ASKAP Survey Science Projects

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Introduction

The Australian Square Kilometre Array Pathfinder (ASKAP) is a next generation radio telescope being built on a radio-quiet site in Western Australia and expected to be operational in 2013. One of ASKAP's operational principles is that telescope time will be assigned to astronomical research projects subject only to scientific merit and to technical and operational feasibility. Over 2008-09, therefore, the ATNF set in motion an open process to determine the key science questions that will be addressed over the first 5 years of ASKAP's operational life.

As part of the process, the ATNF received proposals for ASKAP Survey Science Projects (SSPs) from the international community. SSPs are defined as large and coherent projects that utilize ASKAP's wide field-of-view and fast survey speed to enable major science outcomes. The SSP proposals were evaluated by the SSP Assignment Committee, a committee made up of international experts with a broad range of proficiencies, on the basis of: (1) their scientific merit, (2) the quality of their design study plan, (3) the perceived community benefit and (4) the team organisation. In addition to advising the ATNF Director on the ranking of the SSP proposals, the Committee was also asked to provide advice on the fraction of time which should be devoted to SSPs, opportunities for commensal observing, and data release policies. The members of the Committee were Joseph Lazio (Chair), Roy Booth, Jim Condon, Phil Diamond, Ron Ekers, Tom Jarrett, Tom Oosterloo and Brian Schmidt. The Committee was assisted by the ASKAP Project Scientists, Simon Johnston and Ilana Feain.

Summary of SSP proposal evaluation

Based on the Committee's grades and recommendations to the ATNF Director, the following teams from the successful SSP proposals (listed in order of ASKAP proposal number) are now invited to work with the ATNF through the Design Study phase.

A group: ATNF will provide full support to these SSPs.

- AS014: EMU: Evolutionary Map of the Universe (PI: Norris)
- AS016: WALLABY: Widefield ASKAP L-Band Legacy All-Sky Blind Survey (PIs: Koribalski and Staveley-Smith)

A- group: ATNF will make all reasonable efforts to support these SSPs.

- AS002: ASKAP-FLASH — The First Large Absorption Survey in H I (PI: Sadler)
- AS004: An ASKAP Survey for Variables and Slow Transients (VAST) (PIs: Murphy and Chatterjee)
- AS005: GASKAP: The Galactic ASKAP Spectral Line Survey (PI: Dickey)
- AS007: Polarization Sky Survey of the Universe's Magnetism (POSSUM) (PIs: Gaensler, Taylor and Landecker)
- AS008: The Commensal Real-time ASKAP Fast Transients survey (CRAFT) (PIs: Dodson and Macquart)

- AS012: DINGO: Deep Investigations of Neutral Gas Origins (PI: Meyer)

Strategic Priorities Group: ATNF will work to ensure that capabilities defined by these SSPs are enabled to the extent possible.

- AS003: The High Resolution Components of ASKAP: Meeting the Long Baseline Specifications for the SKA (PI: Tingay)
- AS015: Compact Objects with ASKAP: Surveys and Timing (COAST) (PI: Stairs)

Fraction of ASKAP time devoted to SSPs.

The Committee considered the balance of time that should be allocated for SSPs versus other projects. The Committee's response was that while the nominal value of 75% of ASKAP time, averaged over the first 5 years of operation, seems reasonable, a much higher value (perhaps as high as 90%) would be appropriate initially to aid in the commissioning. The ATNF accepts this recommendation.

Commensal Observing

The Committee noted the opportunities for commensal observing, in particular that some aspects of the WALLABY, EMU, VAST, POSSUM and FLASH proposals could be conducted commensally. The ATNF will endeavour to ensure that commensal operations can be carried out where possible, in order to maximize the science output from ASKAP. Close attention will be paid to this issue during the Design Study phase and ATNF will work closely with the SSP teams to exploit commensal opportunities.

Data Release Policy

The Committee was concerned that many of the SSP teams did not discuss their anticipated data releases in sufficient detail to evaluate or, in some cases, proposed data releases that appear to be inconsistent with ASKAP User Policy. The ATNF shares these concerns and will work together with the SSP teams during the Design Study phase to ensure that they comply with User Policy.

Final Remarks

ATNF faces many challenges between now and the delivery of ASKAP as a working science instrument including technical challenges, cost pressures and aggressive timelines. However, ATNF will continue to aim to deliver ASKAP to the target specifications on the timelines proposed.

All the SSPs are believed to be consistent with ASKAP's technical specifications and deliverables; but delivery of the science represented by the proposals progressing to the Design Studies phase cannot be guaranteed.

In the event that descoping or a significant slippage in the timeline for ASKAP is encountered, the ATNF will keep the SSP teams informed and work with them to continue to maximize ASKAP science outcomes.

The ATNF thanks the SSP Assignment Committee for the difficult task of evaluating the SSP proposals, congratulates the successful SSP teams and looks forward to working closely with the teams over the next few years.

Next steps

The ATNF invites all the PI's of the successful Science Survey Projects (both the A and A-groups) and the Strategic Priorities Group to work with the ASKAP Project Scientists and other ATNF staff as appropriate as part of the ASKAP SSP Working Group. The Working Group will be Chaired by ASKAP Project Scientist Ilana Feain. It is anticipated that the Working Group will meet regularly (perhaps monthly) to ensure close collaboration between the ATNF and the SSP teams, and between SSP teams where appropriate. There will be a one-day SSP Design Study kickoff meeting that will be held at the ATNF headquarters in Sydney in mid-October, to get this process underway.

Over the next 2 months ATNF will establish an ASKAP Survey Review and Science Advisory Committee (with independent international membership) to provide advice on scientific issues relevant to ASKAP, and to oversee progress of all the Science Survey Projects during the Design Phase between now and the start of full ASKAP Science Operations. If changes to ASKAP specifications are required CSIRO will seek high-level advice from the ASKAP Survey Review and Science Advisory Committee and will work closely with the ASKAP Survey Science Working Group.

ASKAP Survey Science Projects

A Group

AS014: EMU: Evolutionary Map of the Universe — PI Norris

EMU is a deep (10 μJy/beam rms) radio continuum survey of 75% of the entire sky. EMU will probe typical star forming galaxies to redshift 1, powerful starbursts to even greater redshifts, Active Galactic Nuclei to the edge of the Universe, as well as undoubtedly discovering new classes of rare objects. The key science goals for EMU are to trace the evolution of star forming galaxies and massive black holes throughout the history of the Universe and to explore large-scale structure. EMU will create the most sensitive wide-field atlas yet made, and provide a long-lasting legacy survey.

AS016: WALLABY: Widefield ASKAP L-Band Legacy All-Sky Blind Survey — PIs Koribalski & Staveley-Smith

WALLABY is an extragalactic neutral hydrogen survey over 75% of the entire sky and will detect up to 500,000 galaxies to a redshift of 0.26. The fundamental aims of WALLABY are to examine the HI properties and large-scale distribution of these galaxies in order to study galaxy formation and the missing satellite problem in the Local Group, evolution and star formation of galaxies, the role of mergers and galaxy interactions, the HI mass function and its variation with galaxy density, the physical processes governing the distribution and evolution of cool gas at low redshift, cosmological parameters relating to gas-rich galaxies and the nature of the cosmic

web. WALLABY will provide the largest, most homogeneous HI sample of galaxies yet made, and will be an important pathfinder for key SKA science.

A- Group

AS002: First Large Absorption Survey in H I (FLASH) — PI Sadler

FLASH is a blind H I absorption-line survey that uses background radio continuum sources to identify and characterize foreground neutral hydrogen. FLASH science outcomes are focused on both the neutral gas content of galaxies and the cosmic HI mass density in the redshift range $0.5 < z < 1.0$ where the HI emission line is too weak to be detectable in individual galaxies. The observations will increase the total number of absorption line systems by an estimated two orders of magnitude, representing a significant data set to study gas assembly and galaxy formation during a time in the history of the Universe that is largely unstudied thus far.

AS004: An ASKAP Survey for Variables and Slow Transients (VAST) — PIs Murphy & Chatterjee

VAST gives unprecedented opportunities to investigate the sky at radio wavelengths for transients with a timescale as short as 5 seconds. ASKAP's wide-field survey capabilities will enable the discovery and investigation of variable and transient phenomena from the local to the cosmological including flare stars, intermittent pulsars, X-ray binaries, magnetars, extreme scattering events, intra-day variables, radio supernovae and the orphan afterglows of gamma-ray bursts. VAST will probe unexplored regions of phase space where new classes of transient sources may be detected.

AS005: GASKAP, the Galactic ASKAP Spectral Line Survey — PI Dickey

The GASKAP survey is a high spectral resolution study of the HI and OH lines in the Milky Way and Magellanic Systems. Compared with existing data, GASKAP will achieve about an order of magnitude improvement in both brightness sensitivity and in angular resolution. GASKAP will detect and map OH masers from evolved stars and star formation regions, diffuse emission from molecular and atomic clouds, HI absorption toward background continuum sources and the structures in the gas that trace the effects of stellar winds and supernova explosions. The Magellanic Clouds will show all these processes as they appear in two other, very different environments. GASKAP will provide stunning images of the interstellar medium that will be indispensible for astronomers working at other wavelengths.

AS007: Polarization Sky Survey of the Universe's Magnetism (POSSUM) — PIs Gaensler, Taylor & Landecker

Understanding the Universe is impossible without understanding magnetic fields. Magnetic fields are key to the non-thermal Universe, yet it is unclear how large-scale magnetic fields are generated and maintained. POSSUM will use radio source polarization, in particular the technique of rotation measure (RM) synthesis, to perform a wide-field survey that will yield a grid of RMs over a substantial fraction of the sky. The science outcomes of POSSUM will revolutionise our understanding of the ordered components of the Milky Way's magnetic field, test dynamo and other models of magnetic field generation in galaxies and clusters, and carry out a comprehensive census of magnetic fields as a function of redshift in galaxies, active galactic nuclei, galaxy clusters and the intergalactic medium.

AS008: The Commensal Real-time ASKAP Fast Transients survey (CRAFT) — PI Dodson & Macquart

CRAFT is a purely commensal survey for transient sources with time-scales shorter than 5 seconds. Short-timescale transients are associated with the most energetic and brightest single events in the Universe. They provide Nature's ultimate laboratory; their emission is generated by matter under extreme conditions whose properties probe physical regimes far transcending the range achievable in terrestrial experiments. Fast timescale transients open new vistas on the physics of high brightness temperature objects, extreme states of matter and the physics of strong gravitational fields. In addition, the detection of extragalactic transients affords us an entirely new and sensitive probe on the huge reservoir of baryons in the intergalactic medium.

AS012: DINGO: Deep Investigation of Neutral Gas Origins — PI Meyer

DINGO will study the evolution of neutral hydrogen (HI) from the current epoch to redshift about 0.5, providing a legacy dataset spanning cosmologically representative volumes. Measurements will be made of key cosmological distributions, including Ω_{HI}, the HI mass function and the halo occupation distribution function. ASKAP data will be combined with optical data to enable a thorough study of the co-evolution of the stellar, baryonic and dark matter content of galaxies.

Strategic Priorities Group

AS003: The High Resolution Components of ASKAP: Meeting the Long Baseline Specifications for the SKA - PI Tingay

ASKAP, in combination with the existing Australian Long Baseline Array, high speed data recording equipment, innovative software correlation facilities and high speed data transport networks provides a high resolution capability that is unmatched in terms of SKA demonstrators around the world. Science outcomes include proper motion and parallax of pulsars, high resolution imaging of Active Galactic Nuclei, follow-up of transient radio sources and distances and proper motions of OH masers.

AS015: Compact Objects with ASKAP: Surveys and Timing (COAST) — PI Stairs

COAST will undertake an observational program of pulsar timing aimed at high profile issues in astrophysics. This includes limits on, or the detection of, a background of gravitational waves, stringent tests of the predictions of General Relativity and other theories of strong gravity and the studies of binary stellar evolution. In addition to pulsar timing, blind searches for pulsars will also be carried out which will lead to a better understanding of the Galactic neutron star population, the pulsar emission mechanism and the structure and magnetic field of the Galaxy.