EVLA Phase II Scientific Overview

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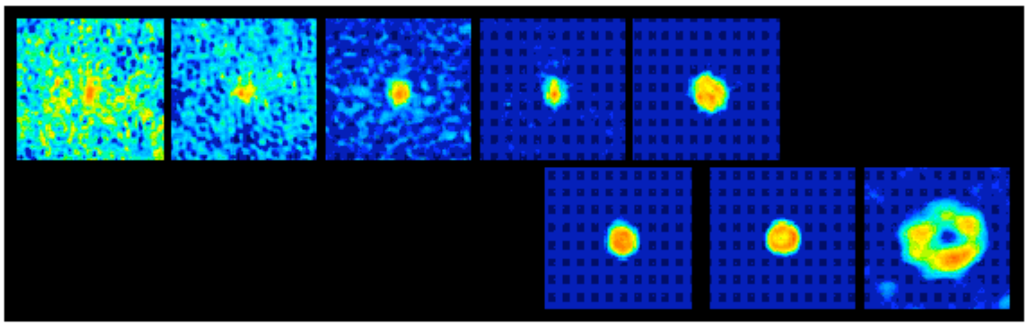
New Mexico Array

- Three arrays in one:
  - NMA+VLA: more than just dots
    - Milliarcsecond imaging of thermal sources
      - Rms 20-40 K from 2-40 GHz, with resolution 6-60mas
    - 0.1 arcsecond imaging of 10 μJy sources at 1.5 GHz
  - Joining the VLA and the VLBA
    - High-fidelity imaging from a few mas to ¼ degree
    - Identical uv-coverage from 0.3 to 45 GHz
  - A stand-alone instrument
    - Sensitivity of current VLA, with 10x the resolution
    - Always available!

NMA Science: novae



• Imaging every nova in the Galaxy, within a few days of the explosion:

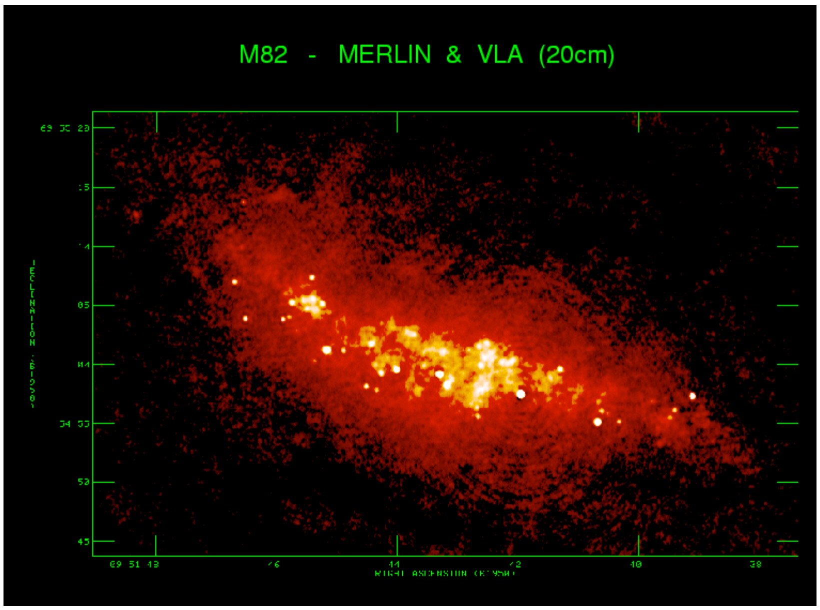
$$\Theta = 0.57\text{mas}\ (v/1000)\ t\_day/d\_kpc$$

→ Evolution from optically thick to thin

→ Mass estimates

→ 3D temperature/density distributions

NMA Science: nearby galaxies

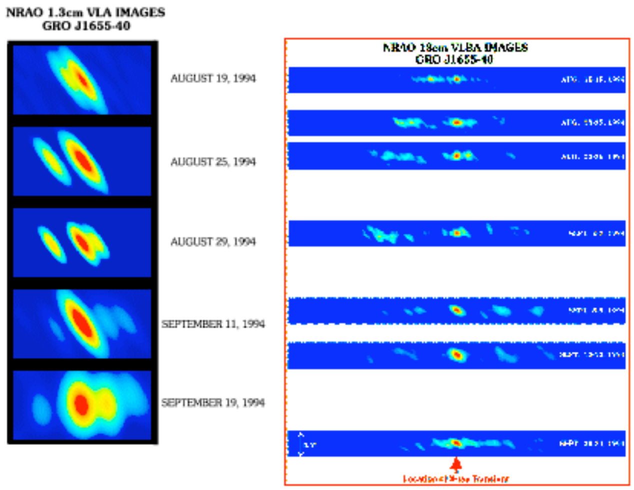


- **Resolve UCHIIs throughout M31/M33** (Θ=0.03pc)
- **Map Tycho/Kepler analogues in M81/M82** (Θ=0.1pc)
- **Image >50 star clusters in the Antennae** (<10pc resolution)

NMA Science: high z mapping

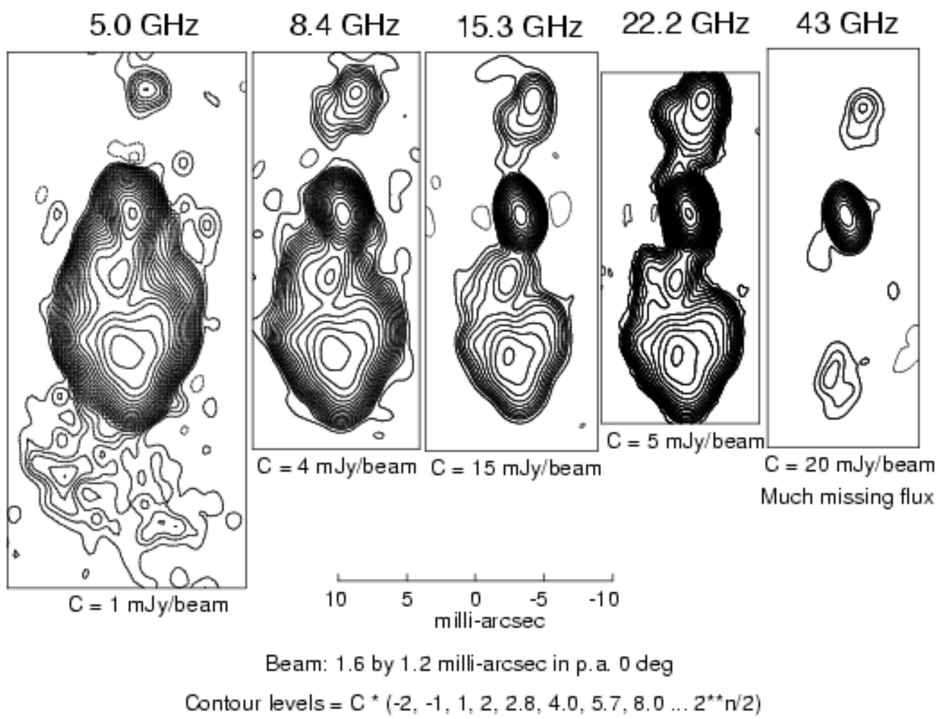
- Distinguishing AGNs from starbursts:
  - HII regions have $T_b<10^5$ K
  - →sources >3.3 mJy which aren't resolved by the NMA, must be AGN
- 1 kpc> 0.1-0.15arcsec at all z
  - Θ=0.125arcsec at 1.5 GHz !

NMA Science: X-ray transients



- Ubiquity of jets
- Monitoring: continuous multi-freq. coverage
- Quiescent source imaging
- Check jet “prejudices” (one-sided, flip-flopping, pattern speeds, orientations)

NMA Science: AGNs



- Spectral index imaging
- Milli-halos
- Small-scale diffuse emission (central starbursts?) (cf. Mrk 231)

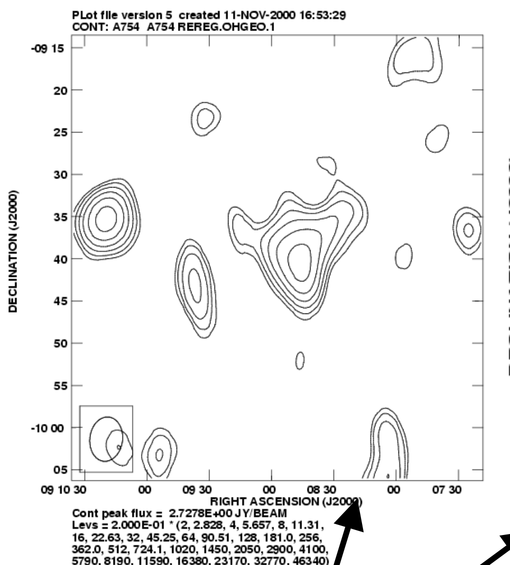
Low-Frequency Science

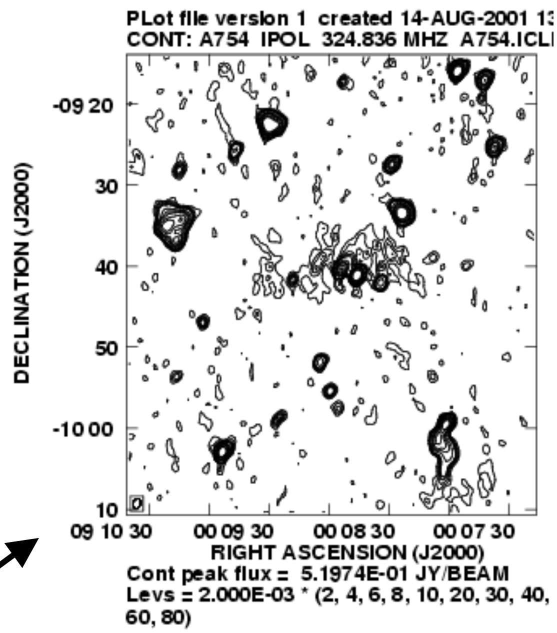
Low frequencies offer:

- Long-lived electrons → relics & halos
- High-z sources (radio continuum, HI, OH)
- Free-free & synchrotron-self absorption
- Faraday rotation & scattering (scale as ν^{-2} & ν^{-4})

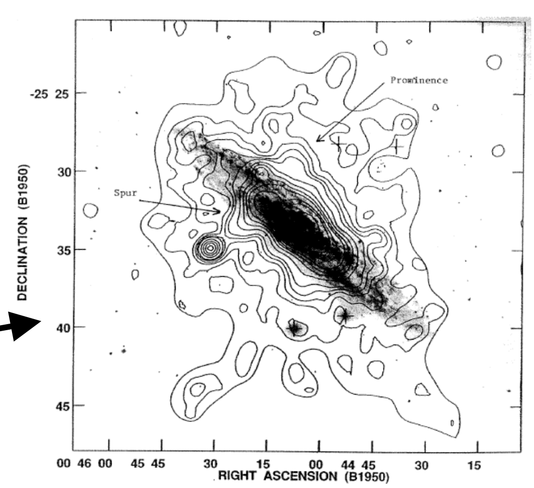
Low-Frequency Science

Relics and Halos





Abell 754



NGC 253

Low-Frequency Science

High-z Steep-Spectrum Sources

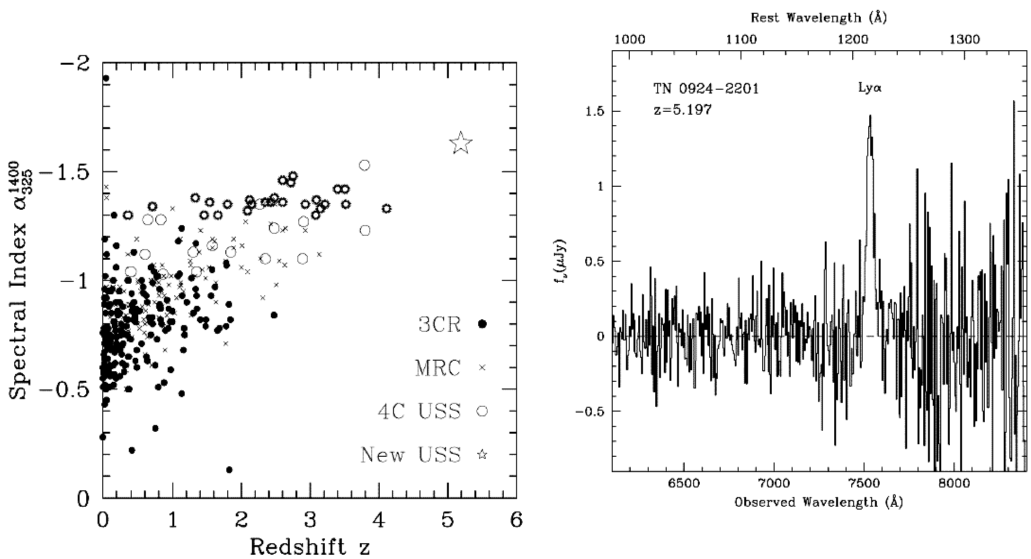


Figure 2.1 Spectral index against redshift **(left)** for two flux-limited samples (3CR and MRC) illustrating the spectral index-redshift relation and two USS samples (4C and the WN/TN sample), illustrating the effectiveness in finding very high redshift objects from such samples. The star denotes the newly discovered radio galaxy 0924-2201. A Keck I LRIS spectrum of TN J0924-2201 is shown on the **(right)**. The emission line has been identified with Lyα, indicating that this galaxy has a redshift of z=5.19.

Low-Frequency Science

Redshifted HI: EVLA vs. GMRT

- Assuming no evolution:

Number of Galaxies Detected in 400 hrs (dV=150 km/s, S/N=5)

Frequency	Redshift	EVLA Cass Focus	EVLA Prime Focus	GMRT
600 MHz	1.37	-	-	0
700 MHz	1.03	-	1	-
800 MHz	0.78	0	46	-
900 MHz	0.58	69	286	2??
1000 MHz	0.42	241	482	27
1100 MHz	0.29	413	507	56

Number of Galaxies Detected in 2700 hrs (dV=150 km/s, S/N=5 over line)

Frequency	Redshift	EVLA Cass Focus	EVLA Prime Focus	GMRT
600 MHz	1.37	-	-	0
700 MHz	1.03	-	200	-
800 MHz	0.78	2	936	-
900 MHz	0.58	767	1631	70??
1000 MHz	0.42	1027	1550	183
1100 MHz	0.29	1004	1150	186

Low-Frequency Science

Damped Lyα Systems: HI absorption

- Opacity & optical N_H → T_{spin}
- 21cm profile → gas kinematics
- NMA → image absorption
  → rotation curves!

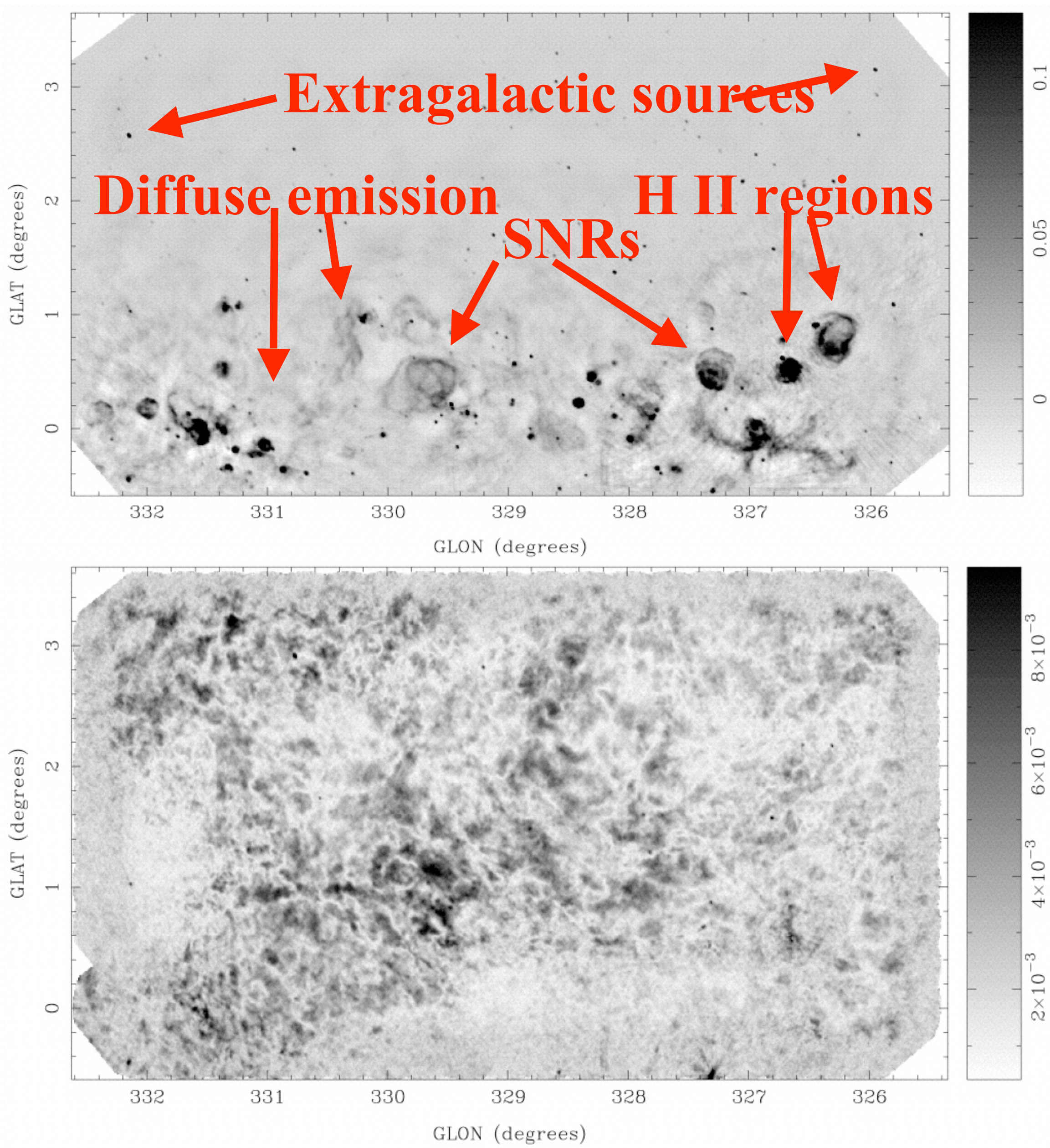
Low-Frequency Science

ISM Polarimetry

- Linearly polarized signals are rotated during ISM propagation
  - Faraday rotation goes as λ^2
  - See detailed structure of ISM
  - Sensitive to very small fluctuations
- Trace regions of turbulence, e.g. near supernova remnants
- Monitor polarization for time variability

  → track size scales, velocities in ISM

Low-Frequency Science

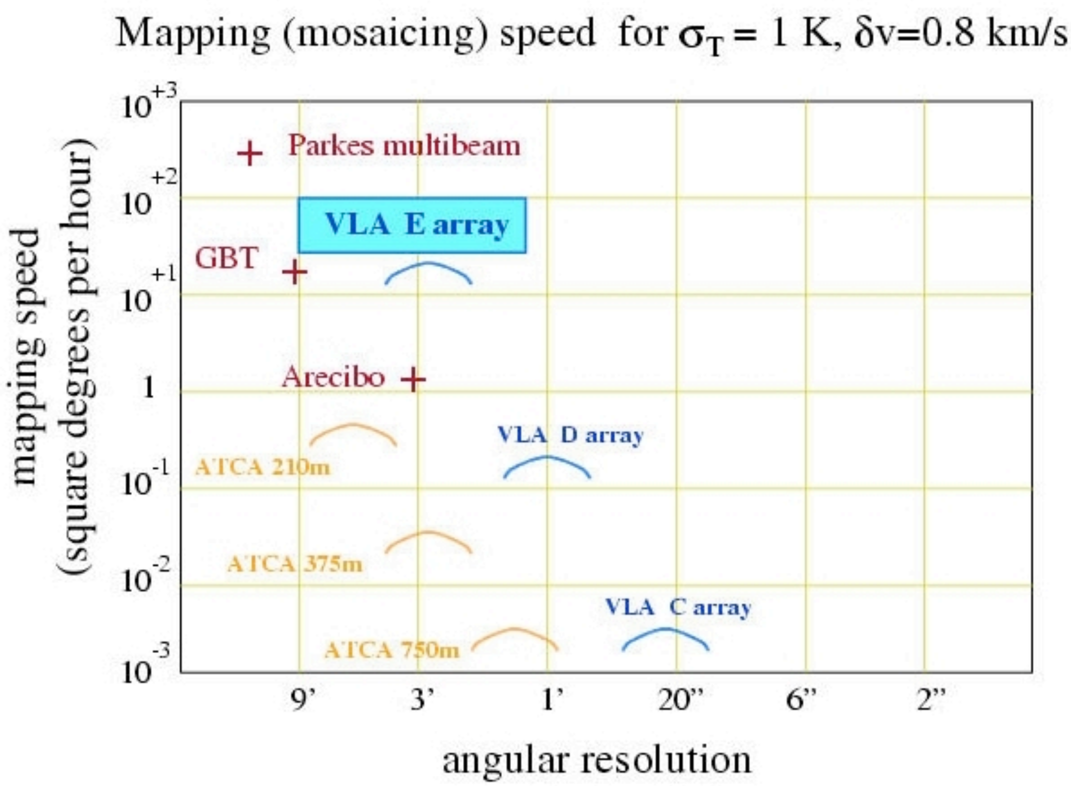


E Configuration Science

- Surface brightness sensitivity
  - Factor 1.5-2 in speed vs. tapered VLA/D (factor 56 vs. untapered)
- Image quality
  - Denser uv-coverage → lower sidelobes at low resolution
  - Fidelity improved by factor ~7 (Holdaway 1996)

➔Mosaics would be faster & produce superior images

E Configuration Science



- Unique combination of resolution, mapping speed, and fidelity
- Especially important for spectroscopy of thermalized lines

E Configuration Science

The Local HI Web

- Theory + opt. studies suggest there should be a “web” of low column density gas joining nearby galaxies.
- A deep (2700hr) integration with VLA/E would yield an rms of 3e15 cm^{-2} (dv=1 km/s)

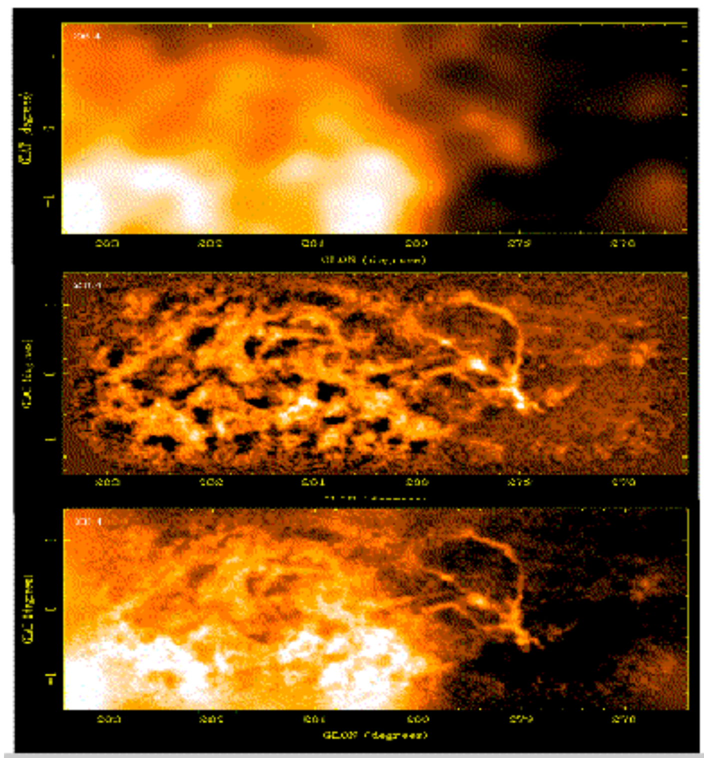
E Configuration Science

Large-scale Mosaics

Parkes

ATCA

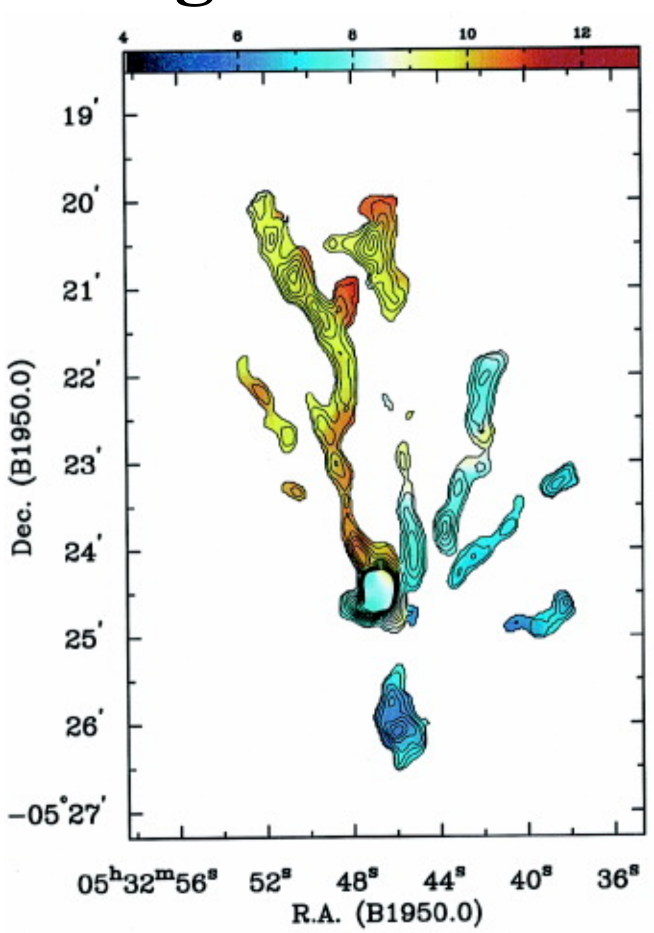
Parkes
+
ATCA



Galactic chimney GSH277+0+36

E Configuration Science

Large-scale Mosaics



High-density ridges of ammonia in Orion

Conclusions

- Phase I brings all the radiation home, with sufficient spectral resolution to use it
- Phase II…
  - provides resolution commensurate with the improved sensitivity
  - builds on the success of the 74 and 330 MHz systems, to create a truly flexible & high-resolution low-frequency array
  - turns the VLA into a high-fidelity mosaicing instrument