



EVLA Phase II Scientific Overview

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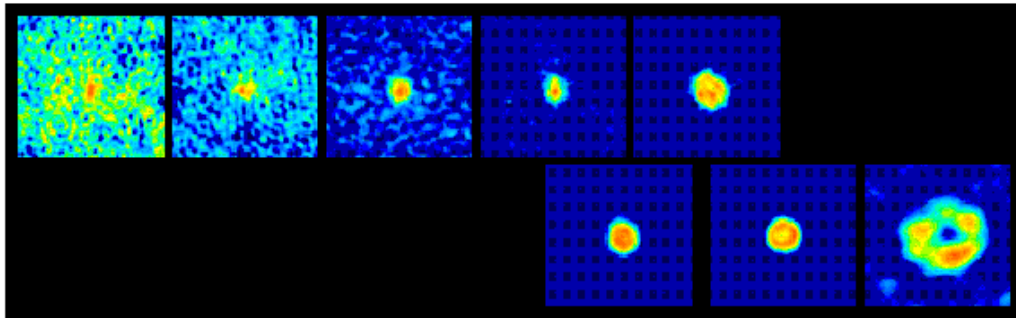
New Mexico Array



- 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 μ Jy sources at 1.5 GHz
 - Joining the VLA and the VLBA
 - High-fidelity imaging from a few mas to $\frac{1}{4}$ 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



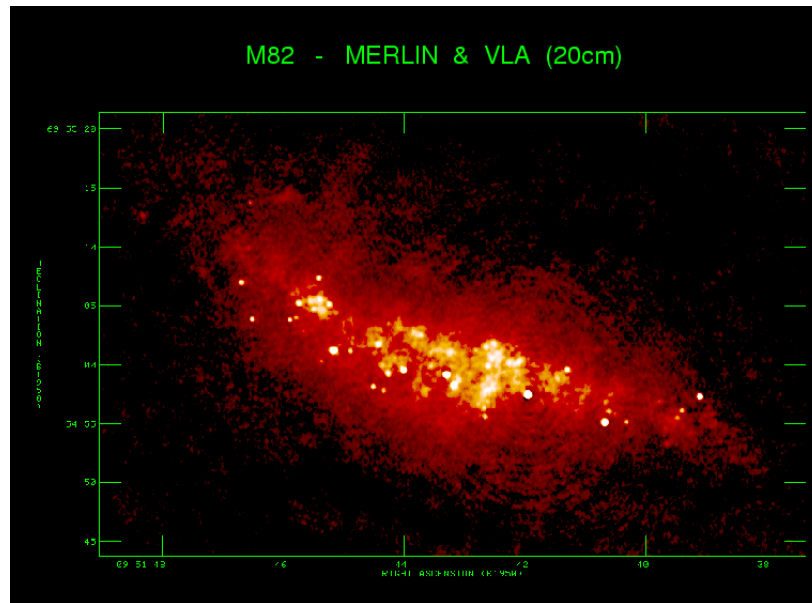
- Imaging every nova in the Galaxy, within a few days of the explosion:

$$\Theta = 0.57 \text{ mas } (v/1000) t_{\text{day}}/d_{\text{kpc}}$$

- Evolution from optically thick to thin
- Mass estimates
- 3D temperature/density distributions



NMA Science: nearby galaxies



- **Resolve UCHIs throughout M31/M33**
($\Theta=0.03\text{pc}$)
- **Map Tycho/Kepler analogues in M81/M82** ($\Theta=0.1\text{pc}$)
- **Image >50 star clusters in the Antennae**
($<10\text{pc}$ resolution)



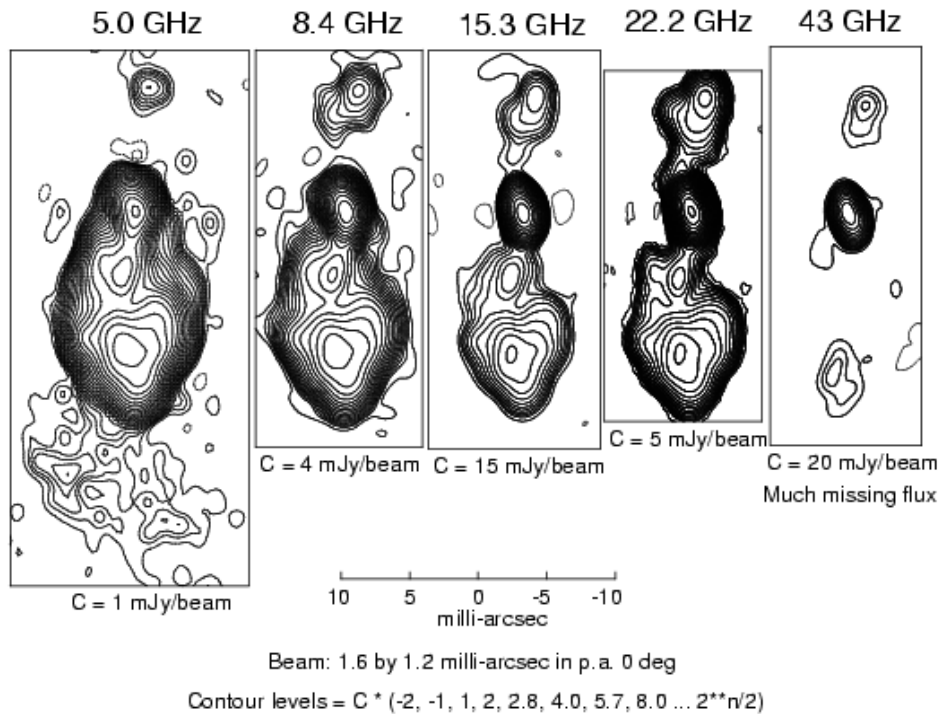
NMA Science: high z mapping



- 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
- $1 \text{ kpc} > 0.1\text{-}0.15 \text{ arcsec}$ at all z
 - $\Theta = 0.125 \text{ arcsec}$ at 1.5 GHz !



NMA Science: AGNs



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



Low-Frequency Science



Low frequencies offer:

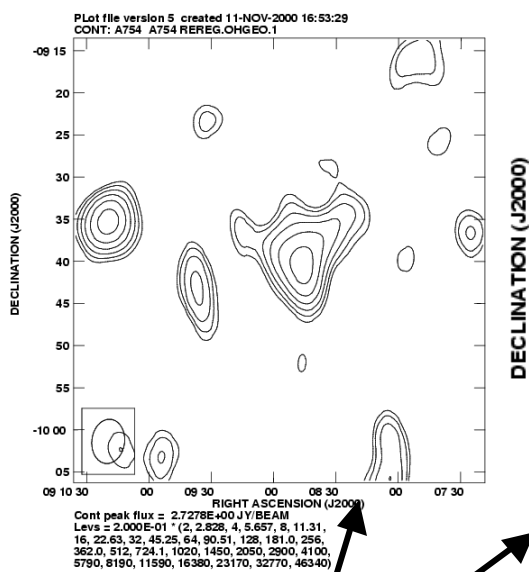
- Long-lived electrons \rightarrow relics & halos
- High- z sources (radio continuum, HI, OH)
- Free-free & synchrotron-self absorption
- Faraday rotation & scattering (scale as ν^{-2} & ν^{-4})



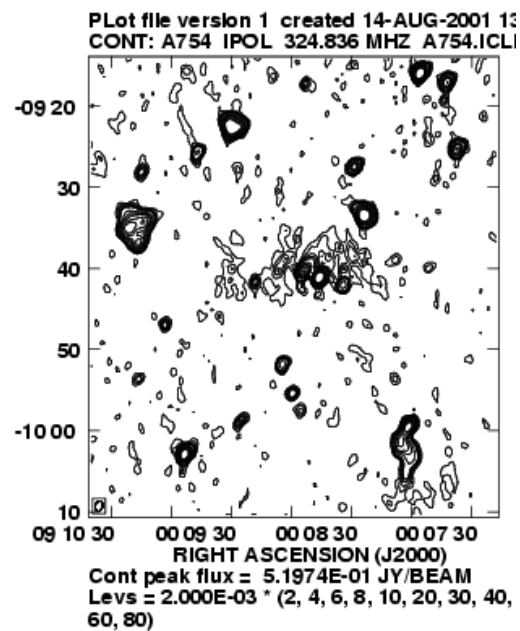
Low-Frequency Science



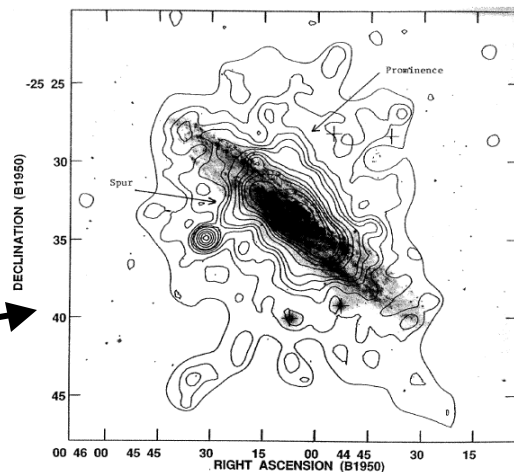
Relics and Halos



Abell 754



NGC 253





Low-Frequency Science



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 Ly α Systems: HI absorption

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



Low-Frequency Science

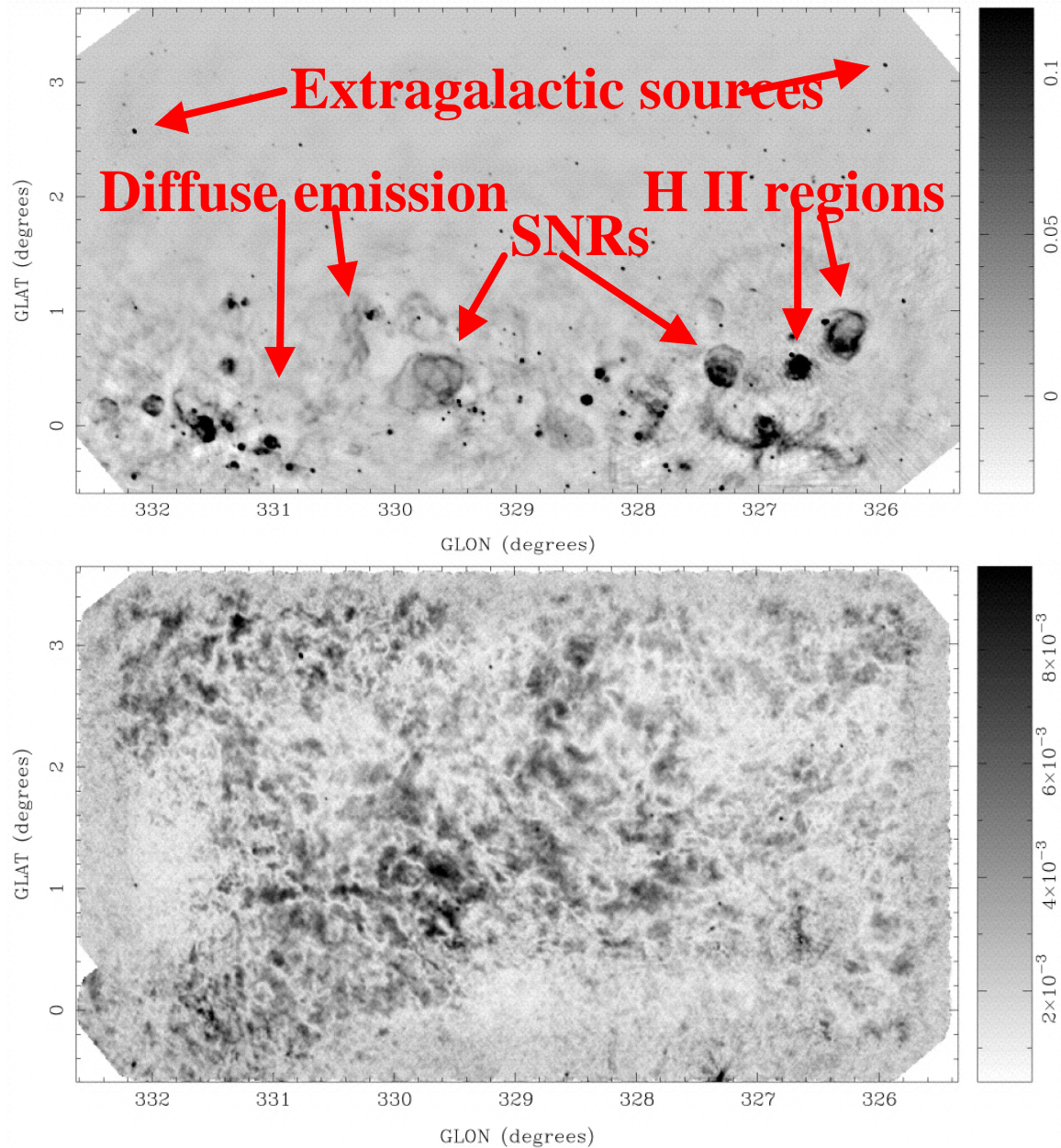


ISM Polarimetry

- 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



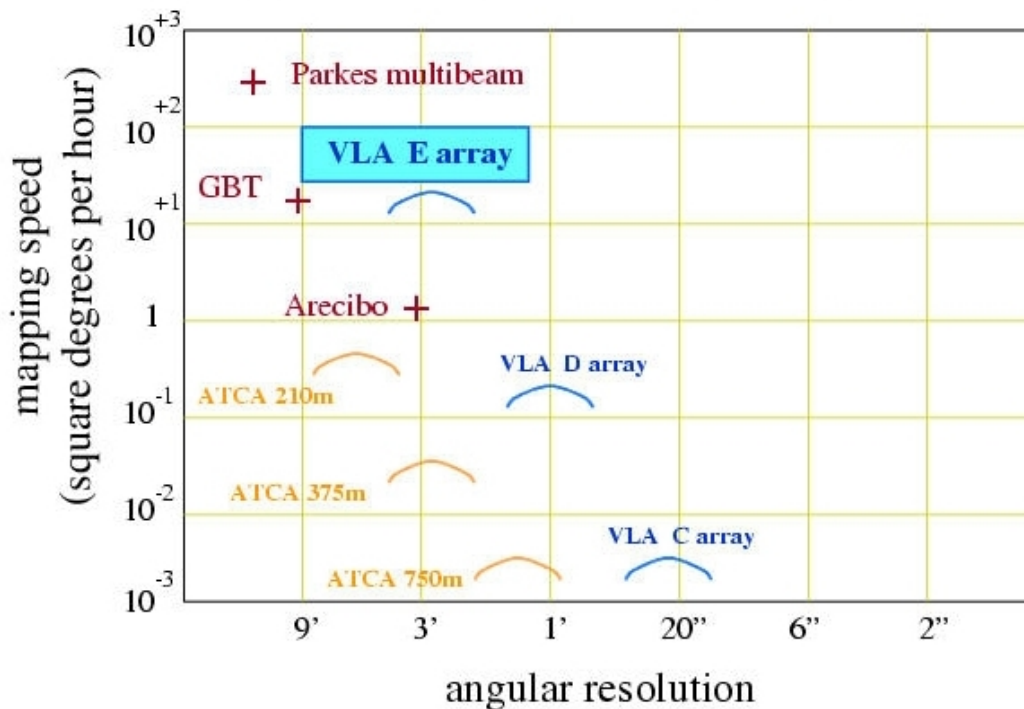
- Surface brightness sensitivity
 - Factor 1.5-2 in speed vs. tapered VLA/D (factor 56 vs. untapered)
 - Image quality
 - Denser uv-coverage → lower sidelobes at low resolution
 - Fidelity improved by factor ~ 7 (Holdaway 1996)
- ➔ Mosaics would be faster & produce superior images



E Configuration Science



Mapping (mosaicing) speed for $\sigma_T = 1$ K, $\delta v = 0.8$ km/s



- 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 $3 \times 10^{-15} \text{ cm}^{-2}$ ($dv=1 \text{ km/s}$)



E Configuration Science

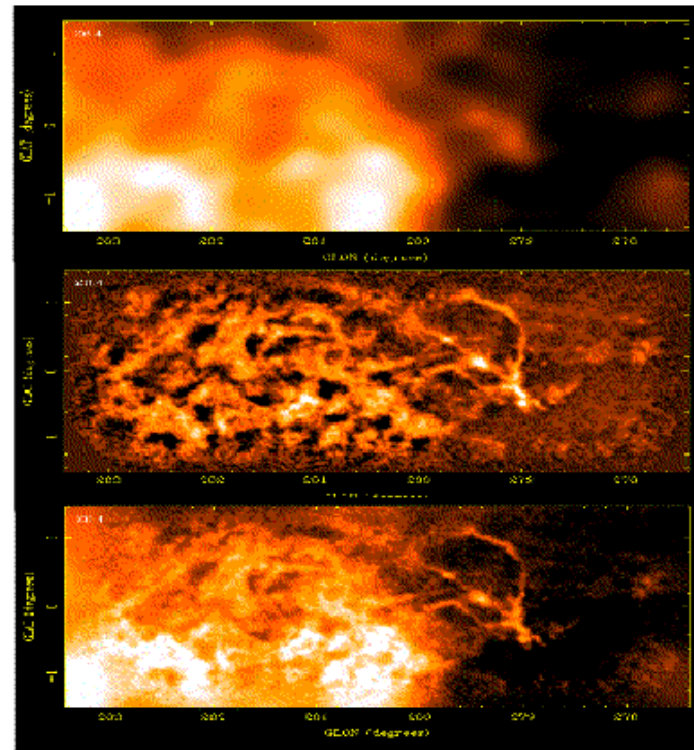


Large-scale Mosaics

Parkes

ATCA

Parkes
+
ATCA



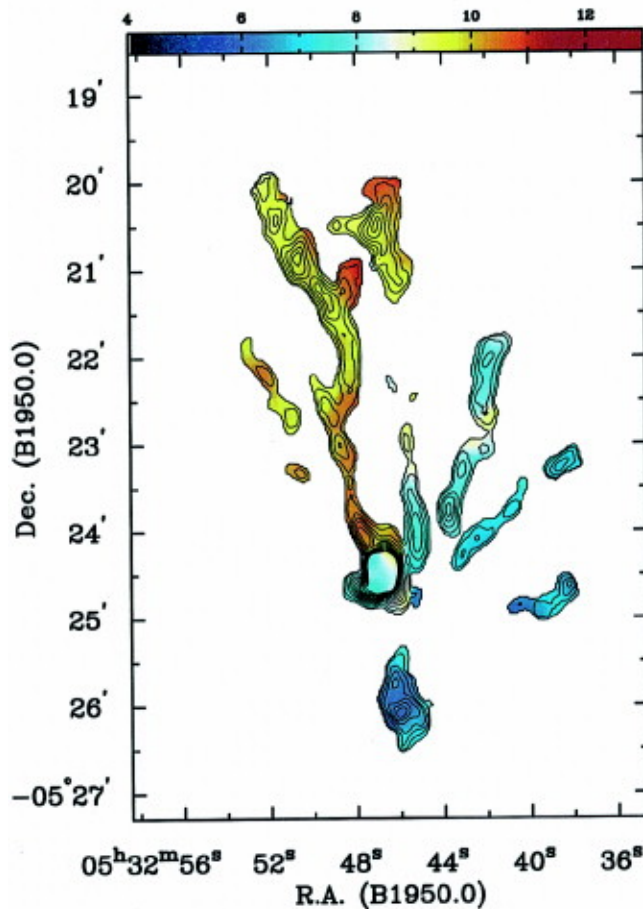
Galactic chimney GSH277+0+36



E Configuration Science



Large-scale Mosaics



High-density ridges of ammonia in Orion



Conclusions



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- 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