A search for intervening HI absorption in galaxies from HIPASS

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A new Era for HI Astronomy

Driven by new technology:
- Wide bandwidths
- Large field-of-view
- Powerful correlators
- Also: Radio Quiet Environment (see RFI workshop)

Will allow us to conduct the first large-scale, blind HI absorption-line surveys
• FLASH: ‘First Large Absorption Survey in HI’
• Main FLASH survey: redshifts $0.5 < z < 1.0$
• Will target 150,000 sightlines to known continuum sources (blind in redshift-space)
• WALLABY-FLASH piggyback survey: redshifts $0 < z < 0.25$
Intervening HI absorption

\[ N_{\text{HI}} = 1.823 \times 10^{18} \frac{T_{\text{spin}}}{f} \int \tau_{\text{obs}}(v)dv, \]

- HI absorption provides a distance-independent probe of neutral hydrogen
- Measurements of neutral hydrogen at different epochs provide important tests of galaxy evolution models
How does the detection rate of intervening absorbers vary with distance from the galaxy?

Related to HI distribution (but not the same thing!)

What is $T_{\text{spin}}$ in the disks of spiral galaxies?

And what about $f$ (covering factor)?

Need to understand these factors in order to correctly interpret FLASH results (galaxy properties)
Gupta et al. (2010):

- Searched 9 sightlines for absorption (~10-55 kpc)
- Targets: Quasar-Galaxy Pairs (QGPs)
- Combine with other studies of QGPs in the literature (15 additional sightlines):
  - Borthakur et al. (2010)
  - Carilli & van Gorkom (1992)
  - Corbelli & Schneider (1990)
  - Boisse et al. (1988)
  - Haschick & Burke (1975)
Results:

• Gupta: one absorption-line (impact parameter \(\sim 11\) kpc)
• Literature search: 6 detections (impact parameters \(\sim 2-15\) kpc)
• Determine that non-detections are due to sightline not piercing galaxy disk
• Estimate 50% detection rate for impact parameters < 20 kpc and \( \tau_{\text{int}} > 0.1 \) km/s
ATCA Project C2573

• Aim: investigate the conditions that lead to the detection of intervening absorption

• Sample:
  • HI-selected sample (HIPASS)
  • Uniform sample $z < 0.04$
  • 16 galaxies
Sample Selection - Final Targets

**SUMSS**
(Sydney University Molonglo Sky Survey)

- $S_{843} > 50$ mJy

**HIPASS BGC**
(Bright Galaxy Catalogue)

Select galaxy-continuum source pairs within 20 kpc

Manual inspection

**ATCA Project C2573**
Final list of targets

Curtin Visit April 2013
• ATCA observations
• CABB 64M-32k configuration - spectral resolution 6-7 km/s
• Using 750m arrays we obtain simultaneous HI absorption and emission data
• Include baselines to antenna 6
• Integrate 12 hours per object
• Reduced data with a variety of weighting schemes

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<thead>
<tr>
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<th>Uniform</th>
<th>Natural</th>
<th>noCA06</th>
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<tbody>
<tr>
<td>Res.</td>
<td>5''</td>
<td>25''</td>
<td>60''</td>
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<tr>
<td>Noise</td>
<td>1-2 mJy</td>
<td>1-2 mJy</td>
<td>2-3 mJy</td>
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Pilot Sample  | Second Sample
---           | ---
ESO150-G005  | ESO300-G014
ESO345-G046  | ESO357-G012
ESO402-G025  | ESO363-G015
IC1954       | IC1914
NGC7412      | NGC1249
NGC7424      | NGC1566
   | NGC2188
   | NGC5156
   | NGC7162A
First HI emission-line maps of the target galaxies

noCA06
Results - HI emission

Curtin Visit April 2013
Radial HI Distribution

The graph shows the radial distribution of HI for different galaxies:
- ESO150-G005
- ESO345-G046
- ESO402-G025
- IC1954
- NGC7412
- NGC7424

The y-axis represents the column density of HI in units of $10^{20}$ atoms cm$^{-2}$, while the x-axis represents the radius $R$ in kpc.
Use Bayesian line-finder - developed by James Allison to search spectra for absorption-lines.
Gas...but no absorption

DEC (J2000)

RA (J2000)

Uniform

Natural

noCA06
Low detection-rate

- 3/6 of the background sources become resolved
- Reduces flux against which to search for absorption - implications for FLASH
Detection!

- $T_{\text{peak}} \sim 0.06$
- Calculate $T_s \sim 160\,\text{K}$ ($f=1$)
- Follow-up observations planned
Findings and Issues

- DLA-like column densities out to ~10-20 kpc
- Properties of background sources found to be important
- Emission both helps and hinders:
  - Gives us information to help understand absorption-line data (especially for non-detections)
  - But could ‘hide’ - or even masquerade as absorption
  - Implications for WALLABY-FLASH piggyback
Next Steps

- Publish results of pilot sample (Reeves et al., in prep)
- Reduce new data - will improve statistics
- Search in archival data
- Follow-up observations of selected sources
Conclusions

- We have conducted a search for intervening HI absorption in nearby, gas-rich galaxies
- Detected one likely absorption line, which we now intend to follow-up
- Successfully mapped the HI distribution, which helps us understand the absorption-line detection rate
- Have encountered several issues relevant for future absorption-line surveys
- Find that loss of continuum source flux is at least partially responsible for our low detection rate
- Emission is a double-edged sword:
  - Gives us additional information to understand absorption-line data
  - Can present difficulties in trying to detect an absorption-line