A blind survey for compact HII regions at 20 GHz

Tara Murphy
Ron Ekers, Martin Cohen, Anne Green

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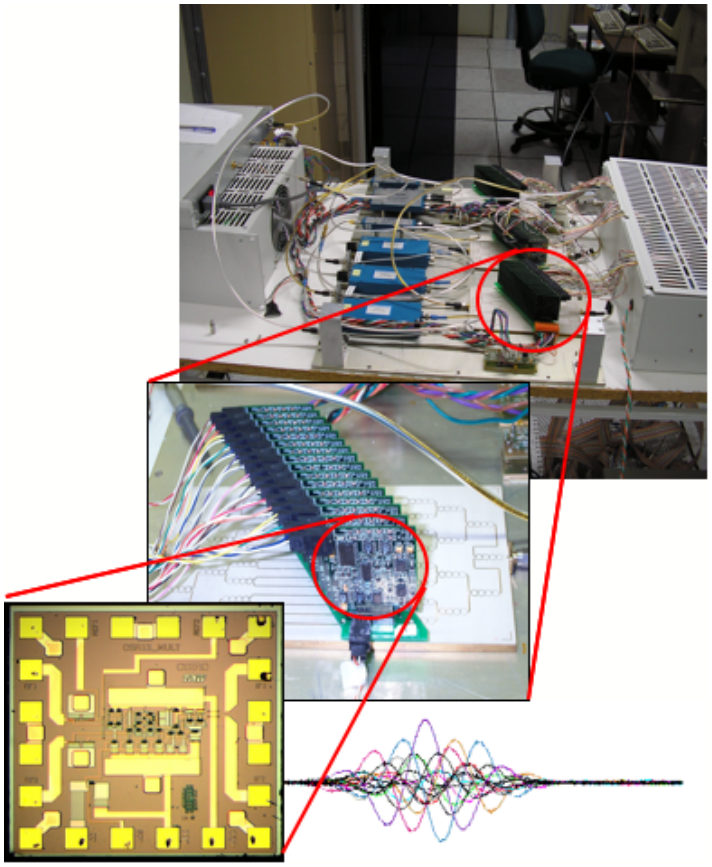
The Australia Telescope 20 GHz Survey (AT20G)

- Covers southern sky ($\delta < 0^\circ$)
- $S_{20} \geq 40$ 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
- Massardi et al., 2008, MNRAS, 384, 775

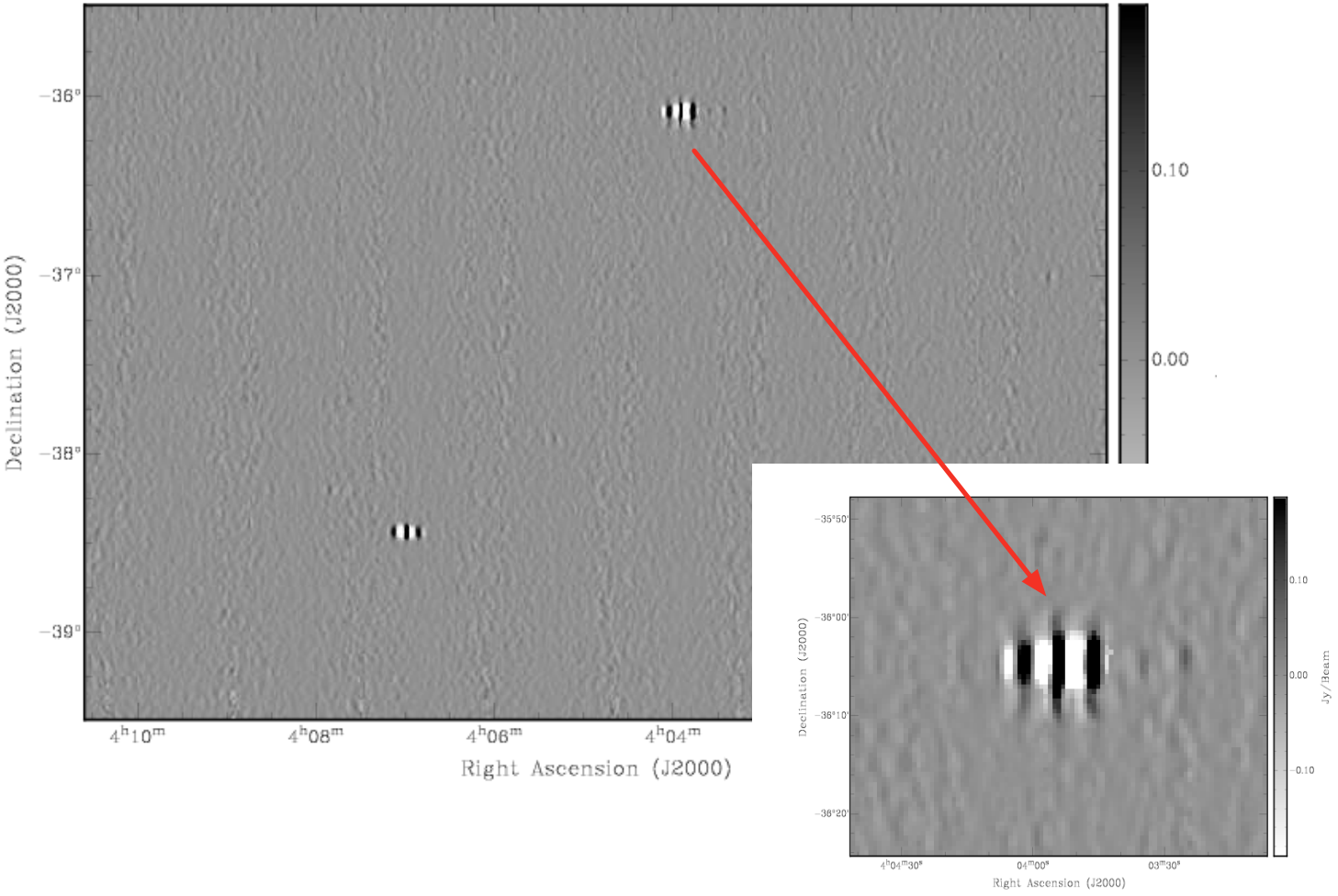
Fast scanning: the survey mode

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



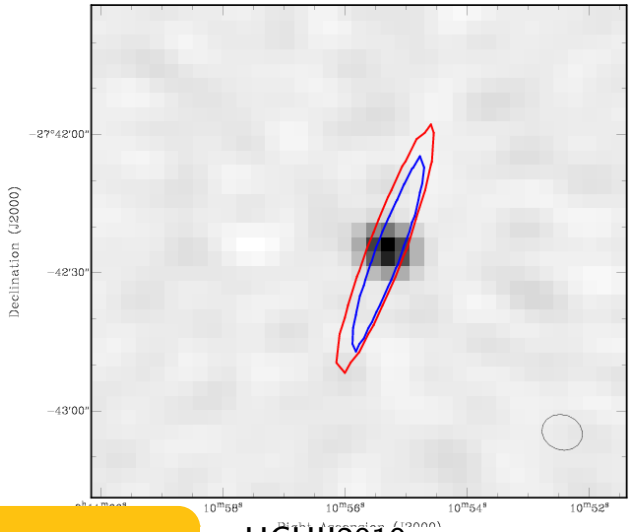
- Hancock 2010, PhD Thesis
- Hancock et al., 2010 *in prep*

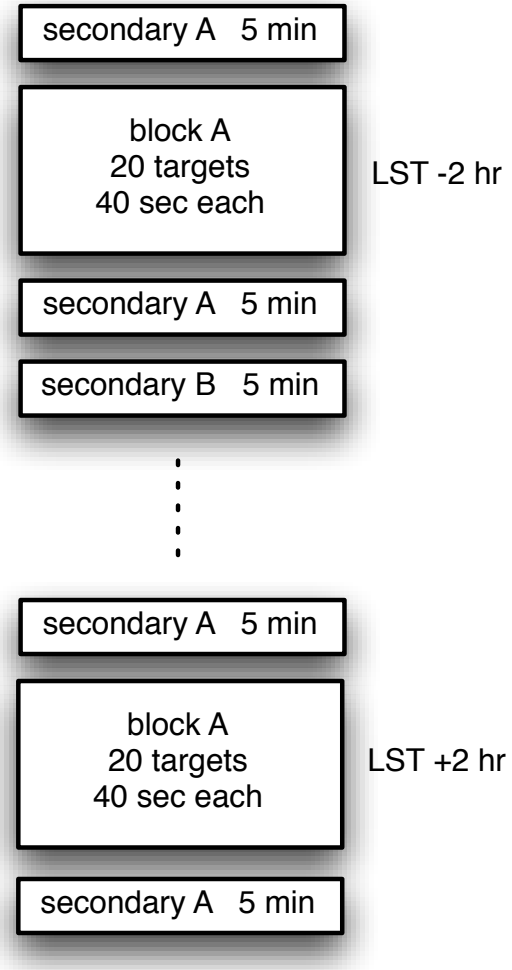
A typical image from the scanning survey



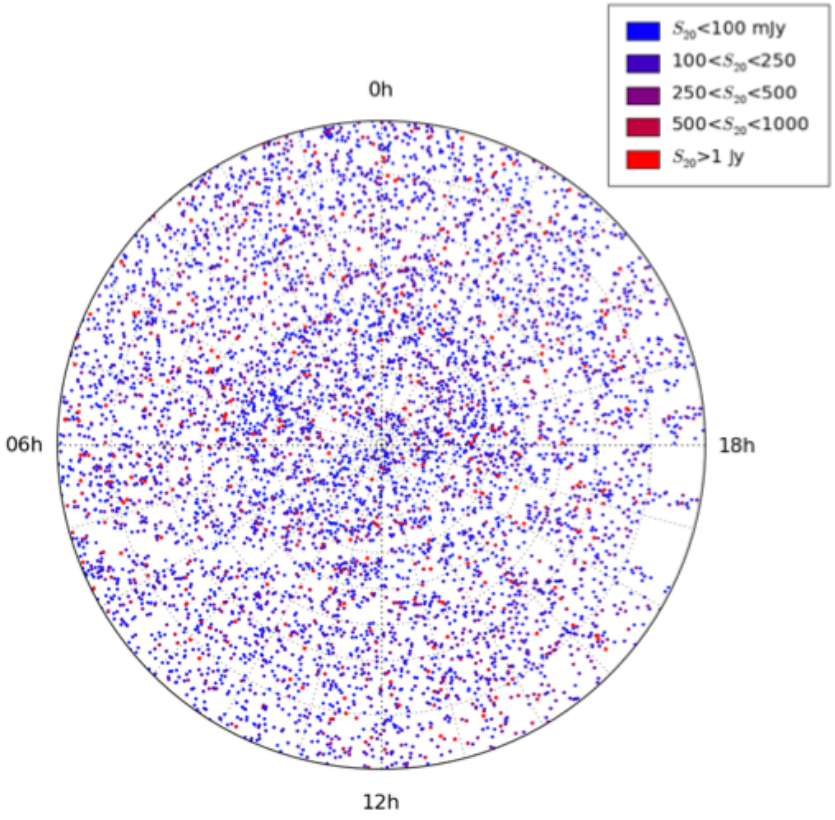
Candidates were followed up in snapshot mode

- 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





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



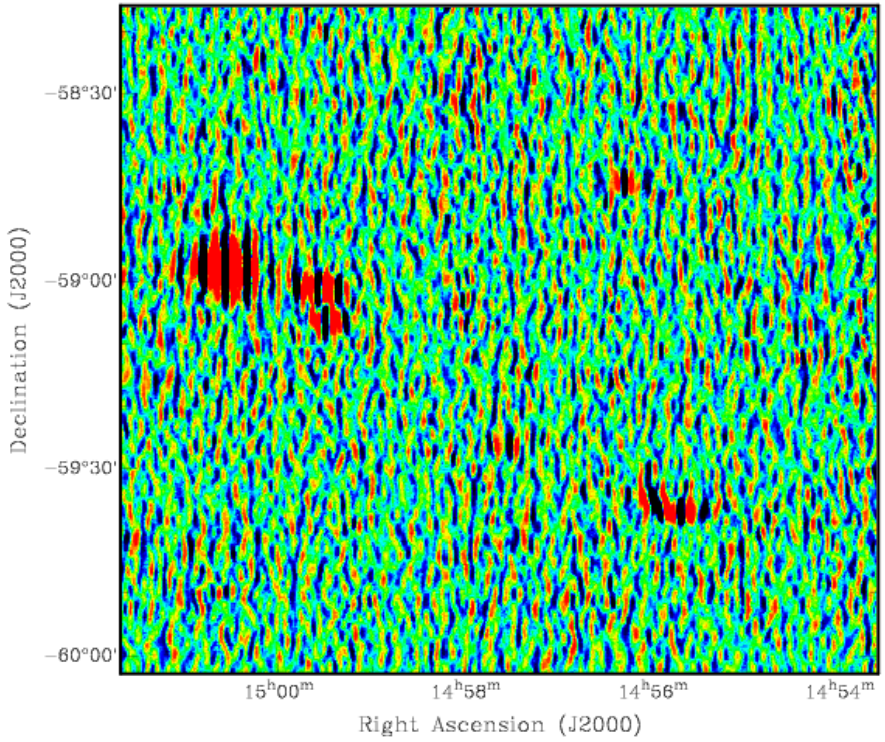
Catalogue available on Vizier and from

http://www.atnf.csiro.au/research/AT20G

Murphy et al. 2010, MNRAS, 402, 2403

The AT20G Galactic plane

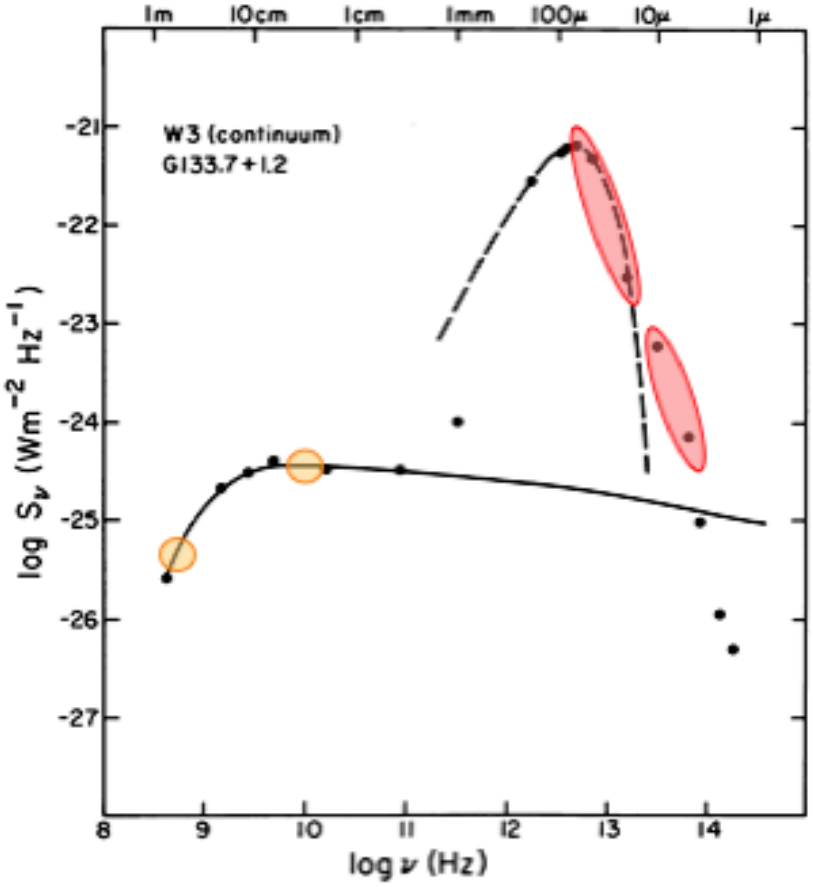
- Galactic plane ($|b| < 1.5°$) hasn't been followed up
- We have scan maps, with fluxes accurate to $\sim 20\%$



- 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 ($|b| \leq 1.5°$)
- Overlap with Molonglo Galactic Plane Survey ($\delta < -30°$)
- **Bright** ($S_{20\,GHz} \geq 200$ mJy)

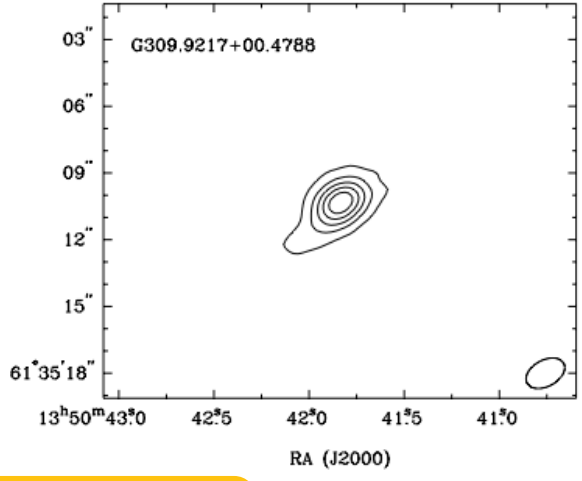
  $\Longrightarrow$ 263 sources

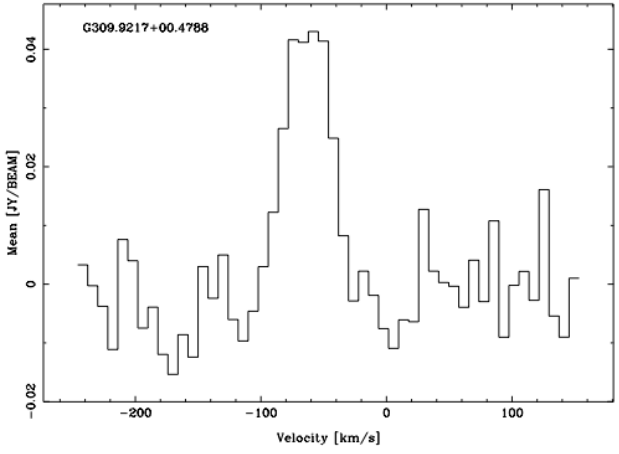
- **Compact** (in AT20G and MGPS-2)
- **Isolated** (in AT20G and MGPS-2)
- **Inverted spectrum** ($\alpha^{20}_{0.843} \geq 0.1$)

  $\Longrightarrow$ 46 sources

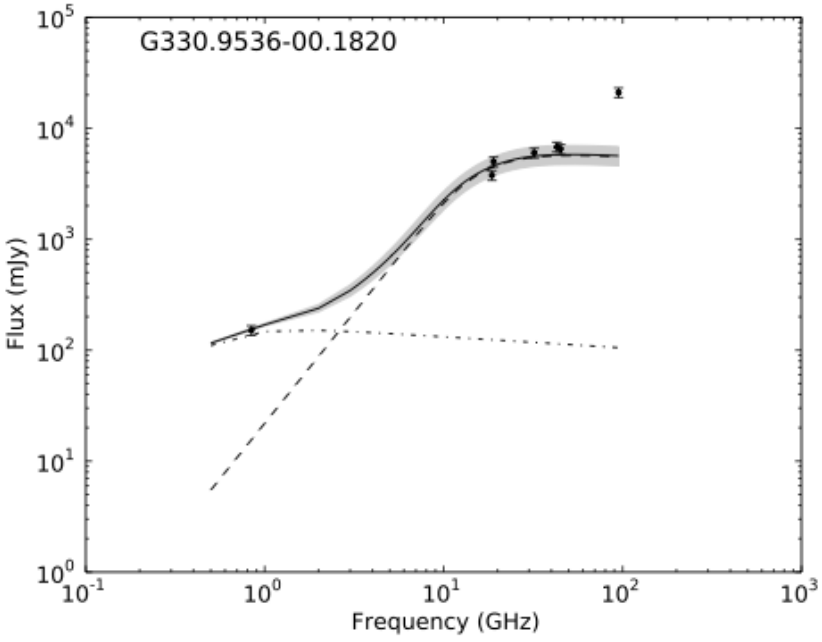
Our follow-up observations aimed to:

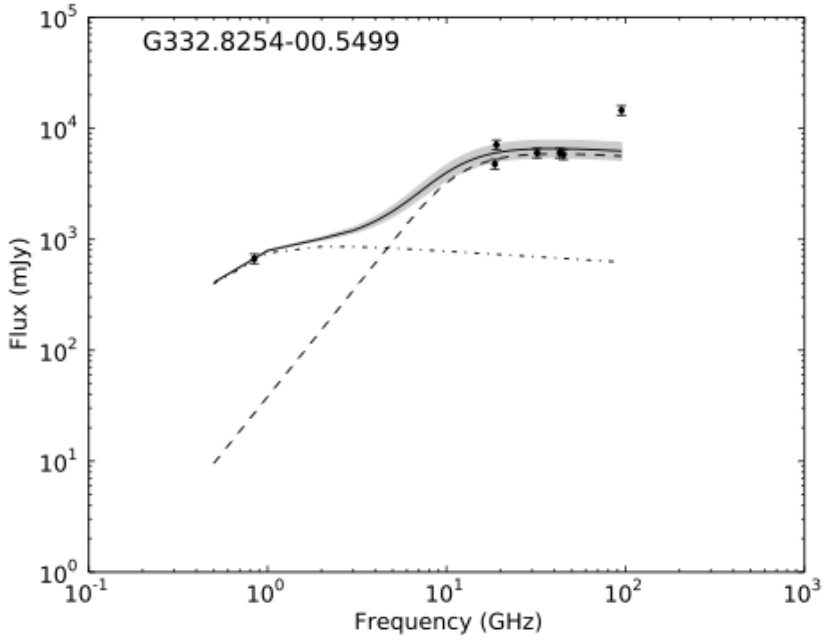
- Measure accurate 20 GHz fluxes
  $\Longrightarrow$ 18.624 GHz follow-up snapshot imaging
- Detect recombination lines to calculate size, T_e
  $\Longrightarrow$ 18.769 GHz H70α recombination line detection
- Compare radio emission with MIR
  $\Longrightarrow$ 18.496 / 19.520 GHz high resolution imaging
- Characterise SEDs of objects
  $\Longrightarrow$ higher frequency (40, 100 GHz) imaging follow-up





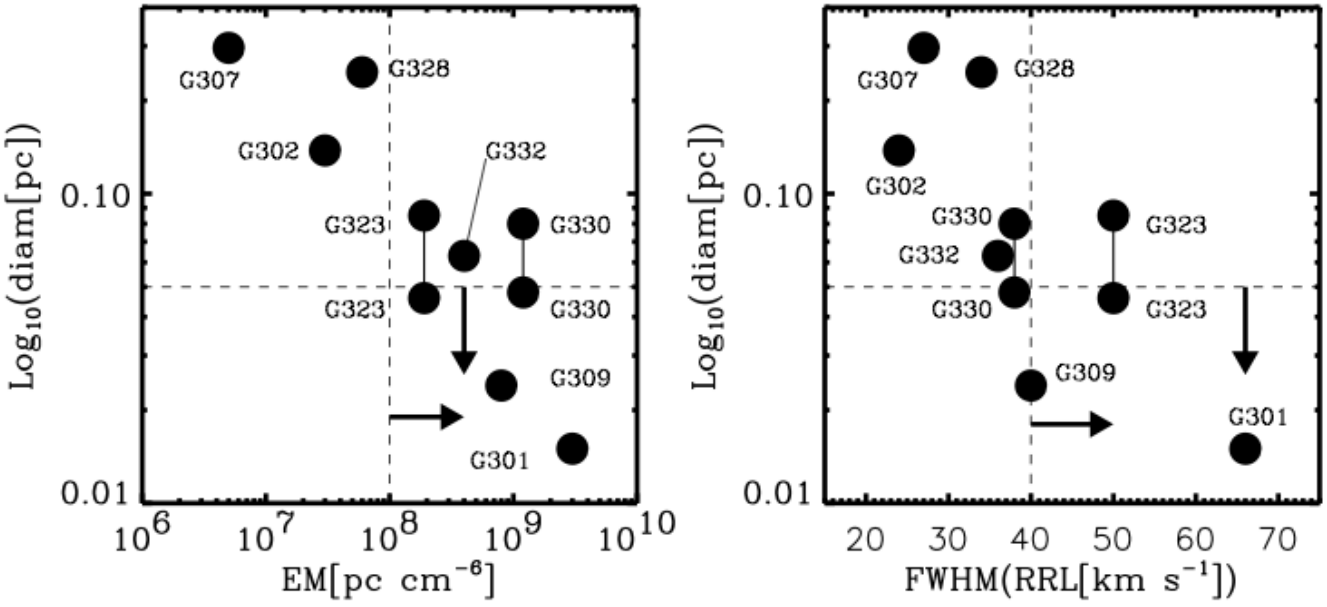
The UCHII SEDs show a 95 GHz excess



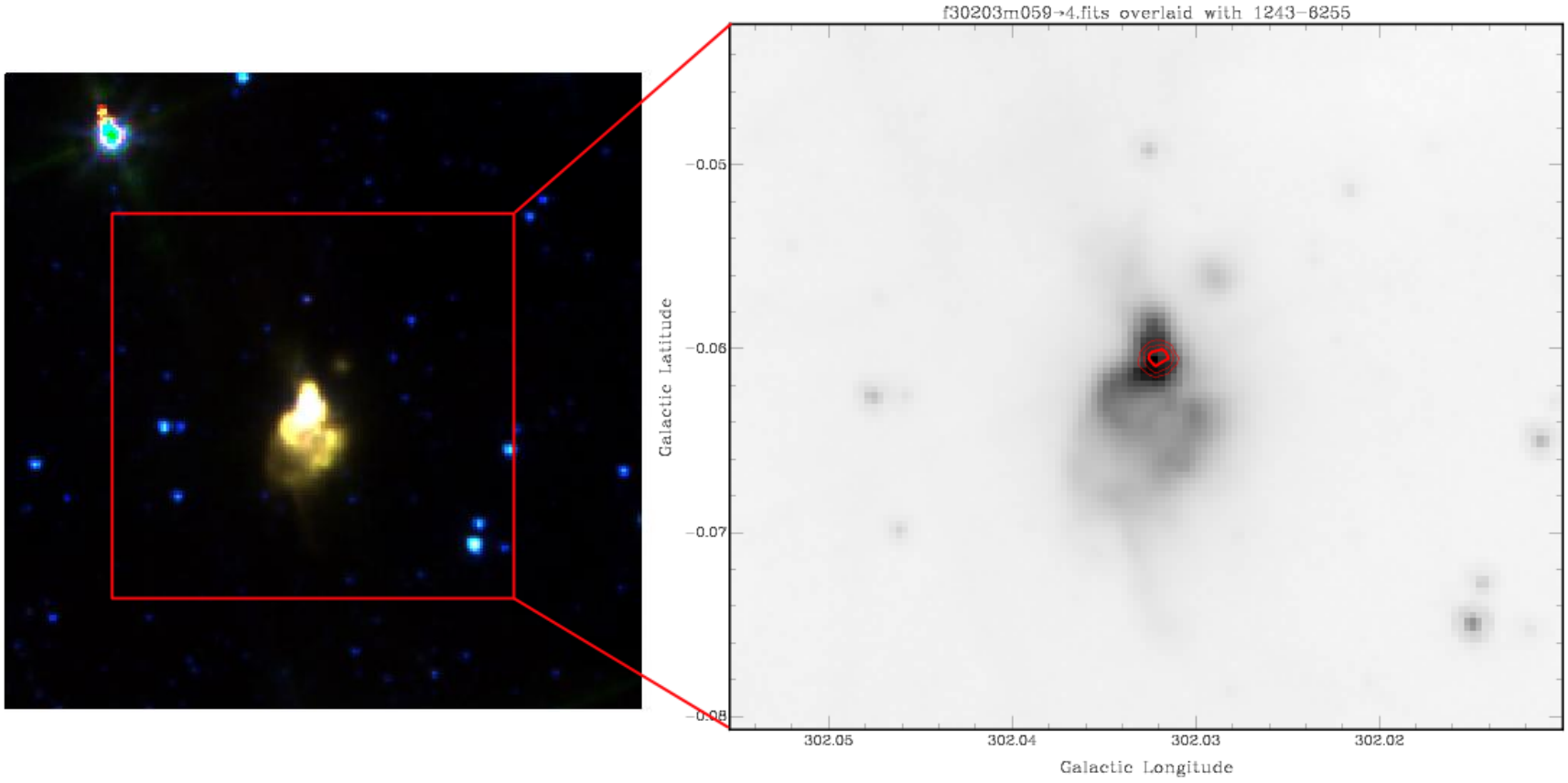


Classification as UCHII or HCHII

Parameter	UCHII	HCHII
Size	< 0.1 pc	< 0.05 pc
Mean density	$\geq 10^4\,\mathrm{cm}^{-3}$	$\geq 3\times 10^5\,\mathrm{cm}^{-3}$
Emission measure	$\geq 10^7\,\mathrm{pc\,cm}^{-6}$	$\geq 10^8\,\mathrm{pc\,cm}^{-6}$
Recombination line width	$\leq 40\mathrm{kms}^{-1}$	$> 40\mathrm{kms}^{-1}$



G302.0321−00.0606



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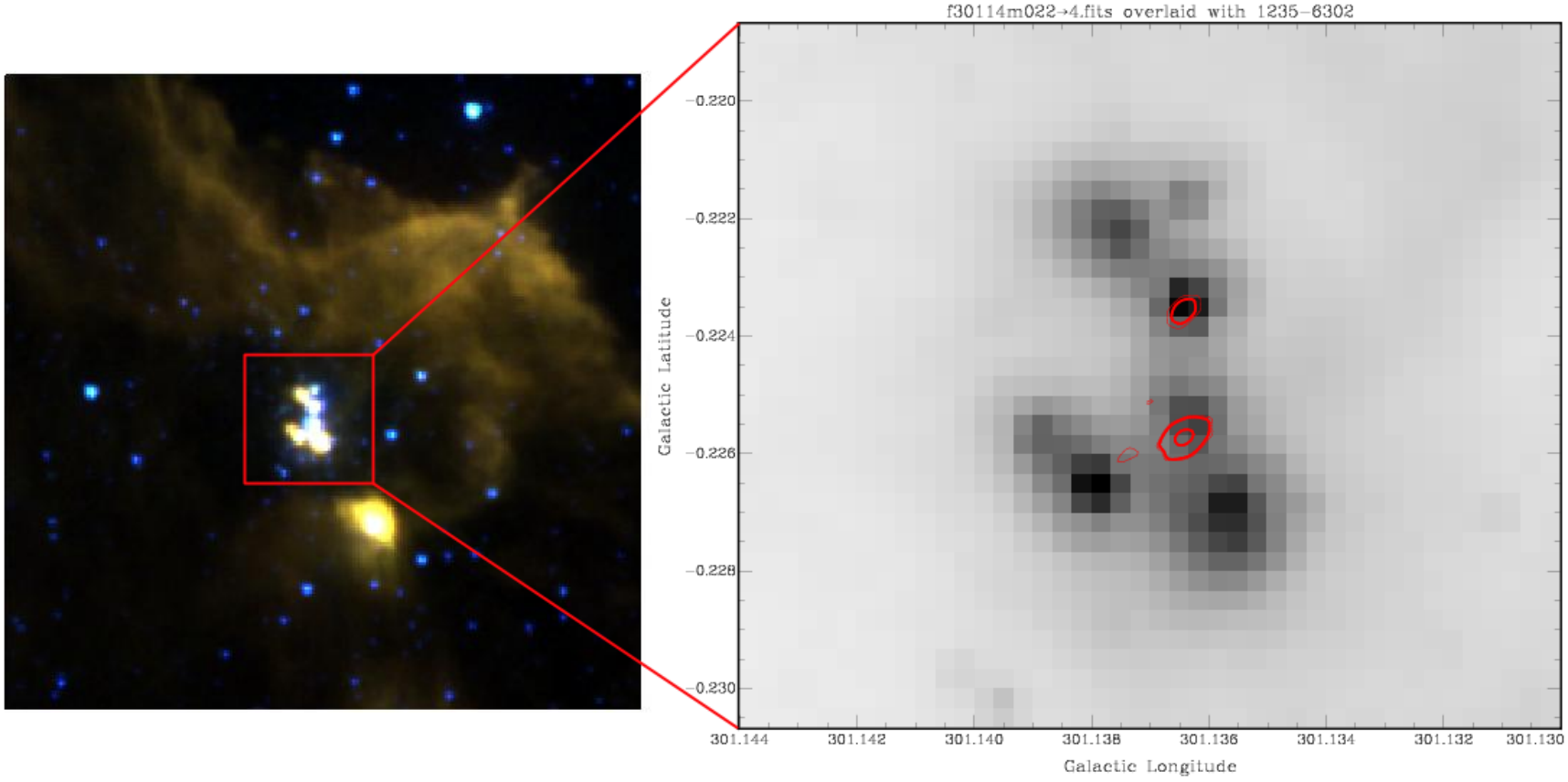

Summary

- 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