Cluster Samples with the Long Wavelength Array (LWA)

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LWA Science Drivers

- Cosmic Evolution
  - The High Redshift Universe
  - Detection and study of the first supermassive black holes
  - Search for localized HI absorption during the Epoch of Reionization
  - The Evolution of Large Scale Structure, Dark Matter & Dark Energy
  - Merging galaxy clusters and the large-scale structure filamentary
  - Cluster emission used to study Dark Matter dominated merging systems
  - Cosmic ray tomography to study the distribution, spectrum, and origin of Galactic cosmic rays
  - Spectral SNR studies to probe shock acceleration, SNR evolution, interactions with the surrounding environment
- Acceleration of Relativistic Particles
  - SNRs in normal galaxies at energies up to 10E15 ev.
  - Cosmic ray tomography to study the distribution, spectrum, and origin of Galactic cosmic rays
  - Radio galaxy lifecycles and radio jet composition
  - In ultra high energy cosmic rays at energies up to 10E21 ev and beyond.

Plasma Physics

- Ionospheric turbulence and structures
  - Including traveling ionospheric disturbances (TIDs)
  - Solar and Planetary Science
  - Active & quiet sun studies, measurements of Coronal Mass Ejections, IP shocks & scintillations
  - The interstellar medium (ISM) and beyond
  - Propagation, scattering, & absorption in the ISM of the MW & normal galaxies
  - Scattering from the inter-galactic medium
  - Census of Galactic SNRs with distances.

Opportunity: Discovery Science

- The greatest discoveries in astrophysics have coupled key technical innovations with the opening of new windows on the EM spectrum.
  - Technical breakthroughs: demonstration of ionospheric calibration with 74 MHz VLA.
  - Last poorly explored spectral region: < 100 MHz.
  - New observing paradigms: multi-beaming, wide-field sky monitoring.
  - Potential new horizons: transients, extra-solar planets, coherent emission sources.

Timeline

- Present: Phase 0
  - 74 MHz capacity to the VLA (completed in 1998), VLA Low-frequency Sky Survey (VLSS)
- 2005-2006: Phase 1
  - Construction of the Long Wavelength Development Array (LWDA)
- 2006-2008: Phase 2
  - 8 or 9 stations with baselines up to 150-200 km
- 2008-2010: Phases 3 & 4
  - Phase 3: compact core of ~15 stations to fill in short baselines
  - Phase 4: addition of more stations to even out UV coverage with baselines up to 500 km
  - Full LWA with 52 stations and full imaging capability across the entire 23-80 MHz range

The LWA project is being developed by the Southwest Consortium (SWC) - a university-based consortium led by UNM, & including ARL-UT, NRL, & LANL:

<URL:http://lwa.nrl.navy.mil & http://lwa.unm.edu>

A Vision of the LWA

Constraining the Cosmological Evolution of Dark Matter & Energy with the LWA

- Current studies: the panels to the left show two examples of how current observations below 100 MHz provide the sensitivity to steep-spectrum emission important for understanding the physical processes in individual clusters.
  - Current observations with the 74 MHz VLA can only detect emission from the brightest, relatively nearby clusters.
  - Cosmology requires studies of much larger, and more distant samples - not currently possible.
- Future studies: the panels to the right show that sensitivities of an emerging generation of much more sensitive low frequency instruments such as the LWA and LOFAR, will increase the census of diffuse radio emission from clusters by 3 orders of magnitude.
  - The current census of diffuse cluster radio emission is very incomplete.
  - Only a few dozens currently known.
  - The LWA and LOFAR will detect thousands of cluster radio halos & relics.
- Cosmology with LWA Cluster Samples (see also poster by T. Clarke)
  - Diffuse cluster radio emission can differentiate between clusters in hydrostatic equilibrium and those having undergone recent merger activity.
  - A complete census of diffuse emission in merging clusters would make it possible to trace the dark matter potentials which govern mergers.
  - They would also define a non-merging cluster sample that would provide the undisturbed systems necessary to study the dark energy equation of state through determination of the baryonic mass fraction in massive clusters.

A text description of these goals can be found at http://lwa.nrl.navy.mil/LWA/LWA_science_summary.html

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