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ASKAP Commissioning Update, May 2019

In this issue, we report on the first iteration of the Rapid ASKAP Continuum Survey, designed to provide a new reference catalogue for radio sources in the Southern hemisphere. We also discuss the progress of test observations for pilot surveys.

The Rapid ASKAP Continuum Survey

Some time ago it was realised that ASKAP's rapid survey speed could be used with great impact for a new kind of project requiring minimal investment of observing time. Although the telescope was built with multi-year surveys in mind, a continuum survey with ASKAP can reach NVSS depths across the entire visible sky in about 10 days.

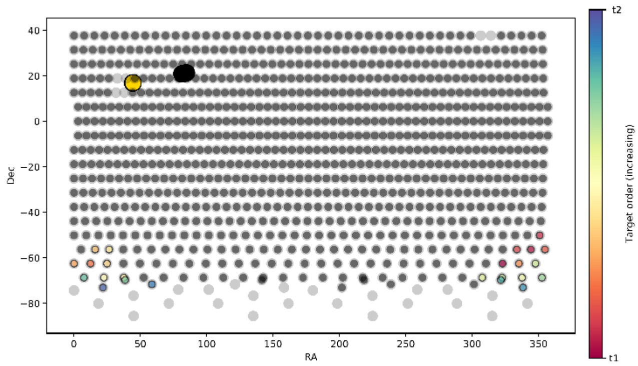
Conducting such a survey has several benefits above and beyond its scientific interest. The resulting catalogue can be used as the basis for a new sky model for the Southern hemisphere, providing a faster way of calibrating the array in future. Processing an all-sky survey also tests many aspects of the data pipeline that are not exercised by observations of individual fields.

RACS design and progress

The Rapid ASKAP Continuum Survey was specified in very simple terms – it should provide a reference catalogue of the entire sky visible to ASKAP with sensitivity as good as the current benchmarks for the Northern hemisphere.

With ASKAP's wide field of view and electronically-formed beams, we have the freedom to select a beam "footprint" and tiling scheme that efficiently covers the sky. We settled on a tiling scheme that uses a 6x6 square arrangement of beams, moved through strips of constant declination, dwelling on each field for 15 minutes. During the design process we considered how to optimise the spacing of beams within this footprint and whether to observe interleaved fields, but eventually decided to start with the simplest possible approach. Given the modest investment of observing time required to complete a single pass, there is room for experimentation in future.

It was decided to begin at the lowest possible frequency band, to take advantage of the relative freedom from RFI in this band at the observatory. Observations were made between 744 and 1032 MHz with 1 MHz frequency resolution. Roughly 900 fields were required to cover the sky South of +40 Dec and to date we have observed down to -70 Dec as shown in the diagram.



Survey completion map with each circle representing a field centre from the survey plan. Shaded circles have been observed. Coloured circles were observed in the most recent scheduling block. The Sun and Moon are also shown.

The first RACS attempt was conducted in April this year using 40 scheduling blocks with roughly 20 different fields per block. This is itself a challenge for the processing pipeline as it was previously tested on observations of single fields or observations that switch between a small number of interleaved fields. Running a full RACS block through the pipeline launches roughly 5000 jobs on the Galaxy supercomputer.

RACS data processing

Although the investment in observing time for a single RACS pass is modest, the time required to image the resulting visibilities will likely be much more significant.

As this is the first attempt at such a survey, we must pay careful attention to quality control and optimisation of processing parameters. It is likely that several processing passes will be required before we can begin to release data. Where possible, the positions and fluxes of sources present in previous surveys such as SUMSS will be used to validate RACS images.

Once quality has been tested, we will be releasing the survey images and catalogues to the public on the ASKAP science data archive, CASDA.

We are using ASKAPsoft to image RACS data, but for this first attempt we have also been processing some of the fields using standard CASA tools so that we can compare image quality and processing performance. Our initial results show a typical noise level of 0.25 mJy/beam.

The future of RACS

In future, we intend to cover the entire frequency range available to ASKAP (up to 1800 MHz) and conduct multiple epochs of RACS to search for transient sources. We may also adjust the footprint and tiling parameters to optimise for uniformity of sensitivity, especially in the regions at the edge of adjacent tiles.

Science team test observations

Another major focus of activity is preparation for pilot surveys. These are 100-hr tests of the strategies that are being developed for multi-year survey campaigns by international teams.

To inform the preparation of survey strategies, we have observed several test fields in modes that we expect to use for the large-scale surveys. These are being processed by the ASKAP operations team and will be deposited on CASDA to test the full end-to-end processing pipeline and ensure that all required data products are present and correct in the archive.

Each science team has nominated a representative to work with the ASKAP operations team, optimising the processing parameters for their survey. These representatives also have the chance to learn about the telescope and how to identify problems that can arise. The knowledge gained during pilot surveys will then be transferred to the wider science community.

GAMA 23 data release

Data from the full ASKAP array has significantly better sensitivity and resolution than previous early science data. It has therefore taken significant effort to tune the processing parameters for the latest observations, but good progress has been made. Quality control is also a significant challenge due to the lack of existing data with similar characteristics. Restricting cross-matches to isolated, unresolved sources greatly reduces the number of viable comparisons, so we have had to explore other techniques such as smoothing ASKAP images to the resolution of SUMSS.

We have recently uploaded the first continuum test observation of the GAMA23 field to CASDA. The data are visible to members of the EMU team who are assisting with quality control. Soon, these data will be validated and released to the public as the first data from ASKAP covering its full field of view with all antennas.

Spectral line modes

WALLABY test observations of the Eridanus cluster are also being processed. Although visualising the extremely large spectral line cubes that ASKAP creates has proven challenging, the data themselves look good. Some work is still required to understand occasional imaging failures in individual beams.

The first zoom mode images have now been created, though additional pipeline parameter tuning will be required to effectively support all possible modes. Obtaining full spectral resolution data has been difficult due to limited disk space and the need for multiple processing passes, but this should be alleviated somewhat with the arrival of a new disk array at Pawsey in the next month or two.

Calibration and data quality

Preliminary analysis of RACS data and other test fields shows that ASKAP data can sometimes contain calibration errors that are not well understood. We hope to use the first RACS pass to thoroughly investigate the circumstances in which calibration errors can occur, leading to a deeper understanding of the problem. We are also investigating the impact of the Sun in daytime fields across a wide range of angular separations.

Commensal transient mode

ASKAP's wide field of view makes it an excellent instrument for advancing the emerging field of Fast Radio Burst (FRB) science. To maximise the contribution that ASKAP can make in this field, we have been developing a commensal transient mode that can run alongside other observing modes. This involves using a fast filter-bank to trigger capture of raw voltages that can be correlated offline. Running this mode in parallel with the correlator places some extra load on the system and it has taken time to ensure that everything works smoothly, but we are now routinely searching for fast transients in all multi-beam observations.

FOR FURTHER INFORMATION
CSIRO Astronomy and Space Science
Aidan Hotan
t +61 8 6436 8543
e aidan.hotan@csiro.au
w www.csiro.au/askap