ASKAP Science Update

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CSIRO

The ASKAP Science Update is a regular series dedicated to conveying the latest news about the Australian SKA Pathfinder (ASKAP) project to the international science community. It is also available online at www.atnf.csiro.au/projects/askap.

ASKAP Construction on Track

Construction of CSIRO's ASKAP radio telescope has begun in Western Australia.

The first of 36 identical 12-metre antennas that will make up ASKAP is currently being assembled and will shortly undergo rigorous testing at the Murchison Radio-astronomy Observatory in the Mid West region of Western Australia.

With the antenna reaching 18 metres in height (about the size of a four-storey building), a large crane has been used to lift the antenna's pedestal, reflector dish and feed support into place.

In coming weeks comprehensive site acceptance testing of the antenna will be completed. Additional CSIRO-made components, including feeds, receivers and data processing systems, will also be installed on the antenna's structure.

> Assembly of the first ASKAP antenna has made rapid progress. Credit: Carole Jackson, CSIRO.

> Installing the antenna's phased array feed housing. Credit: Carole Jackson, CSIRO.

"We're very excited to see the first ASKAP antenna being assembled at its new home, the Murchison Radio-astronomy Observatory. This is a notable milestone in our project," says CSIRO ASKAP Project Director, Dave DeBoer.

The antenna has been designed and built by the 54th Research Institute of China Electronics Technology Group Corporation (known as CETC54). CSIRO awarded the contract for the design and construction of ASKAP's 36 antennas to CETC54 in November 2008 after an international tendering process. Local contractors also assisted the team.

"The CSIRO and CETC54 construction team have made tremendous progress on building the first of ASKAP's antennas, especially in very hot summer conditions," says Dave.

"The ASKAP antenna is an extremely innovative design, having three moving axes (altitude, azimuth and polarisation) where the entire dish rotates in unison with the sky. This feature enables very sensitive images of the sky to be observed. It also means that the radio signals arriving at the antenna's phased array receiver or "radio camera" are fixed with it, making the processing of the signals much simpler than with conventional designs."

Construction of ASKAP's next five antennas will proceed quickly. The first six antennas are due to be operational by 2011 and the complete ASKAP system is expected to be completed by 2013.

Once built, ASKAP will operate as part of CSIRO's radio-astronomy facility for use by Australian and international scientists.

As well as being a world-leading telescope in its own right, ASKAP will be an important test bed for the international Square Kilometre Array radio telescope.

For the latest news on the development and construction of ASKAP visit: **www.atnf.csiro.au/projects/askap**

"ASKAP is going to be an amazing telescope, far more powerful for this type of work than any other telescope ever built."

ASKAP Survey Science Projects

In this edition of ASKAP Science Update we take a detailed look at two of the projects that will make use of ASKAP during its first five years of operation.

EMU Plans to Fly High

"It is ambitious, but that's because our science goals are ambitious" says Ray Norris, Principal Investigator of EMU.

The EMU, or Evolutionary Map of the Universe, project is a deep (10 μJy/beam rms) radio continuum survey of 75% of the entire sky. It is one of the largest surveys that will be undertaken by ASKAP in its first five years with a request for one and a half years of observing time and plans to spend 16 hours on each pointing. It will create the most sensitive wide-field atlas yet made, and provide a long lasting legacy survey.

The project's science goals are to answer some of the biggest questions in astronomy: How do black holes form in the centre of galaxies and how do galaxies evolve from one redshift to another?

To do this, the EMU team will probe typical star forming galaxies to a redshift of $z = 1$, powerful starbursts to even greater redshifts, and Active Galactic Nuclei to the edge of the Universe. In the process it will undoubtedly discover new classes of rare objects.

"In a nutshell, EMU is about looking at the process of galaxy formation and evolution over cosmic time, and seeing if we can figure out how it works," says Ray.

Ray, a Research Project Leader with CSIRO's new division of Astronomy and Space Science (that operates the Australia Telescope National Facility), is no stranger to ambitious projects. Since 2005, Ray has been leading a project called the Australia Telescope Large Area Survey or ATLAS, which has been surveying eight square degrees of sky.

"ATLAS has been very productive. We've discovered a few new types of object, and found that the relationship between star formation and black holes wasn't quite what people thought it was. So when the opportunity arose to propose projects for ASKAP, we could immediately see the potential for building on our experience with ATLAS to achieve far more than any other radio survey," says Ray.

"I'm glad to say that pretty well everybody involved in ATLAS is now part of EMU, and we are using ATLAS as a prototype and test bed for figuring out how to do the EMU project."

There are just over 100 people in the EMU team, representing all stages of the research career from students to professors: 40% are from Europe, 37% from Australia and New Zealand, 18% from North America, and several members from India and South Africa.

As well as being international, EMU is an interdisciplinary team.

"Radio is just one wavelength – one window – that we use in our quest to understand how the Universe works. Amongst members of the EMU team are representatives of most of the other big projects at other wavelengths," says Ray.

Unlike its flightless namesake, the EMU project is looking to launch into a new era of discovery.

"ASKAP is going to be an amazing telescope, far more powerful for this type of work than any other telescope ever built. With EMU, we're going to probe the radio Universe a factor of 40 deeper than any other comparable survey. And when you have such a great telescope that seems to be so beautifully suited to perhaps the greatest challenge facing astronomy, then you just go for it," says Ray.

> Ray Norris, Principal Investigator on the Evolutionary Map of the Universe project, at the Parkes Testbed Facility that is being used by CSIRO to test ASKAP's systems. Credit: John Sarkissian, CSIRO.

Pulsars Beat at the Heart of COAST

Canada's Ingrid Stairs is excited by the prospect of using ASKAP to observe the timing of pulsars over several years.

"We will use ASKAP to monitor a large number of pulsars, including millisecond and young pulsars, to track their long-term timing properties. This will contribute to world timing programs aimed at various issues in pulsar physics, ranging from tests of relativity to providing ephemeris information for pulsar studies with high-energy satellites," says Ingrid, an Associate Professor in the Astronomy Group at the University of British Columbia in Vancouver and the COAST project's Principal Investigator.

"COAST may even contribute to the worldwide effort toward detecting gravitational waves using an array of pulsars."

As the COAST project's full name of Compact Objects with ASKAP: Surveys and Timing suggests, pulsar timing is just one of two main areas on which the study will focus. The survey work that the COAST team also propose to undertake includes point-source observation of possible pulsars and 'blind' survey work.

"We will search for new pulsars by looking at likely point sources identified by other ASKAP survey projects [such as EMU], and develop pulsar search techniques for wide-field interferometers," says Ingrid.

While using an interferometer for pulsar observation will be computationally challenging, COAST will be an important trial in the lead-up to the SKA era of radio astronomy. It is for this reason that COAST has been identified as a strategic priority for ASKAP, which will have a field of view of 30 square degrees.

"COAST will join other experiments in using an interferometer for pulsar timing – with the twist that we will be trying to time multiple pulsars accurately across a wide field of view, which might necessitate new calibration techniques," continues Ingrid.

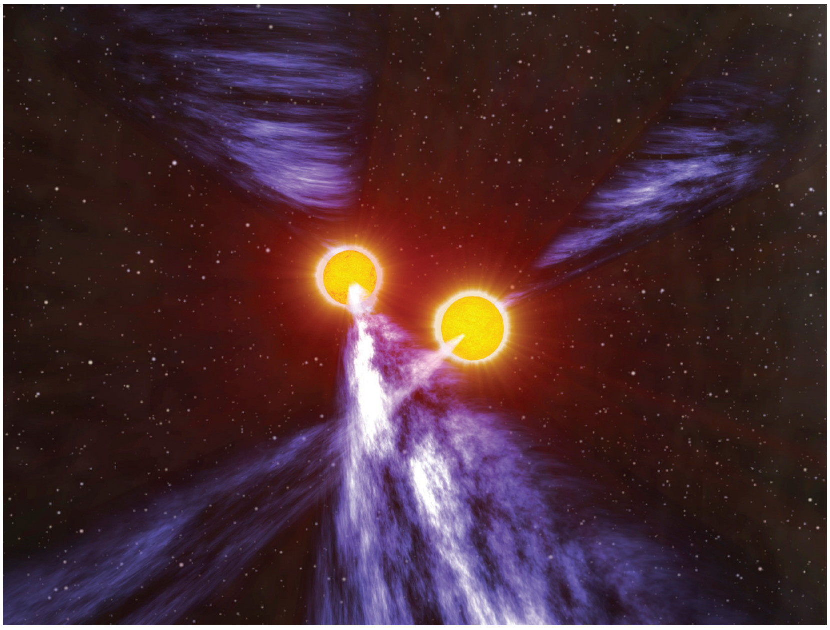
> UBC's Ingrid Stairs, Principal Investigator on the COAST project.

"Meanwhile, we will be developing search methodologies that may eventually be used on the SKA. The point-source search is pretty straightforward (in principle, at least!), but the wide-field survey is very data- and computing-intensive, and it's not yet clear how best to search through the huge datasets that will be generated. For this last survey mode, we'll really be prototyping techniques that we will eventually need for the SKA."

The COAST team isn't just made up of Canadian investigators but about 40 researchers from around the world. "We will be drawing on everyone's expertise" adds Ingrid.

Although there are several science goals for the COAST project, it is the possibility of contributing to fundamentally new science that gets Ingrid's own pulse racing.

"One could say the pulsar community is in a bit of a race with laser interferometer experiments to see who can make the first direct detection of gravitational waves. If and when we find them, then we will start digging into the real science, namely the sources of the waves, which could include merging supermassive black holes or relics of cosmic inflation."



> An artist's impression of a double pulsar system. The COAST team will use ASKAP to monitor a large number of pulsars, including millisecond and young pulsars, over several years. Credit: John Rowe Animations/CSIRO.

ASKAP on Display at AAS 215

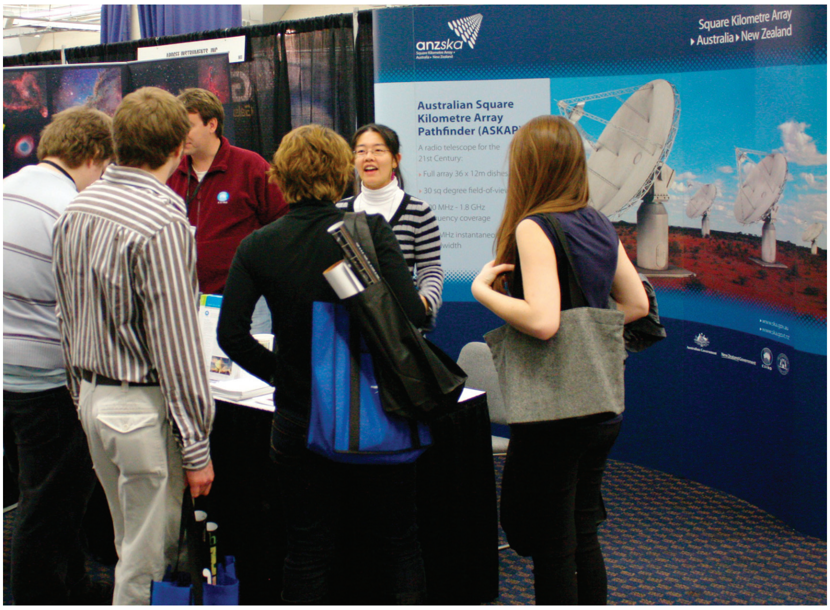
Three of CSIRO's ASKAP team members were kept busy at the recent American Astronomical Society winter meeting in Washington DC.

"Our presence was very successful in generating awareness of the telescope among North American researchers – the ASKAP booth was frequented by many exhibition visitors," says Tobias Westmeier, one of ASKAP's Project Scientists and a meeting participant.

The Washington DC meeting was the fourth successive bi-annual AAS meeting at which ASKAP has been represented with an exhibition booth.

"AAS meetings offer great opportunities to build on existing relationships and develop new ones," says Tobias.

Ten major science projects have been selected to use ASKAP during its first five years of operation. The ten projects represent 363 investigators, of which 30% are based in North America.



> The ASKAP team was kept busy at the 215th AAS meeting in Washington DC. Credit: Tobias Westmeier, CSIRO.

Forthcoming Meetings

Members of the ASKAP team will be attending a number of upcoming scientific meetings:

- SKANZ 2010
  Auckland, New Zealand
  15 – 18 February 2010
- SKA 2010
  Manchester, UK
  22 – 25 March 2010
- AAS 216
  Miami, USA
  23 – 27 May 2010
- International SKA Forum 2010
  Assen, The Netherlands
  15 June 2010

If you would like to find out more or have questions about ASKAP please don't hesitate to find us, we look forward to meeting you.

For further information:

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