The EVLA: A North American Partnership

The EVLA Project on the Web
http://www.aoc.nrao.edu/evla/

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New Science Impact of the EVLA Supercomputing Correlator

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Key EVLA Processing Capabilities

- **Deep Imaging Polarization**
  - 8 GHz Bandwidth (dual polarization).
  - Full polarization processing.
  - Wide-field imaging.

- **Narrow spectral lines Wideband searches**
  - 16,000 channels at max. bandwidth (BW).
  - >10^5 channels at narrow BWs.
  - Spectral resolution to match any linewidth.
  - Spectral polarization (Zeeman Splitting).

- **Flexibility Many resources**
  - 8 tunable 2 GHz wide bands.
  - Each band - 16 tunable sub-bands.
  - Sub-band – independent spectral resolution
  - Simultaneous line and continuum.

- **High time resolution**
  - 1000 pulsar “phase bins”.
  - “Single-dish” data output to user instruments.
  - Very fast time sampling (20 µs).
Star-Forming Galaxies at High Redshift

- Enabled by enhanced sensitivity of EVLA.
- Complementary to ALMA & Spitzer.
- K-correction compensates for z-losses in the 45 GHz band.
- Resolution 50 mas. (200 pc @ z=10).
- Imaging: 1 arcsec over 30 arcmin @ 1.5 GHz.
- EVLA/ALMA gives complete galaxy SED’s:
  - 3 orders of magnitude of frequency,
  - Large range of redshift.

Arp220 SED scaled to high redshifts.
CO Surveys of High-z Star-Forming Galaxies

This is a struggle!

CO $J=3-2$

$Z = 6.42$

Peak $\sim 0.6\,\text{mJy}$

**EVLA sensitivity (red line) in 8 hrs (1 $\sigma$).**

- Detects ($J=1-0, 2-1, 3-2, 4-3$).
- More transitions at high $z$.
- Precise redshift not necessary in advance.
- Spectral resolution will match channel to linewidth.
- Other lines: HCN, HCO$^+$…

**Spectral Line Sensitivity of the VLA**

Arp 220 at $z = 8$, smoothed to 300 km/sec resolution
Setup for CO Z-Search

Sky Frequency Bands

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<th>1-2</th>
<th>2-4</th>
<th>4-8</th>
<th>8-12</th>
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<td>L</td>
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<td>K</td>
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- 40-50 GHz band provides lowest redshift.
- \( z = 1.4 \) to 1.9 for \( J=1-0 \).
- \( z = 3.8 \) to 4.8 for \( J=2-1 \).
- \( \Delta v \sim 5.0 \) km s\(^{-1} \) (1 MHz).
- 200 km-s\(^{-1} \) galaxy would occupy \( \sim 40 \) channels.

Interferometry

- High resolution imaging.
- Good spectral baselines.

Note: Sub-bands can be seamlessly joined across each observing bandwidth.
Magnetic Fields in Star-Forming Regions

- \( \sim 30 \) \( H^+ \) radio recomb. lines in one observation.
- “Stack” lines to improve sensitivity.
- \( H^+, \ He^+, \ C^+ \) recomb. lines.
- EVLA resolution provides images of:
  - gas density,
  - temperature,
  - metallicity,
  - B-fields (Zeeman).

- Sensitivity (12 hr, 5\( \sigma \)):
  - \( \Delta S_{\text{line}} \sim 0.1 \) mJy (stacked, integral)
  - \( \Delta B \sim 150 \) \( \mu \)Gauss.
- Orion, W3, Gal. Center …
Hundreds of Spectral Lines

- Nobeyama spectral scan.
- 414 lines (8 to 50 GHz)
- 38 species.
- Some likely to show Zeeman splitting.
- “D-array” EVLA
  - Resolution,
  - Spectral baseline stability
  - Imaging.
- EVLA can observe 8 GHz at one time – an average of 80 lines --- at 10 km/s velocity res’n (30 GHz)
- EVLA Correlator can “target” many (~60) lines a once.