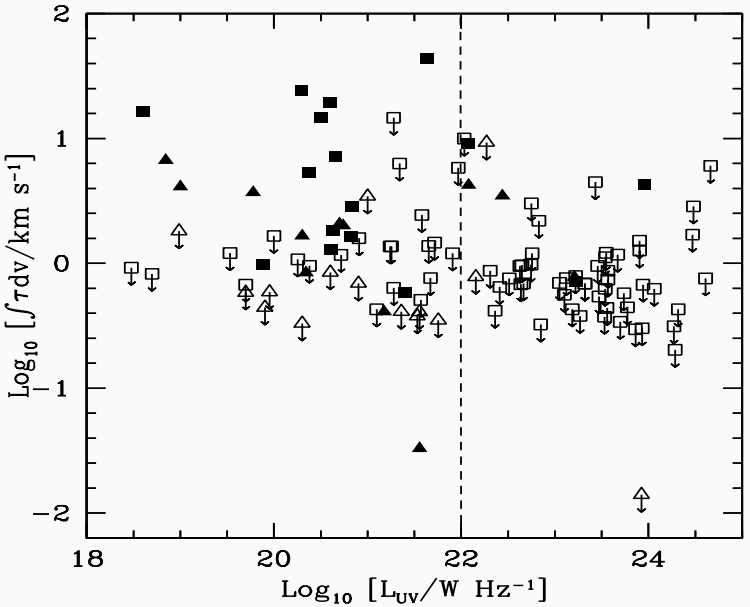
Redshift evolution.

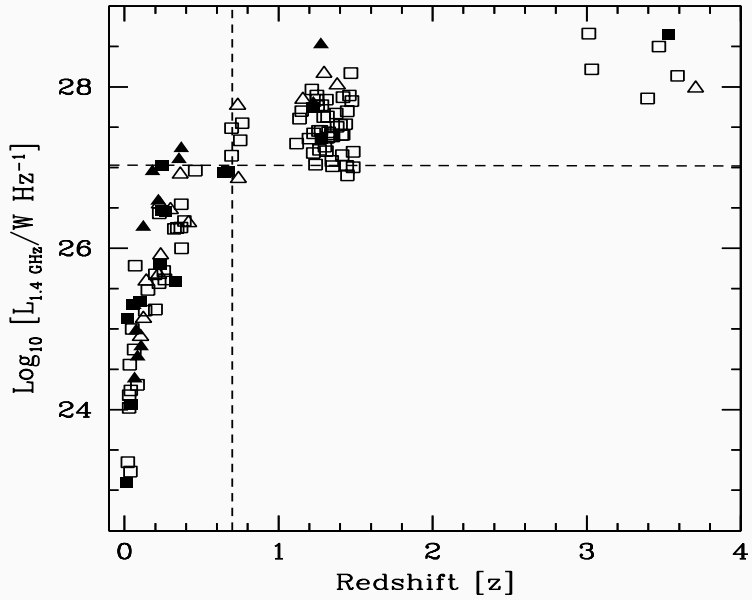
Aditya et al., 2016, 2018b

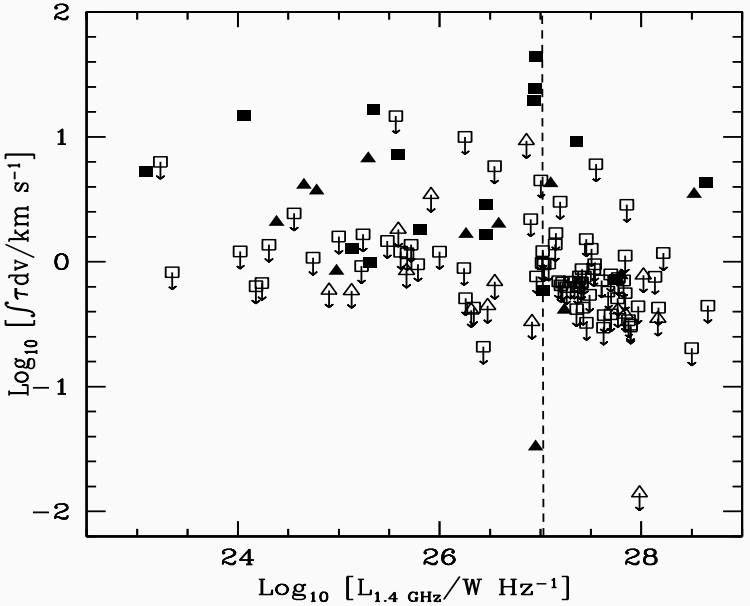


Other dominant cause: AGN luminosity







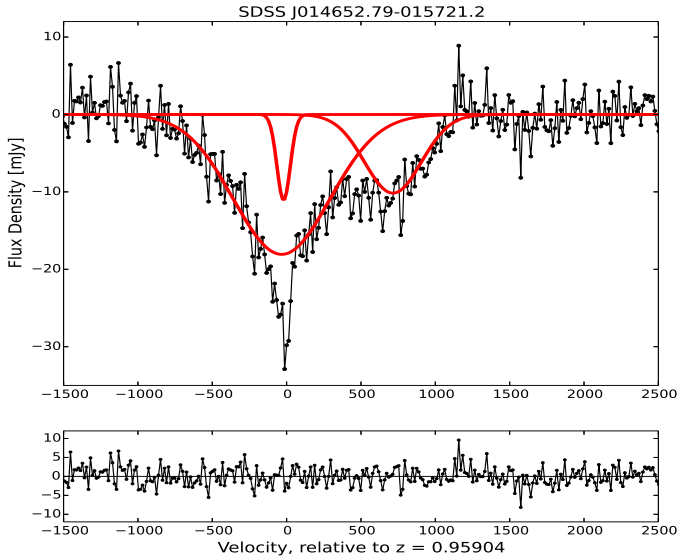


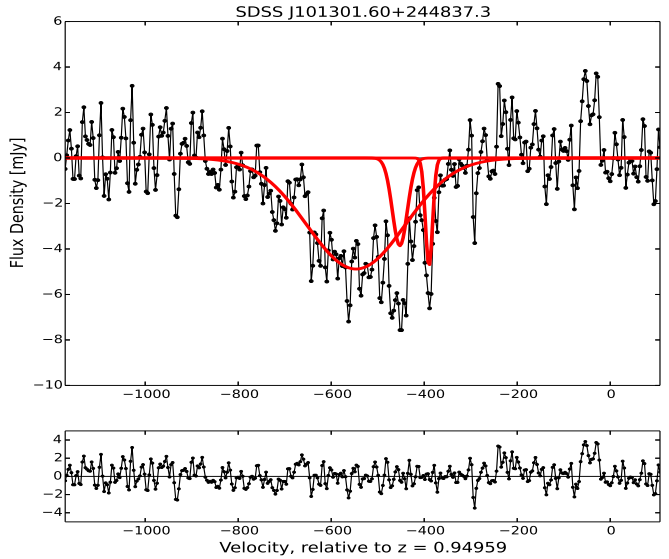
The intermediate redshifts ($0.7 < z < 1.0$)

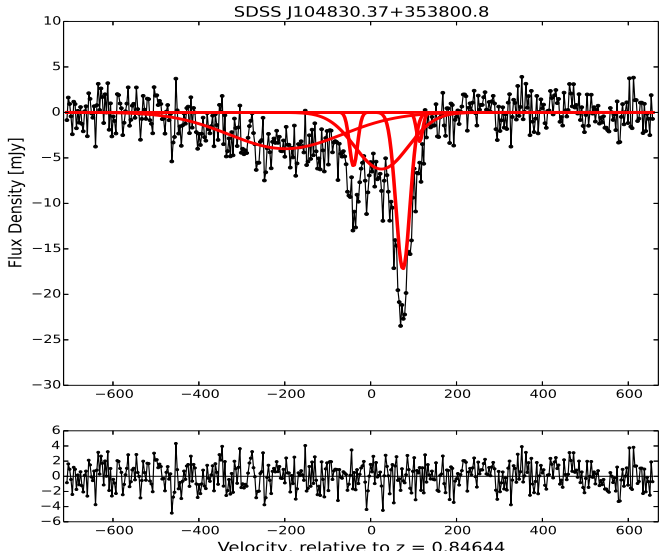
- Current sample size implies that it is difficult to disentangle the degeneracy between redshift evolution and AGN luminosity.
- A high-luminosity sample at **intermediate redshifts ($0.7 < z < 1.0$)** or a sample of low-luminosity AGNs at high redshifts($2.0 < z < 3.0$) is needed to break the degeneracy.
- **Pressing question:** What is the detection rate at $0.7 < z < 1.0$.
- Scantly probed, with just 14 searches (with 4 detections).
- **550 - 850 MHz of uGMRT :** enables associated HI 21 cm search.
- Conducted a pilot survey in a sample of 11 AGNs at $0.7 < z < 1.0$.

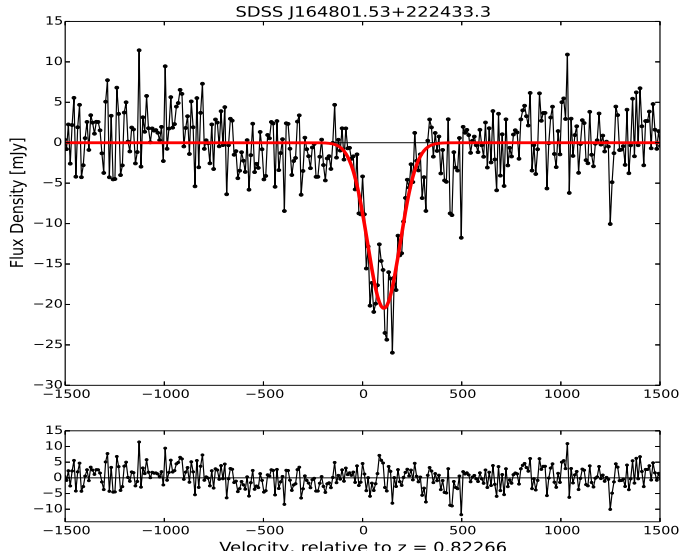
New Detections at $0.7 < z < 1.0$

J.N.H.S. Aditya, 2019, MNRAS 482, 5597

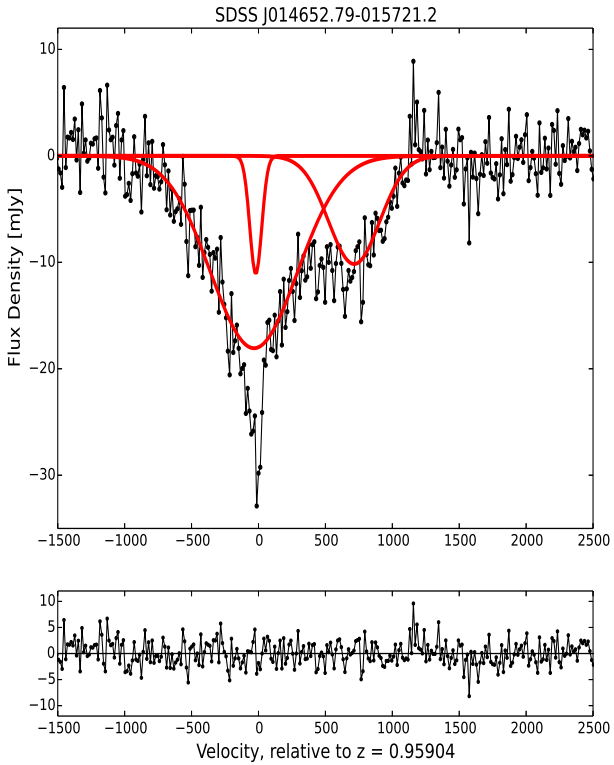








SDSS J014652.79015721.2, at $z = 0.95904$

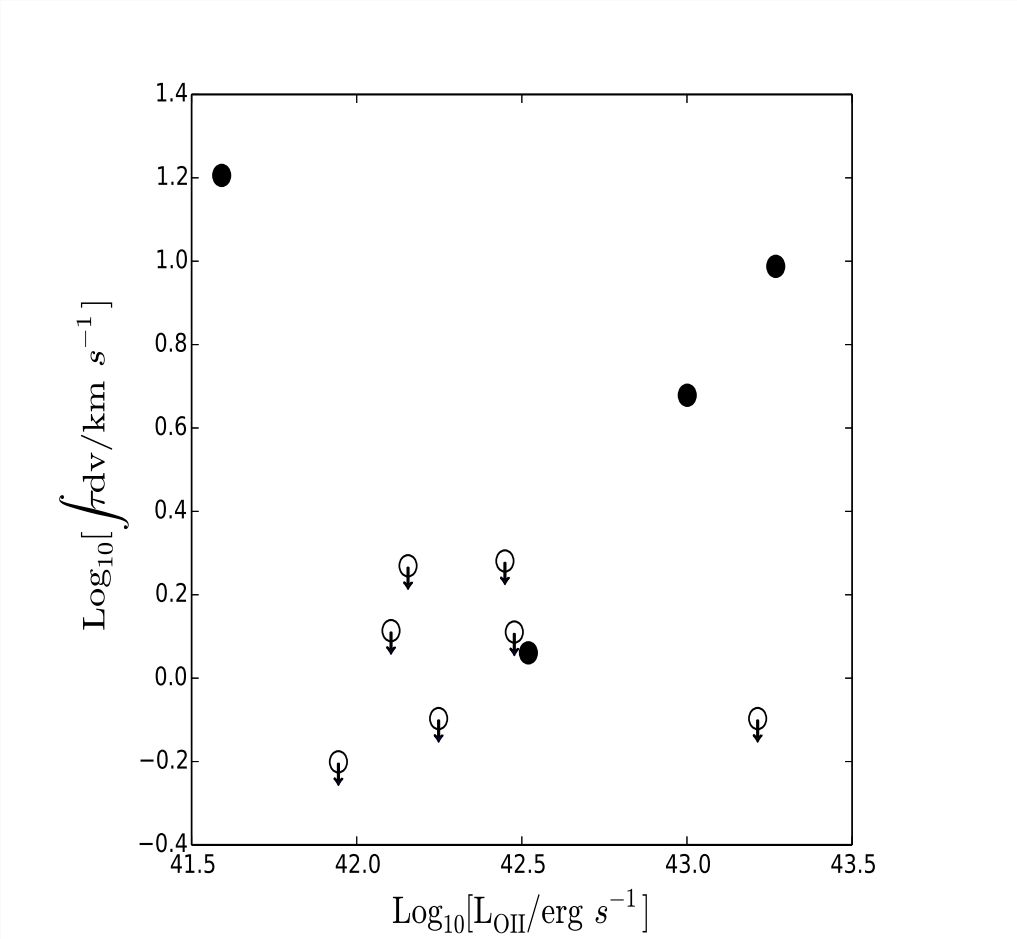


- Peculiar case with a fast inflow and outflow.
- A similar fast ($646\ \mathrm{km\ s^{-1}}$) inflowing HI component was earlier detected towards PKS 0428+20 at $z = 0.219$ by Vermeulen et al. (2003).
- Galaxy mergers, where gas gets channelled to the central regions, could explain such observations.
- HI Mass outflow rate of 78 $M_\odot\ yr^{-1}$
- Assuming: $\mathrm{T_s} = 1000$ K
- Highest cold HI mass outflow rate, compared to similar estimates in literature.

HI distribution and kinematics at high-z

- 4 detections in a sample of 11 indicates that detection rate at $0.7 < z < 1.0$ could be similar to that at $z < 0.4$, $\approx 30\%$.
- 3 detections show significant outflows.
- Relatively high median radio luminosity, $L_{med,1.4\ GHz} = 10^{27}\ W\ Hz^{-1}$, compared to Maccagni et al. 2017 sample at $z < 0.4$.
- Arguably AGN driven.
- High incidence rate of outflows expected at high redshifts due to higher intrinsic luminosities.

[O II] luminosity in outflows



- Low ionization optical lines trace the host-galaxy dynamics and gas distribution.
- Khare et al. (2014) find excess [O II] emission (in quasar rest frame spectrum) particularly for systems with blueshifted Mg II absorption.
- Tentative excess [O II] line luminosity is found for the three systems with HI outflows, consistent with above.
- Suggests strong stellar outbursts in the AGN host, or strong jet-gas interactions.

Summary

- A pilot survey for associated HI 21 cm absorption in a sample of 11 radio bright AGNs at $0.7 < z < 1.0$ was conducted.
- 4 new uGMRT detections in a sample of 11.
- Highest HI mass outflow rate towards SDSS J014652.79015721.2, at $z = 0.95904$.
- Detection rate at $0.7 < z < 1.0$ could be similar to that at $z < 0.4$, on contrary to $< 10\%$ at $z > 1$.
- Tentative excess [O II] line luminosity in AGNs with outflows.