MWA and ASKAP: Radio Astronomy in the Wide-Field Era

Bryan Gaensler
University of Toronto

#CanadaRadioFuture

on behalf of the MWA collaboration, and with thanks to the Wajarri Yamatji people
Murchison Radio-Astronomy Observatory (MRO)

Murchison Shire Boundary

Population Density: 0.002 km$^{-2}$

Steven Tingay
A Unique Radio-Quiet Environment

Sydney
Pop. 4.8 million

Narrabri
Pop. 5,900

Murchison
Pop. 114
Murchison Widefield Array (MWA)

Phase I (2013 – 2016)
› 70-300 MHz, 128 tiles, ~1000 deg$^2$ field of view
› 30 MHz bandwidth, 3 km baselines (~1 arcmin)
› 90+ publications, 15 PB archive (6+ PB public)

Phase II (2017 – 2018)
› Expand to 256 tiles (only 128 at once)
› Epoch of Reionisation array (100 m)
› Long baseline array (5 km)

Phase III (2019 – 2020)
› All 256 tiles correlated simultaneously
› Larger bandwidth, better dynamic range
› GPU correlator
MWA Science (I)

Galaxies

Reionisation

Cosmic Web

Ionosphere

Flux Density (Jy)

Frequency (MHz)

GLEAM J135706-174401

Callingham, Gaensler et al. (2017)

Reionisation

Cold Reionization

Fiducial 21cmFAST model

HERA127

Cold Reionization

Fiducial 21cmFAST model

HERA127

Loi et al. (2016)

Trott 2017 (preliminary)

Vernstrom et al. (2017)

Callingham, Gaensler et al. (2017)

Loi et al. (2016)

Vernstrom et al. (2017)
Australian Square Kilometre Array Pathfinder (ASKAP)

- Array of 36 antennas, 12-m diameter
- Baseline lengths: 23 m – 6 km
- Angular resolution 10” – 30” at 1.4 GHz
- Phased array feeds: 30 deg$^2$ field of view
- 304 MHz instantaneous bandwidth
- Frequency range: 700 – 1800 MHz
- Spectral resolution: 1 MHz or 18.5 kHz
- Current status: 12 dishes, early science

188 low noise amplifiers
Up to 36 beams formed simultaneously
ASKAP Early Science: Continuum

- 150 deg$^2$ in 12 hours x 3 epochs
- Frequency: 711-1015 MHz    Resolution: 1 arcmin    RMS: ~ 1 mJy/beam
- 3722 sources, 1037 in-band spectral indices

Heywood et al. (2016)
ASKAP Early Science: Time Domain

Bannister et al. (2017)

Ian Heywood / CSIRO
Neutral hydrogen (HI) surveys: Detect 600,000 galaxies in 1 year + HI in Milky Way, Magellanic Clouds/stream, HVCs, nearby galaxies (WALLABY, DINGO, FLASH, GASKAP)

Continuum: 70% of sky to 10 µJy (EMU) (detect 70 million galaxies; probe evolution of star forming galaxies to z = 2)

Magnetism: All-sky Faraday rotation (POSSUM) (rotation measures for >10^6 sources)

Fast and slow transients (CRAFT, VAST)

Pulsars (COAST)

Ten survey science teams, 680+ astronomers, open access data
Pawsey Supercomputing Centre

- Calibration and imaging
- Data archive and data portal
- Optical fibre connection from site (10 GB/s MRO → Geraldton; NBN Geraldton → Perth)
Summary

› MRO: A superb site for radio astronomy

› MWA: unique wide-field array, heavy Canadian involvement

› ASKAP: science programs about to begin, substantial Canadian leadership