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CSIRO Australia Telescope National Facility

Annual Report
2013

CSIRO Australia Telescope National Facility Annual Report 2013

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This is the report of the CSIRO Australia Telescope National Facility for the calendar year 2013, approved by the Australia Telescope Steering Committee.

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Cover image: The Australian SKA Pathfinder at the Murchison Radio-astronomy Observatory in Western Australia. Credit: Dragonfly Media.

Inner cover image: A 'wrap-around' view of the Australia Telescope Compact Array, which celebrated the 25th anniversary of its opening on 2 September 2013. Credit: Emil Lenc

Contents

Credit: Wheeler Studios

Director's Report

2013 has been a year of outstanding achievement for the Australia Telescope National Facility (ATNF). Tremendous science has been delivered from the existing facilities, with 146 papers published in refereed journals using data collected with ATNF telescopes. The Compact Array, Parkes and Mopra telescopes have all exceeded their target of at least 75 per cent of time being made available for astronomical observing, and the fraction of unscheduled downtime on all facilities has been below the target of five per cent. Substantial changes to the mode of operations of ATNF telescopes have been very successful, most notably the implementation of remote observing with the Parkes telescope and the establishment of the Science Operations Centre in Marsfield. These changes have generated very positive feedback from the astronomy community.

The fact that six of the papers published during 2013 appeared in the highest-impact journals *Nature* and *Science* is truly remarkable and is a tribute to the quality and relevance of the science being delivered through the use of CSIRO's radio telescopes.

Of course work to deliver on the Australian Square Kilometre Array Pathfinder (ASKAP), CSIRO's next-generation radio-astronomy telescope, and other Square Kilometre Array-related activities has figured very prominently throughout the year. The highest priority for CSIRO's radio-astronomy activities continues to be the successful delivery of ASKAP, and through that, positioning CSIRO and the broader Australian community to play a leading role in the Square Kilometre Array. In this year the team completed the construction, delivery and installation of the six first-generation phased array feeds (PAFs) on a subset of the 36 ASKAP antennas. The PAFs are the innovative widefield 'radio cameras' that are at the heart of ASKAP's capability as the fastest radio survey telescope in the world. The team also demonstrated that the Mk II PAF design will achieve the required sensitivity right across ASKAP's wide frequency band. This will allow us to deliver on the key science goals for the Survey Science Teams that are waiting eagerly for the start of ASKAP science.

Engagement with the astronomy community has been a very high priority for the ATNF during 2013, especially in the development of plans for ASKAP Early Science. The ATNF has also drawn on the expertise of the broader astronomy community to bolster the ASKAP Commissioning and Early Science (ACES) team, with university staff coming to CSIRO on secondment. The ACES team is working together to come to grips with the exciting and challenging task of commissioning ASKAP and delivering the first data sets and demonstrations of the capabilities of a PAF-equipped array.

While ASKAP will be a world-class radio astronomy instrument in its own right, the bigger goal is the SKA. CSIRO cemented its role in the ongoing development of this massive project through successful proposals to lead two, and be a key partner in a further five, of the international consortia that are undertaking the engineering design work for the telescopes. CSIRO secured almost half of the $18.8m funding made available by the Australian Government to organisations to undertake this SKA preconstruction work.

CSIRO's achievements will always be underpinned by the excellence of its staff. I want to commend CASS staff for their achievements through 2013 in delivering the ATNF, and for setting up 2014 to be at least as exciting. It is a pleasure to be leading such a high-performing team. I'd also like to thank the outgoing members of the Steering Committee who have completed their terms at the end of 2013, and especially acknowledge Rachel Webster as the outgoing Chair.

Dr Lewis Ball

DIRECTOR, AUSTRALIA TELESCOPE NATIONAL FACILITY

Chair's Report

Credit: University of Melbourne

In March 2013 Dr Lewis Ball took up the Directorship of the Australia Telescope National Facility (ATNF) as part of his role as Chief of CSIRO Astronomy and Space Science (CASS). Lewis had been Deputy Director of the Atacama Large Millimeter/sub-millimeter Array (ALMA) in Chile, where he was responsible for leading that organisation through its initial scientific operations. Prior to that time, Lewis had held several management roles within CSIRO, including Acting Director of the ATNF and Acting Chief of CASS.

The Steering Committee was delighted by the appointment of Lewis as ATNF Director and will continue to provide independent advice on strategic directions, facility performance and allocation of observing resources to him in this role.

The Steering Committee had three major items it considered during 2013. The first was the status and commissioning of the new ASKAP telescope and the early science it has produced. The Steering Committee has been delighted with the success of efforts to fully equip the new ASKAP antennas with second-generation phased array feeds, which will enhance the capability of the array to deliver world-class scientific outcomes. The ATNF has worked closely with the astronomical community to develop observing programs for the Survey Science Teams that both provide valuable early scientific returns and have input into the development and commissioning of the array.

The second major issue was that the development and support of this substantial new observing facility will require changes to the current operation of the national radio facility. The ATNF is working through these changes in consultation with the Australian astronomical community.

Thirdly, CSIRO is deeply involved in the development and planning for the SKA. Australia is one of two host countries for this facility, and CSIRO is responsible for the development and management of the Murchison site, and for delivering ASKAP as a core part of the scientific capability for the SKA Survey telescope. Understanding and developing the role of CSIRO in this next-generation telescope will be a key focus for the Steering Committee over the next few years.

Finally, the Steering Committee thanks Jacqueline Hewitt of the Massachusetts Institute of Technology (MIT), who left the Steering Committee during 2013.

Professor Rachel Webster

CHAIR,
ATNF STEERING COMMITTEE

Senior Management

ATNF DIRECTOR AND CHIEF CSIRO ASTRONOMY AND SPACE SCIENCE

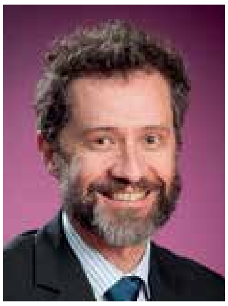
Lewis Ball

DEPUTY CHIEF

Sarah Pearce

ASSISTANT DIRECTOR, OPERATIONS

Douglas Bock

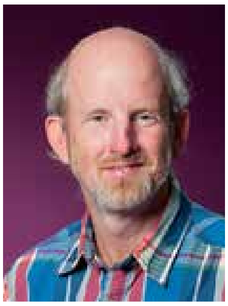


ASSISTANT DIRECTOR, ASKAP

Antony Schinckel

ASSISTANT DIRECTOR, ENGINEERING

Graeme Carrad



ASSISTANT DIRECTOR, ASTROPHYSICS

Simon Johnston

CHIEF SCIENTIST (until May 2013),

Robert Braun

ASSISTANT DIRECTOR, WESTERN AUSTRALIA

Phil Crosby

DATA MANAGEMENT LEADER

Jessica Chapman

COMMERCIAL ADVISOR

Warren Bax

Credit: Wheeler Studios and Flornes Yuen

The ATNF in Brief

This year, phased array feeds were installed on the six ASKAP antennas that form the Boolardy Engineering Test Array (BETA), and commissioning of the telescope began. Credit: Steve Barker

The ATNF in Brief

CSIRO's radio-astronomy observatories are collectively known as the Australia Telescope National Facility, or ATNF. Offering a unique view of the southern-hemisphere radio sky, this set of radio telescopes is a national research facility used by both Australian and international researchers. The ATNF is operated by CSIRO's Division of Astronomy and Space Science (CASS). This report covers ATNF-related activities of CASS over the 2013 calendar year.

OUR MISSION

The ATNF's mission is to:

- operate and develop the Australia Telescope as a national research facility for use by Australian and international researchers
- exploit the telescope's unique southern location and technological advantages to maintain its position as a world-class radio astronomy observatory, and
- further the advancement of knowledge.

AN OVERVIEW OF THE ATNF

The Australia Telescope currently comprises eight antennas and associated instrumentation at three observatories, supported by staff and facilities at the CSIRO Radiophysics Laboratory in Marsfield, Sydney (the headquarters of CSIRO Astronomy and Space Science). The three observatories are near the towns of Parkes, Narrabri and Coonabarabran, all in New South Wales.

Parkes Observatory is home to the 64-m Parkes radio telescope, a single, fully-steerable antenna. It is equipped with receivers that operate in frequency ranges from 74 MHz to 26 GHz, with bands in the range from 700 MHz to 9 GHz being the most commonly used. This telescope has been successfully operated since 1961 and is famous as a national symbol for Australian scientific achievement. Instrumental upgrades, including a 13-beam focal-plane array and innovative backend signal processing instrumentation, have maintained the telescope as a state-of-the-art instrument.

Six identical 22-m antennas make up the Australia Telescope Compact Array (ATCA), an earth-rotation synthesis telescope located at the Paul Wild Observatory outside Narrabri. The ATCA is equipped with receivers that operate at frequencies between 1.0 GHz and 105 GHz, with use at the highest frequencies restricted primarily to a 'winter season' when the atmosphere is at its most stable and transparent. This year (2013) saw the completion of the centimetre upgrade project for the Compact Array, with new receivers that provide almost complete frequency coverage over 1.1–12 GHz and a substantial improvement in system-noise performance.

The Mopra radio telescope is a single 22-m diameter antenna near Coonabarabran, used primarily for large-scale millimetre-wavelength mapping projects and as part of the Long Baseline Array.

CASS also manages the astronomical use of the 70-m and 34-m antennas at the CSIRO-administered Canberra Deep Space Communication Complex, located at Tidbinbilla, ACT. NASA/JPL makes available approximately five per cent of time on the 70-m antenna for astronomical research programs.

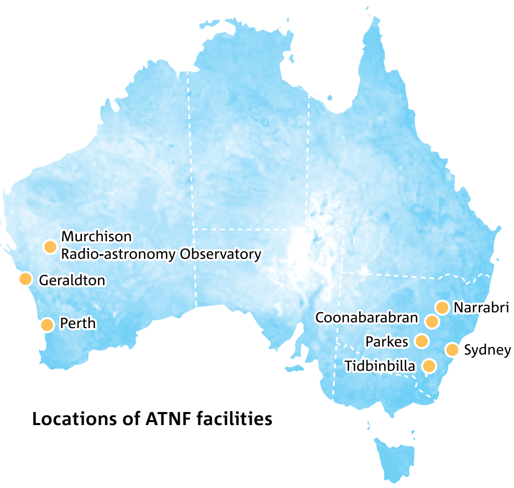
The eight ATNF radio telescopes can be used together as a Long Baseline Array (LBA) — sometimes in conjunction with antennas operated by the University of Tasmania at Ceduna and Hobart, the Tidbinbilla 70-m antenna, and a 12-m antenna operated by AUT University at Warkworth, New Zealand. The technique of using widely separated telescopes in concert is known as very long baseline interferometry (VLBI).

CASS is completing the construction of a next-generation radio telescope, the Australian Square Kilometre Array Pathfinder (ASKAP), which will become part of the ATNF following its commissioning. ASKAP will be a wide field-of-view survey telescope made up of 36 antennas, each 12 metres in diameter, using new, innovative phased array feeds. It is located at CSIRO's Murchison Radio-astronomy Observatory (MRO), a superbly radio-quiet area in the Mid West region of Western Australia, and will be a key demonstrator instrument for new technologies for the international Square Kilometre Array (SKA) project. The MRO Support Facility in Geraldton was opened in 2013 and supports the development and operation of the Murchison Radio-astronomy Observatory.

This year CASS established a permanent presence in Perth, Western Australia. This will allow it to interact more closely with the growing radio astronomy community in Western Australia, and with the State Government. The new office is within the Australian Resources Research Centre (ARRC), which is close to Curtin University and the International Centre for Radio Astronomy Research (ICRAR).

The Australian Resources Research Centre in Perth, home to CASS's new Western Australian office.

The ATNF's Dr Phil Crosby (Assistant Director, Western Australia) in the new Perth office.



Locations of ATNF facilities

GOVERNANCE

The Australia Telescope is operated as a national facility under guidelines originally established by the Australian Science and Technology Council. Until 30 November 2009 the ATNF undertook this activity as a division of CSIRO in its own right. On 1 December 2009, the ATNF was incorporated into a new division, CSIRO Astronomy and Space Science (CASS), through which it is responsible, via the CSIRO Executive, to the Minister for Industry. The Chief of CASS is also the Director of the ATNF.

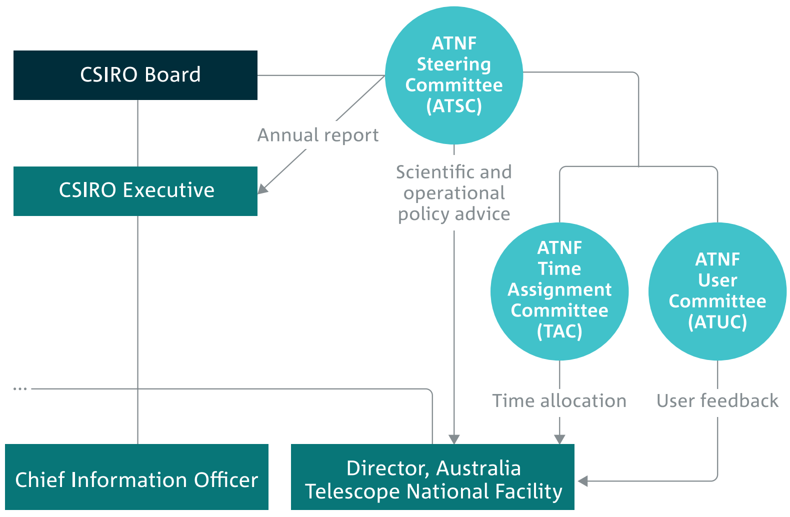
Divisional policy, strategic planning and operational management are the responsibility of the CASS Executive, comprising the Chief (Lewis Ball), the Deputy Chief (Sarah Pearce), Assistant Directors (Graeme Carrad, Douglas Bock, Simon Johnston, Antony Schinckel, Phil Crosby), CDSCC Director (Ed Kruzins) and Commercial Advisor (Warren Bax). There are also three observers on the CASS Executive: Michelle Storey (SKA Centre Executive Manager), Jessica Chapman (Data Management Leader) and Mark McKinnon (SKA Dish Consortium Leader).

Divisional plans reflect CSIRO's Strategic Plan 2012–2015 and the ATNF's mission statement.

ATNF policy is shaped by the Australia Telescope Steering Committee (ATSC), an independent committee appointed by the Minister. The Steering Committee meets at least once a year to advise the Director about the broad directions of the ATNF's scientific activities and longer-term strategies for the development of the Australia Telescope. The Steering Committee appoints the Australia Telescope Users Committee (ATUC) and the Time Assignment Committee (TAC). ATUC represents the interests of the community of astronomy researchers who use the Australia Telescope. The Committee provides feedback to the ATNF Director, discussing problems with, and suggesting changes to, ATNF operations. It also discusses and provides advice on the scientific merit of future development projects. ATUC meetings are also a forum for informing telescope users of the current status and planned development of ATNF facilities, and recent scientific results. The TAC reviews proposals and allocates observing time.

The ATSC, TAC and ATUC members for 2013 are listed in Appendix A.

AUSTRALIA TELESCOPE NATIONAL FACILITY



CASS MANAGEMENT CHANGES IN 2013

In October 2012, CASS Chief Dr Phil Diamond left CSIRO to become Director General of the SKA Organisation. Following an international search for a new Chief, Dr Lewis Ball took up the position in March 2013. Lewis returned to CSIRO from his role as Deputy Director at the Atacama Large Millimeter/sub-millimeter Array (ALMA) in Chile, where he led the successful start of scientific operations. ALMA is currently the world's largest and most complex astronomical observatory, operated by a partnership of 20 countries. Before going to ALMA, Lewis was 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 CASS.

Dr Sarah Pearce, who was Acting Chief prior to Lewis taking up his appointment, returned to her role of Deputy Chief in 2013.

Dr Robert Braun, CASS Chief Scientist, left CSIRO in May 2013 to take up the role of Science Director for the SKA. The Chief Scientist role was advertised, but not filled, in 2013.

Dr Phil Crosby, Strategic Planning and Major Project Specialist, moved to Western Australia to head up CASS's new Perth office as Assistant Director – Western Australia.

Dr Mark McKinnon joined CASS in September 2013 to lead the international SKA Dish Consortium, an $80-m project to manage the research and design of the dishes and receivers for the SKA, as part of the pre-construction phase. The SKA Dish Consortium is led by CSIRO and includes research and industry partners from South Africa, Canada, China and Italy. Mark came to CASS on secondment from the US National Radio Astronomy Observatory, where he was ALMA North American Project Director and has coordinated $600m worth of ALMA construction.

FUNDING

In the financial year 2012–2013, CSIRO's total expenditure for radio-astronomy activities was $40.6m: total revenue was $39.9m, including direct appropriation of $35.6m from CSIRO, representing flat funding compared to the year ending June 2012. External revenue for 2012–2013 was impacted by one-off agreements related to funding for the ASKAP project, which were lower than in the previous financial year. A financial summary is given in Appendix B.

THE AUSTRALIA TELESCOPE COMMUNITY

At the end of 2013 the total staff complement of CASS was around 280 research scientists, engineers, and technical and administrative support personnel, of whom 160 were primarily associated with the ATNF. (This number excludes casuals, contractors and students.) A list of all staff who worked for CASS in 2013 on activities related to radio astronomy, including staff from other CSIRO divisions, is given in Appendix C.

The primary user base of the Australia Telescope is the university community, both within Australia and around the world. Approximately 90 per cent of the Australia Telescope's users come from outside CSIRO and 80 per cent are from outside Australia. They gain access to our facilities on the basis of scientific merit and use them without charge. Similarly, Australian astronomers obtain access to overseas facilities operated on the same principle. This 'open skies' policy follows the general practice of the international radio astronomy community.

In 2013, agreements were signed with the National Astronomical Observatory of Japan and the University of New South Wales to provide them with observing time on the Mopra telescope in return for contributions to Mopra's annual operating costs. Implementation of the agreement was delayed by the Wambelong bushfire that damaged the Mopra observatory in January (see page 40): observing under the new Mopra operations model started in May.

Observing time on ATNF telescopes is awarded twice a year to astronomers on the basis of the merits of their proposed research programs, as judged by the Time Assignment Committee. For 2013, proposals for the Compact Array exceeded the time available by a factor of two for the winter season and 1.7 for the summer season; for Parkes and Mopra proposals this number was closer to 1.3. The most oversubscribed facility in 2013 was the Long Baseline Array, with proposals exceeding the time available by a factor of three. One hundred and fifty-two proposals were received for the summer semester (October 2012 to March 2013) and 176 for the winter semester (April to September 2013). Demand is higher in winter because the weather is better for higher-frequency (millimetre-wavelength) observations with Mopra and the Compact Array.

The Compact Array, the Parkes telescope and the Mopra telescope run on a 'user-operator' model. Members of each observing team operate the telescope for their allocated time and are supported by CSIRO staff and students. For some years, users of the Compact Array and Mopra have enjoyed the flexibility of being able to observe remotely from their home institutes (once they are suitably qualified): in 2013 it also became possible to operate Parkes remotely, and indeed observing from the Science Operations Centre at ATNF headquarters in Marsfield has become the default observing mode for all the telescopes. (See page 40 for more details.)

The ATNF headquarters hosts a constant stream of astronomers from around the world who visit for periods of between a few days and a few weeks. Some of these visitors are observers passing through on their way to the observatories. Others are part of the Scientific Visitor Program, or are giving scientific colloquia. The Science Operations Centre provides desk space for visitors and a place where staff and visitors can meet and discuss their science. Such interactions are important for the international and collaborative nature of astronomical research carried out by CASS astronomers.

Research scientists and engineers are heavily involved in the training of postgraduate students, and this helps to strengthen the interactions between CASS staff and university colleagues. In 2013 CASS staff co-supervised 34 PhD students, most of whom were undertaking degrees at Australian universities. CSIRO provides direct financial support to many of these students, supplementing the funding they receive through their host universities. Most of the PhD students currently with CASS have an Australian Postgraduate Research Award.

THE WIDER ASTRONOMICAL COMMUNITY AND OTHER RELATIONSHIPS

The Australia Telescope Steering Committee provides the ATNF Director with strategic advice from the Australian and international research community. CSIRO staff provide similar input to other parts of the research community.

CSIRO is a full member of Astronomy Australia Ltd, an organisation established in early 2007 as a company with the principal objective of managing the National Collaborative Research Infrastructure Strategy (NCRIS) funds for astronomy.

CSIRO is also a member of CAASTRO (the ARC Centre of Excellence for All-sky Astrophysics). CAASTRO is a partnership and collaboration between several Australian and international universities and research institutions.

CSIRO is a corporate member of the Astronomical Society of Australia. CSIRO sponsors national events such as the 'Women in Astronomy' workshop and the ASA Annual Science Meeting, which in 2013 was held at Monash University in Melbourne.

CASS has contracted links with the research and space community, for the provision of both equipment and research outcomes, data, or aspects of ATNF operations to organisations external to CSIRO. Such contracts are few in number, and in the past have generally concerned the delivery of instrumentation for astronomy, and/or spacecraft tracking services. CSIRO has also entered into contracts with Australian university partners for the provision of services that contribute to the operation of the ATNF. Engagement with university partners is seen as increasingly important and CASS will continue to pursue it actively, as a means of both broadening the ATNF resource base and ensuring the vitality of the Australian astronomy research community as a whole.

As a component of CSIRO's management of the Murchison Radio-astronomy Observatory (MRO), CSIRO has a Collaboration Agreement with the Western Australian Government, supporting collaboration between CSIRO, ICRAR (the International Centre for Radio Astronomy Research, which comprises Curtin University and the University of Western Australia) and SciTech (a major WA science education centre). CSIRO collaborates with the Wajarri Yamatji community under the terms of the Indigenous Land Use Agreement (ILUA) for the site. A project from the Sustainability Round of the Commonwealth Government Education Investment Fund (EIF) has seen CASS working with CSIRO's Energy Group and several industry partners to improve energy efficiency and provide sustainable power for the MRO and for ASKAP's supercomputing requirements at the iVEC Pawsey Centre in Perth.

International alliances are growing, with a small number of 'formal' links underlined by collaborative agreements supplemented by a larger number of informal community collaborations. CSIRO is a member of RadioNet3, a collaboration to coordinate radio-astronomy facilities to benefit European astronomers. The CASS VLBI team's expertise has led to its inclusion in the (mainly European) 'NEXPReS' consortium to develop e-VLBI which seeks to link observatories across the world by high-speed optical fibre to deliver real-time processing and flexibility in observing that is not currently available in VLBI. CASS also works with AUT University (Auckland, New Zealand) on trans-Tasman VLBI observing projects.

CSIRO's relationships with the international astronomical community are increasing in complexity as the SKA project progresses. CSIRO has formal linkages with NRC-Canada, ASTRON in The Netherlands, the international Office for the SKA Organisation, the Australia–New Zealand SKA Coordination Committee (ANZSCC), INAF in Italy, and research groups in the USA, New Zealand, India, and China.

Finally, as CASS moves through the design, development and construction phases of the ASKAP project, industry will play a crucial role in the delivery and through-life support of the technologies and infrastructure required. The size of ASKAP, and the consequent requirement to produce 'at scale' many of its components, continues to draw on the engagement of industry at new levels. Such relationships with industry continued to develop through 2013 via research collaborations and, more strategically, the Australasian SKA Industry Consortium (ASKAIC).

Professor Brian Schmidt (ANU) addressing the Australian SKA Pathfinder (ASKAP) Early Science workshop held at the ATNF headquarters in Sydney on 5 August 2013. The workshop attracted participants from many institutions, and generated input from the broader astronomical community into the ASKAP Early Science program.

THEMES

CASS's research themes pertaining to the ATNF are given below.

Astrophysics

Theme goal

To deliver world-class science that directly influences international astronomical research and shapes our understanding of the Universe.

Theme purpose
To conduct world-class research in astrophysics, retaining astronomy's position as Australia's highest-impact fundamental science, and furthering our understanding of the Universe through innovative use of CSIRO's telescopes. The primary research deliverables of the theme are refereed papers in high-impact international journals. Current outputs are based, to a large extent, on data obtained with the ATNF telescopes, a hardware investment of about $200m made over the past 50 years. About half of theme effort is directed at maximising the scientific return of current and future facilities through the provision of scientific support. This has been directed largely at the ATNF telescopes, but now also extends to the Australian Square Kilometre Array Pathfinder, a $188-m facility now under construction in Western Australia. The theme is also fully engaged in planning for science outcomes from the international Square Kilometre Array, which will provide revolutionary science capabilities from about 2020.

Australia Telescope National Facility Operations

Theme goal
To continue to operate the most productive radio astronomy facility in the southern hemisphere in order to serve the Australian and international scientific community.

Theme purpose
This theme operates the National Facility observatories (the Compact Array near Narrabri, the single-dish Mopra telescope, the Parkes radio telescope, the radio-astronomy activities at NASA's Canberra Deep Space Communication Complex at Tidbinbilla, and the Long Baseline Array) in such a way as to maximise the scientific value of experiments conducted by ATNF users. The theme now also manages the Murchison Radio-astronomy Observatory (MRO) in Western Australia, including operational support of the Australian Square Kilometre Array Pathfinder (ASKAP), which is being built under the ASKAP theme. The MRO is also the site for the Murchison Widefield Array operated by Curtin University.

The high impact of the ATNF will be sustained by ensuring continuous operation with very high reliability (less than five per cent lost time) and excellent data quality, facilitating astronomical research conducted with our radio telescopes that contributes to the understanding of the Universe. The scientific impact of the theme is measured by the output of CSIRO astronomers (Astrophysics theme) and the astronomers worldwide who use the facility. A primary measure is the publication record of CSIRO and non-CSIRO facility users.

Technologies for Radio Astronomy

Theme goal

To develop frontline technology for the advancement of radio astronomy in Australia.

Theme purpose
To ensure that CSIRO's existing radio telescopes remain at the leading edge of world technology, securing continued demand from the astronomical research community for the CSIRO's radio telescopes, with the effect of maximising the science outcomes from astronomy conducted with the ATNF.

This directly complements the development of the new radio telescope undertaken in the sister theme, the Australian Square Kilometre Array Pathfinder.

These technological developments underpin astronomy's position as the highest-impact field of Australian science and its role in shaping our understanding of the Universe.

In addition, this theme supplies radio-astronomy instrumentation to outside organisations and undertakes strategic collaborations with other radio-astronomy institutes. These secondary activities allow a broad range of specialist talent to be maintained and developed within CASS, provide significant external revenue for re-investment in the ATNF, and facilitate the international communication necessary to ensure that technological developments at CASS continue to be world-class.

The window of opportunity for success is medium-term rather than short-term. Work is planned to allow sufficient time for frontline science to be conducted before competing astronomical facilities come online.

The Australian Square Kilometre Array Pathfinder

Theme goal

To maximise Australia's participation in the Square Kilometre Array (SKA).

Theme purpose
The purpose of the Australian Square Kilometre Array Pathfinder (ASKAP) theme is to develop a world-leading survey radio telescope to explore the history of the Universe, through development and deployment of innovative receiver and data-processing technologies, and establishment of a radio-quiet observatory in Western Australia. Embedding the theme developments in the international SKA program is aimed at maximising Australia's participation in the SKA, to take advantage of the opportunity to be a 'key player' in the SKA domain.

ASKAP will create impact through:

- delivering a world-leading instrument to study the southern sky and address the biggest questions regarding our knowledge of the Universe. The complete ASKAP telescope will have a survey speed roughly 20 times greater than that of any other radio telescope
- establishing a world-class astronomical observatory at the world's best site for metre and centimetre radio astronomy, attracting science engagement and further international investment to Australia, including the SKA
- maximising Australia's participation in the SKA — a multi-billion-Euro international facility due for delivery of Phase 1 in about 2022
- creating innovative phased array feeds that lie along the SKA development path.

The ASKAP theme deliverables are timed aggressively and have achieved their desired aim of influencing the choice of site and technology for the SKA, in order to promote Australian opportunities.

Capability Development

Theme goal

To build CASS's capability in astronomy, technology, operations and space science.

Theme purpose
The CASS Capability Development Fund (CDF) is the base for CASS's work on the Square Kilometre Array. In 2013, CASS was successful in bidding as part of international consortia to undertake SKA technical design work, as part of the pre-construction phase. CASS leads both the Dish Consortium and the Australian Infrastructure Consortium. CASS is also a partner in five other consortia, including Assembly, Integration and Verification, which is responsible for the integration of ASKAP into the SKA.

The CDF also runs the CSIRO SKA Centre, established in 2013 and led by Sarah Pearce, which co-ordinates SKA activity across CSIRO; CSIRO's work on radio quietness for the MRO; and CASS's Space Science and Technology activity.

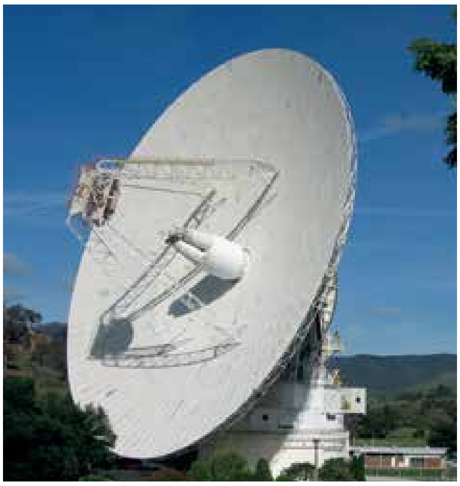
Telescopes

Australia Telescope Compact Array

Credit: Jamie Stevens

Parkes Radio Telescope

Credit: David McClenaghan



LEFT: **Mopra Radio Telescope**

Credit: Emil Lenc

RIGHT: **Canberra Deep Space Communication Complex 70-m DSS-43 antenna**

Credit: CDSCC

Australian Square Kilometre Array Pathfinder

Credit: Dragonfly Media

Performance Indicators

The Australia Telescope Compact Array. In 2013 the Compact Array celebrated its 25th anniversary and generated its highest-ever number of refereed papers. Credit: David Smyth

Performance Indicators

“This year 35 per cent of Compact Array observations were taken by observers not at Narrabri...”

SCHEDULED AND SUCCESSFULLY COMPLETED OBSERVING TIME

The key performance indicators for the Compact Array and the Parkes radio telescope are that at least 70 per cent of time should be allocated for astronomical observations, and that the time lost during scheduled observations from equipment failure should be below five per cent. For the Compact Array and Parkes, approximately ten per cent of time is made available as ‘Director’s time’. This is time that is initially not allocated in the published version of the schedule, but, if not allocated at the discretion of the Director, is later made available for approved observing projects.

Proposing astronomers are required to conduct their observations themselves. For the ATCA, this requires first-time observers to travel to the observatory for their scheduled time: once qualified, they can make subsequent observations remotely. Re-qualification, through another trip to the observatory, is required annually. For Mopra, qualification (or re-qualification) can be gained by observing from the Mopra desk at the Compact Array, or from the Science Operations Centre (SOC) in Marsfield. Remote observing with the Parkes telescope began in December 2012, but until a telescope protection system was fully commissioned, remote observing still required the presence of a person in the telescope tower at Parkes. From 15 July 2013 fully remote observing was possible, and from 15 September the SOC became the default location for Parkes observing. Once qualified at the SOC, observers can conduct later observations from other sites. Observing from Parkes is still permitted for complex or non-standard observations, or in other circumstances where it is the more sensible option. This year 35 per cent of Compact Array observations were taken by observers not present at Narrabri, compared with 39 per cent in 2012. Under the new operations model for Mopra, the National Astronomical Observatory of Japan, the University of New South Wales and the University of Adelaide became responsible for training and qualifying observers who used those institutions’ share of observing time: as a result, this year approximately 95 per cent of Mopra observations were made remotely.

The telescope usage figures are similar to those for recent years. The Mopra ‘millimetre season’ started later than usual in 2013 because significant efforts were required to return the site to an operational state after a bushfire in January (see page 44 for details). Most of the time lost to equipment failure at Parkes was due to an issue with the zenith-drive brake, which took the telescope off-line for several days. Time lost to weather is higher for Mopra than for the other telescopes as most Mopra observing is conducted in the 3-mm band, which is sensitive to atmospheric conditions.

RESPONSE TO RECOMMENDATIONS BY THE USER COMMITTEE

The Australia Telescope User Committee (ATUC) is an advisory group that represents the users of ATNF facilities in the ATNF decision-making process. Its members are listed in Appendix A. The committee normally meets twice a year, and after each meeting it presents a list of recommendations to the ATNF Director. ATUC considers matters raised by the user community, current operations, and priorities for future developments. In 2013 two ATUC meetings were held: the second was in December, later in the year than usual, so that the development of receivers for Parkes could be discussed.

Most ATUC recommendations are accepted and implemented. Following the June 2013 meeting, ATUC made 19 recommendations to the ATNF. Of these, 12 were accepted, five were taken for further consideration, and

TABLE 1:
Telescope usage in 2013.

	ATCA	PARKES	MOPRA*
Successful astronomy observations	78%	83%	81%
Maintenance/test time	16%	10%	5%
Time lost due to equipment failure	3%	4%	4%
Time lost due to weather	2%	2%	9%
Idle time	1%	1%	1%

* Mopra statistics are for dates between 7 May and 14 November, which corresponded to the ‘millimetre season’ for 2013.

in two cases ATUC was advised that the recommendation would not be adopted. Following the December 2013 meeting, ATUC made 24 recommendations to the ATNF. ATUC reports to the ATNF Director, and the Director's replies, can be found at http://www.atnf.csiro.au/management/atuc/index.html.

TIME ALLOCATION ON AUSTRALIA TELESCOPE FACILITIES

Observing time is allocated on the basis of scientific merit. Two six-month observing semesters are scheduled each year, from October to March (OCTS) and from April to September (APRS). For the period from 1 October 2012 to 30 September 2013, a total of 181 proposals were allocated time on ATNF telescopes (each proposal is counted only once each calendar year even though some are submitted twice). One hundred and twenty-six (126) proposals were for the Compact Array, 31 were for Parkes, six were for Mopra and 18 were for the Long Baseline Array. Observing programs allocated time on ATNF facilities are listed in Appendix D.

Proposals requesting service observations with the Canberra Deep Space Communication Complex DSS-43 (70-m) and DSS-34 (34-m) antennas at Tidbinbilla, which are part of the NASA Deep Space Network, are also accepted. Five CDSCC projects were observed during the year.

Figures 1 and 2 show the time allocated to observing teams on the Compact Array and Parkes as a percentage of the total allocated time, determined by affiliation of the team leader. Figures 3 and 4 show the time allocated to observing teams on the Compact Array and Parkes as a percentage of the total allocated time, determined using the affiliations of all team members. In these plots the time allocated to each proposal has been divided evenly between all authors on the proposal. Counting all authors on the proposals, CASS staff were allocated about 24 per cent of observing time during the year for the Compact Array and 25 per cent for the Parkes telescope. As discussed on page 8, Mopra operations changed substantially this year, reducing the amount of National Facility time available. Six Mopra projects were allocated such time.

ATNF telescopes support a broad range of studies in Galactic (ISM, pulsar, X-ray binaries, star formation, stellar evolution, magnetic fields), extragalactic (galaxy

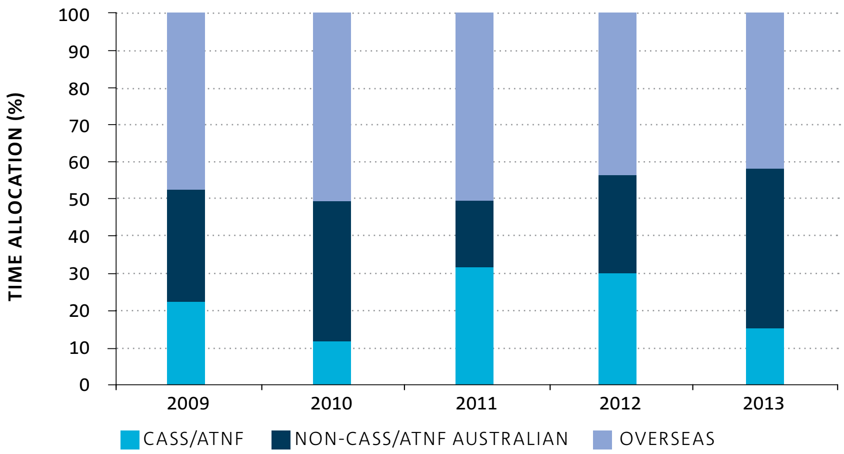


FIGURE 1:
Compact Array time allocation by primary investigator, October 2008 – September 2013. For each year the time allocation is for 12 months from October to September.

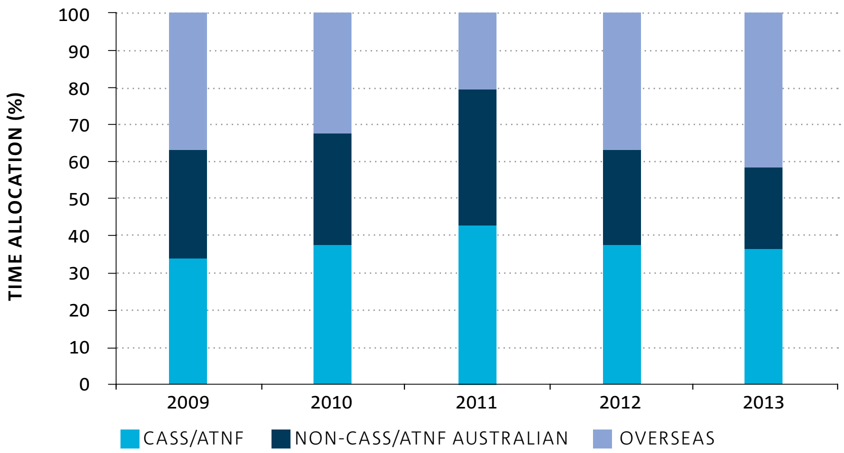


FIGURE 2:
Parkes time allocation by primary investigator, October 2008 – September 2013. For each year the time allocation is for 12 months from October to September.

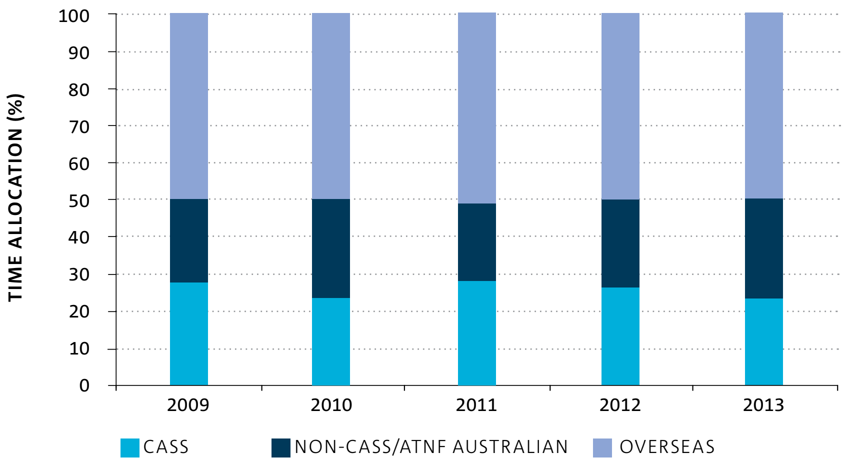


FIGURE 3:
Compact Array time allocation by all investigators, October 2008 – September 2013. For each year the time allocation is for 12 months from October to September.

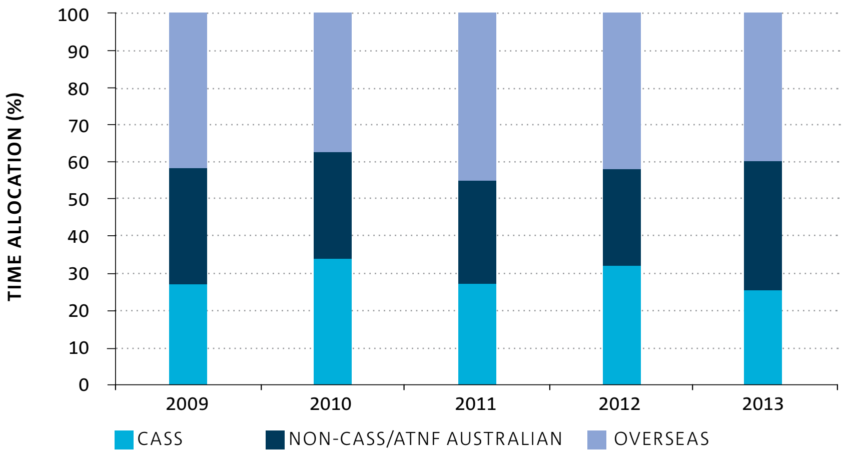


FIGURE 4:
Parkes time allocation by all investigators October 2008–September 2013. For each year the time allocation is for 12 months from October to September.

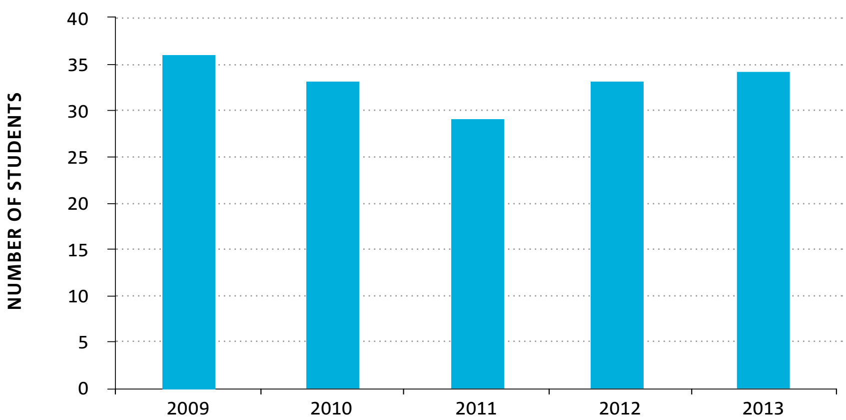


FIGURE 5
Numbers of postgraduate students affiliated with CASS.

formation, ISM, Magellanic Clouds, cosmic magnetism) and cosmological science. The research programs involve astronomers from many institutions in Australia and overseas. The proposals received each semester typically include about 600 authors: about 50 are from CASS, 80 are from other Australian institutions and 470 are from 175 overseas institutions, in 26 countries. The three countries with the greatest numbers of proposers are the USA, UK and Germany.

TEACHING

As of December 2013, 34 PhD students were being co-supervised by CASS staff. Their affiliations and thesis titles are given in Appendix E. Ten students were awarded PhDs during the year: their theses are listed in Appendix F.

Figure 5 shows the numbers of PhD students affiliated with CASS. Figure 6 shows the institutions at which CASS-affiliated students were enrolled in 2013. More than half the students came from just five institutions: the Universities of Sydney, Tasmania, and Western Sydney, and Swinburne and Macquarie Universities.

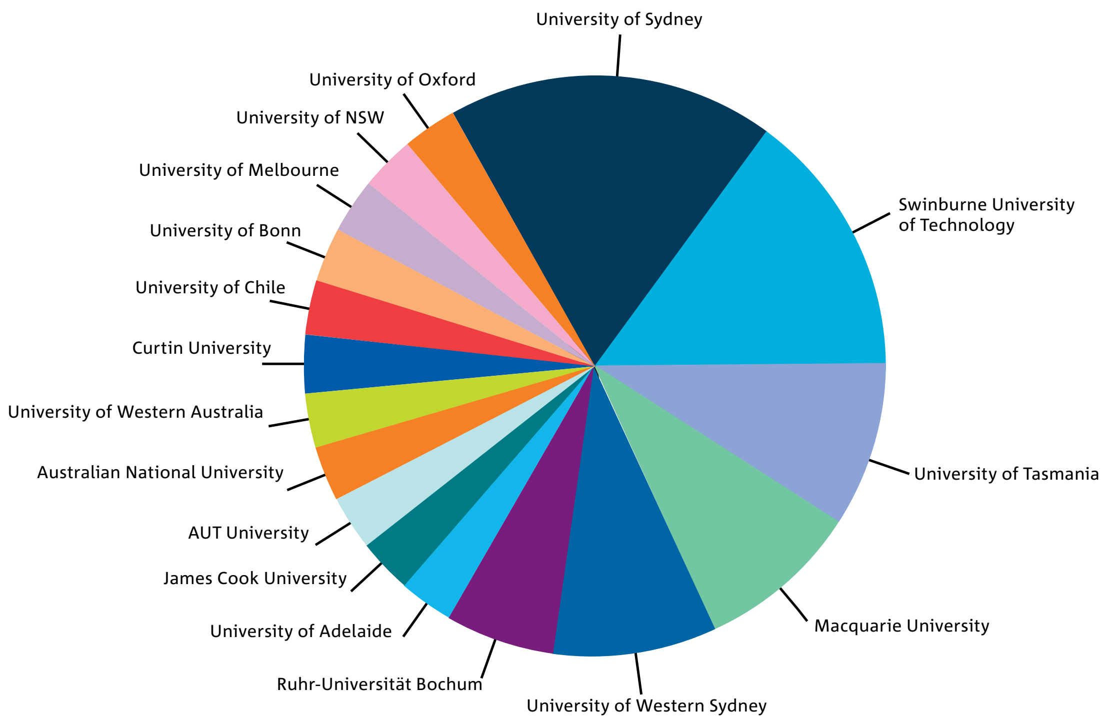


FIGURE 6:
Postgraduate student affiliations 2013.

PUBLICATIONS AND CITATIONS

Figure 7 shows the number of publications in refereed journals that include data from, or related to, ATNF facilities — the Compact Array, Mopra, Parkes, VLBI and Tidbinbilla. The count includes publications relating to the scientific goals or development of ASKAP but not IAU telegrams, abstracts, reports, historical papers or articles for popular magazines. This year 146 papers using data from the National Facility were published in refereed journals. Sixty-three per cent included a CASS author or authors.

Refereed publications by CASS staff, including scientific papers with data from other facilities, have increased year by year, from 101 papers in 2008 to 183 papers in 2013. In total, 236 refereed papers — both those using National Facility data and other papers by CASS staff — were published during the year. They are listed in Appendix G, which also lists 45 conference papers that were either derived from ATNF facilities or include CASS authors.

Figure 8 shows publication numbers for each facility. A small number of papers with data from more than one facility are counted more than once. For the Compact Array the high number of publications evident in 2012 (76) is again seen in 2013 (77). For Mopra the number of refereed publications (23) is the highest to date for any year of its operation: these papers include two in *Nature*.

The ATNF is both cost-effective and scientifically productive. In 2013 six National Facility papers were published in the highly cited journals *Nature* and *Science*. Previous studies have found that the ATNF is ranked second in the world behind NRAO in terms of total number of refereed publications: the Compact Array and Parkes rank second and third respectively in the world in terms of total number of citations to refereed papers (Trimble and Ceja 2008, *Astron. Nachr.* 329, 632–647). In terms of citations per paper, Parkes is the second-most highly cited radio telescope in the world in its class after the Ryle telescope (which has a higher citation/paper ratio but a significantly smaller total number of papers than Parkes). Astronomy leads Australian science as a discipline of international standing and has a very high level of international collaboration.

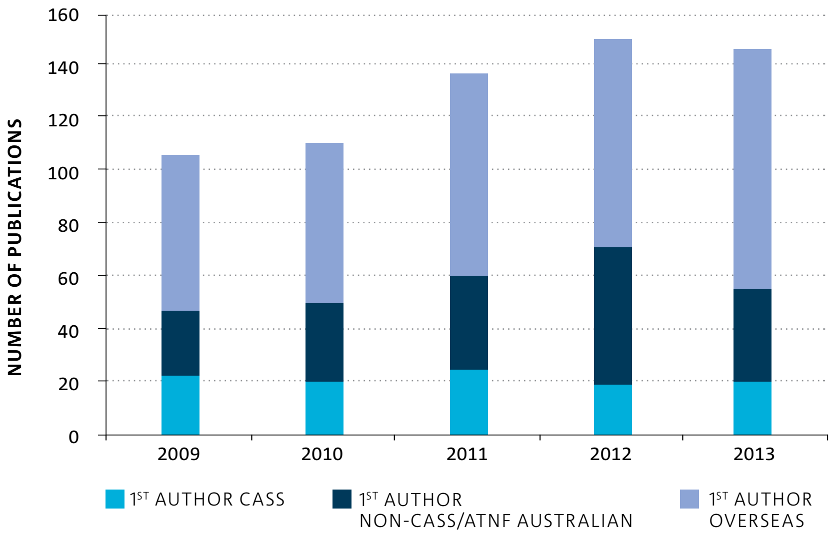


FIGURE 7:
Publications that include data from, or are related to, ATNF facilities (Compact Array, Mopra, Parkes, VLBI, Tidbinbilla and ASKAP), published in refereed journals.

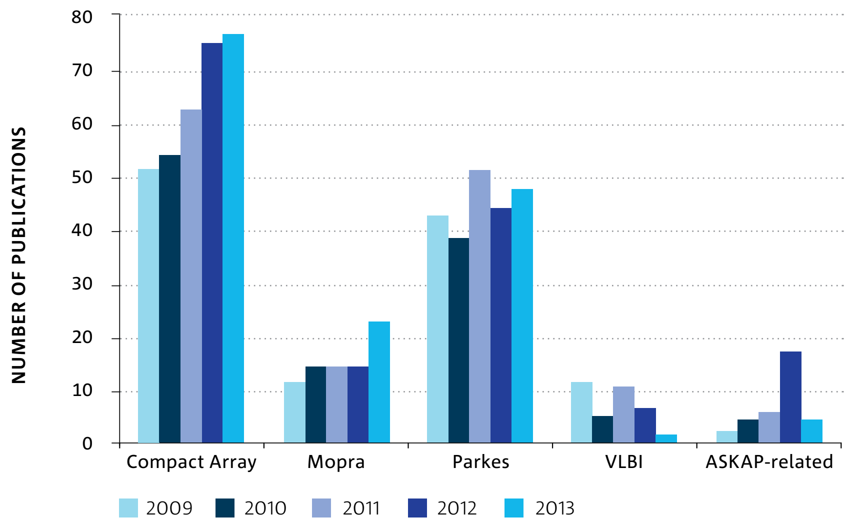


FIGURE 8:
Publications that include data from, or are related to, the Compact Array, Mopra, Parkes, VLBI and ASKAP in 2009–2013.

Across CSIRO, publications performance is now measured by the 'new Crown Index'. This is the average number of citations per paper, normalised to a baseline determined from the global average for all publications in a similar set of journals. (In astronomy the baseline is determined from papers published in refereed journals.) For CASS staff papers published between 2008 and 2012 the new Crown Index, calculated over 687 refereed publications, has an average value of 1.9. This means that on average, papers published by CASS staff (including papers with National Facility data) receive almost twice as many citations per paper as the global average for refereed astronomy papers.

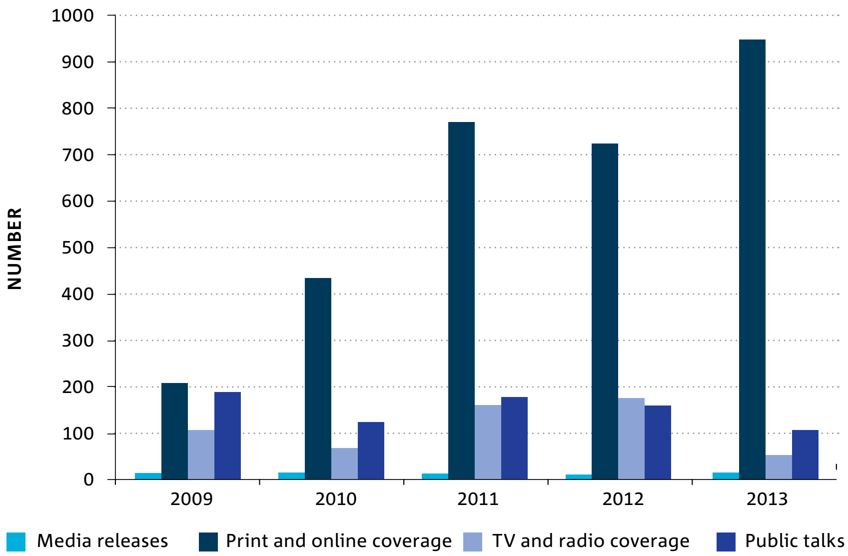


FIGURE 9:
ATNF public relations activities.

PUBLIC RELATIONS

Figure 9 shows the count of public-relations activities for the years 2009–2013. During 2013 CASS issued 14 media releases related to radio astronomy (listed in Appendix H), and featured in at least 948 print and online articles and 50 radio and television segments. The latter figure represents a significant drop on the previous year, for reasons that are not readily apparent. (These numbers exclude coverage of CDSCC activities.) CASS staff delivered at least 108 talks during the year to the general public, amateur astronomers, and education and industry audiences.

In 2013 there were over one million 'visits' (67 million 'hits') to the central ATNF website (www.atnf.csiro.au) and approximately 360,000 visits (9 million hits) to the outreach and education website. CASS also contributed to the central CSIRO website (www.csiro.au) and to CSIRO's social media channels: Facebook, Twitter and the Universe@CSIRO and News@CSIRO blogs.

The number of visitors to the Parkes and Narrabri visitors centres is discussed under 'Outreach and Education' on page 46.

USER FEEDBACK

Observers using the Parkes, Compact Array and Mopra telescopes are asked to complete a user-feedback questionnaire with responses on a scale of 0 (low) to 10 (high) and an optional section for comments. In recent years fewer observers have been completing the questionnaires and, when prompted, often provide a few comments but no grades on the individual items. While comments cannot quantitatively be compared from year to year, generally the most useful feedback is obtained when observers spell out their issues and concerns rather than give a score.

Figures 10 and 11 show the results of user feedback questionnaires (from 2011 to 2013) for Parkes and the Compact Array, respectively. Table 2 indicates the average user responses for 2011–2013.

Feedback from Parkes observers in 2013 was similar in many categories to that of 2012. However, several of the computing categories had noticeably lower scores. These are partly attributable to issues experienced in the early days of remote observing. The biggest decrease in grade occurred for 'freedom from radio interference': the 20-cm band in particular has been increasingly affected by signals from satellites and other airborne sources. Although not enough responses were received to provide a statistically meaningful grade for the Observatory library, one observer noted that "[w]e needed access to a number of obscure tomes and were able to find them in the library, so we appreciate that very much."

Figure 11 shows that in 2013 the feedback from observers using the Compact Array was generally consistent with, and in many cases slightly better than, that given in 2012. There were not enough responses to determine significant grades for UNIX computing facilities or visitor administration support.

With the change to the way Mopra is operated, fewer Mopra observers visited Narrabri or the Science Operations Centre in Sydney. NAOJ, UNSW and University of Adelaide users were not required to complete the observer questionnaires, but at the end of the observing season these funding partners indicated a high level of satisfaction.

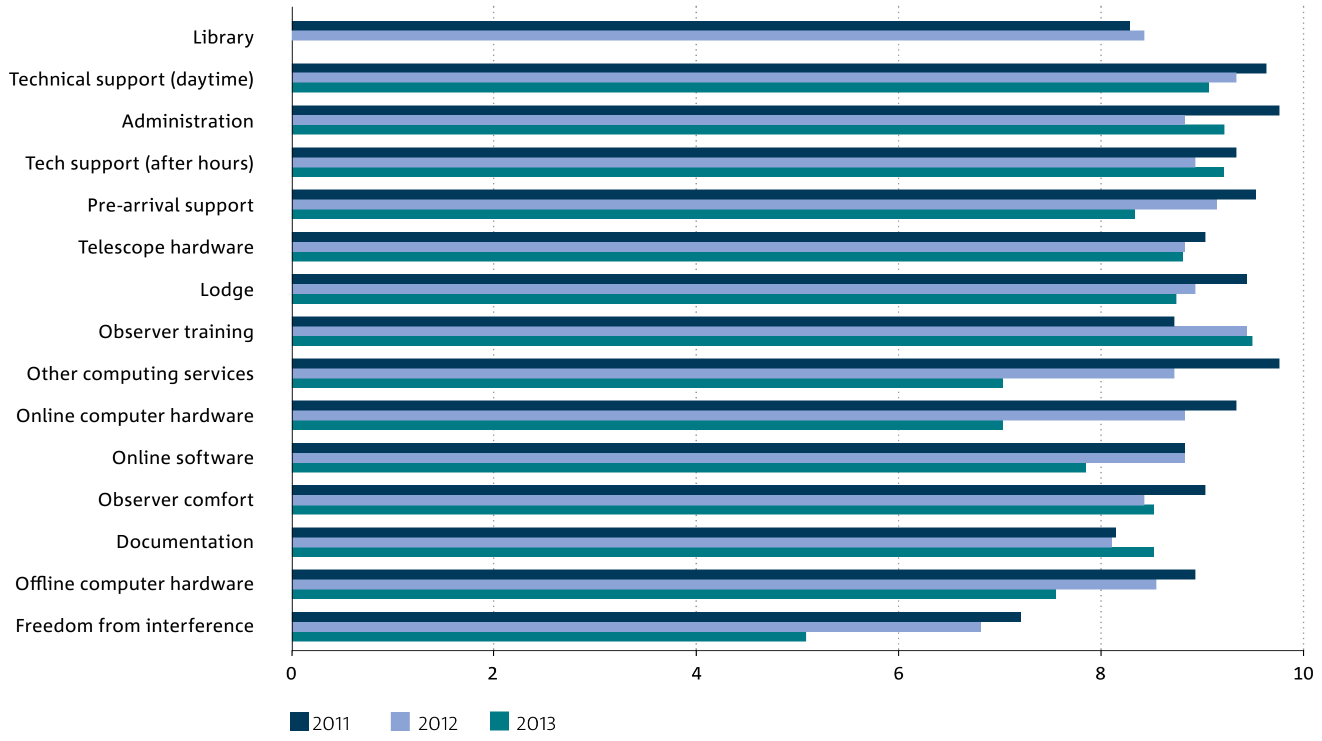


FIGURE 10:
Parkes user feedback on a scale of 1 (poor) to 10 (excellent).

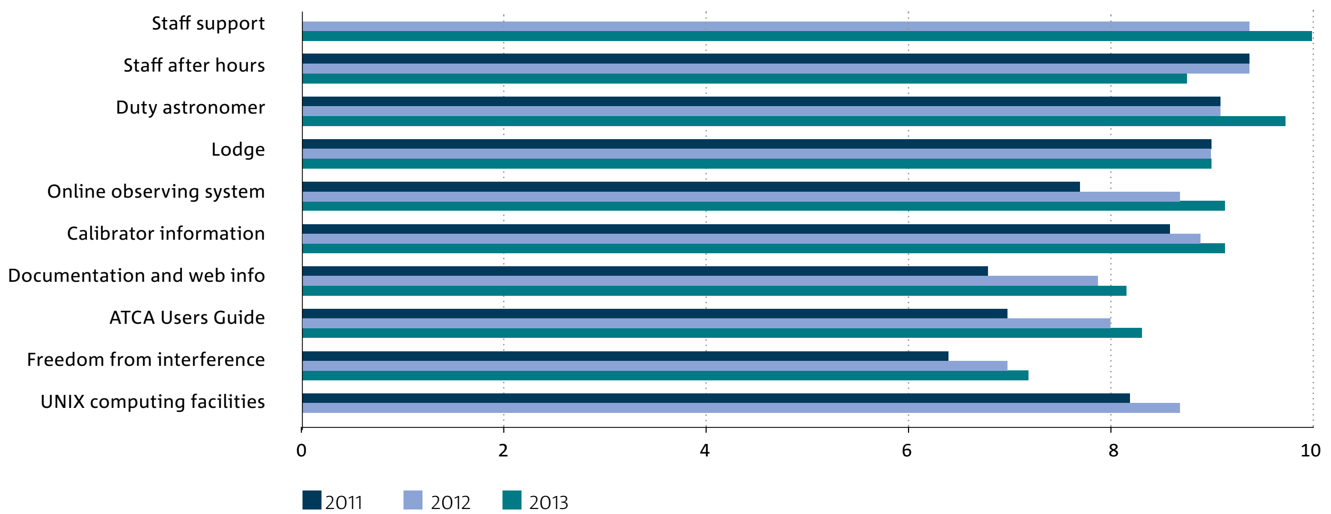
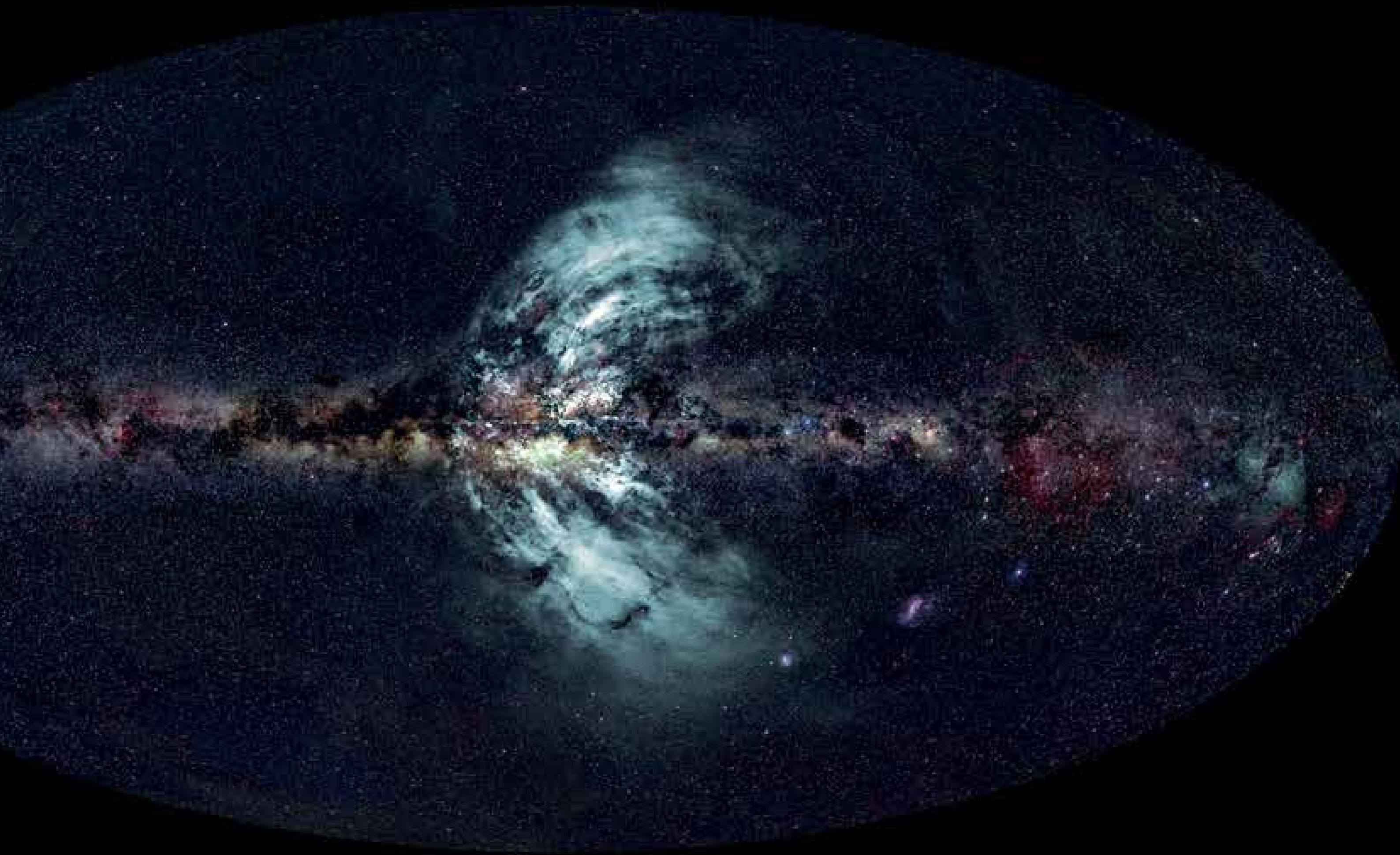


FIGURE 11:
Compact Array user feedback on a scale of 1 (poor) to 10 (excellent).

TABLE 2:
Average user feedback score on a scale of 1 (poor) to 10 (excellent) for 2011–2013.

TELESCOPE	2011	2012	2013
Parkes	9.0	8.6	8.3
ATCA	8.3	8.7	8.9



Astrophysics

Radio-emitting outflows (pale blue) emerging from the
Galactic Centre, mapped with the Parkes telescope. The background
image is the whole Milky Way at the same scale.
The observations were the subject of a *Nature* paper in January 2013.
Credits: Ettore Carretti, CSIRO (radio image); S-PASS survey team
(radio data); Axel Mellinger, Central Michigan University (opticalimage);
Eli Bressert, CSIRO (composition).

Astrophysics

“Maximum scientific impact is delivered by targeting the highest priority science questions.”

OVERVIEW

The CASS Astrophysics Group is a vibrant research body with a wide range of expertise and technical knowledge in radio astronomy and associated techniques. It consists of postgraduate students, postdoctoral staff and Australian Research Council (ARC) Fellows, permanent staff and retirees. The group members have a broad range of interests: this is important for the support they can give to the non-CSIRO user community, and the very diverse range of projects run on ATNF telescopes. Maximum scientific impact is delivered by targeting the highest priority science questions. Publication output remains high. (For more information on CASS staff publications, see page 19 of the ‘Performance Indicators’ chapter.) The Astrophysics Group provides significant support to the National Facility through the Parkes and Compact Array forums and as members of the ASKAP Commissioning team.

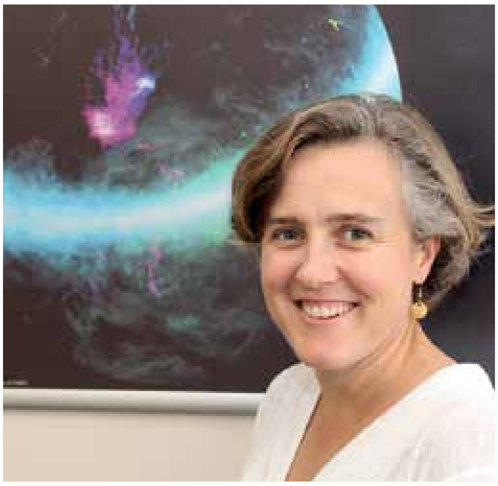
STAFF CHANGES

During 2013 we welcomed Ian Heywood as an indefinite staff member. Ian was previously part of the SKA group at the University of Oxford. His expertise in AGN and galaxy evolution is complemented by his in-depth knowledge of calibration and imaging of radio data. He will be a key person in the ASKAP commissioning team. In addition to Ian, six new postdoctoral fellows joined the group. CSIRO Office of the Chief Executive Fellows Megan Johnson (working on WALLABY and dwarf-galaxy evolution), Matthew Kerr (pulsars, both radio and gamma-ray), Amy Kimball (multiwavelength AGN) and Paolo Serra (WALLABY and galaxy evolution), Australis Fellow Laura Gomez-Gonzalez (high-mass star formation), and Bolton Fellow Joanne Dawson (interstellar medium of the Milky Way) have all made excellent starts to their time at CASS. Meanwhile, departures included OCE postdocs Mike Keith (to the University of Manchester), Bjorn Emonts (to the University of Madrid), Russell Jurek (to industry), Bolton Fellow Eli Bressert (to industry) and ARC Fellow Jimi Green (to the SKA Office in Manchester).

AWARDS

Staff received a number of awards during 2013:

- Julie Banfield received the Ruby-Payne Scott Award. The award provides support to researchers to re-establish themselves after returning from extended maternity leave.
- Naomi McClure-Griffiths received CSIRO's Newton Turner Award to assist in her professional development. Some of the funds were put towards the ‘Phase Transitions in the Diffuse ISM’ meeting in November.
- Ivy Wong and Ray Norris both received significant CSIRO funding (from the ‘Cutting Edge Science Symposia Awards’) for major international conferences. Ivy used her funding to organise the ‘Evolutionary Paths in Galaxy Morphology’ meeting in September. Ray’s funds went towards the ‘Astroinformatics 2013: Knowledge from Data’ meeting in December.



Naomi McClure-Griffiths, winner of CSIRO’s Newton Turner Award in 2013.

Participants of the 'Evolutionary Paths in Galaxy Morphology' meeting, held at Sydney's Powerhouse Museum in September. Credit: Rob Hollow

Participants of the 'Astroinformatics 2013' workshop, organised and hosted by the ATNF in December. Astroinformatics is a new discipline that has emerged at the intersection of astrophysics and applied computer science and engineering: the workshop was held to promote cross-disciplinary collaborations.

The Astrophysics Group will continue to contribute strongly to the development of the ATNF, and of the Australian astronomical community. It will, for instance, play a large part in the scientific commissioning of the Australian Square Kilometre Array Pathfinder — an exciting phase for the project and an excellent learning opportunity for our postdoctoral staff. Astrophysics staff have also been involved in recent upgrades to the Compact Array, and the planning for proposed upgrades at Parkes. Finally, the ramping up of the SKA activities, including the production of a new science case, and the development of the next decadal plan for Australian astronomy, will also require significant contributions from the Astrophysics Group in 2014.

GRADUATE STUDENT PROGRAM

Astrophysics staff continue to co-supervise PhD students enrolled at Australian and overseas universities. The program helps strengthen training in radio-astronomy techniques, and furthers collaborations between CSIRO and universities. In December, there were 34 PhD students affiliated with CASS: they are listed in Appendix E. Ten students completed their PhDs during the year: these are given in Appendix F.

SCIENTIFIC VISITORS PROGRAM

CASS has a scientific visitors program that provides some financial and other support to facilitate visits from researchers for extended periods (from several weeks to a year). During 2013 the Astrophysics Group hosted month-long visits from 11 visitors from around the world. In addition, Jim Jackson (Boston University) joined the group in September for a one-year sabbatical, part-funded by a CSIRO Distinguished Visitor Award. Jim is working with the star-formation group at CASS, in particular on the MALT90 survey and related projects.

"In September 2013, we celebrated 25 years of the Compact Array in Narrabri..."

CONFERENCES AND WORKSHOPS

Astrophysics staff and collaborators organised and hosted a large number of conferences and workshops in 2013. In addition to the international meetings described above, we also hosted the 'Neapolitan of Masers: Variability, Magnetism and VLBI' meeting in Marsfield in May. The third Australian ALMA community workshop was held in Marsfield in October to bring the community up to speed with tools and techniques in advance of a further call for ALMA proposals. The 'Bolton Symposium', held jointly with the Australian Astronomical Observatory over two days in December, showcased the work of early career researchers.

In September 2013, we celebrated 25 years of the Compact Array in Narrabri with a public open day on 1 September (attended by more than 800 visitors), and a formal marquee event on 2 September followed by a three-day science symposium. The first morning of the symposium was given over to the people who had turned the Compact Array into reality, including Bob Frater (Project Leader), John Brooks (Project Engineer), Mal Sinclair (front ends) and Warwick Wilson (back ends). In addition we heard a summary of telescope upgrades over the past 25 years from Mark Bowen. Following lunch the science talks began, covering all the major fields of research that the Compact Array has contributed to, including studies of HI, the Magellanic Clouds, masers, gamma-ray bursts, supernovae, star formation, intra-day variability, active galactic nuclei, pulsars, and stellar clusters; the techniques of polarimetry and VLBI; and surveys large, deep and wide. It was striking to hear the enthusiasm for the Compact Array and its capabilities from the current generation of PhD students.

Dr Bob Frater (who led the Compact Array's construction) cutting the telescope's birthday cake during a celebration of its 25th anniversary on 2 September.

SCIENCE HIGHLIGHTS

The reports that follow describe a few of the many projects carried out by Astrophysics Group staff and other users of ATNF facilities in 2013.

The Milky Way lobes: giant magnetised outflows from the centre of the Galaxy

Ettore Carretti (CASS), on behalf of the S-Pass team

The S-band Polarisation All Sky Survey, carried out with the Parkes telescope, has revealed giant, magnetised gas outflows from the Galactic Centre that closely match the 'Fermi Bubbles'.

Polarised radio emission is a powerful tool for investigating the large-scale structure of our Galaxy. Uncontaminated by free-free emission, it reveals only the synchrotron component emitted by ordered magnetic fields.

Using the Parkes telescope we have conducted a polarisation survey at 2.3 GHz, the S-band Polarisation All Sky Survey (S-PASS). This has revealed a huge structure emerging from the very centre of our Galaxy, the Milky Way lobes (Figure 1 and Carretti *et al*. 2013). The lobes are giant, magnetised gas outflows from the Galactic Centre. They rise up ~8 kpc on either side of the Galactic plane, up to $|b|$=60°. Stretching for a total 120°, they constitute the largest structure ever found in the Galaxy after the Galactic disk itself.

The lobes are nearly symmetrical, bending westward at the top corners. They closely match an equivalent structure in γ-rays, the so-called Fermi Bubbles (Su *et al*. 2010), but extend further at the top-west corners. The mechanism generating the Fermi Bubbles has been hotly debated, the two favourite models being star formation in the Galactic Centre and quasar-like activity of the supermassive central black hole (Su *et al.* 2010, Crocker and Aharonian 2011). Our findings contribute to this debate.

The lobes have substructures. Three ridges corkscrew on their surface and one of them, the Galactic Centre Spur, seems to connect with the Galactic Centre. This structure has been reported in the past as a feature in Stokes I images (Sofue *et al*. 1989), and its nature has been long debated. The other two ridges, previously unreported, have been named the Southern and Northern Ridges. The Northern Ridge runs parallel to the Galactic Centre Spur, but at a higher elevation from the plane. The Southern Ridge possesses a similar curvature, and lies south of the Galactic Plane, at a distance intermediate between that of the other two ridges.

The lobes' emission has a polarisation fraction of about 25 per cent, indicating a highly ordered magnetic field. The field is aligned with the ridges and has an intensity of 6–12 μG in the lobes and ~15 μG in the ridges.

The lobes were discovered thanks to the high frequency of S-PASS. At 1.4 GHz the Galactic emission is strongly depolarised at latitudes lower than $|b|$=30° because of Faraday-rotation effects that hide the Galactic disk. At 2.3 GHz these effects are weaker and the disk is visible to within a few degrees of the Plane.

However, there is an important exception: two large depolarisation areas on either side of the Galactic Centre extend up to $|b|$ ~10° and

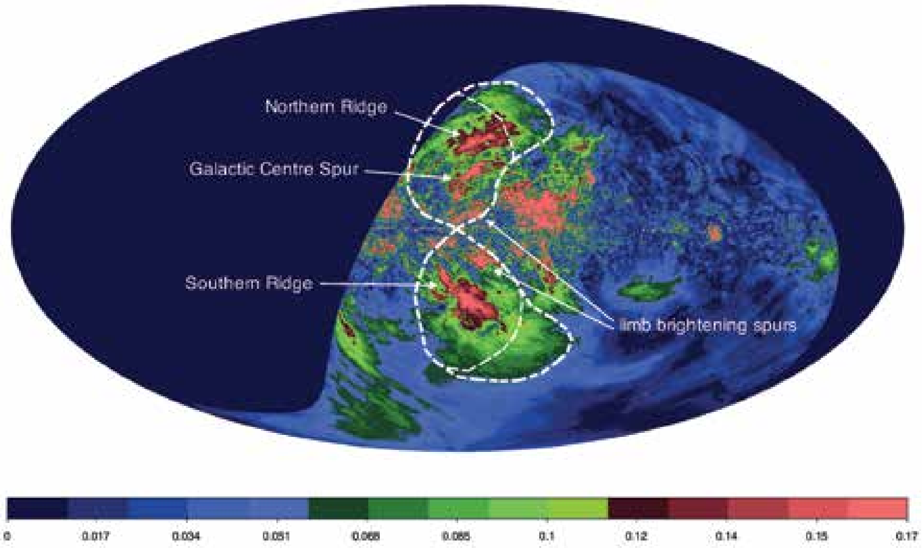


FIGURE 1:
Polarised-intensity image at 2.3 GHz of the S-PASS survey, showing the lobes of radio emission emerging from the Galactic Centre. The lobes' edges are indicated by the thick dashed line, and the limits of the γ-ray Fermi Bubbles by the thin dashed line. The map is in Galactic coordinates centred at the Galactic Centre. Units are Jy/beam. (Figure from Carretti *et al*. 2013).

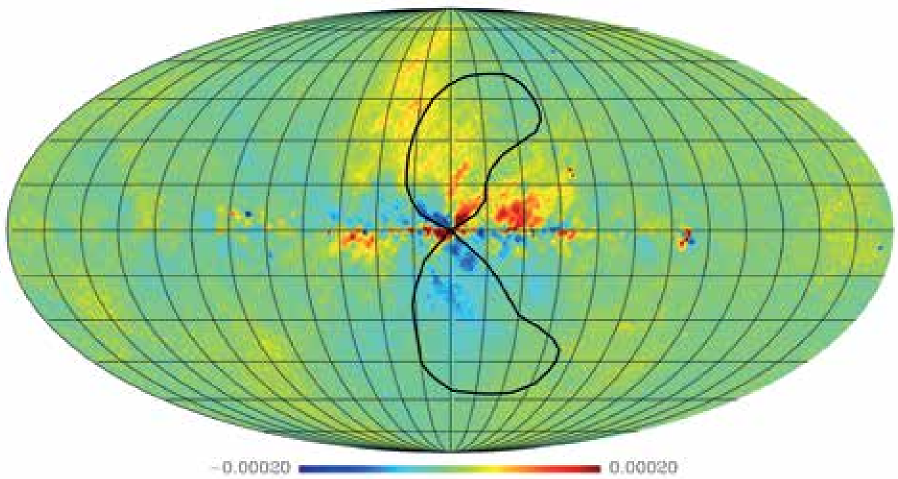


FIGURE 2:
Stokes U emission at 23 GHz from the WMAP data. The 23 GHz polarised emission is mostly unaffected by Faraday Rotation effects and reveals the polarised emission down to the Galactic Plane. Most of the disc emission is on Stokes Q, and Stokes U gives a clearer view of the hourglass X-shaped base of the lobes. (Figure from Carretti *et al*. 2013).

hide the Galactic-Plane ends of the lobes. Our analysis shows that Hα regions are responsible for this depolarisation. Most of them are 1.5 to 2.5 kpc from us in the Sagittarius spiral arm; some are at 3.5 kpc in the Scutum arm. This rules out the lobes being local structures, and sets their front surfaces beyond the Sagittarius arm at a minimum distance of 2.5 kpc. Their rear surfaces are at least 5.5 kpc distant — that is, in the Galactic bulge.

A similar argument holds for the Galactic Centre Spur, setting a lower limit of 2.5 kpc on its distance from us. Sofue *et al*. (1989) were the first to propose that this structure originates in the Galactic Centre, but we can now prove for the first time its non-local nature, and make the association to the Galactic Centre compelling.

The base of the lobes can be viewed at the higher frequency of 23 GHz through the WMAP data (Hinshaw *et al*. 2009). This reveals an hourglass-shaped base that connects back to the Galactic Centre area (Figure 2). This X-shaped structure has counterparts in X-ray and γ-ray emission (Su *et al*. 2010, Bland-Hawthorn and Cohen 2003).

The Galactic Centre area hosts the Central Molecular Zone, the most active star-formation region in the Milky Way. It is a warped gas ring circling the Galactic Centre at a distance of ~80 pc, and within it there is ~0.1 M_{SUN} of star formation per year — about 10 per cent of the star formation of the entire Galaxy. An unresolved issue is the deficit of synchrotron emission in this area, which is more than an order of magnitude lower than that which would be expected from the region's infrared luminosity and star-formation rate. So synchrotron emission must have been generated here and then transported away. But to where?

The integrated synchrotron emission we measure in the lobes equals the amount missing from the Galactic Centre. The synchrotron-emitting gas generated in the Galactic Centre is advected into the halo as outflows and forms the radio lobes we observe. The outflows originate in the Central Molecular Zone and their base rotates with it — clockwise as observed from Galactic north. Moving on their conical base, the outflows bend westward because of angular momentum conservation, creating the winding substructures we observe. The energy contained in the lobes, in the form of magnetic fields and cosmic rays, is enormous — of the order of 10^{56} erg. This corresponds to the energy liberated by a few hundred thousand supernovae, which would be consistent with the stellar production of the Central Molecular Zone over a hundred million years — our estimate for the age of the lobes.

From our observations, we also derive a vertical velocity for the lobes of ~1100 km/s. This assumes that the gas takes about 10 million years — the lifetime of synchrotron-emitting electrons at 2.3 GHz — to reach the top of the lobes. The frequency spectral index we measure steepens from the base to the top of the lobes (-1.0 to -1.2). This is indication of an electron population aging with the distance from the Plane, again consistent with the gas outflows originating at the Galactic Centre.

In summary, all our results strongly suggest that the outflows arise from star-formation at the Galactic Centre. And they raise an additional, intriguing possibility. The lobes transport a strong magnetic field and a huge amount of magnetic energy into the Galactic halo. Could they be generating the halo's magnetic field, unexplained until now?

References

Bland-Hawthorn, J.; Cohen, M. ApJ, 582, 246 (2003)

Carretti, E.; Crocker, R.M.; Staveley-Smith, L.; Haverkorn, M.; Purcell, C.; Gaensler, B.M.; Bernardi, G.; Kesteven, M.J.; Poppi, S. Nature, 493, 66 (2013)

Crocker, R.M.; Aharonian, F. PRL, 106, 101102 (2011)

Hinshaw, G. *et al.* ApJS, 180, 225 (2009)

Sofue, Y.; Reich, W.; Reich, P. ApJL, 341, L47 (1989)

Su, M.; Slatyer, T.R.; Finkbeiner, D.P. ApJ, 724, 1044 (2010)

Pushing the redshift boundary of neutral-hydrogen detection with stacking

Jacinta Delhaize (ICRAR/UWA), Lister Staveley-Smith (ICRAR/UWA/CAASTRO), Martin Meyer (ICRAR/ UWA/CAASTRO), Brian Boyle (CAASTRO)

Using data collected with the Parkes radio telescope, we have achieved strong 'stacked' detections of the 21-cm emission of neutral atomic hydrogen gas (HI) in field galaxies out to z = 0.13 and examined the evolution of the cosmic HI mass density.

To understand the processes involved in galaxy formation and evolution we need to survey large samples of galaxies over a range of redshifts. Such surveys are often limited by the sensitivity of current telescopes. For example, studies of HI, the primary fuel for star formation, are still largely restricted to the local Universe because of the difficulty of detecting the relatively weak 21-cm emission line.

To push the redshift boundary of HI emission studies, and so learn more about the evolutionary trends of this fundamental component, we can use the technique of 'stacking'. This is the process of combining the weak signals of many individual galaxies so as to increase the signal-to-noise ratio and allow a strong statistical detection.

Using the Parkes radio telescope, we conducted a 52-hour blind survey of 21-cm emission at $0.04 < z < 0.13$ over a field of 42 square degrees. This field contains 3,277 galaxies for which there are spectroscopic data from the Two-Degree Field Galaxy Redshift Survey (2dFGRS; Colless *et al*. 2001). HI 21-cm emission was directly detected in only one of these galaxies, one with a redshift of 0.05. Nonethless, valuable information on the average HI properties of the overall galaxy population at these redshifts can be determined via stacking.

We first extracted the HI spectrum at the position of each galaxy in the 2dFGRS catalogue. Using the 2dFGRS redshifts, we then translated each spectrum to rest-frame. Taking the mean of these aligned spectra produced the stacked, or 'co-added' spectrum. Figure 1 illustrates how the rms noise level of the stacked spectrum decreases with the square root of the number of co-added spectra, eventually revealing a statistical detection.

By stacking the HI spectra of all 3,277 galaxies we found a strong, 12-σ detection, shown in Figure 2. We estimate that, without stacking, 888 hours (37 days) of integration time would have been required to achieve this signal-to-noise ratio. Stacking is clearly an efficient method of detecting higher-redshift objects than would otherwise be possible.

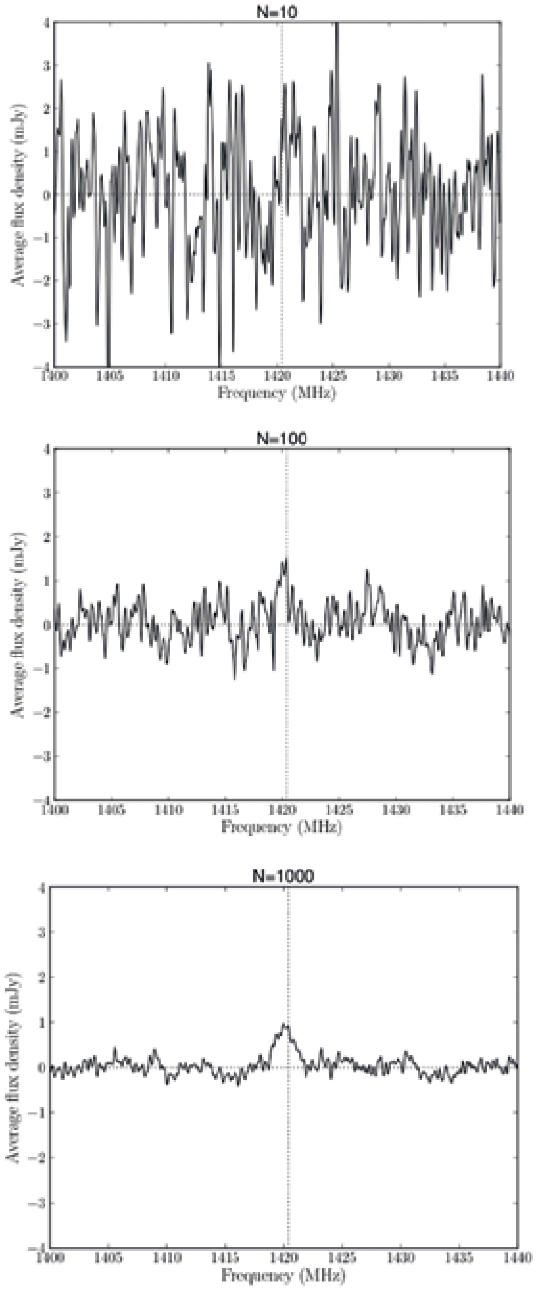


FIGURE 1:
The resulting shape of the co-added HI spectrum when N galaxies are stacked, for three values of N.

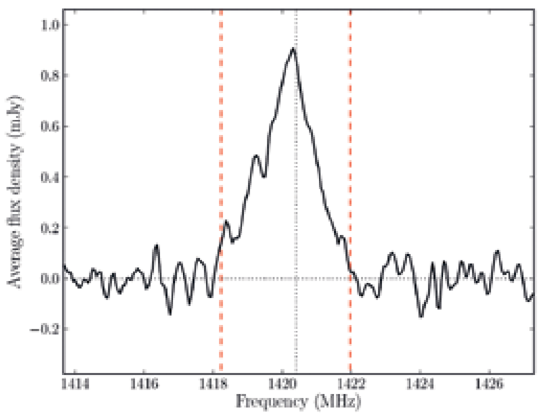


FIGURE 2:
The stacked HI spectrum of 3,277 galaxies with 2dFGRS redshifts at $0.04 < z < 0.13$. The red dashed lines indicate the nominal bounds of the statistical detection.

Using the integrated flux from the final stacked spectrum, we derived the average HI mass of our sample of 2dFGRS galaxies. We then converted this into a measurement of the cosmic HI mass-density (Ω_{HI}). To produce a low-redshift measurement for comparison, we also stacked the HI spectra of 15,093 2dFGRS galaxies at z < 0.04, using 21-cm data from the HI Parkes All Sky Survey (HIPASS).

Our lower- and higher-redshift measurements of Ω_{HI} are shown in Figure 3, together with other observational points and predictions based on simulations. At z ≈ 0, measurements of Ω_{HI} are derived from widefield 21-cm surveys. At higher redshift one can use indirect HI-detection methods, such as damped Lyman-α absorption in QSO spectra. For intermediate redshifts, statistical methods such as stacking and intensity mapping are valuable.

Despite the significant evolution in the star-formation-rate density (Hopkins and Beacom, 2006) and the corresponding build-up of the stellar-mass density (Wilkins *et al*. 2008) over the past ~2 Gyr, we find no evolution in Ω_{HI} over this cosmic time. This is in close agreement with the other measurements and semi-analytical models. Full details of this work can be found in Delhaize *et al*. (2013).

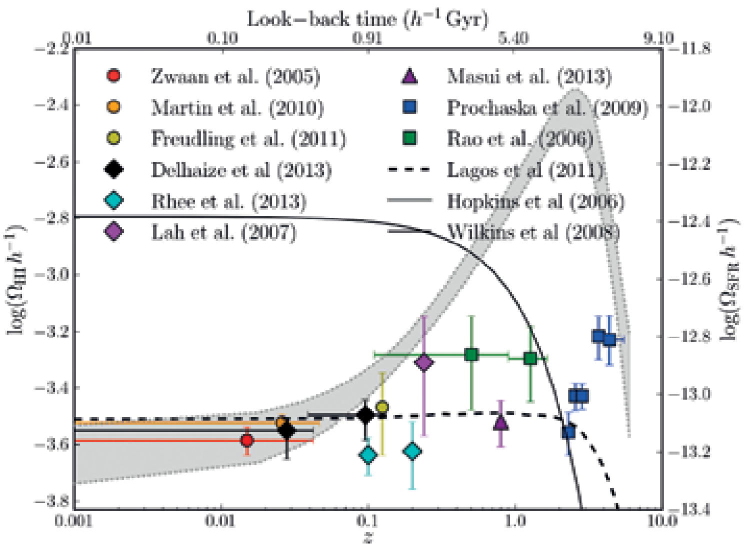


FIGURE 3:
The evolution of the cosmic HI mass density (Ω_{HI}). Observational measurements shown by circles were derived via direct 21-cm detections, diamonds via 21-cm stacking, the triangle via intensity mapping and squares via damped Lyman-α signatures. Our values are shown in black. The dashed line shows the prediction of semi-analytical simulations. For comparison, the grey shaded region shows the evolution of the cosmic star-formation rate density and the solid black line shows the cosmic stellar-mass density.

With stacking we can sample a significantly larger volume of space than with any other technique. Our values will therefore be the least influenced by cosmic-variance bias.

We chose to survey a relatively large field to maximise the number of galaxies available for stacking and to sample a large space volume. The Parkes telescope proved excellent for this, thanks to the rapid survey speed provided by the large instantaneous field-of-view of the multibeam receiver. These survey capabilities will be further improved with the recently installed HI-Pulsar (HIPSR) spectrometer, which provides a wider bandwidth at higher resolution and greater immunity to radio-frequency interference. However, the large primary beam of Parkes also results in a high level of source confusion in our data, which had to be corrected for in our calculation of Ω_{HI}.

Future HI surveys with ASKAP, such as WALLABY and DINGO, will be superb for such stacking experiments. The advanced phased array feed technology of ASKAP will simultaneously provide a large field-of-view (and therefore fast survey speeds) as well as a fine angular resolution (minimising confusion). Stacking data from WALLABY and DINGO should allow the statistical detection of HI in many galaxies out to z ≈ 0.4.

References

Colless, M. *et al*. MNRAS, 328, 1039 (2001)

Delhaize, J.: Meyer, M.J.; Staveley-Smith, L.; Boyle, B.J. MNRAS, 433, 1398 (2013)

Freudling, W. *et al*. ApJ, 727, 40 (2011)

Hopkins, A.; Beacom, J. ApJ, 651, 142 (2006)

Lagos, C. *et al*. MNRAS, 418, 1649 (2011)

Lah, P. *et al*. MNRAS, 376, 1357 (2007)

Martin, A. *et al*. ApJ, 723, 1359 (2010)

Masui, K.W. *et al*. ApJL, 763, L20 (2013)

Prochaska, J.X. *et al*. ApJ, 696, 1543 (2009)

Rao, S.M. *et al*. ApJ, 636, 610 (2006)

Rhee, J. *et al*. MNRAS, 435, 2693 (2013)

Wilkins, S.M. *et al*. MNRAS, 385, 687 (2008)

Zwaan, M.A. *et al*. MNRAS, 359, L30 (2005)

On-the-fly mapping with the Tidbinbilla 70-m radio telescope

Shinji Horiuchi (CASS)

We have successfully demonstrated on-the-fly mapping with the Tidbinbilla 70-m antenna, opening the way to future mapping projects.

The Tidbinbilla 70-m antenna at the Canberra Deep Space Communication Complex (CDSCC) is the most sensitive single-dish instrument in the southern hemisphere. This sensitivity has been useful in many different kinds of projects, from VLBI experiments (where it has increased imaging sensitivity) to single-dish surveys (for detecting weak sources). Recent successful single-dish projects include water maser observations toward extragalactic objects (Breen *et al*. 2013, Hagiwara *et al*. 2013) and ammonia emission-line observations toward Galactic star-forming regions (Lowe *et al*. 2013 and 2014).

Despite its superb sensitivity, the 70-metre had not been used much for mapping projects, with a few exceptions (for example, Kuiper *et al*. 1995, Purcell *et al*. 2009), because of the lack of an on-the-fly (OTF) mapping mode to allow observers to generate maps with raster scans (instead of mapping point by point). But we have now overcome this limitation.

The Tidbinbilla 70-m antenna.

The first step towards an OTF mapping system was taken in late 2010, when a CSIRO Summer Vacation Student, Tye Young from ANU, started work on a project to demonstrate the 70-metre's spectral-line mapping capability and apply the technique to observations of Galactic star-forming regions. We chose three big molecular clouds — the Orion Nebula, Sagittarius B2, and the Carina Nebula — as the targets of test observations, and were able to make ammonia molecular-line maps for all of them, with high sensitivity. Ammonia is a powerful tracer of the characteristics of molecular clouds and acts as a natural thermometer, allowing us to measure the temperature of the gas — one of the key parameters in studying star-formation activity. The Orion Nebula and Sagittarius B2 have been well studied and so are good targets for testing whether the system is working properly. The Carina Nebula contains stars in several phases of evolution and is therefore well suited to studies of star-formation and stellar evolution. Carina, however, can be only seen from the southern hemisphere, and ammonia lines had not been previously detected in this source. Using the 70-metre we were able both to make the first detection of the ammonia and to map it. Tye Young continued this project for his undergraduate Honours thesis, and his results (Young *et al*. 2013) highlight the potential of the Tidbinbilla 70-m radio telescope for sensitive large-scale mapping of ammonia.

The Carina mapping project was conducted using position-switching observations. This was appropriate for this source as the ammonia emission is very weak. Each data point was sampled with frequent position switching between 'on source' and 'off source' to subtract atmospheric and instrumental effects: integration was for a total of eight minutes for each position. We mapped a 2.5 x 4.5 arcminute field over a total of 15 hours. However, for stronger sources and a wider field, the OTF mapping method, sampling data during a raster scan, would be ten times more efficient.

Graeme Wong from the University of Western Sydney worked with us recently to develop the Tidbinbilla OTF as part of his PhD project. To implement raster scan observations he modified the existing spectral-line observing program. We conducted test observations, at 8 GHz, of hydrogen recombination lines, using the Parkes multibeam correlator. The OTF observation data were calibrated and mapped with the software packages ASAP and CASA, thanks to Kanako Sugimoto (ALMA/NAOJ CASA Team), who developed a script to transform the Tidbinbilla data format into one suitable for CASA. Figure 1 shows some of the first OTF maps. For the observation of the Orion Nebula in the radio-recombination line of hydrogen at 8309.37 MHz, 42 x 35 pixels were sampled over 2.4 hours, including reference point scans and overhead, with a three-second integration per point. This was a significant improvement in efficiency.

We have recently installed a new, NASA/JPL-developed, wideband K-band receiver system on the 70-m dish. This system creates an 8-GHz instantaneous band (2 beams x 2 sidebands x 2 polarisations x 1 GHz). It currently covers 21–25 GHz, but the range will be extended to 17–27 GHz. In addition, the Smithsonian Astrophysical Observatory (SAO) has funded a wideband (4 x 1 GHz) spectroscopy backend for Tidbinbilla observations. The first project to use this new backend with the K-band frontend will be the Tidbinbilla AGN Maser Survey (TAMS) project led by Lincoln Greenhill (SAO). We expect this new system will contribute to future multi-transitional OTF mapping projects as well, taking advantage of the wideband and dual-beam capability.

References

Breen, S.; Lovell, J.E.J.; Ellingsen, S.P.; Horiuchi, S.; Beasley, A.J.; Marvel, K. MNRAS, 432, 1382 (2013)

Hagiwara, Y.; Miyoshi, M.; Doi, A.; Horiuchi, S. ApJ, 768, 38 (2013)

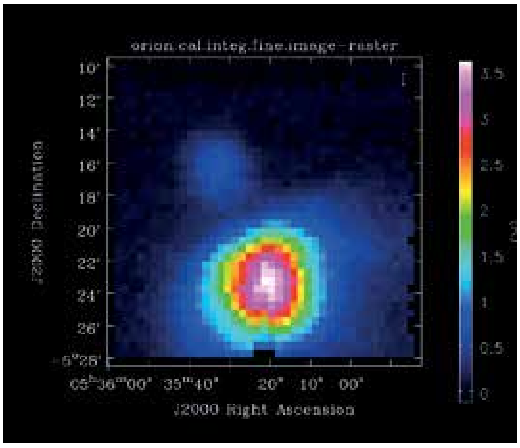
Kuiper, T.B.H; Peters, W.L., III; Foster, J.R.; Gardner, F.F.; Whiteoak, J.B. ApJ, 446, 692 (1995)

Lowe, V.; Cunningham, M.R.; Urquhart, J.S.; Horiuchi, S. IAUS, 292, 50 L (2013)

Lowe, V.; Cunningham, M.R.; Urquhart, J.S.; Marshall, J.P.; Horiuchi, S.; Lo, N.; Jones, P.A.; Walsh, A.J.; Jordan, C.H. MNRAS, 441, 256 (2014)

Purcell, C.R.; Minier, V.; Longmore, S.N.; Andre, Ph.; Walsh, A.J.; Jones, P.; Herpin, F.; Hill, T.; Cunningham, M.R.; Burton, M.G. A&A, 504, 139 (2009)

Young, T.; Horiuchi, S.; Green, J.A.; Jerjen, H. MNRAS, 435, 3568 (2013)



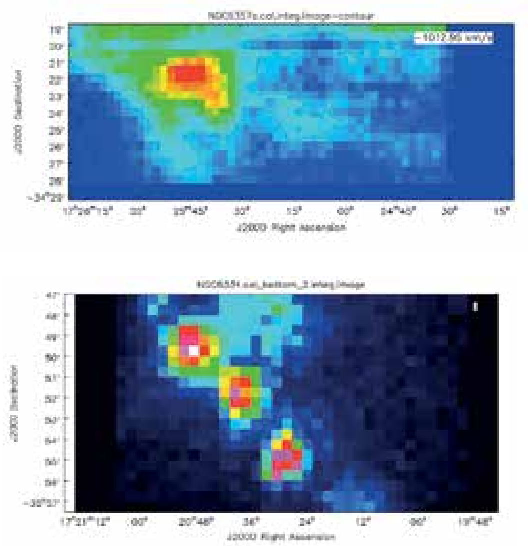


FIGURE 1:
Examples of Tidbinbilla 70-m on-the-fly mapping images: the H92 alpha radio-recombination line in three star-forming regions: Orion Nebula (above), NGC6357 (top right), NGC6334 (bottom right).

Baryons in the jets of a stellar-mass black hole

James Miller-Jones (ICRAR/Curtin)

Using a suite of telescopes including the Australia Telescope Compact Array, we have found evidence suggesting the presence of baryons in the jets from a black-hole binary.

Accreting black holes throughout the Universe are observed to launch powerful, relativistic jets, which feed energy and matter back to their surroundings. The effects of this feedback depend on the composition of the jets, as baryonic jets (those containing atomic nuclei) should contain significantly more kinetic energy than leptonic jets (those made up of electrons and positrons). But decades of study have given us only conflicting, circumstantial evidence for the composition of the jets.

X-ray binaries — stellar-mass black holes accreting matter from less-evolved donor stars — are excellent laboratories for studying jets. Their low black-hole masses imply that their occasional outbursts last for just a few weeks to months, providing us with a time-resolved view of the connection between the accretion process and the ejection of relativistic jets.

Unequivocal evidence for heavy, baryonic jets has been found in just one X-ray binary: the peculiar system SS 433, which is thought to have been persistently accreting above the theoretical maximum Eddington luminosity for the past 20,000 years. That system shows Doppler-shifted X-ray and optical line emission from atomic matter in the jets travelling at a quarter of the speed of light. Its persistent high accretion rate and the strong stellar wind of the donor star (from which the baryons could be entrained) makes it unclear whether the jets of SS 433 are representative of those powered by more typical black holes.

During a recent outburst of the black hole X-ray binary system 4U1630-47, we observed the system with the XMM-Newton X-ray telescope and detected X-ray emission lines. These we interpreted as Doppler-shifted emission from highly-ionised iron and nickel atoms (Diaz Trigo *et al*. 2013). The measured Doppler shifts of the lines (both blueshifted and redshifted) implied material travelling at 66 per cent of the speed of light, at an angle of 65 degrees to our line of sight. From the occasional dips previously detected in the X-ray light curves of the system, the inclination angle of the accretion disc is known to be between 60 and 75 degrees to the line of sight, implying that the atomic matter was moving perpendicular to the accretion disc, consistent with an origin in oppositely directed relativistic jets. With the Compact Array we detected radio emission, characteristic of synchrotron radiation from jets, simultaneous with the X-ray emission. Since all other possibilities for producing X-ray line emission could be ruled out, we inferred that the X-ray lines could be attributed to the jets, thus implying that the jets were baryonic.

An X-ray observation taken three weeks earlier had shown no evidence for emission lines, and no radio emission was detected by a contemporaneous observation with the Compact Array. The X-ray spectrum in that first observation was well fitted by thermal blackbody emission from a standard accretion disc, consistent with an accretion state in which jets are typically quenched. The reignition of the jets was accompanied by the appearance of an additional hard component in the X-ray spectrum, suggestive of the presence of a corona of hot electrons in the inner regions of the accretion flow — a feature associated with the presence of jets in the hard states of typical X-ray binaries. Thus a consistent picture emerged, with a change in the geometry of the accretion flow leading to the launching of relativistic jets containing atomic matter. The only puzzle was why such jets had not been seen in previous outbursts of this or other X-ray binary systems. One possible explanation is that they were unique to the particular, high-luminosity, 'anomalous' accretion state in which we detected the source: more recent work by Neilsen *et al*. (2014) has since shown that no emission lines were seen earlier in the same outburst, when the source was in a different accretion state. If the jet velocity or opening angle were too large (our observations restricted the jet opening angle to 3.7–4.5 degrees) the weak emission lines would become too Doppler-broadened to be detected. Thus, the details of the jet acceleration and collimation processes could determine whether or not atomic lines are detected.

The presence of baryons in the jets would imply that the jets carry away more mechanical power from the accretion flow than had been previously confirmed. Thus, they would have a more significant feedback effect on the surroundings, and the excess energy channelled outwards in the jets would cause the black hole to grow more slowly. Furthermore, if the baryons can be accelerated to speeds approaching that of light, it would imply that X-ray binary jets could be an important source of high-energy gamma rays and neutrinos, raising the prospect of detection by next-generation telescopes.

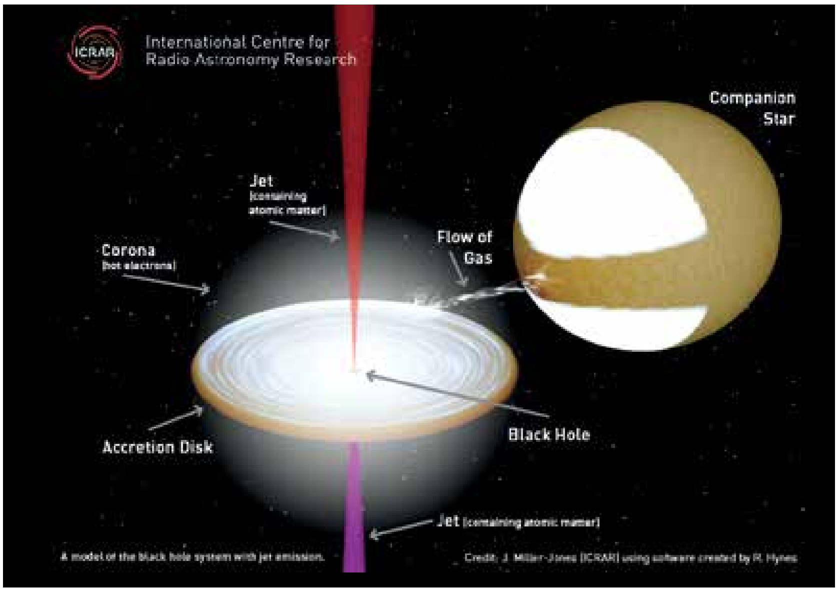


FIGURE 1:
A schematic of the X-ray binary system 4U1630-47. Gas flows from the donor star to the accretion disc, which powers the relativistic jets launched from the central regions of the accretion flow. The jets produce the radio emission detected by the Compact Array, and contain atomic matter that emits the X-ray lines detected with XMM-Newton.

Finally, a confirmation of this detection would place important constraints on the mechanism by which jets are launched. Since the accretion in 4U1630-47 is thought to occur by Roche-lobe overflow, and since the donor star in 4U1630-47 is not known to be particularly massive, it is unlikely that the baryons in the jets are entrained from the stellar wind. This would then suggest that the massive baryons may be loaded into the jets when they are launched, favouring models in which the jets are powered by the accretion disc rather than by the spin of the black hole.

References

Diaz Trigo, M.; Miller-Jones, J.C.A.; Migliari, S.; Broderick, J.W.; Tzioumis, A.K. Nature, 504, 260 (2013)

Neilsen, J.; Coriat, M.; Fender, R.; Lee, J.C.; Ponti, G.; Tzioumis, A.K.; Edwards, P.G.; Broderick, J.W. ApJ, 784, L5 (2014)

High-velocity clouds in the halo of the Milky Way

Vanessa Moss (PhD student, University of Sydney/CASS)
on behalf of the GASS-catalogue and follow-up teams

Combining data from surveys made with the Parkes and Green Bank telescopes has revealed two distinct populations of gas in the Galaxy's high-velocity clouds.

The Milky Way is a dynamic and evolving galactic ecosystem, driven by outflows fuelled by star formation in the disk and infall due to interactions with nearby extragalactic gas. Its fate depends on how fast it will continue to form stars, and how many stars it will form. That in turn depends on the availability of 'fuel' — neutral hydrogen gas. The Galactic halo is a repository of neutral hydrogen, some accreted from other galaxies or the intergalactic medium, and some of Galactic origin, entering the halo via a 'fountain' and now ready for recycling. However, there has been a marked discrepancy between the Galaxy's star-formation rate and the amount of neutral hydrogen, available to fuel star formation, that has been detected in the halo. Our newly discovered evidence, based on the signatures of neutral hydrogen, helps to resolve this issue.

We have used the Parkes Galactic All Sky Survey (GASS, McClure-Griffiths *et al.* 2009) to catalogue southern-sky neutral hydrogen in the halo of the Milky Way at high sensitivity, with detailed spectral and angular resolution (Moss *et al*. 2013). Using automated flood-fill source-finding, we identified connected clouds of neutral hydrogen moving at high speeds relative to the Galactic disk. These clouds, usually referred to as high-velocity clouds (HVCs), have long been thought to be central players in the Galactic ecosystem of outflow and infall (Wakker 1991). There is evidence that HVCs have both extragalactic and Galactic origins.

As well as cataloguing 1693 HVCs, we targeted neutral hydrogen at velocities closer to Galactic rotational velocities that would not have traditionally been classified as HVCs. We refer to this population of 295 clouds as anomalous-velocity clouds (AVCs). We expect these AVCs to more closely trace the boundary between the disk and the halo of the Milky Way, offering new insight into the divide between outflowing and infalling gas.

Figure 1 shows the GASS catalogue of HVCs and AVCs distributed on sky. Clouds have both positive and negative velocities with respect to the Local Standard of Rest. Because GASS preserves sensitivity to large-scale structure, our automated source-finding let us catalogue large regions of neutral hydrogen that are connected by faint gas, such as the Magellanic system and clouds associated with the Galactic disk.

Following the release of the GASS catalogue, we combined the GASS HVCs with the results of the very sensitive survey, conducted by Lockman *et al.* (2002) with the Green Bank Telescope, of neutral hydrogen in the halo (Moss *et al.*, in prep.). While the GASS catalogue targets bright condensations of neutral hydrogen in the form of HVCs, the Lockman survey randomly samples the halo with high sensitivity to detect the faintest neutral hydrogen present. These surveys uncover evidence for two distinct populations of gas: bright, dense gas (like most of the gas in HVCs) and faint diffuse gas (which traces the edges and tails of HVCs). Figure 2 shows two examples of clouds in our sample that exhibit both dense and diffuse gas (shown by the blue triangles and cyan circles respectively).

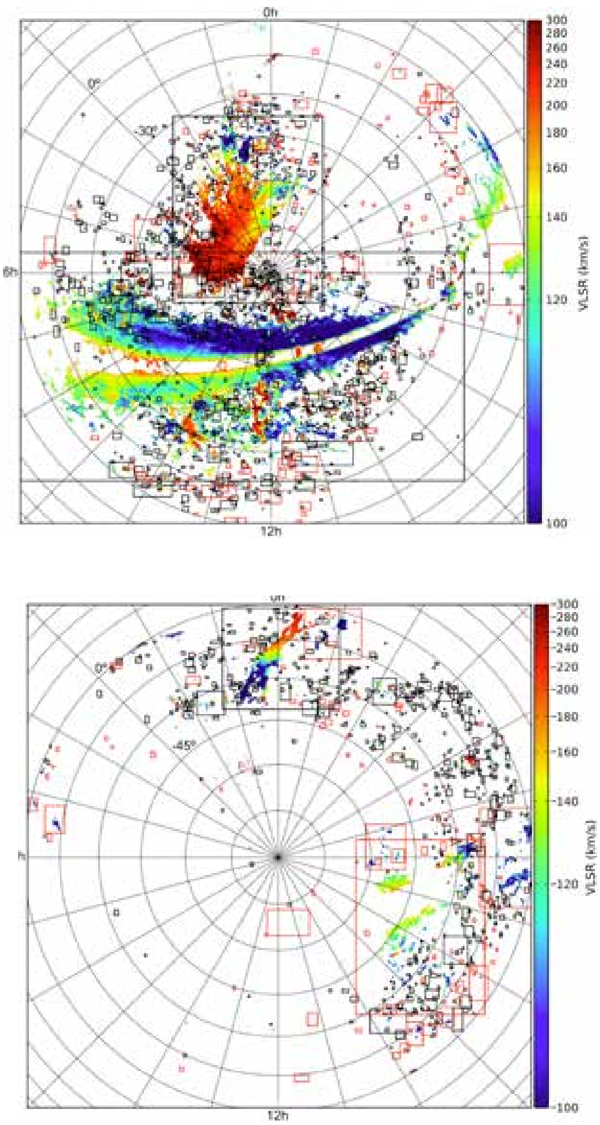
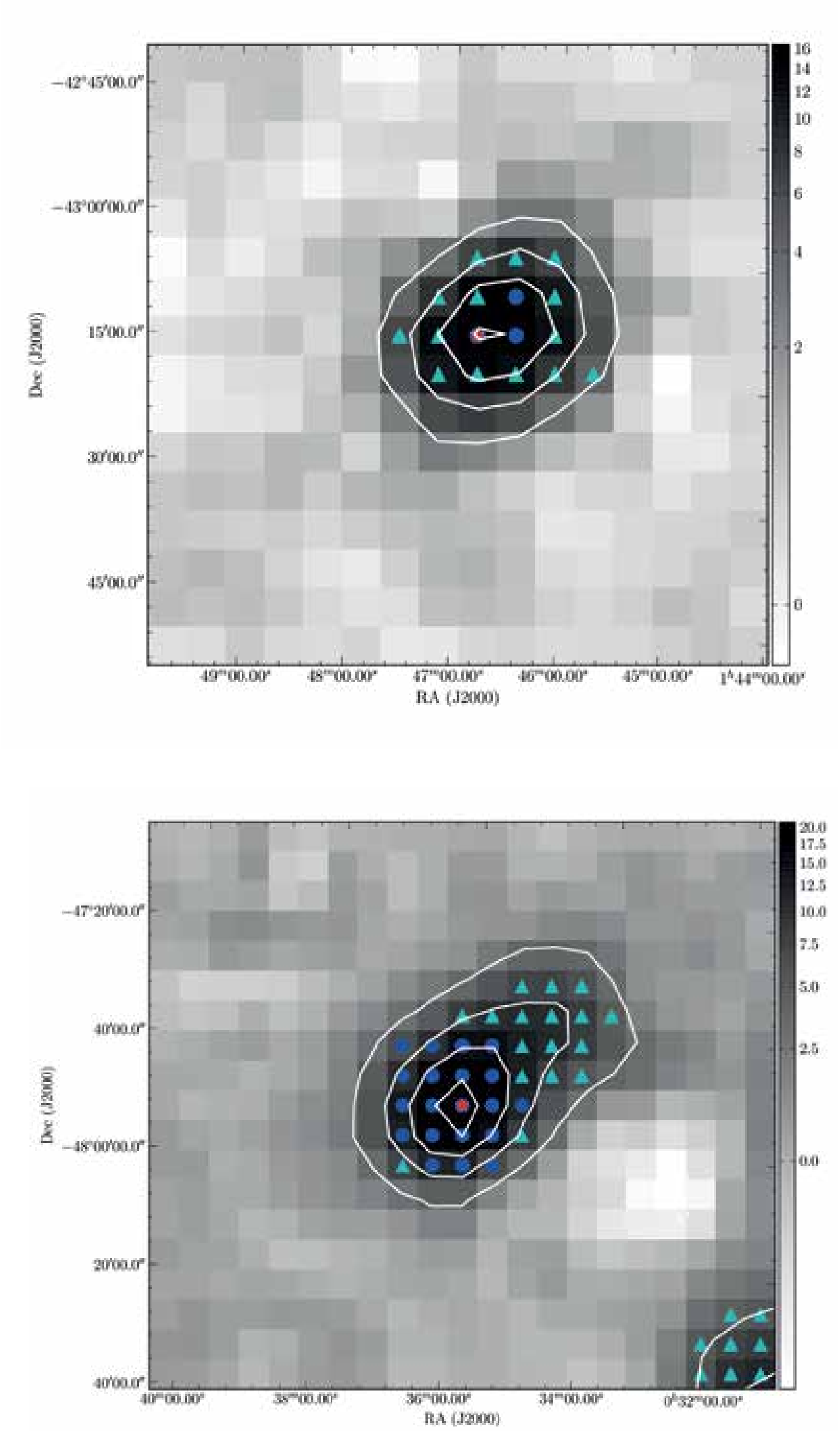


FIGURE 1:
The GASS catalogue of HVCs and AVCs shown on the southern sky (declinations < 0°) at positive and negative velocities with respect to the Local Standard of Rest. Classical HVCs are shown as black boxes, while AVCs are shown as red boxes. The maps are intensity-weighted mean velocity maps (1st moment) scaled with an arcsinh function, shown in zenith equal-area projection.

FIGURE 2:
Two of the HVCs in the sample, GHVC G273.0-70.2+375 and GHVC G310.5-68.8+162. The spectral components across each cloud have been divided into either the dense gas (blue circles) or diffuse gas (cyan triangles), with the catalogued position of the cloud shown as a red star.



Our results support the interpretation of HVCs as embedded condensations of gas within a warmer diffuse medium, and corroborate previous findings at other wavelengths that have suggested the presence of more neutral hydrogen than HI surveys typically find (Lehner *et al.* 2012, Fraternali *et al.* 2013). GASS is one of the first surveys that is both sensitive enough to detect the diffuse gas and has high enough velocity resolution to distinguish between the dense narrow-line gas and diffuse broad-line gas. Based on our findings, the diffuse gas may contribute as much mass to the halo as the dense gas. If the diffuse gas we have detected follows the supernova-driven model of cooling predicted by Fraternali *et al.* (2013), where mixing of disk gas with coronal material triggers cooling of the lower halo and allows accretion of new material onto the disk, then these two populations of neutral hydrogen, combined, can potentially account for the entire Galactic star-formation rate.

Future work using our high-resolution Compact Array observations of GASS HVCs and AVCs with known origins will enable us to study spatial variations in the physical properties across clouds, in order to determine whether environment or origin dominates the physical evolution of interacting neutral hydrogen gas. By combining these insights with our results on the dense and diffuse gas populations, we will construct a new picture of the Milky Way halo, and the continuing activity of our nearest galactic ecosystem will be revealed by the signatures of neutral hydrogen we detect there.

References

Fraternali, F. *et al*. ApJL, 764, L21 (2013)

Lehner, N. *et al*. MNRAS, 424, 2896 (2012)

Lockman, F.J. *et al*. ApJS, 140, 331 (2002)

McClure-Griffiths, N.M. *et al*. ApJS, 181, 398 (2009)

Moss, V.A. *et al*. ApJS, 209, 12 (2013)

Wakker, B.P. A&A, 250, 499 (1991)

The Compact Array. Credit: Alex Cherney/terrastro.com

Operations

In 2013 the ATNF completed a multi-year project to move the Parkes telescope to fully remote observing, in which no staff need be present in the tower. Credit: Ángel López-Sánchez.

Operations

> *"Parkes observations can now be carried out from anywhere, without an observer needing to be present in the telescope tower. Remote observing from the Science Operations Centre at Marsfield has become the default mode of using Parkes; qualified observers can also observe from other locations."*

OVERVIEW

Highlights for the Operations theme in 2013 were the change to remote observing with the Parkes telescope, recovery from the bushfire at the Mopra site, integration of the ASKAP/MRO operations staff into the Operations theme, and celebrating the 25th anniversary of the Australia Telescope Compact Array. Against the backdrop of maintaining high telescope availability and science impact, these made for a busy year.

The Remote Access to the Parkes Telescope (RAPT) project was wrapped up when the commissioning of the new telescope protection system (TPS) was completed. The TPS is an automated logic system that monitors the telescope, alerts staff to critical system alarms, and protects the telescope (for instance, by stowing it). Parkes observations can now be carried out from anywhere, without an observer needing to be present in the telescope tower. Remote observing from the Science Operations Centre at Marsfield has become the default mode of using Parkes; qualified observers can also observe from other locations.

In January the Wambelong bushfire devastated the Warrumbungle National Park and surrounding areas, including part of the nearby Siding Spring Observatory. For the first few days afterwards we also feared that critical instrumentation at the Mopra telescope had been destroyed. Fortunately, while much of the on-site building was damaged, reinforcing kept the fire out of the screened room. Observers were able to start using Mopra in May, only a month behind schedule. This observing period was the first one under a new operating model for Mopra, in which the National Astronomical Observatory of Japan, the University of New South Wales and the University of Adelaide are providing operational funding in exchange for dedicated observing time. ATNF users continued to have access to approximately 30 per cent of Mopra time for millimetre and Long Baseline Array observations.

January's bushfire destroyed much of the control building at the Mopra site but left the antenna structure untouched. Credit: Tim Wilson

The team based at Geraldton in Western Australia moved from its temporary offices into the new Murchison Radio-astronomy Observatory (MRO) Support Facility early in the year. At the same time, the team was transferred from the ASKAP Project to Engineering Operations. The Geraldton team continues to operate the MRO and support ASKAP construction work. MRO Site Manager Barry Turner left CASS in August, and Shaun Amy (Project Leader for the Computing Infrastructure group) began acting as Site Manager during the recruitment process for a new Manager. Shaun's role was in turn covered by Chris Phillips. With commissioning of the six-element Boolardy Engineering Test Array (BETA) under way, Dave McConnell has begun leading an ASKAP Commissioning and Early Science (ACES) team, which will coordinate efforts to bring ASKAP into operation and conduct early science.

The 25th anniversary of the opening of the Compact Array was an opportunity to look back over the history, and pre-history, of the ATCA, and celebrate the telescope's achievements. The ATCA continues to improve: this year it was outfitted with the last of its new 4cm-band receivers, which build on the capabilities provided by the Compact Array Broadband Backend. (See page 26 for more details on the anniversary, and page 52 for more about the receivers.)

Science Operations

The Science Operations group is the main interface between observers and the telescopes: it handles observing proposals, provides accommodation, maintains computing infrastructure, and keeps user guides and documentation up-to-date.

Proposals for the use of ATNF facilities are reviewed by the (partly external) Time Assignment Committee (TAC): the TAC is supported by an international team of 'readers' who supply grades and comments on proposals within their area of expertise but do not attend meetings. TAC members and readers for 2013 are listed in Appendix A. This year the TAC considered 176 proposals for the April semester and 138 for the October semester.

As mentioned above, Engineering Operations and CSIRO support staff restored Mopra to use by early May. Science Operations staff then put the telescope through its paces and confirmed that everything was in place for observing to recommence. Having started later than usual, observing also ran a little later in the year to ensure commitments to our funding partners were met. Within 'ATNF time', priority was given to the completion of two large Mopra projects, MALT-90 and CHaMP (Census of High and Medium-mass Protostars).

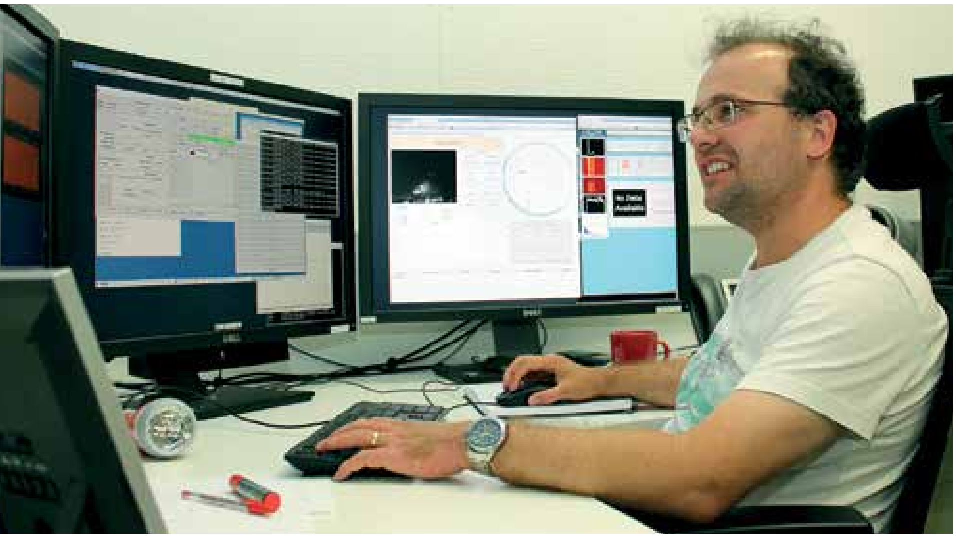
The ATNF continues to have access to telescope time at the Canberra Deep Space Communication Complex (CDSCC) under the host-country agreement with NASA. Observations are carried out in service mode. The 70-m antenna was taken off-line in November 2012 for seven months for repairs to the azimuth track: during this time a 34-m antenna at CDSCC was used for some Long Baseline Array (LBA) observations.

The Long Baseline Array (LBA) uses the technique of very long baseline interferometry (VLBI) to image radio sources with milliarcsecond-scale angular resolution. The core of the LBA consists of the Parkes, Mopra, and Compact Array telescopes, and the Hobart and Ceduna antennas of the University of Tasmania. Observations are also supported on occasions by CDSCC antennas, Hartebeesthoek (South Africa), TIGO (Chile), Warkworth (New Zealand), and the Katherine and Yarragadee antennas of the AuScope geodetic array, operated by the University of Tasmania. A single ASKAP antenna with a traditional ('single-pixel') feed is also sometimes available for 20-cm or 3-cm wavelength band observations. Most recorded LBA observations are correlated, under contract, by Curtin University in Western Australia.

During 2013 there were four major LBA sessions, in March, June, August and November. 'Out of session' participation with a subset of antennas was made in support of RadioAstron space VLBI observations. The ATCA, Hobart, and Ceduna telescopes also participated in a novel international observation of ESA's Mars Express spacecraft in December as it flew by the Martian satellite Phobos, with changes in the spacecraft's trajectory enabling the structure of this small moon to be studied.

Since 2012 we have decreased the number of receiver changes on Parkes each semester. As a result, we expected that it might not be possible to schedule some projects, even if they were highly graded. Proposers were advised that, in such cases, their proposal would be carried over to the following semester with the same grade. In 2013 this occurred twice, with the project scheduled in the following semester in both instances. The restriction on receiver changes is having a larger impact on LBA observing. There was no observing in the 2.3-GHz band in 2013: observers requesting this band were encouraged to consider the 1.6-GHz band as an alternative.

The advent of Parkes remote observing has resulted in a steady stream of Parkes observers using the Marsfield Lodge, but some of the pressure on site accommodation has been relieved by the Australian Astronomical Observatory moving from the Marsfield campus to North Ryde. Because the number of visiting observers at Parkes has



CASS astronomer George Hobbs controlling the Parkes telescope from the ATNF's Science Operations Centre (SOC) in Sydney. The SOC is now the default location for Parkes observing.

fallen, fewer rooms are now made available at the visitors' quarters, and breakfast is the only meal provided. Visitors can use the quarters' kitchen to self-cater for lunches and dinners; meals are also available from the Dish Café on site.

Internet access from the Compact Array started becoming less reliable several years ago when the region's highly reactive soil dried out during a long dry spell, kinking the AARNet fibre that runs from the Paul Wild Observatory at Narrabri to AARNet's trunk line along the Newell Highway. Fibre repair work was completed in September using a different route for a large fraction of the fibre, and new, more robust, fibre.

This year we upgraded computing capabilities at the Compact Array, replacing the online observing servers with a new Linux High-Availability, two-server, cluster. This work complemented the installation of a matching system at Parkes in 2012.

Software and Computing

The Software and Computing group develops and maintains all the software essential for the end-to-end operation of the ATNF telescopes.

This year we made significant upgrades to OPAL, the ATNF proposal handling software, making the work of the Time Assignment Committee easier.

MIRIAD, used for ATCA data reduction since early ATCA operations, was enhanced to support the latest CABB instrument modes. Although MIRIAD remains the preferred package for the initial process of data calibration, the ATNF also now recommends CASA, which has better algorithms for reducing wide-field, multi-frequency synthesis observations. We are collaborating with the US National Radio Astronomy Observatory (NRAO) to have ATCA features and bug-fixes incorporated into CASA.

In 2013 the Software and Computing group contributed to making Parkes remotely operable, by developing a vibration monitoring system that triggers the telescope protection system to automatically stow the Dish if its tower is shaken or disturbed. The group also developed FROG, a web-based application for overall monitoring of Parkes.

This year the group was focused mainly on developing software for ASKAP: for telescope monitoring and control, data processing, and calibration and imaging with the phased array feeds. For more details of these activities, see page 56 in the chapter on ASKAP and the SKA.

Engineering Operations

Engineering Operations operates and maintains the hardware and infrastructure of the ATNF telescopes. Staff are based at Narrabri, Parkes, and Geraldton. Engineering Operations underwent a small structural change at the start of the year, moving away from the independent project-based structure and towards site-based work groups. This provides for more direct supervision of day-to-day activities. Principal Engineer roles were created to allow expert knowledge and advice to be used across sites and to help in the planning of larger projects and improvements.

ASKAP, THE MURCHISON RADIO-ASTRONOMY OBSERVATORY AND GERALDTON

As noted on page 40, the new MRO Support Facility (MSF) was opened in Geraldton this year. The local Engineering Operations team has now set up the facility as a support base for the MRO. It has also finished commissioning the control building at the MRO itself.

Six first-generation phased array feeds were installed on antennas of the Australian SKA Pathfinder this year, forming the Boolardy Engineering Test Array (BETA). Credit: Steve Barker

This year the Engineering Operations team was involved in installing the final first-generation phased array feed (PAF) on an ASKAP antenna, which completed the Boolardy Engineering Test Array; preparing for the deployment of future PAFs; and changing the power supply for the site. More details of these activities are given in the chapter 'The Australian SKA Pathfinder and the SKA'.

PARKES RADIO TELESCOPE

Engineering Operations was significantly involved with the Remote Access to the Parkes Telescope project, delivering and commissioning the telescope protection system described on page 40.

Several years ago we began a phased upgrade of Parkes Observatory's power infrastructure. In 2012 we commissioned the new high-voltage infrastructure feeding power into the observatory; this year we relocated and recommissioned the generator, and began planning new low-voltage distribution boards for the mains supply.

Other Engineering effort this year included:

- upgrading the 8-GHz receiver to use the standard down-conversion system
- decommissioning the analogue filterbank
- replacing the roller door of the master-equatorial room
- replacing the site analogue PABX with a VOIP system.

The Parkes Observatory. Credit: Alex Cherney/terrastro.com

COMPACT ARRAY

As noted on page 52 of the 'Technology' chapter, this year the Compact Array was fitted with the final two '4-cm' receivers. The receivers were developed by the Technologies Group; Engineering Operations helped to produce, install and commission them.

We replaced the control building's air-conditioning plant, parts of which dated back to the 1960s. The immediate benefit of the new system was a fall in electricity consumption.

In September the Compact Array celebrated 25 years since its official opening. Three events were held to mark the occasion: a public Open Day on Sunday 1 September; a ceremony and reception on site for past and present staff and other guests on Monday 2 September; and a Science Symposium held in Narrabri to celebrate the 25 years of Compact Array science. (See pages 26 and 47 for more details.) October saw another milestone, marked with a small celebration by local staff: the 400th reconfiguration of the Compact Array.

The Compact Array. Credit: David Smyth

MOPRA RADIO TELESCOPE

As mentioned on page 40, repairing the bushfire damage to Mopra was a significant activity for Engineering Operations this year. The telescope structure survived the fire, as did the control and equipment rooms. But the rest of the building was burnt to the ground and there was significant damage to the site infrastructure, the power systems in particular. We lost the Telstra backup data link, with local PABX and phone lines destroyed, and the site fence, water tanks, septic system and air-conditioners were damaged. Substantial efforts were required to clear the site, assess the damage, prevent water entering the remains of the building, and to have electronic equipment professionally cleaned to avoid damage from smoke and ash. The L/S (20-cm/13-cm) receiver was removed from the telescope and taken to Narrabri for an extended maintenance period. We checked the antenna surface using photogrammetry, and found no measureable deformities. During the recovery period, equipment and systems were exposed to higher humidity than usual, and this may have caused some of the peculiar failures that occurred even after systems were returned to an operating state.

The bushfire destroyed the accommodation area of the Mopra control building, but the main control room (at left) was protected by its concrete structure and screening on the door and windows. Credit: Tim Wilson

Repair work under way. Credit: Tim Wilson

The Mopra telescope was restored to use by early May. Credit: Emil Lenc

Spectrum Management

To detect very faint cosmic radio signals, radio telescopes have to be extremely sensitive. But as a result, they are highly susceptible to radio-frequency interference (RFI) — radio signals generated by human activities. To enable radio observations it is necessary to protect radio telescopes from RFI. A small fraction of the radio spectrum is reserved worldwide for 'passive services' such as radio astronomy, but more general 'spectrum management' is becoming increasingly important because new telescopes such as the SKA will attempt to access most of the radio spectrum.

The international regulation of the spectrum is the responsibility of the International Telecommunications Union (ITU): the international treaty called the 'radio regulations' is updated every few years via the World Radio Conference (WRC). In Australia spectrum regulation is the responsibility of the Australian Communications and Media Authority (ACMA).

CSIRO strives to protect the radio-astronomy spectrum in general. This requires a good working relationship with ACMA (and through it, with the ITU and other regional and international forums), and with the Department of Defence and other major users of the radio spectrum. CSIRO also works to gain more specific protection for radio observatories. In recent years these efforts have led to the establishment of a 'Radio Quiet Zone' around the Murchison Radio-astronomy Observatory in Western Australia and 'Radio Notification Zones' around other radio observatories.

Our spectrum management activities include:

- active, direct engagement with major Australian spectrum users such as the Department of Defence, NBN Co and telecommunication carriers, to harmonise spectrum use, coordinate operations and minimise RFI
- participating in national spectrum planning and protection activities through ACMA, ITU study groups and the WRC
- participating in regional and international meetings held by the ITU, particularly ITU Working Party 7D (Radio Astronomy) in Study Group 7 (Science Services). The current chairman of this Working Party is from CSIRO
- participating in IUCAF (Scientific Committee on the Allocation of Frequencies for Radio Astronomy and Space Sciences), an inter-union committee of the IAU, URSI and COSPAR. IUCAF has had a significant impact on relevant ITU deliberations
- participating in the Radio Astronomy Frequency Committee in the Asia Pacific region (RAFCAP), which promotes awareness of radio astronomy and protection of the radio spectrum in the Asia Pacific. RAFCAP works closely with the regional spectrum management group, the Asia Pacific Telecommunity. The current RAFCAP chairman is from CSIRO.

Highlights of this work in 2013 were:

- preparing for the next World Radio Congress in 2015. CSIRO took part in activities, led by ACMA, that aimed to give guidance for Australia's position for all items on the meeting agenda. CSIRO also participated in ITU meetings that reviewed studies relevant to the agenda items
- producing a new edition of the ITU 'Radio Astronomy Handbook', which provides the essential background and fundamentals of spectrum management in radio astronomy. It is aimed at regulators, engineers, astronomers and students as an introductory textbook and reference
- preparing for the IUCAF-sponsored 'School on Spectrum Management in Radio Astronomy', to be held at the Joint ALMA Observatory in Santiago, Chile, in April 2014. CASS has organised many aspects of the meeting and will provide speakers for many of the lectures
- hosting a delegation from Malaysia for a week of discussions on spectrum management and RFI
- reciprocal staff visits between the ATNF and ACMA.

Outreach and Education

VISITORS CENTRES

The CASS visitors centres (VCs) — at the Parkes Observatory, Paul Wild Observatory and the Canberra Deep Space Communication Complex — continue to be popular attractions, drawing healthy numbers of travellers, tour groups and schools.

The management of the VCs was amalgamated this year. This should help us to create a more cohesive set of messages for the public about the roles of the facilities: how they differ and how they work together.

Parkes

The Parkes Observatory continues to be an important stop for travellers in the central west of NSW. However, recent visitor figures have been trending downward. Visitor surveys show that the increasing cost of petrol has reduced travel by caravan and campervan users and holidaying families.

This year 89,064 people visited the Observatory's visitors centre. Among them were 69 tour groups, mainly 'seniors', car clubs and Probus clubs. These groups consistently give excellent feedback, with comments such as "Dream come true after watching *The Dish*", "Improved the reasons I love space!" and "Magic, looks new on every visit".

Highlights of the Parkes centre's outreach program this year included:

- a new display celebrating '80 Years of Radio Astronomy'
- performances from the science-based rock group Ologism
- the annual David Malin Astrophotography Awards and exhibition, presented as part of the Central West AstroFest.

School excursion programs remains strong with 58 groups coming to the centre during the year, totalling 2,242 students and teachers. The centre also ran popular school holiday programs of hands-on science activities for children aged 7–15 years.

The shop within the visitors centre has increased its sales and expanded its range of stock. It also supplies goods for sale at other CSIRO sites in Canberra and Sydney. This year revenue from the shop, the online store and the 3D theatre was $587,500 (gross).

ATCA Senior Systems Scientist Jamie Stevens (at right) overseeing the solar viewing at the Compact Array's public open day.

Robin Wark, Operations Manager at the Compact Array, explaining the control-room displays during the public open day.

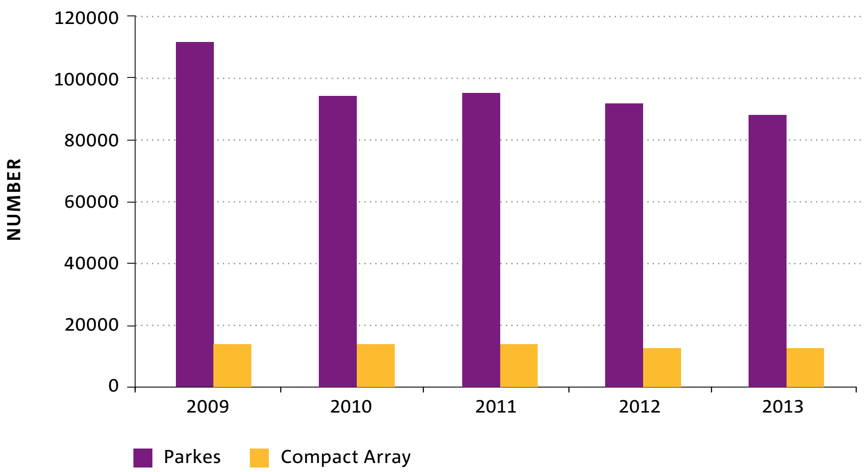


FIGURE 1:
Visitors centre statistics for Parkes and the Compact Array.

Compact Array

The Paul Wild Observatory, site of the Australia Telescope Compact Array, celebrated its 25th anniversary in September 2013. The public open day held to coincide with the anniversary attracted a record crowd of over 700 people.

This year 12,462 people visited the observatory and its visitors centre. This number includes 30 pre-arranged group tours for 'seniors', tourists, university students and astronomy club members. Two school groups also visited.

The visitors centre displays were upgraded during the year and the building interior repainted. The centre continues to operate primarily as a stand-alone, self-guided facility, with some support provided by observatory staff and visiting astronomers.

The nearby town of Wee Waa was the setting for a concert by the international cult music duo, Daft Punk, and the launch of their latest album. This increased visits to the Compact Array in May and following months.

Canberra Deep Space Communication Complex

The Canberra Deep Space Communication Complex (CDSCC) is not formally a part of the ATNF, but its antennas are used for radio astronomy (as noted on page 6). The CDSCC is operated by CSIRO, and its public visitors centre, called the Canberra Space Centre, is managed by CSIRO Astronomy and Space Science.

This year the centre updated its exhibition with new displays of an Apollo spacesuit and spacecraft models, and improved its theatre projection and audio systems. It received 67,952 visitors, including international tour groups and more than 11,500 students and teachers.

Major outreach events at the CDSCC this year were:

- the 40th anniversary celebrations for the CDSCC's 70-metre antenna, Deep Space Station 43. One hundred former staff gathered to celebrate on the spot where 40 years earlier Prime Minister Gough Whitlam had 'pushed the button' to start operations
- the 2013 open day, which attracted a record crowd of nearly 3,000 people.

OUTREACH

Much of the ATNF's outreach this year took place at the observatory visitors centres, but additionally:

- Staff gave 92 public talks to teachers, students, industry and community groups at events in New South Wales, Queensland, Victoria and Western Australia, and in New Zealand and Japan.
- CASS hosted an Artist-in-Residence, Michaela Gleave. Her residency was reflected in her exhibition, *A day is longer than a year,* held at Fremantle Arts Centre in Western Australia, in June, and an evening of events at the Museum of Contemporary Art in Sydney in March, at which several ATNF staff presented.
- In August, staff took part in the *Murchison Astrofest* in Western Australia and ran activities in conjunction with a *Journey to the Planets* concert in Sydney.
- Staff at Parkes and Narrabri took part in several events in their local communities, including 'science days' at local public schools and the annual Parkes Elvis festival.

EDUCATION

This was a busy year for education initiatives. Key activities included:

- a three-day *Astronomy from the Ground Up* teacher workshop at Parkes Observatory in May
- ten other teacher-workshop sessions in New South Wales, Victoria and Queensland
- a National Science Week visit to Townsville to work with local schools
- linking seven current or former staff with schools through the *Scientists in Schools* program

The crowd at the Murchison Astrofest. Credit: Rob Hollow

- CASS partnering with the Australian Astronomical Observatory and Las Cumbres Observatory Global Telescope Network and six universities in the *Opening Real Science: Authentic mathematics and science learning for Australia* project funded for the next three years. *Opening Real Science* targets trainee and current teachers and focuses on incorporating real science into the classroom
- establishing a mentoring scheme that links CASS staff with students at the Pia Wadjarri Remote Community School in the Murchison region of Western Australia. Students at the school also toured the Murchison Radio-astronomy Observatory late in 2013
- thirteen sessions of PULSE@Parkes, an education program in which students control the Parkes telescope over the Internet and use it to observe pulsars. Two hundred and five students and teachers were involved. Highlights of this program for the year were:
    - ◊ the first observing session held in the Parkes radio telescope with students from Parkes High School
    - ◊ a session at our Murchison Support Facility in Geraldton for local schools
    - ◊ a two-week visit to Japan for two staff, funded by a grant from the Australia-Japan Foundation, to run four PULSE@ Parkes sessions.

Undergraduate Vacation Scholars

CASS hosted eight Undergraduate Vacation Scholars and one engineering placement over the 2013–2014 summer. All were based at Marsfield and visited the Compact Array to perform observations. The scholars presented their work at the CSIRO-wide 'Big Day In' for vacation students in February 2014.

Health, Safety and Environment (HSE)

Some health and safety statistics are recorded for CSIRO Astronomy and Space Science (CASS) rather than for the ATNF specifically. During 2013 CASS had fewer reported injuries and incidents (captured by 'lagging indicators') than in 2012. Preventative measures (captured by 'leading indicators') remained at essentially the same level as in 2012.

LEADING PERFORMANCE INDICATORS

Safety contacts

Safety contacts are informal, 15-minute conversations between staff members at the workbench and senior leaders of our organisation, intended to reinforce safe behaviours, challenge 'at risk' ones, and point out non-compliance with established standards. Thirty-three safety contacts were conducted with ATNF staff in 2013 (32 in 2012).

HSE review program

The HSE review program is a targeted review of specific HSE-related issues, risks and management controls by senior managers within business units. Twenty-seven HSE reviews were carried out in 2013 (21 in 2012).

HSE leadship training

Nineteen ATNF supervisors and managers completed modules 1 and 2 of CSIRO's HSE leadership training in 2013, bringing the total number trained to 44.

LAGGING PERFORMANCE INDICATORS

Ten CASS staff experienced an injury while working this year (16 in 2012). Body-stressing injuries are still the most common type, with 41 per cent of injuries attributed to either occupational overuse or manual handling. No incidents were reported to Comcare.

TABLE 1:
CASS health and safety incidents, 2012 and 2013. Abbreviations: (1) E Incidents = environmental incidents (in the sole case this year, an oil leak); (2) H&S = health and safety; (3) LTI = lost-time injuries: injuries that resulted in the loss of one or more whole days after the date of the injury; (4) MTI = medical-treatment injury: an injury requiring medical treatment other than solely first-aid; (5) LTIFR = lost-time injury frequency rate: LTIs per million hours worked; (6) MTIFR = medical-treatment injury rate: MTIs per million hours worked; (7) Claims = workers' compensation claims; (8) Claim FR = workers' compensation claims per million hours worked.

	E INCIDENTS	H&S INCIDENTS*	LTI	MTI	LTIFR	MTIFR	CLAIMS	CLAIM FR	WEEKS LOST
2012	0	16	4	3	8.34	6.25	5	10.42	1
2013	1	10	1	3	2.04	6.12	1	2.04	0

**Injuries only (not inclusive of hazards and near miss reports)*

HSE STRATEGY IMPLEMENTATION UPDATE

This year we focused on preventing fatalities, in particular from forklifts and driving. The ATNF has two forklifts and 22 licensed operators. Using the CSIRO risk-assessment methodology for forklift use, we identified seven critical controls for implementation in 2014. We conducted a detailed HSE review in 2012 on driving 4WDs on unpaved roads. This led to a number of recommendations around training, fatigue and journey preparation that are particularly relevant for staff travelling to and from the Murchison Radio-astronomy Observatory. Five vehicle incidents, all minor, were reported in 2013.

This year we held skin-cancer awareness sessions at all ATNF sites and snake-handling courses at all ATNF observatories.

ENVIRONMENTAL UPDATE

In 2012 CSIRO formed a network of CSIRO 'green champions' called C-Greens: staff who act as role models and leaders in creating environmental sustainability at their sites. With support from CSIRO Property Services, the C-Greens coordinate environmental initiatives that will help align CSIRO's daily operations with its research on sustainability. The first initiative from CSIRO's C-Greens program, recycling, has continued to be successful, with staff now sorting and disposing of their waste at designated waste stations across CASS sites. At Marsfield, the C-Green volunteers regrouped in 2013 to create a new native garden in an area degraded by building works.

Human Resources

STAFFING LEVELS

The total number of ATNF staff was unchanged from 2012, although there were changes in individual categories.

TABLE 2:
Staff levels. The number is as of December each year, and excludes casuals, contractors, affiliates and students.

GROUP	TOTAL STAFF 2011	TOTAL STAFF 2012	TOTAL STAFF 2013
ASKAP/Project specialists	15	17	12.5
Astrophysics	27	24	27
Engineering	59	46	36
Management	9	9	7
Operations	58	55	71
Support	5	8	6.5
Total	173	160	160

STAFF MOVEMENTS

There were several important staff changes this year:

- Lewis Ball commenced as Chief of CASS in March. Dr Ball joined CASS from his position of Deputy Director at the Atacama Large Millimeter/sub-millimeter Array (ALMA) in Chile. He had formerly held a number of positions with CSIRO (including Acting Chief of CASS).
- Sarah Pearce, who had been Acting Chief, resumed her role as Deputy Chief after Lewis Ball's appointment.
- Mark McKinnon joined CASS in September as leader of the international SKA Dish Consortium, which CSIRO heads. Mark is on secondment from the US National Radio Astronomy Observatory, where he was ALMA North American Project Director

Exercise equipment provided for staff at the Murchison Radio-astronomy Observatory. Credit: Wilfredo Pena

CASS Deputy Chief Sarah Pearce working with other C-Green volunteers to build a native garden.

and coordinated $600m worth of ALMA construction.

- Robert Braun resigned his post as CASS Chief Scientist in June to take up an opportunity with SKA in Manchester. The position is currently vacant.
- Phil Crosby moved to Western Australia to head up CASS's new office in Perth as Assistant Director – Western Australia.
- After five years as Operations Research Program Leader, Jessica Chapman stepped down from the role to become the CASS Data Management Leader.
- Kate Brooks was appointed as Deputy Head, ATNF Operations.

Recruitment activity in 2013 was almost parallel with that of 2012, and was largely offset by staff cessations. Fourteen staff ceased employment during 2013 due to: resignation (7), retirement (2), term employment ending (2), redundancy (2), and for other reasons (1). The CSIRO Interim Recruitment Arrangements came into effect in October 2013: these stipulated that, for a period of time, funds would be available for maintaining or filling only 'mission critical' positions.

DIVERSITY AND INCLUSION

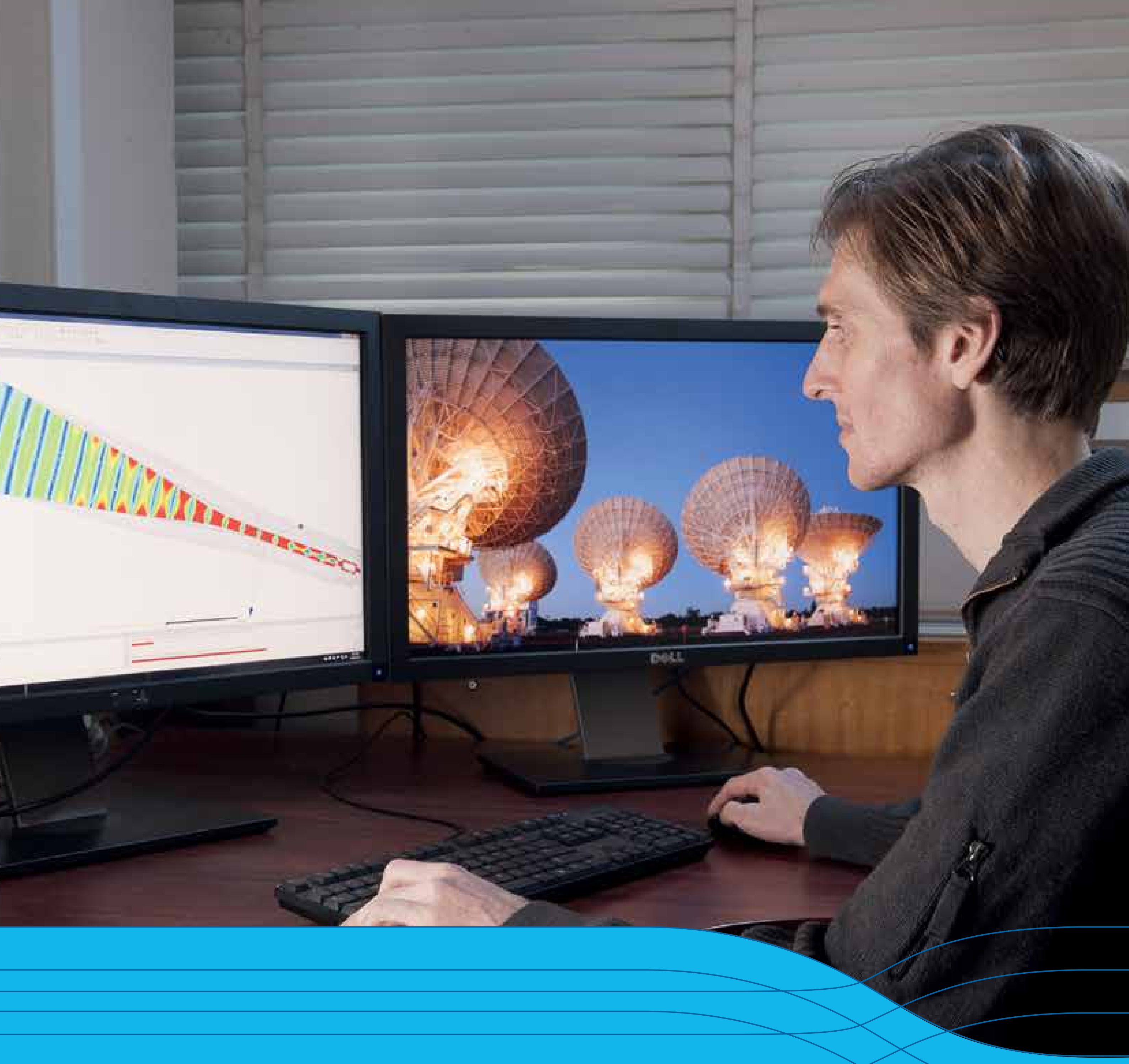
CSIRO is continuing to implement its 2012–15 diversity and inclusion plan. A central part of this is CSIRO's Indigenous engagement strategy, which is aimed at increasing Indigenous participation in CSIRO. As part of the ATNF's contribution to this plan we have continued our relationship with two Indigenous cadets, Kobi Pullen (in Astrophysics) and Michelle McIntosh (in Operations) who were recruited in 2012. The recruitment process for an Aboriginal Liaison Officer in Geraldton and an Indigenous cadet, Ronnie Venables, started in 2013.

Vicki Drazenovic and Priscilla Clayton began training to become Diversity and Inclusion Contact Officers, and have since taken up those roles.

In September a number of ATNF staff attended the Women in Astronomy conference held in Perth, Western Australia. Lisa Harvey-Smith was appointed Chair of the Astronomical Society of Australia's Women in Astronomy Chapter. As the departing Chairperson of the Astronomical Society of Australia, Kate Brooks was the keynote speaker at the Women in Astronomy conference. CASS's Diversity Committee met during the year: Jill Rathborne is now its Chair.

A mandatory CSIRO-wide 'bullying and harassment' e-learning module was launched in November 2012 and rolled out across the ATNF in 2013.

Credit: Emil Lenc



Technology

CASS receiver engineer Alex Dunning designing a new radio feedhorn.
Credit: Wheeler Studios.

Technology

COMPACT ARRAY 6/3-CM RECEIVER UPGRADE

The Compact Array was originally outfitted to work at four wavebands, denominated as 20 cm, 13 cm, 6 cm and 3 cm. In 2011 we upgraded the Array's low-frequency receivers, replacing the 20- and 13-cm bands with a single band (known as the 16-cm band) that covers 1.1–3.1 GHz. This upgrade halved the system temperature. We have now carried out a complementary upgrade at the higher frequencies, replacing the receivers for the 6- and 3-cm bands (covering 4.5–6.5 GHz and 7.5–10.5 GHz respectively) with a suite covering 4–12 GHz. Four production receivers were installed in 2012, and the final two this year: a spare receiver was also provided.

This new '4-cm' band is 50 per cent wider than the previous bands combined and, as with the lower-frequency upgrade, the system temperature has fallen by about half. The full 4–12 GHz band is now available to the Compact Array Broadband Backend processor: observers can place two 2-GHz bands plus up to 32 zoom windows, each with 2,048 channels, within the band. The upgrade has improved sensitivity at least four-fold, and given access to more spectral lines (for instance, the 6.7-GHz line of methanol) and a wider range of velocities. Fabrication of spare low-noise amplifiers and 'post' receiver modules will continue until the project finishes in early 2014, but astronomers are already using the system in earnest. This upgrade has been funded through Astronomy Australia Limited.

CASS receiver engineer Santiago Castillo, with the CASS-designed feed proposed for China's FAST telescope. Credit: Wheeler Studios

Technology theme staff have designed two new feedhorns, which in trials were able to operate up to 12 GHz. Staff presented two papers at the 2013 Asia Pacific Microwave conference in South Korea highlighting the innovative orthomode transducer used in the feedhorns and a filter to exclude radio-frequency interference.

COMPACT ARRAY BROADBAND BACKEND UPGRADE

Effort this year focused on providing a third 'zoom mode', the '16-MHz' mode, which will complement the 1-MHz and 64-MHz modes. Work has progressed, but this mode and its associated zoom functionality are unlikely to be available until the end of 2014.

FAST 19-BEAM RECEIVER FEASIBILITY STUDY

This year we completed a contract from the National Astronomical Observatories, Chinese Academy of Sciences (NAOC) related to the Five Hundred Metre Spherical Telescope, FAST. This is a 500-m diameter surface that sits in a natural hollow in the ground, and when completed in 2016 it will be the world's largest single-dish telescope. ATNF staff carried out a study into the feasibility of implementing a 19-beam cryogenic receiver, covering the frequency band 1.05–1.45 GHz, on this telescope. The working parts of the receiver must be cooled to cryogenic temperatures and housed in a dewar maintained under high vacuum: the challenge was to design a system with a large dewar (about 1.6 m across) but minimise the total weight. The study showed that the ATNF would be able to construct such a large instrument. Members of the FAST project team travelled to Australia in October to discuss the results and take part in measuring a single-pixel element fabricated to demonstrate the performance of such a receiver. Discussions between CSIRO, NAOC and Jodrell Bank Centre for Astrophysics, a third collaborating institution, continue in order to realise this exciting instrument.

NEXT-GENERATION PARKES RECEIVERS

Technology theme staff have worked to determine which receivers would provide the best science opportunities for Parkes while fitting the telescope's operating requirements and the resources available. The leading concept is ultra-wideband receiver packages that might separately cover the 700 MHz–4 GHz and 4–24 GHz bands. Staff have also considered a phased array feed receiver for the telescope. To date, we have worked to identify the technical and resourcing risks involved in realising these receivers and to generate a top-level costing of each project. Excitingly, our investigations have led to the concept of an innovative ultra-wideband feed and orthomode transducer combination. This has been the subject of an invention disclosure. It will be fabricated and tested in 2014 as part of the receiver development program.

The nature of the radio-frequency interference at the telescope has huge implications for the design of these receivers. We are characterising the interference using data-capture hardware originally developed for the 'LunaSKA' observing program to detect radiation generated by ultra-high-energy cosmic neutrinos hitting the Moon.

RADIO-FREQUENCY INTERFERENCE MITIGATION

This year the ATNF hosted Brian Jeffs (University of Utah) as a Visiting Scientist for several months. Brian explored the use of phased-array beam steering to mitigate radio-frequency interference, a technique that could be valuable when observing with phased-array receivers. We now plan to build an antenna system, to be deployed at Parkes, that would detect satellite 'interferers', and to use this data to further the mitigation work. Funding for a postdoctoral position to lead this work has been secured, and that position should be filled in early 2014.

"Excitingly, our investigations have led to the concept of an innovative ultra-wideband feed and orthomode transducer combination. This has been the subject of an invention disclosure. It will be fabricated and tested in 2014 as part of the receiver development program."

CASS technical officer Michael Bourne machining a new orthomode transducer for the Compact Array. Credit: Wheeler Studios

The SKA and the Australian SKA Pathfinder

Aaron Chippendale (L) (CSIRO Astronomy and Space Science) and Stuart Hay (CSIRO Computational Informatics) with a national Engineering Excellence Award for CSIRO's phased array feed. Credit: Engineers Australia

The SKA and the Australian SKA Pathfinder

Development of the Australian Square Kilometre Array Pathfinder (ASKAP), and participation in the international Square Kilometre Array (SKA) program, continued to be strategic priorities for CASS during 2013. The ASKAP project has four principal goals:

- establishing the Murchison Radio-astronomy Observatory (MRO), a unique new radio-quiet observatory that will ultimately host the SKA
- developing new technology to advance radio astronomy, and demonstrating its viability for the SKA
- delivering high-quality science, in particular to establish and explore science themes that will be fully exploited by the SKA
- fostering the next generation of astronomers and engineers, the people who will build and use the SKA.

The ASKAP project has six 'deliverables'. These, and their status at the end of 2013, are given below.

DELIVERABLE	STATUS
Chequerboard phased array feed (PAF) receivers and associated technology for radio astronomy	In 2013 the ASKAP team achieved near-optimal system-noise temperature across the ASKAP band during tests on the prototype of the second-generation (MkII) PAF.
Thirty-six antennas with advanced receiver systems (PAFs) and signal processing	All 36 antennas were erected at the Murchison Radio-astronomy Observatory by the end of 2012. In 2013 the ASKAP team finished installing PAF receivers on six of these antennas. The six antennas and their associated digital systems form BETA, the Boolardy Engineering Test Array.
The geothermally cooled MRO control building and all support infrastructure	The MRO control building was completed in 2012.
A power plant with a significant renewable component	Pending construction of the permanent power plant, the site is powered by rented generators.
The MRO Support Facility in Geraldton	The MRO Support Facility in Geraldton was completed and officially opened in 2013.
An SKA-capable fibre-optic network linking the MRO to the MRO Support Facility and continuing on to Perth	The optical fibre linking the MRO to the iVEC Pawsey Centre in Perth was completed, and began operating, in 2013.

ASKAP ACTIVITIES

In 2013 the ASKAP project team passed many important milestones, including:

- completing the installation of first-generation phased array receivers on six ASKAP antennas at the MRO. These antennas form the Boolardy Engineering Test Array (BETA)
- controlling the ASKAP antennas from the Marsfield Science Operations Centre in Sydney, for debugging and commissioning of BETA
- during commissioning of BETA, making the first measurements with ASKAP of absorption and emission spectral lines

A close-up of a phased array feed (PAF) on an ASKAP antenna — one of the first six PAFs successfully installed this year.

- working closely with the ASKAP Survey Science Teams (SSTs) on simulations for the Early Science program
- achieving excellent system noise-temperature performance in the prototype Mk II phased array feed (PAF). Initial tests showed a noise temperature of better than 50 K across 95 per cent of the ASKAP frequency band (0.7–1.8 GHz), and as low as 40 K in the centre of the band. This result confirms that the Mk II PAF system will reach or exceed its performance specifications
- verifying the performance of a number of subsystems of the Mk II phased array feeds and, where applicable, stress testing them. These tests have 'retired' the technical risks around the Mk II systems, allowing us to start production.

These achievements show ASKAP's potential to become a world-leading survey radio telescope, and are a testament to the dedication of the project staff.

Members of the ASKAP team were also involved in:

- providing advice to governments and the Australian Communications and Media Authority (ACMA) to assist in the establishment of an appropriate legislative framework for radio-spectrum management in the Mid West Radio Quiet Zone
- installing and testing the ASKAP central processor platform at the iVEC Pawsey Centre Perth, ahead of the Centre's operational launch in November
- submitting successful entries for the Engineers Australia Engineering Excellence Awards — for both the Sydney and national level — for the development of the PAF
- developing the CSIRO ASKAP Science Data Archive (CASDA). (See page 60 for more details.)

The phased array feed display for the Engineers Australia Engineering Excellence Awards, on show at the Powerhouse Museum in Sydney. The display includes a prototype 5 x 4 chequerboard array, a moving model of an ASKAP antenna and a series of videos that explain the technology.
Credit: Powerhouse Museum.

ASKAP COMMISSIONING AND EARLY SCIENCE

This year, we created a new team – 'ASKAP Commissioning and Early Science' – from staff already involved in ASKAP commissioning, staff from Telescope Operations and Scientific Services, and members of ATNF Astrophysics. When commissioning and early science are complete, this team will conduct routine ASKAP observations and support ASKAP users.

Commissioning activities

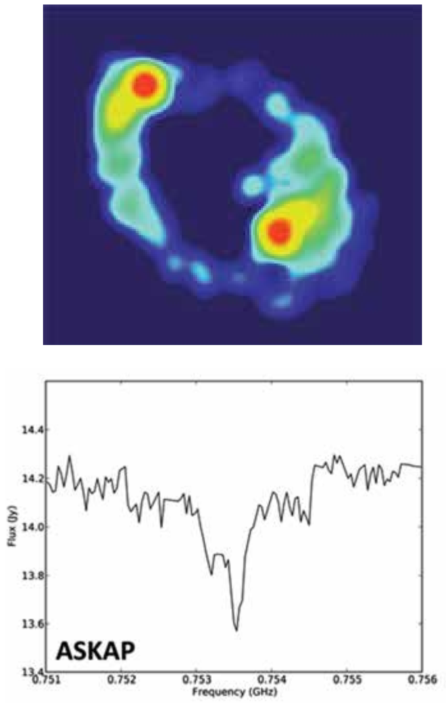
As noted above, this year we finished outfitting six ASKAP antennas with first-generation phased array feeds. The six antennas, known as the Boolardy Engineering Test Array (BETA), will be used by the commissioning teams to prepare for the full fit-out of all 36 ASKAP antennas.

We also installed the new ASKAP hardware correlator and associated firmware at the MRO, making possible the first tests of the ASKAP science processing pipeline. The correlator and firmware provide greater sensitivity, bandwidth and spectral resolution than were previously available.

We made three important sets of observations this year. In each instance, we used three of the six BETA antennas:

- In July, we made the first ASKAP multibeam image. This achievement validated the BETA hardware design, and cleared the way for the next three first-generation phased array feeds to be rolled out at the MRO.
- In October, we made ASKAP's first spectral-line detection. This was an important step towards producing spectral-line image cubes.
- In December, we made the first HI absorption-line measurement, demonstrating that the HI spectral-line mode of ASKAP faithfully reproduces other telescopes' observations of a well-characterised region of the sky.

The ASKAP Survey Science Teams were given access to the raw data from all these observations.



Using three ASKAP antennas fitted with ASKAP'S first-generation phased array feed receiver system and a hardware correlator, a baseline-averaged cross-correlation spectrum was produced of the gravitationally lensed system PKS 1830-211 (5-GHz MERLIN image at top). This system has an absorbing galaxy at z=0.89. (Image credit: Patnaik *et al.* 1994)

Early Science

In January, discussions began about the design and implementation of a program of early science with ASKAP. We released a high-level plan for the ASKAP Early Science program in September. The two main strands of the program are:

- 1-MHz and 18.5-kHz surveys in all four Stokes parameters, from 0.7–1.8 GHz over a wide area of sky, with 6–12 hours integration time per field
- a 18.5-kHz spectral-line survey, over 1.15–1.45 GHz, and targeted toward a small number of fields, with 50–60 hours integration time per field.

These surveys will provide data to the wider astronomical community, and give useful feedback on the performance of the phased array feeds.

The *ASKAP Commissioning* newsletter was launched in April 2013, as a regular, informal communications channel through which the ASKAP Project Scientist can report on activities of interest to the astronomical community. Topics include ASKAP commissioning progress, new results and challenges, bugs in the system, releases of new software and the availability of test-data files. We continue to produce *ASKAP Update* for the science community, industry and other interested stakeholders, to report on broader ASKAP developments.

ASKAP DESIGN ENHANCEMENTS (ADE)

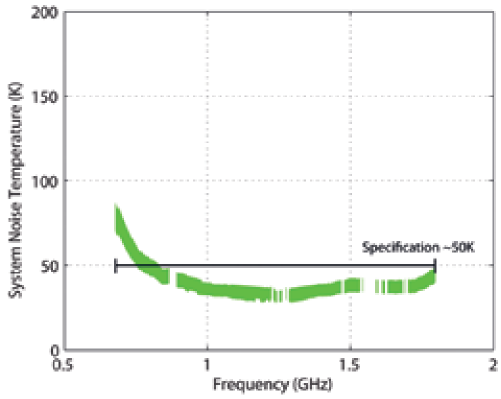
Since August 2011 we have been developing a second-generation receiver and data processing chain for ASKAP, through a program known as ASKAP Design Enhancements (ADE).

We have worked to improve performance and lower the cost of the chequerboard phased array feed (PAF), and make it easier to manufacture and test. The new PAF design meets all the science requirements.

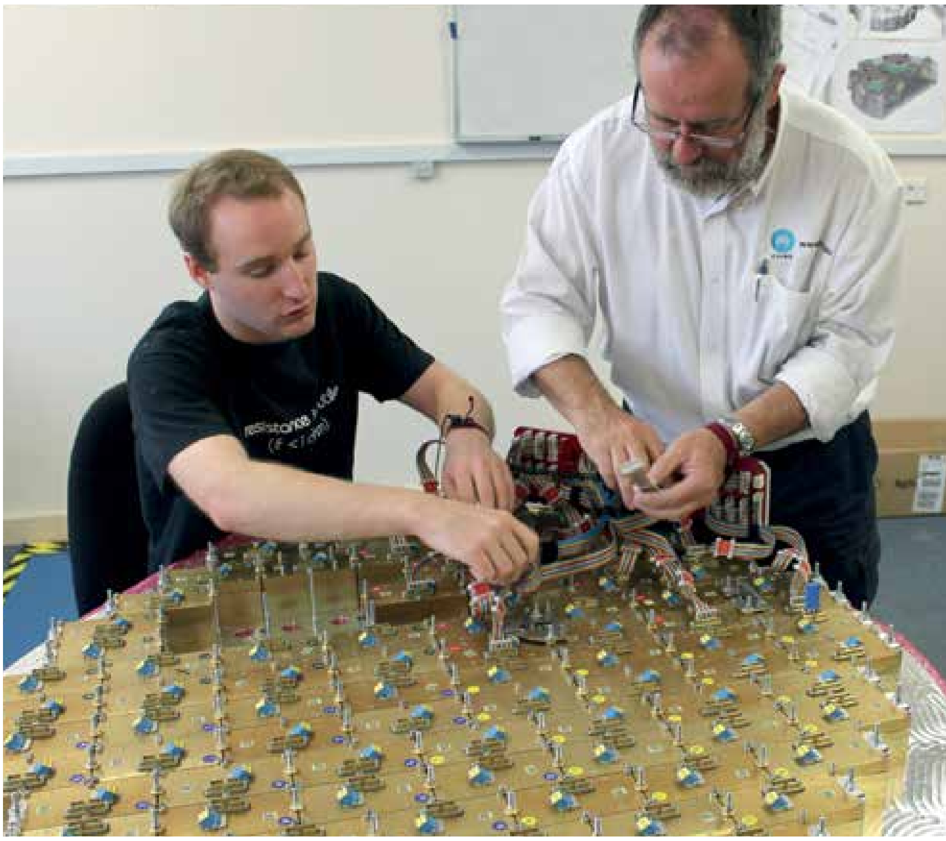
Tests on a proof-of-concept system this year yielded excellent system noise-temperature performance in aperture-array mode, close to 50 K across the entire ASKAP frequency band (0.7–1.8 GHz).

These tests were performed on a 40-element PAF system, including an ADE-style tiled chequerboard, front-end assembly and low-noise amplifiers, using a ground-based test facility at the Parkes Observatory. The test results confirmed that the second-generation design will reach performance targets, and indicated that the full-sized ADE PAF, made up of 188 elements, will perform somewhat better than the test system at the lower end of the frequency range when installed.

Following this successful verification, we are working to produce full-sized ADE PAFs, and expect to deploy them at the MRO in 2014.



System noise-temperature measurements of a prototype ASKAP second-generation phased array feed (with 40 elements). The result demonstrated very good low-noise performance across the 0.7–1.8 GHz frequency range required for ASKAP.



CSIRO staff Aaron Sanders and Chris Cantrall at work on a prototype second-generation phased array feed for the Australian SKA Pathfinder.

CSIRO ASKAP SCIENCE DATA ARCHIVE (CASDA)

In August we began planning for the CSIRO ASKAP Science Data Archive (CASDA). CASDA will be the primary point for storing, managing and sharing fully calibrated and science-ready data products, and will give the ASKAP Survey Science Teams access to processed data products for analysis. The CASDA development team is drawn from CASS and CSIRO Information Management and Technology. Through to the end of 2013, the focus of the project has been to get a more detailed understanding of ASKAP's requirements.

MRO SUPPORT FACILITY

In July we officially opened the new MRO Support Facility (MSF) in Geraldton, Western Australia. The event was a chance for the ASKAP team to thank regional stakeholders for their involvement in the establishment of the MRO, the ASKAP telescope and the MSF itself.

Located within the Geraldton Universities Centre, the MSF is to be a 'home base' for CSIRO staff that support ASKAP and other projects at the MRO, such as the Murchison Widefield Array (MWA) and who will, in the future, support the SKA Phase 1.

CASS staff at the opening of the MRO Support Facility.

SKA ACTIVITIES

The international Square Kilometre Array (SKA) will be the world's largest radio telescope, located in Australia and Southern Africa.

CSIRO has been involved in the SKA project for more than a decade. This year we established the CSIRO SKA Centre to coordinate the growing number of SKA-related activities within the organisation. Headed by the CASS Deputy Chief, Dr Sarah Pearce, the Centre will provide science and engineering expertise and guide CSIRO's engagement in the SKA.

CSIRO INVOLVEMENT IN SKA RESEARCH AND DEVELOPMENT CONSORTIA

To progress the design and validation of the SKA to a stage that will enable tendering and construction of the telescope from 2017, the SKA Organisation (SKAO) this year allocated research and development 'work packages' to consortia from around the world.

We submitted successful proposals to be involved in these consortia, and will play a key role in seven. We will:

- **lead** the largest of them, the *SKA Dish Array Consortium* (SKA-Dish) — responsible for designing SKA antenna dishes and receivers, and further developing PAF receivers
- **lead** the *Infrastructure Australia Consortium* (SKA-Infra Aus) — responsible for designing and costing infrastructure (such as buildings, communications and roads) at the MRO
- **be a key partner in** the *Assembly Integration and Verification Consortium* (SKA-AIV) — responsible for integrating ASKAP, and the South African SKA precursor MeerKAT, into Phase 1 of the SKA telescope
- **participate in** other SKA consortia, including those designing the telescope-control system and the telescope's signal-processing, data-transport and data-processing functions.

The Australian Department of Industry has made $18.8m available for SKA pre-construction consortia: CSIRO has been awarded $9m of this. The funding will contribute to CSIRO's leadership of the *Dish* and *Infrastructure Australia* consortia, and participation in the *Assembly Integration and Verification*, and *Signal and Data Transport* consortia.

AUSTRALIA – NEW ZEALAND SKA COORDINATION COMMITTEE

We are an active member of the Australia – New Zealand SKA Coordination Committee (ANZSCC), the inter-governmental body overseeing Australia and New Zealand SKA strategy and policy. The Chief of CASS represents CSIRO on the ANZSCC.

In 2013 CSIRO officers were members of several ANZSCC groups, including the:

- *Hosting Agreement Working Group*, which is working with the international SKA Organisation to formulate appropriate arrangements for the hosting of SKA in Australia
- *Radio-Quiet Subcommittee* and *Site Establishment Subcommittee*, which provides technical advice to progress site establishment and protection of radio quietness
- *Science Advisory Committee*, which advises ANZSCC on science matters associated with the SKA.

INDUSTRY AND OTHER STAKEHOLDER INVOLVEMENT

Our ASKAP and SKA engagement with industry continued this year through briefings, publications and tender updates, and early-phase research and development collaborations.

As in previous years, the ASKAP team took part in industry events organised by the Mid West Chamber of Commerce and Industry, and the City of Geraldton-Greenough, and in regular meetings with the WARAG (Western Australia Regional Advisory Group) committee, chaired by the Mid West Development Commission.

We also provided assistance to companies in the Mid West region regarding compliance with Radio-Quiet Zone requirements. This included modelling potential interference from new radio transmitters, suggesting measures to reduce interference, and providing advice to the Australian Communications and Media Authority (ACMA) and Government of Western Australia.

As part of preparations for the SKA pre-construction phase, we assisted the Department of Industry in a series of industry briefings around Australia.

We provided technical advice to ACMA on the radio-quietness requirements for SKA Phase 1, and made a submission in support of ACMA's proposed modifications to the Radiocommunications Assignment and Licensing Instruction MS32 over the Mid West Radio-Quiet Zone.

CSIRO continued to be an active member of the Australasian SKA Industry Consortium, a group of companies with a strong interest in ASKAP and the SKA.

Approximately $100m of ASKAP's $188-m budget has been spent on procurement and services from Australian companies.

ASKAP Project Director Ant Schinckel leading a tour group at the Murchison Radio-astronomy Observatory.

COLLABORATOR PROJECTS

The MRO is 'home' to not only ASKAP, but also to other radio-astronomy experiments that can make good use of its superb radio-quietness, principally the Murchison Widefield Array (MWA) and the Experiment to Detect the Global Epoch of Reionization Signature (EDGES).

Murchison Widefield Array (MWA)

Led by Curtin University in Perth, Western Australia, the MWA is a collaboration between US, Indian, New Zealand and Australian institutions (including CSIRO) to build a wide-field dipole array overlapping the low-frequency range specified for the SKA. The instrument has now moved into its full science operations phase. The first full six-month observing cycle, across ten key science projects, has been completed: it generated 1.5 TB of data, which is now archived at the Pawsey Centre in Perth.

Experiment to Detect the Global Epoch of Reionization Signature (EDGES)

The EDGES project was deployed at the MRO in 2009. A collaboration between Arizona State University and MIT/Haystack Observatory, it is funded by the US National Science Foundation. EDGES is collecting data between 80 and 200 MHz, to make long-term baseline measurements of low-level radio-frequency interference and ionospheric conditions. While continuing EDGES observations, the EDGES team began to deploy a second instrument, EDGES-2, in October.

The MRO and EDGES infrastructure was also used this year to support testing of a prototype receiver and antenna for the Dark Ages Radio Explorer (DARE), a NASA mission concept. DARE mirrors the goals and techniques of EDGES and is a collaboration between the EDGES group and a team led by the University of Colorado.

SKA Molonglo Prototype (SKAMP)

This year a small number of CSIRO staff continued to collaborate with the University of Sydney on the Square Kilometre Array Molonglo Prototype (SKAMP) project. The aim of SKAMP is to develop new technology for the SKA by producing a completely new digital-signal pathway on the existing mechanical superstructure of the University's Molonglo Observatory Synthesis Telescope.

CASS astronomer Maxim Voronkov with a student from the Pia Wajarri Remote Community School, during a visit by the school to the Murchison Radio-astronomy Observatory. Credit: Rob Hollow

Appendices

CASS astronomer Ryan Shannon, with students taking part in a PULSE@Parkes observing session at Koriyama Space Park in Japan. More than 1000 students have now participated in this ATNF outreach program, in which they control the Parkes telescope and use it to observe the rapidly rotating stars called pulsars. Credit: Rob Hollow

A: Committee membership

ATNF Steering Committee in 2013

CHAIR

Professor Rachel Webster, University of Melbourne

MEMBERS

Ex-officio

Professor Warrick Couch, Director, Australian Astronomical Observatory

Dr Bronwyn Harch, Chief, CSIRO Computational Informatics

Dr David Williams, Group Executive, CSIRO Information Sciences Group

Astronomers

Professor Brian Schmidt, Australian National University

Professor Steven Tingay, International Centre for Radio Astronomy Research

International advisers

Professor Neal Evans, University of Texas at Austin, USA

Dr Di Li, National Astronomical Observatories, Chinese Academy of Sciences, China

Professor Raffaella Morganti, Netherlands Foundation for Research in Astronomy, The Netherlands

Broader community

Mr Jim Noble, Australian Government Department of Defence (retired)

Mr Noel Wainwright, Lockheed Martin

Australia Telescope User Committee in 2013

CHAIR

Professor John Dickey, University of Tasmania (2012 – 2014)

SECRETARY

Dr Chris Phillips, CSIRO Astronomy and Space Science (October 2010 – June 2013)

Dr Nick Seymour, CSIRO Astronomy and Space Science (October 2013 – May 2015)

MEMBERS

Dr James Allison, University of Sydney (October 2011 – May 2014)

Dr Virginia Kilborn, Swinburne University of Technology (October 2011 – May 2014)

Dr Stephen Ord, International Centre for Radio Astronomy Research (October 2011 – May 2014)

Dr Ryan Shannon, CSIRO Astronomy and Space Science (October 2011 – May 2014)

Dr Minh Huynh, International Centre for Radio Astronomy Research (October 2012 – May 2015)

Dr Tobias Westmeier, International Centre for Radio Astronomy Research (October 2012 – May 2015)

STUDENT MEMBERS

Craig Anderson, University of Sydney (October 2013 – May 2014)

Emily Petroff, Swinburne University of Technology (October 2013 – May 2014)

Vikram Ravi, University of Melbourne (October 2012 – June 2013)

Sarah Reeves, University of Sydney (October 2012 – June 2013)

The Australia Telescope Steering Committee appoints members to the Australia Telescope User Committee. New members usually start their three-year term with the October/November meeting in their first year and finish their term after the May/June meeting in their last year. Students are appointed for one year (two meetings). Dates of the first and last meetings are given.

Australia Telescope Time Assignment Committee in 2013

CHAIR

Professor Michael Drinkwater, University of Queensland

MEMBERS

Ex-officio

Dr Douglas Bock, CSIRO Astronomy and Space Science

Dr Jessica Chapman, CSIRO Astronomy and Space Science

Dr Philip Edwards, CSIRO Astronomy and Space Science

TAC members

Dr Duncan Galloway, Monash University

Dr James Green, CSIRO Astronomy and Space Science

Dr George Hobbs, CSIRO Astronomy and Space Science

Dr Helen Johnston, University of Sydney

Dr Jim Lovell, University of Tasmania

Professor Gerhardt Meurer, International Centre for Radio Astronomy Research

Dr Martin Meyer, International Centre for Radio Astronomy Research

Dr Shane O'Sullivan, CSIRO Astronomy and Space Science

Dr Jill Rathborne, CSIRO Astronomy and Space Science

Dr Emma Ryan-Webber, Swinburne University of Technology

Dr Willem van Straten, Swinburne University of Technology

Dr Andrew Walsh, James Cook University / Curtin University

Readers

Dr Ramesh Bhat, International Centre for Radio Astronomy Research

Dr Simon Ellingsen, University of Tasmania

Dr Gary Fuller, University of Manchester, UK

Dr Jose-Francisco Gomez, Instituto de Astrofisica de Andalucia, Spain

Dr Mareki Honma, National Astronomical Observatory of Japan, Japan

Dr Minh Huynh, International Centre for Radio Astronomy Research

Dr Emil Lenc, University of Sydney

B: Financial summary

The table below summarises the revenue and expenditure applied to CSIRO's radio astronomy activities, also including related activities resourced from the CSIRO ICT Centre.

	Year ending 30 June 2011 (A$'000)	Year ending 30 June 2012 (A$'000)	Year ending 30 June 2013 (A$'000)
Revenue			
External	7,181	13,726	4,213
Appropriation	36,419	35,623	35,668
Total revenue	43,600	49,349	39,881
Expenses			
Salaries	14,046	14,884	16,688
Travel	1,080	1,093	1,432
Other operating	5,028	5,081	5,143
Overheads*	12,914	13,055	12,725
Corporate support services	0	0	0
Depreciation and amortisation	3,953	4,081	4,628
Doubtful debt expense	0	0	0
Total expenses	37,021	38,194	40,616
Profit/(Loss) on sale of assets	0	0	0
Operating result	6,579	11,155	–735

NOTES:

CSIRO has a 'matrix' operating structure. This financial summary refers to the 'output' side of the CSIRO matrix: outputs are CSIRO portfolios and themes.

External revenue for the years ending 30 June 2011 and 30 June 2012 was impacted by one-off agreements related to funding for the ASKAP project.

*Overheads include corporate support services and business-unit support services.

C: Staff list

ALL STAFF WHO WORKED FOR CASS ON RADIO ASTRONOMY RELATED ACTIVITIES IN 2012

This list includes casual staff and honorary fellows, but not students or contractors. It records staff who worked at any point throughout the year.

MARSFIELD		
Allen	Graham	Engineering
Amy	Shaun	Operations
Ball	Lewis	CASS Chief and ATNF Director
Banfield	Julie	Astrophysics
Bannister	Keith	Astrophysics
Bateman	Tim	Engineering
Beresford	Ron	Engineering
Bock	Douglas	Operations
Bolton	Russell	Engineering
Bourne	Michael	Engineering
Bowen	Mark	Engineering
Braun	Robert	Astrophysics
Breen	Shari	Astrophysics
Bressert	Eli	Astrophysics
Broadhurst	Steven	Operations
Brooks	Kate	Operations
Brown	Andrew	Engineering
Carrad	Graeme	Engineering
Carretti	Ettore	Operations
Castillo	Santiago	Engineering
Chapman	Jessica	Operations
Chekkala	Raji	Engineering
Cheng	Wanxiang	Engineering
Chippendale	Aaron	Engineering
Chow	Kate	Project Specialist
Chung	Yoon	Engineering
Contreras	Yanett	Astrophysics
Cook	Geoffrey	Engineering
Cooper	Paul	Engineering
Craig	Daniel	Operations
Crosby	Phil	Business Strategy
Dawson	Joanne	Astrophysics
Death	Michael	Engineering
Doherty	Paul	Engineering

Drazenovic	Vicki	Operations
Dunning	Alexander	Engineering
Edwards	Leanne	Operations
Edwards	Philip	Operations
Ekers	Ron	Fellow
Emonts	Bjorn	Astrophysics
Feain	Ilana	Business Strategy
Ferris	Richard	Engineering
Forsyth	Ross	Engineering
Franzen	Thomas	Astrophysics
Fraser	Vicki	Project Specialist
Frost	Gabriella	Project Specialist
Gomez	Laura	Astrophysics
Gonidakis	Yiannis	Astrophysics
Gough	Russell	Engineering
Green	James	Astrophysics
Guzman	Juan Carlos	Operations
Haan	Sebastian	Astrophysics
Hampson	Grant	Engineering
Harvey-Smith	Lisa	Astrophysics
Haskins	Craig	Operations
Heywood	Ian	Astrophysics
Hill	Alex	Astrophysics
Hobbs	George	Astrophysics
Hotan	Aidan	Project Specialist
Humphreys	Ben	Operations
Huynh	Minh	Engineering
Indermuehle	Balthasar	Operations
Jackson	Carole	Project Specialist
Jeganathan	Kanapathippillai	Engineering
Johnson	Megan	Astrophysics
Johnston	Simon	Astrophysics
Jurek	Russell	Astrophysics
Kamphuis	Peter	Astrophysics
Kanoniuk	Henry	Engineering
Keith	Michael	Astrophysics
Kerr	Matthew	Astrophysics
Kesteven	Michael	Engineering
Kiraly	Dezso	Engineering
Koribalski	Bärbel	Astrophysics
Kosmynin	Arkadi	Operations
Leach	Mark	Engineering
Lie	Jennifer	Engineering
Mackay	Simon	Engineering
Macleod	Adam	Project Specialist
Maher	Tony	Operations
Manchester	Dick	Fellow
Marquarding	Malte	Operations
McClure-Griffiths	Naomi	Astrophysics
McConnell	David	Operations
McIntyre	Vincent	Operations
McKinnon	Mark	Business Strategy

Mickle	Samantha	Engineering
Moncay	Ray	Engineering
Morison	Neale	Operations
Neuhold	Stephan	Engineering
Ng	Alan	Project Specialist
Ng	Andrew	Engineering
Norris	Ray	Astrophysics
O'Sullivan	John	Fellow
O'Toole	Sally	Engineering
Pearce	Sarah	CASS Deputy Chief
Phillips	Chris	Operations
Pope	Nathan	Operations
Rathborne	Jill	Astrophysics
Reilly	Les	Engineering
Reynolds	John	Project Specialist
Roberts	Paul	Engineering
Sanders	Aaron	Engineering
Schinckel	Antony	Project Specialist
Serra	Paolo	Astrophysics
Seymour	Nicholas	Astrophysics
Shannon	Ryan	Astrophysics
Shields	Matthew	Engineering
Shimwell	Timothy	Astrophysics
Sloman	Michael	Engineering
Storey	Michelle	Policy Strategy
Tam	Kam	Operations
Toomey	Lawrence	Operations
Troup	Euan	Operations
Tuthill	John	Engineering
Tzioumis	Tasso	Operations
Voronkov	Maxim	Operations
Whiting	Matthew	Operations
Wilson	Warwick	Fellow
Wilson	Carol	Policy Strategy
Wong	Ivy	Astrophysics
Wright	Adrian	Engineering
Wu	Xinyu	Operations
MARSFIELD RESEARCH SUPPORT		
Barends	Anne	Executive Secretary
Bax	Warren	Commercial Advisor
Broadhurst	Sue	Reception
Clampett	Keith	Stores
Conway-Derley	Flornes	Communications and Outreach
Crawshaw	Tony	Communications and Outreach
D'Amico	Andy	Stores
Fraser	Kylie	Health, Safety and Environment
Gray	Amanda	Administration
Hartmann	Carmel	Administration
Hayes	Jacqui	Communications and Outreach
Hollow	Robert	Communications and Outreach
Joos	Ariana	Library
Kachwalla	Elsa	Reception

Looi	Chee Kong	Health, Safety and Environment
Merrick	Sarah	Finance
O’Loughlin	Vicki	Administration
O'Toole	Sally	Reception
Poshoglian	Meg	Reception
Russell	Gabby	Communications and Outreach
Sestan	Rebekah	Operations
Sim	Helen	Communications and Outreach
Tesoriero	Julie	Administration
Wright	Andrew	Human Resources
Wilson	Briony	Finance
NARRABRI		
Bateman	John	Operations
Brem	Christoph	Operations
Brodrick	David	Operations
Hill	Michael	Operations
Hiscock	Brett	Operations
Lennon	Brett	Operations
Madden	Brian	Operations
McFee	John	Operations
Mirtschin	Peter	Operations
Munting	Scott	Operations
Rex	Jordan	Operations
Stevens	Jamie	Operations
Sunderland	Graeme	Operations
Tough	Bruce	Operations
Wark	Robin	Operations
Wieringa	Mark	Operations
Wilson	John	Operations
Wilson	Tim	Operations
NARRABRI RESEARCH SUPPORT		
Dodd	Susan	Operations
Forbes	Kylee	Operations
Hiscock	Jennifer	Operations
Kelly	Pamela	Operations
McFee	Margaret	Operations
McPherson	Liza-Jane	Operations
Prestage	Joslin	Operations
Rees	Margaret	Operations
Shields	Mick	Health Safety and Environment
Wilson	Christine	Operations
PARKES		
Brady	Scott	Operations
Crocker	Jonathan	Operations
D’Mello	Glen	Operations
Hoyle	Simon	Operations
Hunt	Andrew	Operations
Kaletsch	Robert	Operations
Lees	Tom	Operations
Lensson	Erik	Operations
Lowe	Vicki	Operations
Mader	Stacy	Operations

Pieroz	Allan	Operations
Preisig	Brett	Operations
Reeves	Ken	Operations
Ruckley	Timothy	Operations
Sarkissian	John	Operations
Smith	Malcolm	Operations
Spratt	Gina	Operations
PARKES RESEARCH SUPPORT		
Abbey	Alexander	Communications and Outreach
Chaudhary	Ankur	Operations
Dean	Andrew	Communications and Outreach
Evans	Anne	Operations
Hill	Colin	Communications and Outreach
Hockings	Julia	Operations
Hollingdrake	Chris	Communications and Outreach
Ingram	Shirley	Operations
Marshall	Margaret	Operations
Milgate	Lynette	Communications and Outreach
Trim	Tricia	Communications and Outreach
Unger	Karin	Communications and Outreach
Veale	Roxanne	Communications and Outreach
Wilson	Beverley	Communications and Outreach
GERALDTON		
Armstrong	Brett	Operations
Boddington	Robin	Project Specialist
Briggs	Brayden	Health, Safety and Environment
Clayton	Priscilla	Project Specialist
Cox	Thomas	Operations
Harding	Alex	Operations
Jackson	Suzy	Operations
McConigley	Ryan	Operations
McIntosh	Michelle	Operations
Morris	John	Operations
Pena	Wilfredo	Health, Safety and Environment
Puls	Lou	Operations
Reay	Michael	Operations
Simpson	Godfrey	Project Specialist
Turner	Barry	Operations
Whiting	Gemma	Operations
CANBERRA		
Zamora-Pullin	Kobi	Astrophysics
CANBERRA DEEP SPACE COMMUNICATION COMPLEX		
Nagle	Glen	Communications and Outreach

D: Observing programs

The observations listed are those that were allocated time through the Time Assignment Committee's processes. A small number of 'Target of Opportunity' observations are not listed. Proposal cover sheets are available online through the ATNF proposal application system, OPAL (http://opal.atnf.csiro.au/searchProposals.do).

OBSERVATIONS MADE WITH THE AUSTRALIA TELESCOPE COMPACT ARRAY

October 2012 to September 2013

OBSERVERS	PROGRAM	NO.
Stevens, Edwards, Wark, Wieringa	ATCA calibrators	C007
Staveley-Smith, Gaensler, Tzioumis, Ng, Zanardo,	Supernova remnant 1987A	C015
Ryder, Smith, Böttcher	The 1978 supernova in NGC 1313	C184
Coriat, Tzioumis, Corbel, Fender, Brocksopp	Radio jets in recurrent and new black hole X-ray transients	C989
Corbel, Tzioumis, Fender, Kaaret, Tomsick, Orosz	Large scale radio/X-ray jets in microquasars	C1199
Ryder, Weiler, Stockdale, Van Dyk, Panagia, Amy, Immler, Burlon	NAPA observations of core-collapse supernovae	C1473
Edwards, Macquart, Lovell, Ojha, Kadler, Hungwe, Stevens, Blanchard, Mueller, Wilms, Boeck	ATCA monitoring of gamma-ray loud AGN	C1730
Ubach, Lommen, Maddison, Wright, Wilner	A multi-wavelength study of grain growth in protoplanetary disks	C1794
Eckart, Sjouwerman, Baganoff, Straubmeier, Kunneriath, Garcia-Marin, Valencia-S., Moser, Bursa, Karas, Borkar	2012 coordinated run on SgrA*	C1825
Lumsden, Voronkov, Brooks, Hoare, Garay, Urquhart, Purcell, Guzman, Maud, Cunningham	Ionised winds and jets from massive young stellar objects	C1862
Voronkov, Caswell, Green, Sobolev, Ellingsen, Goedhart, Gaylard, van der Walt, Maswanganye	Understanding periodic flares of the methanol masers	C1929
Edge, Sadler, Combes, Mahony, Fabian, Hamer, McDonald, Russell, Wilman, Hogan, McNamara, Hlavacek-Larrondo, Grainge, Salomé	Linking the radio and X-ray of AGN in cluster cores	C1958
Torkelsson, Pestalozzi, Evangelista, Kifle Hailemariam	Long term variation in the radio flux of BP Cru	C1976
Jordan, Bains, Voronkov, Lo, Jones, Muller, Cunningham, Burton, Brooks, Green, Fuller, Barnes, Ellingsen, Urquhart, Morgan, Rowell, Walsh, Loenen, Baan, Hill, Purcell, Breen, Peretto, Jackson, Lowe, Longmore	The MALT-45 survey	C2029
Corbel, Edwards, Sadler, Ojha, Thompson, Gehrels, Tingay, Cheung, Wieringa, Grenier, Chaty, Dubus, Cameron, Abraham , Schinzel	ATCA follow-up of unidentified flaring Fermi gamma-ray sources	C2051
Emonts, Sadler, Morganti, Norris, Tadhunter, Ekers, Feain, Oosterloo, Miley, Chow, Stevens, Mao, Carilli, Mahony, Saikia, Röttgering, van Moorsel, Villar-Martin, Seymour	CO content of protocluster radio galaxies in the early Universe: a CABB study	C2052
Casassus, Maddison, Wright, Menard, Perez	Planet-formation feedback in HD142527	C2094
Alexander, Gulyaev	Measuring extremely weak stark-broadened RRLs	C2118
Jones, Lo, Cunningham, Thorwirth, Menten, Schilke, Belloche, Mueller, Walsh, Bronfman, Purcell, Cordiner, Remijan, Charnley, Qin, Balnozan	Molecules in Sagittarius B2: a line study of the whole 7-mm band with CABB	C2318
Jarrett, Tsai, Phillips, Norris, Emonts, Cluver, Eisenhardt, Stern, Assef	Decoding the inner core region of binary black-hole candidate WISE J2332-5056	C2328
Sadler, Morganti, Zwaan, Whiting, Curran, Bland-Hawthorn, Oosterloo, Allison, Emonts, Reeves	A search for HI absorption in young compact radio galaxies	C2434
Possenti, Burgay, Israel, Wieringa, Rea, Esposito	Continuum radio emission from magnetars in outburst	C2456
Green, Gaensler, Voronkov, Rathborne, Burton, Brooks, Garay, Purcell, Breen, O'Sullivan, Smith, Reiter	Carina Parkes–ATCA radio centimetre-wavelength survey (CARPARCS)	C2489

OBSERVERS	PROGRAM	NO.
Murphy, Stark, Marrone, McIntyre, Vieira, Carlstrom, Aravena, Chapman, Malkan	Radio spectral indices for high-redshift, strongly-lensed, dusty star-forming galaxies discovered with the South Pole Telescope	C2507
Miller-Jones, Migliari, Diaz-Trigo	Probing the disc wind-jet connection in black-hole transients	C2514
Miller-Jones, Tzioumis, Maccarone, Jonker, Nelemans, Sivakoff	Constraining black hole formation with triggered LBA astrometry	C2538
Coriat, Corbel, Fender, Belloni, Miller-Jones, Soleri	Following the decay of the black-hole candidate X-ray binary SWIFT J1753.5-0127	C2541
Uscanga, Gomez, Miranda, Torrelles, Anglada, Tafoya, Suarez, Boumis	Confirmation of the association of water masers with the planetary nebulae IRAS 12405-6219 and IRAS 16333-4807	C2567
Reeves, Murphy, Koribalski, Sadler, Allison, Emonts	A search for HI absorption in gas-rich galaxies from HIPASS	C2573
Feain, Johnston-Hollitt, Norris, Ekers, O'Sullivan, Anderson, Jiraskova	A detailed study of the vortex/vertex region in Centaurus A's giant southern lobe	C2575
Hunstead, Johnston, Schaefer	Giant radio galaxies from SUMSS: the low-power relic GRG NGC 641	C2583
Miller-Jones, Altamirano, Soria, Tingay, Moin, Sivakoff, Krimm	Jet–disc coupling in black-hole X-ray binary outbursts	C2601
Beaulieu, Ken, Lord	HI Mapping in NGC 5102	C2623
Petrov, Murphy, McConnell, Edwards, Sadler, Taylor, Mahony, Kovalev, Schinzel	ATCA observations of Fermi unassociated sources	C2624
Jones, Fukui, Burton, Rowell, Walsh, de Wilt, Hofverberg	G318.2+0.1: the first unambiguous evidence of a hadronic Pevatron?	C2625
Smolcic, Bremer, Birkinshaw, Raychaudhury, Horellou, Röttgering, Pacaud, McGee, Lidman, Pierre, Chiara, Comastri	ATCA-XXL pilot project: constraining black-hole growth and feedback processes through cosmic times	C2627
Davies, Bremer, Stanway, Birkinshaw, Husband	Confirming and studying an actively star-forming cluster at z~1.8	C2632
Jackson, Rathborne, Foster, Sanhueza, Hoq	Chemical oddballs in the late stages of star formation	C2635
Johnston, Keto, Beuther, Wood, Linz, Boley, Robitaille, van Boekel	Probing the effect of ionization on the circumstellar structure of the massive embedded star AFGL 4176	C2646
Pavan, Filipovic, Crawford, de Horta, Bozzo, Ferrigno	ATCA observation of the 'double-head' bow-shock PWN	C2651
Purcell, Gaensler, McClure-Griffiths, Kaczmarek, Sun, Hill, Burkhart, Lazarian, Gheissari	Measuring the turbulent ISM via polarised radio emission	C2676
Macario, Johnston-Hollitt, Venturi, Brunetti, Dallacasa, Brown, Kale, Pratt, Ferrari, Cassano, Giacintucci, Arnaud, Intema	Searching for radio haloes in the MACS-Planck X-ray-luminous cluster sample (III): final stage	C2679
Loinard, Belloche	Toward an accurate determination of the distance to the Chamaeleon star-forming region	C2682
Hancock, Gaensler, Murphy, Bell, Burlon, de Ugarte Postigo	ATCA observations of the brightest, shortest and highest-redshift GRBs	C2689
Basu, Klein, Nord, Bertoldi, Babul, Dolag, Nagarajan	A census of radio haloes in Planck-SZ-selected galaxy clusters	C2693
Sun, Gaensler, McClure-Griffiths, Purcell, Hill, Burkhart, Lazarian	The energy spectrum and geometrical structure of Galactic turbulent magnetic field	C2698
Fuller, Avison, Cunningham	Probing the evolutionary status of MMB sources	C2699
Michalowski, van der Werf, Hjorth, Castro Cerón, Malesani, Gentile, Baes, Xu, Rossi, Savaglio, Stephane, D'Elia, Palazzi, Hunt, Burlon, Klose, Nicuesa Guelbenzu	The atomic-gas survey of gamma-ray-burst host galaxies	C2700
Kilborn, Koribalski, Wong, Wolfinger, Jurek, Jozsa, Denes, Kauffmann, Catinella	Gas accretion in nearby spiral galaxies	C2705
Hancock, Gaensler, Murphy, Kulkarni, Schmidt	The GRB–SNe central engines as revealed by relativistic SNe	C2707
Izumi, Kohno, Nakanishi, Tamura, Takano, Nakajima	Multi-transition analysis of dense molecular gas in the central kiloparsec region of NGC 253	C2714
Emonts, Sadler, Morganti, Norris, Ekers, Feain, Miley, Mao, Carilli, Mahony, Saikia, Röttgering, van Moorsel, Villar-Martin, Seymour	Widespread molecular gas across the z=2 'Spiderweb' protocluster	C2717
Greiner, Michalowski, Rossi, Savaglio, Palazzi, Hunt, Elliott, Klose, Kruehler, Schady	Probing star formation in the most massive gamma-ray-burst host galaxies	C2718

OBSERVERS	PROGRAM	NO.
Burlon, Gaensler, Murphy, Hancock, Bell, Bannister, Greiner, Klose, Ghirlanda, Nardini	The quest for short gamma-ray-burst radio afterglows	C2721
Norris, Lazio, Oosterloo, Mao, Huynh, Rottgering, Sirothia, Murphy, Condon	The SPARCS reference fields — a pilot study at dec +29	C2723
For, McClure-Griffiths, Staveley-Smith, Westmeier, Bekki	The multiphase structure of high-velocity clouds in the Leading Arm	C2725
Tarchi, Chapman, Panessa, Castangia, Braatz	Water maser and narrow-line Seyfert 1s: the case of IGR16385	C2726
Pascucci, Brooks, Ricci, Hollenbach, Gorti	Free-free continuum emission from photo-evaporating disks	C2727
Banfield, Emonts, O'Sullivan	Radio-source morphology: 'nature or nuture'?	C2728
Collier, Filipovic, Norris, Hopkins, Chow, Tothill, Shabala	Sequencing the earliest stages of AGN development using faint ELAIS GPS/CSS sources	C2730
Huynh, Norris, Emonts, Seymour	Tracing molecular gas in a high-redshift (z = 4.48) radio-loud galaxy	C2732
Buyle, de Rijcke, Cloet-Osselaer	Synchroton emission of intermediate-mass black holes	C2733
Schnitzeler, Macquart, Bignall, Edwards, Ojha, Stevens, Reynolds	Probing the inner regions around AGN cores using the ATCA and rotation-measure synthesis	C2734
Anderson, Gaensler, Feain	A deep new view of thermal and magnetic structure in the radio galaxy Fornax A	C2735
Disney, Lang	A deep new view of thermal and magnetic structure in the radio galaxy Fornax A	C2737
Asaki, Miyoshi, Tsuboi, Horiuchi, Nishiyama, Yonekura, Kato, Takaba, Miyamoto, Takahashi, Saida	First-phase observations of the enormous flare due to vast mass infall onto the Sgr A* black hole	C2738
Hill, Gaensler, McClure-Griffiths	Magnetic structure of a high-velocity cloud	C2741
Kirichenko, Johnston, Camilo, Shibanov, Danilenko, Lai	Hunting for a hyper-fast pulsar	C2742
Aravena, Weiss, de Breuck, Marrone, McIntyre, Vieira, Greve, Chapman, Murphy, Aguirre, Bothwell	Unveiling the cold molecular gas in the brightest and most distant galaxies discovered with the SPT	C2744
Hodgson, Bignall, Ellingsen, Fuhrmann, Godfrey, Shabala, Krichbaum, Savolainen	Micro-arcsecond structure in blazar PKS 1257-326	C2745
Suarez, Gomez, Green, Miranda, Rizzo, Guerrero, Bendjoya, Uscanga	Probing the first case of synchrotron emission in a planetary nebula	C2746
Moldon, Johnston, Miller-Jones, Ribo, Paredes	Unpulsed emission of PSR B1259-63 during apastron (ATCA observation)	C2747
Mao, Norris, Sharp	Star formation in a transitioning radio source	C2749
Burlon, Murphy, Sadler, Ekers, Hancock, Bell	Extreme-spectrum sources from the AT20G	C2753
O'Sullivan, Gaensler, Landecker, Willis	Correcting ionospheric Faraday rotation for ASKAP	C2754
Shimwell, Gaensler, Feretti, Feain, Farrar, Brown, Lage	Probing the synchrotron shocks and the magnetic field of the Bullet Cluster	C2756
Denes, Kilborn, Koribalski	HI-deficient galaxies in low- and intermediate-density environments	C2758
de Gregorio-Monsalvo, Gomez, Brooks, Anglada, Walsh, Osorio, Horiuchi	Completion of an all-sky survey of water masers in Bok globules	C2759
Kamphuis, Koribalski, Serra, Haan, Heald, Summer Vacation Student Program	Fueling star formation in local galaxies	C2764
Ng, Gaensler, Slane, Harvey-Smith	High-resolution radio imaging of the 'Cosmic Hand'	C2765
Fukuda, Yamamoto, Fukui, Torii, Hayakawa, Okuda, Sano, Yoshiike	Detailed 21-cm observations towards the TeV?-ray SNR HESS J1731-347	C2766
Miller, Johnston-Hollitt	Characterising radio emissions in cosmic filaments	C2767
Collier, Filipovic, Norris, Crawford, Tothill, Wong, Shabala	Sequencing the earliest stages of AGN development using mid-strength GPS/CSS sources near the SMC	C2768
Bernet, Gaensler, Lilly, O'Sullivan, Miniati	Magnetic fields in galaxies at high redshifts	C2769
Bignall, McConnell, Edwards	Follow-up of candidate intraday variables from ATPMN: a search for fast scintillators	C2770
Sun, Gaensler, Purcell, Harvey-Smith, Kothes	Magnetic field in the supernova remnant G296.5+10.0	C2772
Kaczmarek, Gaensler, Feain, Purcell, O'Sullivan	Search for internal polarisation and Faraday structure in radio-galaxy lobes	C2776

OBSERVERS	PROGRAM	NO.
Ellingsen, Caswell, Voronkov, Green, Fuller, Breen	Pinpointing the youngest high-mass stars	C2777
Seymour, Norris, de Breuck, Emonts, Sirothia	Episodic radio AGN activity in the Spiderweb Galaxy	C2778
Sadler, McConnell, Edwards, Pracy, Croom, Ching, Shabala	The birthrate of radio galaxies across cosmic time	C2779
Purcell, Gaensler, Carretti, Sun	Probing turbulence in SNRs through RM structure-functions	C2780
Dalton, Johnston, Reinfrank, Oya, Schwanke, Sushch	A search for radio counterparts to the synchrotron–underluminous pulsar wind nebula HESS J1303-631	C2783
Tothill, Filipovic, Walsh, Norris, Stark, Marrone, Crawford, McIntyre, Vieira, Holzapfel, Murphy, Malkan, Collier, Seymour, O'Brien, Spilker	The ATCA–SPT survey of southern extragalactic sky	C2788
Farnes, Gaensler, Feain, Farrell, Bell, O'Sullivan, Anderson, Sun, Akahori	The supernova remnant W50: understanding the magnetic fields in a unique outflow-driven object	C2792
Govoni, Staveley-Smith, Carretti, Feretti, Murgia, Giovannini, Vacca, Brown	Parkes–ATCA Cluster Survey (PACS): single-dish and interferometric imaging of radio ICM diffuse emission in galaxy clusters	C2793
Lacy, Mao, Sajina, Evans, Glikman, Urrutia, Hodge, Petric	CO(1-0) in luminous type-2 quasars selected in the mid-IR	C2794
Jordan, Bains, Voronkov, Lo, Jones, Muller, Cunningham, Burton, Brooks, Green, Fuller, Barnes, Ellingsen, Urquhart, Morgan, Rowell, Walsh, Loenen, Baan, Hill, Purcell, Breen, Peretto, Jackson, Lowe, Longmore	Accurate maser positions for MALT-45	C2797
Ellingsen, Macquart, Bignall, Breen, Reynolds, Imai, Keller, Bekki, Krishnan, Cioni	Measuring the proper motions of the Large and Small Magellanic Clouds	C2798
Doyle, Antonova, Ramsay, Yu, Kuznetsov	Accessing coherent emission events in dMe stars	C2799
Doyle, Antonova, Ramsay, Yu, Kuznetsov	Determining which mechanism is responsible for the broadband emission from low-mass stars and brown dwarfs	C2800
Fontani, Dodson, Cesaroni, Beltran, Brand, Caselli, Rioja, Giannetti, Commerçon	Fragmentation in massive dense clumps: linking low- and high-density gas	C2801
Voronkov, Caswell, Green, Ellingsen, Breen	An 8-mm follow-up of the MMB detections	C2807
Macquart, Bower, Marrone, O'Sullivan	Probing the G2 gas cloud disruption by Sagittarius A*	C2808
Balnozan, Lo, Jones, Cunningham, Hill, Bronfman	Observations of two 'millimetre-only' cores as candidates for early high-mass star-forming regions	C2809
Bannister, Sadler, Norris, Hancock, Bower, O'Sullivan	ATCA observations of a candidate tidal 'discruption' flare	C2810
Malarecki, Staveley-Smith, Subrahmanyan, Saripalli, Jones	An exceptionally large giant radio quasar?	C2812
Huynh, Norris, Emonts, Seymour	Water masers in the early ($z > 2$) Universe	C2813
Huynh, Norris, Emonts, Swinbank, Ivison, Coppin, Smail, Smolcic	Physical conditions of gas in high-redshift ($z > 4.4$) ALMA-detected submillimetre galaxies	C2815
Aravena, Weiss, de Breuck, Stark, Marrone, McIntyre, Vieira, Greve, Chapman, Murphy, Aguirre, Bothwell, Gullberg	Completing the CO spectral-line energy distribution for luminous starburst galaxies discovered with the SPT	C2816
Aravena, Weiss, de Breuck, Stark, Marrone, McIntyre, Vieira, Greve, Chapman, Murphy, Aguirre, Bothwell, Gullberg	Unveiling the molecular gas in the brightest and most distant star-forming galaxies discovered by the SPT	C2818
Bergeron, Beelen, Omont, Muller, Federman, Boisse	Molecular absorbers as probes of cold gas at high redshift: observations in the ATCA 7-mm band	C2825
Spilker, Weiss, de Breuck, Marrone, McIntyre, Vieira, Greve, Aravena, Chapman, Aguirre, Bothwell	An oasis in the redshift desert: completing the first ALMA redshift survey of galaxies discovered by the South Pole Telescope	C2826
Morganti, Oosterloo, Mahony	Tracing HI in the young radio source PKS B1718-649: clues on feeding and feedback	C2832
Peretto, Fuller, Avison, Duarte Cabral, Pineda	How really massive is SDC335 MM1? Determining the centimetre SED of MM1 with ATCA	C2835
Johnston-Hollitt, Basu, Nord, Hindson, Shakouri	A census of radio emission in a complete SZ-derived cluster sample	C2837
Parma, Staveley-Smith, Subrahmanyan, Saripalli, Murgia	Duty cycles of radio galaxies	C2838
Jackson, Rathborne, Sanhueza, Whitaker, Camarata	The evolution of high-mass star-forming cores in the Nessie Nebula	C2839

OBSERVERS	PROGRAM	NO.
Nicuesa Guelbenzu, Michalowski, Rossi, Palazzi, Hunt, Greiner, Klose, Schmidl	Reveiling the dust-obscured SFR in host galaxies of short GRBs	C2840
Sanhueza, Green, Jackson, Foster	Using NH_3 to measure fragmentation in pre-stellar clumps	C2841
Jones, Dickey, Dawson, Anderson, Bania, Balser	Radio recombination lines from HII regions in the outer Galaxy	C2842
Thomson, Sadler, van der Werf, Massardi, Hopkins, White, Michalowski, Bremer, Birkinshaw, Andreani, Croom, Ivison, Eales, Ibar, Lopez-Sanchez, Hardcastle, Jarvis, Temi, Dunne, Seymour, Clements, Bussmann, Bourne	High-resolution imaging of dusty galaxies in H-ATLAS/GAMA	C2845
Heywood, van der Werf, Massardi, Michalowski, Bremer, Coppin, Jarvis, Temi, Seymour, White	Molecular-gas masses of radio galaxies in the peak epoch of galaxy formation	C2847
Cordiner, Jones, Millar, Charnley, Mcelroy, Milam	A closer look at eta Carinae's surprising nitrogen chemistry	C2848
Moss, Murphy, Pisano, McClure-Griffiths, Dawson, Ford, Hill	The infall and outflow of multi-component high-velocity clouds	C2849
Motogi, Walsh, Hirota, Niinuma, Sugiyama, Fujisawa, Yonekura, Honma, Sorai	Millimetre imaging of the extremely-high-velocity molecular jet in G353.273+0.641	C2851
Bignall, Macquart, Jauncey	Additional ATCA monitoring in support of RadioAstron–LBA observations of three high-brightness-temperature blazars	C2859

OBSERVATIONS MADE WITH THE PARKES RADIO TELESCOPE

October 2012 to September 2013

OBSERVERS	PROGRAM	NO.
Freire, Manchester, Kramer, Lyne, D'Amico, Camilo, Lorimer	Timing and searching for pulsars in 47 Tucanae	P282
Bhat, Verbiest, Bailes, van Straten	Studies of relativistic binary pulsars	P361
D'Amico, Possenti, Manchester, Johnston, Kramer, Sarkissian, Lyne, Burgay, Corongiu, Camilo, Bailes, van Straten	Timing of millisecond pulsars in globular clusters	P427
Burgay, Possenti, Manchester, Kramer, Lyne, McLaughlin, D'Amico, Camilo, Stairs, Lorimer, Ferdman, Yuen	Timing and geodetic precession in the double pulsar	P455
Hobbs, Manchester, Sarkissian, Bailes, Bhat, Keith, Burke-Spolaor, Coles, van Straten, Yardley, Ravi, Oslowski, Khoo, Shannon, Wang, Levin	A millisecond-pulsar timing array	P456
Titov, Bignall, Lovell, Dickey, Edwards, Jauncey, Ellingsen, Reynolds, Fey, Natusch, Tingay, Reynolds, Hase, Gulyaev, Shabala, Stanford, Dawson, Johnston, Jacobs, Behrend, Himwich, Thomas, Tregoning, Watson, Ruddick	Improving the terrestrial and celestial reference frame through southern-hemisphere geodetic VLBI observations	P483
Shannon, Possenti, Manchester, Johnston, Hobbs, Keith, Romani, Thompson, Roberts, Weltevrede, Brook	Pulsar timing and the Fermi and AGILE missions	P574
Camilo, Johnston, Sarkissian, Reynolds, Ransom, Halpern	The remarkably active radio magnetar 1E 1547.0-5408	P602
Burgay, Possenti, Sarkissian, Israel, Rea, Esposito	Searching for radio pulsations triggered by the X-ray outburst of magnetars	P626
Champion, Possenti, Johnston, Kramer, Burgay, D'Amico, Bailes, Bhat, Keith, van Straten, Stappers, Bates, Levin, Milia, Ng, Thornton, Coster, Barsdell, Tiburzi, Petroff	The high-time-resolution Universe	P630
Li, Staveley-Smith, Pen, Chang, Peterson, Bandura, Chen, Wang, Price, Montero-Castaño, Anderson, Voytek, Masui, Switzer, Wu, Timbie, Liao, Li	HI-intensity mapping: Parkes-2dFGRS and BAO science	P641
Bauer, Staveley-Smith, Kesteven, Bailes, Hopkins, Meyer, Boyle, van Straten, Delhaize, Driver, Robotham, Price	Galaxy evolution — a pathfinder study	P669
Robishaw, Landecker, Heiles	Can Parkes be a Galactic 21-cm Zeeman machine?	P693
Hobbs, Manchester, Carretti, Johnston, Sarkissian, Reynolds, Bailes, Keith, van Straten, Oslowski, Jameson, Shannon	Instrumental calibration for pulsar observing at Parkes	P737

OBSERVERS	PROGRAM	NO.
Possenti, Manchester, Johnston, Kramer, Sarkissian, Lyne, Burgay, Corongiu, D'Amico, Camilo, Bailes, van Straten	A new deep search for millisecond pulsars in globular clusters	P778
McLaughlin, Johnston, Kramer, Lyne, Burke-Spolaor, Eatough, Stappers, Keane, Miller, Palliyaguru, Cui, Young, Miller	Transient radio neutron stars	P786
Keith, Possenti, Manchester, Johnston, Kramer, Hobbs, Burgay, Camilo, Stairs, Bailes, Burke-Spolaor, Ferdman, Eatough, Lorimer, van Straten, Stappers, Levin, Champion, Ng, Thornton	Timing of binary and millisecond pulsars discovered at Parkes	P789
Camilo	Monitoring known X-ray magnetars for intermittent radio emission	P791
Carretti, Staveley-Smith, Govoni, Feretti, Murgia, Giovannini, Vacca, Brown	Parkes–ATCA cluster survey (PACS): single-dish and interferometric imaging of radio haloes in Galaxy Clusters	P812
Knispel, Kramer, Eatough, Keane, Ng, Allen, Kim	New pulsars from Einstein@Home	P813
Camilo, Johnston, Ransom, Keith, Ray, Kerr, Ferrara, Shannon	Millisecond-pulsar searches in unidentified Fermi sources at high Galactic latitudes	P814
Dawson, Caswell, Gomez, McClure-Griffiths, Jones, Dickey, Cunningham, Green, Carretti, Ellingsen, Walsh, Purcell, Breen, Hennebelle, Imai, Lowe, Gibson, Jones, Krishnan	SPLASH: a southern Parkes large-area survey in hydroxyl	P817
Staveley-Smith, Carretti, Bernardi	Mapping the cosmic web	P819
Mickaliger, McLaughlin, Lorimer	Confirmation and timing of new millisecond pulsars	P824
Kraan-Korteweg, Staveley-Smith, Schroeder, Henning, van Driel, Saeed	Filling in the 2MASX redshift Zone of Avoidance	P831
Young, Kramer, Lyne, Weltevrede, Stappers	Bridging the gap in pulsar modulation timescales with PSR J1107-5907	P832
Veneziani, Paladini, Noriega-Crespo, Carey, Tibbs, Flagey, Piacentini	Characterizing the structure of an unusually cold high-latitude cloud	P833
Staveley-Smith, Manchester, Zanardo	Searching for the pulsar in SN1987A	P834
Westmeier, Koribalski, Meyer, Popping, Obreschkow	Testing CDM predictions with a deep HI survey of the Sculptor Group	P837
Bhat, van Straten, Jameson, Carbone	High-time-resolution studies of giant pulses	P842
Johnson, Koribalski, Ford, McQuinn, Bailin	Determining the starburst trigger in dwarf irregular galaxies	P844

OBSERVATIONS MADE WITH THE MOPRA RADIO TELESCOPE

October 2012 to September 2013

OBSERVERS	PROGRAM	NO.
Barnes, Fukui, Caselli, Molinari, Hernandez, Tan, Yonekura, O'Dougherty, Ma, Butler, Zhang	CHaMP-111 Dynamics and chemistry of molecular-clump envelopes	M161
Indermuehle, Edwards	Maser- and flux-monitoring at 3 mm, 7 mm and 12 mm	M426
Jackson, Lo, Rathborne, Jones, Muller, Cunningham, Brooks, Fuller, Barnes, Menten, Schilke, Garay, Mardones, Minier, Longmore, Wyrowski, Herpin, Hill, Bronfman, Deharveng, Schuller, Motte, Peretto, Bontemps, Wienen, Contreras, Lenfestey, Foster, Sanhueza, Claysmith, Hoq	Millimetre Astronomy Legacy Team 90-GHz Survey (MALT 90)	M516
Wong, Hughes, Ott, Henkel, Muller, Pineda Galvez, Fukui, Maddison, Kawamura, Looney, Bernard, Paradis, Chu, Gruendl, Seale	MAGMITA: an extension of the MAGMA survey to faint clouds	M633
Fissel, Lo, Jones, Cunningham, Fukui, Ward-Thompson, Minier, Olmi, Schneider, Lowe, Quinn, Goodman, Devlin, Netterfield, Novak, Pascale, Podevin	Characterising the importance of magnetic fields in star formation within the Vela molecular ridge	M635
Hughes, Wong, Ott, Muller, Pineda Galvez, Maddison, Meier, Chen, Anderson	Dense gas in the Large Magellanic Cloud	M660

VLBI OBSERVATIONS

October 2012 to September 2013

OBSERVERS	PROGRAM	NO.
Guirado, Jauncey, Reynolds, Marti-Vidal, Marcaide, Lestrade, Preston, Jones, Azulay	The binary star ABDorB: a calibration of PMS models	V186
Ojha, Lovell, Edwards, Kadler	Physics of gamma-ray-emitting AGN	V252
Bietenholz, Tzioumis, Ellingsen, Bartel, Dwarkadas, Booth, Tingay, Horiuchi, Bauer	SN 1996cr: structure, size and distance	V253
Ellingsen, Caswell, Voronkov, Dodson, Phillips, Green, Dawson, Menten, Shen, Reid, Hachisuka, Goedhart, Walsh, Brunthaler, Chen, Fujisawa, Rioja, Zhang, Xu, Zheng, Honma, Krishnan	Astrometric observation of methanol masers: determining Galactic structure and investigating high-mass star formation	V255
Bhat, Verbiest, Deller, Bailes, Tingay	Measuring the proper motion of the relativistic binary PSR J1141-6545	V256
Petrov, Murphy, Tzioumis, Phillips, Sadler, Burke-Spolaor, Pogrebenko, Bertarini, Booth, Fomalont, de Witt	LBA calibrator survey — 6	V271
Zanardo, Staveley-Smith, Tzioumis, Ng, Tingay, Potter	High-resolution observations of SNR 1987A	V389
Miller-Jones, Tzioumis, Maccarone, Jonker, Nelemans, Sivakoff	Constraining black-hole formation with LBA astrometry	V447
Dodson, Tzioumis, Hobbs, Reynolds, Godfrey, Rioja	VLBI multi-view pathfinder: the LBA pulsar proper-motion demonstration	V464
Tzioumis, Bignall, Lovell, Edwards, Phillips, Jauncey, Reynolds, Ekers, Nicolson, Quick, Natusch, Tingay, Reynolds, Kellermann, Gulyaev	High-resolution imaging of PKS1934-638	V465
Harvey-Smith, Gaensler, McClure-Griffiths, Edwards, Dodson, Tzioumis, Phillips, Feain, Hales, Brown, O'Sullivan, Gonidakis	Testing rotation-measure modelling of polarised calibrator sources with the LBA	V471
Allison, Tzioumis, Phillips, Sadler, Curran, Reeves	Characterising the source structure of two nearby galaxies with associated HI-absorption systems	V483
Cerrigone, Menten, Wiesemeyer, Choi	Understanding the fast outflow in IRAS 15452-5459 through VLBI maser observations	V484
Miller-Jones, Dodson, Johnston, Deller, Dubus, Moldon, Ribo, Paredes, Tomsick	Mapping the orbit of PSR B1259-63 with LBA astrometry	V486
Ellingsen, Macquart, Bignall, Dawson, Breen, Reynolds, Imai, Keller, Bekki, Krishnan, Cioni	Measuring the proper motions of the Large and Small Magellanic Clouds	V490
Ellingsen, Voronkov, Lovell, Phillips, Breen	Methanol towards PKS B1830-211: testing cosmological variations in fundamental constants	V492
Gonidakis, Chapman, Tzioumis, Phillips, Harvey-Smith, Imai, Diamond	The importance of magnetic fields in the formation of water fountains	V498
Macquart, Reynolds, Ekers, Deller, Johnston, Shannon	VLBI measurement of the scatter-broadening of the magnetar near Sgr A*	VX017

CDSCC OBSERVATIONS

October 2012 to September 2013

OBSERVERS	PROGRAM	NO.
Millar, Ni Chuimin, Walsh, Cox	A search for hydrocarbon anions in Sgr B2	T080
Hagiwara, Horiuchi	Water-maser survey in young debris disks for exoplanet detection	T203
Wong, Green, Horiuchi, Tothill	The physical conditions of the Lupus clouds	T206
Engels, Green, Menten, Maercker, Nyman, Horiuchi	Continuing H_2O–maser observations of bright southern late-type stars	T207
Heise, Green, Horiuchi, Engels	A search for water masers in silicate carbon star candidates	T208

E: Postgraduate students

PHD STUDENTS CO-SUPERVISED BY CASS STAFF IN 2013 (AS AT DECEMBER 2013)

NAME	UNIVERSITY	PROJECT TITLE
Craig Anderson	University of Sydney	Radio polarimetry and rotation-measure synthesis as probes of inner AGN structure
Tui Britton	Macquarie University	Methanol masers in star-forming regions
Paul Brook	University of Oxford, UK	Variability in pulsars
Jordan Collier	University of Western Sydney	The history of supermassive black holes in the Universe
Paul Coster	Swinburne University of Technology	Accelerated searches for the most relativistic binary pulsars using next-generation instrumentation
Helga Denes	Swinburne University of Technology	Global HI properties of galaxies in the southern sky
Phoebe de Wilt	University of Adelaide	Investigating the connection between star forming regions and unidentified TeV gamma-ray sources
Timothy Galvin	University of Western Sydney	Radio emission from star-forming galaxies at high and low-z
Raheel Hashmi	Macquarie University	ASKAP smart feeds
Andreas Herzog	Ruhr University Bochum, Germany	The broadband spectra of infrared-faint radio sources
Courtney Jones	University of Tasmania	The southern Milky Way
Christopher Jordan	James Cook University	CS(1-0) observations with MALT-45: a 7-mm survey of the southern Galaxy
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
Vasaant Krishnan	University of Tasmania	Astrometric observation of methanol masers
Vicki Lowe	University of New South Wales	The environments of massive star formation
Vanessa Moss	University of Sydney	Low- and intermediate-velocity HI clouds in the Milky Way
Ayna Musaeva	University of Sydney	Intermediate-mass black holes in dwarf galaxies
Nipanjana Patra	Raman Research Institute, India	Measurement of spectral features in the cosmic radio background
Emily Petroff	Swinburne University of Technology	Our dynamic galaxy
Hayden Rampadarath	Curtin University	Application of wide-field VLBI
Vikram Ravi	University of Melbourne	Evincing the history of massive black hole and galaxy populations with gravitational waves
Glen Rees	Macquarie University	Cosmology using next-generation radio telescopes
Sarah Reeves	University of Sydney	HI and OH absorption line studies of nearby galaxies
Elise Servajean	University of Chile, Chile	The physical and kinematical structure of massive and dense cold cores
Anita Titmarsh	University of Tasmania	Investigating the earliest stages of massive star formation
Stuart Weston	AUT University, New Zealand	Data mining for statistical analysis of the faint radio sky: the pathway to EMU
Marion Wienen	University of Bonn, Germany	Multi-wavelength follow-ups to the APEX Telescope Large Area Survey: the Galaxy
Kathrin Wolfinger	Swinburne University of Technology	The effect of environment on the evolution of nearby gas-rich spiral galaxies
Graeme Wong	University of Western Sydney	Physics and chemistry of molecular gas in the Milky Way Galaxy
Tye Young	Australian National University	Multiwavelength properties of dwarf galaxies in the local volume
Rai Yuen	University of Sydney	Investigation on pulsar magnetosphere
Xingjiang Zhu	University of Western Australia	Searching for continuous gravitational waves in the Parkes pulsar timing array data sets
Peter-Christian Zinn	Ruhr University Bochum, Germany	New avenues in galaxy evolution studies: large-scale magnetic fields and properties of high-redshift radio emitters

F: PhD theses

PHD THESES OF STUDENTS CO-SUPERVISED BY CASS STAFF IN 2013

Blanchard, Jay (University of Tasmania, May 2013). "Linking the radio and gamma-ray properties of blazars".

Bray, Justin (University of Adelaide, August 2013). "Ultrahigh energy neutrinos and their detection with the lunar Cherenkov technique".

Deng, Xinping (Chinese Academy of Sciences, China, April 2013). "Pulsar timing and its application in spacecraft navigation".

Drouart, Guillaume (European Southern Observatory, Germany, October 2013). "AGN and star formation history in high redshift powerful radio galaxies".

Hales, Christopher (University of Sydney, January 2013). "Deep imaging of the radio sky in total intensity and linear polarisation".

Oslowski, Stefan (Swinburne University of Technology, January 2013). "The highest precision pulsar timing".

Ubach, Catarina (Swinburne University of Technology, August 2013). "A multi-wavelength study of grain growth in protoplanetary discs".

Thornton, Dan (The University of Manchester, UK, September 2013). "Pulsar and transient searching with GPUs".

Wang, Jingbo (Xingjiang Astronomical Observatory, China, June 2013). "Pulsar glitches and the gravitational wave memory effect".

Yu, Meng (Beijing University, China, January 2013). "Pulsar X-ray thermal emission in a solid quark star model and glitches in southern radio pulsars".

G: Publications

PAPERS PUBLISHED IN REFEREED PUBLICATIONS

This list includes refereed papers with data from, or related to, ATNF facilities and other staff papers.

* Indicates publication with CASS staff (not including CASS staff based at CDSCC)

C = Compact Array, M = Mopra, P = Parkes, V = VLBI, A = ASKAP, S = SKA, O = other staff paper

*Abdo, A.A.; Ajello, M.; Allafort, A.; Baldini, L.; Ballet, J.; Barbiellini, G.; Baring, M.G.; Bastieri, D.; Belfiore, A.; Bellazzini, R. and 201 coauthors. "The second Fermi Large Area Telescope catalog of gamma-ray pulsars". ApJS, 208, A17 (2013). (P)

*Abramowski, A.; Acero, F.; Aharonian, F.; Akhperjanian, A. G.; Angüner, E.; Anton, G.; Balenderan, S.; Balzer, A.; Barnacka, A.; Stevens, J.; Edwards, P.G. and 205 coauthors. "HESS and Fermi-LAT discovery of gamma-rays from the blazar 1ES 1312-423". MNRAS, 434, 1889-1901 (2013). (C)

*Acero, F.; Donato, D.; Ojha, R.; Stevens, J.; Edwards, P.G.; Ferrara, E.; Blanchard, J.; Lovell, J.E.J.; Thompson, D.J. "Hunting for treasures among the Fermi unassociated sources: a multiwavelength approach". ApJ, 779, A133 (2013). (C)

Allison, J.R.; Curran, S.J.; Sadler, E.M.; Reeves, S.N. "Broad, weak 21 cm absorption in an early-type galaxy: spectral line finding and parametrization for future surveys". MNRAS, 430, 157–162 (2013). (C)

Aravena, M.; Murphy, E.J.; Aguirre, J.E.; Ashby, M.L.N.; Benson, B.A.; Bothwell, M.; Brodwin, M.; Carlstrom, J.E.; Chapman, S.C.; Crawford, T.M. and 19 coauthors. "Large gas reservoirs and free–free emission in two lensed star-forming galaxies at z = 2.7". MNRAS, 433, 498–505 (2013). (C)

*Argo, M.; Hollow, R. "Astronomy outreach in the remote Mid West region of Western Australia". CAPP, 13,16–17 (2013). (O)

*Asgekar, A.; Oonk, J.B.R.; Yatawatta, S.; van Weeren, R.J.; McKean, J.P.; White, G.; Jackson, N.; Anderson, J.; Avruch, I. M.; Batejat, F.; Braun, R. and 81 coauthors. "LOFAR detections of low-frequency radio recombination lines towards Cassiopeia A". A&A, 551, L11 (2013). (O)

Ashby, M.L.N.; Stanford, S.A.; Brodwin, M.; Gonzalez, A.H.; Martinez-Manso, J.; Bartlett, J.G.; Benson, B.A.; Bleem, L.E.; Crawford, T.M.; Dey, A. and 11 coauthors. "The Spitzer South Pole Telescope deep field: survey design and infrared array camera catalogs". ApJS, 209, A22 (2013). (C)

*Assaf, K.A.; Diamond, P.J.; Richards, A.M.S.; Gray, M.D. "Polarization morphology of SiO masers in the circumstellar envelope of the asymptotic giant branch star R Cassiopeiae". MNRAS, 431, 1077–1089 (2013). (O)

*Banerji, M.; Glazebrook, K.; Blake, C.; Brough, S.; Colless, M.; Contreras, C.; Couch, W.; Croton, D.J.; Croom, S.; Davis, T.M.; Jurek, R.J. and 16 coauthors. "The stellar masses of ~40 000 UV selected galaxies from the WiggleZ survey at 0.3<z<1.0: analogues of Lyman break galaxies?". MNRAS, 431, 2209–2229 (2013). (O)

*Bannister, K.W.; Cornwell, T.J. "Memory-efficient W-projection with the fast Gauss transform". MNRAS, 430, 2390–2400 (2013). (O)

Barnes, P.J.; Ryder, S.D.; O'Dougherty, S.N.; Alvarez, L.E.; Delgado-Navarro, A.S.; Hopkins, A.M.; Tan, J.C. "Millimetre-wave and near-infrared signposts of massive molecular clump evolution and star cluster formation". MNRAS, 432, 2231–2246 (2013). (M)

*Barr, E.D.; Guillemot, L.; Champion, D.J.; Kramer, M.; Eatough, R.P.; Lee, K.J.; Verbiest, J.P. W.; Bassa, C.G.; Camilo, F.; Johnston, S.; Keith, M.J. and 12 coauthors. "Pulsar searches of Fermi unassociated sources with the Effelsberg telescope". MNRAS, 429, 1633–1642 (2013). (O)

*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). (O)

*Benaglia, P.; Koribalski, B.; Peri, C.S.; Martí, J.; Sánchez-Sutil, J.R.; Dougherty, S.M.; Noriega-Crespo, A. "High-resolution radio emission from RCW 49/Westerlund 2". A&A, 559, A31 (2013). (C)

*Bernardi, G.; Greenhill, L.J.; Mitchell, D.A.; Ord, S.M.; Hazelton, B.J.; Gaensler, B.M.; de Oliveira-Costa, A.; Morales, M.F.; Udaya Shankar, N.; Bunton, J. and 43 coauthors. "A 189 MHz, 2400 deg^2 polarization survey with the Murchison Widefield Array 32-element prototype". ApJ, 771, A105 (2013). (O)

*Bhattacharyya, B.; Roy, J.; Ray, P.S.; Gupta, Y.; Bhattacharya, D.; Romani, R.W.; Ransom, S.M.; Ferrara, E.C.; Wolff, M.T.; Camilo, F. and 10 coauthors. "GMRT discovery of PSR J1544+4937: An eclipsing black-widow pulsar identified with a Fermi-LAT source". ApJ, 773, L12 (2013). (O)

*Blasi, M.G.; Lico, R.; Giroletti, M.; Orienti, M.; Giovannini, G.; Cotton, W.; Edwards, P.G.; Fuhrmann, L.; Krichbaum, T.P.; Kovalev, Y.Y. and 7 coauthors. "The TeV blazar Markarian 421 at the highest spatial resolution". A&A 559, A75 (2013). (O)

Bolatto, A.D.; Warren, S.R.; Leroy, A.K.; Walter, F.; Veilleux, S.; Ostriker, E.C.; Ott, J.; Zwaan, M.; Fisher, D.B.; Weiss, A. and two coauthors. "Suppression of star formation in the galaxy NGC 253 by a starburst-driven molecular wind". Nature, 499, 450–453 (2013). (M)

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). (C)

*Bothwell, M.S.; Aguirre, J.E.; Chapman, S.C.; Marrone, D.P.; Vieira, J.D.; Ashby, M.L.N.; Aravena, M.; Benson, B.A.; Bock, J.J.; Bradford, C.M. and 31 coauthors. "SPT 0538–50: Physical conditions in the interstellar medium of a strongly lensed dusty star-forming galaxy at z = 2.8". ApJ, 779, A67 (2013). (C)

*Bowman, J.D.; Cairns, I.; Kaplan, D.L.; Murphy, T.; Oberoi, D.; Staveley-Smith, L.; Arcus, W.; Barnes, D.G.; Bernardi, G.; Briggs, F.; Brown, S.; Bunton, J.D. and 49 coauthors. "Science with the Murchison Widefield Array". PASA, 30, e031 (2013). (O)

Bozzetto, L.M.; Filipovic, M.D.; Crawford, E.J.; Sasaki, M.; Maggi, P.; Haberl, F.; Uroševic, D.; Payne, J.L.; De Horta, A.Y.; Stupar, M. and two coauthors. "Multifrequency study of SNR J0533–7202, a new supernova remnant in the LMC". MNRAS, 432, 2177–2181 (2013). (C)

*Braun, R. "Understanding synthesis imaging dynamic range". A&A, 551, A91 (2013). (O)

*Braun, R. "Galaxy formation: the cosmic web in focus". Nature, 497,191–192 (2013). (O)

*Bray, J.D.; Ekers, R.D.; Roberts, P. "Noise statistics in a fast digital radio receiver: the Bedlam backend for the Parkes radio telescope". ExA, 36, 155–174 (2013). (P)

*Breen, S.L.; Ellingsen, S.P.; Contreras, Y.; Green, J.A.; Caswell, J.L.; Stevens, J.B.; Dawson, J.R.; Voronkov, M.A. "Confirmation of the exclusive association between 6.7-GHz methanol masers and high-mass star formation regions". MNRAS, 435, 524–530 (2013). (O)

*Breen, S.L.; Lovell, J.E.J.; Ellingsen, S.P.; Horiuchi, S.; Beasley, A.J.; Marvel, K. "Discovery of four water masers in the Small Magellanic Cloud". MNRAS, 432, 1382–1395 (2013). (T, C)

*Brocksopp, C.; Corbel, S.; Tzioumis, A.; Broderick, J. W.; Rodriguez, J.; Yang, J.; Fender, R. P.; Paragi, Z. "XTE J1752–223 in outburst: a persistent radio jet, dramatic flaring, multiple ejections and linear polarization". MNRAS, 432, 931–943 (2013). (C)

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). (C)

*Burgay, M.; Bailes, M.; Bates, S.D.; Bhat, N.D.R.; Burke-Spolaor, S.; Champion, D.J.; Coster, P.; D'Amico, N.; Johnston, S.; Keith, M.J. and 11 coauthors. "The High Time Resolution Universe pulsar survey – VII. Discovery of five millisecond pulsars and the different luminosity properties of binary and isolated recycled pulsars". MNRAS, 433, 259–269 (2013). (P)

*Burgay, M.; Keith, M.J.; Lorimer, D.R.; Hassall, T.E.; Lyne, A.G.; Camilo, F.; D'Amico, N.; Hobbs, G.B.; Kramer, M.; Manchester, R.N. and four coauthors. "The Perseus Arm pulsar survey". MNRAS, 429, 579–588 (2013). (P)

*Burlon, D.; Ghirlanda, G.; Murphy, T.; Chhetri, R.; Sadler, E.; Ajello, M. "The AT20G view of Swift/BAT selected AGN: high-frequency radio waves meet hard X-rays". MNRAS, 431, 2471–2480 (2013). (C)

Burton, M.G.; Braiding, C.; Glueck, C.; Goldsmith, P.; Hawkes, J.; Hollenbach, D.J.; Kulesa, C.; Martin, C.L.; Pineda, J.L.; Rowell, G. and eight coauthors. "The Mopra Southern Galactic Plane CO Survey". PASA, 30, e044 (2013). (M)

Calabretta, M.R.; Lowe, S.R. "Representing the 'butterfly' projection in FITS – projection code XPH". PASA, 30, E50 (2013). (O)

*Carretti, E.; Brown, S.; Staveley-Smith, L.; Malarecki, J.M.; Bernardi, G.; Gaensler, B. M.; Haverkorn, M.; Kesteven, M.J.; Poppi, S. "Detection of a radio bridge in Abell 3667". MNRAS, 430, 1414–1422 (2013). (P)

*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). (P)

*Caswell, J.L.; Green, J.A.; Phillips, C.J. "Parkes full polarization spectra of OH masers – I. Galactic longitudes 350° through the Galactic Centre to 41°". MNRAS, 431, 1180–1219 (2013). (P)

Cerrigone, L.; Menten, K.M.; Wiesemeyer, H. "Probing the fast outflow in IRAS 15452–5459 with ATCA observations of OH, H_2O and SiO masers". MNRAS, 434, 542–551 (2013). (C)

Chakraborti, S.; Ray, A.; Smith, R.; Ryder, S.; Yadav, N.; Sutaria, F.; Dwarkadas, V.V.; Chandra, P.; Pooley, D.; Roy, R. "The Progenitor of SN 2011ja: Clues from circumstellar interaction". ApJ, 774, A30 (2013). (C)

Chen, X.; Gan, C.-G.; Ellingsen, S.P.; He, J.-H.; Shen, Z.-Q.; Titmarsh, A. "Newly identified extended green objects (EGOs) from the Spitzer GLIMPSE II Survey. I. Catalog". ApJS, 206, A9 (2013). (M)

Chen, X.; Gan, C.-G.; Ellingsen, S.P.; He, J.-H.; Shen, Z.-Q.; Titmarsh, A. "Newly identified extended green objects (EGOs) from the Spitzer GLIMPSE II Survey. II. Molecular Cloud Environments". ApJS, 206, A22 (2013). (M)

*Chhetri, R.; Ekers, R.D.; Jones, P.A.; Ricci, R. "The AT20G high-angular-resolution catalogue". MNRAS, 434, 956–965 (2013). (C)

*Chies-Santos, A.L.; Cortesi, A.; Fantin, D.S.M.; Merrifield, M.R.; Bamford, S.; Serra, P. "The nature of faint fuzzies from the kinematics of NGC 1023". A&A, 559, A67 (2013). (O)

*Contreras, C.; Blake, C.; Poole, G.B.; Marin, F.; Brough, S.; Colless, M.; Couch, W.; Croom, S.; Croton, D.; Davis, T.M.; Jurek, R.J. and 16 coauthors. "The WiggleZ Dark Energy Survey: measuring the cosmic growth rate with the two-point galaxy correlation function". MNRAS, 430, 924–933 (2013). (O)

*Contreras, Y.; Rathborne, J.; Garay, G. "Structure and radial equilibrium of filamentary molecular clouds". MNRAS, 433, 251–258 (2013). (O)

*Corbel, S.; Aussel, H.; Broderick, J.W.; Chanial, P.; Coriat, M.; Maury, A.J.; Buxton, M.M.; Tomsick, J.A.; Tzioumis, A.K.; Harvey-Smith, L. and eight coauthors. "Formation of the compact jets in the black hole GX 339–4". MNRAS, 431, L107–L111 (2013). (C)

*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). (C)

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, A97 (2013). (P)

*Crawford, F.; Lyne, A.G.; Stairs, I.H.; Kaplan, D.L.; McLaughlin, M.A.; Freire, P.C.C.; Burgay, M.; Camilo, F.; D'Amico, N.; Faulkner, A.; Manchester, R.N. and four coauthors. "PSR J1723–2837: an eclipsing binary radio millisecond pulsar". ApJ, 776, A20 (2013). (P)

*Curran, S.J.; Allison, J.R.; Glowacki, M.; Whiting, M.T.; Sadler, E.M. "On the HI column density–radio source size anticorrelation in compact radio sources". MNRAS, 431, 3408–3413 (2013). (O)

*Curran, S.J.; Whiting, M.T.; Sadler, E.M.; Bignell, C. "A survey for the missing hydrogen in high-redshift radio sources". MNRAS, 428, 2053–2063 (2013). (O)

*Curran, S.J.; Whiting, M.T.; Tanna, A.; Sadler, E.M.; Pracy, M.B.; Athreya, R. "A survey for HI in the distant Universe: the detection of associated 21-cm absorption at z = 1.28". MNRAS, 429, 3402–3410 (2013). (O)

*Davies, M.L.; Stefan, I.I.; Bolton, R.C.; Carpenter, J.M.; Franzen, T.M.O.; Grainge, K.J.B.; Green, D.A.; Hobson, M.P.; Hurley-Walker, N.; Lasenby, A.N. and 13 coauthors. "The radio source count at 93.2 GHz from observations of 9C sources using AMI and CARMA". MNRAS, 430, 1961–1969 (2013). (O)

*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, A56 (2013). (C, P)

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). (C, P)

De Rijcke, S.; Buyle, P.; Koleva, M. "FCC046: A candidate gaseous polar ring dwarf elliptical galaxy in the Fornax cluster". ApJ, 770, L26 (2013). (C)

*Delhaize, J.; Meyer, M.J.; Staveley-Smith, L.; Boyle, B.J. "Detection of HI in distant galaxies using spectral stacking". MNRAS, 433, 1398–1410 (2013). (P)

Deller, A.T.; Forbrich, J.; Loinard, L. "A very long baseline interferometry detection of the class I protostar IRS 5 in Corona Australis". A&A, 552, A51 (2013). (V)

*Demorest, P.B.; Ferdman, R.D.; Gonzalez, M.E.; Nice, D.; Ransom, S.; Stairs, I.H.; Arzoumanian, Z.; Brazier, A.; Burke-Spolaor, S.; Shannon, R.M. and 17 coauthors. "Limits on the stochastic gravitational wave background from the North American Nanohertz Observatory for Gravitational Waves". ApJ, 762, A94 (2013). (O)

*Deng, X.P.; Hobbs, G.; You, X.P.; Li, M.T.; Keith, M.J.; Shannon, R.M.; Coles, W.; Manchester, R.N.; Zheng, J.H.; Yu, X. Z. and three coauthors. "Interplanetary spacecraft navigation using pulsars". AdSpR., 52, 1602–1621 (2013). (P)

*Diaz Trigo, M.; Miller-Jones, J.C.A.; Migliari, S.; Broderick, J.W.; Tzioumis, T. "Baryons in the relativistic jets of the stellar-mass black-hole candidate 4U1630–47". Nature, 504, 260–262 (2013). (C)

*Díaz-Santos, T.; Armus, L.; Charmandaris, V.; Stierwalt, S.; Murphy, E.J.; Haan, S.; Inami, H.; Malhotra, S.; Meijerink, R.; Stacey, G. and 19 coauthors. "Explaining the [C II]157.7 µm deficit in luminous infrared galaxies — first results from a Herschel/PACS study of the GOALS sample". ApJ, 774, A68 (2013). (O)

*Dickey, J.M.; McClure-Griffiths, N.; Gibson, S.J.; Gómez, J.F.; Imai, H.; Jones, P.; Stanimirovic, S.; Van Loon, J.; Walsh, A.; Alberdi, A. and 48 coauthors. "GASKAP – The Galactic ASKAP Survey". PASA, 30, e003 (2013). (A)

*Dutka, M.S.; Ojha, R.; Pottschmidt, K.; Finke, J.D.; Stevens, J.; Edwards, P.G.; Blanchard, J.; Lovell, J.E.J.; Nesci, R.; Kadler, M. and six coauthors. "Multi-wavelength observations of PKS 2142–75 during active and quiescent gamma-ray states". ApJ, 779, A174 (2013). (C)

*Eatough, R.P.; Kramer, M.; Lyne, A.G.; Keith, M.J. "A coherent acceleration search of the Parkes multibeam pulsar survey – techniques and the discovery and timing of 16 pulsars". MNRAS, 431, 292–307 (2013). (P)

*Ekers, R.D. "Non-thermal radio astronomy". Astroparticle Physics, 53, 152–159 (2013). (C, P)

*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). (M)

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). (C)

*Emonts, B.H.C.; Feain, I.; Röttgering, H.J.A.; Miley, G.; Seymour, N.; Norris, R.P.; Carilli, C.L.; Villar-Martín, M.; Mao, M.Y.; Sadler, E.M.; Ekers, R.D. and five coauthors. "CO(1–0) detection of molecular gas in the massive Spiderweb Galaxy (z = 2)". MNRAS, 430, 3465–3471 (2013). (C)

*Espinoza, C.M.; Guillemot, L.; Çelik, Ö.; Weltevrede, P.; Stappers, B.W.; Smith, D.A.; Kerr, M.; Zavlin, V.E.; Cognard, I.; Johnston, S.; Keith, M.J.; Manchester, R.N.; Shannon, R. and 13 coauthors. "Six millisecond pulsars detected by the Fermi Large Area Telescope and the radio/gamma-ray connection of millisecond pulsars". MNRAS, 430, 571–587 (2013). (O)

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

*Farrar, G.R.; Jansson, R.; Feain, I.J.; Gaensler, B.M. "Galactic magnetic deflections and Centaurus A as a UHECR source". JCAP, 2013, A023 (2013). (C)

*Ferdman, R.D.; Stairs, I.H.; Kramer, M.; Breton, R.P.; McLaughlin, M.A.; Freire, P.C.C.; Possenti, A.; Stappers, B.W.; Kaspi, V.M.; Manchester, R.N.; Lyne, A.G. "The double pulsar: evidence for neutron star formation without an iron core-collapse supernova". ApJ, 767, A85 (2013). (O)

*Filipovic, M.D.; Cajko, K.O.; Collier, J.D.; Tothill, N.F.H. "Radio-continuum observations of a giant radio source QSO J0443.8–6141". SerAJ, 187, 1–10 (2013). (C)

*Finn, S.C.; Jackson, J.M.; Rathborne, J.M.; Chambers, E.T.; Simon, R. "The distribution of infrared dark clouds in the first Galactic quadrant". ApJ, 764, A102 (2013). (M)

*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, A74 (2013). (P)

*Foster, J.B.; Rathborne, J.M.; Sanhueza, P.; Claysmith, C.; Whitaker, J.S.; Jackson, J.M.; Mascoop, J.L.; Wienen, M.; Breen, S.L.; Herpin, F. and 16 coauthors. "Characterisation of the MALT 90 Survey and the Mopra Telescope at 90 GHz". PASA, 30, E038 (2013). (M)

*Fuller, R.S.; Hamacher, D.W.; Norris, R.P. "Astronomical symbolism in Bora ceremonial grounds of southeast Australia". Australian Archaeology, 77, 30–37 (2013). (O)

*Galametz, A.; Stern, D.; Pentericci, L.; De Breuck, C.; Vernet, J.; Wylezalek, D.; Fassbender, R.; Hatch, N.; Kurk, J.; Overzier, R.; Rettura, A.; Seymour, N. "A large-scale galaxy structure at z = 2.02 associated with the radio galaxy MRC 0156–252". A&A, 559, A2 (2013). (O)

*Gallaway, M.; Thompson, M.A.; Lucas, P. W.; Fuller, G.A.; Caswell, J.L.; Green, J.A.; Voronkov, M.A.; Breen, S.L.; Quinn, L.; Ellingsen, S.P. and three coauthors. "The mid-infrared environments of 6.7-GHz methanol masers from the Methanol Multibeam Survey". MNRAS, 430, 808–821 (2013). (P, C)

Gelfand, J.D.; Castro, D.; Slane, P.O.; Temim, T.; Hughes, J.P.; Rakowski, C. "Supernova Remnant Kes 17: An efficient cosmic ray accelerator inside a molecular cloud". ApJ, 777, A148 (2013). (C)

Giannetti, A.; Brand, J.; Sánchez-Monge, Á.; Fontani, F.; Cesaroni, R.; Beltrán, M.T.; Molinari, S.; Dodson, R.; Rioja, M.J. "Physical properties of high-mass clumps in different stages of evolution". A&A, 556, A16 (2013). (C)

*Gómez, L.; Rodríguez, L.F.; Loinard, L. "A one-sided knot ejection at the core of the HH 111 outflow". RMxAA, 49, 79–85 (2013). (O)

*Gonidakis, I.; Diamond, P.J.; Kemball, A.J. “A long-term VLBA monitoring campaign of the v=1, J=1–0 SiO masers towards TX Cam – I. Morphology and shock waves”. MNRAS, 433, 3133–3151 (2013). (O)

*Greiner, J.; Krühler, T.; Nardini, M.; Filgas, R.; Moin, A.; de Breuck, C.; Montenegro-Montes, F.; Lundgren, A.; Klose, S.; Fonso, P.M.J. and 20 coauthors. “The unusual afterglow of the gamma-ray burst 100621A”. A&A, 560, A70 (2013). (O)

*Gruppioni, C.; Pozzi, F.; Rodighiero, G.; Delvecchio, I.; Berta, S.; Pozzetti, L.; Zamorani, G.; Andreani, P.; Cimatti, A.; Seymour, N. and 93 coauthors. “The Herschel PEP/HerMES luminosity function – I. Probing the evolution of PACS selected galaxies to z ~4”. MNRAS, 432, 23–52 (2013). (O)

*Haan, S.; Armus, L.; Surace, J.A.; Charmandaris, V.; Evans, A.S.; Diaz-Santos, T.; Melbourne, J.L.; Mazzarella, J.M.; Howell, J.H.; Stierwalt, S. and eight coauthors. “The build-up of nuclear stellar cusps in extreme starburst galaxies and major mergers”. MNRAS, 434, 1264–1286 (2013). (O)

*Hagiwara, Y.; Miyoshi, M.; Doi, A.; Horiuchi, S. “Submillimeter H_2O maser in Circinus Galaxy – a new probe for the circumnuclear region of active galactic nuclei”. ApJ, 768, L38 (2013). (T)

Hassall, T.E.; Keane, E.F.; Fender, R.P. “Detecting highly dispersed bursts with next-generation radio telescopes”. MNRAS, 436, 371–379 (2013). (P)

*Heinz, S.; Sell, P.; Fender, R.P.; Jonker, P.G.; Brandt, W.N.; Calvelo-Santos, D.E.; Tzioumis, A.K.; Nowak, M.A.; Schulz, N.S.; Wijnands, R.; van der Klis, M. “The youngest known X-ray binary: Circinus X-1 and its natal supernova remnant”. ApJ, 779, A171 (2013). (C)

*Hezaveh, Y.D.; Marrone, D.P.; Fassnacht, C.D.; Spilker, J.S.; Vieira, J.D.; Aguirre, J.E.; Aird, K.A.; Aravena, M.; Ashby, M.L.N.; Bayliss, M.; McIntyre, V. and 56 coauthors. “ALMA observations of SPT-discovered, strongly lensed, dusty, star-forming galaxies”. ApJ, 767, A132 (2013). (O)

*Hill, A.S.; Mao, S.A.; Benjamin, R.A.; Lockman, F.J.; McClure-Griffiths, N.M. “Magnetized gas in the Smith High Velocity Cloud”. ApJ, 777, A55 (2013). (O)

*Hindson, L.; Thompson, M.A.; Urquhart, J.S.; Faimali, A.; Johnston-Hollitt, M.; Clark, J.S.; Davies, B. “The G305 star-forming complex: radio continuum and molecular line observations”. MNRAS, 435, 2003–2022 (2013). (M, C)

*Hobbs, G. “The Parkes Pulsar Timing Array”. CQGra.,30, A224007 (2013). (P)

*Hong, T; Staveley-Smith, L.; Masters, K.L.; Springob, C.M.; Macri, L.M.; Koribalski, B.S.; Jones, D.H.; Jarrett, T.H.; Crook, A.C. “2MTF – II. New Parkes 21-cm observations of 303 southern galaxies”. MNRAS, 432, 1178–1188 (2013). (P)

*Hoq, S.; Jackson, J.M.; Foster, J.B.; Sanhueza, P.; Guzmán, A.; Whitaker, J.S.; Claysmith, C.; Rathborne, J.M.; Vasyunina, T.; Vasyunin, A. “Chemical evolution in high-mass star-forming regions: results from the MALT 90 Survey”. ApJ, 777, A157 (2013). (M)

*Huynh, M.T.; Norris, R.P.; Coppin, K.E.K.; Emonts, B.H.C.; Ivison, R.J.; Seymour, N.; Smail, Ian; Smolcic, V.; Swinbank, A.M.; Brandt, W.N. and 11 coauthors. “Physical conditions of the gas in an ALMA [C II]-identified submillimetre galaxy at z = 4.44” MNRAS, 431, L88–L92 (2013). (C)

*Ibar, E.; Sobral, D.; Best, P.N.; Ivison, R.J.; Smail, I.; Arumugam, V.; Berta, S.; Béthermin, M.; Bock, J.; Cava, A. and 21 coauthors. “Herschel reveals the obscured star formation in HiZELS H-alpha emitters at z = 1.47”. MNRAS, 434, 3218–3235 (2013). (O)

Imai, H.; Katayama, Y.; Ellingsen, S.P.; Hagiwara, Y. “ATCA survey of H_2O masers in the Large Magellanic Cloud”. MNRAS, 432, L16–L20 (2013). (C)

*Inami, H.; Armus, L.; Charmandaris, V.; Groves, B.; Kewley, L.; Petric, A.; Stierwalt, S.; Díaz-Santos, T.; Surace, J.; Rich, J.; Haan, S. and ten coauthors. “Mid-infrared atomic fine-structure emission-line spectra of luminous infrared galaxies: Spitzer/IRS spectra of the GOALS sample”. ApJ, 777, A156 (2013). (O)

*Indermuehle, B.T.; Burton, M,G.; Crofts, J. “Water vapour radiometers for the Australia Telescope Compact Array”. PASA, 30, e035 (2013). (C)

*Jackson, J.M.; Rathborne, J.M.; Foster, J.B.; Whitaker, J.S.; Sanhueza, P.; Claysmith, C.; Mascoop, J.L.; Wienen, M.; Breen, S.L.; Herpin, F. and 45 coauthors. “MALT 90: The Millimetre Astronomy Legacy Team 90 GHz Survey”. PASA, 30, e057 (2013). (M)

*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 seven coauthors. “Extending the nearby galaxy heritage with WISE: first results from the WISE enhanced resolution galaxy atlas”. AJ, 145, A6 (2013). (C)

*Johnson, T.J.; Guillemot, L.; Kerr, M.; Cognard, I.; Ray, P.S.; Wolff, M.T.; Bégin, S.; Janssen, G.H.; Romani, R.W.; Venter, C. and 20 coauthors. “Broadband pulsations from PSR B1821–24: Implications for emission models and the pulsar population of M28”. ApJ, 778, A106 (2013). (O)

*Jones, C.; Dickey, J.M.; Dawson, J.R.; McClure-Griffiths, N.M.; Anderson, L.D.; Bania, T.M. “HI absorption toward HII regions at small Galactic longitudes”. ApJ, 774, A117 (2013). (C, P)

Jones, P.A.; Burton, M.G.; Cunningham, M.R.; Tothill, N.F.H.; Walsh, A.J. “Spectral imaging of the central molecular zone in multiple 7-mm molecular lines”. MNRAS, 433, 221–234 (2013). (M)

*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). (C)

*Jurek, R.J.; Drinkwater, M.J.; Pimbblet, K.; Glazebrook, K.; Blake, C.; Brough, S.; Colless, M.; Contreras, C.; Couch, W.; Croom, S. and 16 coauthors. “The WiggleZ Dark Energy Survey: star formation in UV-luminous galaxies from their luminosity functions”. MNRAS, 434, 257–281 (2013). (O)

*Kamphuis, P.; Rand, R.J.; Józsa, G.I.G.; Zschaechner, L.K.; Heald, G.H.; Patterson, M.T.; Gentile, G.; Walterbos, R.A.M.; Serra, P.; de Blok, W.J.G. “HALOGAS observations of NGC 5023 and UGC 2082: modelling of non-cylindrically symmetric gas distributions in edge-on galaxies”. MNRAS, 434, 2069–2093 (2013). (O)

*Kardashev, N.S.; Khartov, V.V.; Abramov, V.V.; Avdeev, V. Yu.; Alakoz, A.V.; Aleksandrov, Yu. A.; Ananthakrishnan, S.; Andreyanov, V.V.; Andrianov, A.S.; Ekers, R.D. and 124 coauthors. “‘RadioAstron’” – A telescope with a size of 300 000 km: Main parameters and first observational results”. ARep., 57, 153–194 (2013). (O)

*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 nine coauthors. “Measurement and correction of variations in interstellar dispersion in high-precision pulsar timing”. MNRAS, 429, 2161–2174 (2013). (P)

*Keith, M.J.; Shannon, R.M.; Johnston, S. “A connection between radio state changing and glitch activity in PSR J0742–2822”. MNRAS, 432, 3080–3084 (2013). (P)

*Kim, D.-C.; Evans, A.S.; Vavilkin, T.; Armus, L.; Mazzarella, J.M.; Sheth, K.; Surace, J. A.; Haan, S.; Howell, J.H.; Díaz-Santos, T. and four coauthors. "Hubble Space Telescope ACS imaging of the GOALS Sample: quantitative structural properties of nearby luminous infrared galaxies with $L_{IR} > 10^{11.4} L_{SUN}$". IR ApJ, 768, A102 (2013). (O)

*Knispel, B.; Eatough, R.P.; Kim, H.; Keane, E.F.; Allen, B.; Anderson, D.; Aulbert, C.; Bock, O.; Crawford, F.; Eggenstein, H.-B.; Sarkissian, J. and ten coauthors. "Einstein@Home discovery of 24 pulsars in the Parkes Multibeam Pulsar Survey". ApJ, 774, A93 (2013). (P)

*Krishnan, V.; Ellingsen, S.P.; Voronkov, M.A.; Breen, S.L. "The first high-resolution observations of 19.9-GHz methanol masers". MNRAS, 433, 3346–3363 (2013). (C)

*Lacy, M.; Ridgway, S.E.; Gates, E.L.; Nielsen, D.M.; Petric, A.O.; Sajina, A.; Urrutia, T.; Cox Drews, S.; Harrison, C.; Seymour, N.; Storrie-Lombardi, L.J. "The Spitzer mid-infrared Active Galactic Nucleus survey. I. Optical and near-infrared spectroscopy of obscured candidates and normal active galactic nuclei selected in the mid-infrared". ApJS, 208, A24 (2013). (O)

*Lagattuta, D.J.; Mould, J.R.; Staveley-Smith, L.; Hong, T.; Springob, C.M.; Masters, K.L.; Koribalski, B.S.; Jones, D.H. "WISE TF: A mid-infrared, 3.4 μm extension of the Tully–Fisher Relation using WISE photometry". ApJ, 771, A88 (2013). (O)

Lakhchaura, K.; Singh, K.P.; Saikia, D.J.; Hunstead, R.W. "A cluster pair: A3532 and A3530". ApJ, 767, A91 (2013). (C)

*Lalitha, S.; Fuhrmeister, B.; Wolter, U.; Schmitt, J.H.M.M.; Engels, D.; Wieringa, M.H. "A multi-wavelength view of AB Doradus outer atmosphere. Simultaneous X-ray and optical spectroscopy at high cadence". A&A, 560, A69 (2013). (C)

*Levin, L.; Bailes, M.; Barsdell, B.R.; Bates, S.D.; Bhat, N.D.R.; Burgay, M.; Burke-Spolaor, S.; Champion, D.J.; Coster, P.; D'Amico, N.; Johnston, S. and nine coauthors. "The High Time Resolution Universe Pulsar Survey – VIII. The Galactic millisecond pulsar population". MNRAS, 434, 1387–1397 (2013). (P)

*Lewis, G.F.; Braun, R.; McConnachie, A.W.; Irwin, M.J.; Ibata, R.A.; Chapman, S.C.; Ferguson, A.M.N.; Martin, N.F.; Fardal, M.; Dubinski, J.; Widrow, L.; Mackey, A.D.; Babul, A.; Tanvir, N.R.; Rich, M. "PAndAS in the Mist: the stellar and gaseous mass within the halos of M31 and M33". ApJ, 763, A4 (2013). (O)

Longmore, S.N.; Bally, J.; Testi, L.; Purcell, C.R.; Walsh, A.J.; Bressert, E.; Pestalozzi, M.; Molinari, S.; Ott, J.; Cortese, L. and six coauthors. "Variations in the Galactic star formation rate and density thresholds for star formation". MNRAS, 429, 987–1000 (2013). (M)

Longmore, S.N.; Kruijssen, J.M.D.; Bally, J.; Ott, J.; Testi, L.; Rathborne, J.; Bastian, N.; Bressert, E.; Molinari, S.; Battersby, C.; Walsh, A.J. "Candidate super star cluster progenitor gas clouds possibly triggered by close passage to Sgr A". MNRAS, 433, L15–L19 (2013). (O)

Lorimer, D.R.; Camilo, F.; McLaughlin, M.A. "Timing of pulsars found in a deep Parkes multibeam survey". MNRAS, 434, 347–351 (2013). (P)

*Lorimer, D.R.; Karastergiou, A.; McLaughlin, M.A.; Johnston, S. "On the detectability of extragalactic fast radio transients". MNRAS, 436, L5–L9 (2013). (P)

Ma, B.; Tan, J.C.; Barnes, P.J. "The galactic census of high- and medium-mass protostars. II. Luminosities and evolutionary states of a complete sample of dense gas clumps". ApJ, 779, A79 (2013). (M)

Macquart, J.-P.; Godfrey, L.E.H.; Bignall, H.E.; Hodgson, J.A. "The microarcsecond structure of an active galactic nucleus jet via interstellar scintillation". ApJ, 765, A142 (2013). (C)

Malarecki, J.M.; Staveley-Smith, L.; Saripalli, L.; Subrahmanyan, R.; Jones, D.H.; Duffy, A. R.; Rioja, M. "Giant radio galaxies – I. Intergalactic barometers". MNRAS, 432, 200–224 (2013). (C)

*Manchester, R.N. "Pulsar searching and timing". IJMPD, 22, A1341007 (2013). (P)

*Manchester, R.N. "The International Pulsar Timing Array". CQGra, 30, A24010 (2013). (P)

*Manchester, R.N.; Hobbs, G.; Bailes, M.; Coles, W.A.; van Straten, W.; Keith, M.J.; Shannon, R.M.; Bhat, N.D.R.; Brown, A.; Burke-Spolaor, S.G. and 21 coauthors. "The Parkes Pulsar Timing Array Project". PASA, 30, e017 (2013). (P)

*Margutti, R.; Soderberg, A.M.; Wieringa, M.H.; Edwards, P.G.; Chevalier, R.A.; Morsony, B.J.; Barniol Duran, R.; Sironi, L.; Zauderer, B.A.; Milisavljevic, D. and two coauthors. "The signature of the central engine in the weakest relativistic explosions: GRB 100316D". ApJ, 778, A18 (2013). (C)

*Marín, F.A.; Blake, C.; Poole, G.B.; McBride, C.K.; Brough, S.; Colless, M.; Contreras, C.; Couch, W.; Croton, D.J.; Croom, S.; Jurek, R.J. and 17 coauthors. "The WiggleZ Dark Energy Survey: constraining galaxy bias and cosmic growth with three-point correlation functions". MNRAS, 432, 2654–2668 (2013). (O)

*Massardi, M.; Burke-Spolaor, S.G.; Murphy, T.; Ricci, R.; López-Caniego, M.; Negrello, M.; Chhetri, R.; De Zotti, G.; Ekers, R.D.; Partridge, R.B.; Sadler, E.M. "A polarization survey of bright extragalactic AT20G sources". MNRAS, 436, 2915–2928 (2013). (C)

Maxted, N.I.; Rowell, G.P.; Dawson, B.R.; Burton, M.G.; Fukui, Y.; Walsh, A.; Kawamura, A.; Horachi, H.; Sano, H.; Yoshiike, S.; Fukuda, T. "Interstellar gas towards CTB 37A and the TeV gamma-ray source HESS J1714–385". MNRAS, 434, 2188–2201 (2013). (M)

Maxted, N.I.; Rowell, G.P.; Dawson, B.R.; Burton, M.G.; Yasuo, F.; Lazendic, J.; Kawamura, A.; Horachi, H.; Sano, H.; Walsh, A.U.; Yoshike, S.; Fukuda, T. "Dense gas towards the RX J1713.7–3946 supernova remnant". PASA, 30, e55 (2013). (M)

*McClure-Griffiths, N.M.; Green, J.A.; Hill, A.S.; Lockman, F.J.; Dickey, J.M.; Gaensler, B.M.; Green, A.J. "Atomic hydrogen in a galactic center outflow". ApJ, 770, L4 (2013). (C)

*McIntosh, G.C.; Indermuehle, B. "The velocity centroid periodicity of L2 Puppis' SiO maser emission". ApJ, 774, A21 (2013). (M)

*McIntosh, G.; Indermuehle, B. "A comparison of the velocity parameters of SiO v=1, J=1–0, and J=2–1 maser emission in long period variables". AJ, 145, A131 (2013). (M)

*McKinley, B.; Briggs, F.; Gaensler, B.M.; Feain, I.J.; Bernardi, G.; Wayth, R.B.; Johnston-Hollitt, M.; Offringa, A.R.; Arcus, W.; Barnes, D.G. and 43 coauthors. "The giant lobes of Centaurus A observed at 118 MHz with the Murchison Widefield Array". MNRAS, 436, 1286–1301 (2013). (O)

*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.; Bunton, J.D. and 42 coauthors. "Low-frequency observations of the moon with the Murchison Widefield Array". AJ, 145, A23 (2013). (O)

*Meunier, C.; Bauer, F.E.; Dwarkadas, V.V.; Koribalski, B.; Emonts, B.; Hunstead, R.W.; Campbell-Wilson, D.; Stockdale, C.; Tingay, S.J. "Performing a stellar autopsy using the radio-bright remnant of SN 1996cr". MNRAS, 431, 2453–2463 (2013). (C)

*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). (O)

Miller, J.J.; McLaughlin, M.A.; Rea, N.; Lazaridis, K.; Keane, E.F.; Kramer, M.; Lyne, A. "Simultaneous X-ray and radio observations of rotating radio transient J1819-1458". ApJ, 776, A104 (2013). (P)

*Moin, A.; Chandra, P.; Miller-Jones, J.C.A.; Tingay, S.J.; Taylor, G.B.; Frail, D.A.; Wang, Z.; Reynolds, C.; Phillips, C.J. "Radio observations of GRB 100418a: test of an energy injection model explaining long-lasting GRB afterglows". ApJ, 779, A105 (2013). (C)

*Moss, V.A.; McClure-Griffiths, N.M.; Murphy, T.; Pisano, D.J.; Kummerfeld, J.K.; Curran, J.R. "High-velocity clouds in the Galactic All Sky Survey. I. Catalog". ApJS, 209, A12 (2013). (P)

Motogi, K.; Sorai, K.; Niinuma, K.; Sugiyama, K.; Honma, M.; Fujisawa, K. "Intermittent maser flare around the high-mass young stellar object G353.273 + 0.641 – II. Detection of a radio and molecular jet". MNRAS, 428, 349–353 (2013). (C)

Muller, S.; Beelen, A.; Black, J.H.; Curran, S.J.; Horellou, C.; Aalto, S.; Combes, F.; Guélin, M.; Henkel, C. "A precise and accurate determination of the cosmic microwave background temperature at z = 0.89". A&A, 551, A109 (2013). (C)

*Murphy, T.; Chatterjee, S.; Kaplan, D.L.; Banyer, J.; Bell, M.E.; Bignall, H.E.; Bower, G.C.; Cameron, R.A.; Coward, D.M.; Cordes, J.M.; Johnston, S. and 28 coauthors. "VAST: an ASKAP survey for variables and slow transients". PASA, 30, e6 (2013). (A)

*Ng, C.-Y.; Zanardo, G.; Potter, T.M.; Staveley-Smith, L.; Gaensler, B.M.; Manchester, R.N.; Tzioumis, A.K. "Evolution of the radio remnant of Supernova 1987A: morphological changes from day 7000". ApJ, 777, A131 (2013). (C)

*Norris, R.P.; Afonso, J.; Bacon, D.; Beck, R.; Bell, M.; Beswick, R.J.; Best, P.; Bhatnagar, S.; Bonafede, A.; Brunetti, G. and 41 coauthors. "Radio continuum surveys with Square Kilometre Array pathfinders". PASA, 30, e020 (2013). (A)

*Norris, R.P.; Kesteven, M.J. "The life and times of the Parkes–Tidbinbilla Interferometer". JAHH, 16, 55–66 (2013). (P, T)

*Norris, R.P.; Norris, C.; Hamacher, D.W.; Abrahams, R. "Wurdi Youang: an Australian aboriginal stone arrangement with possible solar indications". Rock Art Research, 30, 55–65 (2013). (O)

*Noutsos, A.; Schnitzeler, D.H.F.M.; Keane, E.F.; Kramer, M.; Johnston, S. "Pulsar spin-velocity alignment: kinematic ages, birth periods and braking indices". MNRAS, 430, 2281–2301 (2013). (O)

O'Brien, A.N.; Filipovic, M.D.; Crawford, E.J.; Tothill, N.F.H.; Collier, J.D.; De Horta, A.Y.; Wong, G.F.; Draškovic, D.; Payne, J.L.; Pannuti, T.G. and four coauthors. "Radio-continuum study of the nearby Sculptor Group galaxies. Part 2: NGC 55 at lambda = 20, 13, 6 and 3 cm". Ap&SS, 347, 159–168 (2013). (C)

*O'Sullivan, S.P.; Feain, I.J.; McClure-Griffiths, N.M.; Ekers, R.D.; Carretti, E.; Robishaw, T.; Mao, S.A.; Gaensler, B.M.; Bland-Hawthorn, J.; Stawarz, L. "Thermal plasma in the giant lobes of the radio galaxy Centaurus A". ApJ, 764, A162 (2013). (P, C)

*O'Sullivan, S.P.; McClure-Griffiths, N.M.; Feain, I.J.; Gaensler, B.M.; Sault, R.J. "Broadband radio circular polarization spectrum of the relativistic jet in PKS B2126–158". MNRAS, 435, 311–319 (2013). (C)

*Olausen, S.A.; Zhu, W.W.; Vogel, J.K.; Kaspi, V.M.; Lyne, A.G.; Espinoza, C.M.; Stappers, B.W.; Manchester, R.N.; McLaughlin, M.A. "X-ray observations of high-B radio pulsars". ApJ, 764, A1 (2013). (O)

Oliveira, J.M.; van Loon, J.Th.; Sloan, G.C.; Sewilo, M.; Kraemer, K.E.; Wood, P.R.; Indebetouw, R.; Filipovic, M.D.; Crawford, E.J.; Wong, G.F. and five coauthors. "Early-stage young stellar objects in the Small Magellanic Cloud". MNRAS, 428, 3001–3033 (2013). (C, P)

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

*Ott, J.; Meier, D.S.; McCoy, M.; Peck, A.; Impellizzeri, V.; Brunthaler, A.; Walter, F.; Edwards, P.G.; Anderson, C.N.; Henkel, C. and two coauthors. "Discovery of nuclear water maser emission in Centaurus A". ApJ, 771, L41 (2013). (C)

Pan, H.-A.; Lim, J.; Matsushita, S.; Wong, T.; Ryder, S. "Formation of dense molecular gas and stars at the circumnuclear starburst ring in the barred galaxy NGC 7552". ApJ, 768, A57 (2013). (C)

*Papitto, A.; Ferrigno, C.; Bozzo, E.; Rea, N.; Pavan, L.; Burderi, L.; Burgay, M.; Campana, S.; di Salvo, T.; Falanga, M. and 13 coauthors. "Swings between rotation and accretion power in a binary millisecond pulsar". Nature, 501, 517–520 (2013). (P, C)

Peretto, N.; Fuller, G.A.; Duarte-Cabral, A.; Avison, A.; Hennebelle, P.; Pineda, J.E.; André, Ph.; Bontemps, S.; Motte, F.; Schneider, N.; Molinari, S. "Global collapse of molecular clouds as a formation mechanism for the most massive stars". A&A, 555, A112 (2013). (M)

*Pérez-Sánchez, A.F.; Vlemmings, W.H.T.; Tafoya, D.; Chapman, J.M. "A synchrotron jet from a post-asymptotic giant branch star". MNRAS, 436, L79–L83 (2013). (C)

*Perrott, Y.C.; Scaife, A.M.M.; Green, D.A.; Davies, M.L.; Franzen, T.M.O.; Grainge, K.J.B.; Hobson, M.P.; Hurley-Walker, N.; Lasenby, A.N.; Olamaie, M. and ten coauthors. "AMI Galactic Plane Survey at 16 GHz – I. Observing, mapping and source extraction". MNRAS, 429, 3330–3340 (2013). (O)

*Petroff, E.; Keith, M.J.; Johnston, S.; van Straten, W.; Shannon, R.M. "Dispersion measure variations in a sample of 168 pulsars". MNRAS, 435, 1610–1617 (2013). (P)

*Petrov, L.; Mahony, E.K.; Edwards, P.G.; Sadler, E.M.; Schinzel, F.K.; McConnell, D. "Australia Telescope Compact Array observations of Fermi unassociated sources". MNRAS, 432, 1294–1302 (2013). (C)

Pineda, J.L.; Langer, W.D.; Velusamy, T.; Goldsmith, P.F. "A Herschel [CII] Galactic plane survey. I. The global distribution of ISM gas components". A&A, 554, A103 (2013). (M)

*Pletsch, H. J.; Guillemot, L.; Allen, B.; Anderson, D.; Aulbert, C.; Bock, O.; Champion, D.J.; Eggenstein, H.B.; Fehrmann, H.; Hammer, D. and eight coauthors. "Einstein@Home discovery of four young gamma-ray pulsars in Fermi LAT data". ApJ, 779, L11 (2013). (O)

*Polsterer, K.L; Zinn, P.-C.; Gieseke, F. "Finding new high-redshift quasars by asking the neighbours". MNRAS, 428, 226–235 (2013). (O)

*Poole, G.B.; Blake, C.; Parkinson, D.; Brough, S.; Colless, M.; Contreras, C.; Couch, W.; Croton, D.J.; Croom, S.; Davis, T.; Jurek, R.J. and 16 coauthors. "The WiggleZ Dark Energy Survey: probing the epoch of radiation domination using large-scale structure". MNRAS, 429, 1902–1912 (2013). (O)

Pratley, L.; Johnston-Hollitt, M.; Dehghan, S.; Sun, M. "Using head-tail galaxies to constrain the intracluster magnetic field: an in-depth study of PKS J0334–3900". MNRAS, 432, 243–257 (2013). (C)

*Purcell, C.R.; Hoare, M.G.; Cotton, W.D.; Lumsden, S.L.; Urquhart, J.S.; Chandler, C.; Churchwell, E.B.; Diamond, P.; Dougherty, S.M.; Fender, R.P. and 20 coauthors. “The coordinated radio and infrared survey for high-mass star formation. II. Source catalog”. ApJS, 205, A1 (2013). (O)

*Pursimo, T.; Ojha, R.; Jauncey, D.L.; Rickett, B.J.; Dutka, M.S.; Koay, Jun Yi; Lovell, J.E.J.; Bignall, H.E.; Kedziora-Chudczer, L.; Macquart, J.-P. “The Micro-Arcsecond Scintillation-Induced Variability (MASIV) survey. III. Optical identifications and new redshifts”. ApJ, 767, A14 (2013). (O)

*Rawlings, J.I.; Seymour, N.; Page, M.J.; De Breuck, C.; Stern, D.; Symeonidis, M.; Appleton, P.N.; Dey, A.; Dickinson, M.; Huynh, M. and eight coauthors. “Polycyclic aromatic hydrocarbon emission in powerful high-redshift radio galaxies”. MNRAS, 429, 744–756 (2013). (O)

*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 six coauthors. “Radio detection of the Fermi-LAT blind search millisecond pulsar J1311–3430”. ApJ, 763,L13 (2013). (P)

Rea, N.; Esposito, P.; Pons, J.A.; Turolla, R.; Torres, D.F.; Israel, G.L.; Possenti, A.; Burgay, M.; Viganò, D.; Papitto, A. and 14 coauthors. “A strongly magnetized pulsar within the grasp of the Milky Way's supermassive black hole”. ApJ, 775, L34 (2013). (P)

Reynolds, M.T.; Loi, S.T.; Murphy, T.; Miller, J.M.; Maitra, D.; Gültekin, K.; Gehrels, N.; Kennea, J.A.; Siegel, M.H.; Gelbord, J. and seven coauthors. “G306.3–0.9: a newly discovered young Galactic supernova remnant”. ApJ, 766, A112 (2013). (C)

Reynoso, E.M.; Hughes, J.P.; Moffett, D.A. “On the radio polarization signature of efficient and inefficient particle acceleration in supernova remnant SN 1006”. AJ, 145, A104 (2013). (C)

*Ricci, R.; Righini, S.; Verma, R.; Prandoni, I.; Carretti, E.; Mack, K.-H.; Massardi, M.; Procopio, P.; Zanichelli, A.; Gregorini, L. and three coauthors. “A 20 GHz bright sample for $\delta > 72°$ – II. Multifrequency follow-up”. MNRAS, 435, 2793–2805 (2013). (O)

Ridley, J.P.; Crawford, F.; Lorimer, D.R.; Bailey, S.R.; Madden, J.H.; Anella, R.; Chennamangalam, J. “Eight new radio pulsars in the Large Magellanic Cloud”. MNRAS, 433,138–146 (2013). (P)

*Rocca-Volmerange, B.; Drouart, G.; De Breuck, C.; Vernet, J.; Seymour, N.; Wylezalek, D.; Lehnert, M.; Nesvadba, N.; Fioc, M. “Starburst and old stellar populations in the z = 3.8 radio galaxies 4C 41.17 and TN J2007–1316”. MNRAS, 429, 2780–2790 (2013). (O)

*Rubio-Herrera, E.; Stappers, B.W.; Hessels, J.W.T.; Braun, R. “A search for radio pulsars and fast transients in M31 using the Westerbork Synthesis Radio Telescope”. MNRAS, 428, 2857–2873 (2013). (O)

*Sahai, R.; Vlemmings, W.H.T.; Huggins, P.J.; Nyman, L.-Å.; Gonidakis, I. “ALMA Observations of the coldest place in the Universe: the Boomerang Nebula”. ApJ, 777, A92 (2013). (O)

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, A21 (2013). (C)

*Schammel, M.P.; Feroz, F.; Grainge, K.J.B.; Hobson, M.P.; Hurley-Walker, N.; Lasenby, A.N.; Olamaie, M.; Perrott, Y.C.; Pooley, G.G.; Shimwell, T. and seven coauthors. “AMI SZ observations and Bayesian analysis of a sample of six redshift-one clusters of galaxies”. MNRAS, 431, 900–911 (2013). (O)

*Schneider, N.; André, Ph.; Könyves, V.; Bontemps, S.; Motte, F.; Federrath, C.; Ward-Thompson, D.; Arzoumanian, D.; Benedettini, M.; Bressert, E. and 12 coauthors. “What determines the density structure of molecular clouds? A case study of Orion B with Herschel”. ApJ, 766, L17 (2013). (O)

*Serra, P.; Koribalski, B.; Duc, P-A.; Oosterloo, T.; McDermid, R.M.; Michel-Dansac, L.; Emsellem, E.; Cuillandre, J.-C.; Alatalo, K.; Blitz, L. and 18 coauthors. “Discovery of a giant HI tail in the galaxy group HCG 44”. MNRAS, 428, 370–380 (2013). (O)

Shannon, R.M.; Johnston, S. “Radio properties of the magnetar near Sagittarius A from observations with the Australia Telescope Compact Array”. MNRAS, 435, L29–L32 (2013). (C)

*Shannon, R.M.; Ravi, V.; Coles, W.A.; Hobbs, G.; Keith, M.J.; Manchester, R.N.; Wyithe, J.S.B.; Bailes, M.; Bhat, N.D.R.; Burke-Spolaor, S. and seven coauthors. “Gravitational-wave limits from pulsar timing constrain supermassive black hole evolution”. Science, 342, 334–337 (2013). (P)

*Shimwell, T.W.; Carpenter, J.M.; Feroz, F.; Grainge, K.J.B.; Hobson, M.P.; Hurley-Walker, N.; Lasenby, A.N.; Olamaie, M.; Perrott, Y.C.; Pooley, G.G. and seven coauthors. “A joint analysis of AMI and CARMA observations of the recently discovered SZ galaxy cluster system AMI-CL J0300+2613”. MNRAS, 433,2036–2046 (2013). (O)

*Shimwell, T.W.; Rodríguez-Gonzálvez, C.; Feroz, F.; Franzen, T.M.O.; Grainge, K.J.B.; Hobson, M.P.; Hurley-Walker, N.; Lasenby, A.N.; Lloyd-Davies, E.J.; Olamaie, M. and ten coauthors. “Sunyaev-Zel'dovich observations with AMI of the hottest galaxy clusters detected in the XMM-Newton Cluster Survey”. MNRAS, 433, 2920–2937 (2013). (O)

*Spezzi, L.; Cox, N. L. J.; Prusti, T.; Merín, B.; Ribas, Á.; Alves de Oliveira, C.; Winston, E.; Kóspál, Á.; Royer, P.; Vavrek, R.; Bressert, E. and six coauthors. “The Herschel Gould Belt Survey in Chamaeleon. II. Properties of cold dust in disks around young stellar objects”. A&A, 555, A71 (2013). (O)

*Stawarz, L.; Tanaka, Y.T.; Madejski, G.; O'Sullivan, S.P.; Cheung, C.C.; Feain, I.J.; Fukazawa, Y.; Gandhi, P.; Hardcastle, M.J.; Kataoka, J. and eight coauthors. “Giant lobes of Centaurus A radio galaxy observed with the Suzaku X-ray satellite”. ApJ, 766, A48 (2013). (O)

*Stierwalt, S.; Armus, L.; Surace, J.A.; Inami, H.; Petric, A.O.; Diaz-Santos, T.; Haan, S.; Charmandaris, V.; Howell, J.; Kim, D.C. and 22 coauthors. “Mid-infrared properties of nearby luminous infrared galaxies. I. Spitzer infrared spectrograph spectra for the GOALS sample”. ApJS, 206, A1 (2013). (O)

*Stilp, A.M.; Dalcanton, J.J.; Skillman, E.; Warren, S.R.; Ott, J.; Koribalski, B. “Drivers of HI turbulence in dwarf galaxies”. ApJ, 773, A88 (2013). (O)

*Stilp, A.M.; Dalcanton, J.J.; Warren, S.R.; Skillman, E.; Ott, J.; Koribalski, B. “Global HI kinematics in dwarf galaxies”. ApJ, 765, A136 (2013). (O)

Sturm, R.; Draškovic, D.; Filipovic, M.D.; Haberl, F.; Collier, J.; Crawford, E.J.; Ehle, M.; De Horta, A.; Pietsch, W.; Tothill, N.F.H.; Wong, G. “Active galactic nuclei behind the SMC selected from radio and X-ray surveys”. A&A, 558, A101 (2013). (C)

*Sweet, S.M.; Meurer, G.; Drinkwater, M.J.; Kilborn, V.; Dénes, H.; Bekki, K.; Hanish, D.; Ferguson, H.; Knezek, P.; Koribalski, B. and 17 coauthors. “Choirs, HI galaxy groups: catalogue and detection of star-forming dwarf group members”. MNRAS, 433, 543–559 (2013). (P)

*Symeonidis, M.; Vaccari, M.; Berta, S.; Page, M.J.; Lutz, D.; Arumugam, V.; Aussel, H.; Bock, J.; Boselli, A.; Seymour, N. and 50 coauthors. “The Herschel census of infrared SEDs through cosmic time”. MNRAS, 431, 2317–2340 (2013). (O)

Tan, J.C. "Astrophysics: A dark cloud unveils its secrets". Nature, 500, 537–538 (2013). (M)

*Tanna, A.; Curran, S.J.; Whiting, M.T.; Webb, J.K.; Bignell, C. "A fourth HI 21 cm absorption system in the sight line of MG J0414+0534: a record for intervening absorbers". ApJ, 772, L25 (2013). (O)

*Thorat, K.; Subrahmanyan, R.; Saripalli, L.; Ekers, R.D. "High-resolution imaging of the ATLBS regions: the radio source counts". ApJ, 762, A16 (2013). (C)

*Thornton, D.; Stappers, B.; Bailes, M.; Barsdell, B.; Bates, S.; Bhat, N. D. R.; Burgay, M.; Burke-Spolaor, S.; Champion, D.J.; Coster, P.; Johnston, S. and nine coauthors. "A population of fast radio bursts at cosmological distances". Science, 341, 53–56 (2013). (P)

*Thyagarajan, N.; Udaya Shankar, N.; Subrahmanyan, R.; Arcus, W.; Bernardi, G.; Bowman, J.D.; Briggs, F.; Bunton, J.D.; Cappallo, R.J.; Corey, B.E. and 39 coauthors. "A study of fundamental limitations to statistical detection of redshifted HI from the epoch of reionization". ApJ, 776, A6 (2013). (O)

*Tiburzi, C.; Johnston, S.; Bailes, M.; Bates, S.D.; Bhat, N.D.R.; Burgay, M.; Burke-Spolaor, S.; Champion, D.; Coster, P.; D'Amico, N. and nine coauthors. "The High Time Resolution Universe survey – IX. Polarimetry of long-period pulsars". MNRAS, 436, 3557–3572 (2013). (P)

*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, e007 (2013). (A, S)

*Tingay, S.J.; Kaplan, D.L.; McKinley, B.; Briggs, F.; Wayth, R.B.; Hurley-Walker, N.; Kennewell, J.; Smith, C.; Zhang, K.; Arcus, W. and 53 coauthors. "On the detection and tracking of space debris using the Murchison Widefield Array. I. Simulations and test observations demonstrate feasibility". AJ, 146, A103 (2013). (O)

*Titmarsh, A.M.; Ellingsen, S.P.; Breen, S.L.; Caswell, J.L.; Voronkov, M.A. "G 10.472+0.027: an extreme water maser outflow associated with a massive protostellar cluster". ApJ, 775, L12 (2013). (C)

*Titov, O.; Stanford, L.M.; Johnston, H.M.; Pursimo, T.; Hunstead, R.W.; Jauncey, D.L.; Maslennikov, K.; Boldycheva, A. "Optical Spectra of Candidate International Celestial Reference Frame (ICRF) flat-spectrum radio sources". AJ, 146, A10 (2013). (O)

*Tsai, C.-W.; Jarrett, T.H.; Stern, D.; Emonts, B.; Barrows, R.S.; Assef, R.J.; Norris, R.P.; Eisenhardt, P.R.M.; Lonsdale, C.; Blain, A.W. and seven coauthors. "WISE J233237.05–505643.5: A double-peaked, broad-lined active galactic nucleus with a spiral-shaped radio morphology". ApJ, 779, A41 (2013). (C)

Tsitali, A.E.; Belloche, A.; Commerçon, B.; Menten, K.M. "The dynamical state of the first hydrostatic core candidate Chamaeleon-MMS1". A&A, 557, A98 (2013). (M)

Tuntsov, A.V.; Bignall, H.E.; Walker, M.A. "Power-law models of totally anisotropic scattering". MNRAS, 429, 2562–2568 (2013). (C)

van der Horst, A.J.; Curran, P.A.; Miller-Jones, J.C.A.; Linford, J.D.; Gorosabel, J.; Russell, D.M.; de Ugarte Postigo, A.; Lundgren, A.A.; Taylor, G.B.; Maitra, D. and 24 coauthors. "Broad-band monitoring tracing the evolution of the jet and disc in the black hole candidate X-ray binary MAXI J1659–152". MNRAS, 436, 2625–2638 (2013). (C)

*van der Laan, T.P.R.; Schinnerer, E.; Emsellem, E.; Meidt, S.; Dumas, G.; Böker, T.; Hunt, L.; Haan, S.; Mundell, C.; Wozniak, H. "Explaining two circumnuclear star forming rings in NGC 5248". A&A, 556, A98 (2013). (O)

*van Haarlem, M.P.; Wise, M.W.; Gunst, A.W.; Heald, G.; McKean, J.P.; Hessels, J.W.T.; de Bruyn, A.G.; Nijboer, R.; Swinbank, J.; Braun, R. and 189 coauthors. "LOFAR: The LOw-Frequency ARray". A&A, 556, A2 (2013). (O)

van Straten, W. "High-fidelity radio astronomical polarimetry using a millisecond pulsar as a polarized reference source". ApJS, 204, A13 (2013). (P)

Venturi, T.; Rossetti, M.; Bardelli, S.; Giacintucci, S.; Dallacasa, D.; Cornacchia, M.; Kantharia, N.G. "Radio emission at the centre of the galaxy cluster Abell 3560: evidence for core sloshing?" A&A, 558, A146 (2013). (C)

*Vieira, J.D.; Marrone, D.P.; Chapman, S.C.; De Breuck, C.; Hezaveh, Y.D.; Weiß, A.; Aguirre, J.E.; Aird, K.A.; Aravena, M.; Ashby, M.L.N. and 60 coauthors. "Dusty starburst galaxies in the early Universe as revealed by gravitational lensing". Nature, 495, 344–347 (2013). (O)

*Viero, M.P.; Wang, L.; Zemcov, M.; Addison, G.; Amblard, A.; Arumugam, V.; Aussel, H.; Béthermin, M.; Bock, J.; Boselli, A.; Seymour, N. and 43 coauthors. "HerMES: Cosmic infrared background anisotropies and the clustering of dusty star-forming galaxies". ApJ, 772, A77 (2013). (O)

*Villar-Martín, M.; Emonts, B.; Rodríguez; M;. Torres, M.P.; Drouart, G. "SDSS J002531.46–104022.2 at z = 0.30: a candidate for the (ultra)luminous infrared galaxy to optical quasar transition". MNRAS, 432, 2104–2111 (2013). (C)

*Villar-Martín, M.; Rodríguez, M.; Drouart, G.; Emonts, B.; Colina, L.; Humphrey, A.; García Burillo, S.; Graciá Carpio, J.; Planesas, P.; Pérez Torres, M.; Arribas, S. "Molecular gas in type 2 quasars at z ~0.2–0.3". MNRAS, 434, 978–991 (2013). (C)

*Voigtländer, P.; Kamphuis, P.; Marcelin, M.; Bomans, D.J.; Dettmar, R.-J. "The kinematics of the diffuse ionized gas in NGC 4666". A&A, 554, A133 (2013). (O)

*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, A59 (2013). (O)

*Weiß, A.; De Breuck, C.; Marrone, D.P.; Vieira, J.D.; Aguirre, J.E.; Aird, K.A.; Aravena, M.; Ashby, M.L.N.; Bayliss, M.; Benson, B.A.; McIntyre, V. and 56 coauthors. "ALMA redshifts of millimeter-selected galaxies from the SPT Survey: the redshift distribution of dusty star-forming galaxies". ApJ, 767, A88 (2013). (O)

*Westmeier, T.; Koribalski, B.S.; Braun, R. "Gas and dark matter in the Sculptor Group: NGC 55". MNRAS, 434, 3511–3525 (2013). (C)

*Wolfinger, K.; Kilborn, V.A.; Koribalski, B.S.; Minchin, R.F.; Boyce, P.J.; Disney, M.J.; Lang, R.H.; Jordan, C.A. "A blind HI survey in the Ursa Major region". MNRAS, 428, 1790–1817 (2013). (O)

*Wylezalek, D.; Galametz, A.; Stern, D.; Vernet, J.; De Breuck, C.; Seymour, N.; Brodwin, M.; Eisenhardt, P.R.M.; Gonzalez, A.H.; Hatch, N. and four coauthors. "Galaxy clusters around radio-loud active galactic nuclei at 1.3 < z < 3.2 as seen by Spitzer". ApJ, 769, A79 (2013). (O)

*Wylezalek, D.; Vernet, J.; De Breuck, C.; Stern, D.; Galametz, A.; Seymour, N.; Jarvis, M.; Barthel, P.; Drouart, G.; Greve, T. R. and nine coauthors. "The Herschel view of the environment of the radio galaxy 4C+41.17 at z = 3.8". MNRAS, 428, 3206–3219 (2013). (O)

*Young, T.; Horiuchi, S.; Green, J.A.; Jerjen, H. "High-sensitivity mapping of ammonia emission in the Trumpler 14/Car I photodissociation region". MNRAS, 435, 3568–3574 (2013). (T)

*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 two coauthors. "Detection of 107 glitches in 36 southern pulsars". MNRAS, 429, 688–724 (2013). (P)

Yu, N.-P.; Wang, J.-J. "A multi-transition molecular line study of infrared dark cloud G331.71+00.59". RAA,13, 28–38 (2013). (M)

*Zanardo, G.; Staveley-Smith, L.; Ng, C.-Y.; Gaensler, B.M.; Potter, T.M.; Manchester, R.N.; Tzioumis, A.K. "High-resolution radio observations of the remnant of SN 1987A at high frequencies". ApJ, 767, A98 (2013). (C)

*Zinn, P.-C.; Middelberg, E.; Norris, R.P.; Dettmar, R.-J. "Active galactic nucleus feedback works both ways". ApJ, 774, A66 (2013). (O)

CASS PAPERS PUBLISHED IN CONFERENCE PUBLICATIONS

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*Abeywickrema, S.; Allen, G.; Ardern, K.; Schinckel, A.; Leitch, A.; Wilson, C.; Beresford, R. "Practical solutions for realising an RFI compliant building for the Australian SKA Pathfinder telescope". In: Asia-Pacific International Symposium and Exhibition on Electromagnetic Compatibility, Melbourne, Australia, 20-23 May, 2013, 368–371 (2013). (A)

Allison, J.R.; Sadler, E.M.; Curran, S.J.; Reeves, S.N. "Probing the cool ISM in galaxies via 21 cm HI absorption". In: IAUS 292: Molecular Gas, Dust, and Star Formation in Galaxies, Beijing, China, August 2012, 8, 188 (eds. T. Wong, J. Ott) (2013). (C)

*Benaglia, P.; Koribalski, B.; Peri, S.C.; Marti, J.; Sanchez-Sutil, R.J.; Dougherty, M.S. "First results from 3D-arcsec resolution cm-images of RCW 49/Westerlund 2". In: Massive Stars: From Alpha to Omega, Rhodes, Greece, 10–14 June 2013 (2013). (C)

*Beresford, R.; Bunton, J. "Shielding requirements for ADE receivers". In: Asia-Pacific International Symposium and Exhibition on Electromagnetic Compatibility, Melbourne, Australia, 20–23 May 2013, 300–303 (2013). (A)

*Beresford, R.; Li, Li. "Pre-compliance EMC measurements for MRO equipment". In: Asia-Pacific International Symposium and Exhibition on Electromagnetic Compatibility, Melbourne, Australia, 20–23 May, 2013, 296–299 (2013). (A)

*Bignall, H.E.; Koay, J.Y.; Lovell, J.E.J.; Jauncey, D.L.; Macquart, J-P.; Pursimo, T.; Ojha, R.; Rickett, B.; Kedziora-Chudczer, L.; Reynolds, C.; Khoo, S. "An update on MASIV: how intrinsic properties influence interstellar scintillation of AGN. Resolving the Sky – Radio Interferometry: Past, Present and Future, Manchester, United Kingdom, 17–20 April, 2012, 134 (eds. M.A. Garrett, C. Greenwood) (2013). (C, V)

*Bock, D.C.-J.; Carrad, G. "The Australia Telescope National Facility – recent upgrades and future plans". In: 2013 US National Committee of URSI National Radio Science Meeting, Boulder, USA, 9–12 January, 2013, 1, 17 (2013). (C, P)

*Bray, J.D.; Ekers, R.D.; Protheroe, R.J.; James, C.W.; Phillips, C.J.; Roberts, P.; Brown, A.; Reynolds, J.E.; McFadden, R.A.; Aartsen, M. "LUNASKA neutrino search with the Parkes and ATCA telescopes". In: 5th International Workshop on Acoustic and Radio EEV Neutrino Detection Activities: ARENA 2012, Erlangen, Germany, 19–22 June, 2012 ,1535, 21–26 (eds. R. Lahmann, T. Eberl, K. Graf *et al.*) (2013). (P, C)

*Breen, S.L.; Ellingsen, S.P. "An evolutionary sequence for high-mass star formation". In: IAU 292: Molecular Gas, Dust, and Star Formation in Galaxies, Beijing, China, 20–24 August, 2012, 292, 39 (eds. T. Wong, J. Ott) (2013). (M)

Burton, M.G.; Jones, P.A. "The Central Molecular Zone with Mopra". In: IAU 292: Molecular Gas, Dust, and Star Formation in Galaxies, Beijing, China, 20–24 August, 2012, 292, 75–78 (eds. T. Wong, J. Ott) (2013). (M)

*Caswell, J.L. "The Methanol Multibeam Survey: a unique window on high-mass star formation in our Galaxy". In: IAU 292: Molecular Gas, Dust, and Star Formation in Galaxies, Beijing, China, 20–24 August, 2012, 292, 79–82 (eds. T. Wong, J. Ott) (2013). (P)

*Chippendale, A.; Wormnes, K. "Spectrum quietness metrics for radio astronomy". In: Asia-Pacific International Symposium and Exhibition on Electromagnetic Compatibility, Melbourne, Australia, 20–23 May 2013, 312–315 (2013). (A)

*Chung, Y.S.; Dunning, A.; Bowen, M.A. "Ultra sharp roll-off bandpass filter design for near pass-band RFI mitigation". In: Asia Pacific Microwave Conference, Seoul, Korea, 5–8 November, 2013, 491–493 (2013). (O)

*Corbet, R.; Cheung, C.; Coe, M.; Coley, J.; Donato, D.; Edwards, P.; McBride, V.; McSwain, M.; Stevens, J. "Multi-wavelength observations of known, and searches for new, gamma-ray binaries". In: The Fast and the Furious: Energetic Phenomena in Isolated Neutron Stars, Pulsar Wind Nebulae and Supernova Remnants, Madrid, Spain, 22–24 May, 2013 (2013). (O)

*Dawson, J.R.; McClure-Griffiths, N.M.; Fukui, Y.; Dickey, J.; Wong, T.; Hughes, A.; Kawamura, A. "The supershell-molecular cloud connection in the Milky Way and Beyond". In: IAU 292: Molecular Gas, Dust and Star Formation in Galaxies, Beijing, China, 20–24 August 2012, 8, 83–86 (eds. T. Wong, J. Ott) (2013). (O)

*Dunning, A.; Chung, Y.; Bowen, M. "Offset quad ridged ortho-mode transducer with a 3.4:1 bandwidth". In: Asia Pacific Microwave Conference, Seoul, Korea, 5–8 November, 2013, 3p (2013). (O)

Durán-Rojas, M.C.; Gómez, J.F.; Osorio, M.; Rizzo, J.R.; Anglada, G.; Suárez, O.; Miranda, L.F.; D'Alessio, P.; Calvet, N.; Pérez-Cáceres, F.J. "Modeling the circumstellar structure of Water Fountain evolved stars". In: Highlights of Spanish Astrophysics VII, Proceedings of the X Scientific Meeting of the Spanish Astronomical Society (SEA), Valencia, Spain, 9–13 July, 2012, 648 (eds. J.C. Guirado, L.M. Lara, V. Quilis, J. Gorgas) (2013). (C)

*Forsyth, R.; Jackson, C.; Kesteven, M.; Li, L.; Mickle, S.; Zhang, Y.; Shi, M.; Feng, Z. "Lessons from the delivery of antennas for the Australian Square Kilometre Array pathfinder radio telescope (ASKAP)". In: Thirteenth Australian Symposium on Antennas, Sydney, Australia, 13–14 Feb 2013 (2013). (A)

Friedlander, A.; Frean, M.; Johnston-Hollitt, M.; Hollitt, C. "Latent Dirichlet allocation for image segmentation and source finding in radio astronomy images". In: The 27th Conference on Image and Vision Computing New Zealand, Dunedin, New Zealand, 26–28 November, 2012, 429–434 (eds. B. McCane, S. Mills, J. Deng) (2013). (C)

*Haan, S.; Surace, J.; Armus, L.; Evans, A. "Probing the build-up of stellar mass in the center of IR luminous major mergers with HST". In: IAU 295: The Intriguing Life of Massive Galaxies, Beijing, China, 20–31 August, 2012, 8, 311 (2013). (O)

Hay, S.G.; Bunton, J.D.; Shaw, R.D. "FoV analysis and design for the Australian SKA Pathfinder". In: Proceedings of the Seventh European Conference on Antennas and Propagation, Gothenburg, Sweden, 8–12 April, 2013, 4p (2013). (A)

*Hobbs, G. "Pulsar timing arrays: status and techniques". In: IAU 291: Neutron Stars and Pulsars: Challenges and Opportunities after 80 Years, Beijing, China, 20–24 August, 2012, 8, 165–170 (2013). (P)

*Hong, T.; Staveley-Smith, L.; Masters, K.; Springob, C.; Macri, L.; Koribalski, B.; Jones, H.; Jarrett, T. "The 2MASS Tully–Fisher Survey: mapping the mass in the Universe". In: IAUS 289: Advancing the Physics of Cosmic Distances, Beijing, China, August 2012, 289, 312–315 (ed. Richard de Grijs) (2013). (P)

*Jackson, C.A.; Forsyth, A.R.; Li, L.; Kesteven, M.J.; Mickle, S. "EMC considerations for the ASKAP dish antennas". In Asia-Pacific International Symposium and Exhibition on Electromagnetic Compatibility, Melbourne, Australia, 20–23 May 2013, 360–363 (2013). (A)

*Jauncey, D.L.; Bignall. H.E.; Kedziora-Chudczer, L.; Koay, J.Y.; Lovell, J.E.J.; Macquart, J-P.; Ojha, R.; Pursimo, T.; Reynolds, C.; Rickett, B. "Microarcsecond resolution with inter-stellar scintillation". In: Resolving the Sky – Radio Interferometry: Past, Present and Future, Manchester, United Kingdom, 17–20 April, 2012, 117 (eds. M.A. Garrett, C. Greenwood) (2013). (C, V)

Kawamura, A.; Minamidani, T.; Onishi, T.; Mizuno, T.; Kizawa, J.; Mizuno, N.; Fukui, Y. "Physical properties of molecular clouds in the Magellanic Clouds revealed by observations in multi-transition CO molecular lines". In: New Trends in Radio Astronomy in the ALMA Era: The 30th Anniversary of Nobeyama Radio Observatory, Hakone, Japan, 3–8 December, 2012, ASP Conf. Ser., 476, 73 (2013). (M)

*Li, L.; Forsyth, R.; Jackson, C. "Potential of steel-fibre-reinforced concrete to increase RFI mitigation of antenna foundations". In: Asia-Pacific International Symposium and Exhibition on Electromagnetic Compatibility, Melbourne, Australia, 20–23 May 2013, 307–307 (2013). (A)

Lo, N.; Cunningham, M.R.; Jones, P.A.; Bronfman, L. "Gas content in the GMC G333: hierarchical structure of turbulence". In: IAU 292: Molecular Gas, Dust, and Star Formation in Galaxies, Beijing, China, 20–24 August, 2012, 292, 49 (eds. T. Wong, J. Ott) (2013). (M)

*Lowe, V.; Cunningham, M.R.; Urquhart, J.S.; Horiuchi, S. "Ammonia towards dust clumps in the giant molecular cloud associated with RCW 106". In: IAU 292: Molecular Gas, Dust, and Star Formation in Galaxies, Beijing, China, 20–24 August, 2012, 292, 50 (eds. T. Wong, J. Ott) (2013). (M, T)

*Mao, M.Y.; Emonts, B.; Norris, R.P. "CO(1–0) in high-redshift radio galaxies using the ATCA". In: The Interstellar Medium in High Redshift Galaxies Comes of Age, Virginia, USA, 13–15 September, 2012, 28, 5 (ed. J.G. Mangum) (2013). (C)

*McFadden, R.; Ekers, R.; Bray, J. "Ionospheric propagation effects for UHE neutrino detection with the lunar Cherenkov technique". In: 32nd International Cosmic Ray Conference, Beijing, China, 11–18 August, 2011, 4, 284 (2013). (C,P)

Ng, C. "Conducting the deepest all-sky pulsar survey ever: the all-sky High Time Resolution Universe survey". In: IAU 291: Neutron Stars and Pulsars: Challenges and Opportunities after 80 years, Beijing, China, 20–31 August, 2012, 291, 53–56 (ed. J. van Leeuwen) (2013). (C)

*Norris, R.P.; Mao, M.Y.; Lenc, E.; Emonts, B.; Sharp, R.G. "The brightest ULIRG: watching the birth of a quasar". In: The Interstellar Medium in High Redshift Galaxies Comes of Age, Virginia, USA, 13–15 September, 2012, 28, 6 (ed. J.G. Mangum) (2013). (C)

Ott, J.; McCoy, M.; Meier, D. "An ALMA and ATCA molecular line survey toward Centaurus A". In: IAU 292: Molecular Gas, Dust, and Star Formation in Galaxies, Beijing, China, 20–24 August, 2012, 292, 251 (eds. T. Wong, J. Ott) (2013). (C)

*Piner, B.G.; Edwards, P.G. "The parsec-scale structure of the newer TeV blazars". In: The Innermost Regions of Relativistic Jets and Their Magnetic Fields, Granada, Spain, 10–14 June, 2013, 61, A04021 (ed. José L. Gómez) (2013). (V)

*Roberts, P.; Beresford, R. "New instrumentation for EMC work in radio astronomy". In: Asia-Pacific International Symposium and Exhibition on Electromagnetic Compatibility, Melbourne, Australia, 20–23 May, 2013, 468–470 (2013). (A)

Sokolovsky, K.V. "RadioAstron Early Science Program Space-VLBI AGN survey: strategy and first results". In: The 11th European VLBI Network Symposium & Users Meeting, Bordeaux, France, 9–12 October 2012, 6 p (2013). (V)

Stephens, I.W.; Looney, L.W.; Indebetouw, R.; Chu, Y.-H.; Gruendl, R.A.; Chen, C.-H.R.; Seale, J.P.; Evans, J.M. "Evolution of HII regions around massive YSOs". In: IAU 292: Molecular Gas, Dust, and Star Formation in Galaxies, Beijing, China, 20–24 August, 2012, 292, 56 (eds. T. Wong, J. Ott) (2013). (C)

*Tingay, S.J.; Oberoi, D.; Cairns, I.; Donea, A.; Duffin, R.; Arcus, W.; Bernardi, G.; Bowman, J.D.; Briggs, F.; Bunton, J.D.; Cappallo, R.J.; Corey, B.E.; Deshpande, A.; deSouza, L.; Emrich, D.; Gaensler, B.M. and 37 coauthors. "The Murchison Widefield Array: solar science with the low frequency SKA Precursor". In: Journal of Physics: Conference Series: Eclipse on the Coral Sea: Cycle 24 Ascending, Palm Cove, Australia, 12–16 November, 2012, 440, A012033 (2013). (O)

Väisälä, M.; Harju, J.; Mantere, M.; Miettinen, O.; Walmsley, M. "High-resolution ammonia mapping of the protostellar core Cha-MMS1". IAU 292: Molecular Gas, Dust, and Star Formation in Galaxies, Beijing, China, 20–24 August, 2012, 292, 61 (eds. T. Wong, J. Ott) (2013). (C)

*Wang, J.; Hobbs, G.; Wang, N. "Search for the gravitational wave memory effect with the Parkes Pulsar Timing Array". In: IAUS 291: Neutron Stars and Pulsars: Challenges and Opportunities after 80 years, Beijing, China, August 2012, 291, 543–545 (ed. J. van Leeuwen) (2013). (P)

*Webster, N. “Safe laser pointer or prohibited weapon. How do you know?” In: Australasian Radiation Protection Society Annual Conference, Cairns, Australia, 12–16 October, 2013 (2013). (O)

*Wilson, C.; Storey, M.; Tzioumis, T. “Measures for control of EMI and RFI at the Murchison Radioastronomy Observatory, Australia”. Asia-Pacific International Symposium and Exhibition on Electromagnetic Compatibility, Melbourne, Australia, 20–23 May, 2013, 376–379 (2013). (A)

*Yan, W.; Manchester, R.N.; Wang, N. “Rotation measure variations for millisecond pulsars”. In: IAU 291: Neutron Stars and Pulsars: Challenges and Opportunities after 80 Years, Beijing, China, 20–24 August, 2012, 8, 568–570 (2013). (P)

*Yuen, R.; Manchester, R.N.; Burgay, M.; Camilo, F.; Kramer, M.; Melrose, D.B.; Stairs, I.H. “Changes in polarization position angle across the eclipse in the double pulsar system”. In: IAU 291: Neutron Stars and Pulsars: Challenges and Opportunities after 80 Years, Beijing, China, 20–24 August, 2012, 8, 580–582 (2013). (P)

H: Media releases

CASS/ATNF MEDIA RELEASES ISSUED IN 2013

Our Galaxy's 'geysers' are towers of power (3 Jan 2013)

'Monster' outflows of charged particles from the centre of our Galaxy, stretching more than halfway across the sky, have been detected and mapped with CSIRO's 64-m Parkes radio telescope.

http://www.csiro.au/Portals/Media/Our-Galaxys-geysers-are-towers-of-power.aspx

CSIRO telescope takes temperature of Universe (23 Jan 2013)

Astronomers using a CSIRO radio telescope have taken the Universe's temperature, and have found that it has cooled down just the way the Big Bang theory predicts.

http://www.csiro.au/Portals/Media/CSIRO-telescope-takes-temperature-of-Universe.aspx

New leader for Australia's astronomy and space science research (31 Jan 2013)

CSIRO's astronomy, spacecraft tracking and space science activities will be headed up by a new leader, with the announcement today that Dr Lewis Ball has been appointed as the incoming Chief for CSIRO's Astronomy and Space Science (CASS) division.

http://www.csiro.au/Portals/Media/New-leader-for-Australias-astronomy-and-space-science-research.aspx

Astronomers spy on galaxies in the raw (24 Jun 2013)

The Australia Telescope Compact Array has been used to study cold molecular hydrogen gas — the raw material for making stars — in galaxies that formed when the Universe was just three billion years old.

http://www.csiro.au/en/Portals/Media/Astronomers-spy-on-galaxies-in-the-raw.aspx

Deep-space flashes light up a new face of Nature (17 Jul 2013)

CSIRO's Parkes radio telescope has detected brief flashes of radio emission from the distant Universe. Their origin is unknown.

http://www.csiro.au/en/Portals/Media/Deep-space-flashes-light-up-a-new-face-of-Nature.aspx

Pulsars make a GPS for the cosmos (20 Aug 2013)

CSIRO scientists have written software that could guide spacecraft to Alpha Centauri, show that the planet Nibiru doesn't exist ... and prove that the Earth goes around the Sun.

http://www.csiro.au/Portals/Media/Pulsars-make-a-GPS-for-the-cosmos.aspx

CSIRO telescope marks 25 years of success (28 Aug 2013)

One of the world's most successful astronomy observatories, CSIRO's Australia Telescope Compact Array near Narrabri, NSW, turns 25 years of age on 2 September.

http://www.csiro.au/en/Portals/Media/CSIRO-telescope-marks-25-years-of-success.aspx

Magnetic field may shape 'blooming' star (16 Sep 2013)

A star is 'blooming' in the southern sky — and astronomers using a CSIRO telescope are a step closer to knowing why.

http://www.csiro.au/Portals/Media/Magnetic-field-may-shape-blooming-star.aspx

Astronomers find 'missing link' pulsar (26 Sep 2013)

An international team of astronomers has used X-ray telescopes in space and ground-based telescopes, including two of CSIRO's, to identify a pulsar that switches between emitting X-rays and emitting radio waves. This is the first direct evidence of one kind of pulsar turning into another.

http://www.csiro.au/en/Portals/Media/Astronomers-find-missing-link-pulsar.aspx

Gravitational waves 'know' how black holes grow (18 Oct 2013)

Supermassive black holes: every large galaxy's got one. But how did they grow so big? A paper in today's issue of the journal Science [18 October 2013] pits the front-running ideas about the growth of supermassive black holes against observational data — a limit on the strength of gravitational waves from pairs of black holes, obtained with CSIRO's 64-m Parkes radio telescope in eastern Australia.

http://www.csiro.au/Portals/Media/Gravitational-waves-know-how-black-holes-grow.aspx

Lead role for CSIRO in SKA R&D (5 Nov 2013)

CSIRO will play a lead role in the next stage of the development of the world's largest radio telescope, the Square Kilometre Array (SKA), to be located in Australia and in Africa.

http://www.csiro.au/Portals/Media/Lead-role-for-CSIRO-in-SKA-RandD.aspx

Pill-popping galaxy hooked on gas (7 Nov 2013)

Our Galaxy may have been swallowing 'pills' — clouds of gas with a magnetic wrapper — to keep making stars for the past eight billion years.

http://www.csiro.au/en/Portals/Media/Pill-popping-galaxy-hooked-on-gas.aspx

Black hole jets pack a powerful punch (14 Nov 2013)

High-speed 'jets' spat out by black holes pack a lot of power because they contain heavy atoms, astronomers have found.

http://www.csiro.au/Portals/Media/2013/Black-hole-jets-pack-a-powerful-punch.aspx

Find black holes while you're on the bus (19 Dec 2013)

'Radio Galaxy Zoo' is a citizen-science project that lets anyone become a cosmic explorer. It uses data from the Australia Telescope Compact Array.

http://www.csiro.au/en/Portals/Media/Find-black-holes-while-youre-on-the-bus.aspx

I: Abbreviations

AAL	Astronomy Australia Ltd
AAO	Australian Astronomical Observatory
AARNet	Australia's Academic and Research Network
ACMA	Australian Communications and Media Authority
ADASS	Astronomical Data and Software Systems
AGN	Active Galactic Nuclei
AIPS	Astronomical Image Processing System
ALFA	Arecibo L-band Feed Array
ALMA	Atacama Large Millimeter/sub-millimeter Array
ANZSCC	Australia – New Zealand SKA Coordination Committee
APSR	ATNF Parkes Swinburne Pulsar Recorder
ARC	Australian Research Council
ASA	Astronomical Society of Australia
ASCC	Australian SKA Coordination Committee
ASDAF	ASKAP Science Data Archive Facility
ASKAIC	Australasian SKA Industry Consortium
ASKAP	Australian Square Kilometre Array Pathfinder
ATCA	Australia Telescope Compact Array
ATLAS	Australia Telescope Large Area Survey
ATNF	Australia Telescope National Facility
ATSC	Australia Telescope Steering Committee
ATUC	Australia Telescope User Committee
AUT	Auckland University of Technology
BETA	Boolardy Engineering Test Array
CAASTRO	ARC Centre of Excellence for All-sky Astrophysics
CABB	Compact Array Broadband Backend
CALOSIS	Centaurus A Synthesis Imaging Survey
CASS	CSIRO Astronomy and Space Science
CCI	CSIRO Computational Informatics
CDSCC	Canberra Deep Space Communication Complex
CDF-S	Chandra Deep Field South
CMIS	CSIRO Mathematical and Information Sciences
CSOF	CSIRO Officer
CONRAD	Convergent Radio Astronomy Demonstrator
CoRE	Cosmological Reionization Experiment
COSMOS	Cosmological Evolution Survey
COSPAR	Committee on Space Research
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAS	Data Acquisition Systems
DFB	Digital Filterbank
DBCDE	Department of Broadband, Communications and the Digital Economy
DIISRTE	Department of Innovation, Industry, Science, Research and Tertiary Education
DSN	Deep Space Network
EIF	Education Investment Fund
EDGES	Experiment to Detect the Global Epoch of Reionization Signature
ELAIS	European Large Area ISO Survey
e-MERLIN	Extended Multi-Element Radio Linked Interferometer
EPICS	Experimental Physics and Industrial Control System
ESO	European Southern Observatory
EU SKADS	European SKA Design Study
FARADAY	Focal-plane Arrays for Radio Astronomy: Design, Access and Yield
FIR	Far Infrared
FITS	Flexible Image Transport System
FPA	Focal Plane Array
FPGA	Field Programmable Gate Arrays
FTE	Full Time Equivalent
GASS	Galactic All Sky Atomic Hydrogen Survey
GW	Gravitational Wave
HEMT	High Electron Mobility Transistor
HI	Neutral Hydrogen
HIPASS	HI Parkes All Sky Survey
HIZOA	HI Zone of Avoidance
HPC	High Performance Computing
HSE	Health, Safety and Environment
HVC	High Velocity Clouds
IAU	International Astronomical Union
ICIP	Industry Cooperative Innovation Programme
ICRAR	International Centre for Radio Astronomy Research
ICTC	Information and Communications Technology Centre
IEEE	Institute of Electrical and Electronics Engineers
IFRS	Infrared Faint Radio Sources
InP	Indium Phosphide
ISM	Interstellar Medium
ISSC	International SKA Steering Committee
IT	Information Technology
ITU	International Telecommunications Union
IUCAF	Scientific Committee on the Allocation of Frequencies for Radio Astronomy and Space Sciences
IVS	International VLBI Service
JIVE	Joint Institute for VLBI in Europe
JPL	Jet Propulsion Laboratory
KAT	Karoo Array Telescope
LBA	Long Baseline Array, used for Australian VLBI observations
LFD	Low Frequency Demonstrator
LNA	Low Noise Amplifier
LO	Local Oscillator
LOFAR	Low Frequency Array
LOFAR DMT	Low Frequency Array Dark Matter Telescope
LVHIS	Local Volume HI Survey
MASIV	Micro-Arcsecond Scintillation-Induced Variability

MERLIN	Multi-Element Radio Linked Interferometer
MIRIAD	Multichannel Image Reconstruction Image Analysis and Display
MIT	Massachusetts Institute of Technology
MMBS	Methanol Multibeam Survey
MMIC	Monolithic Microwave Integrated Circuit
MNRAS	Monthly Notices of the Royal Astronomical Society
MNRF	Major National Research Facilities
MOPS	Mopra Spectrometer
MRO	Murchison Radio-astronomy Observatory
MSF	Murchison Radio-astronomy Observatory Support Facility
MSP	Millisecond Pulsar
MWA	Murchison Widefield Array
NASA	National Aeronautics and Space Administration
NCRIS	National Collaborative Research Infrastructure Strategy
NRAO	National Radio Astronomy Observatory
NRC-HIA	National Research Council Canada – Herzberg Institute of Astrophysics
NOT	Nordic Optical Telescope, Spain
NSF	National Science Foundation
OCE	CSIRO's Office of the Chief Executive
PAF	Phased Array Feed
PAPER	Precision Array to Probe Epoch of Reionization
PDFB	Polyphase Digital Filterbank
PMPS	Parkes Multibeam Pulsar Survey
PPTA	Parkes Pulsar Timing Array
PrepSKA	Preparatory Phase Studies for the Square Kilometre Array
PTF	Parkes Testbed Facility
RAFCAP	Radio Astronomy Frequency Committee in the Asia Pacific
RFI	Radio Frequency Interference
RSAA	Research School of Astronomy and Astrophysics
SCG	Southern Compact Group
SEST	Swedish-ESO Submillimetre Telescope
SINGS	Spitzer Infrared Nearby Galaxies Survey
SKA	Square Kilometre Array
SKAMP	SKA Molonglo Prototype
TAC	Time Assignment Committee
THEA	Thousand Element Array
TIGO	Transportable Integrated Geodetic Observatory
UCSD	University of California, San Diego
UNSW	University of New South Wales
URSI	International Union of Radio Science
USNO	United States Naval Observatory
VLA	Very Large Array
VLBI	Very Long Baseline Interferometry
VO	Virtual Observatory
VSOP	VLBI Space Observatory Program
WDM	Wavelength Division Multiplexed
WLAN	Wireless Local Area Network
WRC	World Radio Conferences

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