The ASKAP-FLASH survey

Early science results

Elizabeth Mahony | with Elaine Sadler, James Allison, Vanessa Moss, Matt Whiting + team FLASH
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Neutral hydrogen in the distant Universe

FLASH Team:
50 members from 24 institutions in 10 countries

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Our goal:
• Use ASKAP to probe the neutral hydrogen (HI) content of individual galaxies in the redshift range $0.4 < z < 1.0$ (look-back time 4-8 Gyr)
• Test current galaxy evolution and mass assembly models in this redshift range
Searching for HI in the distant Universe

21cm HI emission is very weak

• For today’s largest telescopes can only detect HI emission out to z=0.2-0.4

Searching for HI in absorption

• Detection limit determined by flux density of background sources

Advantages of ASKAP:

• 700-1000 MHz freq. band corresponds to redshift range 0.4<z<1.0
• radio quiet site
• Large f.o.v. + wide bandwidth

QSO DLAs

Rhee et al., 2018
Searching for HI in the distant Universe

Strategy: All-sky survey in HI absorption! In 2-3 months of observing time, FLASH will target over 150,000 sightlines to bright background continuum sources across the whole southern sky - an increase of more than two orders of magnitude over previous 21cm HI absorption searches.

Detections can be split into two categories:

- **Intervening absorbers**: Study the cosmic evolution of HI, testing current galaxy evolution and mass assembly models

- **Associated absorbers**: Study AGN fuelling and feedback processes in powerful radio galaxies
New detections with ASKAP

PKS B1740-517
Associated absorption line, radio galaxy

J170109-295442
Absorbed X-ray source, no optical z

J161749-771716
Intervening line towards background QSO

J040848-750720
Proximate absorption against radio lobe

PKS1829-718
Associated absorption in red QSO
PKS 1740-517: The first new ASKAP detection

Lookback Time (Billion Years)

Absorbed Signal (percentage)

Radio Frequency (MHz)

Allison+ 2015
PKS 1740-517: ALMA follow-up

Allison+ in prep
PKS1740-517: ALMA follow-up

[Image of a spectral comparison graph]

Allison+ in prep
PKS 0409-75: HI absorption against a radio lobe

• $z_{HI} = 0.674$, but $z_{opt}=0.693$ -> HI blueshifted by 3000 km/s
  • Is this absorption associated with the host galaxy?
  • Or associated with another galaxy in the group?
    – Need follow-up observations for confirmation:
      optical spectroscopy of nearby source, ALMA
• A chance alignment?

Mahony+ in prep
PKS 0409-75: HI absorption against a radio lobe

- Optical follow-up with Gemini-South
PKS1610-77: Intervening absorption towards background QSO

ASKAP spectrum

QSO @ $z = 1.7$

Unidentified line

Sadler+ in prep

Courbin+ 1997
PKS1610-77: Intervening absorption towards background QSO

ASKAP spectrum

QSO @ z = 1.7

NaD at z=0.45!
PKS1610-77: HI selected galaxy at z=0.45

- Optical follow-up with Gemini-South:

![Image of optical spectra and galaxy positions]
Gallery of intervening 21cm HI lines

Results: 53 sightlines observed, five intervening HI abs. lines detected
**HI DLA number density at $z \approx 0.7$**

*Preliminary result!* 53 bright QSOs observed, redshift path length $\Delta z \approx 21.4$, five 21-cm lines detected (four with DLA-like column densities)

Large error bars for this small sample, but results appear broadly consistent with other work

Already the largest untargeted radio survey in redshift path-length!

Sadler+ in prep
Summary

• The FLASH survey will target 150,000 sightlines towards bright radio sources in the southern sky, resulting in an HI-selected galaxy sample at 0.4<z<1.0.

• Early science + commissioning observations have already revealed a number of unexpected results
  • ALMA reveals intriguing kinematics of cold gas in PKS1740-517 (Allison et al., in prep)
  • HI absorption towards radio lobe of PKS0409-75 – would have been missed in previous absorption line surveys (Mahony et al., in prep)
  • An HI selected galaxy group at z=0.45 (Sadler et al., in prep)
  • ++many more (e.g. X-ray+HI absorption (Moss et al., 2017), HI absorption in red QSOs (Glowacki et al., in prep))
Thank you

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