Newsletter 3

September 2010

PI Report

Tara Murphy and Shami Chatterjee

This quarter has seen funding success for VAST. We will have several new postdoctoral researchers as part of the "Dynamic Sky" theme of the ARC Centre of Excellence (CAASTRO). A number of VAST people are CAASTRO investigators: Bryan Gaensler (Director), Lister-Staveley-Smith, Steven Tingay, Brian Schmidt, Elaine Sadler, Michael Kramer, Tara Murphy and J-P Macquart.

For the next month we will be focused on preparing for the internal review of the ASKAP survey science projects. Tara will be presenting a public talk on VAST on Monday 1st November, and will be interviewed by the review panel on Monday 8th November.

There will be a 3-day ASKAP Working Meeting for members of all ASKAP projects on 29th November to 1st December at CASS in Sydney. All VAST members are encouraged to attend!

http://www.atnf.csiro.au/research/conferences/2010/askap

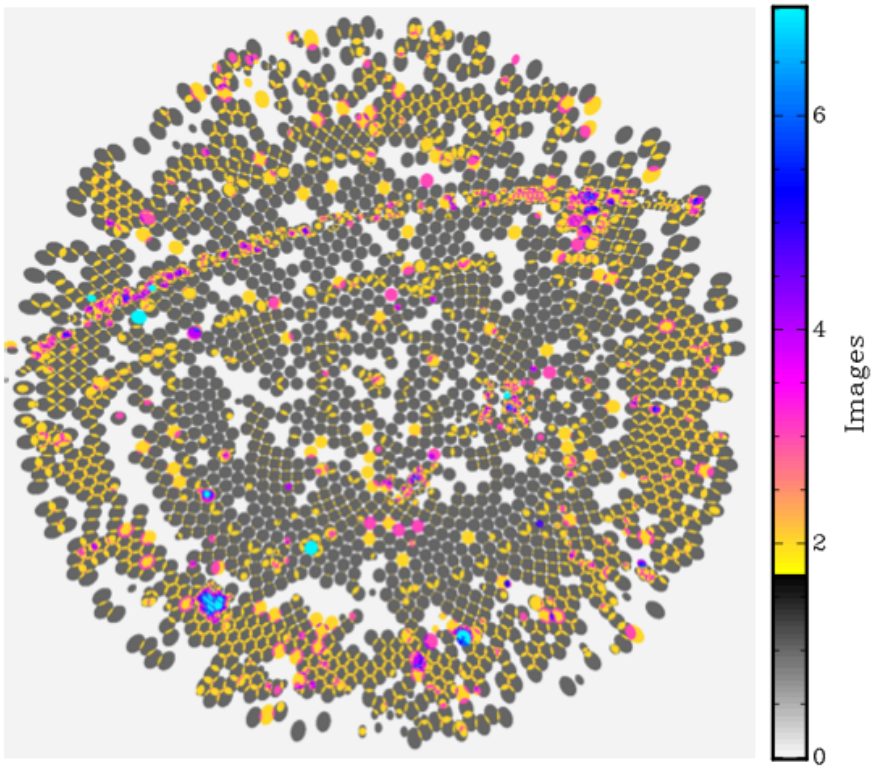
Science Report

A Search for Radio Variability and Transients using the Molonglo Observatory Synthesis Telescope

Keith Bannister, Tara Murphy, Bryan Gaensler, Dick Hunstead and Shami Chatterjee

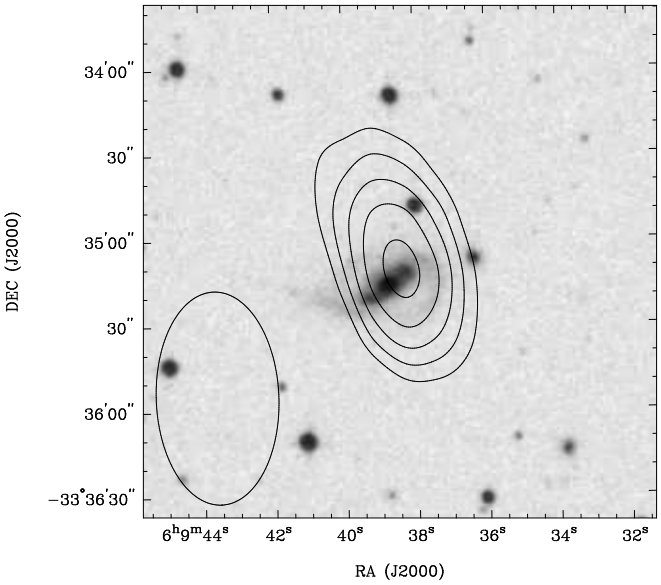
The Molonglo Observatory Synthesis Telescope (MOST) has been observing the radio sky at 843 MHz almost every night since 1986. The data archive spans 22 years and contains over 7000 12-hr synthesis images from two Galactic plane surveys (MGPS-1 and MGPS-2) and the all-sky Sydney University Molonglo Sky Survey (SUMSS) as well as directed observations of particular sources. The resulting archive covers the 10 000 square degrees of the southern sky once, 1000 square degrees twice, and some small regions of the sky over fifty times. This coverage is among the widest and deepest (5 sigma = 14mJy) radio variability surveys to date, and makes the MOST archive ideally suited to a blind archival search for radio transients and variability.

We have recently completed processing the

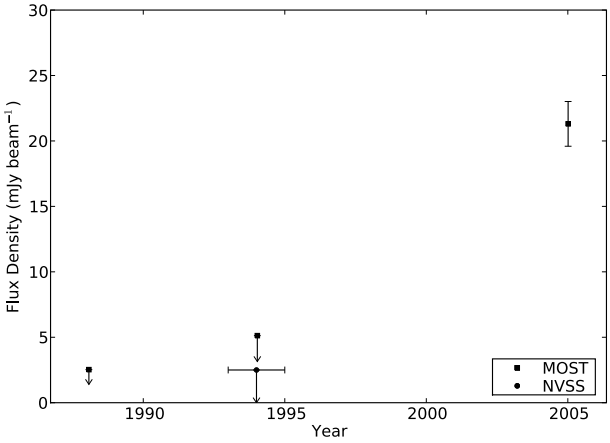


Sky coverage of the MOST archive used in our analysis. The data is shown in a Lambert equal area projection sampled on 0.1 degree grid centred on the South Celestial Pole. The colour axis is the number of usable epochs after visual inspection and post-facto calibration.

The SUMSS survey covers the sky south of -30 degree and the Galactic plane surveys: MGPS-1 and MGPS-2 can be clearly seen as a band from the left-middle to top-right.



Radio transient J060938-333508. MOST contours from 6 to 18 mJy/beam in steps of 3 mJy/beam for the brightest epoch (2004 December 9) overlaid on a SuperCOSMOS B image. The MOST synthesised beam is drawn at the bottom left.



Radio transient J060938-333508. MOST and NVSS light curves indicating a single detection in 2004 at 21.3 mJy/beam and 3 non-detections.

archival images and analysed almost 30 000 light curves to reveal 53 highly variable sources and 15 transient sources. Three of the transient sources were already known (SN1987A, GRO 1655-40 and Nova Muscae 1991) with the remainder never having been classified as transient or variable. We suspect the majority of the sources are scintillating AGN, with the transients only occasionally appearing above our threshold. However, three of the sources appear to be associated with star forming galaxies at redshift around $z = 0.02$, possibly indicating the radio emission is related to some sort of stellar process.

Statistically we were able to conclude that if you survey the sky twice with a separation of about 6 months, you would find about 0.0013 transient sources and 0.27 highly variable sources per square degree, above about 14 mJy.

One of the key questions one can ask is 'How do you define a transient source?' This turns out to be a question which is more difficult than it first appears. One could argue that, if you wait long enough, the whole universe is transient! Whether something appears to be transient or not is a function of the number of measurements, measurement cadence, maximum interval and sensitivity, among other factors. We chose a simple definition that it had to be not detected (< 5 sigma) in at least one epoch and detected (> 6 sigma) in at least one epoch, and with a variability in flux that was unlikely to be explained by the instrument noise. Some of our transients have light curves consistent with explosive phenomena, while others seem to be variable sources occasionally appearing above our threshold (such as scintillating AGN), or flaring sources (such as X-ray binaries or flare stars).

One can similarly ask 'how do you define a variable source?' It is not sufficient to choose sources whose flux changes by some large fraction, as this simply selects a lot of light curves whether the scatter is due to measurement noise! Instead we developed a metric that took into account the measurement noise for each observation. Because we have such a large number of light curves, we were also able to confirm our estimates of the measurement errors and show that the highly variable sources where indeed far more variable than could be explained by the measurement noise alone.

Where to from here? We are putting the finishing touches on the paper (Bannister et. al. MNRAS 2010) and we have obtained follow-up radio observations with ATCA and optical spectroscopy with the WiFeS spectrograph on the RSAA 2.3m at Siding Spring, which we will publish next year.

Profile – Randall Wayth

Randall is a postdoctoral research fellow at Curtin University/ICRAR. He currently has fingers in several pies including: the V-FASTR project, CRAFT, the MWA, an Australia-India collaboration aiming to use the GMRT for VLBI and an EoR global signal project. He is also the chair of VAST Working Group 1!

What are your main research interests?

Galaxy formation and dynamics, the structure of AGNs, transient radio sources, the EoR, and low frequency radio astronomy instrumentation. I've also spent a fair amount of effort on simulating the MWA and the MWA's real-time data processing system.

What papers are you working on at the moment?

The main paper I'm currently working on is for the V-FASTR radio transient project, which runs commensally on the VLBA. This project looks for dispersed radio pulses that occur in regular VLBA observations in a purely commensal mode and really is and exploration of the unknown.

What excites you about ASKAP?

Someone else does all the calibration and imaging! Seriously though, ASKAP's forte is FoV and all the projects that take advantage of this are very exciting. The ones that are exploring unknown territory, like VAST, are most exciting.

What is the main challenge for Working Group 1?

For VAST, there is a fair amount of uncertainty about the source populations that will make up the variable and transient sky, which is of course, why we're looking. For ASKAP, we will see something of a paradigm shift in the data that scientists receive from the telescopes, with the onus for calibration and imaging part of the instrument itself. Our challenge in WG1 then, is to help the ASKAP calibration and imaging team understand their pipeline and how it responds to a variable sky on different timescales.

What do you enjoy outside astronomy?

Reading, growing vegetables, playing with my daughter, going out for brunch, motorbikes, footy and shooting the breeze with interesting people.

Working Group Reports

WG1 – Simulations and Imaging

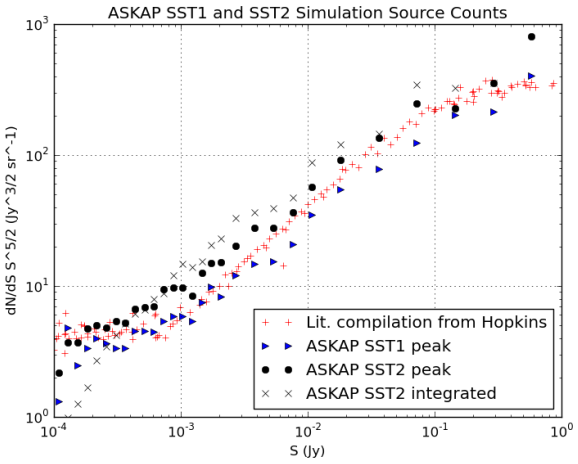
Randall Wayth

The WG1 team has been working to provide the ASKAP software team with generic methods to incorporate realistic variability into the existing database of SKADS sources, which are the basis for continuum simulations. Focus thus far has been on refractive interstellar scintillation (RISS), which will affect all compact sources to some degree. By using the properties of sources from the SKADS database combined with a model for the Galactic free electron density (NE2001), the ASKAP simulation team will be able to generate realistic variability in sources due to RISS on arbitrary timescales.

WG2 – Source Finding

Tara Murphy

WG 2 has focused on the evaluation of different source-finding programs. This has been led by Paul Hancock, who is testing various packages including Miriad, AIPS and SeXTractor. We are currently working on the simulated images from the ASKAP computing team - the aim is to identify how well the packages perform on a range of quantitative metrics. We are also comparing with Duchamp, the ASKAP source-finder to find areas in which it needs improvement.



Source counts from the ASKAP continuum simulations with a comparison to a compilation from the literature provided by Andrew Hopkins.

WG3 – Survey Strategy

Shami Chatterjee

VAST WG 3 members joined WG 3 members across other SSPs in the ASKAP. Cross-SSP discussion sessions, and have begun to investigate the effects of various ASKAP parameters on our optimal and minimal survey requirements. Should the ASKAP imaging pipeline for VAST discard short spacings in order to enhance point source detection capability?

We have chosen simulation parameters to compare images created with different amounts of short UV spacings discarded, and the next round of ASKAP simulations will help us answer this question.

WG4 – Hardware and Commissioning

Simon Johnston

We had a kick off meeting in mid August to talk about tests and science with BETA. Ideas for VAST include monitoring (and imaging) of bright variable sources, source finding and the fast survey mode of operation. We plan to define two test fields which contain a useful number of bright sources. One suggestion was the MWA EoR fields so that we have complementary low frequency observations. Once we choose some test fields, we plan to observe bright sources in these fields with the ATCA to monitor their variability. If you have opinions on appropriate fields, please email us!

WG5 – Data Format and Access

Hayley Bignall

The main activity of WG5 has been drafting an initial overview of the data requirements for VAST. Our data requirements differ from most of the other survey science projects in two obvious ways. Firstly, we need to store multiple epochs of data for each source. Secondly, the transient detection pipeline needs to access a database on 5-second timescales. We expect that the specific requirements will evolve as the design study progresses and during BETA commissioning.

WG6 – Transient Detection Pipeline

David Kaplan

We have continued to work through preliminary MWA data to assess the difficulty and prospects of using the array for transient identification. They are a very rich data set, but also present interesting calibration problems. We are awaiting new data from the X14 site visit to continue this work.

WG7 - Ongoing Science Projects

Duncan Galloway

Members of WG7 met via telecon in July to exchange progress reports and introduce new members Scott Hyman (SBC) and James Miller-Jones (Curtin). Scott is working on low-frequency monitoring of the Galactic centre with the VLA & GMRT, in collaboration with Joe Lazio. The MWA team have completed some observations in engineering verification mode, and members of the group have tested transient detection pipeline software successfully on these data. While some calibration issues remain, analysis should be complete within the year.

VAST has been discussed in many forums, most recently by Hayley Bignall at the Asia-Pacific Radio Science Conference.

News and Updates

SKAMP handover

Over the last few years, the Molonglo Observatory Synthesis Telescope has been transforming into SKAMP, via the addition of new low-noise amplifiers, digital filterbanks and an FX correlator. On Friday 10th of September we celebrated a major milestone in the project, the handover of the completed digital system from the CSIRO to The University of Sydney.

PiGSS paper published

The first paper describing the Allen Telescope Array PiGSS catalogue has been accepted for publication in ApJ and is available online at:

http://arxiv.org/abs/1009.4443

The paper presents the first 10 deg^2 region from PiGSS which was constructed from 75 daily observations over a 4-month period and has an rms flux density between 200 and 250 μJy.

NSF proposal success

An NSF proposal by Shami Chatterjee, David Kaplan, Geoff Bower, Jim Cordes and Dale Frail to study transients in the VLA archive was approved this month. The goals of the project are:

- To detect and characterize transient events in the archival record from 1980 to the present day;
- To understand the physical processes that produce variable and transient behavior;
- To develop a transient detection pipeline to be deployed at the Expanded VLA; and
- To develop algorithms, software pipelines, and expertise for the next generation of wide field radio surveys.

Membership and Publication Policy

We now have a VAST membership and publication policy, available on the wiki under Organisation/Policies. Feedback is welcome!