Survey Science with ASKAP: Variables and Slow Transients (VAST)

D. K. Galloway (Monash), S. Chatterjee (Cornell), T. Murphy (U. Sydney) for the VAST collaboration

Overview

Time domain astronomy provides a rich discovery space, as demonstrated by all-sky surveys at high energies (ROSAT, CGRO, Fermi, etc.) and current and future synoptic optical surveys (Pan-STARRS, LSST etc.).

The Australian Square Kilometre Array Pathfinder (ASKAP) enables synoptic radio surveys with high sensitivities, as well as detection of radio transients.

The VAST mission:
- To explore the transient sky at radio wavelengths.
- To seek out new variable and transient phenomena, from the local to the cosmological.
- To boldly go where no radio survey has gone before.

Survey Design

Continuous commensal observations: piggyback with all other surveys at ASKAP.

And

Dedicated surveys being designed at present.

Strawman proposal for first two years:
- **VAST Wide**: 10,000 sq deg observed daily (400 pointings x 40 sec each; 0.5 mJy/beam).
  - Optimized for bright-rare transients: ESEs, IDVs, nearby GRBs / Radio SNe, etc.
- **VAST Deep**: 10,000 sq deg observed twice (400 pointings x 1 hr; 50 μJy/beam, many ΔT).
  - Optimized for faint-common transients: distant events, unknown source classes.
- **VAST Galactic plane**: 750 sq deg; ΔT ~ 2-7 days (33 pointings x 16 min each; 0.1 mJy/beam).
  - Survey the Milky Way and Magellanic Clouds.

Target Source Classes

Based on underlying mechanism:
- **Explosions**: Radio SNe, prompt GRB emission, orphan afterglows.
- **Propagation**: scintillation, IDVs, extreme scattering events.
- **Accretion and Magnetism**: AGN, flare stars, CVs, XRBs, microquasars, magnetars, pulsars.

More important: as yet unexplained and undiscovered source classes.

As we know, there are known knowns. There are things we know we know. We also know there are known unknowns. That is to say, we know there are some things we do not know. But there are also unknown unknowns, the ones we don’t know we don’t know.

—— US Sec Def. Donald Rumsfeld, DoD briefing, 12 Feb 2002

About the Australian Square Kilometre Array Pathfinder (ASKAP)

- Murchison shire in Western Australia: extremely radio-quiet site. (Area 16,000 sq miles, larger than Massachusetts; population ~110.)
- ASKAP = 36 antennas, 12-m each, Tyas = 50K, baselines up to 6 km.
  - 3-axis design (az, el, poln) to eliminate FoV rotation.
- Will observe at 0.7–1.8 GHz, with 300 MHz bandwidth; optimized for survey speed e.g., 220 sq deg/hr continuum survey (10° resolution, 100 μJy).
- 30 sq deg instantaneous field of view; focal plane array feeds (PAFs) → 30 beams on the sky.
- Operational in 2013, initially with 6 antennas with PAFs.

Data Flow and Processing

- Continuous real-time operation on ASKAP images.
- VOEvent alert mechanism for follow-up obs.

Get Involved!

- Open collaboration: we welcome new members.
- Current membership is 70+ participants from 32 institutions on 4 continents.
- Design Study currently has 7 working groups:
  - **WG 1**: Simulations & Imaging (Randall Wayth)
  - **WG 2**: Source finding (Tara Murphy)
  - **WG 3**: Survey strategy (Shami Chatterjee)
  - **WG 4**: Commissioning (Simon Johnston)
  - **WG 5**: Data format & access (Hayley Bignall)
  - **WG 6**: Transient detection pipeline (David Kaplan)
  - **WG 7**: Pathfinder science (Duncan Galloway)

Interested? Please contact us:
tara@physics.usyd.edu.au, shami@astro.cornell.edu

Or look at the VAST website:
http://wwwastro.cornell.edu/vast/