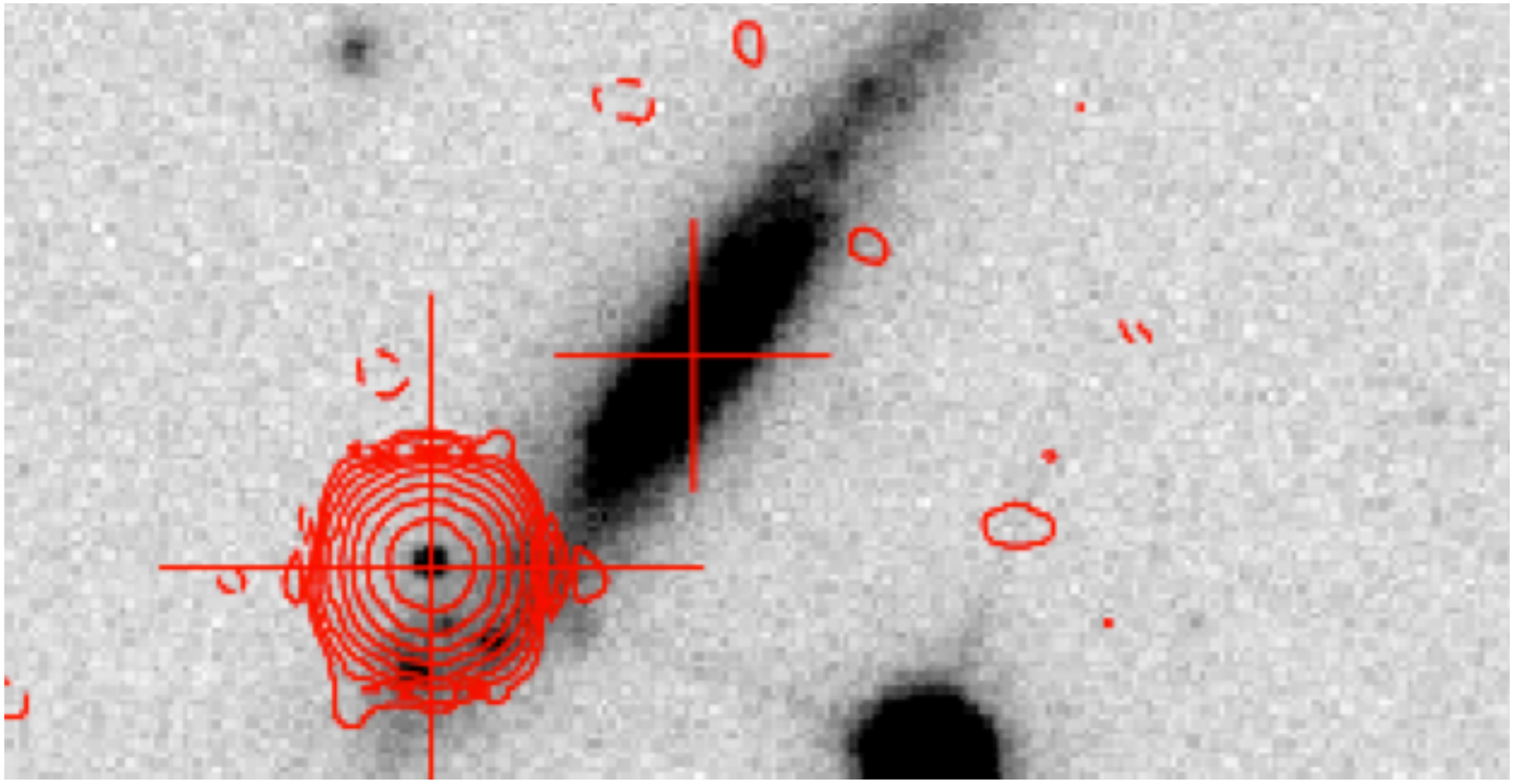


The MeerKAT Absorption Line Survey: building the dust unbiased quasar sample

Neeraj Gupta (IUCAA, India)

MeerKAT Absorption Line Survey

MALS

4000 hrs to search for 21cm and OH absorbers at z<1.8.

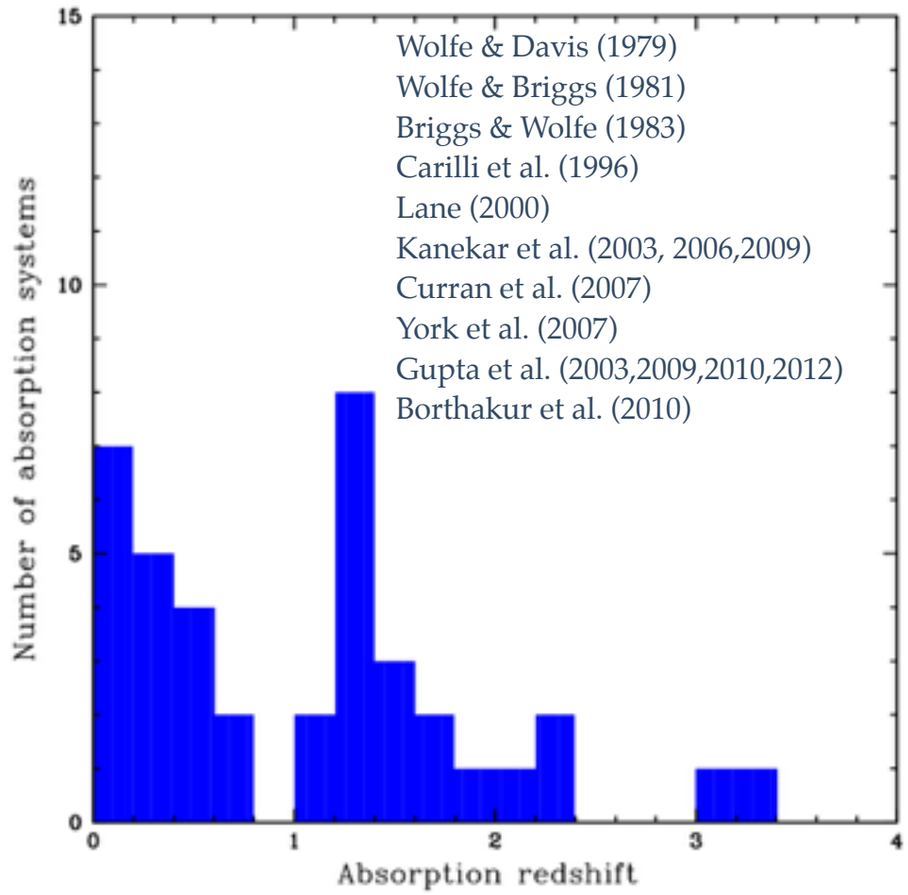
Principal Investigators

N. Gupta and R. Srianand (IUCAA)

Co-Investigators (30)

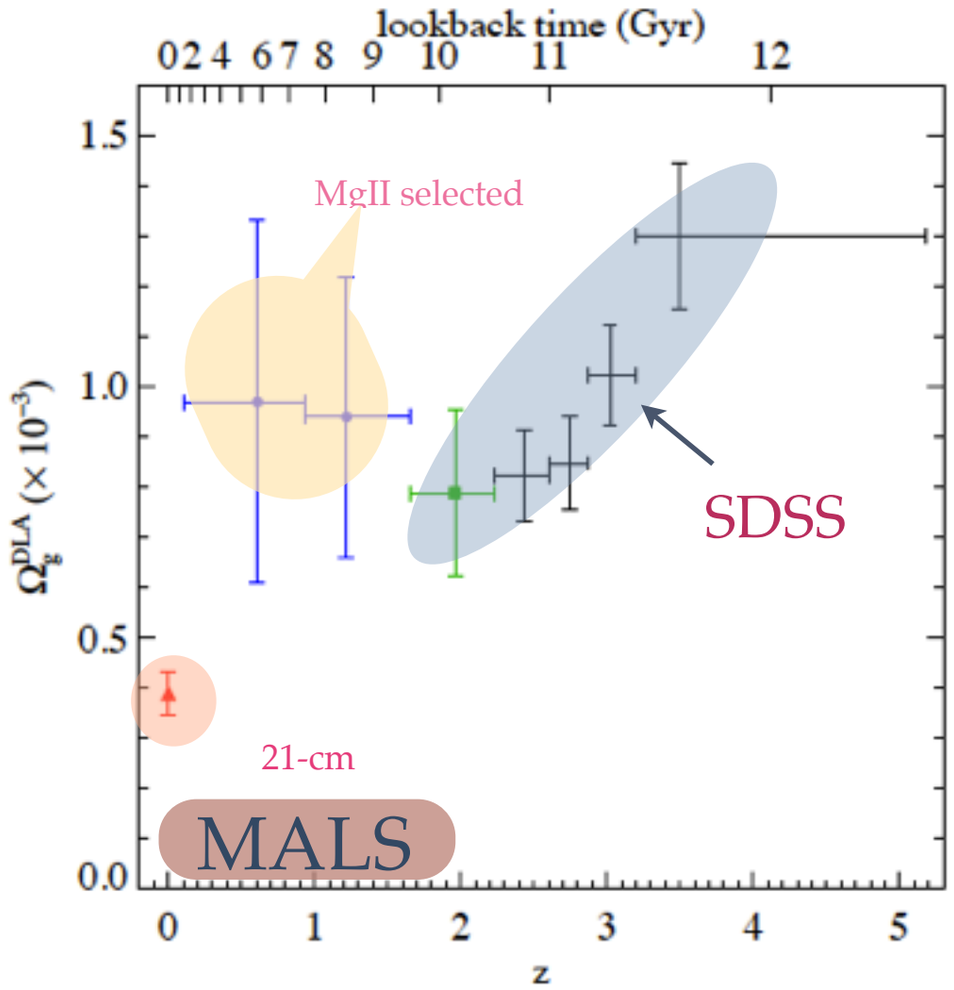
- **Europe:** F. Combes (Observatoire de Paris), W. Baan, R. Morganti, T. Oosterloo (ASTRON), P. Noterdaeme, P. Petitjean (IAP), T. van der Hulst (Kapteyn), J. Fynbo, J-K Krogager (Dark Cosmology Center), R. Beswick (Univ. of Manchester), H. Klockner (Univ. of Oxford)
- **Chile:** C. Ledoux (ESO)
- **India:** D. Bhattacharya, R. Dutta, R. Joshi, A. Kembhavi (IUCAA)
- **S. Africa:** C. Cress, M. Jarvis (Univ. of Western Cape), M. Hilton, K. Moodley, C. Zunckel (Univ. of KwaZulu Natal), S. Goedhart, G. Jozsa (SKA SA)
- **USA:** A. Baker (Rutgers), S. Bhatnagar, C. Carilli, E. Momjian (NRAO), A. Mahabal (Caltech), V. Kulkarni (Univ. of S. Carolina), M. Vivek (Univ. of Utah)

Cold gas evolution through radio absorption lines



~50 absorbers known till date.
Only 12 at z<0.4.

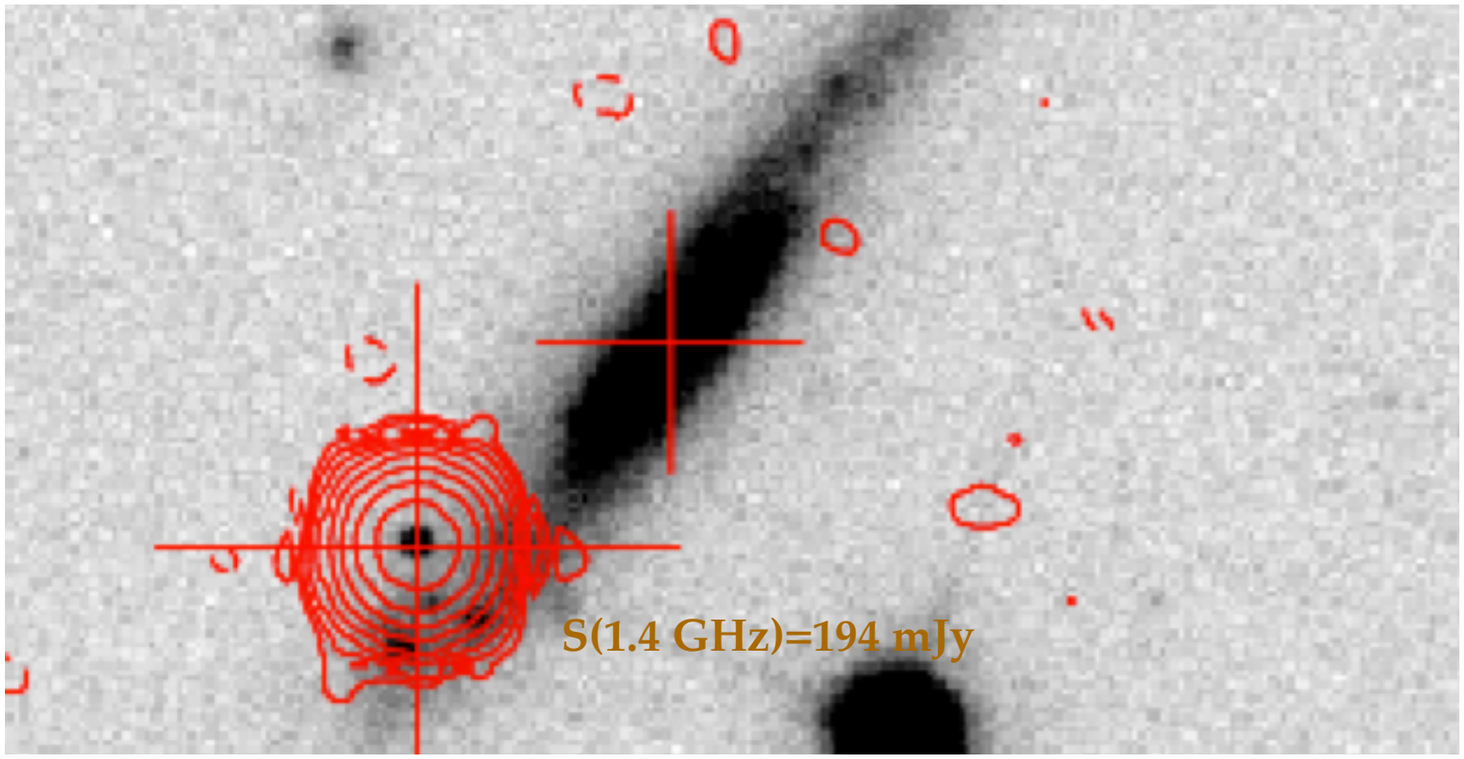
Only 5 molecular absorbers known at z>0.1.

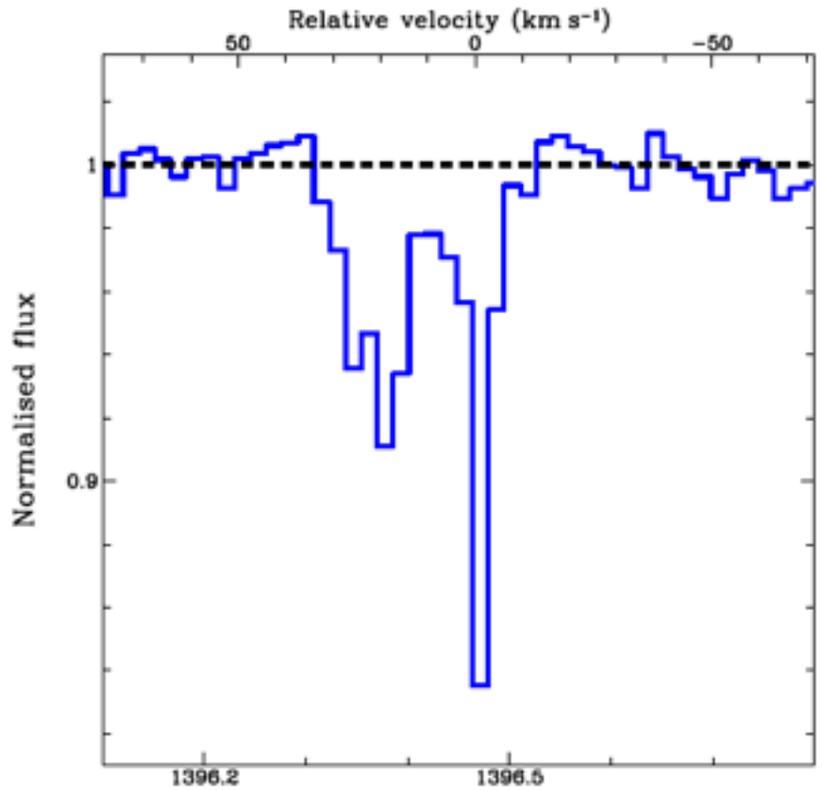


Comparable to SDSS DR7-DLA survey in redshift path.

MALS detects > 600 intervening 21-cm absorbers @ z< 1.8

Quasar absorption lines: 21-cm absorption





$$x = \frac{\alpha^2 g_p}{\mu}$$

$$N(\mathrm{H\ I}) = 1.835 \times 10^{18}\ \frac{T_\mathrm{s}}{f_\mathrm{c}} \int \tau(v)\ \mathrm{d}v\ \mathrm{cm}^{-2}$$

MALS: Goals

1) Blind search for 21cm and OH absorbers at z<1.8 (**dust unbiased**):
   using 580- 1750 MHz frequency band(s).
2) Detect more than ~600 intervening 21-cm absorbers:
   20 times the number of absorbers known.
3) Measure the evolution of cold atomic and molecular gas at z<1.8:
   the z-range where most of the evolution in SFRD takes place.
4) Time variation of the fundamental constants of physics:
   using OH lines, and 21-cm and optical/UV absorption lines
   (SALT + TMT + ALMA).
5) Probe the magnetic field in absorbing galaxies:
   using rotation measure and Zeeman splitting.
6) Synergy with ALMA, EVLA, TMT, ...

Quasars at z>1.5 are the preferred targets (especially for the UHF-band).

Why MeerKAT?

Most sensitive radio telescope at cm wavelength until SKA-I

Driven by:

$$\text{SurveySpeed}(\tau < \tau_o) \propto (A_e/T_{sys})^2 \times \Delta z \times N_t$$

sensitivity; redshift coverage; number of targets

Sensitivity: 100 K gas in subDLAs

Redshift coverage: $0 < z < 2$

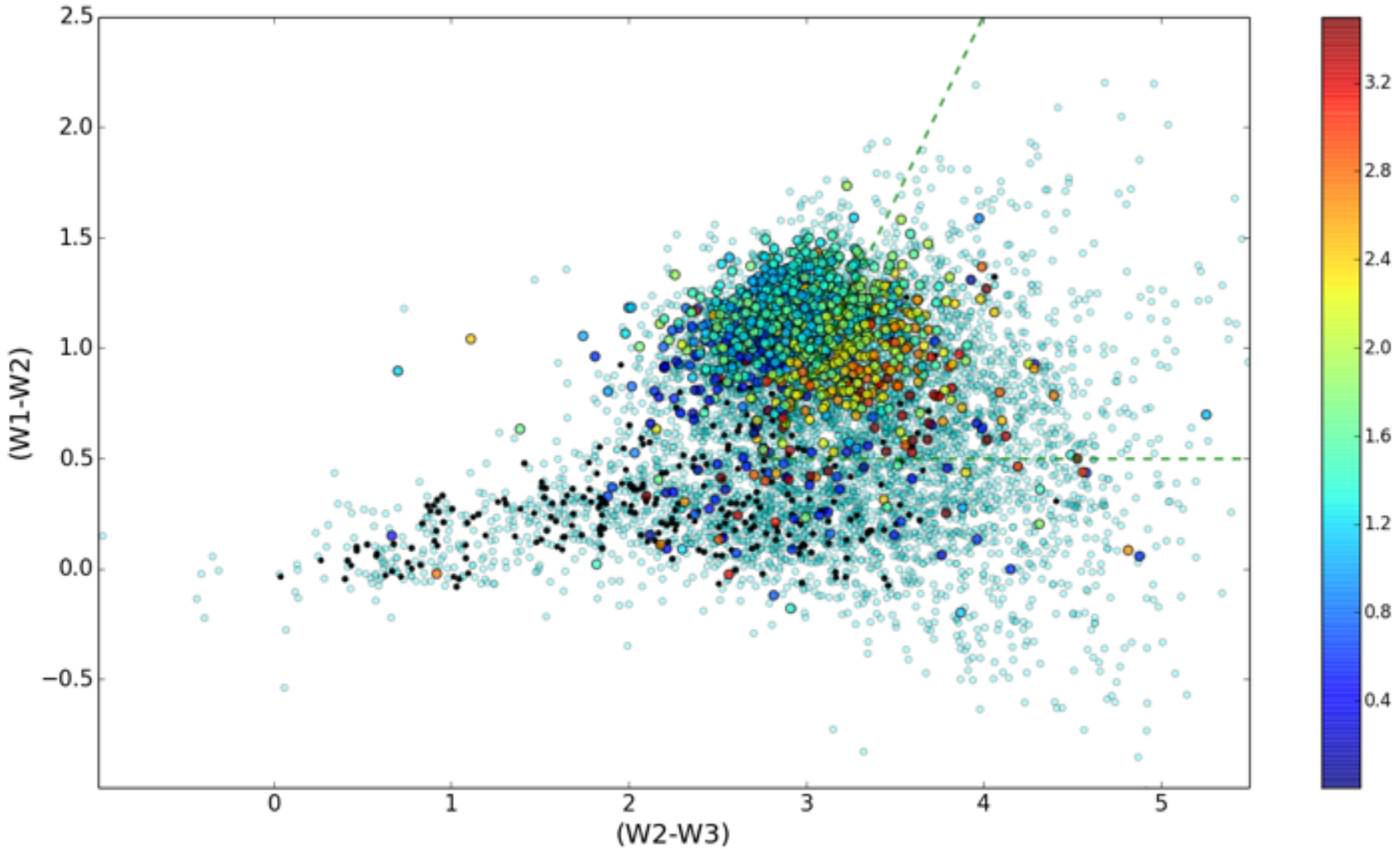
Number of targets / redshift path: constrain dn/dz to 10% accuracy

MALS: observing plan

- Observe sources brighter than 200 mJy (580 - 1420 MHz)
- 5-sigma sensitivity to detect 100 K gas for N(HI) > 10^{19} cm^{-2}
- OH in diffuse molecular clouds
- Need 4 hrs per target (roughly) to cover 0<z<1.8 in two settings
- **Need QSOs at z>1.5 to maximize detection probability i.e. redshift path**
- Bright radio sources are scarce (1 per sq degree)
- Optical spectroscopic coverage in southern hemisphere is sparse
- Of 29000 sources at declination < 20 deg: only ~300 QSOs at z>1.5
  - and also probably biased to optical colour selections and mag cuts
- **Need to identify 700 QSOs at z>1.5 for UHF band!**

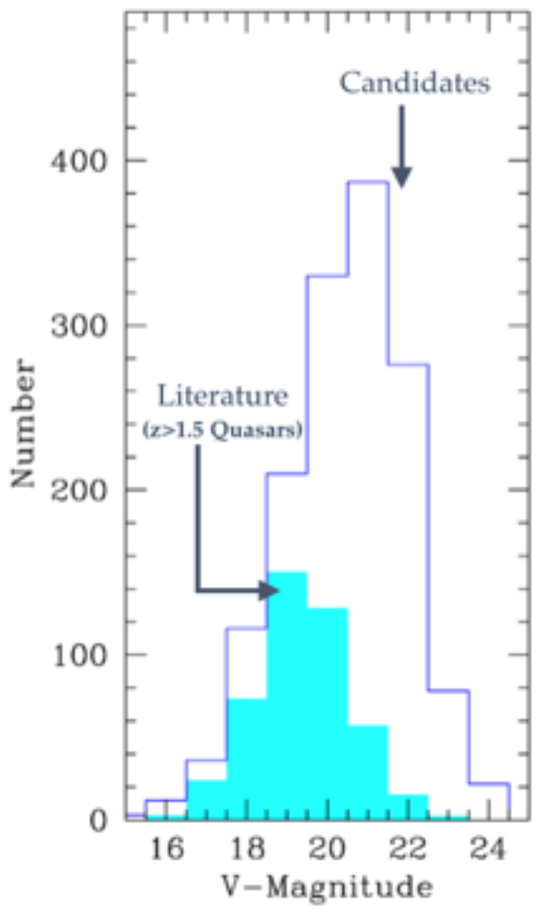
MALS: target selection

- Use WISE colors to identify z>1.5 QSO candidates
- AllWISE catalog provides all sky W1 (3.4μm), W2 (4.6μm), W3 (12μm) and W4 (22μm) photometry



MALS: target selection

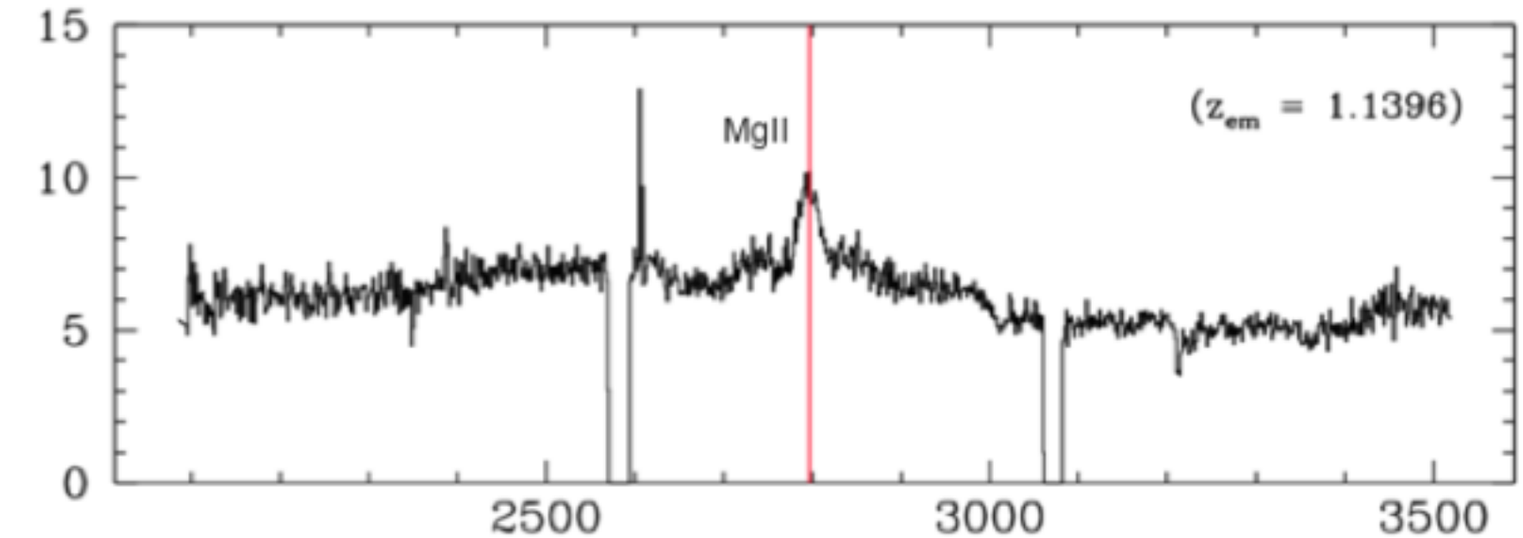
- 1500 z>1.5 QSO candidates (75% success rate expected):
  - based on WISE color cuts and CRTS detection
- Need to observe 1000 (perhaps ~700 will be adequate)
- Goal to observe ~350 by preserving magnitude distribution
- V<20: NOT; V<22: NTT, SALT; V>22: VLT



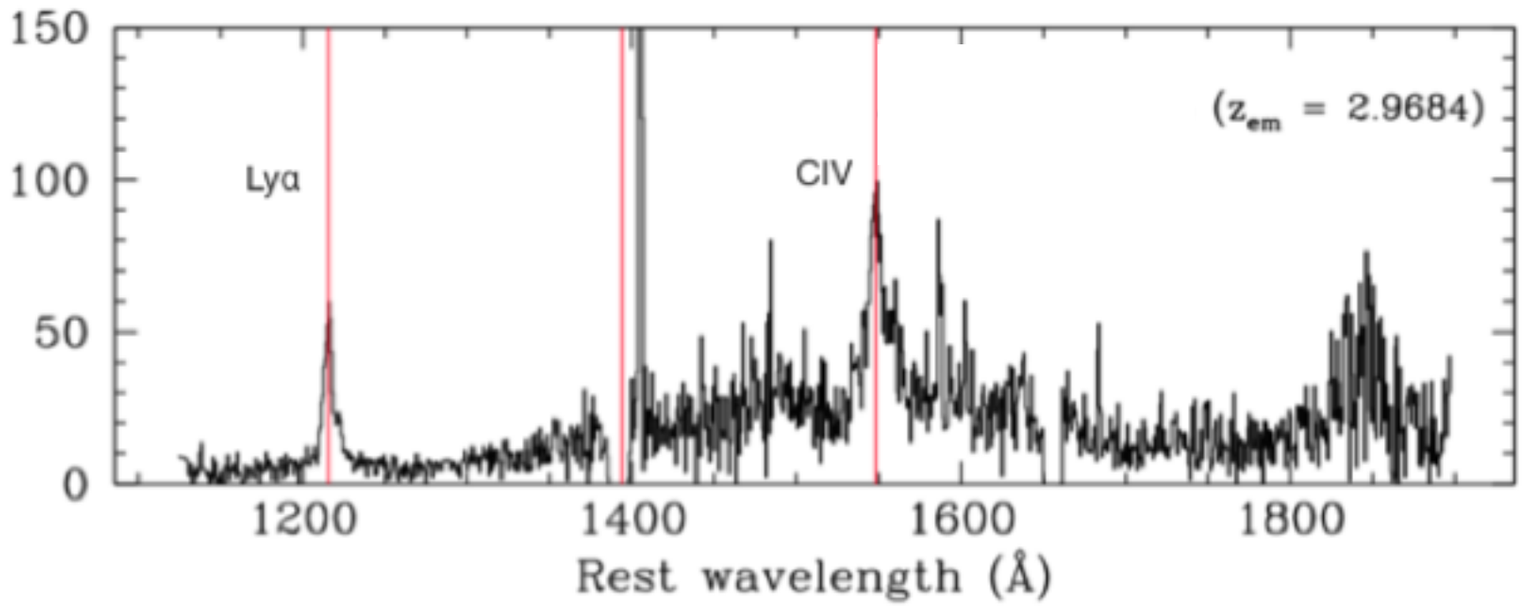
Ideal sample for both UHF and L-band !

SALT: pilot project (2014-1-SCI-027)

Observed 16 candidates (20 mins on-source; 8 ~hrs) using RSS pg0900 covering 4500 - 7500 Å.



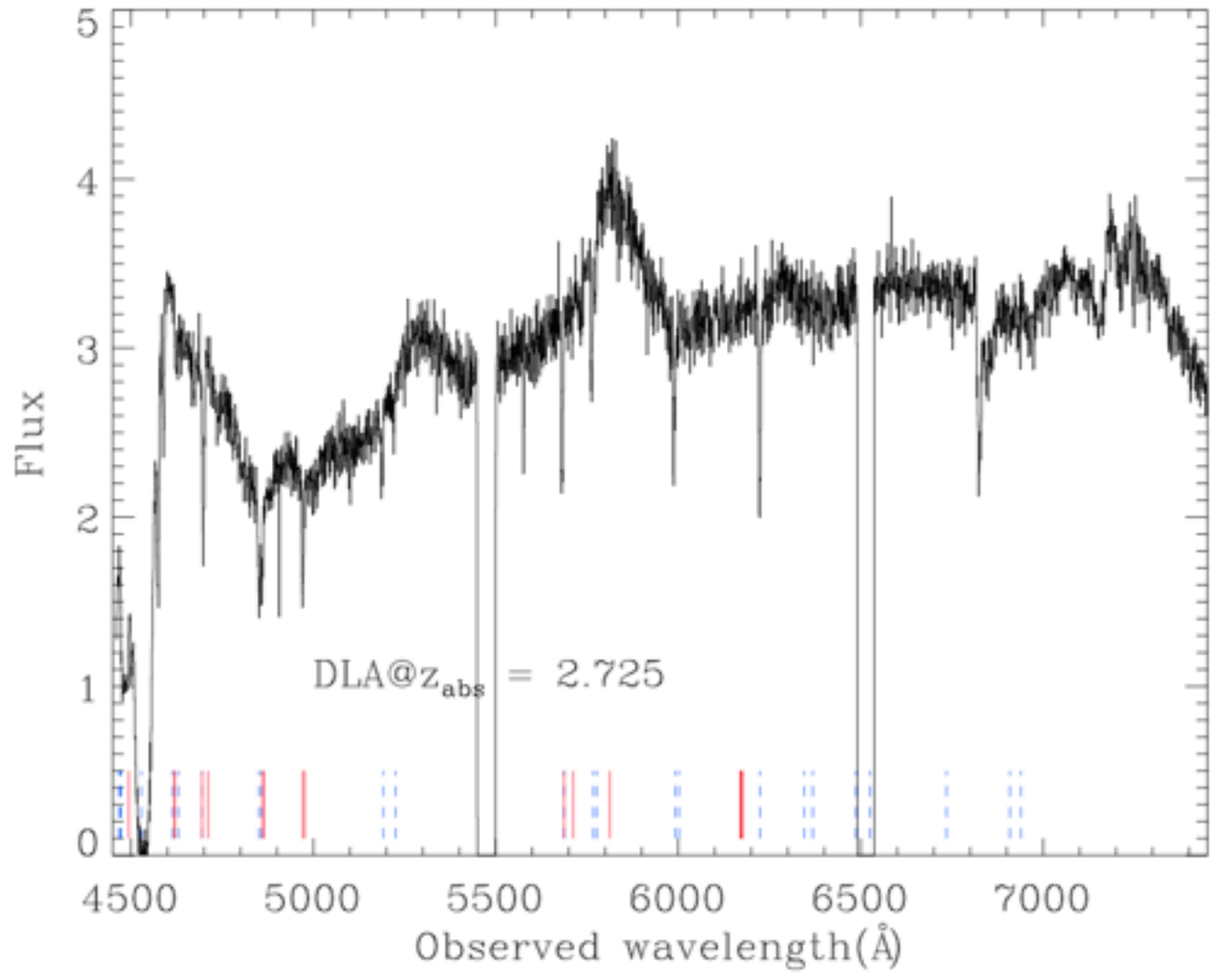
V~19.5



V~21.5

SALT survey (IUCAA + SA + Rutgers: 2015-1-SCI-012; 2015-2-SCI-030)

Observed 150 candidates (75~hrs) using RSS pg0900.
Identified 100 new RLQs; observing 200 more this year.



Dust unbiased sample of quasars

Besides identifying targets for MALS, the SALT+ spectra of this IR selected sample will be readily useful for distinguishing between different models that link the evolution of RLQs to the orientation of AGN or the phases of host galaxy evolution. For this, using SED fitting and properties of emission lines, we will determine the degree of dust obscuration, measure BH mass and accretion rates, etc.

Also uGMRT follow-up of DLAs + extended Lya halo

Goal to identify 300 new z>1.5 RLQs with SALT by mid-2017.
Another 150 using NTT and VLT.

Thank You