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ATNF News

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CSIRO Astronomy and Space Science — Undertaking world-leading astronomical research and operating the Australia Telescope National Facility.

Editorial

Welcome to the April 2013 edition of *ATNF News*.

We start this issue by welcoming Lewis Ball, the newly appointed Chief of CSIRO Astronomy and Space Science and ATNF Director, who returns to CSIRO following two and a half years as Deputy Director of the Atacama Large Millimeter/submillimeter Array (ALMA) in Chile.

On Sunday 13 January, a massive bushfire swept through the Warrumbungle National Park and Siding Spring Observatory, near Coonabarabran in the northwest of New South Wales. CSIRO's Mopra radio telescope, close to Siding Spring Observatory, was also impacted by the fire. Starting on page 4, Narrabri and Mopra Site Manager Brett Hiscock gives an account of the fire and damage at Mopra, as well as the current state of site remediation.

The Compact Array centimetre receiver upgrade project, outlined by Mark Bowen, has now been substantively completed with the installation of new receiver systems on all six antennas.

We give an overview of the latest ASKAP and SKA news, including successful remote observing with ASKAP from Marsfield (a distance of more than 3,400 km) and on-site commissioning activities.

We report on recent changes to the ATNF website, the launch of an astronomy 'blog' and a new memorial dedicated to pioneering radio astronomer Grote Reber that has been installed at Parkes Observatory, as well as pay tribute to the late Dick McGee. In other news, Jill Rathborne gives an account of the first ALMA results presented at a meeting in December, and Malte Marquarding reports on the successful Astroinformatics Summer School held in February.

The ATNF is at the heart of an active science community. Two science articles give a snapshot of the latest radio astronomy research being conducted with the facility, including:

- Jimi Green and coauthors' overview of the MAGMO project, which used the Compact Array and OH masers to map the Galactic magnetic field; and
- predictions for neutral hydrogen surveys to be conducted with the Australian Square Kilometre Array Pathfinder—WALLABY (an all-sky survey) and DINGO (a deeper and smaller area survey)—which Alan Duffy estimates will detect more than 700,000 galaxies.

Our regular contributions, including updates on new postdoctoral staff, graduate students and visitors, as well as recent publications, highlight the connections between the facility and the astronomy community.

We hope you enjoy this issue. Your comments and suggestions are always welcome. If you would like to contribute to future editions of ATNF News, please contact the newsletter team.

Gabby Russell and Tony Crawshaw

The *ATNF News* Editorial Team (*newsletter@atnf.csiro.au*)

Front cover image

Mopra radio telescope, with Mopra rock in the background, photographed by CSIRO's John Masterson in 1988. On 13 January 2013 a bushfire swept across the Mopra site: see page 4 for more details.

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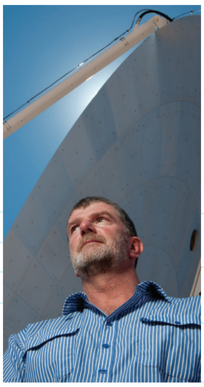



From the Chief of CSIRO Astronomy and Space Science

LEWIS BALL (CHIEF OF CASS)

I am pleased to be writing this message shortly after returning to CSIRO and the ATNF. Having previously spent nine years with CSIRO, I feel right at home and would like to thank CASS staff and the local astronomy community for welcoming me back so warmly. My time as Deputy Director of the Atacama Large Millimeter/submillimeter Array provided me with wonderful experience in managing a large-scale, multi-national astronomy project, and I look forward to bringing this experience to bear as CSIRO continues to play a leading role in the design and development of the Square Kilometre Array.

Already, 2013 has had its challenges as well as its high points.

The bushfire at Mopra has been an unfortunate blow. We have poured considerable effort into assessing the extent of the fire damage and the impact this might have on observing with the telescope: fortunately it appears that little damage has been suffered by the telescope and equipment critical to its operation. While there has been significant damage to on-site buildings at Mopra, the nearby Siding Spring Observatory, the Warrumbungle National Park and private properties, we are grateful that staff, astronomers and local community members are all safe.

The successful completion of the Compact Array centimetre receiver upgrade project earlier this year is already having a big impact on the scientific capability of the instrument and attracting international interest. It is fitting that this upgrade, which complements the recent Compact Array Broadband Backend project, should be completed in 2013—the Compact Array's 25th anniversary.

I look forward to sharing news of the Compact Array's September 'birthday' celebrations with you in the next edition of ATNF News. In the meantime, I'll be getting down to work with CASS staff and the astronomy community to ensure our continued delivery of world-class radio astronomy facilities.

New Chief appointed

TONY CRAWSHAW (CASS)

Following an extensive international search, Dr Lewis Ball has been appointed Chief of CSIRO's Astronomy and Space Science (CASS) division. He succeeds Dr Philip Diamond who left CSIRO in October 2012 to take up the position of Director General of the SKA Organisation.

As the new CASS Chief, Dr Ball leads approximately 280 staff and is responsible for operating and developing CSIRO's Australia Telescope National Facility as well as its newest telescope the Australian SKA Pathfinder (ASKAP); managing (on NASA's behalf) the Canberra Deep Space Communication Complex; as well as driving the organisation's contribution to the first phase of the international Square Kilometre Array (SKA) telescope in Australia.

Lewis returned to CSIRO from the Atacama Large Millimeter/submillimeter Array (ALMA) Observatory in Chile where he was Deputy Director. There he led the successful commencement of ALMA's scientific operation, currently the world's largest and most complex astronomical observatory and a partnership involving 20 countries.

Previous to his ALMA role, he had been with CSIRO for nine years in a number of management roles including leadership of CSIRO's astronomy division from February 2009 to May 2010, first as Acting Director of the Australia Telescope National Facility (ATNF) and then as Acting Chief of CSIRO Astronomy and Space Science.

Lewis earned his PhD in Theoretical Physics from the University of Sydney. He is a recognised international expert on radio supernovae and their evolution and is best known for his comprehensive record of the evolving radio emission from Supernova 1987A.

He formally began as CASS Chief on Monday 18 March.

Dr Lewis Ball has been appointed the incoming Chief for CSIRO's Astronomy and Space Science (CASS) division. Credit: ALMA (ESO/NAOJ/NRAO), M. Alexander (ESO).

Bushfire at Mopra telescope

BRETT HISCOCK (CASS)

On Sunday evening, 13 January, a bushfire in Warrumbungle National Park west of Siding Spring Observatory and CSIRO's Mopra radio telescope suddenly changed direction. The 'Wambelong' fire swept to the east and ran over both sites, and then continued eastward where it caused significant damage to property and homes along Timor Road—the access road to Mopra from the nearby town of Coonabarabran. *The Sydney Morning Herald* reported that it was one of the most destructive fires in New South Wales in more than a decade. While an area of 53,000 hectares was burnt and 53 homes, more than 100 sheds and outbuildings, and stock and wildlife were lost, thankfully, there was no loss of human life.

At Narrabri, some of the local CASS staff became aware of the fire and evacuation along Timor Road through the NSW Rural Fire Service and social media connections. We confirmed that nobody was at the Mopra site or expected to arrive there in the next little while. A small group then formed, comprising staff and visiting observers, in the Narrabri control room and we began to watch events unfold at Mopra live via our communication network: the Mopra web cameras, Mopra antenna protection system (MAPS), and 'Monica' monitoring software.

A still image from Mopra's 'sky' camera, captured at 5.54pm on 13 January, shows bushfire approaching the telescope site.

Looking back at the MAPS information, it was clear that the site had been affected by adverse weather throughout the afternoon: there was a high wind alert and air temperatures hovered around 40 degrees Celsius between 3 pm and 4 pm. Three separate, brief power outages followed in the next hour; a further power outage and another four wind alerts occurred in the following 30 minutes.

At approximately 5.30pm, staff in the Narrabri control room remotely started the Mopra site generator in case the local energy supplier, concerned about further fire risk from power lines, cut power to the region. Not long after, mains power to the Mopra site was cut. By now, the rate at which MAPS wind alerts were occurring increased. Full logs of data from Mopra were not available, but the maximum wind speed at that time was greater than 55 km/hr.

According to information retrieved from MAPS, at 5.58pm both antenna wind vanes issued wind alerts and the site fire panel went into its alarm state; this also set off the Mopra audible alarm at Narrabri. The fire alarm, in turn, caused generator power to be removed from all site equipment, even though the generator's diesel engine remained running at the time. Site air temperatures at the weather station recorded a peak around 63 degrees. From this point on, the site uninterruptible power supplies continued to deliver power to some equipment until their batteries ran down. So for a short while, items such as network gear, web cameras and site monitoring equipment remained running, which meant monitoring information and web images were still being sent live to Narrabri.

The Mopra antenna remains intact with very little evidence of damage but there has been significant damage to the control building.

It was evident to those watching the web cameras just how incredibly fast the fire was moving:

- At 5:55 pm the building-mounted web camera showed that the fire had just started to come down the ridge to the west of Mopra.
- At 5.56 pm the cameras showed the site covered in smoke with parts of the antenna visible, but the control building was almost invisible.
- At 5.57 pm the site was surrounded by flames, with tree canopies ignited to the east of the control building and glowing embers blowing across the site. For the next several minutes smoke swirled around the control building; the staff at Narrabri were hopeful that the antenna and building had survived.
- At 6.16 pm the building-mounted camera captured its last image before failing; the web camera at the gate failed shortly afterwards.
- At 6:22 pm the sky camera took its last image.

The MAPS remote connection between Narrabri and Mopra, and the live Monica monitoring, stopped during the above sequence—shortly after power from the generator ceased.

While the last web camera images gave the impression that the antenna and building had survived the initial fire front, the real situation wasn't clear. With no further information coming from the site, staff spent an anxious night waiting to find out how Mopra had fared. Having seen the ferocity with which the fire had hit Mopra, staff in the Narrabri control room were concerned for the town of Coonabarabran itself. Fortunately, there was a wind change and the fire changed direction before it reached the town.

The main control room of the control building (at left), protected by its self-contained concrete structure and radio-frequency interference screening around the door and windows, is largely intact, however, the accommodation, office and living areas have been ruined.

Outside the telescope compound, the high-voltage transformer that was supplying power to the site was burnt to the ground.

Assessment of damage

Early the next day, Monday 14 January, the Mopra web camera images of the bushfire were being used by television news reports. By late morning, staff from the Australian Astronomical Observatory had permission to access their site at Siding Spring; they did a quick 'drive by' Mopra and provided a verbal report. This was the first indication that Mopra hadn't survived unscathed: the accommodation, office and living areas of the control building had been ruined. The report also indicated that while the main control room appeared to be intact, the condition inside was not visible. There remained hope that some equipment had survived as computer network data traffic was making it in and out of the room.

On the Monday afternoon, Narrabri staff were prevented from accessing the site as conditions around Coonabarabran worsened.

The next day, two staff members were permitted to access the site to inspect the control building. This revealed that nothing inside the equipment room had burnt. The site was then closed because of safety concerns and a site clearance plan put in place.

Subsequent site visits indicated that the antenna and garage had remained intact, with very little evidence of damage. There were signs of very high temperatures around the antenna, including some gearbox oil that has been exhausted onto the cryogenic compressors. The receivers and all equipment inside the antenna looked to be in good condition. There were signs that hot embers had landed on the Gore-Tex cover above the vertex room. The pedestal room's temperature alarm had gone off, but all equipment looked to be sound.

Photogrammetry has now been performed on the telescope surface and sub-reflector and, as far as can be measured, there has been no degradation as a result of the fire.

The control building's control and equipment room appears to have been lucky to have survived, with the front door being partly burnt along with part of the door jam. The fact that the room was built as a self-contained concrete structure, with radio-frequency interference screening around the door and windows, seems to be the reason it has survived and is testament to those involved in its design and construction. There was significant damage to other parts of the building, however: the roof and ceiling had collapsed, and the site's mains power board was destroyed.

Outside the control building, most air conditioners were destroyed, and the bio-cycle, gutters and overflow pipes all damaged. Various cables in and out of the building were also burnt. The main equipment room air conditioner was only partly damaged.

It appears that the site generator shut down when the mains board was burnt. There was damage to wiring associated with the generator's control in the mains board, fuel tank wiring and the fuel hose. Outside the telescope compound, the mains meter box and electricity poles were damaged.

Site remediation

The meter board has now been repaired and a temporary mains board installed at the building so that power is now available all the time. The site rubble has been removed and specialist contractors have filtered and dried the air in the control and equipment room. Following this process, the electronics in the control room have been cleaned to remove ash residue before it caused further damage. The pedestal room has also been cleaned. The site generator has been serviced and a temporary control commissioned so that it can supply back up power to the site if required.

Following cleaning, we have tested and 'powered up' the site. Repairs were necessary to a number of items including an Uninterruptible Power Supply and a number of other power supplies, which was a little surprising considering the items physically looked okay. The LS receiver was removed and transported to Narrabri as it had been assessed as requiring significant maintenance as an indirect result of the fire. The millimetre receiver was repaired *in situ* and tests were conducted firstly with the receiver warm to ascertain that we didn't have significant damage to other systems at Mopra. The millimetre receiver has been successfully cooled. The telescope drive systems have been serviced, which included changing the gearbox oil, and then the telescope driven to point at a strong maser. We are now carrying out fault-finding tests on MOPS.

Given this good progress, we hope that observing may be able to start again in a few weeks' time. Updates on the remediation of the Mopra site will be posted to the 'News' section of the ATNF website, *www.atnf.csiro.au*.

Compact Array centimetre receivers upgraded

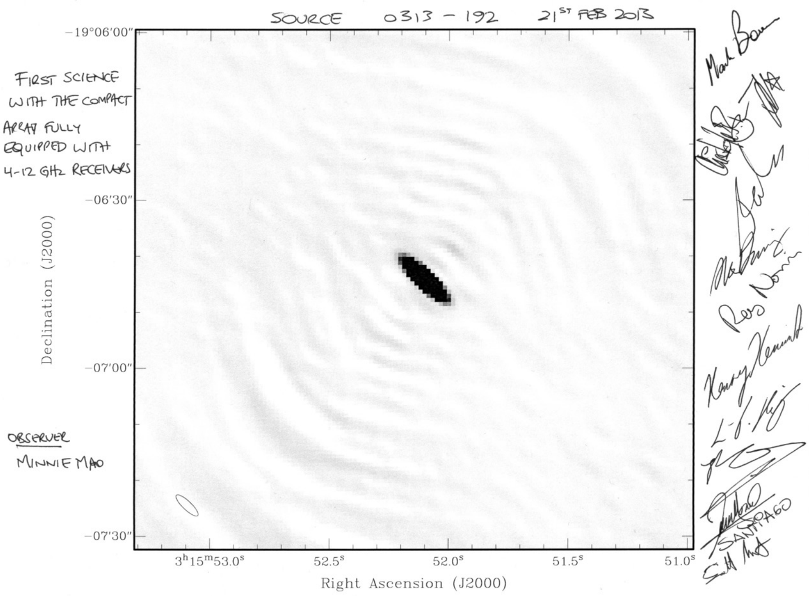
MARK BOWEN (CASS)

The installation of two upgraded 4–12 GHz receivers on the Compact Array in February saw substantive completion of the third and final phase of the Compact Array centimetre receiver upgrade project, with production 4-cm receiver systems now installed on all six Compact Array antennas. The upgrade has breathed new life into the instrument's 6/3-cm receiver systems, which are over 20 years old. As well as now leading the world in bandwidth and sensitivity, the receivers will ensure the long-term viability of the array. The 6/3-cm receiver upgrade was made possible by a A$1.471 million grant from Astronomy Australia Limited (AAL) as part of the Education Investment Fund (EIF); the grant will end in June 2013 when the project will be officially completed.

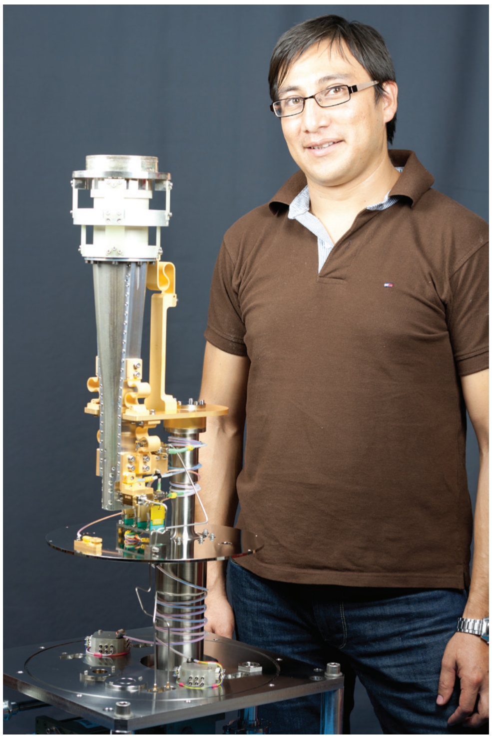
Within hours of the installation of the last two receivers, Minnie Mao (NRAO, USA) made the first image taken with the upgraded Compact Array. The object is a particularly exciting one, being a rare example of a radio galaxy associated with a supermassive black hole embedded within a spiral galaxy. CASS astronomer Shari Breen and her team have also embraced the opportunities afforded by the receivers' extra sensitivity and are currently looking for masers that have never before been observed.

The 6/3-cm receiver upgrade is the final phase of the Compact Array centimetre upgrade and involved replacement of the core components of the receiver systems. The aim of the project was to merge the 6-cm and 3-cm bands from the original 4.4–6.9 GHz and 8.0–9.2 GHz bands to provide continuous frequency coverage of approximately 4–12 GHz. The upgrade has delivered a system temperature of less than 20 Kelvin over the frequency range 4.2–10.8 GHz, which constitutes a 25% increase in operating bandwidth and a 40% improvement in the system noise performance. This upgrade complements the 20/13-cm receiver upgrade, completed in early 2011, which increased the frequency coverage of the 20/13-cm receiver systems from 1.25–1.8 GHz and 2.2–2.5 GHz bands to approximately 1.1–3 GHz. Together, these upgrades give the Compact Array unprecedented access to the centimetre radio spectrum from 1.1 GHz to 12 GHz at a sensitivity that is improved over that previously available by more than a factor of two. This high performance capability will enable fundamentally new scientific programs such as follow-up surveys to further identify and understand transients detected by CSIRO's Australian Square Kilometre Array Pathfinder (ASKAP), as well as exploring the origin of magnetic fields in galaxy disks and active galactic nuclei.

The project commenced in 2011, with preliminary work focused on replacing the existing frequency diplexer and low noise amplifiers (LNAs). It became apparent early in the development process that the existing ortho-mode transducers (OMTs) and feed horns would impose significant limitations on the system's performance, however, work on these components was originally outside the scope of the project. Based on the success of the 20/13-cm OMT upgrade and promising results from a preliminary investigation, CASS agreed to proceed with the development of a new 4–12 GHz OMT. Laboratory testing of a prototype receiver system incorporating all of these components commenced in October 2011 and was installed on the Compact Array in December 2011. Initial measurements of the system on the Compact Array indicated



This figure was the first image taken with the new receivers, and was observed by Minnie Mao within hours of the completion of the installation; it has been signed by members of the centimetre receiver upgrade project team. The object (0313-192) is a particularly exciting one, being a rare example of a radio galaxy associated with a supermassive black hole embedded within a spiral galaxy. In the local Universe nearly all supermassive black holes are associated with elliptical galaxies—galaxies that have exhausted most of their gas in star formation, and are settling down to a long (and possibly boring) middle age. So how come this supermassive black hole is embedded in a vigorous young star-forming galaxy? Minnie hopes to find the answer using these observations, and thereby gain new understanding about how supermassive black holes regulate the host galaxies that surround them.



CSIRO Technical Officer Santiago Castillo with one of the upgraded 4-cm receiver systems (the vacuum dewar has been removed).

the system temperature was less than 20 Kelvin over the frequency range 4.2–10.8 GHz, significantly exceeding expectations. Original projections were that the planned frequency coverage could be achieved but this would be at the cost of only realising a modest reduction in system temperature.

The rollout of fully upgraded receiver systems on the Compact Array commenced in August 2012. A further two receivers were installed during November 2012, with installation of the final two receivers during February 2013. Use of the Mopra 6/3-cm receiver as an additional 'spare', with the consent of the VLBI community, enabled the receivers to be upgraded in pairs greatly speeding up the process. Work remains to upgrade the spare receiver and incorporate modifications to the modules that interface the receiver systems to the Compact Array Broadband Backend system (CABB).

Early laboratory testing of the prototype receiver system showed acceptable performance beyond 12.2 GHz. This held out potential to enable observation of the methanol (CH_3OH) line at 12.2 GHz and gave rise to a desire to investigate the feasibility of developing a feed horn capable of utilising the frequency coverage of the receiver system. Following their feasibility study, BAE Systems Australia were contracted to design and manufacture two prototype 4–12.25 GHz feed horns. The first feed horn was delivered in June 2012; after delivery of the second prototype, both 4–12.25 GHz feed horns were installed on the Compact Array during September 2012. The CABB system is only capable of operation up to 12.0 GHz and extension of the frequency coverage to 12.25 GHz was not part of the original project. Consequently, a detailed assessment of the cost and scope of the work required to enable operational use of the system at 12.25 GHz has been undertaken but the work has not yet been funded.

The success of the upgrade is testament to the skill and dedication of the team of CASS engineers and technicians from the Front End Technologies Group (Alex Dunning, Henry Kanoniuk, Les Reilly, Yoon Chung and Santiago Castillo), machine shop (Michael Bourne, Michael Death, Geoff Cook, Ray Moncay and Paul Cooper) and Narrabri site staff (Jock McFee, Christoph Brem, John Wilson and Bruce Tough).

The Compact Array centimetre upgrade project has already been recognised nationally. It received a highly commended award in the research and development category of Engineers Australia's Engineering Excellence Awards (Sydney Division) announced in September 2012 and was a finalist in the manufacturing and high tech design category of *The Australian* Innovation Challenge 2012 (see page 21 for more information).

ASKAP and SKA news

FLORNES CONWAY-DERLEY (CASS), SARAH PEARCE (CASS), CAROLE JACKSON (CASS) AND STEVEN TINGAY (ICRAR/CURTIN)

Following the celebrations of the ASKAP and MRO Opening Ceremony in October 2012, the ASKAP team is now focused on continuing engineering and science commissioning activities at the Murchison Radio-astronomy Observatory (MRO), construction and occupation of the MRO Support Facility in Geraldton, and establishing remote observing in the new Science Operations Centre (SOC) at CASS headquarters in Sydney, where the ASKAP team recently achieved remote operation of the ASKAP antennas for the first time.

The team has been involved in discussions and activities for SKA pre-construction, both nationally and internationally. We have also received good news from our collaborators: the iVEC Pawsey Centre supercomputer in Perth is progressing well, and an opening ceremony for the Murchison Widefield Array (MWA) project was held at the MRO in late 2012.

Even though the ASKAP team had recently success with remote observing tests from Sydney, the team is still hard at work on the ground at the MRO. Here Brett Armstrong keeps his cool under a beach umbrella while working from an elevated work platform.

ASKAP MOVES INTO THE MRO CONTROL BUILDING

The MRO Control Building is a unique facility that houses power distribution, networking and communications equipment, telescope control computers, and the complex digital processing, beamforming and correlator equipment to be used by ASKAP and other major instruments under development at the Murchison Radio-astronomy Observatory (MRO).

Construction activities on the MRO Control Building were completed in mid-2012, and the facility was officially handed over to the ASKAP team for occupation.

The building is the control centre of the MRO, and the distribution hub for power and data cables which connect the site to the outside world. It is crucial for the operation of CSIRO's ASKAP radio telescope and two other experiments currently located at the site: the Murchison Widefield Array (MWA) and Experiment to Detect the Global Epoch of Reionization Signature (EDGES). Development of the building required unique construction solutions for challenges associated with the remote location and stringent RFI specifications that make the MRO one of the best locations for radio astronomy.

A view of the Murchison Radio-astronomy Observatory from the air, with the MRO Control Building visible at the bottom of the photo.

John Morris working in the plant room of the MRO Control Building following handover and occupation in late 2012.

The MRO Control Building arrived by truck from South Australia October 2011 in the form of modules—partially pre-fabricated sections ready for assembly on the site. The design of the building reflects the extremely careful consideration given to ensure that the equipment the building houses produces minimal RFI impact on the MRO's radio-quiet environment.

During commissioning of the building, the main task was to relocate peripheral devices from the 'BETA Box' and other temporary buildings into the Control Building. The BETA Box was a modified 20-foot shipping container housing devices necessary for observatory operation while the Control Building was being built. These devices included beamformers, computing and networking equipment and a correlator for the first ASKAP antennas already outfitted with Phased Array Feed (PAF) receiver systems.

The successful decommissioning of the BETA Box, and the recommissioning of data transport links from the digital receivers to the beamformers in the Control Building, now paves the way for commissioning of the next ASKAP antennas that will make up the second half of the six-antenna Boolardy Engineering Test Array (BETA).

VISITORS TO THE MRO

CASS was pleased to host a senior delegation from the Chinese Academy of Sciences (CAS) in February 2013. This group, which included the Vice President, Zhan Wenlong, spent some time here the Marsfield headquarters, before travelling to the Murchison Radio-astronomy Observatory (MRO) for a day. CAS members are very interested in many aspects of science collaboration with Australia and CSIRO, and on this visit they were keen to discuss details of the SKA.

The MRO has recently welcomed a number of other distinguished guests, including Arnold van Ardenne and Erwin de Blok, from ASTRON (The Netherlands), the Japanese Consul General Ishikawa and Dr Imai, David Loop and Gordon Lacy (DRAO), Isak Theron (SKA South Africa) and William Garnier (SKA Office).

The CASS and CAS delegation visited the Murchison Radio-astronomy Observatory in February 2013.

NEWS FROM GERALDTON

CSIRO's office in Geraldton is known as the MRO Support Facility (MSF). The staff based at the MSF provide critical technical, administrative and project management support to the development and operation of ASKAP and the MRO, 370km away.

Construction of the MRO Support Facility (MSF) building began in 2012 at the Geraldton University Centre (GUC). Construction works reached 'practical completion' in February, and the building was officially occupied in March.

The MSF provides remote operations services for ASKAP and other international projects currently being constructed at the MRO site, as well as office and workshop space for administrative, technical, maintenance and research staff, many of whom spend significant time at the MRO itself.

The facility has the technical and workshop capability to support some of the maintenance work required on parts of ASKAP. It also features a dedicated room (the 'portal') for researchers based in Geraldton and its region who have been awarded computing time on iVEC's Pawsey Centre supercomputers.

The installation of the high-speed optical fibre Internet connection between the MSF and the MRO (370 km) was completed by CSIRO in 2012 as an integral part of the MRO infrastructure development. A link between the MSF and the iVEC Pawsey Centre in Perth has also been installed, as part of the National Broadband Network; AARNet is playing a key role in providing data communications services from the MRO to the Pawsey Centre.

The address of the MSF is now 33 Onslow Street, Geraldton, WA, 6530; however, the phone numbers remain unchanged. Details are available on the ATNF website (http://www.atnf.csiro.au/facilities/msf.html).

ASKAP Commissioning

SCIENCE COMMISSIONING SEES FIRST MULTI-PAF IMAGES

Prior to the relocation of the BETA Box systems to the MRO Control Building, the science commissioning team were able to demonstrate single- and multi-beam observations at the MRO using three phased array feeds and a 16 MHz bandwidth software correlator. The resulting images of 1934-638, created using short integrations (less than four hours) and three baselines, look just as the team expected, and confirm that the preliminary systems work as expected.

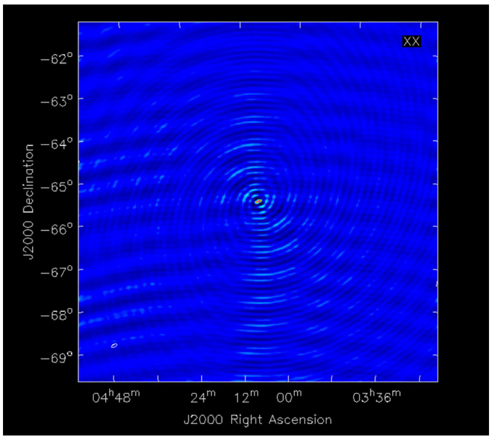
Following decommissioning of the BETA Box and recommissioning of the systems in the MRO Control Building, the team returned to the MRO in late January 2013 to re-test the system in its new location. Despite some hardware bugs, the team was quickly able to make a long-track image (with an integration of 10 hours) using a single PAF beam of the radio source PKS 0407-658 in a single polarisation and a total bandwidth of 16 MHz.

The results confirmed not only that the preliminary systems work as expected, but also that the ASKAP PAFs are able to make multiple beams.

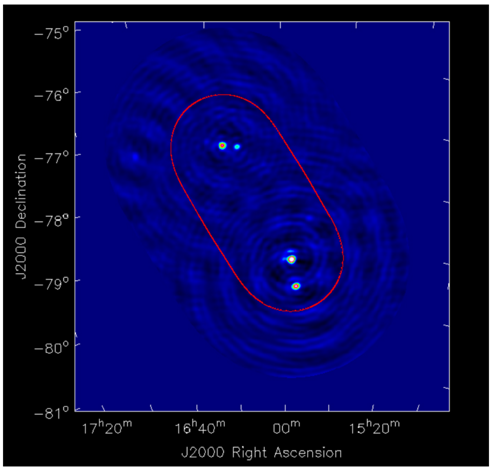
Then in April CSIRO's ASKAP team successfully produced the first multi-beam image ever made using PAFs on an

The new MRO Support Facility in Geraldton.

The initial image of radio source PKS 0407-658 using three ASKAP PAFs. To produce this image, the BETA software correlator was used with a single beam, single polarization and a total bandwidth of 16 MHz.



The first multi-beam image ever made using PAFs on an interferometer, created with ASKAP's BETA-1 array. (See text for details.



interferometer. The image was created with BETA-1 array of three ASKAP antennas, each fitted with a PAF. Three separate beams were created for each PAF and lined up to track an elongated patch of sky over a 12-hour observation. This field was specifically chosen to contain strong and well-known extragalactic sources with suitable angular separations: (from top left) PKS 1610-771, PKS 1606-772, PKS 1549-790 and PKS 1547-795. The red contour shows the 50% sensitivity region—the envelope of the three overlapping PAF beams.

Importantly, the sources in this image are too far apart to be observed simultaneously using a single pixel feed on a 12-m dish (the size of a single ASKAP antenna). This is a striking demonstration of the power of PAF imaging, particularly given the very limited u-v coverage that three antennas can achieve.

The software correlator used in previous observations was again used in these tests. It correlated the data captured for the three beams simultaneously, with image processing performed in ASKAPsoft, the software custom-designed for the telescope by the ASKAP Computing team. Over the coming months the Systems Commissioning team will work with the Computing and Digital Systems groups at Marsfield, further developing a hardware correlator to be deployed at MRO later this year.

REMOTE OBSERVING A SOCCESS FOR ASKAP

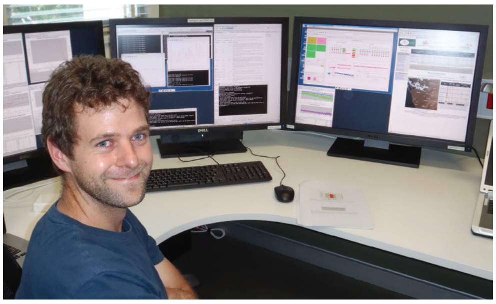
A remote connection is now in place between the new Marsfield Science Operations Centre (SOC) in Sydney and the MRO Control Building in Western Australia (over 3,400 km away). As part of continuing commissioning activities, remote observing tests were set up to validate the stability of the ASKAP system using three of the ASKAP antennas at the MRO.

Previously, the antennas had been controlled remotely from Boolardy Homestead, and partially from offices in Marsfield as part of VLBI, but these tests mark the first time the ASKAP antennas have been operated *fully* from outside the MRO or Boolardy Homestead.

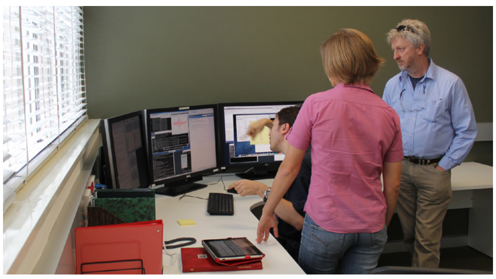
Not only do the tests provide insight into the remote science operations and observations that will take place with ASKAP, but the benefits of remote access at this, the commissioning stage, mean increased efficiency as workers need to spend less time travelling to the remote desert environment of the MRO.

CSIRO Chief Executive Megan Clark had a chance to see the system in action during her visit to the Marsfield site in February, when the team was running remote testing.

The ASKAP commissioning team will initially use one of the larger observing rooms in the SOC, with a 'smart board' linked to a similar unit at the MRO site to ensure there is a single source of current information available to engineers and commissioning teams.



Initial fringes were successfully obtained during early remote testing, and mark a significant step forward in the commissioning process.



Max Voronkov, Lisa Harvey-Smith and John Reynolds, conducting successful remote control of the ASKAP antennas from the Marsfield headquarters. The SOC will be an invaluable platform as remote BETA commissioning begins to ramp up in earnest.

SKA activities

SKA PRE-CONSTRUCTION UPDATE AND PLANNING WORK

CAROLE JACKSON AND SARAH PEARCE

Over the last six months, following on from the completion of the EU framework 7 programme 'Preparing for SKA' (PrepSKA), the formation of the new SKA Organisation and the SKA site selection decision, there has been much progress in realising the SKA project and moving towards the formal 'ready to build' work.

As a result, CASS staff have been working with the International SKA Project Office (now called the Office of the SKA Organisation (SKAO)) and many of the SKA Member institutes. Mainly this effort has been around the key issues of:

- SKA pre-construction management planning, systems engineering, science requirements analysis (setting the SKA specification) and Concept of Operations.
- Progressing planning for a number of SKA pre-construction work package Consortia (as detailed below).
- Ongoing support by Phil Crosby for global industry engagement matters including IP policy preparation, procurement strategies for the disperse project, project costing approaches and industrial liaison.

Douglas Bock is leading the new SKA Operations Working Group. The group is currently producing a draft of the SKA Concept of Operations (ConOps). The ConOps complements the Design Reference Mission and the Baseline Design by describing how, from an organisational perspective, the SKA is to be operated. A set of principles for the Concept of Operations will be put to the SKA Board shortly.

As at March 2013, the SKA project is now at the stage to finalise and verify the design (technologies) for the SKA1 and do detailed planning ready for implementation (build) of SKA1. SKA1 will be built across two sites. It consists of:

1. An array of 60 SKA-design dishes, equipped with Phased Array Feeds (PAFs) ('SKA1_survey'), and a large low-frequency array ('SKA1_low'), both to be located on Boolardy. SKA1_survey will integrate with ASKAP.
2. An array of 190 SKA-design dishes, equipped with single pixel feeds ('SKA1_mid'). The dishes will be capable of being retrofitted with WBSPFs and/or PAFs in the future. SKA1_mid will be located at the Karoo SKA site in South Africa and integrated with MeerKAT.

The two SKA dish arrays will have different but complementary science capabilities. Furthermore, the starting concept is to make the two arrays as similar as possible (reusing same components and designs) and only diverging where justified. This will allow maximum flexibility when designing and building SKA2.

The SKA Pre-Construction Phase will run from ~mid-2013 through to ~mid-2016 and be executed by a number (of order 12) work package Consortia that will deliver the Critical Design Reviews in 2016. The CDR will be followed by ~1 year's further work to take the outputs from pre-construction and prepare tender specifications, etc., to be ready to let contracts for construction of SKA1 in 2017.

The CDR requires that the SKA elements for SKA1 be delivered to Technology Readiness Level (TRL) 8. The Consortia for each of the components are now planning to respond to the SKAO's Request for Proposals (for work plans, etc.) for the SKA pre-construction phase.

CSIRO PARTICIPATION IN SKA WORK PACKAGE CONSORTIA

With the SKA entering a formal 'pre-construction' phase to progress the SKA design and validation processes, CASS has defined a strategy to participate in seven (7) of SKA pre-construction work package consortia. SKA pre-construction will be managed and directed by the Engineering and Management team based at the SKA Office (SKAO), Jodrell Bank, UK. The SKAO has design authority for the SKA and receives direct funds from the member countries to pay for its personnel and associated activity.

CASS's primary goal is to lead the Dishes consortium, with significant efforts to realise the PAF suite of feeds on SKA1_survey with a number of international SKA partners. The Dishes work package includes the development of phased array feeds (PAFs)—a key CSIRO platform technology, where ASKAP and ADE are critical building blocks for this further work.

In addition, CASS intends to participate in these other major SKA pre-construction work package Consortia:

- The Science Data Processor (computing) work package: CSIRO will be a significant partner in this, building on the substantial expertise developed for ASKAP.
- The Power and Site work packages: CSIRO aims to be a small but influential partner in each to guide SKA implementation—particularly as we are the manager/operator of the MRO.
- Three other consortia—the Central signal processor (digital systems), Signals & Data transport, and the Synchronisation & Timing work packages—where CSIRO will be a minor partner in each.
- The Telescope Monitoring work package, where CSIRO will be an expert reviewer.

SKA pre-construction Dishes briefing was held in January, with interest from those who had responded to the DIICCSRTE Expressions of Interest in late 2012.

AUSTRALIAN PARTICIPATION AND CO-FUNDING FROM DIICCSRTE

During the SKAO RfP (request for proposal) process during March–June 2013, the Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education (DIICCSRTE) will run its own process to allocate the $18.8m SKA pre-construction funds to Australian entities participating in the consortia bids. This process builds on the open EOI run by DIICCSRTE in November 2012 to seek interest from all potential industry partners. CSIRO and other Australian institutes have since been in contact with many of the commercial respondents to identify key areas of expertise and best fit within the consortium.

CSIRO convened a SKA pre-construction Dishes briefing on 18 January 2013. Invitations were sent to approximately 30 companies who had responded to the Australian and NZ EOI calls (including associated tasks, for example systems engineering, project management), along with a few larger multinationals and representatives of DIICCSRTE; the Ministry of Business, Innovation and Employment; ASKAIC; and the WA Department of Commerce.

Almost all invitees attended the briefing with many participants being on the line from New Zealand: a follow-up will be made of those who remain able to participate, understanding that co-investment is necessary to gain DIICCSRTE funding.

More information on DIICCSRTE's processes can be found on the Department's website: *http://www.ska.gov.au/industry/Pages/ExpressionsofInterest.aspx*

DISHES WORK PACKAGE/ CONSORTIUM BUILDING

A major SKA pre-construction Dish Consortium (SKADC) discussion was held at Marsfield during 11 – 14 February. Participants included staff of CASS and the CSIRO ICT Centre with major roles in the Dishes work, and their counterparts from Canada, South Africa, China, Sweden, Germany, Italy and the UK. These discussions set the framework and planning for the RfP response.

The BAE Systems single pixel feed (SPF) study, commissioned by CASS, was released as SKA memo 146, 'Octave Bandwidth Single Pixel Feed Study for the Square Kilometre Array'. The memo can be seen publicly (i.e., on the public access part of the SKA web site, not the internal wiki) at the following link by selecting 'Memo Series' from the 'Documents' menu: *http://www.skatelescope.org/publications/*.

This is an important benchmark for assessing some of the challenges of adopting single pixel (horn) feeds (SPFs) for SKA.

Collaborator projects

MWA LAUNCHED AND OPEN FOR PROPOSALS

STEVEN TINGAY

The Murchison Widefield Array (MWA) was formally launched at ceremonies at the Murchison Radio-astronomy Observatory (MRO) and in Geraldton on November 30, 2012. The launch was performed by Minister Gary Gray, Australian Government Special Minister of State; Minister John Day, Western Australian Government Minister for Science and Innovation; and Prof. Jeanette Hacket, Vice-Chancellor of Curtin University.

The MWA is now being readied for the start of its operational phase in July 2013. In December 2012, an Announcement of Opportunity was released (*http://www.mwatelescope.org*) to the community that sets out the steps toward first operations. Step one was a call for Expressions of Interest (EoI) in MWA science programs, conducted during January 2013. EoIs were received from 23 teams consisting of several hundred investigators in total, expressing strong interest in all four of the MWA science themes (and revealing some new areas of science interest).

After the EoI stage closed, a face-to-face briefing and pre-operations workshop was held at Curtin University on 25 - 26 February, 2013, attended by 55 representatives of the EoI teams and other potential users. The MWA management team provided briefings and advice regarding the final expected instrument capabilities.

Following the briefing workshop, the first MWA Call for Proposals was released in early March (http://www.mwatelescope.org). The proposal submission period will run until the end of April, then MWA Time Allocation Committee will convene in May to rank the proposals and provide a recommendation to the MWA Director on the allocation of observing time for the period July 2013 - December 2013.

Observing schedules will be prepared for this period in June and full science operations will commence in July.

At the upcoming annual meeting of the Astronomical Society of Australia, the MWA will feature in a special session, titled "A New Era in Australian Radio Astronomy: MWA, ASKAP and SKA". This will be an excellent opportunity to update the Australian community on the status of the MWA at the start of its operational phase, and showcase some early science results.

New look for ATNF website

GABBY RUSSELL (CASS)

In January the ATNF website was given a facelift. The 'new look' site has a fresh new appearance and features to make it easier to use: a more comprehensive navigational menu, quick links to our most popular pages, and our handy search facility that now appears on most pages.

The appearance of some pages, however, hasn't yet changed. These pages include the 'Outreach' section (*http://outreach.atnf.csiro.au*), which will be updated in the near future. We'll also be updating site content over coming months.

We understand that the ATNF website is an important resource for our telescope users, the astronomy community and teachers, so we've been working to ensure the transition has minimal impact on site visitors. The changes have been made in consultation with website users and staff.

We're sure you'll enjoy the site's new appearance and improved navigation features. If you would like to provide feedback on the website changes, please use our online form at *www.atnf.csiro.au/feedback*.

Visit the website at *www.atnf.csiro.au*.

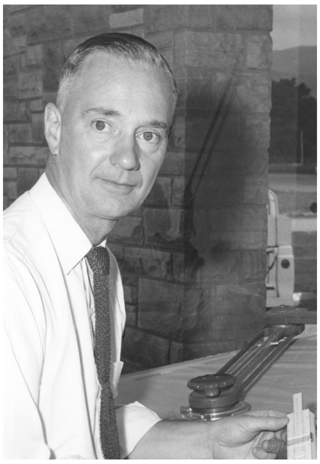
Astronomy blog launched

TONY CRAWSHAW (CASS)

CSIRO has launched a new blog, 'Universe@CSIRO', dedicated to astronomy, space science, space tracking and the Universe in general.

Written for general readers with an interest in astronomy and space, stories feature our research, facilities and people—including research conducted with the ATNF—as well as other national and international astronomy and space news. 'Wormhole Wednesday', which treats readers to astronomy and space tidbits, is a regular weekly feature.

Take a look at Universe@CSIRO by visiting *http://csirouniverseblog.com*. We hope you'll find it interesting, entertaining and informative. To receive alerts each time a new post is added, use the site's prompts to 'follow' Universe@CSIRO.



Grote Reber at work in 1975.
Credit: NRAO/AUI.

Memorial to Grote Reber unveiled at Parkes

DAVID JAUNCEY, CHRIS HOLLINGDRAKE AND BEVERLEY WILSON (CASS)

A memorial dedicated to Grote Reber—known by some as the 'father of radio astronomy'—was unveiled at the Parkes Observatory Visitors Centre on 20 December 2012, the tenth anniversary of his death. The memorial houses a portion of Grote's ashes, which were presented to Parkes Observatory by the Reber Foundation in 2005.

Grote Reber was born in Chicago on 22 December 1911 and died in Tasmania on 20 December 2002. He studied radio engineering, was a ham radio operator and possessed a keen and enquiring mind. When Grote learnt of Karl Jansky's 1932 discovery of radio waves coming from the Milky Way, he wanted to learn more. So he built himself a 31.4-foot (9.6-m) diameter parabolic dish radio telescope in his mother's backyard in Wheaton, Illinois. Working at night to avoid automobile interference, Grote painstakingly mapped the radio sky at 160 MHz. His map of the Milky Way revealed the Galactic Centre in the south as well as the strong sources in Cygnus and Cassiopeia, and a new branch of astronomy—radio astronomy—was born.

The new Grote Reber monument at Parkes Observatory.

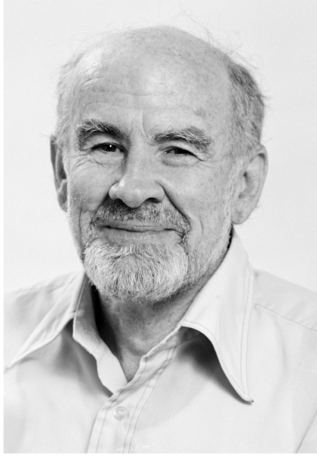
The proceedings at Parkes began with a simple and respectful interring of the ashes. During the morning tea that followed, staff were entertained with a presentation on the invention and innovation that were central to Grote's amazing life. We were delighted to discover that Grote had built the first Square Kilometre Array, operating at 2 MHz, in a paddock in Tasmania! Ahead of the curve, recognising fossil fuels are finite, he also built and drove his own electric car.

Along with Parkes, Grote's ashes were distributed to 14 other major radio observatories around the world.

Grote Reber now has a permanent place at Parkes Observatory near the iconic 'Dish', itself a result of his quest for knowledge and hands-on abilities. Come and take a look at the memorial on your next visit to Parkes.

Vale R X McGee (1921–2012)

HELEN SIM (CASS)



Dick in 1983.

"Forthright, friendly, very clever and extremely loud." That was how Richard Xavier (Dick) McGee struck his friend and colleague, John Brooks, when they first met in 1965. And, says Brooks, "nothing has happened [since] that has caused me to change my mind".

Dick McGee died on 19 December, aged 90. He was born in Marrickville, Sydney, on 31 December 1921, to Henry Xavier McGee and his wife Johanna (née O'Keeffe), the eldest of six children.

Dick attended the Christian Brothers school in Lewisham (Sydney) and completed the Leaving Certificate in 1938. He then worked as a clerk in the Customs Department until mid-1941, when he was called up for military service.

Posted to Darwin, he served in the 2nd Australian Imperial Force as a driver. During the first Japanese bombing of Darwin in February 1942, he narrowly missed being killed: while he was driving a truck back from unloading a ship at the docks, a plane came over and dropped bombs either side of the vehicle. Dick jumped out and took shelter in a ditch.

He had wanted to join the Royal Australian Air Force, and finally received permission to do so in 1943. He was sent to Canada to train as a navigator at the Air Navigator School at Edmonton, Alberta, and finally landed at Liverpool, UK, in July 1944. He became a navigator in Lancaster bombers (Bomber Command 5 Group), with the rank of Pilot Officer. His war record is full of praise from his commanding officers.

At the war's end Dick returned to Australia, and he was demobilised in April 1946. He returned to his old job in Customs for the rest of the year.

Then his life took a different turn. In 1947 he was awarded a Commonwealth Reconstruction Training Scheme scholarship to attend the University of Sydney. He graduated in 1950 with First Class Honours in Physics and joined the CSIRO Radiophysics Laboratory (which later became the Division of Radiophysics, the organisational 'ancestor' of CASS).

These were the pioneering days of radio astronomy. Dick's first research at CSIRO was with the famous 'hole-in-the-ground' telescope at Dover Heights, a 72-foot (24-metre) parabolic reflector that a few 'young Turks' at Radiophysics had built, unofficially, in their lunchtime, by digging a hole out of the sandy cliff top and lining it with steel strips from packing cases. In the finest tradition of radio astronomy, the instrument was soon upgraded—extended to 80 feet, lined with concrete, and the metal strips replaced with higher-tech chicken wire. With this instrument, John Bolton and Dick McGee made a survey of the sky between Declinations of -17 and -49 degrees. The beam size was two degrees, but that was good enough to show that the radio source Sagittarius A, previously seen only as an extended source, was in fact an intense point source. These observations led to a *Nature* paper (McGee and Bolton, *Nature* vol 173, 985 (1954)) in which the authors suggested that Sagittarius A was the Galactic Centre. (In 1958 the IAU in effect agreed, redefining the Galactic coordinate system on the basis of radio observations of neutral hydrogen. Sagittarius A*, a subcomponent of Sagittarius A, is the best physical marker of the Galactic Centre, being offset about 0.07 degrees from the defined centre.)

Dick went on to map the HI in both the Galaxy and the Magellanic Clouds with his colleagues James Hindman and Frank Kerr, using a 21-foot (7-metre) radio telescope at the Murraybank field station in West Pennant Hills, northwest of Sydney. From 1955 they began to carry out a hydrogen-line survey of the whole sky. This produced such a glut of data that

> *... it was clearly impossible to reduce it 'by hand', and McGee asked Maston Beard, the design engineer of the CSIRAC MKI [computer], to devise a means of recording the data digitally. Beard's successful equipment was produced in time for a trial survey of the Magellanic Clouds in 1961, leading to the exciting discovery of a 'bridge' of neutral hydrogen between the two clouds. This was the first use at Radiophysics of computing techniques to reduce astronomical data.*[1]

1 Raymond Haynes, Roslynn Haynes, David Malin and Richard McGee, *Explorers of the Southern Sky* (CUP 1996), p. 232

Radiophysics' upgraded, 80-foot 'hole-in-the-ground' radio telescope at Dover Heights, Sydney. In this photograph, taken in 1953, Gordon Stanley is adjusting the position of the aerial mast.

Dick (at left) and John Murray analysing data at the Murraybank field station.

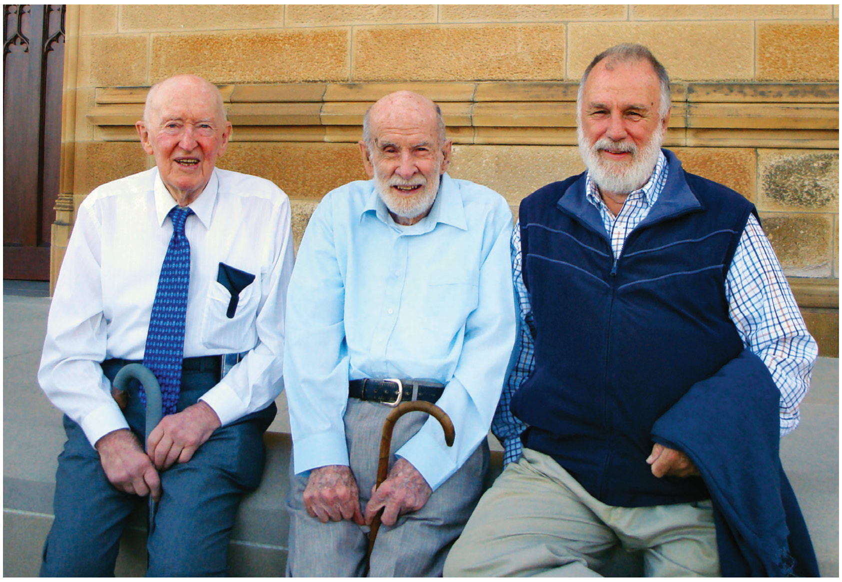
From 1961, Dick and his colleagues used Radiophysics' new Parkes telescope to continue this work, at higher resolution. Dick and Janice Milton were able to show that regions of ionised hydrogen and supergiant stars—star-forming regions—sat at the centres of large clouds of neutral hydrogen. They also found that, while the Large Magellanic Cloud appears irregular when viewed at optical wavelengths, its neutral hydrogen exhibits a spiral structure.

In the early 1970s Dick and others made another continuum survey of the Magellanic Clouds at several wavelengths. He was also involved in some of the earliest measurements of molecules in space, starting with investigations of the OH molecule near the Galactic Centre in the 1960s. Dick was a member of the International Astronomical Union's Division H (Commission 34), which is concerned with the study of the interstellar medium.

Over his career Dick published about 80 papers in refereed journals. He was awarded a DSc by the University of Sydney in 1967.

Dick's contribution to the running of Radiophysics went far beyond just doing good science, however. Although a member of management, "Dick was a great supporter of the underdog," says John Brooks. Another long-term Radiophysics staff member, Phil Sharp, remembers Dick's role in the Radiophysics cricket team. "You could always hear Dick encouraging the batsman to run," says Sharp. "He always encouraged people to do their very best. He always had confidence in people even if they didn't have confidence in themselves." Malcolm Sinclair, who later headed up the Radiophysics receiver group, remembers Dick as "a real mentor, a real father-figure". He was very kind, says Sinclair, "but also a prodder, always on my back about me keeping up with my studies [in electrical engineering]".

Dick "set the tone for an egalitarian workplace," Brooks recalls. "During our … successes, Dick would always push his fellow workers to the fore. Whenever we failed, …[he would] take whatever 'brickbats' came our way. Mind you, he never took any flak without responding." Mal Sinclair remembers how inclusive Dick was: when they worked together at Murraybank, Dick would have him come along to the lab's scientific colloquia, even though at that time he was "a young kid just out of the workshops". Best of all, says Brooks, "Dick always took the rotten shifts when on an observing team and … made sure his shift mates didn't take all the chocolate biscuits … so there were some left for the next shift."



(From left) John Murray, Dick McGee and Mal Sinclair at the launch of *Under the Radar*, Great Hall, University of Sydney, 25 November 2009. Credit: Jim Roberts.

"A master of the English language" according to Brooks, Dick was in charge of the editorial process at Radiophysics. "[A] ll of us who had to go through the process of having Dick and his crew … review our horrible attempts at writing papers were grateful for his input." He also oversaw the Radiophysics photographers. Dick was editor of the journal of the Astronomical Society of Australia (ASA) from 1971 to 1988: he had also been a founding member of the Society and had served as its Secretary in 1961. He was made an Honorary Fellow of the ASA in 1990.

In the 1990s Dick coauthored books on the history of Australian astronomy: first *Explorers of the Southern Sky: A History of Australian Astronomy* (1996) with Raymond Haynes, Roslynn Haynes and David Malin, and then *Under the Radar: The First Woman in Radio Astronomy, Ruby Payne-Scott* (2009) with Miller Goss.

Dick married his first wife, Marie Elizabeth Givney, in 1950; they had three children—Elizabeth, John and Mark.

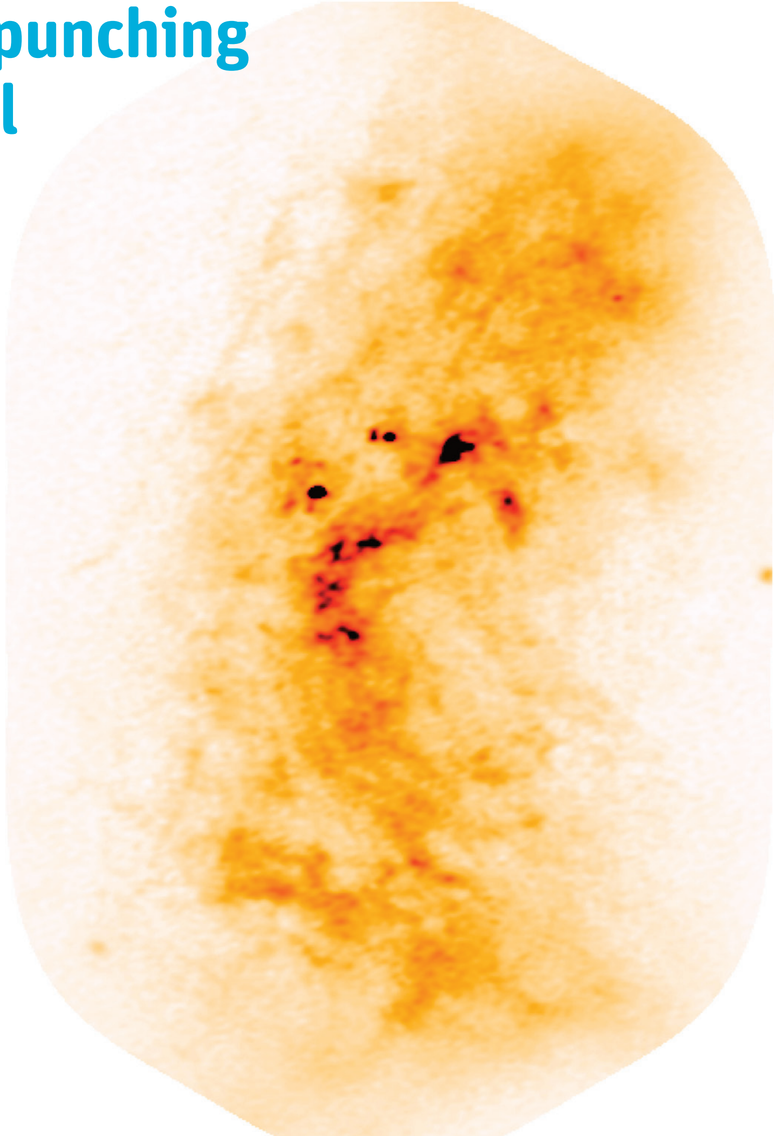
When his sons started playing Rugby Union, Dick became very involved in the sport, taking up first coaching and then refereeing junior Rugby, which he continued to do well into his late 70s. He was Registrar of the Eastwood Rugby Union Referees Association for many years and was made a life member of Eastwood Junior Rugby Union and Eastwood Rugby Union Referees Association. Dick was also a great fan of (English) soccer, had been acknowledged as the best leg-spinner on the Radiophysics' cricket team, and surfed.

Dick retired from CSIRO in 1986. In 1988 he married his second wife, Lynette (Lyn) Newton, who had also worked at Radiophysics. They had three children—Katherine, Tristan and Toby.

Those who knew Dick will always remember him as a mentor and supporter. "Whenever a promotion came my way it was always Dick first through the door with his sincere congratulations," says John Brooks. "He was a wonderful, warm friend and colleague, and those of us who had the honour of working with him will never forget him."

ALMA first results: punching through a brick wall

JILL RATHBORNE (CASS)



The Atacama Large Millimetre/submillimeter Array (ALMA) is now officially open for business. Its inauguration, held on 13 March, marked an important transition for this groundbreaking project, from the construction phase to a fully fledged observatory. Representatives from the global scientific community, current and former ALMA personnel, as well as the members of local communities, all joined together to toast to its success.

In December the global scientific community met in southern Chile to showcase and discuss the first results from ALMA's 'early science' phase. While only utilising a limited number of antennas and a fraction of its full capabilities, the images provided by ALMA are already changing our view of the cool, dusty Universe. Results presented at this meeting were eagerly anticipated and the excitement surrounding ALMA's full potential was high.

The team I lead presented results at this meeting, having been one of the fortunate few teams to have accessed ALMA in its early science phase. Our observations obtained a large mosaic of the 3-mm line and continuum emission across a very cold, dense molecular cloud that sits close to the centre of our Galaxy. This extreme cloud, dubbed 'The Brick' because it is so cold and dense that it blocks background light, was identified as unique during the HOPS and MALT90 surveys of the Galactic plane taken with CSIRO's Mopra telescope.

The Brick has caught our attention as it may be a precursor to a very massive star cluster. While extreme star clusters exist in our Galaxy, very little is known about their formation. By looking into the cold interiors of clouds like The Brick with unprecedented detail, ALMA has the potential to reveal how the most massive stars and clusters in our Galaxy are formed. Where previous telescopes saw these stellar nurseries as big, amorphous blobs, ALMA has the ability to resolve and measure the individual stellar embryos. By counting how many stellar embryos there are within clouds like The Brick, measuring their masses, and determining how they are moving with respect to one another we can begin to test theories that describe how the most massive star clusters are formed.

The ALMA images of The Brick are spectacular and reveal a complicated web of gas and dust, in both emission and absorption. We are seeing, for the first time, the details of how massive clouds of gas and dust collapse. ALMA has 'snapped into focus' the small pockets of gas and dust that will eventually form the stars: we have found more than 50 of these stellar embryos within The Brick, each with masses close to 1,000 solar masses. The ALMA images contain so much information that it's likely we'll be analysing these data for years to come. To kick things off, our 13-member team will be meeting at CASS headquarters in April for a 'busy week' to work on these exciting new data.

While it's already producing game-changing results, ALMA is just warming up. Stay tuned for some very exciting results that are guaranteed to revolutionise our understanding of the cool Universe.

ALMA's view of the dust within the cold interior of 'The Brick', an immense dense molecular cloud that may be forming a massive cluster of stars. This 3-mm continuum image covers 1.5 x 3 arcmins and improves remarkably our ability to resolve and measure the individual stellar embryos within this unique cloud. Obtained with only a fraction of ALMA's full capabilities and taking a mere six hours of time, this breathtaking image is already changing our understanding of how immense clouds of dust and gas collapse to form star clusters.

Astroinformatics Summer School 2013

MALTE MARQUARDING (CASS)

CASS has continued its ongoing support of the Astronomical Society of Australia's Astroinformatics Summer School, which was hosted by the University of Queensland in February. The biennial workshop provides three days of training in information technology (IT) for graduate students and postdoctoral fellows, giving participants skills that are now essential to performing cutting-edge astronomy research.

A wide range of IT topics relevant to astronomy research were covered starting with Unix and programming skills in Python—including a presentation by CASS Bolton Fellow Eli Bressert—and then progressing to more advanced techniques such as database access and version control. Most of these tutorials were 'hands on' and came with notes and exercises that are publicly available via the workshop webpage at *www.smp.uq.edu.au/anitaworkshop2013/?page_id=30*.

CASS astronomer Naomi McClure-Griffiths closed the school with a great presentation on applying programming skills to the whole sequence of research starting with proposal planning and moving all the way to publishing data.

Malte Marquarding, a member of the ATNF Operations Software and Computing team, was chair of the Scientific Organising Committee.

Feedback on the workshop was extremely positive, with all 55 participants saying they would recommend it to others. "Fantastic. Course material was pitched at the perfect level, with something for everybody to take home," said one student of the workshop.

We are looking forward to contributing to the next event in two years' time.

Awards and appointments

GABBY RUSSELL (CASS)

Two DECRAs equal a 'win' for maser research

Two of the five Australian Research Council's Discovery Early Career Researcher Award (DECRA) fellowships in astronomical and space sciences announced in November went to CSIRO astronomers Shari Breen and Jimi Green.

Shari's project will focus on tracing the evolution of high-mass stars by combining maser evolutionary timelines with chemical clocks, while Jimi's project will see him studying the magnetic and dynamic properties of the Milky Way through masers and associated observations.

DECRAs aim to support and advance promising early career researchers. They are three-year awards, which include up to A$40,000 per year in project funds. For more information on DECRAs visit *www.arc.gov.au/ncgp/decra.htm*.

Telescope upgrade recognised

The Compact Array centimetre receiver upgrade project managed by CSIRO's Mark Bowen received a highly commended award in the research and development category of Engineers Australia's Engineering Excellence Awards (Sydney Division), announced in September.

Mark led a team of engineers that designed new receivers for the 25-year-old telescope. The upgrade enabled the full capability of the Compact Array Broadband Backend upgrade at centimetre wavelengths to be used, doubling the telescope's sensitivity and keeping the facility at the forefront of international radio astronomy research.

The project was also a finalist in the manufacturing and high tech design category of *The Australian* Innovation Challenge 2012, announced in December.

See page 7 for more information on the Compact Array centimetre receiver upgrade project.

(From left) Mark Bowen, Alex Dunning and Henry Kanoniuk collected the Compact Array centimetre receiver upgrade project's highly commended award in the research and development category at the Engineers Australia's Engineering Excellence Awards (Sydney Division).

New postdoctoral staff

GABBY RUSSELL AND SIMON JOHNSTON (CASS)

Since the October 2012 edition of *ATNF News* was published, CASS has welcomed another two postdoctoral staff, Eli Bressert and Kate Chow. We asked Eli and Kate to tell us, in their own words, about their research interests. Please join us in welcoming Eli and Kate.

ELI BRESSERT

Bolton Fellow
PhD: University of Exeter, UK, 2012

"My PhD focused on the initial spatial distribution of stars in star-forming environments. The environments ranged from low-mass star-forming systems, like Taurus, to some of the most massive complexes in the nearby galaxies like 30 Doradus. While I'm at CASS, I will research how stellar clusters form. This will entail a detailed study on understanding how star-forming molecular clouds foster stellar cluster formation. To study the progenitors of stellar clusters, long wavelength observations from submillimetre to radio are needed. With the expertise of scientists at CASS on gas and submillimetre/radio observations along with the suite of telescopes available at CSIRO, I will be able to achieve my research objectives. Additionally, I hope to learn more about atomic gas, the precursor stage to molecular clouds."

KATE CHOW

OCE Postdoctoral Fellow
PhD: University of Sydney, 2012

"My research interests include deep radio surveys, such as the Australia Telescope Large Area Survey (ATLAS) and the Evolutionary Map of the Universe (EMU) projects, and the evolution of radio galaxies, particularly gigahertz peaked spectrum (GPS) and compact steep spectrum (CSS) sources. My PhD was focused on exploring the properties and evolution of CSS and GPS sources and the radio spectral index properties of sources in ATLAS. While at CASS, I will continue to work on projects within ATLAS and EMU and, in particular, I hope to determine the best way to distinguish between active galactic nuclei and star-forming galaxies in ATLAS, and how to measure the active galactic nuclei contribution to these galaxies."

Russell Jurek has recently completed his postdoctoral term; we wish him success in his new role.

Graduate student program

GEORGE HOBBS (CASS)

In January George Hobbs took over coordination of the CASS student program; our thanks go to Bärbel Koribalski for running the program for the past seven years. As part of the change in coordination, a new set of web pages describing the student program have been developed. These pages provide instructions on how to join the program, and the benefits and requirements for students and their supervisors.

We would like to officially welcome the following students into the program:

- Xingjiang Zhu (University of Western Australia) – *Searching for continuous gravitational waves in the Parkes pulsar timing array data sets*
- Claire-Elise Green (University of New South Wales) – *The relationship between starbursts and black holes in galaxies*
- Sarah Hegarty (University of Queensland) – *Making the first multibeam images with an ASKAP PAF*
- Jane Kaczmarek (University of Sydney) – *Investigating the role of magnetic fields in galaxy and structure evolution*
- Dane Kleiner (Monash University) – *The large scale structure's effect on the HI content of galaxies*
- Nipanjana Patra (Raman Research Institute, India) – *Measurement of spectral features in the cosmic radio background*, and
- Emily Petroff (Swinburne University of Technology) – *Study of the interstellar medium through radio phenomena of short duration.*

Congratulations on the award of their PhD and best wishes for their future career goes to the following students:

- Meng Yu (Peking University, China) – *Pulsar X-ray thermal emission in solid quark star model and glitches in southern radio pulsars*
- Stefan Oslowksi (Swinburne University of Technology) – *The highest precision pulsar timing*, and
- Chris Hales (University of Sydney) – *Deep imaging of the radio sky in total intensity and linear polarisation.*

To all students, well done! If you are interested in joining the program, or wish to learn more, visit *www.atnf.csiro.au/research/student* or contact George Hobbs.

Meng Yu

Scientific visitors

NAOMI MCCLURE-GRIFFITHS (CASS)

We've recently made some changes to the successful distinguished visitors program, to continue to meet the needs of visitors to the CASS Astrophysics Group. These changes have included renaming the program and reducing the minimum visit length to two weeks. Researchers at all levels are welcome to apply to the program, which will continue to provide financial and logistical support to facilitate working visits.

Financial support for visits typically covers the cost of on-site accommodation at CASS headquarters in Marsfield or its equivalent (approximately A$500 per week). Visits funded through the program should be for at least two weeks and could last for up to one year. Visitors may be located at any of the ATNF sites and are expected to deliver at least one colloquium or seminar during their stay at the CASS.

We also encourage extended visits of six or twelve months. For these longer visits there is the possibility to seek additional funds through CSIRO. Please contact the Chair of the Visitors Committee, Naomi McClure-Griffiths, for more information.

Potential visitors should make contact with a local member of staff or the Chair of the Visitors Committee to develop a proposal. Proposals to the program should include a brief description of a collaborative project to be conducted during the visit, an estimate of the dates of the visit and support required, a current CV and a list of publications. Proposals are reviewed quarterly (in February, May, August and November).

For more information on the scientific visitors program visit *www.atnf.csiro.au/people/scientific_visitors.html*.

MAGMO: Mapping the Galactic magnetic field through OH masers

JIMI GREEN (CASS), JAMES CASWELL (CASS), NAOMI MCCLURE-GRIFFITHS (CASS), TIM ROBISHAW (NRC-HIA), LISA HARVEY-SMITH (CASS), AND SUI ANN MAO (UNIVERSITY OF WISCONSIN-MADISON)

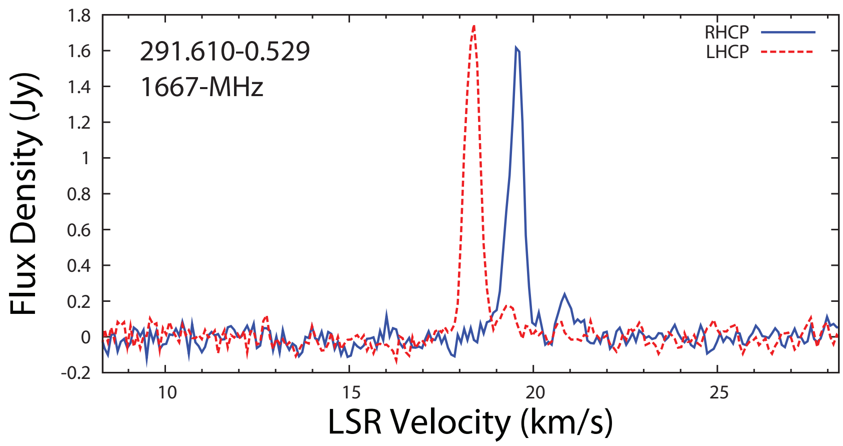


FIGURE 1: An example Zeeman splitting spectrum showing the right-hand circularly polarised (solid blue line) and left-hand circularly polarised (red dashed line) maser features seen towards the high-mass star formation source G291.610-0.529 (Green *et al.* 2012).

We have recently completed the observations of a project to examine large-scale magnetic fields through the polarised properties of hydroxyl (OH) masers. This project—titled 'MAGMO'—utilised the Australia Telescope Compact Array, with its Compact Array Broadband Backend (CABB), to obtain full polarisation observations of four transitions of OH masers towards sites of 6.7 GHz methanol maser emission (from the highly successful Parkes Methanol Multibeam Survey).

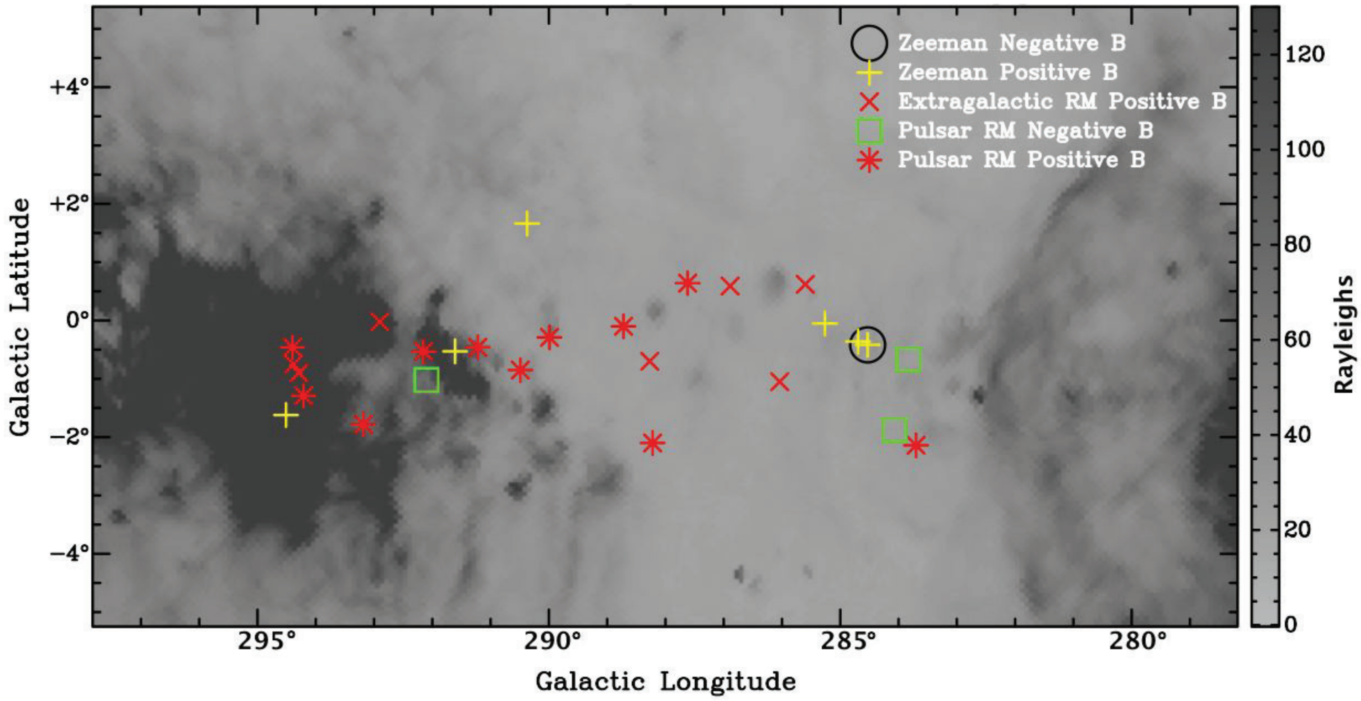
Masers of the OH molecule are ideal magnetic field tracers: they have a large Zeeman splitting factor combined with typically very narrow spectral line emission, producing fully resolved Zeeman pairs (see Figure 1). Zeeman splitting is essentially the production of two opposite circularly polarised components of spectral line emission due to the presence of a magnetic field. For the case of OH maser Zeeman splitting, and unlike many situations within the interstellar medium, the total magnetic field strength is measured and is typically in the order of 5–10 milliGauss. These masers can be found towards a variety of astrophysical objects, but those associated with 6.7 GHz methanol masers exclusively trace high-mass star forming regions, and are thus confined to the spiral arms of our Galaxy.

The Zeeman splitting of the OH maser emission determines the strength and orientation of the *in situ* magnetic field, allowing us to test if the orientations of weak large-scale magnetic fields can be maintained in the contraction (and field amplification) to the high densities of high-mass star formation. Davies (1974) provided the first suggestion that this may be the case, finding coherent orientations across eight sites of OH maser emission, based on a simple pattern of clockwise Galactic rotation. Reid and Silverstein (1990) then found coherence over scales of a few kiloparsecs in a sample of 17 OH magnetic field measurements spread across the Galactic plane (although with a pattern more complex than Davies suggested, with orientations consistent within spiral arms, rather than with a global clockwise direction). Fish *et al.* (2003) found consistent orientation amongst sources from the second and third Galactic quadrants and amongst sources within approximately 1 kpc of the Sun in the first and fourth quadrants (but with the inner and outer Galaxy sources showing opposite orientations in agreement with rotation measure estimates, for example, Brown *et al.* 2007).

Although encouraging, these previous studies were limited in scale, with the largest looking at 40 star forming regions, all visible from the northern hemisphere, and with only a few masers per Galactic spiral arm. Now, with the completion of the Methanol Multibeam Survey, and the advent of new receiver and backend technology at the Compact Array, the time is ripe to conduct a new survey across the Galactic plane.

The MAGMO survey has observed all the 6.7 GHz methanol masers south of Declination -10 degrees, which took approximately 400 hours of observing over 18 months. Preliminary detection statistics indicate the presence of hydroxyl maser emission in half of the methanol maser sites and the likelihood of several hundred Zeeman pairs across the Galaxy. This sample will significantly improve on previous studies (by an order of magnitude) and allow for the potential of tracing large-scale magnetic fields with statistical significance.

The recently published pilot observations (Green *et al.* 2012) focused on a particular part of the Galactic plane, 280 to 295 degrees Galactic longitude, where the Carina-Sagittarius spiral arm is tangential to the line of sight. This region allows the magnetic fields to be explored without ambiguity. We detected maser emission from 17 sites across six high-mass star formation regions. More than 70% of the maser features have significant circular



polarisation. We found 11 Zeeman pairs across the six sites of high-mass star formation with implied magnetic field strengths between -1.5 mG and +3.8 mG and median field strength of +1.6 mG. Our measurements of Zeeman splitting imply that a coherent field orientation is experienced by the maser sites across a distance of ~5 kpc within the Carina-Sagittarius spiral arm tangent (*see Figure 2*).

FIGURE 2: This figure (from Green et al. 2012) compares the magnetic field directions from rotation measures and Zeeman splitting measurements, overlaid on the composite H-alpha emission of Finkbeiner (2003) using the Southern H-Alpha Sky Survey Atlas data of Gaustad *et al.* (2001). The H-alpha emission indicates regions of ionised hydrogen. Yellow pluses are positive magnetic field Zeeman measurements (conventionally fields away from us) and a black circle is the sole site of negative magnetic field Zeeman measurements (a field towards us); red asterisks are positive rotation measures (fields towards us) from pulsars; green squares are negative rotation measures (fields away from us) from pulsars (Taylor *et al.* 1993; Han *et al.* 1999, 2006) and red crosses are positive rotation measures (fields towards us) from extragalactic sources (Brown *et al.* 2007). The rotation measures, from both pulsars and extragalactic sources, are all along lines of sight in the proximity of, or directly passing through, HII regions (Nota and Katgert 2010, references therein).

References

Brown, J.C., Haverkorn, M., Gaensler, B.M., Taylor, A.R., Bizunok, N.S., McClure-Griffiths, N.M., Dickey, J.M., Green, A.J. 2007, ApJ, 663, 258

Davies, R.D. 1974, IAU Symp. 275, Galactic Radio Astronomy, Astron. Soc. Pac., San Francisco, p. 275 (eds F.J. Kerr, S.C. Simonson)

Finkbeiner, D.P. 2003, ApJS, 146, 407

Fish, V.L., Reid, M.J., Argon, A.L., Menten, K.M. 2003, ApJ, 596, 328

Gaustad, J.E., McCullough, P.R., Rosing, W., Van Buren, D. 2001, PASP, 113, 1326

Green, J.A., McClure-Griffiths, N.M., Caswell, J.L., Robishaw, T., Harvey-Smith, L. 2012, MNRAS, 425, 2530

Han, J.L., Manchester, R.N., Qiao, G.J. 1999, MNRAS, 306, 371

Han, J.L., Manchester, R.N., Lyne, A.G., Qiao, G.J., van Straten, W. 2006, ApJ, 642, 868

Nota, T., Katgert, P. 2010, A&A, 513, 65

Reid, M.J., Silverstein, E.M. 1990, ApJ, 361, 483

Taylor, J.H., Cordes, J.M. 1993, ApJ, 411, 674

Predictions for ASKAP neutral hydrogen surveys

ALAN R. DUFFY (UNIVERSITY OF MELBOURNE/ICRAR/UWA)

Abstract

When building a next-generation telescope as powerful as the Australian Square Kilometre Array Pathfinder (ASKAP) it is a challenge just to predict the expected performance, much less create entire mock catalogues. Yet to derive the maximum science from ASKAP one must create a model universe for comparison. This universe should contain everything we know about galaxy formation and the underlying cosmology of the Universe, as well as the abilities of ASKAP itself.

To that end we have used one of the largest dark matter simulations ever created to form the most accurate predicted catalogues for the ASKAP neutral hydrogen (HI) emission surveys. The all sky-survey (WALLABY) is a shallow 3π survey from z = 0–0.26 that will probe the mass and dynamics of over 600,000 galaxies. The deeper, smaller area, survey (DINGO) will be able to trace the evolution of HI in nearly 100,000 galaxies over the redshift range 0–0.43, a cosmic time of 4 billion years.

The realism of the catalogues has enabled us to consider the effects of resolution and confusion in limiting these surveys, as well as the potential benefits in deploying the full 36-antenna ASKAP configuration with 6-km baselines. Furthermore we can study the properties of the HI selected catalogue, finding that the underlying dark matter haloes will range over five orders of magnitude in total mass (10^{11} to 10^{15} $M_{\odot}$) and the stellar mass covers seven orders of magnitude. This analysis has been published in Duffy *et al.* (2012c) with catalogues and images/movies available on request.

Introduction

Neutral hydrogen (HI) is a ubiquitous tracer of large-scale structure in the Universe. It allows us to study the physical and dynamical processes within galaxies, including the kinematic properties of structures such as bars, disks and warps. Each galaxy HI spectrum provides a large set of galaxy properties, for example the systemic velocity, the integrated flux density and the velocity width. These are used to derive the galaxy distance, its gas mass and its total dynamical mass, respectively. The gas mass is also a good indicator of ongoing star formation.

The evolution of HI is of fundamental importance to understanding the build-up of both stellar and gas mass within galaxies as well as the method by which galaxies accrete their material. Due to the inherent signal weakness of the 21-cm hyperfine splitting transition, the detection of HI emission in distant galaxies requires high resolution and high sensitivity observations. It is a crucial window into galaxy formation over time; and while we wait for the next generation of large-scale HI surveys, we will explore their potential via N-body simulations.

There are three precursor instruments to the Square Kilometre Array: the Murchison Widefield Array (MWA; Lonsdale *et al.* 2009), the Meer-Karoo Array Telescope (MeerKAT; Booth *et al.* 2009) and the Australian Square Kilometre Array Pathfinder (ASKAP; Johnston *et al.* 2008; DeBoer *et al.* 2009).

Here we will focus on planned HI surveys with ASKAP, which is currently under construction at the Murchison Radio-astronomy Observatory in Western Australia. ASKAP will consist of 36 antennas (each 12-m diameter); of these, 30 antennas are located within a 2-km diameter circle. ASKAP's large field-of-view—30 square degrees—is provided by novel phased array feeds (Chippendale *et al.* 2010), making ASKAP a 21-cm survey machine.

Surveys

The Widefield ASKAP L-band Legacy All-sky Blind surveY (WALLABY) is a large project led by Bärbel Koribalski (CASS) and Lister Staveley-Smith (ICRAR/UWA). WALLABY proposes to observe approximately 75% of the sky ($-90° < \delta < +30°$) out to a redshift of z = 0.26.

The WALLABY goals (outlined in Koribalski *et al.* 2009) are to examine the properties, environment and large-scale distribution of gas-rich galaxies. In summary, WALLABY will study galaxy formation and the missing satellite problem in the local group, evolution and star formation in galaxies, mergers and interactions in galaxies, the HI mass function and its variation with local environment, processes governing the evolution and distribution of cool gas at low redshift, and the nature of the cosmic web. WALLABY will also be able to investigate cosmological parameters. For example, we will be able to measure the matter power spectrum in the local Universe. Furthermore, we should be able to constrain the equation of state of dark energy to better than 20% (Duffy *et al.* 2012b).

The Deep Investigation of Neutral Gas Origins (DINGO) survey is led by Martin Meyer (ICRAR/UWA) and consists of 'DEEP' and 'UltraDEEP' phases that differ in area and depth. In the first phase, the survey proposes to target five non-contiguous fields, 150 deg^2 in total, out to z = 0.26. While the redshift range is the same as for WALLABY, the integration per field is 500 hours (more than 60 times longer) providing eight times better sensitivity. Where feasible, the target fields will be selected to overlap with the Galaxy and Mass Assembly (GAMA; Driver *et al.* 2009) survey. The second phase is proposed to consist of two ultra-deep fields, 60 deg^2 in total, over the redshift range z = 0.1–0.43.

The simulation

The galaxy catalogue was created using the semi-analytic model of Croton *et al.* (2006) to produce galaxies based on the underlying dark-matter-only Millennium Simulation (Springel *et al.* 2005). This sample of galaxies accurately recreates the observed stellar mass function with a combination of supernovae feedback and, crucially to this model, feedback at the high mass end from active galactic nuclei.

We then utilised the Theoretical Astrophysical Observatory, which is a cloud-based web application that produces mock catalogues from different cosmological simulations and galaxy models in the form of a lightcone (detailed in Bernyk *et al.*, in prep.) to create an all-sky galaxy catalogue extending to z = 0.26 for the WALLABY survey and to z = 0.43 for the narrower but deeper DINGO survey.

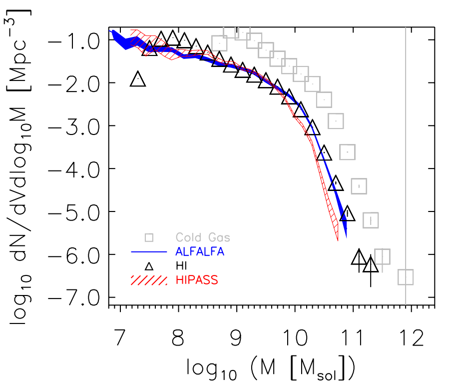


FIGURE 1: To create the HI mass: Starting with the cold gas mass function from the Croton *et al.* (2006) semi-analytic model (grey squares) we reduced the HI fraction of the cold gas until we matched observed HI mass function from ALFALFA (blue solid line; Martin *et al.* 2010) or HIPASS (red hatched line; Zwaan *et al.* 2005). Errors are Poissonian.

To create the most accurate HI mass for each object we calibrated the HI fraction of the cold gas masses from the simulation to observations (see Figure 1) ensuring that the catalogue was as close to the final ASKAP results as possible.

The galaxies

We then took the HI masses from the simulation and estimated the structural properties of the galaxies using a series of empirical relations, as first considered in Duffy *et al.* (2008) and references therein.

Firstly, we made use of the well-known correlation between HI mass and observed HI diameter from Broeils and Rhee (1997) and Verheijen and Sancisi (2001) where D_{HI} [kpc] = (M_{HI} / $10^{6.8}$ [$M_\odot$])$^{0.55}$ (for HI surface densities greater than 1 $M_\odot$ pc^2). The typical velocity width for an HI mass is given in Briggs and Rao 1993; Lang *et al.* 2003 as 420 [km/s] x (M_{HI} / 1010 [$M_\odot$])0.3 which can be transformed to line of sight velocity using a Tully-Fouque rotation scheme (Tully and Fouque 1985) and assumed random inclination axis to the observer. Finally, we can model how objects are resolved out by the interferometer, represented as incoherent addition of the separate beams that the galaxy spans (hence reducing signal-to-noise as the square root of the number of beams).

Survey results

Figure 2 shows the expected number density of detections, as a function of redshift, for the two surveys. It is clear that WALLABY and the deeper DINGO survey are

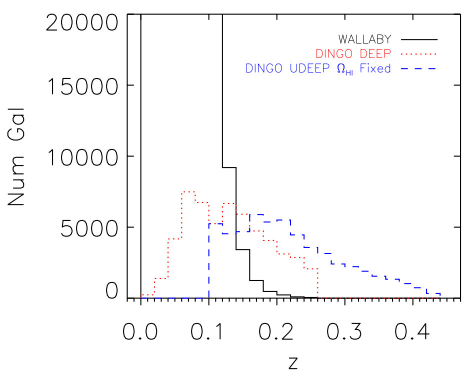


FIGURE 2: Wedding-cake-like surveys: the expected number of galaxy detections as a function of redshift for the two HI surveys with ASKAP. The all-sky WALLABY and deeper DINGO (split in two: the DEEP and UltraDEEP components; the latter has, conservatively, assumed no evolution in the HI fraction of the Universe).

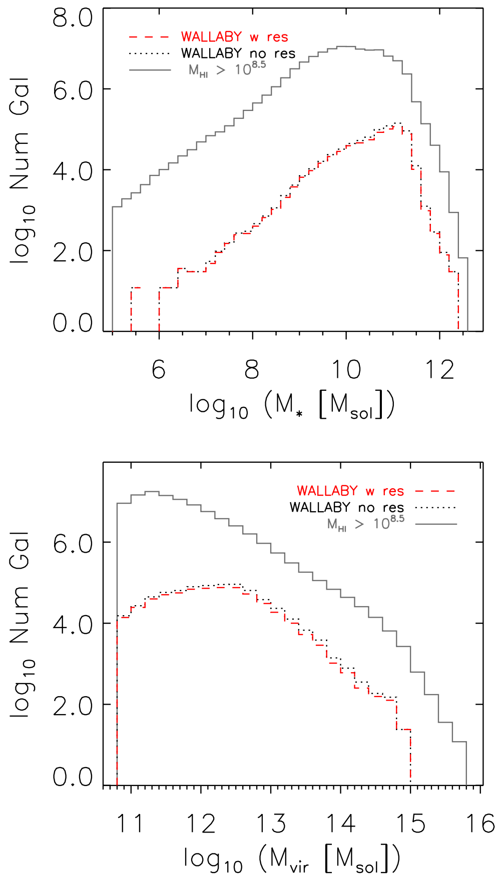


FIGURE 3: HI surveys are a new way to see the Universe. In these plots we show the resultant likely galaxy properties probed by the WALLABY survey. Red and black histograms represent the detected samples in WALLABY, while the grey histogram is the volume-limited galaxy distribution (that is, all galaxies above $M_{HI} = 10^{8.5}$ $M_{\odot}$). The differences between the red and black histograms are subtle. If galaxies appear larger on the sky than our telescope resolution we must piece together the multiple images to form the whole galaxy. In doing so, we can lose signal-to-noise and hence some galaxies drop out of our sample: the red curve conservatively includes this resolution effect, while the black ignores it. As shown by the similarity of the histograms, WALLABY won't suffer unduly from resolution effects.

well complemented, providing a wedding-cake-like tiered structure where the deeper survey takes over from the shallower one, ensuring significant galaxy counts in each redshift slice.

We can expect that the WALLABY survey will detect 600,000 galaxies with signal-to-noise greater than five, and the two components of the DINGO survey, in combination, will catalogue 100,000 galaxies (out to z = 0.43).

The deeper DINGO survey is able to test evolutionary models of HI. The cold gas mass of our galaxies naturally evolves in the simulation due to cooling and star formation being incorporated in the Croton *et al.* (2006) model. We can either fix the HI fraction of this gas to probe the universal HI density evolution or vary the HI fraction to ensure a constant HI density (the latter is more likely; as shown in Duffy *et al.* 2012a, the universal density is constant within a factor of two from $0 < z < 2$).

The UltraDEEP component to DINGO will find 6,000 more galaxies (over 10%) in the former case, potentially constraining the evolution in the universal HI density over the last 4 billion years.

Limitations with HI surveys

The next-generation HI surveys with ASKAP will attain low sensitivities over significant fractions of the sky, however, with increasing source density we will face a limitation in the ability to uniquely identify close pairs of objects on the sky, an issue known as 'confusion'.

We expect that with 2-km baselines WALLABY will never be significantly limited by confusion, whereas DINGO can have as many as 10% of sources at the survey edge confused although even this becomes negligible (<3%) if 6-km baselines are used.

A unique catalogue

We expect that the ASKAP HI surveys will detect orders of magnitude more galaxies than current facilities and, for the first time, across cosmological distances. The HI-selected galaxies will also be unique tracers of large-scale structures (four orders of magnitude in total mass) and local features such as star formation (probing seven orders of magnitude in stellar mass). In Figure 3 we show the expected range of these last two properties, out of the dozens provided by the catalogues now available online, for the WALLABY survey.

The catalogues will also probe a variety of structures, from the empty voids to superclusters of galaxies. This is shown in Figure 4 where the cosmic web is clearly visible in the WALLABY sample and the huge depth of the DINGO survey is easily seen.

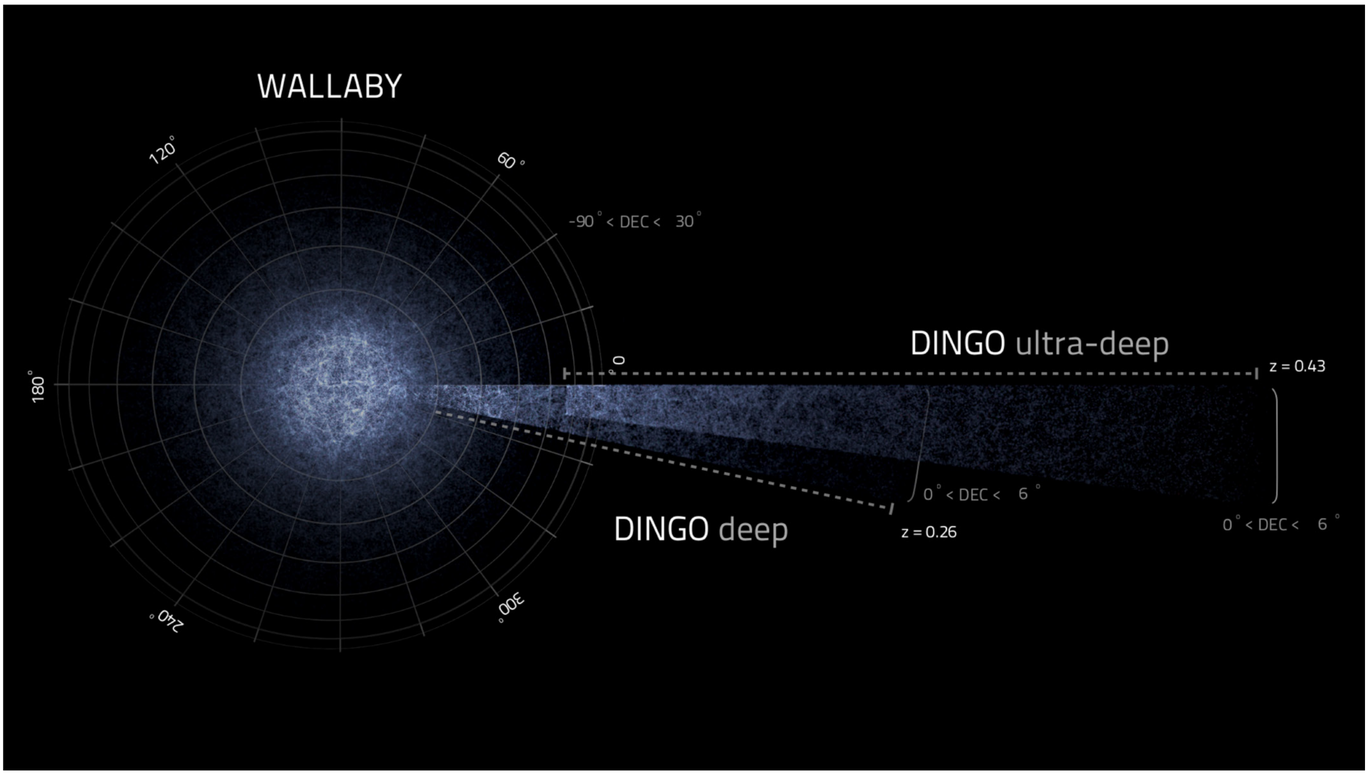


FIGURE 4: The lightcone pie plot for the shallow all-sky survey WALLABY and the two deeper surveys from DINGO. We have taken the entire Declination range of the survey and projected it onto a redshift-RA 2D plot. Brightness is based on the number density of the sources in each map pixel. The cosmic web is clearly visible in this image; a key science driver of WALLABY is the measurement of the HI mass function in different environments. In this volume are over 600,000 galaxy detections; in contrast, HIPASS and ALFALFA had approximately two orders of magnitude fewer detections. The DINGO survey will probe evolution in the high mass end of the HI mass function over 4 billion years of cosmic time. Additionally, DINGO will overlap with existing GAMA fields to enable a wealth of multiwavelength data to be used when analysing the HI detections, as well as enabling HI spectral stacking at given optical spectroscopic redshifts to extend the HI detections. The DINGO fields are not actually contiguous, as pictured here, but are spaced across the sky. For the mock lightcone we made the simplifying assumption that the fields were contiguous, but this had no impact on the final number of galaxies predicted. High resolution versions of this image and fly-through movies are available at *http://ict.icrar.org/store/Movies/MNRAS/MN-12-1210-MJ.R1/*.

References

Booth, R.S., de Blok, W.J.G., Jonas, J.L., Fanaroff, B. 2009, ArXiv e-prints

Briggs, F.H., Rao, S. 1993, ApJ, 417, 494

Broeils, A.H., Rhee, M.-H. 1997, A&A, 324, 877

Chippendale, A.P., O'Sullivan, J., Reynolds, J., Gough, R., Hayman, D., Hay, S. 2010, in IEEE Int. Symp., Phased Array Systems and Technology (ARRAY), p. 648

Croton, D.J., Springel, V., White, S.D.M., De Lucia, G., Frenk, C.S., Gao, L., Jenkins, A., Kauffmann, G., Navarro, J.F., Yoshida, N. 2006, MNRAS, 365, 11

DeBoer, D.R., Gough, R.G., Bunton, J.D., Cornwell, T.J., Beresford, R.J. *et al.* 2009, IEEE Proceedings, 97, 1507

Driver, S.P., Norberg, P., Baldry, I.K., Bamford, S.P., Hopkins, A.M. *et al.* 2009, Astronomy and Geophysics, 50, 050000

Duffy, A.R., Battye, R.A., Davies, R.D., Moss, A., Wilkinson, P.N. 2008, MNRAS, 383, 150

Duffy, A.R., Kay, S.T., Battye, R.A., Booth, C.M., Dalla Vecchia, C., Schaye, J. 2012a, MNRAS, 420, 2799D

Duffy, A.R., Moss, A., Staveley-Smith, L. 2012b, PASA 29, 202D

Duffy, A.R., Meyer, M.J., Staveley-Smith, L., Bernyk, M., Croton, D.J., Koribalski, B.S., Gerstmann, D., Westerlund, S. 2012c, MNRAS, 426, 3385

Johnston, S., Taylor, R., Bailes, M., Bartel, N., Baugh, C. *et al.* 2008, Experimental Astronomy, 22, 151

Koribalski, B., Stavely-Smith, L. 2009, ASKAP Survey Science Proposal

Lang, R.H., Boyce, P.J., Kilborn, V.A. *et al.* 2003, MNRAS, 342, 738

Lonsdale, C.J., Cappallo, R.J., Morales, M.F., Briggs, F.H., Benkevitch, L. *et al.* 2009, IEEE Proceedings, 97, 1497

Martin, A.M., Papastergis, E., Giovanelli, R., Haynes, M.P., Springob, C.M., Stierwalt, S. 2010, ApJ, 723, 1359

Springel, V., White, S.D.M., Jenkins, A. *et al.* 2005, Nature, 435, 629

Tully, R.B., Fouque, P. 1985, ApJS, 58, 67

Verheijen, M.A.W., Sancisi, R. 2001, A&A, 370, 765

Zwaan, M.A., Meyer, M.J., Staveley-Smith, L., Webster, R.L. 2005, MNRAS, 359, L30

Education and outreach

ROB HOLLOW (CASS)

An eclipsed Sun rises over a ridge at Maitland Downs, Queensland.

"Without doubt the most amazing thing about this program was that we actually had our own telescope time at either Parkes or ATCA…we got to do our own observations, and to reduce and analyse that data, just like any real-world scientist would do every day."

– Ayna Musaeva (University of Sydney), CASS undergraduate vacation student 2012–2013.

Education and outreach activities

Over recent months, CASS Education Officer Rob Hollow has been busy running teacher workshops around the country. At the invitation of the Science Teachers' Association of Tasmania he visited Tasmania in October, presenting six workshops in Hobart, Launceston, Ulverstone and Wynyard to about 100 teachers. Rob also presented sessions at several science teacher conferences in Sydney, Melbourne and Brisbane.

Far north Queensland was the focus of the astronomical world on 13 November when it witnessed a total solar eclipse. Several CASS staff travelled to the region, some in a professional capacity as expert astronomers to show the public or tour groups the spectacular event: Naomi McClure-Griffiths and David McConnell were offshore on a cruise ship whilst Ray Norris and Rob Hollow were inland at 'Maitland Downs' cattle station where clear skies ensured a stunning view of the spectacle. Rob was assisting at the 'Under a Darkened Star' student astronomy education conference attended by 100 schools students from across north Queensland and astronomers from around the world.

'PULSE@Parkes' sessions were held at Marsfield with some of the groups using the new interaction space adjacent to the Science Operations Centre. In February we were delighted to host students from Danebank Anglican School for Girls to Marsfield for their first PULSE@Pakes observing session. Danebank was the school at which Ruby Payne-Scott, the pioneering former CSIRO astronomer, taught after leaving CSIRO.

In January, CASS hosted a one-day astronomy event for Double Helix Club members as part of a school holiday program organised by CSIRO Education. The keen students learnt about the work CSIRO does in astronomy and space science from Rob and CASS astronomers George Hobbs and Eli Bressert. The students asked a wealth of probing questions and the day was a great success.

CASS hosted an artist-in-residence, Michaela Gleave, during the summer. Michaela is a highly successful artist, working in a range of media, with many exhibitions and awards to her credit. She met with many of our staff, sat in on the lecture program for our undergraduate vacation students and accompanied some of the students to Narrabri as part of their observing trip. Michaela is particularly interested in interpretations of space and astronomical themes. She is currently working on material gathered from her time with us to develop a major exhibition to be held in Fremantle later this year.

Undergraduate vacation scholarship program

The CASS undergraduate vacation scholarship program attracted a very talented group of students this year. They worked on a diverse range of astrophysics, computing, engineering, operations and outreach projects. Most were based at Marsfield, with one at Parkes and one at Narrabri.

This year half the group visited Parkes, while the other half visited Narrabri, for a week in January, which allowed each student to do their own observing project with 12 hours of telescope time.

The students presented talks on their main projects at CSIRO Information Sciences Group's 'Big Day In' at Macquarie University in February. They found the overall program to be highly worthwhile and several will be continuing their collaboration with CASS through co-supervised Honours or PhD projects.

Better than the beach? Half of our undergraduate vacation students spent a week at 'The Dish', where they completed their own observing projects; the other half of the group visited the Compact Array.

Operations

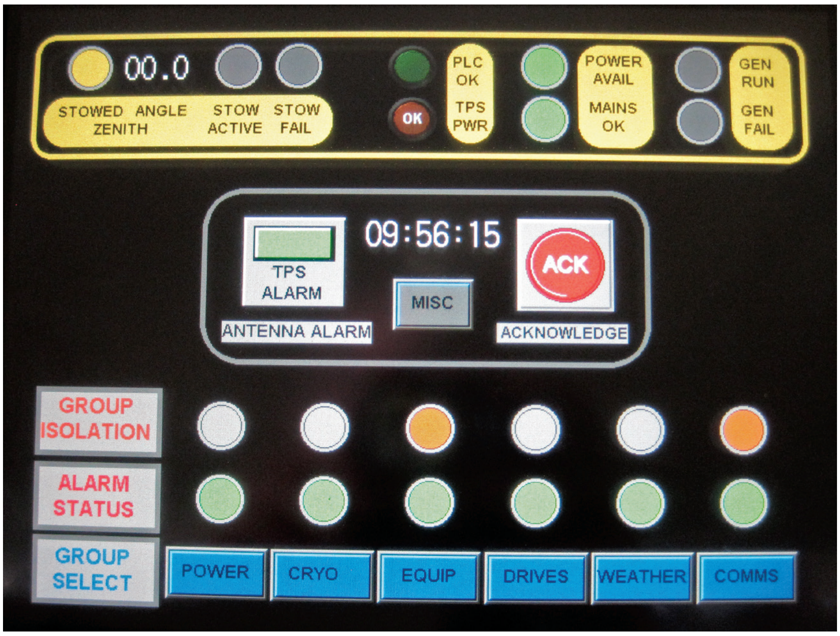
DOUGLAS BOCK, KATE BROOKS, PHIL EDWARDS, JC GUZMAN, BRETT HISCOCK AND DAVE MCCONNELL (CASS)

Parkes radio telescope

In the previous edition of *ATNF News* we reported on the construction of a telescope protection system (TPS) to enable safe remote observing with the Parkes radio telescope. The TPS is now complete, installed in the upper control room at Parkes and is undergoing final testing and debugging. During the test period, which commenced in December, some remote observing has been conducted by observers in the new Science Operations Centre at Marsfield (and in several instances at Swinburne University of Technology), but with backup members of Parkes Observatory staff or the observing team stationed in the telescope base tower. This mode of testing will continue until we have sufficient confidence in the reliability of the TPS. The TPS watches over a selection of equipment, power and environmental conditions. When abnormal conditions are detected some appropriate action is taken (such as turning on the auxiliary power source) and alarms are issued to Parkes staff. An important component of the TPS is the drives/vibration monitor (known locally as 'PkVibe'). It samples motor current and speed signals and the outputs of two accelerometers, all at 128 Hz. This allows the detection of a range of abnormal behaviours in the system. PkVibe has already uncovered two faulty tachometers and presented symptoms that, at the time of writing, we believe is an intermittent fault in the motor controller electronics. These give us confidence that potentially serious telescope control problems can be detected automatically, before they would have become evident without the monitor.

Observers accessing Parkes remotely have two new facilities available to them: a remote observing portal and 'FROG' (a close relative of the facility 'TOAD' that will be familiar to Mopra observers). The portal is accessed in a web browser and presents a range of useful information in several tabs; its chat window has proven to be popular with both staff and observers. FROG, also accessed in a browser, presents summaries of the current state of the telescope, and delivers warnings and alarms to observers on a range of conditions. FROG will continue to be developed to support an increasing set of fault conditions in the telescope's observing systems.

A milestone for Parkes has been the decommissioning and replacement of the original high voltage (HV) infrastructure after 50 years of service. New Parkes staff member Bob Kaletsch led the technical work as his first main project. The new HV equipment comprises: a switch gear cabinet with circuit breaker, meter and monitoring, a three-phase regulator, a new 750 kVA transformer, and enhanced monitoring capabilities. All within one day, the old equipment was decommissioned and the new equipment was connected, commissioned and supplying power to the site. Erik Lensson was the project leader, and other staff at Parkes and Narrabri provided assistance. Future plans include relocation of the site generator and replacement of the incoming low voltage mains distribution boards.



Parkes' new telescope protection system status and control panel.

Australia Telescope Compact Array

The last two new 4-cm receivers were installed on the Compact Array in mid-February, replacing the old 3cm/6-cm receivers (see page 7 for more information on the Compact Array centimetre receivers upgrade project). A new user-friendly version of the ATCA sensitivity calculator, including the performance of the 4-cm receivers, is available at *www.narrabri.atnf.csiro.au/myatca/sensitivity_calculator.html*. In addition to the new receivers, two antennas have been outfitted with prototype feeds to extend the frequency coverage from the current limit around 10.8 GHz, to above 12 GHz. This makes the full range of the CABB 4–12 GHz band available and offers the potential in the future, with the addition of a down-conversion stage, of making observations of the 12.2 GHz methanol line. The prototype feeds have been installed on antennas CA03 and CA05, and tests indicate that they have had the desired effect of improving the sensitivity at the top end of the 4-cm band. A side effect of the new feeds is that the focus position has changed significantly for the standard 3-cm observing frequency of 9.0 GHz from the previous centimetre-band position. The new positions are given on the Compact Array current issues web page (at *www.narrabri.atnf.csiro.au/observing/CurrentIssues.html*) and the 'assistance' computer program will warn observers if they have not optimised the focus on these antennas when they start observing.

Mopra radio telescope

As described in the last edition of *ATNF News*, agreement has been reached with the National Astronomical Observatory of Japan, University of NSW and University of Adelaide to fund the ongoing operation of the Mopra telescope, with the majority of observing time to be provided to the funding organisations. In the first year of operation under this new model, the portion of time made available to ATNF users will be used primarily for the completion of current, large projects approved by the ATNF Time Assignment Committee. Observing time in October 2012 was used to complete the CHaMP project (M161, led by Peter Barnes) and to bring the MALT-90 project (M516, led by Jim Jackson) 300 hours closer to its conclusion.

The recent bushfire at Mopra (see page X for more details) has naturally delayed plans for observing this winter.

Marsfield Science Operations Centre

The new Science Operations Centre (SOC) at Marsfield is now open for business. The SOC includes an interaction space as well as desks for casual and pre-booked visitors. The ATCA and Mopra remote observing stations were moved from their former location in Room 23 to the SOC observing area in time for successful tests in November. Remote observing with Parkes became a reality in early December: George Hobbs (PI of the Parkes Pulsar Timing Array project, P456) had the honour of being the first remote observer while the CSIRO CEO, Megan Clark, was the most recent. The SOC is also being used for ASKAP commissioning.

Suitably qualified remote observers who wish to observe from the SOC should nominate this as their observing site on the usual remote observing request web form. SOC users have priority for Marsfield on-site accommodation (with recently improved soundproofing) if they make their reservation more than two weeks in advance. A member of the CASS Astrophysics Group is being rostered to provide support to SOC users and visitors during business hours: they will normally be seated as Desk 1 in the visitors' desk area. A user guide for the SOC, at *www.atnf.csiro.au/observers/SOC*, is in place and is being updated as required.

Time Assignment Committee

The ATNF Time Assignment Committee (TAC) met on 6 and 7 February to review the 176 proposals submitted for use of the Compact Array, Parkes, Mopra, Tidbinbilla and the Long Baseline Array in the April 2013 semester (2013 APR). Proposals for Mopra were solicited only for the range 22:00 to 11:00 LST (the remainder will be allocated to MALT-90).

It was noted that a number ongoing proposals simply resubmit their cover sheets and observations tables from previous semesters. This is discouraged, as the forms for both are regularly updated to reflect changes in the availability or functionality of equipment: we recommend that all proposers take the small amount of extra time required to reload the table into the cover sheets or observations table editor and double-check the options they have selected.

The checking of grades and comments was finally completed on 28 February, with the outcomes being released through OPAL to the proposal teams. This often serves as motivation for well-intentioned proposers to contact the scheduler with updated information about their (im)possible observing dates. However, as the scheduler has been working frantically since the end of the TAC meeting to piece the schedules together, any information received at this late stage cannot be acted upon. PIs are encouraged to provide any updates on availability of observers before the TAC meets.

For Parkes, one highly ranked proposal that requested a rarely used receiver in 2013 APR could not be scheduled due to resource constraints. As was noted in the call for proposals, "Highly graded proposals requesting a receiver that is not installed in the focus cabin in 2013 APR will be reconsidered for scheduling in the 2013 OCT semester with the same grade, without the need to resubmit the proposal". The team can, of course, resubmit the proposal if they believe they can strengthen their case further, but if they do not they will automatically be assigned the same grade for consideration in the 2013 OCT semester.

The February meeting was the last for Jessica Chapman, who has served as TAC Secretary for the best part of the last 20 years. In her new role as Data Management Leader, Jessica will still be actively involved in the management of OPAL (and ATOA), but she has handed the reins for keeping the TAC on track to Jill Rathborne for the next meeting.

Software and computing

A new group within ATNF Operations, 'Software and Computing', has been created. This group is the result of merging the 'Science Computing and Archives' and 'ASKAP Computing' teams, and brings together CSIRO's expertise in software development for astronomical applications, radio interferometry calibration and imaging, high performance computing and science data archiving for the ATNF facilities. Juan Carlos (JC) Guzman was appointed leader of the group in December.

The Software and Computing Group has been divided into three major teams supporting all ATNF telescopes, including ASKAP:

- Science Data Archives, led by Jessica Chapman, is responsible for developing and maintaining all the software and computing that support science data archiving and user access to science data
- Science Data Processing, led by Ben Humphreys, is responsible for all software and computing development to support calibration and imaging, and
- Telescope Monitoring and Control, led by JC Guzman, is responsible for all the software development and maintenance involved in observation scheduling, observation execution (data acquisition) and maintenance.

The group will also support CSIRO's work on Square Kilometre Array pre-construction projects.

Staff changes

Over the past few months the Geraldton Engineering Group has also joined ATNF Operations. With the computing group changes mentioned above, ATNF Operations has grown to approximately 75 staff. After five years as the Operations Research Program Leader, Jessica Chapman has stepped down from this role to focus on the new science data archives project.

To accommodate these changes there has been some reorganisation of management responsibilities within Operations: Douglas Bock remains the ATNF Assistant Director – Operations (Head of ATNF Operations), and Kate Brooks has taken on the new role of Deputy Head of ATNF Operations to focus on the capability management of the four ATNF observatory sites.

There are now three ATNF Operations groups: Science Operations (lead by Phil Edwards), Engineering Operations (lead by Erik Lensson) and Software and Computing (lead by JC Guzman). At the observatories the site managers remain unchanged (Geraldton and MRO – Barry Turner, Narrabri and Mopra – Brett Hiscock, Parkes – Mal Smith). Barry Turner is based in Geraldton along with the rest of the MRO Operations staff. The group has recently moved their offices into the new MRO Support Facility on the campus of the Geraldton Universities Centre.

JC Guzman has been appointed leader of the new Software and Computing Group within ATNF Operations

Kate Brooks has taken on the new role of Deputy Head of ATNF Operations.

Publications

The following list of publications includes published refereed papers that use ATNF data or are by CASS authors; the list has been compiled following publication of the October 2012 issue of *ATNF News*. Papers that include CASS authors are indicated by an asterisk. Please email any updates or corrections to this list to *Julie.Tesoriero@csiro.au*.

Publication lists for papers that include ATNF data or CASS authors are also available on the ATNF website at *www.atnf.csiro.au/research/publications*.

*Agliozzo, C.; Umana, G.; Trigilio, C.; Buemi, C.; Leto, P.; Ingallinera, A.; Franzen, T.; Noriega-Crespo, A. “Radio detection of nebulae around four luminous blue variable stars in the Large Magellanic Cloud”. MNRAS, 426, 181-186 (2012).

*Allison, J.R.; Sadler, E.M.; Whiting, M.T. “Application of a Bayesian method to absorption spectral-line finding in simulated ASKAP data”. PASA, 29, 221-228 (2012).

Bagchi, M.; Nieves, A.C.; McLaughlin, M. “A search for dispersed radio bursts in archival Parkes Multibeam Pulsar Survey data”. MNRAS, 425, 2501-2506 (2012).

*Bannister, K.W.; Murphy, T.; Gaensler, B.M.; Reynolds, J.E. “Limits on prompt, dispersed radio pulses from gamma-ray bursts”. ApJ, 757, 38 (2012).

*Barger, K.A.; Haffner, L.M.; Wakker, B.P.; Hill, A.S.; Madsen, G.J.; Duncan, A.K. “Present-day galactic evolution: Low-metallicity, warm, ionized gas inflow associated with high-velocity Cloud Complex A”. ApJ, 761, 145 (2012).

*Bates, S.D.; Bailes, M.; Barsdell, B.R.; Bhat, N.D.R.; Burgay, M.; Burke-Spolaor, S.; Champion, D.J.; Coster, P.; D’Amico, N.; Jameson, A. and 12 coauthors. “The High Time Resolution Universe Pulsar Survey - VI. An artificial neural network and timing of 75 pulsars”. MNRAS, 427, 1052-1065 (2012).

*Battistelli, E.S.; Carretti, E.; de Bernardis, P.; Masi, S. “Large radio telescopes for anomalous microwave emission observations”. AdAst., 2012, id 607384 (2012).

*Beardsley, A.P.; Hazelton, B.J.; Morales, M.F.; Arcus, W.; Barnes, D.; Bernardi, G.; Bowman, J.D.; Briggs, F.H.; Bunton, J.D.; Cappallo, R.J.; Stevens, J. and 40 coauthors. “The EoR sensitivity of the Murchison Widefield Array”. MNRAS, 429, L5-L9 (2013).

*Beardsley, A.P.; Hazelton, B.J.; Morales, M.F.; Capallo, R.J.; Goeke, R.; Emrich, D.; Lonsdale, C.J.; Arcus, W.; Barnes, D.; Bernardi, G.; Stevens, J. and 38 coauthors. “A new layout optimization technique for interferometric arrays, applied to the Murchison Widefield Array”. MNRAS, 425, 1781-1788 (2012).

*Blake, C.; Brough, S.; Colless, M.; Contreras, C.; Couch, W.; Croom, S.; Croton, D.; Davis, T.M.; Drinkwater, M.J.; Jurek, R.J. and 16 coauthors. “The WiggleZ Dark Energy Survey: joint measurements of the expansion and growth history at z < 1”. MNRAS, 425, 405-414 (2012).

Bonaldi, A.; Bonavera, L.; Massardi, M.; De Zotti, G. “The Planck-ATCA Co-eval Observations project: the spectrally selected sample”. MNRAS, 428, 1845-1854 (2013).

Bozzetto, L.M.; Filipovic, M.D.; Urosevic, D.; Crawford, E.J. “Radio-continuum observations of small, radially polarised supernova remnant J0519-6902 in the Large Magellanic Cloud”. SerAJ, 185, 25-33 (2012).

*Breen, S.L.; Ellingsen, S.P.; Caswell, J.L.; Green, J.A.; Voronkov, M.A.; Fuller, G.A.; Quinn, L.J.; Avison, A. “12.2-GHz methanol maser Methanol Multibeam follow-up catalogue . II. Longitude range 186-330”. MNRAS, 426, 2189-2207 (2012).

*Brunetti, G.; Blasi, P.; Reimer, O.; Rudnick, L.; Bonafede, A.; Brown, S. “Probing the origin of giant radio haloes through radio and gamma-ray data: the case of the Coma cluster”. MNRAS, 426, 956-968 (2012).

Burgasser, A.J.; Melis, C.; Zauderer, B.A.; Berger, E. “Detection of radio emission from the hyperactive L dwarf 2MASS J13153094-2649513AB”. ApJ, 762, L3 (2013).

*Camera, S.; Santos, M.G.; Bacon, D.J.; Jarvis, M.J.; McAlpine, K.; Norris, R.P.; Raccanelli, A.; Röttgering, H. “Impact of redshift information on cosmological applications with next-generation radio surveys”. MNRAS, 427, 2079-2088 (2012).

*Carretti, E.; Crocker, R.M.; Staveley-Smith, L.; Haverkorn, M.; Purcell, C.; Gaensler, B.M.; Bernardi, G.; Kesteven, M.J.; Poppi, S. “Giant magnetized outflows from the centre of the Milky Way”. Nature, 493, 66-69 (2013).

*Casey, C.M.; Berta, S.; Béthermin, M.; Bock, J.; Bridge, C.; Budynkiewicz, J.; Burgarella, D.; Chapin, E.; Chapman, S.C.; Clements, D.L.; Seymour, N. and 22 coauthors. “A redshift survey of Herschel far-infrared selected starbursts and implications for obscured star formation”. ApJ, 761, 140 (2012).

*Casey, C.M.; Berta, S.; Béthermin, M.; Bock, J.; Bridge, C.; Burgarella, D.; Chapin, E.; Chapman, S.C.; Clements, D.L.; Conley, A.; Seymour, N. and 21 coauthors. “A population of z > 2 far-infrared Herschel-SPIRE-selected starbursts”. ApJ, 761, 139 (2012).

*Cassano, R.; Brunetti, G.; Norris, R.P.; Röttgering, H.J.A.; Johnston-Hollitt, M.; Trasatti, M. “Radio halos in future surveys in the radio continuum”. A&A, 548, A100 (2012).

*Corbel, S.; Coriat, M.; Brocksopp, C.; Tzioumis, A.K.; Fender, R.P.; Tomsick, J.A.; Buxton, M.M.; Bailyn, C.D. “The ‘universal’ radio/X-ray flux correlation: the case study of the black hole GX 339-4”. MNRAS, 428, 2500-2515 (2013).

*Corongiu, A.; Burgay, M.; Possenti, A.; Camilo, F.; D’Amico, N.; Lyne, A.G.; Manchester, R.N.; Sarkissian, J.M.; Bailes, M.; Johnston, S. and 2 coauthors. “A Shapiro delay detection in the binary system hosting the millisecond pulsar PSR J1910-5959A”. ApJ, 760, 100 (2012).

Crawford, F.; Altemose, D.; Li, H.; Lorimer, D.R. “Variability of the pulsed radio emission from the Large Magellanic Cloud pulsar PSR J0529-6652”. ApJ, 762, 8 (2013).

*Curran, S.J.; Whiting, M.T. “Complete ionization of the neutral gas: why there are so few detections of 21 cm hydrogen in high-redshift radio galaxies and quasars”. ApJ, 759, 117 (2012).

*D'Ammando, F.; Rau, A.; Schady, P.; Finke, J.; Orienti, M.; Greiner, J.; Kann, D.A.; Ojha, R.; Foley, A.R.; Stevens, J. and 4 coauthors. "PKS 2123-463: a confirmed gamma-ray blazar at high redshift". MNRAS, 427, 893-900 (2012).

*Dawson, J.R.; McClure-Griffiths, N.M.; Wong, T.; Dickey, J.M.; Hughes, A.; Fukui, Y.; Kawamura, A. "Supergiant shells and molecular cloud formation in the Large Magellanic Cloud". ApJ, 763, 56 (2013)

De Horta, A.Y.; Collier, J.D.; Filipovic, M.D.; Crawford, E.J.; Uroševic, D.; Stootman, F.H.; Tothill, N.F.H. "Radio confirmation of galactic supernova remnant G308.3-1.4". MNRAS, 428, 1980-1985 (2013).

*Demorest, P.B.; Ferdman, R.D.; Gonzalez, M.E.; Nice, D.; Ransom, S.; Stairs, I.H.; Arzoumanian, Z.; Brazier, A.; Burke-Spolaor, S.; Chamberlin, S.J. and 17 coauthors. "Limits on the stochastic gravitational wave background from the North American Nanohertz Observatory for Gravitational Waves". ApJ, 762, 25 (2013).

*Duffy, A.R.; Meyer, M.J.; Staveley-Smith, L.; Bernyk, M.; Croton, D.J.; Koribalski, B.S.; Gerstmann, D.; Westerlund, S. "Predictions for ASKAP neutral hydrogen surveys". MNRAS, 426, 3385-3402 (2012).

*Ellingsen, S.P.; Breen, S.L.; Voronkov, M.A.; Dawson, J.R. "Testing maser-based evolutionary schemes: a new search for 37.7-GHz methanol masers". MNRAS, 429, 3501-3516 (2013).

Ellingsen, S.P.; Sobolev, A.M.; Cragg, D.M.; Godfrey, P.D. "Discovery of two new class II methanol maser transitions in G 345.01+1.79". ApJ, 759, L5 (2012).

Elson, E.C.; de Blok, W.J.G.; Kraan-Korteweg, R.C. "HI synthesis observations of the blue compact dwarf NGC 1705". MNRAS, 429, 2550-2561 (2013).

*Esamdin, A.; Abdurixit, D.; Manchester, R.N.; Niu, H.B. "PSR B0826-34: Sometimes a Rotating Radio Transient". ApJ, 759, L3 (2012).

Esposito, P.; Tiengo, A.; Rea, N.; Turolla, R.; Fenzi, A.; Giuliani, A.; Israel, G.L.; Zane, S.; Mereghetti, S.; Possenti, A. and 6 coauthors. "X-ray and radio observations of the magnetar Swift J1834.9-0846 and its dust-scattering halo". MNRAS, 429, 3123-3132 (2013).

*Faimali, A.; Thompson, M.A.; Hindson, L.; Urquhart, J.S.; Pestalozzi, M.; Carey, S.; Shenoy, S.; Veneziani, M.; Molinari, S.; Clark, J.S. "The G305 star-forming complex: embedded massive star formation discovered by Herschel Hi-GAL". MNRAS, 426, 402-415 (2012).

Fok, T.K.T.; Nakashima, J.-I.; Yung, B.H.K.; Hsia, C.-H.; Deguchi, S. "Maser observations of Westerlund 1 and comprehensive considerations of maser properties of red supergiants associated with massive clusters". ApJ, 760, 21 (2012).

*For, B.-Q.; Staveley-Smith, L.; McClure-Griffiths, N.M. "Galactic All-Sky Survey high-velocity clouds in the region of the Magellanic Leading Arm". ApJ, 764, 74 (2013).

*Frater, R.H.; Ekers, R.D. "John Paul Wild 1923–2008". Historical Records of Australian Science, 23, 212-227 (2012).

*Fritz, J.; Gentile, G.; Smith, M.W.L.; Gear, W.K.; Braun, R.; Roman Duval, J.; Bendo, G.J.; Baes, M.; Eales, S.A.; Verstappen, J. and 23 coauthors. "The Herschel Exploitation of Local Galaxy Andromeda (HELGA). I. Global far-infrared and sub-mm morphology". A&A, 546, A34 (2012).

*Godfrey, L.E.H.; Lovell, J.E.J.; Burke-Spolaor, S.; Ekers, R.; Bicknell, G.V.; Birkinshaw, M.; Worrall, D.M.; Jauncey, D.L.; Schwartz, D.A.; Marshall, H.L. and 3 coauthors. "Periodic structure in the megaparsec-scale jet of PKS 0637–752". ApJ, 758, L27 (2012).

*Green, J.A.; McClure-Griffiths, N.M.; Caswell, J.L.; Robishaw, T.; Harvey-Smith, L. "MAGMO: coherent magnetic fields in the star-forming regions of the Carina-Sagittarius spiral arm tangent". MNRAS, 425, 2530-2547 (2012).

*Greve, T.R.; Vieira, J.D.; Weiß, A.; Aguirre, J.E.; Aird, K.A.; Ashby, M.L.N.; Benson, B.A.; Bleem, L.E.; Bradford, C.M.; Brodwin, M.; McIntyre, V. and 57 coauthors. "Submillimeter observations of millimeter bright galaxies discovered by the South Pole Telescope". ApJ, 756, 13 (2012).

*Gwinn, C.R.; Johnson, M.D.; Reynolds, J.E.; Jauncey, D.L.; Tzioumis, A.K.; Hirabayashi, H.; Kobayashi, H.; Murata, Y.; Edwards, P.G.; Dougherty, S. and 5 coauthors. "Size of the Vela pulsar's emission region at 18 cm wavelength". ApJ, 758, 7 (2012).

*Gwinn, C.R.; Johnson, M.D.; Reynolds, J.E.; Jauncey, D.L.; Tzioumis, A.K.; Dougherty, S.; Carlson, B.; Del Rizzo, D.; Hirabayashi, H.; Kobayashi, H. and 5 coauthors. "Noise in the cross-power spectrum of the Vela pulsar". ApJ, 758, 13 (2012).

*Hales, C.A.; Murphy, T.; Curran, J.R.; Middelberg, E.; Gaensler, B.M.; Norris, R.P. "BLOBCAT: software to catalogue flood-filled blobs in radio images of total intensity and linear polarization". MNRAS, 425, 979-996 (2012).

*Hamacher, D.W.; Fuller, R.B.; Norris, R.P. "Orientations of linear stone arrangements in New South Wales". AuArc., 75, 46-54 (2012).

*Hobbs, G.; Coles, W.; Manchester, R.N.; Keith, M.J.; Shannon, R.M.; Chen, D.; Bailes, M.; Bhat, N.D.R.; Burke-Spolaor, S.; Champion, D. and 14 coauthors. "Development of a pulsar-based time-scale". MNRAS, 427, 2780-2787 (2012).

*Huynh, M.T.; Hopkins, A.M.; Lenc, E.; Mao, M.Y.; Middelberg, E.; Norris, R.P.; Randall, K.E. "The ATLAS 5.5 GHz survey of the extended Chandra Deep Field South: catalogue, source counts and spectral indices". MNRAS, 426, 2342-2358 (2012).

*Huynh, M.T.; Hopkins, A.; Norris, R.; Hancock, P.; Murphy, T.; Jurek, R.; Whiting, M. "The completeness and reliability of threshold and false-discovery rate source extraction algorithms for compact continuum sources". PASA, 29, 229-243 (2012).

*Ivison, R.J.; Smail, I.; Amblard, A.; Arumugam, V.; De Breuck, C.; Emonts, B.H.C.; Feain, I.; Greve, T.R.; Haas, M.; Ibar, E. and 7 coauthors. "Gas-rich mergers and feedback are ubiquitous amongst starbursting radio galaxies, as revealed by the VLA, IRAM PdBI and Herschel". MNRAS, 425, 1320-1331 (2012).

*Jarrett, T.H.; Masci, F.; Tsai, C.W.; Petty, S.; Cluver, M.E.; Assef, R.J.; Benford, D.; Blain, A.; Bridge, C.; Donoso, E.; Koribalski, B. and 7 coauthors. "Extending the nearby galaxy heritage with WISE: first results from the WISE enhanced resolution galaxy atlas". AJ, 145, 34 (2013).

*Jordan, C.H.; Walsh, A.J.; Lowe, V.; Lo, N.; Purcell, C.R.; Voronkov, M.A.; Longmore, S.N. "Pilot observations for MALT-45: a Galactic plane survey at 7 mm". MNRAS, 429, 469-481 (2013).

*Jurek, R. "The characterised noise HI source finder: detecting HI galaxies using a novel implementation of matched filtering". PASA, 29, 251-261 (2012).

*Jurek, R.; Brown, S. "Examining alternatives to wavelet denoising for astronomical source finding". PASA, 29, 352-358 (2012).

Kavanagh, P.J.; Sasaki, M.; Points, S.D. "XMM-Newton view of the N 206 superbubble in the Large Magellanic Cloud". A&A, 547, 11 (2012).

*Keith, M.J.; Coles, W.; Shannon, R.M.; Hobbs, G.B.; Manchester, R.N.; Bailes, M.; Bhat, N.D.R.; Burke-Spolaor, S.; Champion, D.J.; Chaudhary, A. and 9 coauthors. "Measurement and correction of variations in interstellar dispersion in high-precision pulsar timing". MNRAS, 429, 2161-2174 (2013).

*Koay, J.Y.; Macquart, J.-P.; Rickett, B.J.; Bignall, H.E.; Jauncey, D.L.; Pursimo, T.; Reynolds, C.; Lovell, J.E.J.; Kedziora-Chudczer, L.; Ojha, R. "Why do compact active galactic nuclei at high redshift scintillate less?". ApJ, 756, 29 (2012).

*Koribalski, B.S. "Overview on spectral line source finding and visualisation". PASA, 29, 359-370 (2012).

*Koribalski, B.S. "Source finding and visualisation". PASA, 29, 213 (2012).

*Li, J.; Esamdin, A.; Manchester, R.N.; Qian, M.F.; Niu, H.B. "Radiation properties of extreme nulling pulsar J1502-5653". MNRAS, 425, 1294-1298 (2012).

*Li, K.L.; Kong, Albert K.H.; Charles, P.A.; Lu, T.-N.; Bartlett, E.S.; Coe, M.J.; McBride, V.; Rajoelimanana, A.; Udalski, A.; Masetti, N.; Franzen, T. "A luminous Be+White dwarf supersoft source in the wing of the SMC: MAXI J0158-744". ApJ, 761, 99 (2012).

*Lico, R.; Giroletti, M.; Orienti, M.; Giovannini, G.; Cotton, W.; Edwards, P.G.; Fuhrmann, L.; Krichbaum, T.P.; Sokolovsky, K.V.; Kovalev, Y.Y. and 6 coauthors. "VLBA monitoring of Mrk 421 at 15 GHz and 24 GHz during 2011". A&A, 545, 8 (2012).

Lorimer, D.R.; Lyne, A.G.; McLaughlin, M.A.; Kramer, M.; Pavlov, G.G.; Chang, C. "Radio and X-ray observations of the intermittent pulsar J1832+0029". ApJ, 758, 6 (2012).

*Madsen, E.C.; Stairs, I.H.; Kramer, M.; Camilo, F.; Hobbs, G.B.; Janssen, G.H.; Lyne, A.G.; Manchester, R.N.; Possenti, A.; Stappers, B.W. "Timing the main-sequence-star binary pulsar J1740-3052". MNRAS, 425, 2378-2385 (2012).

Maggi, P.; Haberl, F.; Bozzetto, L.M.; Filipovic, M.D.; Points, S.D.; Chu, Y.-H.; Sasaki, M.; Pietsch, W.; Gruendl, R.A.; Dickel, J. and 4 coauthors. "Multi-frequency study of supernova remnants in the Large Magellanic Cloud. Confirmation of the supernova remnant status of DEM L205". A&A, 546, 11 (2012).

*Mao, M.Y.; Sharp, R.; Norris, R.P.; Hopkins, A.M.; Seymour, N.; Lovell, J.E.J.; Middelberg, E.; Randall, K.E.; Sadler, E.M.; Saikia, D.J. and 2 coauthors. "The Australia Telescope Large Area Survey: spectroscopic catalogue and radio luminosity functions". MNRAS, 426, 3334-3348 (2012).

*Mao, S.A.; McClure-Griffiths, N.M.; Gaensler, B.M.; Brown, J.C.; van Eck, C.L.; Haverkorn, M.; Kronberg, P.P. and 3 coauthors. "New constraints on the galactic halo magnetic field using rotation measures of extragalactic sources toward the outer galaxy". ApJ, 755, 15 (2012).

*Mao, S.A.; McClure-Griffiths, N.M.; Gaensler, B.M.; Haverkorn, M.; Beck, R.; McConnell, D.; Wolleben, M.; Stanimirovic, S.; Dickey, J.M.; Staveley-Smith, L. "Magnetic field structure of the Large Magellanic Cloud from Faraday rotation measures of diffuse polarized emission". ApJ, 759, 25 (2012).

Marsh, K.A.; Jarrett, T.H. "Optimal multiwavelength source detection: experience gained from the WISE mission". PASA, 29, 269-275 (2012).

*Mazzarella, J.M.; Iwasawa, K.; Vavilkin, T.; Armus, L.; Kim, D.-C.; Bothun, G.; Evans, A.S.; Spoon, H.W.W.; Haan, S.; Howell, J.H. and 17 coauthors. "Investigation of dual active nuclei, outflows, shock-heated gas, and young star clusters in Markarian 266". AJ, 144, 43 (2012).

*McKinley, B.; Briggs, F.; Kaplan, D.L.; Greenhill, L.J.; Bernardi, G.; Bowman, J.D.; de Oliveira-Costa, A.; Tingay, S.J.; Gaensler, B.M.; Oberoi, D. and 42 coauthors. "Low-frequency observations of the moon with the Murchison Widefield Array". AJ, 145, 23 (2013).

Mickaliger, M.B.; Lorimer, D.R.; Boyles, J.; McLaughlin, M.A.; Collins, A.; Hough, L.; Tehrani, N.; Tenney, C.; Liska, A.; Swiggum, J. "Discovery of five new pulsars in archival data". ApJ, 759, 5 (2012).

*Middelberg, E.; Deller, A.T.; Norris, R.P.; Fotopoulou, S.; Salvato, M.; Morgan, J.S.; Brisken, W.; Lutz, D.; Rovilos, E. "Mosaiced wide-field VLBI observations of the Lockman Hole/XMM". A&A, 551, A97 (2013).

Mingo, B.; Hardcastle, M.J.; Croston, J.H.; Evans, D.A.; Kharb, P.; Kraft, R.P.; Lenc, E. "Shocks, Seyferts, and the supernova remnant connection: a Chandra observation of the Circinus galaxy". ApJ, 758, 13 (2012).

*Moore, T.J.T.; Urquhart, J.S.; Morgan, L.K.; Thompson, M.A. "The effect of spiral arms on star formation in the Galaxy". MNRAS, 426, 701-707 (2012).

*Ng, C.-Y.; Kaspi, V.M.; Ho, W.C.G.; Weltevrede, P.; Bogdanov, S.; Shannon, R.; Gonzalez, M.E. "Deep X-ray observations of the young high-magnetic-field radio pulsar J1119-6127 and supernova remnant G292.2-0.5". ApJ, 761, 65 (2012).

*Oliver, S. J.; Bock, J.; Altieri, B.; Amblard, A.; Arumugam, V.; Aussel, H.; Babbedge, T.; Beelen, A.; Béthermin, M.; Blain, A.; Seymour, N. and 93 coauthors. "The Herschel Multi-tiered Extragalactic Survey: HerMES". MNRAS, 424, 1614-1635 (2012).

*Oslowski, S.; van Straten, W.; Demorest, P.; Bailes, M. "Improving the precision of pulsar timing through polarization statistics". MNRAS, 430, 416-424 (2013).

*Ott, J.; Stilp, A.M.; Warren, S.R.; Skillman, E.D.; Dalcanton, J.J.; Walter, F.; de Blok, W.J.G.; Koribalski, B.; West, A.A. "VLA-ANGST: a high-resolution HI survey of nearby dwarf galaxies". AJ, 144, 123 (2012).

*Parkinson, D.; Riemer-Sørensen, S.; Blake, C.; Poole, G.B.; Davis, T.M.; Brough, S.; Colless, M.; Contreras, C.; Couch, W.; Jurek, R.J. and 18 coauthors. "The WiggleZ Dark Energy Survey: final data release and cosmological results". PhRvD, 86, 3518 (2012).

*Popping, A.; Jurek, R.; Westmeier, T.; Serra, P.; Floer, L.; Meyer, M.; Koribalski, B. "Comparison of potential ASKAP HI survey source finders". PASA, 29, 318-339 (2012).

*Posselt, B.; Arumugasamy, P.; Pavlov, G.G.; Manchester, R.N.; Shannon, R.M.; Kargaltsev, O. "XMM-Newton observation of the very old pulsar J0108-1431". ApJ, 761, 10 (2012).

*Purcell, C.R.; Longmore, S.N.; Walsh, A.J.; Whiting, M.T.; Breen, S.L.; Britton, T.; Brooks, K.J.; Burton, M.G.; Cunningham, M.R.; Green, J.A. and 12 coauthors. "The H_2O Southern Galactic Plane Survey: NH_3 (1,1) and (2,2) catalogues". MNRAS, 426, 1972-1991 (2012).

Rampadarath, H.; Morgan, J.S.; Tingay, S.J.; Trott, C.M. "The first very long baseline interferometric SETI experiment". AJ, 144, 8 (2012).

*Ravi, V.; Wyithe, J.S.B.; Hobbs, G.; Shannon, R.M.; Manchester, R.N.; Yardley, D.R.B.; Keith, M.J. "Does a "stochastic" background of gravitational waves exist in the pulsar timing band?". ApJ, 761, 84 (2012).

*Ray, P.S.; Ransom, S.M.; Cheung, C.C.; Giroletti, M.; Cognard, I.; Camilo, F.; Bhattacharyya, B.; Roy, J.; Romani, R.W.; Ferrara, E.C.; Johnston, S.; Keith, M. and 6 coauthors. "Radio detection of the Fermi-LAT blind search millisecond pulsar J1311-3430". ApJ, 763, L13 (2013).

*Righini, S.; Carretti, E.; Ricci, R.; Zanichelli, A.; Mack, K.-H.; Massardi, M.; Prandoni, I.; Procopio, P.; Verma, R.; López-Caniego, M. and 2 coauthors. "A 20 GHz bright sample for delta > +72° - I. Catalogue". MNRAS, 426, 2107-2114 (2012).

*Rodríguez-Gonzálvez, C.; Shimwell, T.W.; Davies, M.L.; Feroz, F.; Franzen, T.M.O.; Grainge, K.J.B.; Hobson, M.P.; Hurley-Walker, N.; Lasenby, A.N. and 8 coauthors. "Detailed Sunyaev-Zel'dovich study with AMI of 19 LoCuSS galaxy clusters: masses and temperatures out to the virial radius". MNRAS, 425, 162-203 (2012).

*Rousseau, R.; Grondin, M.-H.; Van Etten, A.; Lemoine-Goumard, M.; Bogdanov, S.; Hessels, J.W.T.; Kaspi, V.M.; Arzoumanian, Z.; Camilo, F.; Casandjian, J.M.; Johnston, S. and 5 coauthors. "Fermi-LAT constraints on the pulsar wind nebula nature of HESS J1857+026". A&A, 544, A3 (2012).

Sánchez-Monge, Á.; Beltrán, M.T.; Cesaroni, R.; Fontani, F.; Brand, J.; Molinari, S.; Testi, L.; Burton, M. "Different evolutionary stages in massive star formation. Centimeter continuum and H_2O maser emission with ATCA". A&A, 550, 84 (2013).

*Schnitzeler, D.H.F.M. "Modelling the Galactic distribution of free electrons". MNRAS, 427, 664-678 (2012).

*Scrimgeour, M.I.; Davis, T.; Blake, C.; James, J.; Poole, G.B.; Staveley-Smith, L.; Brough, S.; Colless, M.; Contreras, C.; Jurek, R.J. and 19 coauthors. "The WiggleZ Dark Energy Survey: the transition to large-scale cosmic homogeneity". MNRAS, 425, 116-134 (2012).

*Seymour, N.; Altieri, B.; De Breuck, C.; Barthel, P.; Coia, D.; Conversi, L.; Dannerbauer, H.; Dey, A.; Dickinson, M.; Drouart, G. and 23 coauthors. "Rapid coeval black hole and host galaxy growth in MRC 1138-262: the hungry spider". ApJ, 755, 8 (2012).

*Shannon, R.M.; Cordes, J.M. "Pulse intensity modulation and the timing stability of millisecond pulsars: a case study of PSR J1713+0747". ApJ, 761, 64 (2012).

Shetty, R.; Beaumont, C.N.; Burton, M.G.; Kelly, B.C.; Klessen, R.S. "The linewidth-size relationship in the dense interstellar medium of the central molecular zone". MNRAS, 425, 720-729 (2012).

*Smith, D.J.B.; Dunne, L.; da Cunha, E.; Rowlands, K.; Maddox, S.J.; Gomez, H.L.; Bonfield, D.G.; Charlot, S.; Driver, S.P.; Popescu, C C.; Seymour, N. and 30 coauthors. "Herschel-ATLAS: multi-wavelength SEDs and physical properties of 250 µm selected galaxies at z < 0.5". MNRAS, 427, 703-727 (2012).

*Smith, M.W.L.; Eales, S.A.; Gomez, H.L.; Roman-Duval, J.; Fritz, J.; Braun, R.; Baes, M.; Bendo, G.J.; Blommaert, J.A D.L.; Boquien, M. and 20 coauthors. "The Herschel Exploitation of Local Galaxy Andromeda (HELGA). II. Dust and gas in Andromeda". ApJ, 756, 40 (2012).

*Sullivan, I.S.; Morales, M.F.; Hazelton, B.J.; Arcus, W.; Barnes, D.; Bernardi, G.; Briggs, F.H.; Bowman, J.D.; Bunton, J.D.; Cappallo, R.J.; Stevens, J. and 40 coauthors. "Fast holographic deconvolution: a new technique for precision radio interferometry". ApJ, 759, 6 (2012).

*Thorat, K.; Subrahmanyan, R.; Saripalli, L.; Ekers, R.D. "High-resolution imaging of the ATLBS regions: the radio source counts". ApJ, 762, 14 (2013).

*Tingay, S.J.; Goeke, R.; Bowman, J.D.; Emrich, D.; Ord, S.M.; Mitchell, D.A.; Morales, M.F.; Booler, T.; Crosse, B. and 52 coauthors. "The Murchison Widefield Array: the Square Kilometre Array precursor at low radio frequencies". PASA, 30, 32 (2013).

*Ubach, C.; Maddison, S.T.; Wright, C.M.; Wilner, D.J.; Lommen, D.J.P.; Koribalski, B. "Grain growth signatures in the protoplanetary discs of Chamaeleon and Lupus". MNRAS, 425, 3137-3161 (2012).

van Straten, W. "High-fidelity radio astronomical polarimetry using a millisecond pulsar as a polarized reference source". ApJS, 204, 13 (2013).

Venzmer, M.S.; Kerp, J.; Kalberla, P.M.W. "The four leading arms of the Magellanic Cloud system. Evidence for interaction with Milky Way disk and halo". A&A, 547, 11 (2012).

*Vivian, U; Sanders, D.B.; Mazzarella, J.M.; Evans, A.S.; Howell, J.H.; Surace, J.A.; Armus, L.; Iwasawa, K.; Kim, D.-C.; Haan, S. and 12 coauthors. "Spectral energy distributions of local luminous and ultraluminous infrared galaxies". ApJS, 203, 9 (2012).

*Walsh, A.J.; Purcell, C.; Longmore, S.; Jordan, C H.; Lowe, V. "Maser source-finding methods in HOPS". PASA, 29, 262-268 (2012).

*Wardlow, J.L.; Cooray, A.; De Bernardis, F.; Amblard, A.; Arumugam, V.; Aussel, H.; Baker, A.J.; Béthermin, M.; Blundell, R.; Bock, J.; Seymour, N and 75 coauthors. "HerMES: candidate gravitationally lensed galaxies and lensing statistics at submillimeter wavelengths". ApJ, 762, 28 (2013).

*Warren, S.R.; Skillman, E.D.; Stilp, A.M.; Dalcanton, J.J.; Ott, J.; Walter, F.; Petersen, E.A.; Koribalski, B.; West, A.A. "Tracing cold HI gas in nearby, low-mass galaxies". ApJ, 757, 84 (2012).

White, G.J.; Hatsukade, B.; Pearson, C.; Takagi, T.; Sedgwick, C.; Matsuura, S.; Matsuhara, H.; Serjeant, S.; Nakagawa, T.; Lee, H.M. and 11 coauthors. "A deep ATCA 20 cm radio survey of the AKARI Deep Field South near the South Ecliptic Pole". MNRAS, 427, 1830-1846 (2012).

*Whiting, M.; Humphreys, B. "Source-finding for the Australian Square Kilometre Array Pathfinder". PASA, 29, 371-381 (2012).

Wong, G.F.; Filipovic, M.D.; Crawford, E.J.; Tothill, N.F.H.; De Horta, A.Y.; Galvin, T.J. "New 20-cm radio-continuum study of the Small Magellanic Cloud: Part III - Compact HII regions". SerAJ, 185, 53-64 (2012).

*Yu, M.; Manchester, R.N.; Hobbs, G.; Johnston, S.; Kaspi, V. M.; Keith, M.; Lyne, A.G.; Qiao, G.J.; Ravi, V.; Sarkissian, J.M. and 2 coauthors. "Detection of 107 glitches in 36 southern pulsars". MNRAS, 429, 688-724 (2013).

*Zinn, P.-C.; Blex, S.; Seymour, N.; Bomans, D.J. "X-ray stacking of Lyman break galaxies in the 4 Ms CDF-S. X-ray luminosities and star formation rates across cosmic time". A&A, 547, A50 (2012).

The Australia Telescope Compact Array (along with Parkes Observatory) hosted students participating in the CASS undergraduate summer vacation scholarship program in January 2013. This photograph of the Compact Array at night was taken by one of the students, Charles Li. See page 30 for a report on the student vacation program. Credit: Charles Li.

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