A blind survey for compact HII regions at 20 GHz

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The Australia Telescope 20 GHz Survey (AT20G)

- Covers southern sky \((\delta < 0^\circ)\)
- \(S_{20} \geq 40~\text{mJy}\)
- Follow-up at 20, 8 and 5 GHz
- Carried out from 2004 to 2008
- \(\sim 3000\) hours of observing
- Main aims were:
  - Population characterisation
  - Spectral index distribution
  - Variability studies
  - Polarisation
  - Extended sources

- Murphy et al., 2010, MNRAS, 402, 2403
Fast scanning: the survey mode

- Wideband analogue correlator (8 GHz bandwidth)
- ATCA fast scanning capability (15 deg min\(^{-1}\))
- 3 antennas scan sky in bands of 10 – 15° in Dec.
- Earth rotation covers RA
- Cover sky fast despite \(\sim 2.4'\) FoV
- Candidate sources extracted from the raw data

- Hancock 2010, PhD Thesis
- Hancock et al., 2010 \textit{in prep}
A typical image from the scanning survey
Candidates were followed up in snapshot mode

- Primary follow-up at 20 GHz
  Resolution $\sim 10 - 15$ arcsec
  Hybrid array: $\sim 80 - \sim 300$ m
- Low freq follow-up (within weeks)
  5 and 8 GHz
  Resolution $\sim 10 - 20$ arcsec
- Stokes IQUV at all frequencies

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HCHII2010

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The final catalogue: 5890 sources with $S_{20} > 40$ mJy

Catalogue available on Vizier and from
http://www.atnf.csiro.au/research/AT20G


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The AT20G Galactic plane

- Galactic plane ($|b| < 1.5^\circ$) hasn’t been followed up
- We have scan maps, with fluxes accurate to $\sim 20\%$

- We have done a pilot follow-up on a small sample
UCHII are signposts of massive star formation

- Mostly detected from MIR colour-colour selection criteria
- Rising spectral index at radio frequencies
Sample selection

- AT20G Galactic plane region ($|b| \leq 1.5^\circ$)
- Overlap with Molonglo Galactic Plane Survey ($\delta < -30^\circ$)
- **Bright** ($S_{20\,GHz} \geq 200$ mJy)
  \[\implies 263\text{ sources}\]
- **Compact** (in AT20G and MGPS-2)
- **Isolated** (in AT20G and MGPS-2)
- **Inverted spectrum** ($\alpha_{20\,0.843} \geq 0.1$)
  \[\implies 46\text{ sources}\]
Our follow-up observations aimed to:

- Measure accurate 20 GHz fluxes
  $\Rightarrow$ 18.624 GHz follow-up snapshot imaging
- Detect recombination lines to calculate size, $T_e$
  $\Rightarrow$ 18.769 GHz H70$\alpha$ recombination line detection
- Compare radio emission with MIR
  $\Rightarrow$ 18.496 / 19.520 GHz high resolution imaging
- Characterise SEDs of objects
  $\Rightarrow$ higher frequency (40, 100 GHz) imaging follow-up
The UCHII SEDs show a 95 GHz excess.
## Classification as UCHII or HCHII

<table>
<thead>
<tr>
<th>Parameter</th>
<th>UCHII</th>
<th>HCHII</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>$&lt; 0.1$ pc</td>
<td>$&lt; 0.05$ pc</td>
</tr>
<tr>
<td>Mean density</td>
<td>$\geq 10^4$ cm$^{-3}$</td>
<td>$\geq 3 \times 10^5$ cm$^{-3}$</td>
</tr>
<tr>
<td>Emission measure</td>
<td>$\geq 10^7$ pc cm$^{-6}$</td>
<td>$\geq 10^8$ pc cm$^{-6}$</td>
</tr>
<tr>
<td>Recombination line width</td>
<td>$\leq 40$ kms$^{-1}$</td>
<td>$&gt; 40$ kms$^{-1}$</td>
</tr>
</tbody>
</table>

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G301.1366–00.2248
Summary

- We have conducted the first blind radio survey for ultra and hyper-compact HII regions.
- We have found 33 HII regions, of which at least 4 are UCHII, 2 are HCHII and 2 are borderline.
- We are currently monitoring several sources as potential high frequency flux calibrators for the ATCA.
- For more information: Murphy et al. 2010, MNRAS, 405, 1560

- We welcome collaboration on this project or other ideas for Galactic science with the AT20G data.
  http://www.atnf.csiro.au/research/AT20G