www.csiro.au

ATNF News

Issue No. 69, October 2010

ISSN 1323-6326

CSIRO Astronomy and Space Science – undertaking world leading astronomical research and operator of the Australia Telescope National Facility.

Two of CSIRO's new Australian Square Kilometre Array Pathfinder (ASKAP) antennas, close to the centre of the array, during assembly at the Murchison Radio-astronomy Observatory in September 2010.

Credit: Carole Jackson

A reflector dish is placed on its pedestal as one of CSIRO's new ASKAP anennas is assembled at the Murchison Radio-astronomy Observatory.

Credit: Ross Forsyth

Cover page image

Three newly constructed CSIRO ASKAP antennas pictured at the Murchison Radio-astronomy Observatory in Western Australia.

Editorial

Welcome to the October issue of *ATNF News* for 2010.

In this issue we report on a number of staff changes including the arrival of Dr Phil Diamond, on 1 June as new CASS Chief and ATNF Director, as well as the recent departures of Lewis Ball to the Atacama Large Millimeter Array (ALMA) and Dave DeBoer to the University of California, Berkeley. We wish both Lewis and Dave well in their new endeavours. You can read more about Phil Diamond's first impressions of CASS and the ATNF in his column on page four.

In other news, we report on CASS success at being awarded three of the Australian Research Council's new Super Science Fellowships. The Fellowships, worth a total of $835,000 over three years, will help develop technology for the future international Square Kilometre Array (SKA) radio telescope.

In other newsletter highlights, we feature a number of science articles, all based on the fantastic research that is being undertaken at our observatories. In the first, Roberto Soria reports on a new Compact Array study of a microquasar in the galaxy NGC 7793. His research suggests that the true power of black hole jets is a thousand times larger than the power estimated from observed radio emissions. We also feature an article by Michael Keith and collaborators, who report on the intriguing discovery of a magnetar, by its radio emission alone.

Also on a science front, Professor Steven Tingay reports on successful VLBI observations undertaken using the first of the ASKAP antennas to be installed at the Murchison Radio-astronomy Observatory, along with a new 12-m antenna installed at Warkworth in New Zealand.

We also feature a report on the MALT-90GHz survey, and examine how this activity has been used as a demonstration project in the development of a Science Operations Centre in Sydney.

In other news, Phil Edwards looks at the Japanese solar sail mission IKAROS — successfully tracked by the Mopra telescope; we report on this year's CASS Radio Astronomy School held recently at the Narrabri Observatory; Chris Hollingdrake details a successful public open day at the Compact Array; and Kjetil Wormnes undertakes the International Space University's Space Studies Program in France.

As always, we provide our regular in-depth update on CSIRO's Australian Square Kilometre Array Pathfinder (ASKAP) and SKA related activity. As we go to print, the ASKAP project remains well on track with staff currently busy at the MRO site, constructing ASKAP antennas numbers 2-6.

To conclude, we finish with our regular Operations report.

If you would like to contribute to future editions of the ATNF News, please contact the newsletter team.

Tony Crawshaw and Joanne Houldsworth

The ATNF Newsletter Production Team (newsletter@atnf.csiro.au)

Contents

From the Chief of CSIRO Astronomy and Space Science

Phil Diamond

Chief of CASS

In years past I would receive, originally by post and then more recently via a URL, a copy of the ATNF Newsletter. I was always admiring of the Newsletter: a professional looking document with a range of articles of interest to the users of the ATNF and the wider community. I now find myself in the role of the Chief of CSIRO Astronomy and Space Science (CASS) and the Director of the ATNF and so it is a pleasure to write the "Chief's Column" for the first time.

To begin, I'd like to take the opportunity to give my views on the current status of the Division and the ATNF as well as to elaborate, to some extent, on future strategic direction. Since starting this role on the 1 June 2010 I've discovered that there is no getting away from the fact that CASS and the ATNF are embedded within CSIRO, a large organisation of 6,500 people. This brings with it various challenges and opportunities. One personal challenge is that I've had to learn CSIRO-speak at which I am told, to my dismay, that I am already alarmingly proficient. More seriously, I have been impressed at the huge support that CSIRO and the Australian government provide for radio astronomy, a sum exceeding $300M over the last few years. This support is driven both by the excellent science undertaken with the current facilities (see articles elsewhere in this Newsletter) and the huge potential opportunity of the SKA and the local precursor project, ASKAP.

Opportunities however also bring challenges. A big issue facing CASS and the Australian astronomy community is the rapidly changing strategic landscape. CSIRO is building ASKAP and aims to be delivering science to the user community in 2013. One immediate challenge is ensuring that we have the full operating funds for ASKAP and the existing ATNF facilities, an issue that is being vigorously pursued right now.

In the slightly longer term we need to understand what might be the impact of the SKA on radio astronomy in Australia. As I write, I am preparing to attend a series of high-level SKA meetings in Oxford, which will be taking decisions vital for the future of the project. As we see the outcomes of these meetings the future structure of the SKA will become clearer and then, of course, we need to know where the SKA will be located. All of these issues will have implications for radio astronomy across the planet.

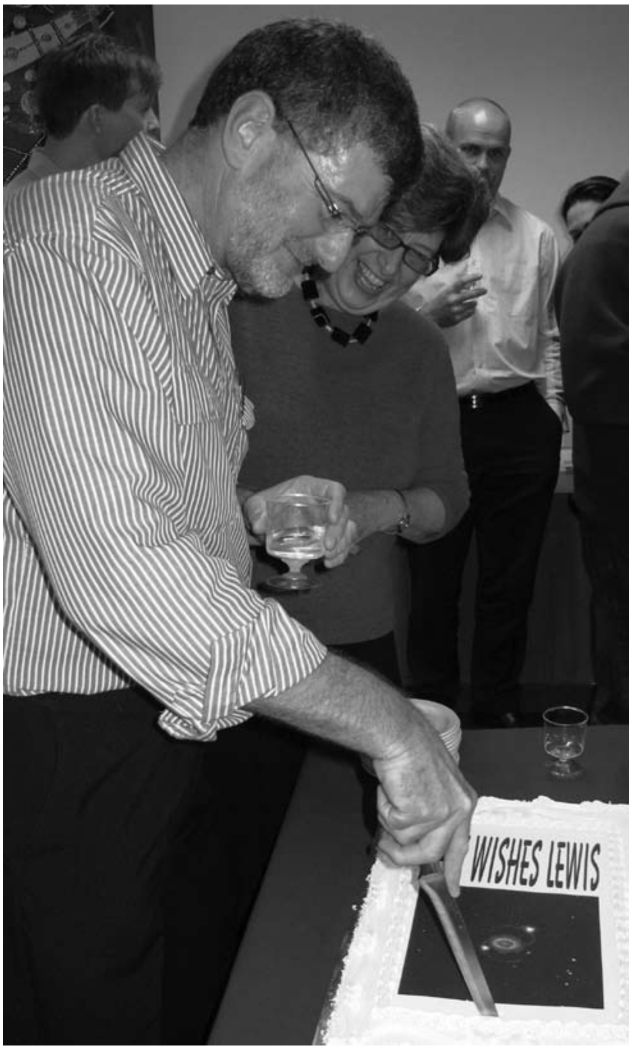
To conclude the column, I'd like to share with you one of the principal attractions of coming to lead CASS — and that's the chance to work with such an excellent team. Australia and CSIRO in particular, have always had a world-class reputation in radio astronomy. This is still the case. People express concern when essential senior staff approach retirement. I worry less, especially when I see the quality of the young engineering team here at CASS. This is a talented team that is oriented towards the future.

I hope you enjoy reading this issue of the ATNF Newsletter. These are exciting times for radio astronomy Down Under.

CASS Organisational Change

Tony Crawshaw (CASS)

Since the previous issue of ATNF News (April edition), CSIRO Astronomy and Space Science has seen a number of organisational and personnel changes.



Lewis Ball - "best wishes" for the future
Credit: Flo Conway-Derley, CSIRO.

June 1st saw Dr Phil Diamond on board as CASS Chief, arriving from his previous role as Director at the Jodrell Bank Centre for Astrophysics at the University of Manchester.

Lewis Ball announced his departure as Deputy Chief of CASS to take up a new role as the Deputy Director for ALMA, the ~US$1B Atacama Large Millimeter Array. Graeme Carrad has taken on the role of Acting Deputy Chief of CASS (effective 17 September) with a search to recruit a new Deputy Chief currently underway.

Dave DeBoer, ASKAP Project Leader will be leaving CSIRO in early October and is moving back to UC Berkeley to take up a post working on the Allen Telescope Array and other projects. The post became available as a result of the untimely death of Don Backer. As a result of this move, Ant Schinckel replaced Dave DeBoer as ASKAP Leader in a substantive appointment on 1 September.

In other role changes, CSIRO's SKA Director Brian Boyle has become the Project Director for the Australia – NZ SKA site bid, spending 80% of his time on secondment to the Department of Innovation, Industry, Science and Research.

We wish everyone well in their new appointments and thank Lewis and Dave for their many years of service within CSIRO.

ASKAP and SKA News

Florence Conway-Derley (CASS)

Antenna construction underway at the MRO

As this article goes to print, construction of CSIRO's next five Australian Square Kilometre Array (ASKAP) antennas is well underway at the Murchison Radio-astronomy Observatory (MRO).

The initial manufacture of ASKAP antennas 2 – 6 was completed on schedule earlier in the year, with the antennas passing factory acceptance testing in July. Antenna build on site, site acceptance testing and commissioning then took place during September and October.

Technology Update

The ASKAP project continues to reach key milestones, progressing towards successful delivery of the project.

- Two prototype ASKAP prime focus receivers are being designed and assembled, and are destined for testing at the Parkes Testbed Facility (PTF) and at one of the ASKAP antennas.
- Data networks have taken on a three tier development; with networks specific to the testbed at CSIRO's Marsfield site, at Parkes, and at the ASKAP site, the Murchison Radio-astronomy Observatory (MRO).
- Prototype assemblies for test and engineering software have been developed, and initial integration of an ASKAP testbed system at CSIRO's Marsfield site has been achieved with a preliminary connection (in the lab) of the analog pedestal system to the digital system.
- Design of civil works, building and power and data distribution at the MRO is now complete; a prototype ground-coupled cooling system has been trialled at the site of the first antenna and preliminary design work has commenced for a solar/diesel hybrid power plant.
- The long-haul fibre link from Geraldton to the MRO is progressing well with AARNET; civil works have commenced with the route surveyed and pegged for direct burial fibre along the 390 km route.
- A process to validate the electromagnetic compatibility (EMC) of all equipment destined for the MRO is in place, with an EMC test facility operational at CSIRO's Marsfield site.
- Monitoring of radio frequency interference (RFI) at the Australasian core site for the SKA has concluded.

General News

CSIRO-ASTRON to Collaborate on the Development of Phased Array Feeds

During the *International SKA Forum (ISKAF2010)*, held in Assen in June 2010, CSIRO and the Netherlands Institute for Radio Astronomy (ASTRON) signed a Statement of Intent to cooperate on the development and testing of phased array feed technology for the SKA.

The partnership is an example of the cooperation needed to bring a monumental undertaking such as the SKA project to fruition.

The collaboration pools world-leading expertise from ASTRON and CSIRO to develop phased array feeds for future radio telescopes. The wide field of view capability that phased arrays offer would fully exploit the science potential of the SKA.

CSIRO delivers new SKAMP Digital System

A major milestone has been reached for the Square Kilometre Array Molonglo Prototype (SKAMP) project with the delivery of its new digital correlator. CSIRO officially handed-over the completed digital system to the SKAMP team in September.

Over the last few years, the Molonglo Observatory Synthesis Telescope (MOST) has been transforming from the narrowband MOST (4-MHz centred at the operating frequency of 843-MHz) into SKAMP — a significant SKA prototype.

SKAMP increases the bandwidth, sensitivity, field of view and adds spectral line capabilities of MOST by the installation of a correlator. Greatly improved calibration of astronomical data and significantly improved image quality can be achieved.

Representatives from CSIRO, ASTRON and SPDO celebrate the signing of the Collaborative Agreement at ISKAF 2010. From left: Richard Schilizzi (SPDO), Dr Brian Boyle (CSIRO), Dr David DeBoer (CSIRO), Wim van Cappellen (ASTRON), Dr Carole Jackson (CSIRO), Dr Mark Verheijen (ASTRON), Dr Tom Oosterloo (ASTRON), and Professor Mike Garrett (ASTRON). Credit: Hans Hordijk

CSIRO SKA Director Dr Brian Boyle hands over a correlator board to SKAMP Project Leader Prof Anne Green. Credit: Tony Crawshaw, CSIRO

In SKAMP, the data is received by an analog system and digitised before being sent to the correlator. The correlator processes this data into a form that is then used to generate radio images and spectral cubes; this is the astronomer's "result".

The development of the digital correlator has been a joint collaboration between CSIRO and the University of Sydney, with the ASKAP Digital Systems team providing a major part of the technical and implementation expertise. CSIRO is also building the digital correlator for the Murchison Widefield Array (MWA) SKA Precursor project.

ASKAP is building on the digital systems design developed for both the SKAMP digital systems and the Compact Array Broadband Backend installed at the Australia Telescope Compact Array (ATCA, Narrabri NSW).

SKAMP was also recently designated an official SKA Pathfinder project by the SKA Science and Engineering Committee (SSEC). It was determined that SKAMP's contribution satisfied the Pathfinder criteria within the areas of technology, science and operations.

The next (final) stage of the SKAMP project will see the installation of a new electronically-steered wide-band feed system capable of observing over an expanded frequency range (700 MHz – 1100 MHz).

Renewable Energy Solutions to Support the SKA

With funding from the Sustainability Round of the Australian Government's Education Investment Fund (EIF), CSIRO will utilise full-scale, clean energy technology to support the Australia – New Zealand bid to host the international SKA project.

The *Sustainable Energy for the SKA project* will develop renewable energy technologies to help power the MRO. This includes CSIRO working to develop a collaborative partnership with Western Australia's Horizon Power to develop a solar/diesel power generation system for ASKAP and other telescopes under construction at the MRO. The funding also allows a variety of demand-side management technologies to be implemented.

Additionally, the nation's largest direct heat geothermal demonstrator will be developed to help cool ASKAP's support computing facility, the Pawsey High Performance Computing Centre for SKA Science based in Perth.

As both the MRO and the Pawsey Centre will have high electricity demands, a combination of on-site geothermal and renewable systems will deliver clean, green energy and provide a reduced carbon footprint with ongoing demand-side management.

Working with Melbourne-based company Direct Energy, CSIRO has already installed a prototype geoexchange system at the site of ASKAP's first antenna. This technology has the potential for long term sustainability, using the ground as a heat sink to reduce the telescope's overall energy use.

Super Science Fellowships Awarded to CASS

Tony Crawshaw (CASS)

CSIRO has been awarded three of the Australian Research Council's new Super Science Fellowships, worth a total of $835,000 over three years, to help develop technology for the international Square Kilometre Array (SKA) radio telescope.

The announcement was made in April 2010, by Senator Kim Carr, Minister for Innovation, Industry, Science and Research.

The aim of the awards is to give early career researchers the opportunity to work in areas of national significance. Space science and astronomy is one of the three areas targeted by the Super Science Fellowships — the other two are marine and climate science, and future industries (biotechnology and nanotechnology).

The three CSIRO Fellows are likely to be in place by the end of the year. One will be working on refining the innovative radio camera (or phased array feed) of the Australian Square Kilometre Array Pathfinder (ASKAP) telescope. The other two will be solving some of the technical challenges of the highest priority all-sky surveys being carried out with ASKAP; the WALLABY survey of neutral hydrogen emission of the nearby universe and the EMU survey of the continuum sky. ASKAP is currently being built at the Murchison Radio-astronomy Observatory in the mid west of Western Australia.

Robert Braun, Head of Astrophysics at CASS commented, "The Super Science Fellowships provide a vital contribution to enabling world-class science in Australia. The three CSIRO fellows will play a key role in facilitating that science with ASKAP and further refining our cutting edge, wide-field technology so that it is SKA-ready."

Support for SKA related science was evident in the Minister's announcement, with twenty-one of the one-hundred new Fellowships announced, going towards research related to the development of SKA pathfinder instruments in Australia or the use of those instruments to undertake ground-breaking research.

ASKAP and SKA related Fellowships went to Curtin University of Technology, The University of Western Australia, the Anglo-Australian Observatory, the University of Sydney, the University of Tasmania, Swinburne University of Technology, the University of Melbourne and Monash University.

Distinguished Visitors

Robert Braun (CASS)

Over the past months we have enjoyed working visits from Jianping Yuan (Urumqi Obs,ervatory China), Ding Chen (Chinese Acadamy of Sciences, China), Marchella Massardi (Instituto Nazionale di Astrofisica, Italy), James Jackson (Boston University, USA), Martin Cohen (University of California Berkeley, USA), Bill Coles (University of California, San Diego, USA), Marianne Lemoine (Bordeaux, France), Thierry Reposeur (Bordeaux, France) and Marie-Helene Grondin (Bordeaux, France).

Upcoming visitors we expect include Dale Frail (National Radio Astronomy Observatory, USA) and Patricia Henning (University of New Mexico, USA).

The Distinguished Visitors program remains a very productive means of enabling collaborative research projects with local staff, adding substantially to the vitality of the research environment. Visits can be organised for periods ranging from only a few weeks up to one year.

For more information please see

www.atnf.csiro.au/people/distinguished_visitors.html

Prospective visitors should contact the local staff member with the most similar interests.

Education and Outreach

Rob Hollow (CASS)

PULSE@Parkes

With the recent PULSE@Parkes observing session held at the Victorian Space Science Education Centre (VSSEC) in September 2010, over 500 students from 47 schools have now observed remotely with the 64-m CSIRO Parkes radio telescope. Regular sessions have been held at the CASS Marsfield site, with another recently held at SPICE in the University of Western Australia as part of National Science Week activities in August. The interstate sessions involve students from a number of schools coming together for an intense day of background talks, observing and data analysis. Interest in the program continues to grow and it was featured as part of an article in the *Sydney Morning Herald* about the search for gravitational waves at Parkes.

The program continues its international expansion with students from Emelwerda College in the Netherlands controlling *the Dish* in May during the second international PULSE@Parkes event hosted and supported by ASTRON. Project Coordinator Rob Hollow and team member Dr David Champion from Bonn were assisted by several ASTRON staff including regular Parkes observer Dr Marijke Haverkorn. The students showed great interest in the session and were the first group to see one of the project's nulling pulsars actually turn on whilst being observed.

Teacher Workshops and School Events

The highly popular *Astronomy from the Ground Up* teacher workshop held at the Parkes Observatory in May saw a record number of 30 teachers participate in the three-day event. A diverse range of talks, workshop sessions, practical activities, a viewing night and a telescope tour kept the teachers engaged and stimulated. Some of the participating teachers also presented sessions, sharing with other participants, the activities that they and their students undertake.

CASS Education Officer Rob Hollow also ran a one-day workshop *Teaching Astronomy and Astrophysics for the VCE* in collaboration with VSSEC at Scienceworks in Melbourne in April. CSIRO SKA Director Dr Brian Boyle gave the prestigious *Stanhope Oration* at *CONASTA 59*, the annual national conference for Australian Science Teachers. His talk *The Square Kilometre Array: Inspiring the Next Generation and beyond* was extremely well received and prompted lengthy discussion and questions. Rob Hollow also ran workshop sessions at the conference. He also presented a session on careers in science at the second *Mid West Youth Science Forum* in Geraldton in July as well manning the astronomy desk with Professor Steven Tingay from ICRAR for a Q&A session with Year 10 students.

CSIRO's Rob Hollow linking Dutch students to the Parkes telescope. Credit: CSIRO

Graduate Student Program

Baerbel Koribalski (CASS)

We would like to officially welcome the following students into the ATNF co-supervision program.

- Vanessa Moss (University of Sydney): *Low and intermediate velocity HI clouds in the Milky Way* with supervisors Dr Tara Murphy and Dr Naomi McClure-Griffiths (CASS).
- Yanett Contreras (Universidad de Chile): *Study of filamentary structures in the southern galactic plane* with supervisors Dr Guido Garay (Universidad de Chile) and Dr Jill Rathborne (CASS).
- Kathrin Wolfinger (University of Swinburne):*The effect of environment on the evolution of gas-rich spiral galaxies* with supervisors Dr Virginia Kilborn, Dr Emma Ryan-Weber (both University of Swinburne), and DrBaerbel Koribalski (CASS).

Congratulations to the following graduating students.

- Urvashi Rao Venkata (Department of Physics, New Mexico Institute of Mining and Technology, Socorro, NM, USA): *Parameterized Deconvolution for Wide-Band Radio Synthesis Imaging.*
- Paul Hancock (University of Sydney): *The Australia Telescope 20 GHzSurvey and the Search for Young Radio Galaxies.*
- Emma Kirby (Australian National University): *Sharing the Baryons: Stars and Gas in Local VolumeGalaxies.*
- Alyson Ford (University of Swinburne): *The HI Cloud Population in the Lower Halo of the Milk Way.*
- Shari Breen (University of Tasmania): *Masers as evolutionary tracers of high-mass star formation.*

Dr Shari Breen is now a Bolton Fellow at ATNF, CSIRO Astronomy & Space Science.

Dr Urvashi Rao Venkata is now working at the National Radio Astronomy Observatory Science Operations Center.

Dr Alyson Ford is now a postdoc at the University of Michigan, USA.

Dr Paul Hancock is now a postdoc at the University of Sydney.

Well done !

A summary of the ATNF Graduate Student Program, current and past students, as well as new application forms can be found at

http://www.atnf.csiro.au/research/graduate/scholars.html

Images clockwise from top left: Urvashi Rao Venkata, Paul Hancock., Alyson Ford, Emma Kirby, and Shari Breen, Images courtesy Baerbel Korabilski.

Australia Telescope Compact Array Open Day

Chris Hollingdrake (CASS)

More than 700 people took advantage of the rare opportunity to get a closer look at the Australia Telescope Compact Array (ATCA) during the recent Open Day on the 17 July. The Open Day aims to give the public an increased understanding of radio astronomy and the research that we undertake.

Two things generally help to ensure a successful Open Day — lots of enthusiastic volunteers and beautiful weather. This year we had the perfect combination of both. Around fifty volunteers donated their time to help showcase the great work of our division, and Narrabri put on perfectly clear blue skies. Our volunteers came from around the state including staff from Narrabri, Marsfield, Parkes and Tidbinbilla.

Attendance was up twenty percent on the previous Open Day. Early planning and demographic surveying of the previous Open Day allowed us to target our promotional activities in the region. Family groups were by far the most common attendees.

The most popular activities were the antenna tours, control building tours and astronomy and space science talks. Antenna tours ran continuously throughout the day, with the compact configuration of the array allowing us access to four antennas. These guided tours took visitors up and inside the antennas and allowed our Compact Array experts to share their enthusiasm and test their knowledge with the many tricky questions thrown their way.

Four talks were held across the day with each being well attended. Dr Jamie Stevens presented *Under the hood of the Compact Array*, Dr Phil Edwards presented *From the Universe to Culgoora*, Glen

Caption: Visitors make their way around the Observatory. Credit: Cornelia Kellenberg

Nagle from Tidbinbilla presented *Bootleg postcards: Participatory exploration of distant worlds* and Professor Jim Jackson presented *Star birth and snaky dark clouds*.

CSIRO Education supported the Open Day with their fantastic hands-on physics displays. CSIRO Education officer, Mitch Serena, did a great job entertaining many of the families, dazzling them with fun and educational demonstrations. A visit by the local scout group tested the durability of both Mitch and his equipment. The laughter and excitement of the group indicated the activity was a good match for this age group.

Other activities offered included solar telescope viewing, a science and astronomy education shop, face painting and a jumping castle. The assortment of quality activities saw visitors staying longer at the Open Day. Some families spent the entire day at the observatory.

One of the major benefits of holding open days is the opportunity for CASS staff to socialise away from our usual places of work. The Saturday night barbeque was a great success. Thank you to the Narrabri staff for putting on such wonderful hospitality. The evening topped off a great weekend.

Thank you also to all the volunteers who made the Open Day such a great success and I look forward to our next Open Day in Parkes in 2011.

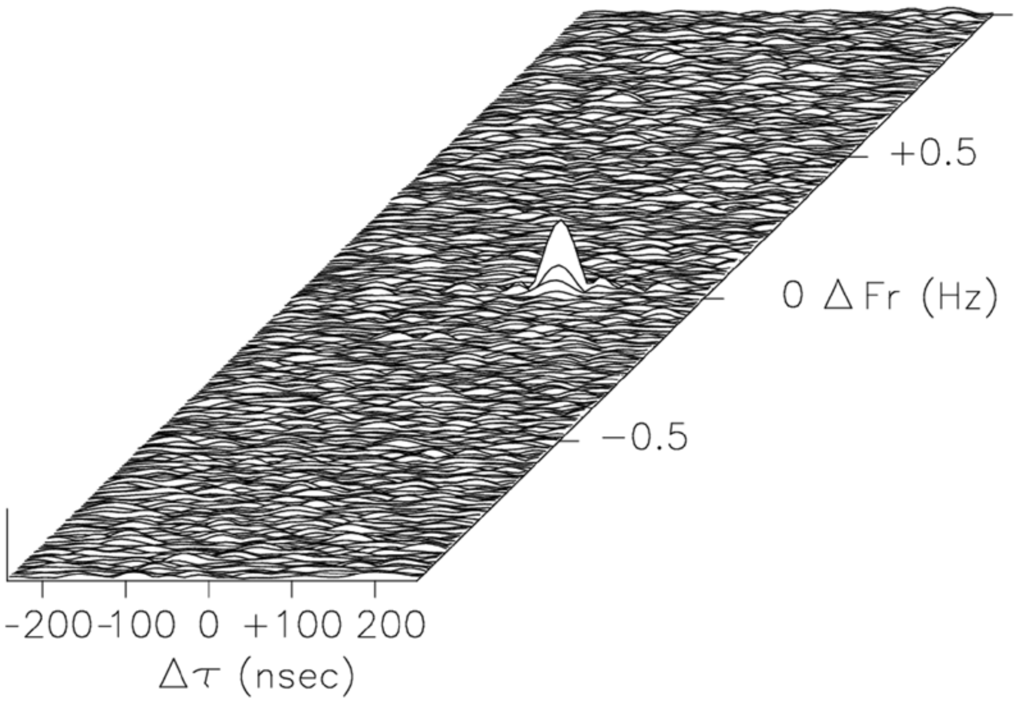
Shane O'Sullivan and Angela Hein, two of the many volunteers that helped out on the day. Credit: Tony Crawshaw, CSIRO

Visitors wait for their antenna tour. Credit: Cornelia Kellenberg

CASS Telescopes Track IKAROS

Phil Edwards

CASS's Mopra radio-telescope and CDSCC's Tidbinbilla antennas were used in August as part of a program to track the Japanese solar sail mission, IKAROS.
The Interplanetary Kite-craft Accelerated by Radiation Of the Sun (IKAROS) is an experimental spacecraft of the Japan Aerospace Exploration Agency (JAXA). The main purpose of a Japanese H-IIA rocket launch on 21 May this year was to send the Akatsuki spacecraft on its way to Venus. The opportunity was also used to launch four other small spacecraft, one of which was the 300kg IKAROS craft.



This figure shows the successful search for interferometric fringes on the baseline between the Mopra 22-m telescope and the Usuda 64-m telescope in Japan. The data used to produce this figure are from an 81 second integration at 8.4-GHz on PKS 1354-17, which was used as a phase reference calibrator for IKAROS spacecraft from the observation on 1 July, 2010. The x-axis shows the delay residual, and the y-axis shows the residual rate. The fringes can be seen at a delay of 62 nanoseconds, and a rate close to zero.

IKAROS is the first spacecraft to use solar sailing as the main means of propulsion. Unfurling of the sail, which is made of a polyimide membrane 7.5 micrometres thick — thinner than a human hair! — was completed on 10 June. The sail is square in shape and measures 14 metres on each side. Thin-film solar cells are integrated into the sail to power the spacecraft payload, and eight LCD panels are embedded in the sail to control the orientation of the spacecraft by electronically adjusting the reflectance of each panel.

On 9 July, JAXA announced that they had detected the very slight acceleration of the spacecraft due to the pressure of sunlight on the solar sail. The main spacecraft payload includes the on-board computer and antennas to receive commands from Earth and transmit signals back. By measuring the time taken for signals to be transmitted from Earth to IKAROS and returned, the distance to the spacecraft and the speed with which it is receding can be calculated. However this technique does not allow the position of the spacecraft on the sky to be determined, and that's where a network of radio telescopes is coming to the rescue.

IKAROS includes a transmitter that sends a series of tones in the 8-GHz band, and by detecting these with a widely-spaced array of radio telescopes (using the technique of Very Long Baseline Interferometry), the spacecraft's position in the plane of the sky can be accurately determined, perfectly complementing the method of timing signals to and from the spacecraft, which constrain the position along the line of sight.

The JAXA coordinator of these observations, Dr Hiroshi Takeuchi, notes "Long north-south baselines are vital, because the conventional range and range-rate based orbit determination has less sensitivity to the Declination component of the spacecraft position when the declination of the spacecraft is low. The long Australian – Japanese baselines are ideal for evaluating the performance of the VLBI-based orbit determination for IKAROS."

Dr Chris Phillips, who arranged the Mopra observations, commented "These observations demonstrate the strides made recently with international compatibility. We were able to easily observe the spacecraft with standard LBA setups then transfer all the data electronically to Japan for processing."

The Mopra observations were conducted with the kind cooperation of the MALT-90 survey team, who were willing to give up the 1~2 hour blocks required for the IKAROS observations and who were able to be compensated with additional time on other days.

Radio telescopes in Japan, China, and Australia are collaborating in this venture. In Australia, besides Mopra and Tidbinbilla, the Hobart dish operated by the University of Tasmania, and the European Space Agency's antenna at New Norcia in Western Australia have been used.

The orbit of IKAROS will take it past Venus in December this year, and then on a three year journey to the far side of the Sun as seen from the Earth. However there is only a limited opportunity for radio astronomers to contribute: as the orientation of the spacecraft changes, the antenna transmitting the series of tones will end up pointing further and further away from the Earth. The next chance to use this technique may come in March 2011, but as the nominal lifetime for IKAROS is only 8 months, it may not live long enough to "talk" to us again next year.

The initial successes of IKAROS are likely to pave the way for other solar-sail spacecraft, with both the USA and Japan developing plans for future missions based on this "energy efficient" approach.

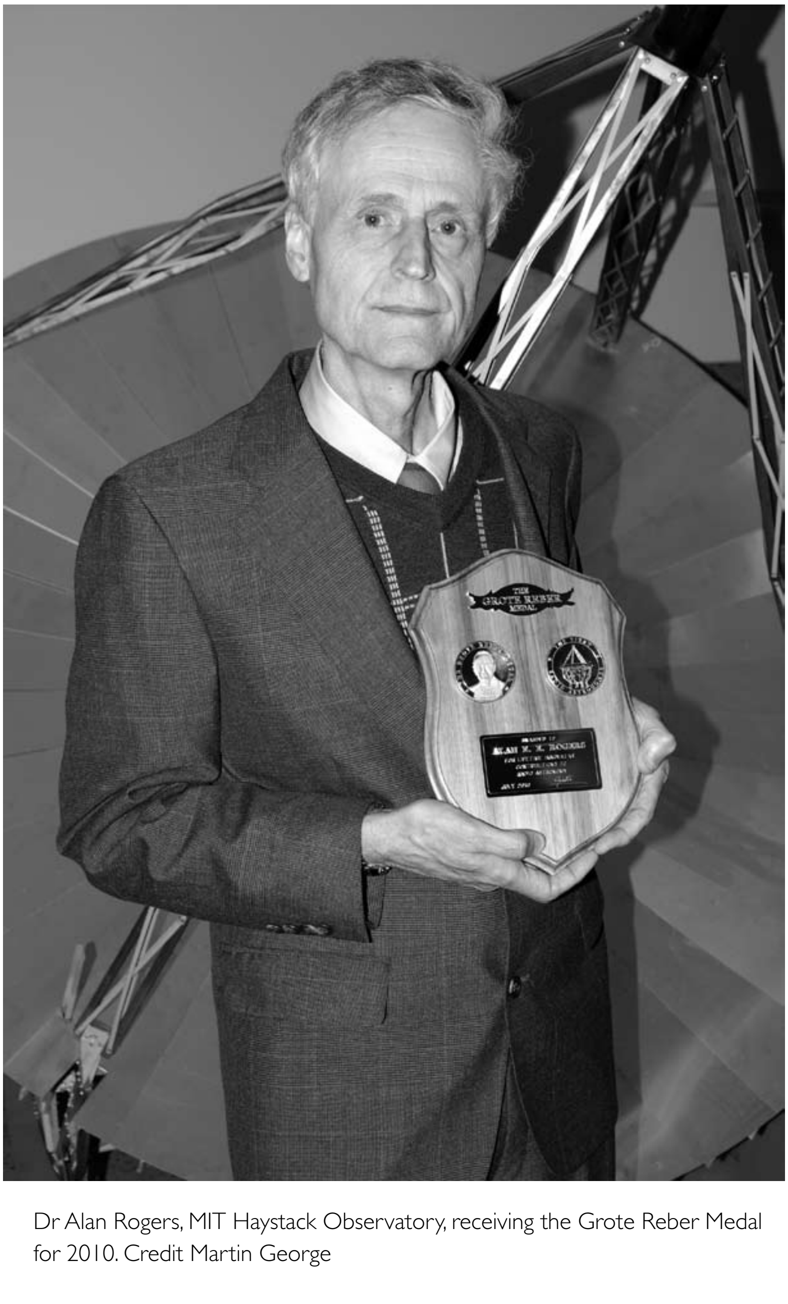
2010 Grote Reber Medal Awarded to Alan Rogers

Helen Sim (CASS)

The 2010 Grote Reber Gold Medal for outstanding and innovative contributions to radio astronomy has been awarded to Dr Alan Rogers, a Research Affiliate at the Massachusetts Institute of Technology Haystack Observatory. Rogers is being honoured for his many pioneering developments in radio and radar interferometry, radio spectroscopy, and for his application of radio astronomy techniques to society.

The Medal was presented on 7 July 2010 in Hobart, Tasmania, at the annual meeting of the Astronomical Society of Australia. The Reber Medal was established by the Trustees of the Grote Reber Foundation to honour the achievements of Grote Reber and is administered by the Queen Victoria Museum in Launceston, Tasmania.

The previous winners of the Grote Reber Medal have been Professor Bill Erickson (University of Maryland, 2005), Professor Bernard Mills (University of Sydney, 2006), Professor Govind Swarup (Tata Institute of Fundamental Research, 2007), Dr Sander Weinreb (Caltech–



Dr Alan Rogers, MIT Haystack Observatory, receiving the Grote Reber Medal for 2010. Credit Martin George

Jet Propulsion Laboratory, 2008) and Dr Barry Clark (National Radio Astronomy Observatory, 2009).

Alan Rogers received his B.Sc. degree in mathematics and physics from the University College of Rhodesia in 1962, and his S.M. and Ph.D degrees in Electrical Engineering from Massachusetts Institute of Technology in 1964 and 1967 respectively. Following a year as a Lecturer at the University of Zimbabwe in 1968, he has since been at the Haystack Observatory where he was the Associate Director until his retirement in 2006.

Rogers is best known for his contributions over many decades to the techniques of Very Long Baseline Interferometry. More recently, he developed an innovative radio array which he successfully used to detect the 327 MHz line of interstellar deuterium, capping a 40-year quest for this important astrophysical atomic gas. He was also the leader of a program to apply radio astronomy techniques to locate emergency calls from mobile telephones.

Rogers is now working with Judd Bowman of Caltech on an Epoch-of-Reoinisation project, the Experiment to Detect the Global EoR Signature (EDGES). The aim of this NSF-funded experiment, which uses a single low-frequency dipole antenna and a high dynamic-range radio spectrometer, is to detect the cosmological epoch of reionization (EoR), a significant but poorly understood period in the history of the Universe. The experiment measures the all-sky radio spectrum between 100 and 200 MHz in order to probe the global evolution of 21-cm emission from neutral hydrogen gas at high redshift. In this type of measurement, reionization should produce a faint, step-like contribution to the spectrum that is superimposed on the much brighter Galactic synchrotron foreground. The observed frequency of the "step" and its sharpness encode both the redshift and duration of the reionization epoch. The EDGES antenna and receiver were deployed in August 2009 at the Murchison Radio-astronomy Observatory in Western Australia (Australia and New Zealand's candidate site for the SKA core). The first three-month deployment of EDGES was successful, and yielded constraints on reionization that have implications for future EoR experiments.

Who was Grote Reber? For almost a decade—1937 to 1946—he was the world's sole radio astronomer. Born in Wheaton, Illinois, in 1911, he moved to Tasmania in 1954 and spent more than half of his long life there. (He died in 2002.) Reber's achievements include:

- in 1937, building the world's first purpose-built radio telescope (a 9.75-m diameter dish);
- in the late '30s and early '40s, making the world's first detailed radio map of the sky (published in 1944). This was done at 160 MHz, and showed for the first time the Galactic Centre in Sagittarius, the radio source Cassiopeia A, and the first observational evidence for spiral arms in our Milky Way Galaxy;
- in the early 1940's, being the first to publish the detection of radio emission from the "quiet" sun and the intense radio emission associated with solar activity.
- in the early 1950s, becoming the first astronomer to build a high-altitude observatory in Hawai'i (on Mt Haleakala); and
- from the mid 1950s, building the first "Square Kilometre Array" — an array of dipoles covering an area of one square kilometre in central Tasmania. This operated at a frequency of 2.13 MHz. In the 1960s Reber mapped the southern sky with this telescope.

Next year, 2011, is the 100th anniversary of Grote Reber's birth.

For more information please see the Grote Reber Medal homepage

http://www.qvmag.tas.gov.au/?articleID=539

2010 CASS Radio Astronomy School

Phil Edwards (CASS)

The 2010 CASS Radio Astronomy School was held at the Narrabri Observatory from Monday 27 September to Friday 1 October. A total of 45 participants attended, with a number of students travelling from China, South Korea, and New Zealand for the School.

The program of talks included introductions to radio astronomy fundamentals by Jay Lockman (NRAO Green Bank) and John Reynolds, and to the principles of interferometry by Rick Perley (NRAO Socorro). CASS Chief Phil Diamond gave a talk on next generation radio telescopes. Tara Murphy described the astronomers IT toolkit, with information on the software packages and computing skills that are becoming increasingly important in all fields of astronomical research. John Storey rounded out Monday's program by taking his audience on a tour of telescopes of the world, replete with tales of their germination, growth, and harvesting!

The School Dinner was held in Narrabri on Monday evening, with Steven Tingay giving an after-dinner talk entitled *Connecting radio astronomy with indigenous culture in Western Australia*, which described a successful introduction to the Murchison Radio Astronomy Observatory and cultural exchange of astronomical stories, which inspired indigenous artists to capture the experience on canvas, leading to a series of national and international exhibitions.

Tuesday talks focussed more on the specifics of using the Compact Array, with Alex Dunning and Dick Ferris giving an overview of the front-end receiver design and back-end processing electronics. Maxim Voronkov described observing strategies and Kate Brooks gave particular attention to aspects of mm-wavelength observing. The tutorial session on Tuesday took full advantage of the availability of Mopra on the day, with all four tutorial groups having the chance to see Mopra put through its paces. Other sessions on the Tuesday were "Q&A with Rick & Jay", an introduction to ATCA observing, and an antenna tour.

Robert Braun kicked off Wednesday with an introduction to Fourier Transforms, which had the unintended consequence of a couple of cats and one Radio School student being Fourier Transformed in subsequent days! Jamie Stevens introduced calibration and editing, and Emil Lenc walked the students through imaging and deconvolution, before Naomi McClure-Griffiths described various approaches to data analysis. This placed the participants in good stead for the Wednesday and Thursday tutorial sessions, which were divided into scheduling an ATCA observation, hands-on ATCA observing, and data reduction. Thanks to the Sydney University Stellar Interferometer team, who were visiting that week, participants were also able to have a guided tour to SUSI. Fortunately the skies cleared in time for participants to enjoy optical views of the night sky before and after wood-fired pizzas on site at the Observatory. After dinner, Jay Lockman gave an entertaining pictorial history of the Green Bank Observatory.

Thursday's program started with Steven Tingay describing error recognition, which was followed by an introduction to polarisation by Dave McConnell (and his Poincare spheres!). Galvanised by another cup of coffee, students returned for Rick Perley to further stoke the polarisation furnace and distill an improved understanding, sullied only by some remaining D-terms. Mark Wieringa concluded the morning with a review of observing

Participants of the 2010 CASS Radio Astronomy. School Credit: Emil Lenc

sensitivity and the approaches to attempting to improve it.

The school concluded on Friday with an overview of VLBI by Jamie Stevens, an introduction to wide-field imaging by Maxim Voronkov, and a description of OPAL and ATOA by Jessica Chapman. The school wrapped up with a BBQ lunch with Narrabri staff, and a opportunity to join a tour to Sawn Rocks in the afternoon.

The efforts of all Narrabri staff in setting up the Visitors Centre for the school and in keeping participants well-fed, caffeinated, transported, and educated are applauded, particularly the unstinting efforts of Jo Houldsworth and Marg McFee in keeping everything running smoothly!

All speakers, and additional tutors John Bateman, Shari Breen, Jimi Green, Balt Indermuehle, James Urquhart, Robin Wark, and the SUSI team, ensured the week was a great success. Finally, the contribution of financial support from the Donovan Trust is gratefully acknowledged.

In France at the International Space University's Space Studies Program

Kjetil Wormnes (CASS)

In July and August of 2010, with the fantastic support of CASS, I was fortunate enough to attend the International Space University's (ISU) Space Studies Program (SSP). The annual program is held at international facilities — last year at NASA AMES and this year at the main campus of the ISU in Strasbourg, France. All aspects of space-related activity are covered over the intensive nine week program.

And what a time it was. There were 36 countries represented by 122 participants and various attending lecturers, as well as those running workshops and other activities. Backgrounds as diverse as journalism, law and business to of course engineering and science were represented by the group. Staff and faculty were usually well-known names within NASA, ESA or one of many other space-related organisations or businesses around the world. With visits often lasting a few weeks, it gave us time to get to know them "off-line".

The first four weeks covered lectures from the seven departments of the ISU; Engineering, Law, Space and Society, Business, Space Life Sciences, Physical Sciences and Satellite Applications. The second half of the program allowed us to focus on a department of choice and was finished off by a large team project.

My group (of about 45) investigated the future feasibility of mining Near Earth Asteroids (NEA). NEAs have attracted some interest in recent years as many of them fall into the category of being potentially hazardous to us here on Earth. NASA has undertaken an effort to detect and characterise 90% of NEAs larger than 140 meters in diameter over the next 10 years; a huge task and one in which we can expect a lot of interest to build as more information (and funding) becomes available over the coming years.

There were two other Australians participating in this year's program, one from the Defence Space Coordination Office and the other who used to be in the mining industry. Among the lecturers and

Kjetil's final project team. Credit: K. Wormnes teaching staff there were actually quite a few Australians, mainly in the Policy and Law areas.

I also had the pleasure to talk to David Southwood, the director of Science and Robotic Exploration at ESA. We spoke about his involvement with Australia in establishing the first of ESA's deep space antennas, located at New Norcia outside Perth.

Other attendees included people from Brazil who were involved with the launch vehicle to be used by SHEFEX-2, a project by the German Aerospace Centre (DLR) which will be launched from Woomera later this year, as well as those involved with the landing of Hayabusa at Woomera in June.

From 2010 onwards, a Southern Hemisphere version of the SSP is planned, with a format mostly similar to the SSP, but a bit shorter and with more focus on applications. This year it will be based in Adelaide, but it will eventually move around the Southern Hemisphere just as the ISU SSP does in the north. I expect it will attract the same calibre of lecturers and staff, and being closer to home, and held during our summer, will be a program that more Australians will be able to attend.

I hope we will be able to work with them to share some of the tremendous expertise available within CASS. It is an opportunity for us to build a relationship with the ISU and through that promote both astronomy and space science not only in Australia but around the rest of the Southern Hemisphere as well.

The Southern Cross Astrophysics Conference Series* Fourth annual conference

Sydney Powerhouse Museum, 20-24 June 2011

Supernovae and their Host Galaxies

Motivation

The current generation of wide field transient surveys will revolutionise our understanding of why stars become supernovae. Designed to revisit large areas of sky at multiple wavelengths, these surveys are now discovering hundreds of supernovae each year. During the coming year, the number of supernova discoveries will increase even further as new transient surveys come online. As well as finding rare and possibly new types of supernovae, these surveys will generate new insights into both core-collapse and thermonuclear supernovae. It is therefore timely to have a conference that explores the current (observational and theoretical) supernova landscape and the connection between supernovae and their host galaxies.

Some topics to be covered include

- the many different paths to a supernova explosion
- the progenitors of supernovae
- supernova remnants
- supernova rates
- the relationships between the properties of supernovae and the properties of their host galaxies
- supernovae as tracers of star formation
- unusual supernovae
- unexplained transients
- current and future transient surveys

* Jointly organised by CASS and the AAO.

Australian Government
Department of Innovation Industry, Science and Research

AAO

The MALT 90 GHz Survey and the SOC Pilot Project

Jill Rathborne, Jessica Chapman, Kate Brooks (CASS) and Jim Jackson (Boston University)

On behalf of the MALT90 science team and the Mopra Large Surveys Working Group

Abstract:

Underway this year is a new, large, molecular line survey of dense cores at 90 GHz, the Millimetre Astronomy Legacy Team 90 GHz (MALT90) survey. The MALT90 survey will exploit the fast-mapping capability of the Mopra radio telescope, combined with the broadband MOPS correlator which allows the simultaneous imaging of 16 molecular lines near 90 GHz. These molecular lines will probe the physical conditions, chemical state, and evolutionary state of ~3,000 dense molecular cores. The target cores are selected as likely sites for the early stages of high-mass star formation and to span the complete range of their evolutionary states. Each core will be mapped simultaneously in 16 molecular lines at excellent angular (40 arcsec) and spectral (0.1 km/s) resolution. MALT90 will be especially useful to identify important targets for future ALMA observations.

A major goal for CASS is to develop a Science Operations Centre (SOC) in Sydney. Ultimately the SOC will provide the full range of activities carried out for the science operations of ATNF facilities. As well as a major science project, the MALT90 project has been used for a trial of SOC-mode observing. In the first part of this article we describe the science goals of the MALT90 survey. The second part describes the SOC Pilot study.

The MALT90 Science Project

Although the basic sequence for high-mass protostellar evolution is generally thought to be the same as for low-mass stars, modern theories (e.g., see reviews by Zinnecker & Yorke 2007 and McKee & Ostriker 2007) suggest the possibility of two important differences. Firstly, although low-mass stars are thought to acquire their mass by accreting material solely from their parental molecular cores, high-mass stars may instead acquire most of their mass by "competitive accretion," a process by which high-mass cores agglomerate material well outside of their gravitationally-bound parental cores (e.g., Bonnell et al. 1997). In this theory, material falls through the potential well of a large molecular cloud, and is funnelled down to molecular cores near the centre. The cores near the cloud centre thus receive a fresh supply of material, and continue to accrete additional mass. Secondly, while low-mass stars reach the main-sequence after the accretion process has essentially finished, young O stars first reach the main-sequence as B stars that are still significantly accreting (e.g., Behrand & Maeder 2001).

All theories agree that a high-mass star begins its life as a "pre-stellar" or "starless" core, which collapses to form a deeply embedded, accreting protostar or "hot molecular core." When fusion begins, the star enters the main-sequence and ionizes its surrounding material to form hyper- and ultra-compact H II regions. Observationally, however, the very earliest stages of high-mass protostellar evolution have remained elusive. Only a handful of candidate high-mass pre-stellar cores have been tentatively identified, and it has been difficult to confirm their pre-stellar nature. The earliest well-characterised phase is the "hot molecular core" phase, well after accretion has begun. Recently, earlier phases have been identified as cold, compact cores within Infrared Dark Clouds (IRDCs; e.g., Carey et al.2000; Rathborne et al. 2005, 2006).

The community has now identified a large number of high-mass protostars. These span the range from cold pre-stellar cores found in IRDCs, to hot cores, and compact H II regions. Important new samples have been found using the *Spitzer* GLIMPSE (3-8 um) and MIPSGAL (24 um) surveys, the HOPS Survey (1.3 cm), and various mm and submm continuum surveys. With these new surveys, we can begin to study the evolutionary sequence of high-mass protostellar evolution by finding large numbers of objects in each of these stages. The major goal of the MALT 90 GHz Survey is to characterise high-mass star-forming cores and to study their physical and chemical evolution.

The *Spitzer* Galactic surveys GLIMPSE and MIPSGAL have shown that IRDCs host the massive dense cores, which are making the transition from cold, quiescent pre-stellar cores to active hot cores and H II regions. Moreover, submm Galactic surveys such as the Apex Telescope Large Area Survey of the Galaxy (ATLASGAL) are now identifying huge numbers (~10,000) of dense molecular cores associated with star formation. We aim to capitalise on these advances in high-mass star formation by conducting a large, new molecular line survey of dense cores with the Mopra radio telescope.

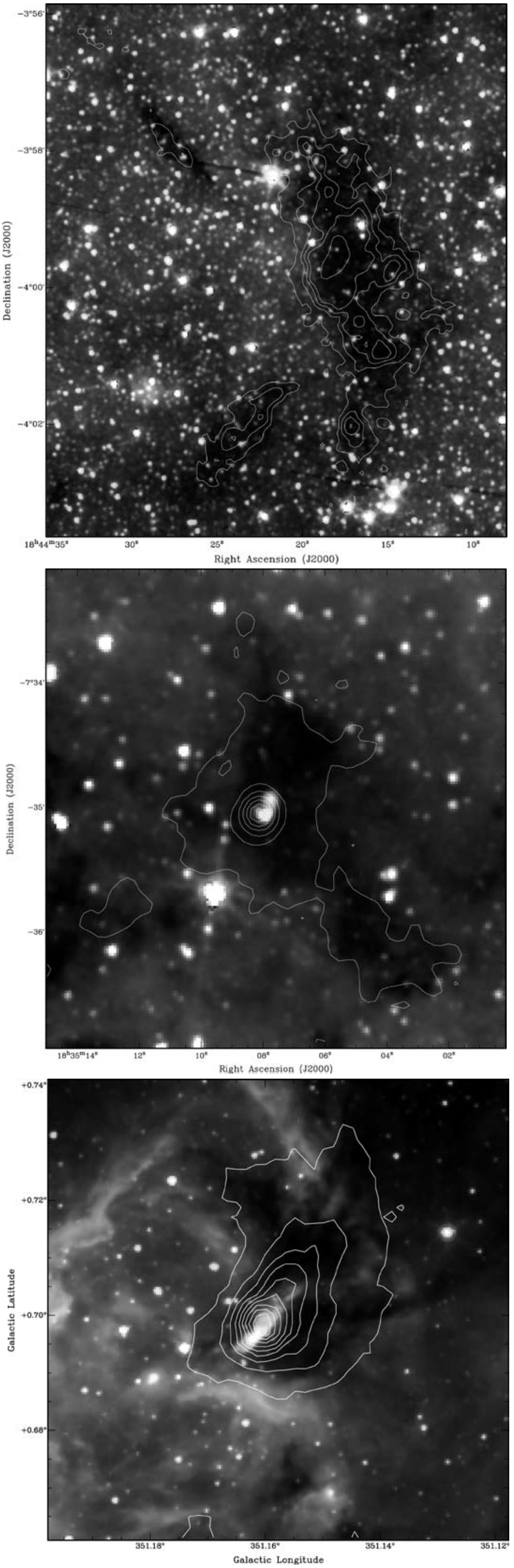


Figure 1: *Spitzer* GLIMPSE and MIPSGAL images toward three examples of high-mass star forming cores (contours are of the 1.2 millimetre continuum dust emission): Pre-stellar (top), Protostellar (middle), and a HII region (right). The primary goal of the MALT 90 GHz Survey is to characterise star-forming cores and to study their physical and chemical evolution.

The 90 GHz molecular lines are especially interesting probes because they require high-densities for excitation. Because the cores are much denser than typical CO-emitting molecular clouds, 90 GHz emission will arise only from the dense, star-forming cores. Moreover, since these lines span a large range of excitation energies and critical densities, they indicate distinct physical conditions and distinct stages of chemical evolution. Mopra's unique broad-band capability allows us to image 16 of these molecular lines simultaneously. Finally, because many chemical species are observable, for the first time a large systematic survey of core chemistry can be conducted.

Due to the small solid angle occupied by star-forming cores emitting strongly at 90 GHz, a blind, fully sampled survey of a significant portion of the Galactic plane is impractical. Thus, to survey significant numbers of star-forming cores efficiently, we must choose selected targets. Because submm emission traces cores in all evolutionary stages, we are using the ATLASGAL point source catalogue as our basic target list, supplemented by core categorisation based on GLIMPSE and MIPSGAL images. We aim to image roughly 1,000 cores each in the pre-stellar, protostellar, and H II region phases. MALT90 will be the largest systematic molecular line survey of dense cores ever undertaken. MALT90 will be valuable not only in its own right, but also as an important finding chart to identify key ALMA targets.

MALT90 has just completed its first observing season, spanning more than 860 hours since mid-July. The season was extremely successful; we obtained maps toward ~ 520 cores, which spanned the complete range in the proposed evolutionary sequence. We are in the process of completing the final data reduction before the data are released to the team. We expect a data release to the wider community early next year. Already the team has identified over 12 key science projects, which aim to characterise the high-mass star-forming cores. The MALT90 team consists of over 50 astronomers worldwide.

MALT90 and the SOC Pilot project

An important part of the planning for future ATNF Operations, that will include the operations of ASKAP, now under construction in Western Australia, is the establishment of a Science Operations Centre (SOC) in Sydney.

At present, most observations are carried out in a mode where astronomers are present for and control their own observations, at either the Parkes or Narrabri site. Additionally, some observing is done remotely by astronomers from other locations. In the future, this "user-operator" mode will continue to be used for the Compact Array, and the Parkes and Mopra telescopes. However, an increasing amount of observing will be carried out from the SOC, particularly for observing teams that require expert support. The user-operator mode will *not* be used for ASKAP. Instead, ASKAP observations will be taken remotely from the SOC in a queue-based model. Astronomers will access their data and data products through archive facilities.

The full SOC will be developed using a staged approach. As a first step, in the 2010 April semester, we have carried out a pilot study to try out "SOC-mode" observing where the observers and the astronomers who provide observing support are based in Sydney. The MALT90 project has been used as a demonstration project for this study.

The goals of this pilot study are to:

- Trial SOC-mode observing from Marsfield, initially for observations of Mopra Large Surveys from Sydney.
- Establish and implement the technical and user requirements needed to do this.
- Gain experience of Sydney-based observing, and working with science teams on Large Projects.

- Extend the ATNF data archives (ATOA) to provide a search facility and access to the processed data cubes that will result from the MALT90 survey.

To establish and implement the technical and support requirements for this pilot study, in May 2010 a "Mopra Large Surveys Working Group" was established. This group worked in consultation with the MALT90 project team leader (Jim Jackson) and other members of the science team. Suggestions received from Australia Telescope Users Committee (ATUC) and input from focus groups were also included in this planning.

The MALT90 project was allocated ~860 hours of observing time between mid July and late September. The science team initially spent three weeks at Narrabri to ensure that their observing and data reduction strategies were working effectively. Almost all of the observing from early August was then carried out from Sydney. To support this, a number of new facilities were introduced. These included:

- Dedicated access to remote observing computing facilities in Marsfield. This area is used for remote observations with the Compact Array and/or Mopra.
- A powerful new server and dedicated disk space was provided to allow for fast off-line data processing of the Mopra Large Survey data.
- A high-quality point-point video link has been installed at Narrabri and Marsfield to facilitate the interactions between staff and observers located at the two sites.
- Improvements have been made to the Marsfield Lodge services to provide darker bedrooms and hot meals after hours and at weekends. Access to a small kitchen near the observing areas was also provided.
- Some improvements have been made to the on-line observing software tools, including the use of an on-line observing log. Other improvements that will include batch processing of schedule files and automated telescope pointing are planned but not yet completed.

A critical element of SOC observing is to provide local support to the observers in Marsfield. For the MALT90 project, support astronomers were available on the site at all times during the scheduled observations. The support roster was set up with a default of two 3.5 day blocks per week. Accommodation and travel costs were provided for support astronomers who travelled to the site and gave at least seven days support.

In the next few weeks a review will be held to consider the "lessons learnt" from this pilot study. Initial feedback shows that the science team found it straightforward to observe from Sydney, and appreciated the high level of expert support they received. The observing systems were robust, with very few technical problems and the video connection helped facilitate working between the two sites. The level of comfort provided by the Visitors Services Group, and the hot meals were also appreciated. There has been some impact on local staff who worked long hours, some staff and visitors raised concerns over the use of the video system. These matters will be carefully considered over the next few months as we learn from the recent experience.

Over the next year, CASS will continue to provide support for SOC-mode observing, with a focus on Mopra Large Surveys. Further information on SOC observing for the 2011 April semester will be provided to the community with the next Announcement of Opportunity in mid-November 2010.

Discovery of a Radio–loud X-ray–quiescent Magnetar in the High Time Resolution Universe Survey

M J Keith, L Levin, M Bailes, S Johnston, M Kramer, A Possenti, A Jameson, W van Straten, S D Bates, N D R Bhat, M Burgay, S Burke-Spolaor, N D'Amico, S Milia, B W Stappers

Magnetars are neutron stars with some of the strongest magnetic fields in the known universe, typically above 10^{14} Gauss. These stars are usually observed through highly energetic X-ray and gamma-ray outbursts, thought to be powered by the release of energy trapped in the structure of the magnetic field itself. In recent years we have detected radio pulses, similar to those from pulsars, associated with these energetic outbursts in two magnetars. Now, for the first time, we have discovered a magnetar by its radio emission alone. This is most intriguing, especially as the standard pulsar emission theories do not allow for radio emission in the presence of such extreme magnetic fields.

The High Time Resolution Universe survey

The Parkes radio telescope has a long and impressive record of pulsar discoveries, having discovered almost half of all known radio pulsars. This success can be put down to a combination of the location of the antenna (the Galactic Centre passes directly overhead) and the excellent receivers and backend hardware available. Of particular merit is the "20-cm Multibeam" receiver, which packs 13 feeds into the focus of the antenna. This enables 13 patches of sky to be surveyed in a single observation, allowing for deep surveys of large areas of sky, such as the Parkes Multibeam Pulsar Survey (PMPS; Manchester et al. 2001). This survey ran for six years beginning in 1997 and discovered over 700 pulsars, more than doubling the known population of pulsars at the time.

Even though the survey was highly successful, the finite width of the analogue filters in the recording system limited the ability to detect the fastest pulsars and transient events. This is because as pulses travel to the Earth, the low frequencies are delayed with respect to the high frequencies by interstellar dispersion. The result is that the pulse is smeared out over the finite bandwidth of our instrument. This effect can be negated by recording the observation in sufficiently narrow frequency channels that can then be corrected for the delay.

In order to detect faster objects located deeper in the disk of the Galaxy, we have designed and built a new an all-digital multi-beam filterbank system known as BPSR. This system provides ten times the frequency resolution of the old system, and in the typical observing

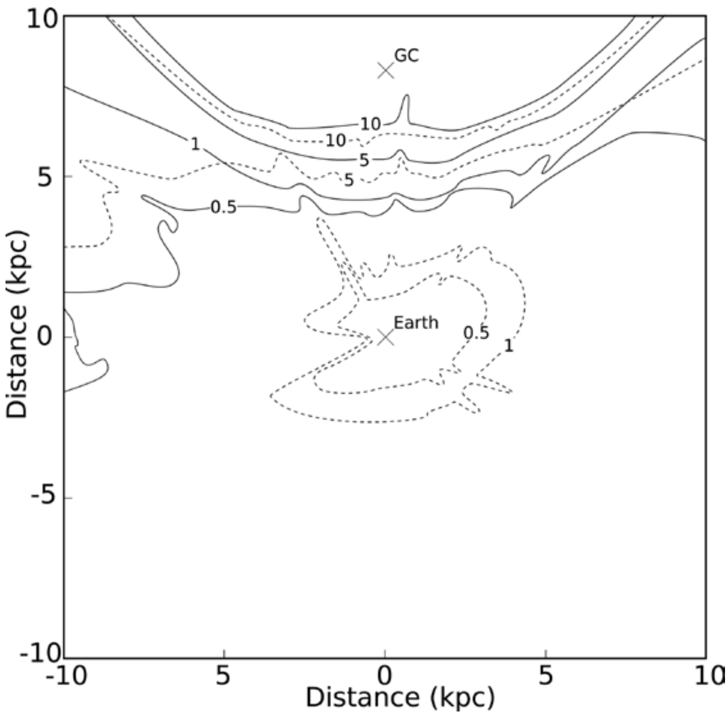


Figure 1: Contours of constant smearing time for the analogue (dotted) and BPSR digital (solid) filterbank systems. Contours are 0.5, 1,5 and 10 ms. The Galactic centre is marked "GC"

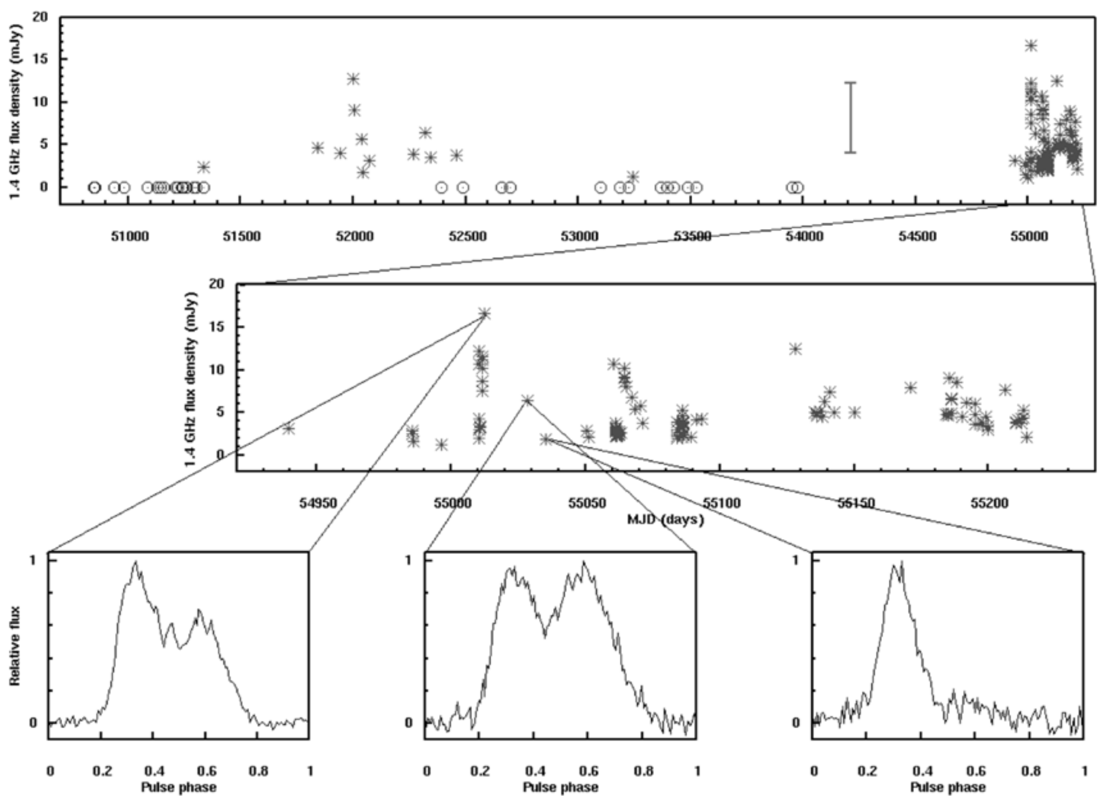


Figure 2: Light curve and profile variations for PSR J1622−4950. The top plot shows the temporal variation of flux density at 1.4 GHz. Archival timing data collected within the framework of the Parkes Multibeam Survey ends just before MJD = 54000, and the discovery of PSR J1622−4950 by the HTRU pulsar survey was made on MJD = 54939. The asterisks show the detections (with errors smaller than the size of the points), and the circles indicate observations during which PSR J1622−4950 was not detected (down to a limiting flux density of 1.2 mJy). The purple error bar indicates the observation centered at 6.3 GHz from the Methanol Multibeam survey that detected PSR J1622−4950. When converted into a 1.4 GHz flux density, the large error is dominated by the uncertainty in the spectral index; the top value of the bar corresponds to a flat radio spectrum, and the bottom value is derived from our best estimate of the spectral index. The bottom plots show three different pulse profiles from three consecutive observations, taken on 30 June 2009, 16 July 2009, and 23 July 2009.

mode records samples every 64 microseconds. With this new digital system we can see through much more of the interstellar medium. Figure 1 shows contours of constant smearing timescale for the analogue hardware (dotted lines) and the BPSR system (solid lines). This makes it clear that for the fastest pulsars, the BPSR system can see more than twice as far into the Galactic plane.

To take advantage of these new advances we have embarked on the High Time Resolution Universe survey for pulsars and fast transients. This survey covers the entire sky, with northern declinations being covered by a twin survey at Effelsberg. For the Parkes portion of the survey the mean sensitivity is ~0.10 mJy for Galactic latitudes between ±3.5°, ~0.25 mJy for those between ±15° and 0.32 mJy for the remainder of the sky. The survey is expected to run for four more years, and full details of the survey are given in Keith et al. (2010).

In addition to discovering many millisecond pulsars, the survey is turning up many longer period pulsars. Some are found because they fell in regions of low sensitivity of earlier surveys, for example, between adjacent observations. In the case of PSR J1622−4950, however it was clear that something very different was happening.

The radio magnetar PSR J1622–4950

PSR J1622−4950 was discovered in April of 2009, with a spin period of 4.3 s, and a dispersion measure of 830 cm^{-3} pc (Levin et al. 2010). In the survey observation the pulsar was detected with a signal-to-noise ratio of 250, by far the brightest pulsar discovered in the HTRU survey. Follow up observations indicated that the pulsar was highly variable, both in the shape of and the intensity of the pulse.

The area of sky containing PSR J1622−4950 was previously covered by the PMPS but, somewhat surprisingly given its large apparent flux density and DM, the pulsar was not detected in these data. However, that survey did find two other radio pulsars in close proximity to PSR J1622−4950 and monitored them for a number of years, namely PSRs J1623−4949 and J1622–4944 at an angular separation of 11′ and 7′, respectively. These archival data were reprocessed using the period and DM of PSR J1622−4950. As can be seen in Figure 2, the pulsar was not detected until data from June 1999. It was

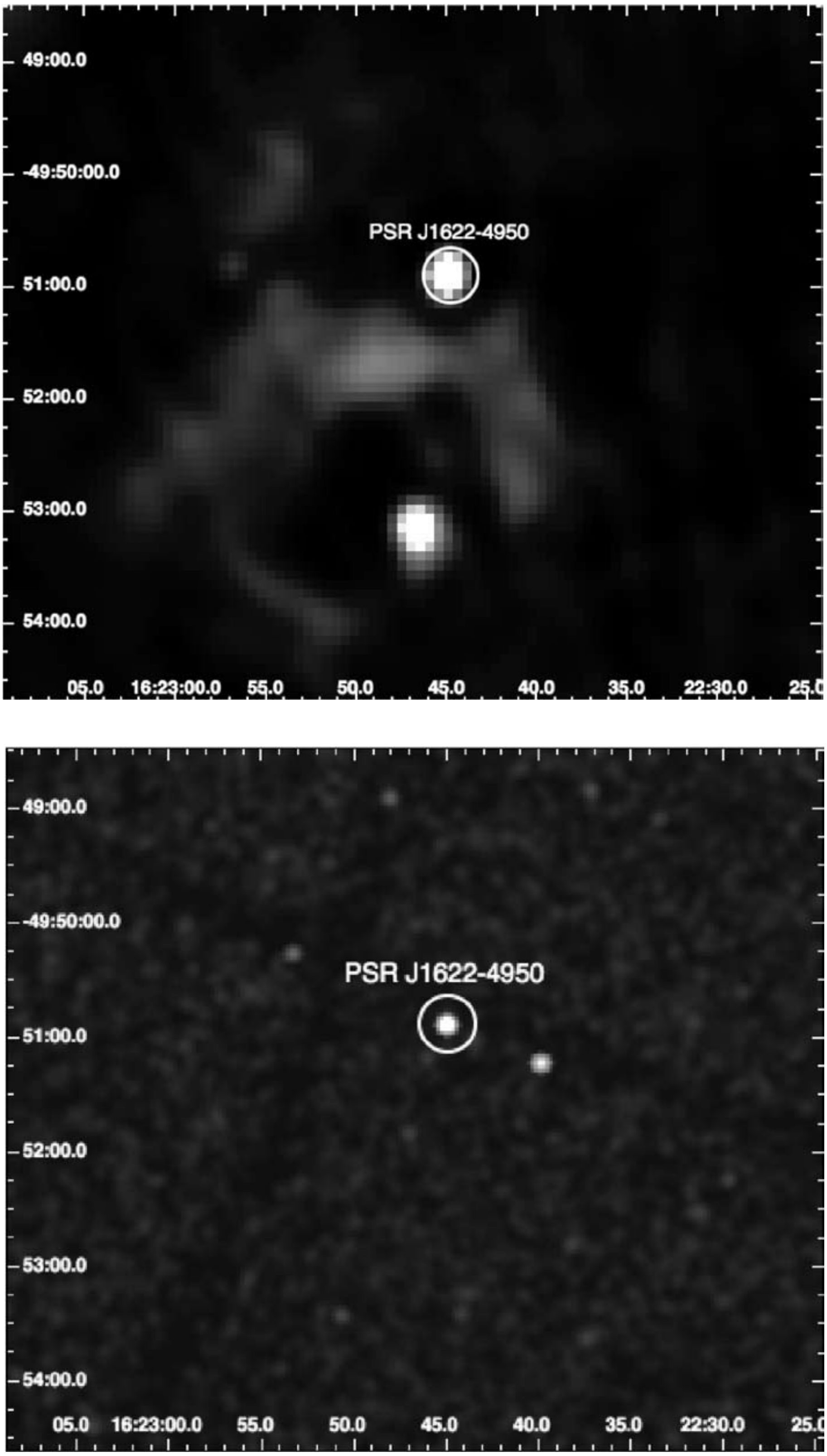


Figure 3: Top panel shows a 5.5 GHz image made with the ATCA. Bottom panel shows Chandra X-ray image of the same region of sky. Detailed analysis indicates that PSR J1622-4950 is the bright point source visible in both images.

again detected in 11 observations taken between October of 2000 and July of 2002, after which the pulsar was detected only in the 14 subsequent observations. In April of 2007 the area of sky was covered by the 6.7 GHz pulsar survey at Parkes, where it was again detectable (though it was missed in the original analysis as it was confused with interference signals).

Figure 2 demonstrates this flux variability, and indicates that there have been at least two quiescent periods in the radio emission. Also shown are samples of pulse profiles taken in adjacent observations, indicating the considerable change in the integrated pulse profile on fairly short time-scales.

The radio polarisation of the magnetar is also variable, however it is often almost completely linearly polarised. The polarisation fraction is typically greater at 3.1 GHz than at 1.4 GHz, similar to young radio pulsars. It also occasionaly displays significant circular polarisation, particularly at the leading edge of the pulse. Faraday rotation has been detected with a rotation measure of -1484 ± 1 rad m^{-2}.

The characteristic spin-down age of the magnetar is only 4000 years, and therefore any remnant from the supernova event that formed it would likely still be visible. To search for such a remnant we performed 12-hour tracks of the source with the Australia Telescope Compact Array, in each of the EW352 and 750B configurations. The observations utilised the simultaneous 2-GHz bands centred at 5.5 and 9 GHz made available by the Compact Array Broadband Backend. The image showed a highly-polarised flat-spectrum point source co-incident with both an X-ray source. Additional Compact Array observations confirmed that this source matched the magnetar's flux density at 1.4 GHz and was therefore the only suitable candidate.

The image also shows a tantalising ring of nebulous emission. This ring lacks an infrared counterpart and appears to be non-thermal, whereas the slightly extended radio source in the south of the ring is clearly thermal in nature. If we assume a distance of ~9 kpc to the magnetar and further assume it was born in the centre of the ring, the magnetar would need a velocity of ~1300 km/s to reach its current location whereas the ring itself would have a lower expansion velocity. Such a velocity is high (though not impossible) for pulsars but rather low for expanding SNRs. Therefore we feel that this association, though possible, is unlikely.

This discovery of a highly polarised, radio-luminous magnetar is the first major result from the HTRU survey. The pulsar shares many of the properties of the two known radio magnetars, however PSR J1622−4950 indicates that bright radio emission can be present even when a magnetar displays an X-ray luminosity typical of a quiescent state. We finally note that the extreme variability in the flux density of PSR J1622−4950 also demonstrates the advantages of surveying the radio sky at regular intervals with even modest sensitivity. This highlights the potential of the upcoming radio facilities like the LOFAR, ASKAP, or SKA which promise to characterise the dynamic radio sky at an unprecedented level.

References

Keith M. J. et al., 2010, MNRAS, in press (arXive:1006.5744)

Levin L. et al., 2010, ApJ Letters, 721 L33

Manchester R. N. et al., 2001, MNRAS, 328, 17

First Science from the ASKAP and Warkworth Antennas: on the Path to "Maximum Discovery"

Professor Steven Tingay, International Centre for Radio Astronomy Research – Curtin University
On behalf of the Australian and New Zealand VLBI teams

One of the ten ASKAP Survey Science Projects is aimed at high angular resolution observations using CSIRO's Australian Square Kilometre Array Pathfinder (ASKAP) telescope as part of Australian and international very long baseline interferometry (VLBI) arrays. This Survey Science Project (SSP) pursues activities in two main areas:
1) achieving early science results from ASKAP as an element of the Australian VLBI array, from the point at which a single ASKAP antenna is available, through the use of custom RF and digital systems;
2) produce an operational VLBI system for the mature ASKAP that is fully integrated with the final versions of the ASKAP RF and digital systems.

Goal 1 is a near term goal and one that has been primarily the focus of work over the year since the SSP was approved. Work for goal 2 has a longer-term focus and will proceed at the pace at which the various ASKAP sub-systems mature into their final forms.

We report here on the first science results to emerge from ASKAP, a consequence of success with goal 1 and preparatory work toward goal 2.

Over the course of a three week period in late April and early May 2010, successful VLBI observations were performed using the first of the ASKAP antennas to be installed at the Murchison Radio-astronomy Observatory (MRO), along with a new 12-m antenna installed at Warkworth on New Zealand's North Island. Figure 1 shows the distribution of the antennas used in these observations.

The observations used a custom RF system built by engineers at CSIRO Astronomy and Space Science and a custom digital backend built at the International Centre for Radio

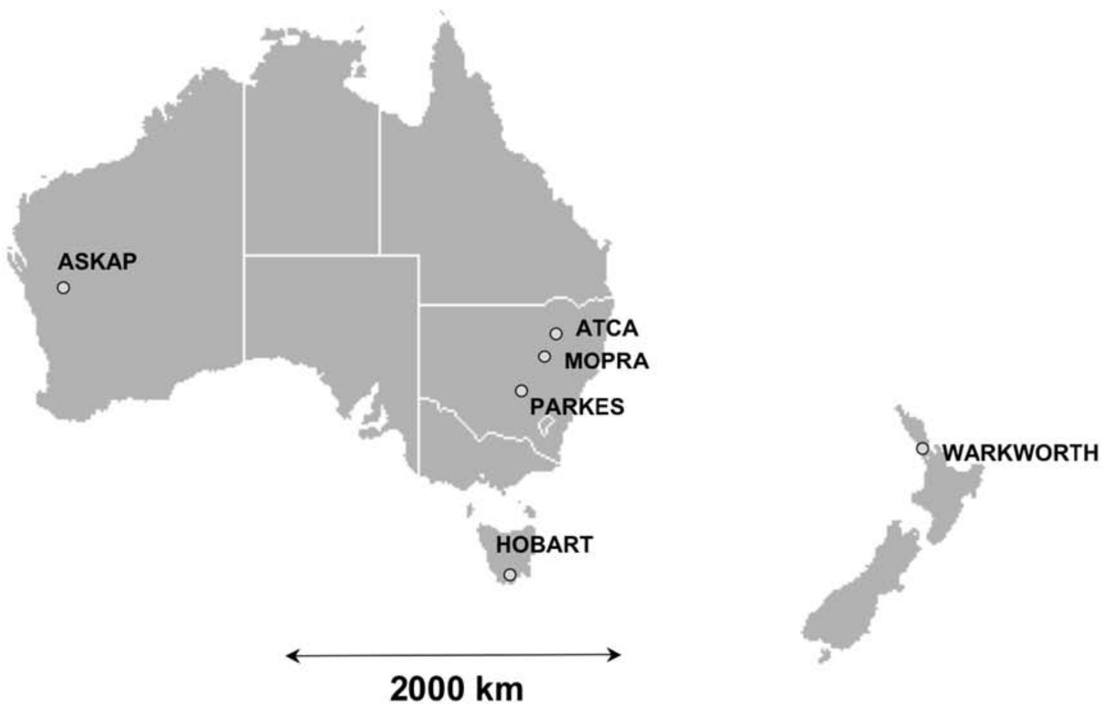


Figure 1: Geographic distribution of antennas used for VLBI observations in April/May 2010. ASKAP, ATCA, Mopra and Parkes are operated by CASS. Hobart is operated by The University of Tasmania.

Astronomy Research (ICRAR), Curtin University, by PhD candidate Mr Bruce Stansby. Identical systems were installed at ASKAP and Warkworth. Regular systems were used at the rest of the LBA stations.

The data recorded at each telescope were transferred to ICRAR and correlated using the DiFX software correlator.

High quality data were obtained for a range of astronomical objects: 3C 273; PKS 1934-638; Centaurus A; and a selection of geodetic calibration sources. The data yielded images with a resolution of approximately 5 mas at 1.4 GHz (dual-polarisation 64 MHz bandwidth). Shown below in Figure 2 is the image of Centaurus A that accompanied a press release announcing the success of the experiment — *Aussies and Kiwis forge a cosmic link*:

http://www.csiro.au/news/Aussies-and-Kiwis-forge-a-cosmic-connection.html.

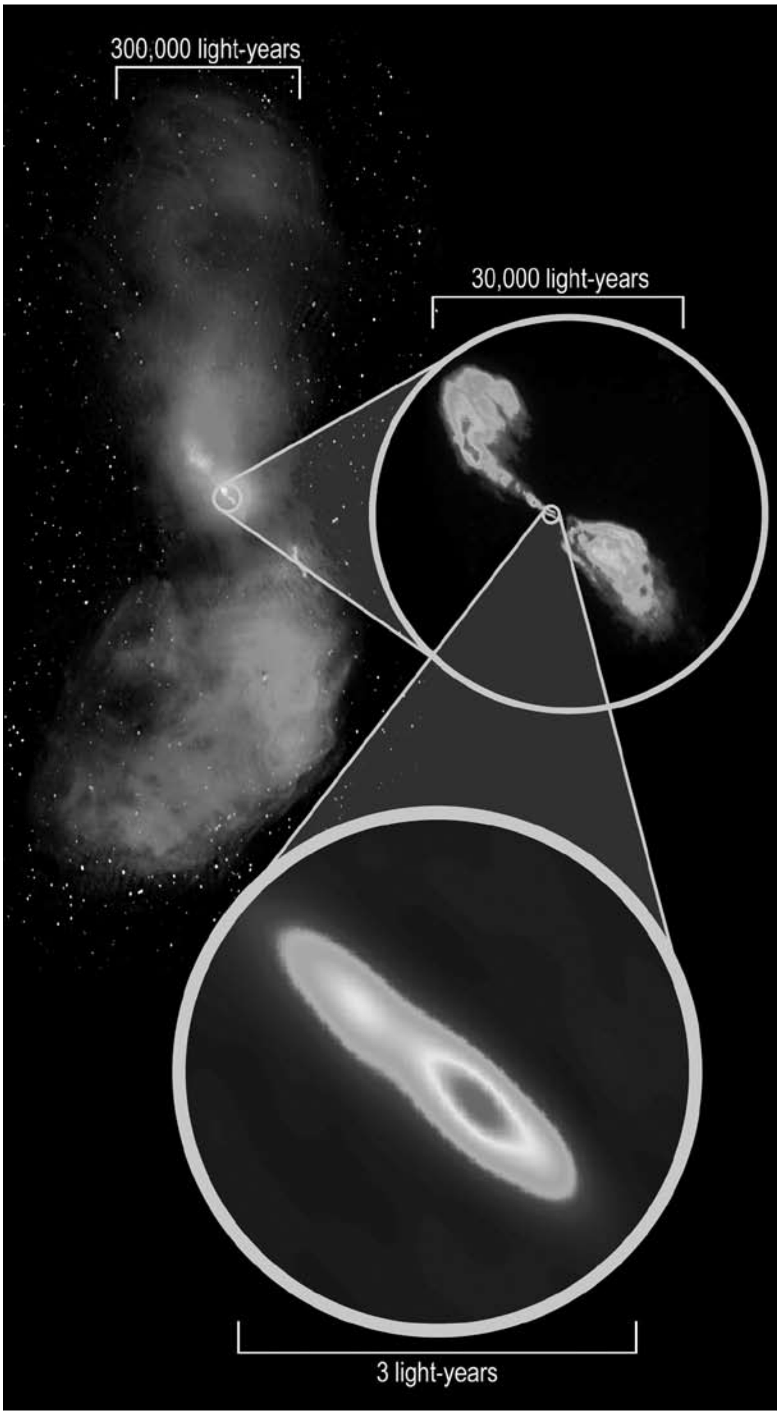


Figure 2: The structure of Centaurus A, from the largest scales observed with the ATCA, to the smallest scales probed by new VLBI observations with a maximum baseline of 5500 km, from Western Australia to New Zealand.

Image credit – Whole galaxy: I Feain, T Cornwell & R Ekers (CSIRO/ATNF); ATCA northern middle lobe pointing courtesy R Morganti (ASTRON); Parkes data courtesy N Junkes (MPIfR). Inner radio lobes: NRAO / AUI / NSF. Core: S Tingay (ICRAR) / ICRAR, CSIRO and AUT

NB: For reference, please see the colour image published on the back page of this newsletter.

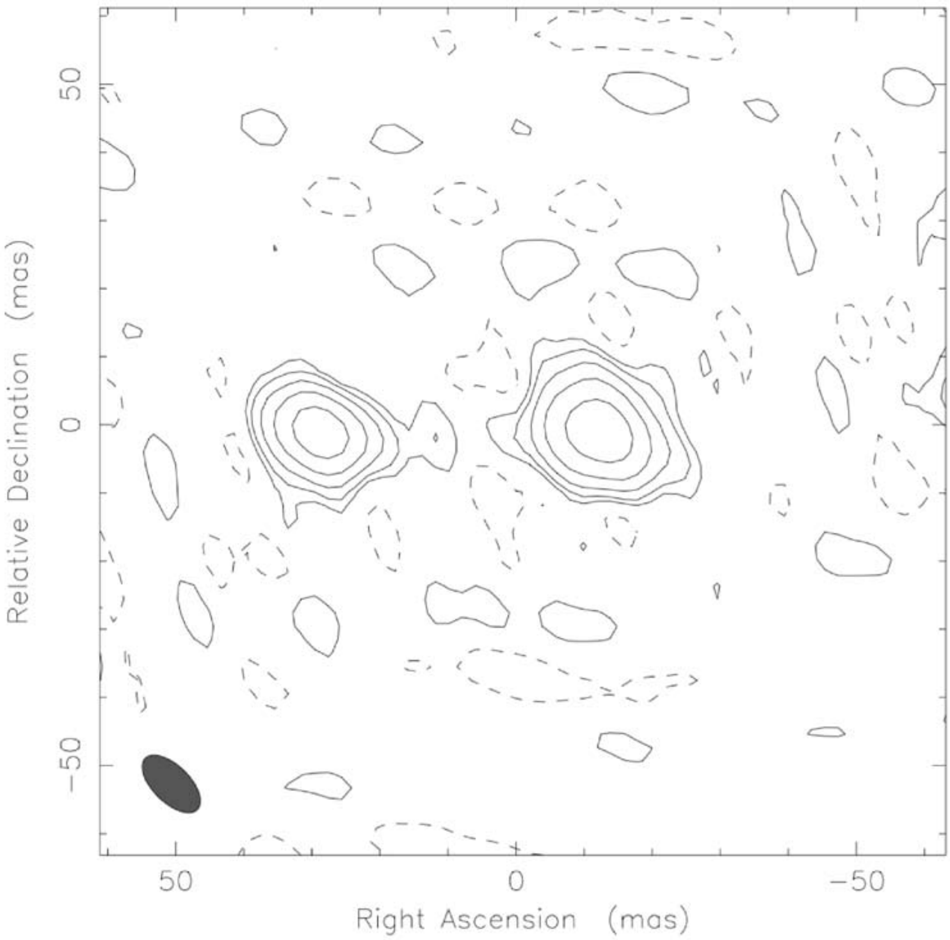


Figure 3: Image of the double component structure of PKS 1934-638 at 1.4 GHz, part of a paper submitted for publication to The Astronomical Journal.

The Centaurus A data were featured at the 2010 International SKA Forum, held recently in Assen, The Netherlands. In his address to the forum, Professor Brian Boyle presented the results as a step toward the demonstration of the "Maximum Discovery" possible for an SKA located in Australia – New Zealand.

Another significant result arose from observations of PKS 1934-638, an archetypal GHz-Peaked spectrum radio galaxy. Because of the high angular resolution obtained at low frequency, these observations have revealed for the first time a frequency-dependant angular separation between the two compact components in this radio galaxy, likely due to synchrotron self-absorption. Previously this frequency dependant structure has been incorrectly identified as structural evolution over a 40 year period. The new observations show the way to the correct conclusion that the structure is frequency dependant due to absorption effects and very stable with time. Figure 3 shows the image of PKS 1934-638 obtained from the observations.

The PKS 1934-638 results have been submitted for publication in The Astronomical Journal (Tzioumis et al. 2010, submitted) and document the first science to be obtained from the ASKAP and Warkworth antennas.

The VLBI capability established in the first year of this SSP will be retained and deployed for a range of observations during the remaining ASKAP development and will transition to the full system as ASKAP matures. Both ASKAP and Warkworth are now included in the Australian Long Baseline Array call for proposals and are thus available to proposers who require high angular resolution at 1.4 GHz.

The SSP team is also working with Indian colleagues to establish the Giant Metrewave Radio Telescope (GMRT) for VLBI observations, aiming to extend the reach of VLBI in the region, adding to regular VLBI partners in South Africa, Japan, China and the USA.

Bonsai-ed Radio Galaxy Gives Clue to Jet Energies

Robert Soria (University of Sydney)

A new Australia Telescope Compact Array (ATCA) study of a microquasar in the galaxy NGC 7793 strongly suggests that the true power of black hole jets is a thousand times larger than the power estimated only from their observed radio emission.

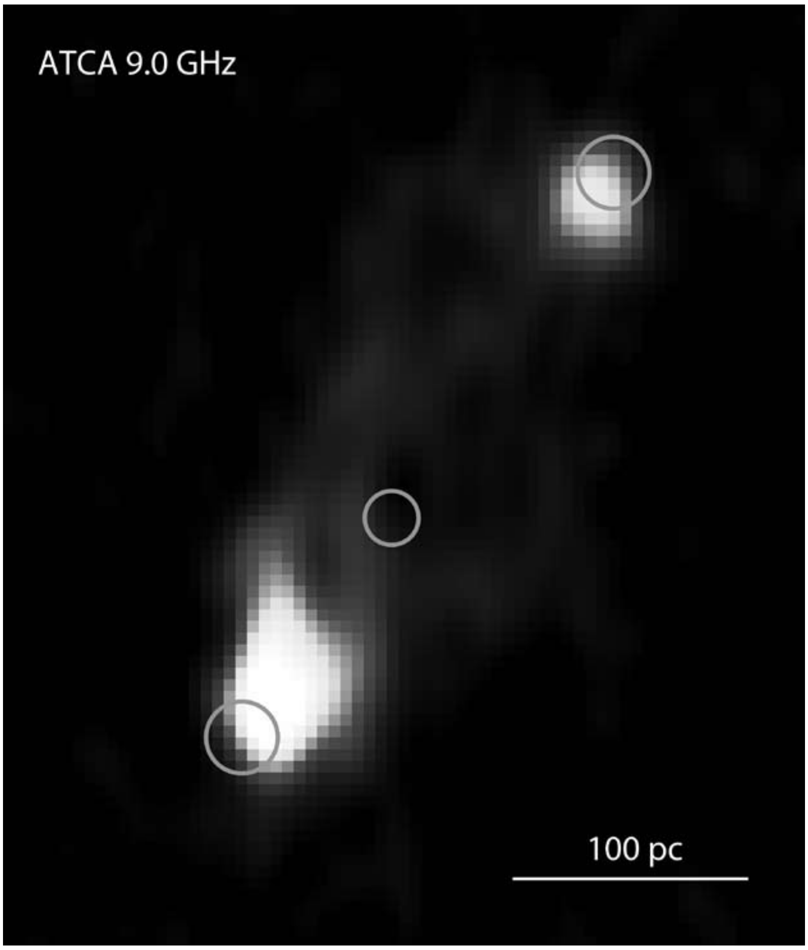


Figure 1: The ATCA 3-cm map with the position of the X-ray core (black hole) and hot spots highlighted.

The ATCA observations of this object, S26, complement optical and X-ray observations carried out with Chandra and European Southern Observatory's Very Large Telescope, published in *Nature* earlier this year. The radio observations have made it clear that S26 is a near-perfect analogue for a radio galaxy. The new data show that S26 has exactly the structure of a radio galaxy, in a way never seen before in microquasars derived from stellar-mass black holes.

Measuring the power of black hole jets, and therefore their heating effect, is usually very difficult. Powerful jets are characterised by strong radio emission from their lobes: large, expanding blobs of energetic electrons, moving at close to the speed of light, at the end of the jet. But such radio-emitting electrons contain only a small fraction of the total jet energy. The rest of the energy is generally not detected: only in rare cases can it be indirectly estimated from its effect on the surrounding gas.

S26 helps shed light on the energetics of these systems. The radio, optical and X-ray observations reveal bright radio lobes at the end of the pair of jets, plus a supersonically-expanding bubble of heated gas. We can directly measure the energy in both the lobes and bubble: because we have good observations in three wavebands, we can determine what fraction of the initial jet power (kinetic energy of the particles in the jet) is converted to thermal energy of the warm gas ($T \sim 10{,}000$ K, emitting optical lines); what fraction is given to the hot gas ($T > 10^6$ K, emitting in the X-rays); and what fraction is given to relativistic electrons (emitting in the radio bands).

We find that about a thousandth (or, at most, a few parts in a thousand) of the jet power is given to the radio-emitting electrons in the lobes, while the rest is used to blow the large bubble of heated gas, 300 pc across.

This result confirms models positing that the true power of black hole jets is a thousand times larger than the power estimated only from its observed radio emission. It suggests that black hole jets can be both more powerful and more efficient than previously thought, and therefore that their cosmic heating effect can be stronger. And it gives us a way to estimate the true jet power in other black holes (including those in quasars and radio galaxies) where only the radio lobes may be directly observable, not the bubble of hot gas.

The significantly improved continuum sensitivity of the Compact Array Broadband Backend (CABB) let us trace the radio morphology at sensitivity levels of less than 10 microJanskys/beam, in three days of observations. Before CABB this would have taken 15 days. As this is much longer than the typical ATCA time allocation, it's likely that, without being able to use CABB, we would not have been allocated the time to do this work and hence would not have been able to map the fine structure of the radio lobes and cocoon.

References

Pakull, Manfred W.; Soria, Roberto; Motch, Christian. *A 300-parsec-long jet-inflated bubble around a powerful microquasar in the galaxy NGC 7793.* Nature, 466, 209 (2010)

Soria, Roberto; Pakull, Manfred W; Broderick, Jess W; Corbel, Stephane; Motch, Christian. *Radio lobes and X-ray hot spots in the microquasar S26*. MNRAS, in press (2010)

National Facility Operations

Douglas Bock, Jessica Chapman, Phil Edwards, Erik Lensson, Mark Bowen (CASS)

Remote Operations

Several efforts are underway to prepare for remote operation of all the telescopes. A pilot Science Operations Centre project was conducted over the winter, with most observations of the MALT-90 Mopra survey taken from Marsfield. The results will be used to inform the design of the Science Operations Centre that will eventually serve users of all ATNF instruments including ASKAP.

At Parkes, projects to improve the reliability of power and drive control, and to automate frontend and backend re-configurations are at the installation phase. The impact of this work on observing time this semester is described below. In addition, a new UPS for the Marsfield PABX and UPS batteries for Parkes and for the ATCA antennas will be installed over the summer.

Water Vapor Radiometers

Water Vapour Radiometers for all Compact Array antennas have been delivered by Melbourne company ASTROWAVE. They have been installed on the antennas and are undergoing calibration. Pleasingly, a comparison with the 12 mm "science" data shows that they are tracking phase changes as required. Development of algorithms to correct astronomical data for phase effects continues through the efforts of Balt Indermuehle (CSIRO) and Michael Burton (University of New South Wales).

Managing Radiofrequency Interference (RFI) at National Facility Observatories

The increasing demand for commercial wireless communications and government services represents an ongoing challenge for the national facility observatories and radioastronomy facilities worldwide. About forty CSIRO Astronomy and Space Science staff met at Marsfield on 1 September 2010, to share experiences and practical approaches to dealing with increasingly complex radiofrequency interference (RFI) and spectrum use matters relevant to running national facility observatories. Workshop participants included staff from ATNF Engineering and Science Operations, Astrophysics, Technologies for Radio Astronomy and ASKAP, as well as a number of staff from the Canberra Deep Space Communications Complex at Tidbinbilla. The in-house event concentrated on practical operational objectives:

1. Increasing staff awareness as to the different kinds of RFI related expert skills and experience that already exists across the observatories and CSIRO Astronomy and Space Science generally;

2. sharing knowledge about hardware and software tools useful for operational RFI management;

3. improving cross-site collaboration on RFI detection, identification and tracking;

4. considering strategies for transitioning the National Facility Operations to ASKAP and beyond.

Many topical issues were outlined and discussed, including relevant international RFI threshold standards in Recommendation ITU-R RA.769 (Tasso Tzioumis), international vs national regulation (Carol Wilson), approaches to site related electromagnetic compatibility (Mal Smith), RFI identification, & tracking (John Reynolds), tools for RFI hunting & tracking (Peter Mirtschin), mitigation (Mike Kesteven), dealing with other spectrum users and current & future challenges from geostationary and non-geostationary satellite RFI sources, airborne and space radars (Erik Lensson). Staff also heard about the development of the Murchison Radio Quiet Zone (Michelle Storey) and related RFI level measurements (Ron Beresford).

The day concluded with an open "Q&A" Panel Session (Phil Edwards), with further discussions about the key issues identified during the course of the day. These issues will be further considered as part of future planning for national facility operations, including:

- new and improved RFI related databases and analysis software tools to support staff and observers at existing and new observatories;
- the creation of a new online "RFI Report", as an adjunct to the existing generic observatory "Fault Report", for streamlining the reporting and tracking of RFI events, including data mining of related ATNF archives;
- options for improved observatory RFI monitoring, independent of the actual observing instruments, including facilities for time-series analysis, automated source identification and reporting.

October 2010 Time Assignment

The Time Assignment Committee met at Marsfield on 22 – 23 July to consider proposals for the 2010 October semester (2010OCTS) A total of 163 proposals were reviewed, 103 for the Compact Array, 26 for Parkes, 14 for Mopra, seven for Tidbinbilla and 13 for the Long Baseline Array.

The Time Assignment Committee was pleased to see that the revised guidelines for Large Projects (requiring more than 400 hours for the expected lifetime of the program) were observed by proposers. Please note that Proposers allocated time for Large Projects are now required to provide web pages on their projects. Please include information on the spectral coverage, spatial coverage, and sensitivity of the survey observations. For ongoing surveys, regular updates should be provided to indicate the current survey status, including the areas of the survey that have been completed. For further information see

www.atnf.csiro.au/observers/apply/large_projects.html

In a number of cases, proposers re-submitted previous proposals but used a new proposal code: if a proposal is resubmitted (regardless of whether or not it has been allocated time in previous semesters) then please use the same proposal identification code as allocated previously.

Notes on the Compact Array

The 2010OCTS will commence with the "standard" CABB 1 MHz continuum mode available, and with up to four zoom bands per IF available in the 1M – 0.5k mode. It is hoped that a problem affecting one of the four zoom bands (specifically all baselines to CA04 in one polarisation) will be resolved early in the October semester.

The 64-MHz CABB mode was first used in late September. Initially, the 64-MHz mode has a single 64-

MHz band in each IF, with 2048 channels across the band. (Thus, if the 64-MHz mode is selected for an IF, the total bandwidth in that IF will be 64 MHz, *not* 2 GHz.) For continuum plus spectral line studies, having one IF set with the 64-MHz mode and the other with the standard 2048 1-MHz-wide channels is possible. For spectral line studies, 64-MHz is available in both IFs — with separations up to 7 GHz between the two 64 MHz channels possible. As only two 64 MHz zoom bands will be available at the beginning of the semester, several highly ranked proposals for observations of multiple lines with 64 MHz zoom bands have not been scheduled: these should be resubmitted at the 15 December deadline (using the same proposal code) for consideration in the 2011 April Semester.

During the 2010OCTS it is expected that progress will be made toward expanding the number of zoom bands per IF in the 1-MHz CABB mode, and that pulsar binning and higher time resolution modes will become available. It is also hoped that the 64-MHz mode will be expanded to provide more 64-MHz bands per IF.

The weeks starting on 18 October and 6 December will be used for maintenance towards the next stages of the 20cm/13cm (L/S) receiver upgrade. By the start of the semester, antennas CA02, CA03, CA04, and CA06 had been outfitted with the new 1.1 – 3.0 GHz receivers. By the time you receive this newsletter, CA05 should be outfitted with the new receiver. CA01 will be without an LS receiver until December.

Notes on Parkes

The 2010OCTS schedule for Parkes has two shutdown periods. The first, from 5 – 19 October, is primarily for commissioning of the new RF switching matrix. This will enable "recabling" between standard observing set-ups to be carried out quickly and automatically. The second, from 28 February – 24 March, is primarily for a major overhaul of the telescope Manual Control Panel. The H-OH receiver has recently been upgraded and fitted with a new feed, which will increase the bandwidth available. Testing of this receiver on the telescope is also planned for this second shutdown period.

Parkes observers have at times this year been adversely affected by strong Radio-Frequency Interference (RFI). To help with efforts to mitigate against RFI and to characterise the various sources, observers are asked to record as accurately as possible the onset, duration, and spectral characteristics of any RFI experienced during observing.

Publications List

Publication lists for papers which include ATNF data or CASS authors are available on the Web at *www.atnf.csiro.au/research/publications*. Please email any updates or corrections to this list to

Jennifer.Lee@csiro.au or *Julie.Tesoriero.@csiro.au.*

This list includes published refereed papers compiled since the April 2010 Newsletter. Papers which include CASS staff are indicated by an asterisk.

*ABBOTT, B. P., ... HOBBS, G.B., ... MANCHESTER, R.N. et al."Searches for gravitational waves from known pulsars with science run 5 LIGO data ". ApJ,713,671-685(2010).

*ABDO, A.A., ... , HOBBS, G., ... , JOHNSTON, S., ... , MANCHESTER, R.N. et al."Discovery of pulsed g-rays from PSR J0034-0534 with the Fermi Large Area Telescope: a case for co-located radio and g-ray emission regions". ApJ,712,957-963(2010).

*ABDO, A.A., ... HOBBS, G., ... JOHNSTON, S., ... MANCHESTER, R.N. et al."Detection of the energetic pulsar PSR B1509Ð58 and its pulsar wind nebula MSH 15Ð52 using the Fermi-Large Area Telescope". ApJ,714,927-936(2010).

*ABDO, A.A., ... HOBBS, G., ... MANCHESTER, R.N. et al."The Vela pulsar: results from the first year of Fermi LAT observations". ApJ,713,154-165(2010).

*ABDO, A.A., ... JOHNSTON, S. et al."Fermi Large Area Telescope observations of the Vela-X pulsar wind nebula ". ApJ,713,146-153(2010).

*ABDO, A.A. ..., JOHNSTON, S. ..., MANCHESTER, R.N., ..., WELTEVREDE, P. et al."The first Fermi Large Area Telescope catalog of gamma-ray pulsars". ApJS,187,460-494(2010).

*ABDO, A.A. ..., WELTEVREDE, P. et al."Observations of the Large Magellanic Cloud with Fermi ". A&A,512,A7(2010).

*ALVES, M.I.R., DAVIES, R.D., DICKINSON, C., DAVIS, R.J., AULD, R.R., CALABRETTA, M. & STAVELEY-SMITH, L."Diffuse radio recombination line emission on the Galactic plane between 1=36o and 44o". MNRAS,405,1654-1669(2010).

*BOQUIEN, M. ..., KORIBALSKI, B. et al."100 mm and 160 mm emission as resolved star-formation rate estimators in M 33 (HERM33ES)". A&A,518,L70(2010).

*BREEN, S.L., CASWELL, J.L., ELLINGSEN, S.P. & PHILLIPS, C.J."Water masers accompanying OH and methanol masers in star formation regions". MNRAS,406,1487-1532(2010).

*CARRETTI, E., HAVERKORN, M., McCONNELL, D., BERNARDI, G., McCLURE-GRIFFITHS, N.M, CORTIGLIONI, S. & POPPI, S."The Parkes Galactic Meridian Survey: observations and CMB polarization foreground analysis". MNRAS,405,1670-1689(2010).

*CASWELL, J.L., FULLER, G.A., GREEN, J.A., AVISON, A., BREEN, S.L., BROOKS, K.J., BURTON, M.G., CHRYSOSTOMOU, A., COX, J., DIAMOND, P.J., ELLINGSEN, S.P., GRAY, M.D., HOARE, M.G., MASHEDER, M.R.W., McCLURE-GRIFFITHS, N.M., PESTALOZZI, M.R., PHILLIPS, C.J., QUINN, L., THOMPSON, M.A., VORONKOV, M.A. et al."The 6-GHz methanol multibeam maser catalogue. I. Galactic Centre region, longitude 3450 to 60". MNRAS,404,1029-1060(2010).

*CASWELL, J.L., HUTAWARAKORN KRAMER, B., SUKOM, A. & REYNOLDS, J.E."LBA observations of the maser cluster OH 330.953-0.182". MNRAS,402,2649-2656(2010).

*COLES, W.A., RICKETT, B.J., GAO, J.J., HOBBS, G. & VERBIEST, J.P.W."Scattering of pulsar radio emission by the interstellar plasma". ApJ,717,1206-1221(2010).

*COPPIN, K.E.K., CHAPMAN, S.C., SMAIL, I., SWINBANK, A.M., WALTER, F., WARDLOW, J.L., WEISS, A., ALEXANDER, D.M., BRANDT, W.N., DANNERBAUER, H., DE BREUCK, C., DICKINSON, M., DUNLOP, J.S., EDGE, A.C., EMONTS, B.H.C. et al."Detection of molecular gas in a distant submillimetre galaxy at z=4.76 with Australia Telescope Compact Array". MNRAS Lett.,407,L103-L107(2010).

*CORBELLI, E., LORENZONI, S., WALTERBOS, R., BRAUN, R. & THILKER, D."A wide-field H I mosaic of Messier 31. II. The disk warp, rotation, and the dark matter halo". A&A,511,A89(2010).

*CROFT, S. ... , DeBOER, D. et al."The Allen Telescope Array Twenty-dentimeter Survey - A 690o2 12 epoch radio data set. I. Catalog and long-duration transient statistics". ApJ,719,45-58(2010).

*CSEH, D., KAARET, P., CORBEL, S., KORDING, E., CORIAT, M., TZIOUMIS, A. & LANZONI, B."Radio observations of NGC 6388: an upper limit on the mass of its central black hole". MNRAS,406,1049-1054(2010).

*CURRAN, S.J. & WHITING, M.T. "H I 21 cm absorption and unified schemes of active galactic nuclei". ApJ,712,303-317(2010).

*DESAI, K.M., CHU, Y.H., GRUENDL, R.A., DLUGER, W., KATZ, M., WONG, T., CHEN, C.H.R., LOONEY, L.W., HUGHES, A. et al."Supernova remnants and star formation in the Large Magellanic Cloud". AJ,140,584-594(2010).

*DOUGHERTY, S.M., CLARK, J.S., NEGUERUELA, I., JOHNSTON, T. & CHAPMAN, J.M."Radio emission from the massive stars in the galactic super star cluster Westerlund 1". A&A,511,A58(2010).

*ELLINGSEN, S.P., BREEN, S.L., CASWELL, J.L., QUINN, L.J. & FULLER, G.A."Masers associated with high-mass star formation regions in the Large Magellanic Cloud". MNRAS,404,779-791(2010).

ELSON, E.C., DE BLOK, W.J.G. & KRAAN-KORTEWEG, R.C."The dark matter content of the blue compact dwarf NGC 2915". MNRAS,404,2061-2076(2010).

*EMONTS, B.H.C., MORGANTI, R., STRUVE, C., OOSTERLOO, T.A., VAN MOORSEL, G., TADHUNTER, C.N., VAN DER HULST, J.M., BROGT, E., HOLT, J. & MIRABAL, N."Large-scale H I in nearby radio galaxies. II. The nature of classical low-power radio sources". MNRAS,406,987-1006(2010).

*FERDMAN, R.D., STAIRS, I.H., KRAMER, M., McLAUGHLIN, M.A., LORIMER, D.R., NICE, D.J., MANCHESTER, R.N., HOBBS, G. et al."A precise mass measurement of the intermediate-mass binary pulsar PSR J1802-2124". ApJ,711,764-771(2010).

*FINN, L.S. & LOMMEN, A.N."Detection, localization, and characterization of gravitational wave bursts in a pulsar timing array". ApJ,718,1400-1415(2010).

*GLIOZZI, M., PAPADAKIS, I.E., GRUPE, D., BRINKMANN, W.P., RAETH, C. & KEDZIORA-CHUDCZER, L."A panchromatic view of PKS 0558-504: an ideal laboratory to study the disk-jet link". ApJ,717,1243-1252(2010).

*GONZALO-NUEVO, J. ..., BONAVERA, L. et al."Herschel-ATLAS: blazars in the science demonstration phase field". A&A,518,L38(2010).

*GRANET, C., KESTEVEN, M.J. & SMART, K.W. "Design, manufacture and test of an optimized horn for a holography experiment". In: EuCAP 2010 - The 4th European Conference on Antennas and Propagation, Barcelona, Spain, 12-16 April 2010, Art. 5504971(2010).

HARVEY-SMITH, L., GAENSLER, B.M., KOTHES, R., TOWNSEND, R., HEALD, G.H., NG, C.-Y. & GREEN, A.J."Faraday rotation of the supernova remnant G296.5+10.0: evidence for a magnetized progenitor wind". ApJ,712,1157-1165(2010).

*HENNING, P.A., SPRINGOB, C.M., MINCHIN, R.F., MOMJIAN, E., CATINELLA, B., McINTYRE, T., DAY, F., MULLER, E., KORIBALSKI, B. et al."The Arecibo L-band Feed Array Zone of Avoidance survey. I. Precursor observations through the inner and outer Galaxy". AJ,139,2130-2147(2010).

*HILL, D.T., DRIVER, S.P., CAMERON, E., CROSS, N., LISKE, J. & ROBOTHAM, A."The ugrizYJHK luminosity distributions and densities from the combined MGC, SDSS and UKIDSS LAS data sets". MNRAS,404,1215-1230(2010).

HILL, T., LONGMORE, S.N., PINTE, C., CUNNINGHAM, M.R., BURTON, M.G. & MINIER, V."Physical characterization of southern massive star-forming regions using Parkes NH3 observations". MNRAS,402,2682-2702(2010).

*HUANG, C.W.L. ... , & WILSON, W."AMiBA: scaling relations between the integrated Compton-y and X-ray-derived temperature, mass, and luminosity". ApJ,716,758-765(2010).

*HUGHES, A., WONG, T., OTT, J., MULLER, E., PINEDA, J.L., MIZUNO, Y., BERNARD, J.P., PARADIS, D., MADDISON, S., REACH, W.T., STAVELEY-SMITH, L. et al."Physical properties of giant molecular clouds in the Large Magellanic Cloud". MNRAS,406,2065-2086(2010).

*JACKSON, J.M., FINN, S.C., CHAMBERS, E.T., RATHBORNE, J.M. & SIMON, R. "The 'Nessie' Nebula: cluster formation in a filamentary infrared dark cloud". ApJ,719,L185-L189(2010).

*JAMES, C.W., EKERS, R.D., ALVAREZ-MUNIZ, J., BRAY, J.D., McFADDEN, R.A., PHILLIPS, C.J., PROTHEROE, R.J. & ROBERTS, P."LUNASKA experiments using the Australia Telescope Compact Array to search for ultrahigh energy neutrinos and develop technology for the lunar Cherenkov technique". Phys. Rev. D.,81,042003(2010).

KELSO, C.M. & HOOPER, D."Synchrotron emission from young and near by pulsars". J. Cosmol. Astropart. Phys.,5,039(2010).

*KRAMER, C. ..., KORIBALSKI, B. et al."PACS and SPIRE photometer maps of M 33: first results of the HERschel M 33 Extended Survey (HERM33ES)". A&A,518,L67(2010).

KUNNERIATH, D. et al."Coordinated NIR/mm observations of flare emission from Sagittarius A".A&A,517,A46(2010).

*LI, C.T. ... , WILSON, W., ... , KESTEVEN, M.J. et al."AMiBA wideband analog correlator". ApJ,716,746-757(2010).

LI, J., AN, T., SHEN, Z.-Q. & MIYAZAKI, A."ATCA observations of SiO masers in the Galactic center". ApJ,720,L56-L61(2010).

*LIAO, Y.W., ... KESTEVEN, M., ... & WILSON, W."AMiBA: Sunyaev-Zel'Dovich Effect-derived properties and scaling relations of massive galaxy clusters". ApJ,713,584-591(2010).

LOMMEN, D.J.P. et al."Grain growth across protoplanetary discs: 10 mm silicate feature versus millimetre slope". A&A,515,A77(2010).

*LOPEZ-SANCHEZ, A.R. & ESTEBAN, C."Massive star formation in Wolf-Rayet galaxies. III. Analysis of the O and WR populations". A&A,516,A104(2010).

*LOPEZ-SANCHEZ, A.R. & ESTEBAN, C."Massive star formation in Wolf-Rayet galaxies. IV. Colours, chemical-composition analysis and metallicity-luminosity relations". A&A,517,A85(2010).

*LYNE, A., HOBBS, G., KRAMER, M., STAIRS, I. & STAPPERS, B."Switched magnetospheric regulation of pulsar spin-down". Science,329,408-412(2010).

*MAHONY, E.K., SADLER, E.M., MURPHY, T., EKERS, R.D., EDWARDS, P.G. & MASSARDI, M."High-frequency radio properties of sources in the FERMI-LAT 1 Year Point Source Catalog". ApJ,718,587-595(2010).

*MAO, M.Y., SHARP, R., SAIKIA, D.J., NORRIS, R.P., JOHNSTON-HOLLITT, M., MIDDELBERG, E. & LOVELL, J.E.J."Wide-angle tail galaxies in ATLAS". MNRAS,406,2578-2590(2010).

*MAO, S.A., GAENSLER, B.M., HAVERKORN, M., ZWEIBEL, E.G., MADSEN, G.J., McCLURE-GRIFFITHS, N.M., SHUKUROV, A. & KRONBERG, P.P."A survey of extragalactic Faraday rotation at high Galactic latitude: the vertical magnetic field of the Milky Way towards the Galactic poles". ApJ,714,1170-1186(2010).

*MARSHALL, H.L., HARDCASTLE, M.J., BIRKINSHAW, M., CROSTON, J., EVANS, D., LANDT, H., LENC, E. et al."A flare in the jet of Pictor A". ApJ,714,L213-L216(2010).

*MASSARDI, M., EKERS, R.D., ELLIS, S.C. & MAUGHAN, B."High angular resolution observation of the Sunyaev-Zel'Dovich effect in the massive z~=0.83 cluster Cl J0152-1357". ApJ,718,L23-L26(2010).

*MIZUNO, Y. ..., HUGHES, A. et al. "Warm and dense molecular gas in the N 159 region: 12CO J = 4Ð3 and 13CO J = 3Ð2 observations with NANTEN2 and ASTE". PASJ,62,51-67(2010).

*MOTTRAM, J.C., HOARE, M.G., LUMSDEN, S.L., OUDMAIJER, R.D., URQUHART, J.S., MEADE, M.R., MOORE, T.J.T. & STEAD, J.J."The RMS survey: far-infrared photometry of young massive stars". A&A,510,A89(2010).

*MULLER, E., OTT, J., HUGHES, A., PINEDA, J.L., WONG, T. et al."Characterizing the low-mass molecular component in the northern Small Magellanic Cloud". ApJ,712,1248-1258(2010).

*MURPHY, T., COHEN, M., EKERS, R.D., GREEN, A.J., WARK, R.M. & MOSS, V. "Ultra- and hyper-compact HII regions at 20 GHz". MNRAS,405,1560-1572.(2010).

*MURPHY, T., SADLER, E.M., EKERS, R.D. ... , MAHONY, E. ... , BURKE-SPOLAOR, S., CALABRETTA, M., CHHETRI, R. ... , EDWARDS, P.G., EKERS, J.A., JACKSON, C.A., KESTEVEN, M.J. ... , NEWTON-McGEE, K., PHILLIPS, C., ROBERTS, P. ... , WILSON, W.E."The Australia Telescope 20 GHz Survey: the source catalogue". MNRAS,402,2403-2423(2010).

*NANDI, S., PIRYA, A., PAL, S., KONAR, C., SAIKIA, D.J. & SINGH, M."A multifrequency study of the large radio galaxies 3C46 and 3C452". MNRAS,404,433-441(2010).

*NG, C.-Y., GAENSLER, B.M., CHATTERJEE, S. & JOHNSTON, S."Radio polarization observations of G319.9-0.7: a bow-shock nebula with an azimuthal magnetic field powered by pulsar J1509-5850". ApJ,712,596-603(2010).

*RAVI, V., MANCHESTER, R.N. & HOBBS, G."Wide radio beams from g-ray pulsars". ApJ,716,L85-L89(2010).

*RENAUD, M., MARANDON, V., GOTTHELF, E.V., RODRIGUEZ, J., TERRIER, R., MATTANA, F., LEBRUN, F., TOMSICK, J.A. & MANCHESTER, R.N."Discovery of a highly energetic pulsar associated with IGR J14003-6326 in the young uncataloged galactic supernova remnant G310.6-1.6". ApJ,716,663-670(2010).

RIDLEY, J.P. & LORIMER, D.R. "New limits on the population of normal and millisecond pulsars in the Large and Small Magellanic Clouds". MNRAS Lett.,406,L80-L84(2010).

*ROY, A.L., OOSTERLOO, T., GOSS, W.M. & ANANTHARAMAIAH, K.R."Detection of the H92a recombination line from NGC 4945". A&A,517,A82(2010).

RUSSEIL, D., ZAVAGNO, A., MOTTE, F., SCHNEIDER, N., BONTEMPS, S. & WALSH, A.J."The earliest phases of high-mass star formation: the NGC 6334-NGC 6357 complex". A&A,515, A55(2010).

SCHWARTZ, D.A. et al."Modeling X-ray emission of a straight jet: PKS 0920-397". Int. J. Mod. Phys. D,19,879-885(2010).

SESANA, A. & VECCHIO, A."Measuring the parameters of massive black hole binary systems with pulsar timing array observations of gravitational waves". Phys. Rev. D,81,104008(2010).

*SRIANAND, R., GUPTA, N., PETITJEAN, P., NOTERDAEME, P. & LEDOUX, C."Detection of 21-cm, H2 and deuterium absorption at z > 3 along the line of sight to J1337+3152". MNRAS,405,1888-1900(2010).

*STRUVE, C., OOSTERLOO, T.A., MORGANTI, R. & SARIPALLI, L."Centaurus A: morphology and kinematics of the atomic hydrogen". A&A,515,A67(2010).

*SUBRAHMANYAN, R., EKERS, R.D., SARIPALLI, L. & SADLER, E.M."ATLBS: the Australia Telescope Low-Brightness Survey". MNRAS,402,2792-2806(2010).

*TAM, C.R., STAIRS, I.H., WAGNER, S., KRAMER, M., MANCHESTER, R.N., LYNE, A.G., CAMILO, F. & D'AMICO, N."A search for the binary companion to PSR J1740-3052". MNRAS,406,1848-1852(2010).

*VAN EYMEREN, J., KORIBALSKI, B.S., LOPEZ-SANCHEZ, A.R., DETTMAR, R.-J. & BOMANS, D.J."A kinematic study of the neutral and ionized gas in the irregular dwarf galaxies IC4662 and NGC5408". MNRAS,407,113-132(2010).

*VAN STRATEN, W., MANCHESTER, R.N., JOHNSTON, S. & REYNOLDS, R.E."PSRCHIVE and PSRFITS: definition of the Stokes parameters and instrumental basis conventions". PASA,27,104-119(2010).

*VIEIRA, J.D.E. ... , McINTYRE, V. et al."Extragalactic millimeter-wave sources in South Pole Telescope survey data: source counts, catalog, and statistics for an 87 square-degree field". ApJ,719,763-783(2010).

*VORONKOV, M.A., CASWELL, J.L., ELLINGSEN, S.P. & SOBOLEV, A.M."New 9.9-GHz methanol masers". MNRAS,405,2471-2484(2010).

WALSH, A.J., THORWIRTH, S., BEUTHER, H. & BURTON, M.G."Mopra line survey mapping of NGC 6334 I and I(N) at 3 mm". MNRAS,404,1396-1414(2010).

*WELTEVREDE, P., JOHNSTON, S., MANCHESTER, R.N., BHAT, R., BURGAY, M., CHAMPION, D., HOBBS, G.B., KIZILTAN, B.B., KEITH, M., POSSENTI, A., REYNOLDS, J.E. & WATTERS, K."Pulsar timing with the Parkes Radio Telescope for the Fermi mission". PASA,27,64-75(2010).

*WHITE, G.J., PEARSON, C., BRAUN, R. et al."A deep survey of the AKARI north ecliptic pole field. I.WSRT 20 cm radio survey description, observations and data reduction". A&A,517,A54(2010).

*YUAN, J.P., WANG, N., MANCHESTER, R.N. & LIU, Z.Y."29 glitches detected at Urumqi Observatory". MNRAS,404,289-304(2010).

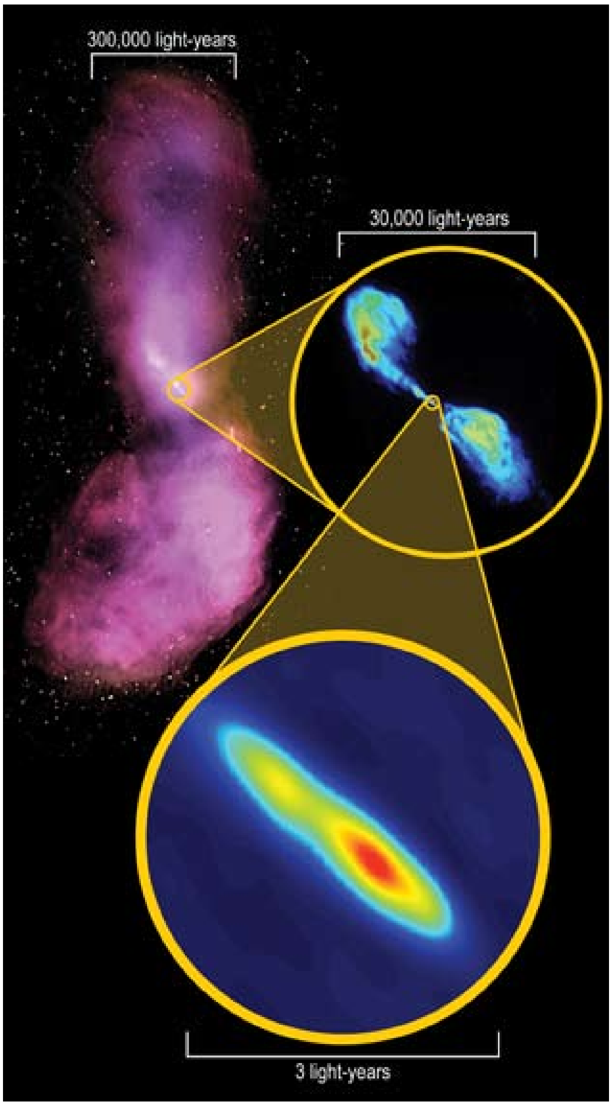
ZWAAN, M.A., MEYER, M.J. & STAVELEY-SMITH, L."The velocity function of gas-rich galaxies". MNRAS,403,1969-1977(2010).

Right: One of CSIRO's new ASKAP antennas being assembled at the Murchison Radio-astronomy Observatory, October 2010.

Credit: Ross Forsyth

Below: An elevated view of three of CSIRO's new ASKAP antennas at the Murchison Radio-astronomy Observatory, October 2010.

Credit: Ross Forsyth



The structure of Centaurus A, from the largest scales observed with the ATCA, to the smallest scales probed by new VLBI observations with a maximum baseline of 5500 km, from Western Australia to New Zealand.

See page 31

For further information:

CSIRO Astronomy & Space Science
Email enquiries: atnf-enquiries@csiro.au, Email newsletter: newsletter@atnf.csiro.au
Web central: www.atnf.csiro.au
Web newsletter: www.atnf.csiro.au/news/newsletter,
Web outreach: outreach.atnf.csiro.au

Contact Us
Phone: 1300 363 400
+61 3 9545 2176
Email: enquiries@csiro.au
Web: www.csiro.au