Detecting the cold neutral gas in young radio galaxies

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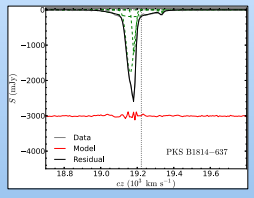
1 A search for 21cm HI absorption in young radio galaxies

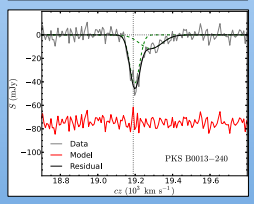
Observations of the 21cm line of neutral atomic hydrogen (HI), seen in absorption against bright radio continuum sources, provide a unique probe of the distribution and kinematics of cold neutral gas in the innermost regions of galaxies. Recent targeted studies of associated HI absorption in radio galaxies are starting to map out the location, and potential cosmological evolution, of cold gas in the host galaxies of Active Galactic Nuclei (AGNs). The observed 21cm absorption-line profiles often show two distinct components: narrow, deep lines arising from cold gas in the disc of the galaxy, and broad, shallow lines, thought to be gas close to the AGN.

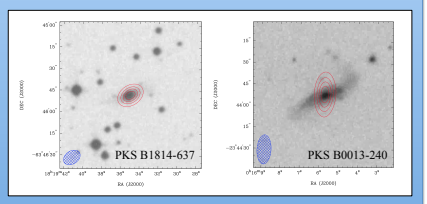
Here, we present results from a targeted search for associated HI absorption in the youngest and most recently-triggered radio AGNs in the local universe (Allison et al. 2012a). So far, by using the recently commissioned Australia Telescope Compact Array Broadband Backend (CABB), we have detected two new absorbers and one previously-known system. While two of these show combined broad, shallow and narrow, deep components, one of the new detections only exhibits a single broad, shallow component. Interestingly, the host galaxies of the first two detections are classified as gas-rich spirals, while the latter is an early-type galaxy.

Image Credit: Sarah Allison

2 Detecting absorption



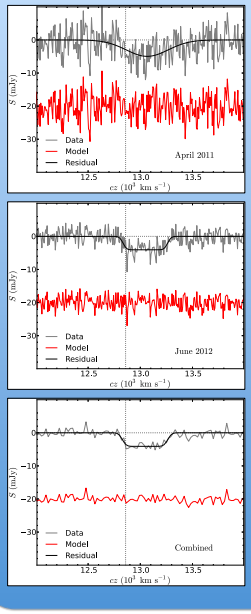




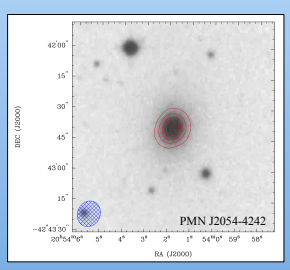
Using a spectral-line detection and modeling method, based on Bayesian inference (Allison et al. 2012b), we obtain detections toward 3 of the 29 radio sources, selected from the AT20GHz survey (Murphy et al. 2010).

Two of the detections arise from HI gas towards compact sources hosted by gas-rich spiral galaxies. The second detection has a similar 21cm line profile to that of the known absorption in PKS B1814-637. It is likely that the narrow components arises from gas in the extended disc, while the broad component gas is located closer to the AGN (Morganti et al. 2011).

3 Cold HI gas in an early-type radio galaxy

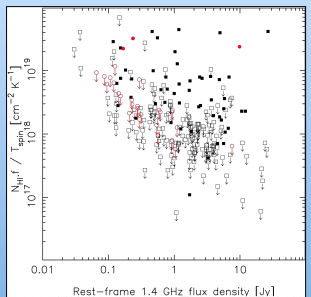


Further 21cm observations with CABB have confirmed the detection of cold HI gas towards the compact flat-spectrum source PMN J2054-4242 (Allison et al. 2013).

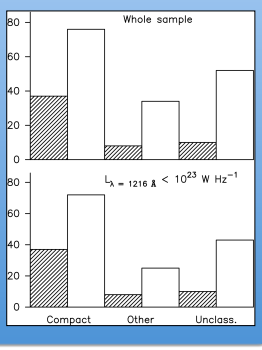


The 21cm spectral-line profile is broad, indicating that the absorbing gas is likely close to the central AGN.
The absence of a narrow component may indicate that the extended gas either has low column density, or is orientated away from the line-of-sight to the source.

4 The detection rate



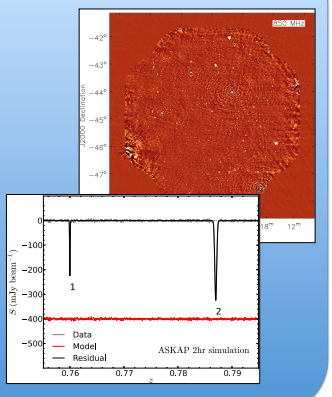
Our search has so far yielded a 10% detection rate for associated absorption.
Left: We compare our results (red) with the literature (black), for both the normalised column density and the continuum flux.



Right: A comparison of the number of detections (filled) and non-detections (empty) for compact and other sources in the literature. We find 33% (compact) versus 24% (other) for sources below the L_{UV} limit given by Curran & Whiting 2010.

5 Absorption with ASKAP

Absorption is a vital tool in searches for HI gas in distant galaxies, where the 21cm emission is too weak to be detected with existing radio telescopes. The First Large Absorption Survey in HI (FLASH) will be carried out with the new wide-field Australian Square Kilometre Array Pathfinder (ASKAP), providing us with a means of constraining the evolution of universal cold neutral gas upto redshifts of 1.



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