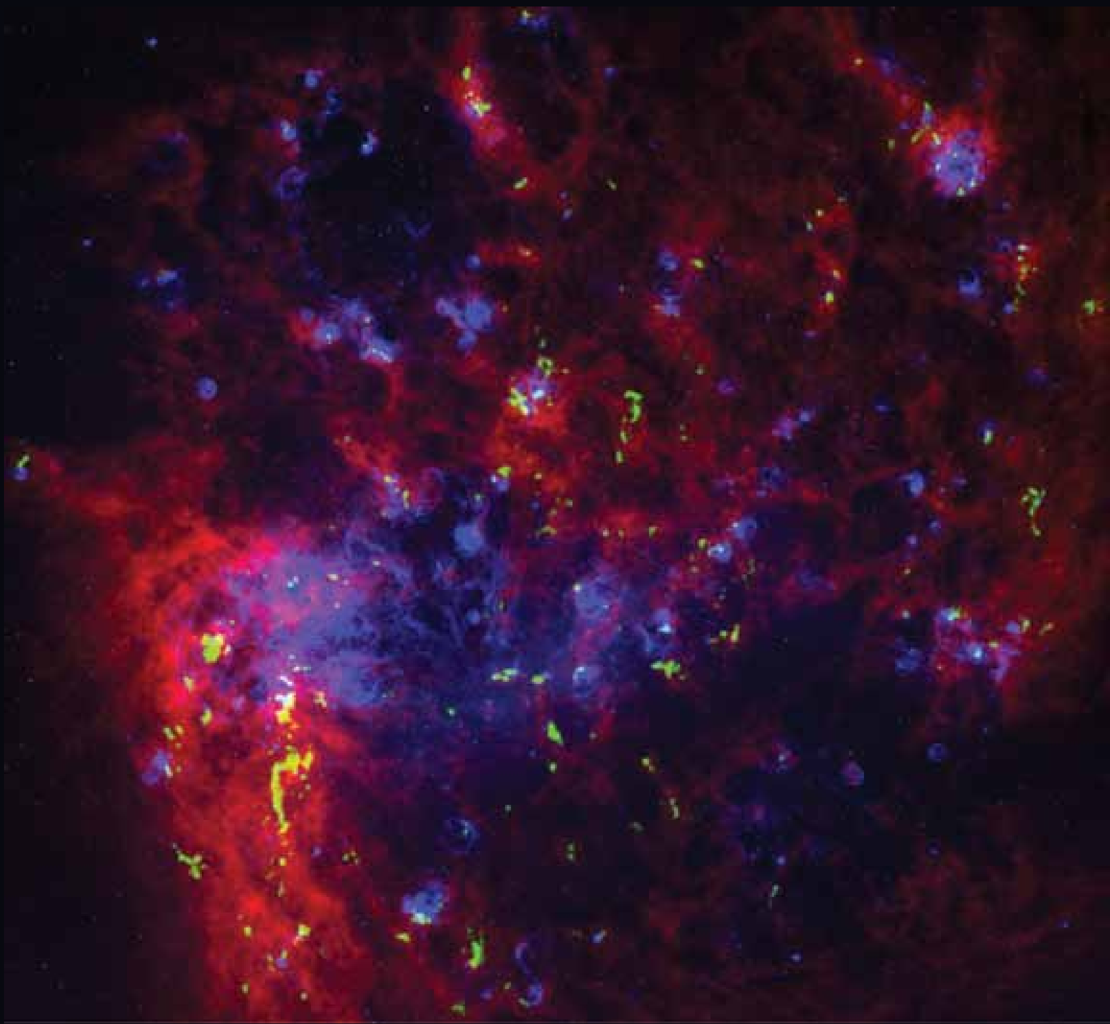
CSIRO

Ionised, atomic and molecular gas phases in the Large Magellanic Cloud



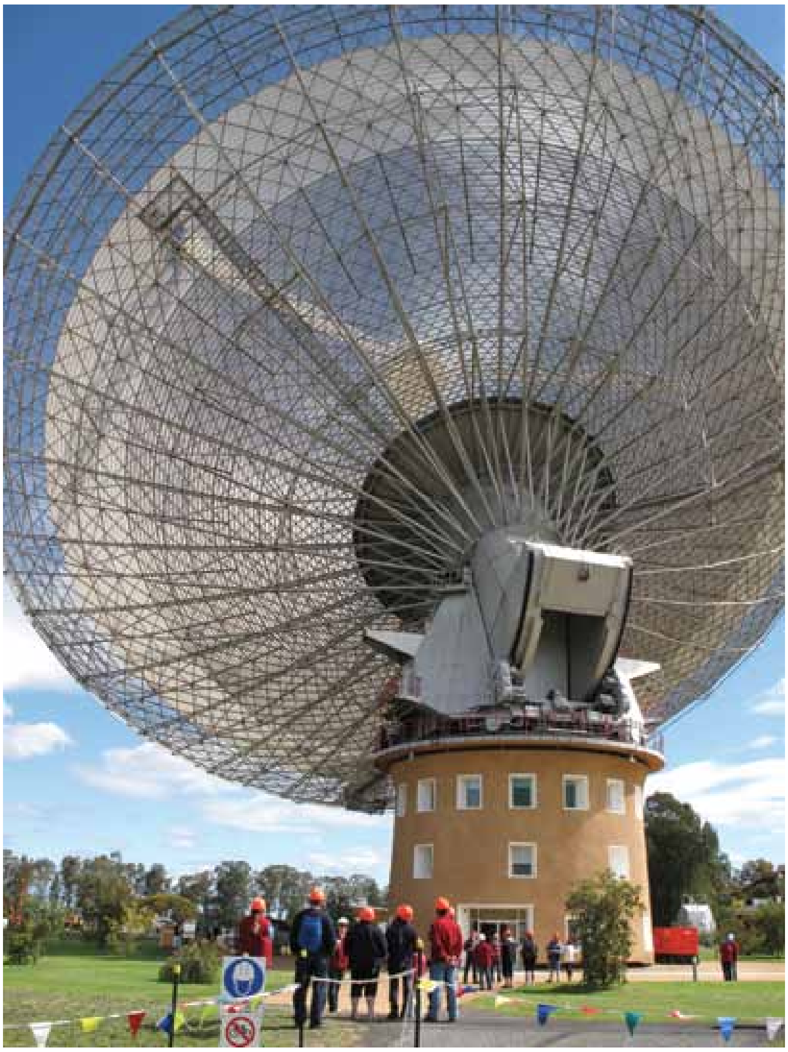
www.csiro.au

ATNF News

Issue No. 71, October 2011 **ISSN 1323-6326**

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

Editorial



Visitors queue to tour *The Dish* during the Parkes Observatory 50th Anniversary Open Weekend. Image credit Tony Crawshaw, CSIRO

Front cover page image

A three-colour image of the ionised, atomic and molecular gas phases in the Large Magellanic Cloud. Red is the integrated intensity HI emission from the ATCA+Parkes HI survey (Kim et al. 2003), blue is Halpha emission by MCELS (Smith et al 1999), and green is CO integrated intensity from the recently completed MAGMA survey (Wong et al 2011). See article on page 28.

Welcome to the October 2011 issue of the ATNF News.

In a bumper edition, we start first with an update on proposed future ATNF operational strategy by CASS Chief Philip Diamond and Head of Operations Douglas Bock.

We then feature a diverse range of articles, ranging from a report on the Parkes Observatory 50th Anniversary Open Weekend (which saw many thousands of people from the local community and beyond explore our 64-m dish), through to reports on this year's Radio Astronomy School which was also held at Parkes. We also acknowledge CASS' Dr Bärbel Koribalski who has been recently awarded a prestigious Newton Turner Award. The Award is designed to further the scientific careers of exceptional senior scientists within CSIRO.

In other news we report on our new CASS Chief Scientist role (filled by previous CASS Head of Astronomy Robert Braun); we follow John Sarkissian in his search for high quality video footage of the Apollo 11 moon walk; and we report on early science observations with ALMA noting CSIRO astronomer Jill Rathborne's success in gaining telescope time for ALMA's early science stage.

We then run our regular collection of science articles focusing on the latest in radio astronomical research. This includes an article by Annie Hughes and collaborators on

Contents

science highlights from MAGMA, the Magellanic Mopra Assessment.

Jimi Green and collaborators then report on new insights into Galactic structure via a trace of the inner Galaxy with 6.7-GHz methanol masers.

Vikram Ravi examines giant pulsars with the Australia Telescope Compact Array (ATCA).

Finally, Shane O'Sullivan and collaborators report on results using ATCA's newly upgraded 1.1 to 3.1 GHz receivers. Results show that the Faraday rotation measure of unresolved Active Galactic Nuclei (AGN) may be a lot more complicated than had been previously thought.

In other news, CASS Education Specialist Robert Hollow reports on recent outreach activity including successful teacher workshops and an international PULSE@ Parkes session held in England. He also provides a roundup from the inaugural Murchison Astrofest held at Murchison Roadhouse in the Mid West of WA.

As always, we provide our regular in-depth update on CSIRO's Australian Square Kilometre Array Pathfinder and Square Kilometre Array related activity and we conclude with our regular Operations report.

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

Tony Crawshaw and
Joanne Houldsworth
The ATNF Newsletter Production Team
(newsletter@atnf.csiro.au)

Future ATNF Operations

Phil Diamond (CASS Chief)

Douglas Bock (Assistant Director – Operations)

By now, most members of the community will be aware of changes proposed to the ATNF from late 2012. The changes are intended to ensure that the ATNF can sustainably support high-impact science once the Australian Square Kilometre Array Pathfinder (ASKAP) is operating.

The full cost of operating ASKAP ($12.2m per year) will exceed the present cost ($10.5m in 2010–11) of operating all the current facilities. Therefore, although we are receiving substantial new operations funding from CSIRO for ASKAP, we do not expect to be able to keep all current facilities as they are used today. This consequence was envisaged in the decadal plan for Australian astronomy, *New Horizons*, and *ATNF Science in 2010-2015 (August 2008)*, and recently re-affirmed in the Mid-Term Review of the plan.

Our proposal for the existing ATNF facilities, endorsed by the ATNF Steering Committee, is that:

- We seek external funding to operate Mopra. If it is not forthcoming then CSIRO expects to stop operating Mopra in October 2012;
- We will position Parkes to continue to deliver high impact science through a change in its operational model aimed at delivering savings over time. To achieve this goal we will seek to:
  1. Operate Parkes entirely remotely;
  2. Significantly reduce observing support, focusing on high impact projects with modest support requirements;
  3. Reduce substantially the available instrumentation (frontends and backends).
- CSIRO's Australia Telescope Compact Array (ATCA) at Narrabri will continue to be operated as a major element of the National Facility, with on-site and remote observing supported. We will explore measures to reduce the cost of operations at the ATCA;
- The Long Baseline Array and community time on the 70-m Tidbinbilla antenna will continue to be available approximately as at present. We will seek to keep Mopra as part of the LBA if possible.

The following factors have led us to strongly prefer this scenario:

- The broader science scope and the larger, more diverse user base of the ATCA compared to Parkes;
- The opportunities for the ATCA to provide high frequency follow-up observations to surveys conducted with ASKAP;
- The viability of a strong science case for Parkes, through high impact, large-scale projects, even with the changed model;
- The remarkable regeneration of the ATCA through upgrades to the front-ends (16-cm receivers, 3/6-cm receivers, high frequency capability) and back-end (with the flexibility and bandwidth coverage of CABB).

The implementation of any changed operational model is not expected to affect observing in the current (2011 October) semester. For the 2012 April semester we anticipate offering the current suite of capabilities on Mopra and the ATCA, but a modestly reduced set of instrumentation at Parkes.

We will spend the coming weeks in discussions with the astronomical community and other stakeholders. CASS leadership will visit universities around Australia. A schedule will be available shortly on the ATNF website.

We can consider other scenarios for the existing facilities, however any model that is adopted must ensure both science capability and financial viability. Later this year, following these consultations, CSIRO will update users on the strategy for future ATNF operations.

We welcome your views on the proposed model for the existing ATNF facilities by email to

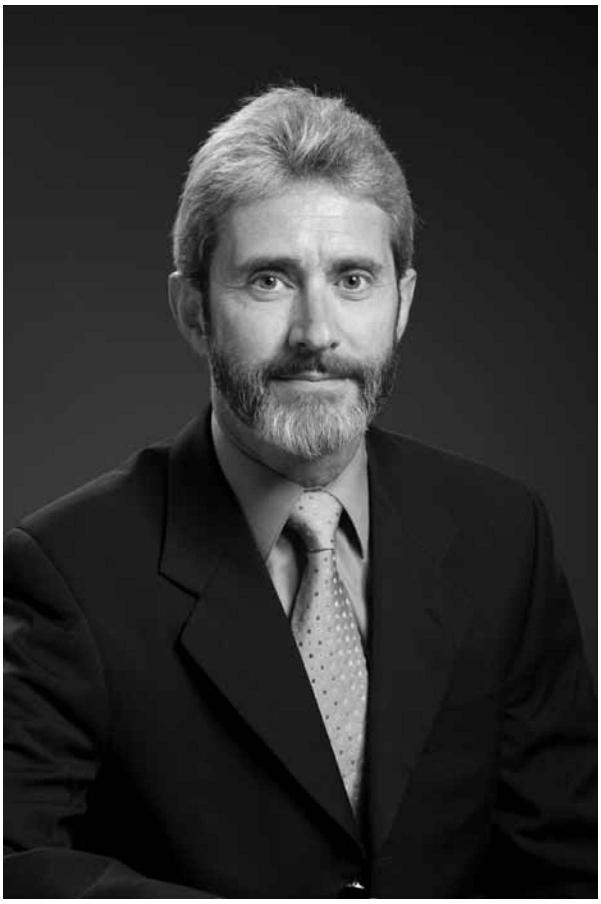
Director@atnf.csiro.au

by 30 November 2011.

New Chief Scientist Role Created

Tony Crawshaw (CASS)

July 1st 2011 saw the establishment of a new position — Chief Scientist — in CSIRO's division of Astronomy and Space Science. The role, taken on by Dr Robert Braun (previously CASS Assistant Director for Astrophysics), is a strategic appointment, reporting directly into the CASS Chief, Philip Diamond.



Dr Robert Braun, CASS Chief Scientist.
Image credit: Wheeler Studios

As Chief Scientist, Dr Braun is responsible for establishing, with the appropriate theme leaders, a long-term science strategy for both astrophysics and engineering. He is also working with the CSIRO SKA Project Scientist and the international SKA Science Team to further develop the science case for the SKA.

Additional responsibilities include representing CSIRO on appropriate committees and other bodies and building relationships with other CSIRO Chief Scientists to facilitate collaborative projects. He is also looking to attract world-class researchers to join CASS.

Recent activity has seen Robert take the lead role in coordinating activity for the Division's quadrennial Science Review, which took place during September.

The coming years should prove particularly interesting for Robert with an SKA site decision imminent, with all the consequences that might entail for CASS, as well as the exceptional opportunities to further develop and deploy phased array feeds to enable revolutionary advances in wide-field and high precision radio astronomy.

Replacing Robert Braun as Assistant Director, Astrophysics is CASS' Simon Johnston.

CSIRO Astronomer Receives Newton Turner Award

Gabby Russell (CASS)

CSIRO Astronomy and Space Science's Dr Bärbel Koribalski has been awarded a prestigious Newton Turner Award. The Award is designed to further the scientific careers of exceptional senior scientists in CSIRO, and recipients receive a grant to contribute towards their professional development.

Bärbel joined CSIRO in 1993 with the aim to explore the Universe, in particular the star formation, kinematics and dark matter content of nearby galaxies. Her research interests cover a broad range of topics, from proto-planetary disks, massive stars, fast-rotating pulsars and high-velocity clouds in our Galaxy to nearby galaxies, such as the Magellanic Clouds, spectacular starbursts, interacting galaxy pairs/groups and distant mergers.

Bärbel leads several international research teams, most prominently the *Local Volume HI Survey* (*LVHIS* — pronounced ELVIS) and the *ASKAP HI All-Sky Survey* (nick-named *WALLABY*).

WALLABY will conduct an extragalactic neutral hydrogen survey over 75 percent of the entire sky using CSIRO's Australian Square Kilometre Array Pathfinder (ASKAP) telescope, which is currently under construction. The project aims to examine the HI properties and large-scale distribution of up to 500,000 galaxies to a redshift of 0.26. By comparison, only about 22,000 galaxies with HI emission are currently known.

The Newton Turner Award will allow Bärbel to explore the Local Universe in novel ways (for example, by using interactive 3D visualisation and computer graphics) and communicate the research results to professional audiences and the public.

"I'm excited to be one of the recipients of CSIRO's Newton Turner Award for 2011–2012," says Bärbel. "The support I have received will help me to reach my goal of producing an HD television movie of a fly-through of the Local Universe. Through this I look forward to inspiring others to study astronomy and enjoy the beauty of our Universe."

Bärbel holds a PhD in Physics (1993) from the University of Bonn, Germany. She was awarded the Max Planck Society's Otto Hahn Medal for her PhD Thesis research and is a member of the Astronomical Society of Australia.

Dr Bärbel Koribalski. Image credit: Gabby Russell, CSIRO

The Newton Turner Award, named after Dr Helen Alma Newton Turner (15 May 1908 – 26 November 1995), was established by CSIRO in 2008. Dr Turner is rightly regarded as one of Australia's foremost geneticists. Her career with CSIRO was dedicated to research into the genetic improvement of sheep for wool production and had a large impact on animal breeding research and application in Australia and internationally.

C/X Receiver Upgrade — Input Sought

Naomi McClure-Griffiths (CASS)

CASS is in the process of upgrading the existing C/X receivers on the Australia Telescope Compact Array to merge the 6 and 3-cm bands from the current (4.4–6.9 GHz and 8.0–9.2 GHz) bands to approximately 4–12 GHz. The dominant scientific drivers for this project are increased continuum sensitivity and better access to spectral regions not presently available or poorly covered. With an upgrade of the Low-Noise Amplifiers (LNAs) the instantaneous bandwidth will increase from the 2.0 GHz at 6 cm and 1.2 GHz at 3 cm accessible with CABB and the current receivers to 2 x 2.0 GHz anywhere in the ~4–12 GHz range. Furthermore, we expect an improvement in the system temperature of ~30%. The upgrade is planned to be complete by mid 2013.

The original project plan specified that the receiver upgrade would cover the range 4–12 GHz, however recent measurements of the C/X feed show that in order to extend the upper frequency limit beyond 10.8 GHz would require an upgrade to the feeds. This may result in a delay in delivery and a guaranteed, significant extra cost. $100k is not an unreasonable estimate. CASS is therefore soliciting community input on the impact of restricting the frequency coverage from 4–11 GHz rather than the 4–12 GHz originally proposed. Input should be sent directly to the project scientist, Naomi McClure-Griffiths

(*Naomi.McClure-Griffiths@csiro.au*).

Distinguished Visitors

Simon Johnston (CASS)

Over the past months we have enjoyed working visits from Edo Ibar (Royal Observatory Edinburgh), Trish Henning (University of New Mexico), Paul Nulsen (CfA, Harvard) and Martin Cohen (University of California, Berkeley).

Current visitors include Daniel Yardley, Dominic Schnitzeler, Bill Coles (University of California, San Diego) and Xiao-Peng You (South Western University, China), with a visit by Ken Kellerman (National Radio Astronomy Observatory) and Tom Jarrett (Caifornia Institute of Technology) to come before Christmas.

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

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

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

Parkes Observatory's 50th Anniversary Open Weekend

Chris Hollingdrake (CASS)

A big occasion calls for a special celebration. The weekend of the 8 – 9 October at Parkes Observatory was a celebration fitting this impressive milestone. Around 3000 visitors explored the observatory over the weekend and more than 2000 attended a special celebration concert on the Saturday night.

Visitors were treated to behind the scenes tours of the famous *Dish* along with the opportunity to meet our astronomers, engineers, technicians and other support staff. In a first, the Parkes receiver lab was opened to the public allowing those craving technical insight a chance to delve a little deeper into the world of radio physics.

Other CASS activities were highlighted, including advances in ASKAP (the Australian Square Kilometre Array) through a self guided walk to the 12-m test bed antenna and an ASKAP display, information on Australia's bid to host the SKA and CASS's other observatories.

Families are the most common attendees at CASS open days, so a range of activities were offered to entertain the whole family. Questacon provided two street performers, Einstein and an astronaut zipping about on a segway, and CSIRO Education supplied a hands-on science exhibition with fun physics activities to explore. Hundreds of budding astronomers spent hours designing, decorating and constructing around 300 paper dishes to assemble a ten percent SKA paper array.

The weekend's gala event was a fundraising concert held under the telescope on the

Confetti canons fire in celebration of the Parkes Observatory Anniversary.
Image credit: Robert Hollow, CSIRO

Saturday evening. This was the brainchild of soprano Helen Barnett, one of the four soloists who performed along with the Macquarie Philharmonia orchestra. The guests of honour were the Governor-General, Her Excellency Quentin Bryce, and the US Consul General, Niels Marquardt, who read out a congratulatory letter from NASA. The evening ended with fireworks. *Opera at The Dish* has been nominated for various events and cultural awards in the Central West NSW region.

Opera at The Dish. Image credit: Tony Crawshaw, CSIRO

Months of planning and preparation paid off with the weekend running smoothly. In particular the Open Weekend committee at Parkes put in a huge amount of effort and should be congratulated for their dedication to showcasing this world-leading observatory. More than 90 volunteers from around the state contributed over the weekend, which is an amazing show of support. Thank you to all involved.

The Apollo 11 Restored Video

by John Sarkissian (CASS)

In July 1969, six hundred million people, one-sixth of mankind at the time, witnessed the historic Apollo 11 moonwalk live on television.

At the time, three tracking stations were receiving the TV signals from the Moon. They were the CSIRO Parkes Radio Telescope and the NASA tracking stations at Honeysuckle Creek near Canberra and Goldstone in California. As the signals were being received they were recorded onto magnetic data tapes.

The TV signal that was transmitted directly from the Moon was of a non-standard format that had to be scan-converted on Earth before it could be broadcast worldwide. The scan-conversion process unavoidably produced a lower quality version of the TV pictures. It was this version that was witnessed by the world and archived by NASA.

Beginning in the late 1990's, I began searching for the original data tape recordings with the aim of recovering the higher quality TV. Later, I was joined by four colleagues including fellow Australian, Colin Mackellar, the editor of the Honeysuckle Creek web site. In 2006, this search was formalised by NASA and headed up by the NASA Goddard Space Flight Center Deputy Director, Dorothy Perkins. Following an exhaustive search, the Apollo 11 Tape Search Team reluctantly concluded in 2009 that these data tape recordings no longer existed.

Forunately, during the search, many of the very best scan-converted recordings were discovered in various archives around the world. These were digitised and the best parts of each were used to compile a complete recording of the Apollo 11 moonwalk.

The bulk of the footage was sourced from the signals received by the CSIRO Parkes Radio Telescope, but it also included new, never-before-seen footage sourced from the Honeysuckle Creek tracking station.

In 2009, NASA contracted the California company, Lowry Digital (a pioneer in video enhancement), to process and restore this recording for the Apollo 11 40th Anniversary.

The restoration involved digitally repairing damaged sections of the recordings, removing noise from the video, correcting for vignetting, stabilising and brightening the TV picture and other adjustments. The result is the best and most complete video record yet of the Apollo 11 moonwalk.

As Neil Armstrong has stated, "the restored video is a valuable contribution to space exploration and space communication history".

The NASA Goddard Space Flight Center produced three archival sets of hard drives containing the complete Apollo 11 restored video — one set was sent to the US National Archives in Washington and another went to the Johnson Space Center in Houston, Texas. The third set was destined for Australia in recognition of the

Neil Armstrong handing over the restored Apollo 11 video to Dr Philip Diamond, Chief of CASS, with John Sarkissian (left) and Colin Mackellar (right) looking on with approval – 24 August 2011. Image credit: John Sarkissian, CSIRO

substantial involvement of the Australian tracking stations in receiving the Apollo 11 television signal. They arrived in Australia on 16 August 2011 and delivered to the Canberra Deep Space Communication Complex at Tidbinbilla, having been previously organised by the former Director, Dr Miriam Baltuck.

A week later, on 24 August, Neil Armstrong was in Sydney to address the CPA Australia 125th Anniversary celebrations.

During his address, Neil Armstrong paid a glowing tribute to the many Australians who worked at the tracking stations and helped to ensure the success of his Apollo 11 mission. Some of them were present in the audience and were individually acknowledged by him.

In a brief ceremony following the event, Neil Armstrong symbolically handed over the Australian disks to Dr Philip Diamond, CSIRO Astronomy and Space Science Chief — the custodian of the disks in Australia. This ceremony effectively brought the restoration effort to a close.

The Australian disks will eventually be deposited in permanent archival storage, most likely with the National Film and Sound Archive in Canberra.

DVDs of the restored Apollo 11 video have been produced and were available in time for the Parkes Observatory's 50th Anniversary celebrations.

A New Backend for Parkes

Lister Staveley-Smith (ICRAR) and Danny Price (University of Oxford)

Work is underway on a new digital backend for the Parkes 21-cm multi-beam receiver, which will provide larger instantaneous bandwidth, finer spectral resolution and increased dynamic range, as well as providing increased processing power for pulsar observations. The backend is being developed in collaboration between ICRAR (The University of Western Australia and Curtin University), Swinburne University, The University of Oxford and CSIRO, and is funded by an ARC Linkage, Infrastructure, Equipment and Facilities grant (Lead Investigator: Lister Staveley-Smith).

The digital signal processing is divided between CASPER ROACH boards and a CPU/GPU Beowulf cluster. The ROACH (Reconfigurable Open Architecture Computing Hardware) is a processing board designed specifically for radio astronomy by the Collaboration for Astronomy Signal Processing and Electronics Research (CASPER). The ROACH is powered by Xilinx Virtex-5 Field Programmable Gate Arrays (FPGAs), and is designed so that multiple ROACH boards may be interconnected via standard 10-gigabit Ethernet. Low-level signal processing such as digitisation and channelisation are conducted on a series of ROACH boards, which then stream packetised data over Ethernet to the CPU/GPU cluster. More complex algorithms, such as pulsar de-dispersion and radio frequency interference (RFI) mitigation, may then be conducted on the CPU/GPU cluster.

Danny Price.

The development of the new backend is driven by three main science goals: to provide large bandwidth, high resolution spectra suitable for HI stacking experiments; to investigate novel RFI mitigation algorithms and spatial filtering techniques; and, to upgrade the Berkeley Parkes Swinburne Recorder (BPSR), which is currently in use in the High Time Resolution Survey. As the ROACH FPGA gateware is dynamically reconfigurable, separate gateware is being written for the BPSR filterbank, which requires high time resolution, and for the high spectral resolution filterbank required for HI observations.

In comparison to the existing Parkes multi-beam correlator, MBCORR, the new backend offers a factor of 2–3 increase in survey speed, higher spectral resolution, improved inter-channel isolation, and increased dynamic range through 8-bit sampling, making it more resilient to RFI. While it is not intended as an immediate replacement for MBCORR, it is designed such that future FPGA gateware and software upgrades could extend its functionality to such a level. Commissioning of the new backend is expected to begin later in 2011.

Danny Price and Lister Stavely-Smith on behalf of the development teams at Oxford, ICRAR, Swinburne and CSIRO.

Graduate Student Program

Bärbel Koribalski (CASS)

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

- Chris Jordan (James Cook University) — *CS(1-0) observations with MALT-45: A 7 mm Survey of the Southern Galaxy*, with supervisors Dr Andrew Walsh (James Cook University), and Dr Maxim Voronkov (CASS).
- Tye Young (Australian National University) — *Mapping interstellar molecular emission lines with the Tidbinbilla 70-m radio telescope* (Honours Thesis) with supervisors Dr Helmut Jerjen (Australian National University), Dr Shini Horiuchi and Dr Jimi Green (both CASS).
- Vikram Ravi (University of Melbourne) — *Evincing the history of massive black hole and galaxy populations with gravitational waves* with supervisors Dr Stuart Wyithe (University of Melbourne) and Dr George Hobbs (CASS).
- Sarah Reeves (University of Sydney) — *HI and OH absorption line studies of nearby galaxies* with supervisors Dr Elaine Sadler, Dr Tara Murphy (both University of Sydney), and Dr Bärbel Koribalski (CASS).
- Rai Yuen (University of Sydney) — *Investigation on Pulsar Magnetosphere* with supervisors Dr Don Melrose, Dr Michael Wheatland (both University of Sydney), and Dr Dick Manchester (CASS).
- Helga Denes (University of Swinburne) — *Global HI properties of galaxies in the Southern Sky* with supervisors Dr Virginia Kilborn (University of Swinburne) and Dr Bärbel Koribalski (CASS).
- Dan Thornton (University of Manchester, UK) — *Pulsar and transient searching with GPUs* with supervisors Dr Ben Stappers (University of Manchester), and Dr Simon Johnston (CASS).

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

- Deanna Matthews (La Trobe University) — *The Magellanic Stream south of zero degr declination - a high-resolution ATCA and Parkes HI investigation.*
- Daniel Yardley (University of Sydney) — *Studying Gravitational Waves With Pulsars: Results from the Parkes Pulsar Timing Array.*
- Doug Hayman (Macquarie University) — *Beamforming and Evaluation of Focal Plane Arrays for Radio Astronomy.*

Daniel Yardley.
Image credit: CSIRO

- Aquib Moin (Curtin University) — *e-VLBI Science with LBA. Exploring Science Application for the Long Baseline Component of ASKAP.*

Dr Aquib Moin is now a postdoc at the Shanghai Astronomical Observatory, China. Dr Doug Hayman is a CASS staff member, working on the ASKAP phased array feeds. Dr Daniel Yardley is currently a CASS visitor, and Dr Deanna Matthews is working at La Trobe University in Melbourne.

Well done !

A summary of the ATNF Graduate Student Program, current and past students, as well as new application forms can be found at *http://www.atnf.csiro.au/research/graduate/scholars.html*

Australian ALMA Community Workshop

Jill Rathborne (CASS)

The Australian ALMA Community Workshop was held on 5–6 May 2011 at the CSIRO Astronomy and Space Science headquarters at Marsfield, Sydney.

Workshop participants. Image credit: Vincent McIntyre, CSIRO

The workshop was extremely successful, attracting more than 70 astronomers (including eight PhD students) from 11 institutions across Australia.

Funding by CSIRO and Astronomy Australia Limited (AAL) helped subsidise attendance at the conference dinner for all students who asked a question during the workshop, which had the desired result of encouraging student participation!

The workshop consisted of presentations from Atacama Large Millimeter/submillimeter Array (ALMA) experts — including Crystal Brogan, Marcella Massardi, Lars-Ake Nyman, Juergen Ott, Mark Rawlings, Lister Staveley-Smith and Eric Villard — on the early science capabilities, the proposal and time allocation processes, data reduction pipeline, and tutorials on the ALMA proposal preparation tools.

More than 15 science talks were included that covered a broad range in potential ALMA science projects, from those addressing long-standing questions in star and galaxy formation to those describing the role ALMA will play in the era of the Australian Square Kilometre Array Pathfinder and the Square Kilometre Array.

The feedback from participants was very positive; there was considerable excitement and interest from the community in ALMA and in submitting proposals for early science observations.

Proposals for "Cycle 0" early science observations, using the first sixteen 12-m antennas on site, were oversubscribed by a factor of ~10, indicating the level of interest in this new facility. This first cycle of observations will use receiver bands 3, 6, 7 and 9 (wavelengths of about 3, 1.3, 0.8 and 0.45 mm) and baselines up to 250 m enabling observations of a variety of scientific targets.

Early science observations with ALMA began on 30 September 2011, and an ALMA press release on the first ALMA image of the interacting galaxies NGC 4038/4039, known as the Antennae, was picked up by a number of media outlets in Australia.

A second Australian ALMA Community Workshop is being planned for February 2012, to ensure local users are informed of progress and developments in the lead up to the Cycle 1 proposal deadline, which is expected to be in late March or early April 2012. Information on the workshop will be made available from the ATNF website.

The workshop was possible thanks to generous funding support from Kate Brooks and Ilana Feain through their CSIRO Ruby Payne-Scott Awards and from AAL.

Organising Committee:

Jill Rathborne, Kate Brooks, Ilana Feain, Bjorn Emonts, Shari Breen, Andrew Hopkins.

Footnote:

ALMA received more than 900 applications for telescope use during the Early Science stage with only 112 high priority projects selected. CSIRO astronomer Jill Rathborne heads up one of these priority projects and was the only Australian Principal Investigator to gain telescope time. Her ALMA observations will reveal the location, mass, and kinematics of the small-scale fragments within an extreme molecular cloud that appears to be on the verge of forming a massive cluster. These observations can only be achieved with the order of magnitude improvement in sensitivity and dynamic range provided by ALMA.

CASS Radio School 2011

Phil Edwards (CASS)

The CASS Radio School this year was held at Parkes in the week of 26 September 2011. The school was filled to capacity, with 35 students in attendance, coming from Australia, Chile, China, New Zealand, South Africa and the UK, and a number of late requests to register having to be turned down.

The school commenced with a talk from John Sarkissian on the history of Parkes, highlighting the beginnings of the observatory and its participation in tracking a range of spacecraft. This was followed by an *Introduction to Radio Astronomy* by Dave Jauncey, which began with the contributions of the pioneers in the field and emphasised the opportunities a career in astronomy offered in answering challenging scientific questions while having fun doing so.

The two international speakers at the School, Jim Condon (National Radio Astronomy Observatory) and Jim Jackson (Boston University) then gave clear and concise presentations on radio astronomy fundamentals, laying the foundation for the rest of the week. Alex Dunning described receiver technologies, with his computer simulations of the workings of ridged feed horns being particularly well-received. John Reynolds followed by guiding the students along the signal path in a series of carefully calibrated steps. The first day ended with Douglas Bock introducing the general concepts of correlators and filterbanks, and the specifics of the instruments at the ATNF facilities and several other radio observatories.

On Tuesday morning the possibilities and practicalities of various forms of observing were covered, with Jim Condon giving a broad overview of continuum observations, Simon Ellingsen narrowing in on spectral line observations, and Ryan Shannon delivering a pulsating talk on rotating neutron star observations. Jill Rathborne's lecture on millimetre observations was interspersed with centimetre-sized chocolate-flavoured rewards for students able to answer questions reviewing the material just presented — and student attentiveness reached record levels during this talk! The afternoon was the first of three hands-on tutorial sessions: the students were divided into three groups, with one group having a tour of the telescope and learning how to observe, the second having a tutorial on Miriad data reduction, and the third experiencing both ASAP and pulsar data reduction. The School dinner on Tuesday evening was a wonderful meal provided by Craig at *The Dish* Café, with a floodlit dish observing outside the window, and was followed by a "whodunnit" mystery talk from John Sarkissian on the fate of the Apollo 11 moon-landing tape recordings.

Wednesday started with George Hobbs outlining the many varieties of science that could be addressed with pulsar observations, from detecting gravitational waves, to measuring the mass of Jupiter, to locating Parkes on the Earth's surface! This was followed by Jamie Stevens and Jim Jackson outlining (or baselining!) the fundamentals of interferometry, including the transforming work of Fourier, and providing some visibility to the concepts of cleaning, deconvolution, and self-calibration. The morning was wrapped up by Simon Ellingsen describing Stokes parameters, Jones vectors, Mueller matrices, and Green jokes in an introduction to polarisation. The afternoon was again taken up by tutorials.

On Thursday morning Shane O'Sullivan disproved the adage that "the larger our ignorance, the stronger the magnetic field", with his 45 minute talk clocking in at precisely 0.03125 Fara-Days. After a broad-brush introduction to Very Long Baseline Interferometry (which might just have well been called RIOTS!), Jo Dawson described how to "see both the forest and the trees" in a well-illustrated talk on combining single dish and interferometric data. This was followed by a question and answer session with the speakers, which started slowly but was sparked into life by a

CASS Radio School participants for 2011. Image Credit: John Sarkissian, CSIRO

question on the likely timescale for the Square Kilometre Array and the role of existing facilities in the interim! The final tutorial session was held in the afternoon, and followed the tradition from two years earlier of having at least one tour of the telescope compromised by poor weather!

The final day was started by Malte Marquading opening up the *Astronomer's IT toolkit* and demonstrating the use of a number of tools. The students were then given some advice on proposal-writing and insight into the time assignment review process, together with an introduction to the ATNF Online Proposal Applications & Links (OPAL) and Australia Telescope Online Archive (ATOA) by Jessica Chapman. Robert Braun rounded out proceedings by reviewing the development of radio astronomy, and looking to the future with overviews of ASKAP and the SKA. All presentations have been made available from the Radio School webpage,

http://www.atnf.csiro.au/research/radio-school/2011/ .

Overall, the School was a great success, with overwhelmingly positive feedback from the questionnaire completed by students at the end of the week. All the credit goes to Shari Breen and Jimi Green, who quietly presided over proceedings, calmly handling the unavoidable withdrawal of eight(!) speakers from the program in the weeks before the School, and dealing with all manner of enquiries and requests. Many thanks are also due to Brett Armstrong, Chris Hollingdrake, Stacy Mader, Brett Preisig, John Sarkissian, Mal Smith, and all other Parkes staff; Craig and staff at *The Dish* café for keeping the students and speakers supplied with lunches and morning and afternoon teas; and Sue Broadhurst for admin support and handling the student registrations. From the number of students declaring they would be back to learn more next year, the 2012 Radio School will also have no shortage of participants!

ASKAP and SKA News

Flornes Conway-Derley (CASS)

Project Re-scope

During early 2011 CSIRO's Australian Square Kilometre Array Pathfinder (ASKAP) telescope project went through a significant process of project evaluation and internal review. This included a "bottom up" budget evaluation including schedule and risk reviews. As a result, a revised plan for the delivery of ASKAP has been developed. The revised plan for ASKAP has the following key components:

- Delivery of a fully functional Murchison Radio-astronomy Observatory (MRO) and 36 antennas by early 2012, six of them equipped with phased array feeds (PAFs). This to form the Boolardy Engineering Test Array (BETA), with BETA then commissioned;
- The development of the next generation of PAF, and the equipping of six of the remaining ASKAP antennas with these Mark II PAFs;
- By March 2013, the delivery of an instrument that will begin to explore the science possible with a radio survey interferometer;
- In parallel, the seeking of additional funds to build PAFs for the remaining 24 antennas.

This plan was presented to the ASKAP Steering Committee (16 June 2011) and CSIRO Board (29 June 2011) and approved at both these meetings.

Construction Update

Construction of ASKAP at the MRO in Western Australia has continued to make rapid progress during 2011. At the time of writing, nine of ASKAP's 36 antennas have been constructed at the MRO, and parts for a further five antennas have been delivered to the site awaiting assembly.

Construction of supporting infrastructure at the MRO is also well advanced; main access roads, antenna access tracks and the MRO airstrip upgrade are almost complete. Additionally, fibre optic and power transmission cabling is underway and laying of the foundations for ASKAP's control building and geo-cooling system has begun.

News from the MRO

The MRO has welcomed a number of special guests over recent months, including CSIRO Chief Executive Megan Clark, CSIRO board members Simon McKeon and Eileen Doyle in June, and the Western Australian Minister for Science and Innovation, the Hon. John Day. A local community event was also held in June, at which the first six ASKAP antennas were officially given Wajarri Yamatji names.

Signs direct to the ASKAP antenna locations at the MRO.
Image credit: Rob Hollow, CSIRO

Wajarri Yamatji Names for CSIRO ASKAP Antennas

Chosen by the Wajarri Yamatji people, the names were bestowed by representatives of seven Aboriginal families at a ceremony at the Murchison Radio-astronomy Observatory on Thursday 2 June 2011.

The Wajarri names chosen for the antennas are: Bilyarli (which both means galah and is also the name of a past Wajarri Elder, Mr Frank Ryan); Bundarra (stars); Wilara (the Moon); Jirdilungu (the Milky Way); Balayi (a lookout, as this antenna looks down westward to others); and Diggidumble (a nearby table-top hill).

Roads and other significant structures will also be given Wajarri names. One of the roads will be called Ngurlubarndi, the Wajarri name for Mr Fred Simpson, a past Wajarri Elder and father of Wajarri Elder Mr Ike Simpson.

Further naming of the remaining 30 antennas will take place as more are installed on site, so that eventually all 36 of CSIRO's ASKAP antennas will have a Wajarri name.

Simon McKeon and Megan Clark at the MRO in June 2011.
Image credit: Tony Crawshaw, CSIRO

Technology

First ASKAP PAF Passes Tests

Detailed system tests have been taking place using the first full-sized phased array feed (PAF) chequerboard receiver on the ASKAP antenna testbed at the CSIRO Parkes Radio Telescope site.

The ASKAP PAF is the first chequerboard receiver specifically built for radio astronomy; with 188 active elements it is a revolutionary "radio camera" with the ability to simultaneously sample large areas of sky.

Prior to installation on ASKAP antennas at the MRO, the team first needed to rigorously test the full system to ensure the basic functionalities are robust. A complete ASKAP system was duplicated at CASS headquarters — the Marsfield ASKAP Test Engineering System (MATES) — comprised of the full analogue, digital processing and support systems required to fully test the novel receiver system.

The full-sized chequerboard PAF and supporting analogue and digital systems were transported to the Parkes Testbed Facility in June. Initial ground-based tests confirmed the array performed consistently with the model and results from previous tests performed using the "proof-of-concept" 5x4 receiver in 2010.

The PAF was then installed on the Patriot 12-metre antenna and "first light" was achieved by correlating all 188 PAF elements with the single beam of the 64-metre dish and observing radio-galaxy PKS1934-638.

Installation of the PAF onto the Parkes Testbed Facility. Image credit: John Sarkission, CSIRO

Performing full end-to-end tests on the PAF in a controlled observatory environment allows the ASKAP team to prepare for full deployment of "Alpha", the first full ASKAP receiver system destined for the MRO, in the coming months.

All components of Alpha are undergoing factory acceptance tests, and once at the MRO will undergo on-site system integration and a full suite of functionality tests to ensure that the system is ready for operational (on-sky) testing.

Following successful testing with Alpha, five more ASKAP PAF systems will be sent to the MRO, along with a dedicated correlator capable of correlating the 36 beams of 300 MHz each from the six antennas.

This six antenna system, known as the Boolardy Engineering Test Array (BETA), is an intermediate engineering and scientific commissioning instrument and a major milestone in the development of the full ASKAP telescope.

Science

First Light for anzSKA e-VLBI

During the International SKA Forum in Banff, Canada, July 2011, the first e-VLBI demonstration was performed between CSIRO's ASKAP telescope in Western Australian and other radio telescopes across Australia and New Zealand.

Using the newly commissioned optical fibre link between the MRO and Perth, six telescopes including ASKAP, Parkes, Mopra and ATCA, a University of Tasmania telescope and the Warkworth telescope operated by the Auckland University of Technology, were used together to observe a radio source, PKS0637-752, a quasar that is more than seven and a half billion light-years away.

During the experiment CSIRO's Dr Tasso Tzioumis and Dr Chris Phillips controlled all the telescopes over the internet from Sydney. Data from the sites were streamed in real time to Curtin University in Perth (a node of ICRAR), where processing took place using a system built by a research team led by Professor Steven Tingay.

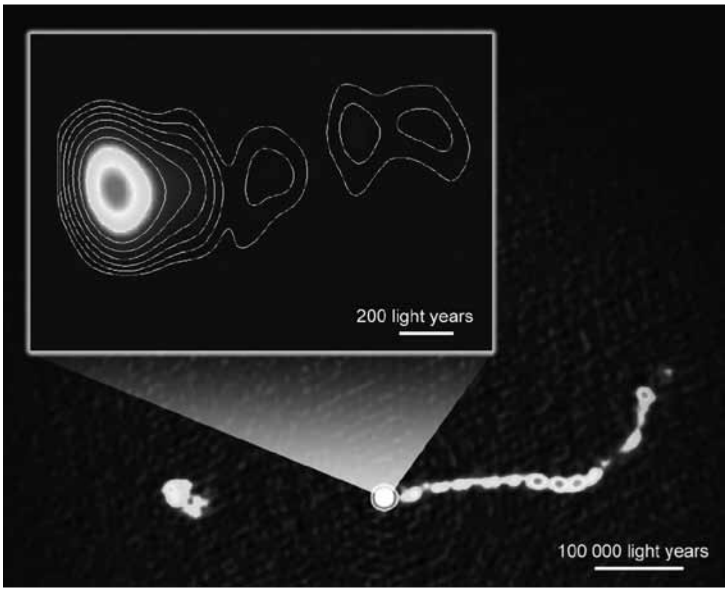
First Science Fields Characterised for ASKAP BETA

In May, CSIRO's ATCA was used in characterisation observations of two well-known radio sources in preparation for first science with BETA.

According to CSIRO ASKAP Project Scientist Ilana Feain, the two sources observed will act as controls for testing the unknown calibration systematics and workings of the new telescope.

"Though ASKAP BETA is primarily an engineering test array, astronomy observations will be possible during periods when the instrument is not required for other testing," says Ilana. "When we observe these two fields with BETA we would like to know exactly what we expect to see in order to compare the quality and integrity of BETA observations against those already performed on the ATCA."

Two separate week-long sessions of 24-hour-a-day observations were held, and have provided the ASKAP Survey Science projects with a wealth of data to begin testing calibration and imaging pipelines in preparation for first science with BETA.



Zooming into the heart of quasar PKS0637-752. Image credit: ATCA image by L Godfrey (Curtin University) and J Lovell (University of Tasmania). Image from telescope network by S Tingay (Curtin University) et al.

SKA Activities

Key SKA updates since the previous issue of the ATNF News went to print include:

- The Australian Communications and Media Authority (ACMA) announced enhanced protection for the Mid West Radio-Quiet Zone to support the development and enhance radio astronomy activities taking place at the MRO.
- CSIRO continued participation in the Concept Design Reviews (CoDRs) for PrepSKA WP2 (the SKA Technology Work Package), leading the SKA PAF subsystem concept.
- The team also continued preparation for reviews across the SKA digital systems, dish array, signal transport and computing, working with international colleagues to outline options and cost estimates for SKA-ready systems.
- In September, Australia and New Zealand submitted their written response to a request for information; an important step in the decision making process to determine the best place to site the international project. The submission was a result of major collaboration between 47 agencies, including CSIRO, across the two countries.

Science Highlights from MAGMA, the Magellanic Mopra Assessment

A Hughes (MPIA), T Wong (University of Illinois), J Ott (NRAO), E Muller (NAOJ), J Pineda (NASA/JPL), S Maddison (University of Swinburne) and the MAGMA team

I. Introduction

Among the different phases of the interstellar medium (ISM), the dense molecular hydrogen is especially deserving of study. It is the primary component by mass of the ISM in the central regions of spiral galaxies, and the principal — perhaps only — site of star formation (Young & Scoville, 1991, but cf. Krumholz, McKee & Leroy 2011, Glover & Clark 2011). The bulk of the molecular gas resides in giant molecular clouds (GMCs), discrete structures with masses between 10^4 and $10^7 M_{\odot}$, sizes between 10 and 100 pc, and volume-averaged densities of $n \sim 100$ cm^{-3} (Blitz, 1993). GMCs occupy a negligible fraction of the ISM volume, but the massive stars that they form are responsible for roughly half the energy density of the ISM (Lequeux 2005), which they supply through radiative and mechanical feedback, and (in the later stages of their evolution) via the acceleration of cosmic rays. Despite their importance, our knowledge of GMC populations in other galaxies remains incomplete. The range of interstellar environments in which GMCs have been studied is limited: few existing surveys have obtained cloud-scale maps of the CO emission for dwarf galaxies, or for the interarm regions and outer disks of spiral galaxies. Since intense radiation fields, low metal abundances and high gas-to-dust ratios are thought to have prevailed in the early Universe, the molecular gas in these poorly studied environments may hold the key to understanding star formation and its scaling laws through cosmic time.

The Magellanic Mopra Assessment (MAGMA, PI: Tony Wong) is a Mopra Telescope Large Programme that aims to obtain high resolution maps of the ^{12}CO(J = 1 $\rightarrow$ 0) emission from the majority of the molecular cloud population in the LMC and northern half of the SMC. In this article, we briefly describe the survey observations and highlight some recent MAGMA science results.

II. MAGMA Observations

In both the LMC and SMC, the MAGMA project has pursued a natural extension to previous CO surveys: targeted mapping of CO cloud complexes identified at lower resolution by NANTEN (Fukui et al. 2008, Mizuno et al. 2001). The FWHM beam size of Mopra at 115GHz (33") corresponds to a spatial resolution of 8 pc in the LMC and 10 pc in the SMC, which is sufficient to resolve individual, intermediate mass GMCs. In the LMC, MAGMA observations have targeted 114 NANTEN GMCs with CO luminosities L_{CO} > 7000 K km s^{-1} pc^2, and peak integrated intensities > 1 K km s^{-1} in the NANTEN cloud catalogue. These clouds represent ~ 50% of the GMCs in the NANTEN catalogue, but contribute ~ 70% of the LMC's total CO luminosity. In the SMC, MAGMA has focused on the northern cloud population which — unlike GMCs in the southwest of the SMC — had never previously been mapped at high resolution (e.g. Rubio et al. 1993). A small number of clouds associated with well-known active star formation regions in the south and east of the SMC were also selected for MAGMA mapping.

MAGMA observations were conducted with Mopra from 2005 May to 2010 October. More than 1150 5' x 5' square patches were mapped in the On-The-Fly (OTF) mode, producing more than 3 million CO spectra (counting both polarisations), which were pipeline processed using the ATNF's Livedata and Gridzilla packages. In the LMC, the ^{12}CO spectra were gridded to an effective resolution of 45" (11 pc) in the spatial domain and binned to a velocity channel spacing of 0.526 km s^{-1}. The final LMC datacube covers a combined field of view of ~3.6 square degrees, with an average sensitivity of ~0.3 K per 1 km s^{-1} channel. The CO emission in the SMC is weaker, so MAGMA SMC observations cover a more restricted field of view (0.4 square degrees), but they are also considerably deeper (0.1 K per 1 km s^{-1} channel). With the advent of the MOPS spectrometer in 2006, simultaneous

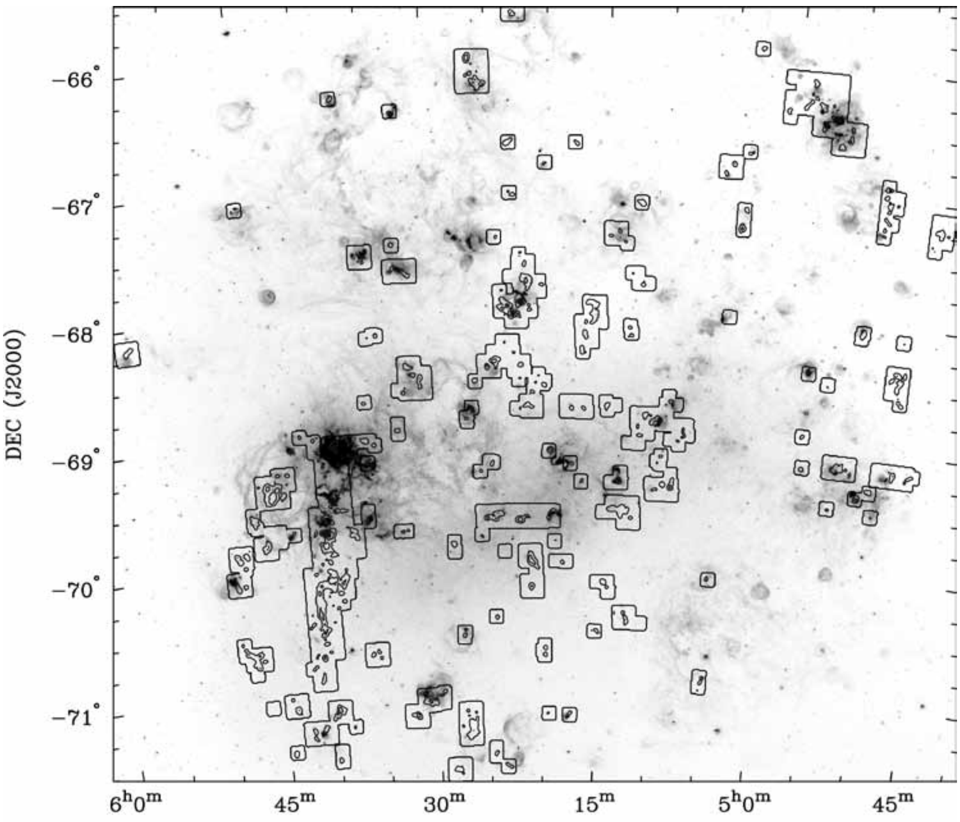


Figure 1: CO integrated intensity contours from the MAGMA LMC survey, at levels of 2 and 10 K km s^{-1}, overlaid on an Halpha image from the Magellanic Clouds Emission Line Survey (MCELS, Smith et al. 1999). The black irregular-shaped boxes indicate the regions mapped in CO by MAGMA. The 30 Doradus nebula is the brightest peak in the Halpha image, located near 05h38, -69d06 (J2000).

^{13}CO and $C^{18}O$ spectra were obtained for the many of the mapped regions in both Clouds.

III. Science Highlights

i) The Influence of the FUV Radiation Field on Molecular Gas Properties

Almost 30% of the CO-bright molecular gas in the LMC is concentrated to the south and east of the 30 Doradus nebula (see Figure 1), the most active star-forming region in the Local Group. Together with several neighbouring high mass star clusters, the R136 super star cluster at the centre of 30 Dor produces a strongly varying far-ultraviolet (FUV) radiation field across this region. The area surrounding 30 Dor is therefore an ideal laboratory to study the influence of the FUV radiation field on the properties of low-metallicity molecular gas. In Pineda et al. (2009), we used a clump finding algorithm to identify CO clumps along the molecular ridge, the chain of CO clouds situated south of 30 Dor. We estimated the CO luminosity, viral mass, radius, velocity dispersion and CO-to-H_2 conversion factor for each clump and compared these properties to the strength of the local far-ultraviolet radiation field. Contrary to theoretical expectations (e.g. van Dishoeck & Black 1988), we found that CO clump properties are insensitive to changes in the strength of the FUV radiation field over almost 3 orders of magnitude. The requisite physical conditions for CO emission provide a possible explanation for the absence of such trends. Since the photodissociation of CO is enhanced in low-metallicity systems, CO emission may only trace regions that are well-shielded from the FUV radiation. In this case, the 30 Dor molecular ridge might contain a substantial fraction of H_2 coexisting with other carbon species such as C and C+, and the fraction of "CO-dark" molecular gas may increase with the radiation field. Future observations with Herschel that trace the dust continuum and emission lines from atomic and ionised carbon will be able to test this hypothesis.

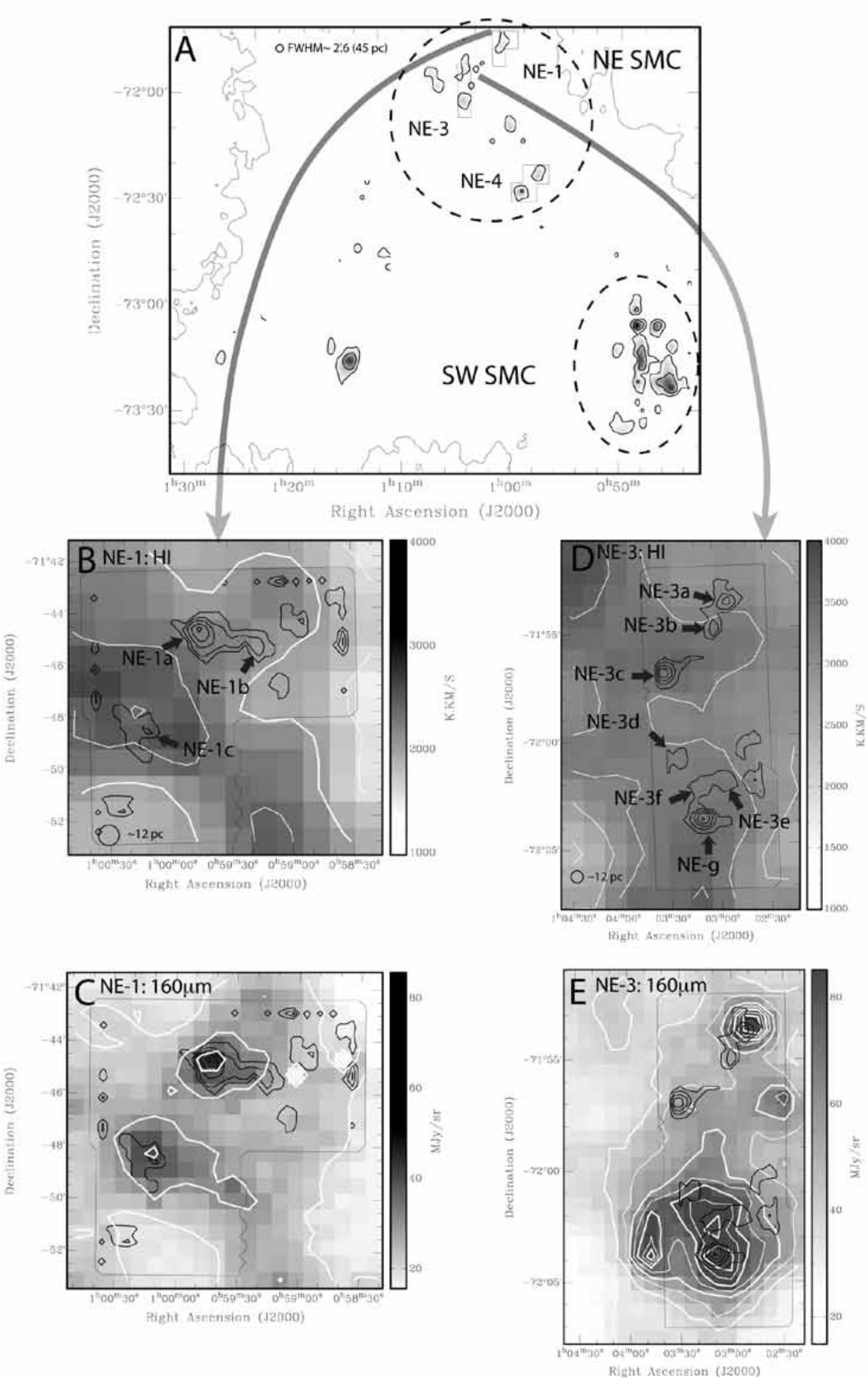


Figure 2: (a) NANTEN map of CO integrated intensity in the SMC (Mizuno et al. 2001), with boxes locating the areas observed by MAGMA. Dotted ellipses denote the regions that we refer to as the "southwest" and "northeast" of the SMC. Lower panels: MAGMA integrated intensity CO contours for SMC molecular clouds NE-1 (left) and NE-3 (right), overlaid on maps of integrated intensity HI (panels b & d, Stanimirovic et al. 1999) and 160 μm (panel c & e, Bolatto et al. 2007) emission. The black contours indicate MAGMA CO integrated intensity levels of 0.5+1 K km s^{-1}.

ii) The Link Between GMCs and Star Formation in the LMC

In Wong et al. (2011), the complete MAGMA LMC ^{12}CO survey is presented. Using the CPROPS IDL software of Rosolowsky & Leroy (2006), significant CO emission was isolated into 450 discrete structures in position-velocity space, dubbed "islands" since in some cases they may represent blended GMC complexes. We also experimented with further decomposition of the islands into substructures, with parameters tuned to identifying GMC-like structures ("physical" clouds) or the smallest resolvable structures ("data-based" clouds). An important result of this exercise was that the scatter in the size-linewidth relation, perhaps the most fundamental of the Larson (1981) laws for molecular clouds, increases markedly with further decomposition. The cloud mass function also steepens, but even without decomposition appears steeper than -2 (i.e. alpha < -2) when written in differential form (dN/dM \propto M^alpha). This is in contrast to the slope of -1.5 found for the inner Galaxy by Solomon et al. (1987), which has been the basis of conventional wisdom that most of the molecular gas mass is found in the most massive GMCs. A steeper than -2 slope suggests that low-mass GMCs may contribute substantially to the total molecular gas mass in the LMC.

Comparisons of Spitzer-selected Young Stellar Object (YSO) candidates from Gruendl & Chu (2009) with the MAGMA GMCs reveal a good correlation overall, in contrast to the rather poor correlation of CO and H_alpha emission. This is likely due to the Spitzer-selected YSOs tracing an earlier, more embedded phase of massive star formation. The correlation works in both directions: more massive GMCs are more likely to contain YSO candidates, and more luminous YSO candidates are more likely to be associated with CO emission. It is important not to over-interpret these trends since the CO maps are sensitivity-limited and cover only a fraction of the galaxy, while the YSO catalogs are likely incomplete and contaminated at low luminosities. Thus, it is as yet unclear whether some of the young stars have formed in the absence of CO emission, and whether the GMCs without YSOs are truly devoid of star formation.

Still, a couple of inferences appear to be possible. First, whereas the likelihood of hosting a YSO is strongly related to the CO luminosity, it appears unrelated to the virial parameter of the GMC (the ratio of a cloud's kinetic to self-gravitational energy). This raises some doubts about whether star-forming GMCs are necessarily self-gravitating, although alternative methods of measuring the gravitational energy, not reliant on CO emission, should be examined in the future. Second, less luminous YSOs are more likely to be coincident with CO emission at the coarser resolution of the NANTEN survey while *not* being coincident with CO at MAGMA's resolution. This suggests that less luminous YSOs (which on average are probably older) are less spatially associated with CO emission, and may thus be outliving their natal GMCs.

iiI) Physical Properties of GMCs in the Magellanic Clouds

Analysis of extragalactic GMC populations has suggested that the properties of molecular clouds may vary with interstellar conditions. Molecular clouds in NGC 6822, for example, appear to be smaller and less massive than Galactic clouds (e.g. Wilson, 1994), while a trend for the mean CO-to-H_2 conversion factor to increase with decreasing metallicity has frequently been reported (e.g. Taylor et al. 1998). Yet much of the apparent galaxy-to-galaxy variation could be due to observational or methodological differences (Sheth et al. 2008). Using a consistent method to identify and measure the properties of ~100 resolved GMCs in twelve galaxies, a recent comparative study by Bolatto et al. (2008) concluded that GMCs in fact demonstrate nearly uniform properties across the Local Group.

In Muller et al. (2010) and Hughes et al. (2010), we have presented an analysis of the CO-derived physical properties of GMCs in the LMC and northern SMC. Using the same analysis techniques as Bolatto et al. (2008), we found that GMCs in the Magellanic Clouds are less luminous and have narrower linewidths than GMCs elsewhere in the Local Group. Assuming that the CO emission reliably traces H_2 mass, these observations imply that Magellanic GMCs also have low mass surface densities. This result is difficult to reconcile with our knowledge of star formation in the Magellanic Clouds: star formation appears to occur more efficiently with respect to the total CO-bright H_2 mass in the Magellanic Clouds than in nearby spiral galaxies, yet the free-fall time of star-forming clouds should increase as their mass surface densities decrease.

Comparative studies between MAGMA CO and Spitzer/Herschel dust observations should help to resolve this issue. Muller et al. (2010) showed that the CO clouds in the SMC are especially small: most of the CO emission is confined to compact clumps, with little or no emission that is truly resolved by the MAGMA survey observations. This is strikingly different to the cold dust distribution, which is clearly extended and yields molecular gas mass surface densities that are comparable to values obtained for Galactic GMCs (e.g. Leroy et al. 2007). In the LMC, a detailed comparison has so far only been conducted for two GMCs (Roman-Duval et al. 2010), but this work also suggests a substantial gas reservoir that is not traced by CO emission. A possible explanation that would reconcile these diverse results is selective photodissociation of CO molecules, which confines CO to the relatively dense interior of GMCs. In this case, the CO linewidth might only reflect the kinematics of the CO-bright core and not the gravitational potential of an entire molecular (i.e. H_2) cloud, while strong clumping of the CO emission beneath our survey's angular resolution limit would produce a low covering factor of CO emission relative to Galactic clouds and hence low CO brightness. If true, this interpretation of the properties of MAGMA GMCs inferred from their CO emission casts doubt on the applicability of a Galactic CO-to-H_2 conversion factor to more distant metal-poor systems.

Summary & Outlook

Observations for MAGMA are now complete. Our analysis of the data has already provided important insights into the properties and evolution of GMCs in the Magellanic Clouds. Collaborative projects involving the MAGMA data and other state-of-the-art surveys of neutral gas, dust and young stellar objects are ongoing (e.g. Minamidani et al. 2008, Mizuno et al. 2010, Seale et al. 2011, submitted), and we expect the MAGMA dataset to have significant legacy value until more sensitive and spatially complete mapping surveys are possible with multi-pixel receivers. The LMC ^{12}CO data products have been released to the astronomical community and may be downloaded from websites hosted at the University of Illinois

(*http://mmwave.astro.illinois.edu/magma/DR1*)

and CSIRO

(*http://www.atnf.csiro.au/research/MAGMA/DR1/*).

Acknowledgments

We are deeply indebted to the ATNF and CASS staff for the generous allocation of time to the MAGMA project, and for assistance with all aspects of the observations and data reduction.

References

Blitz, L., 1993, in Protostars & Planets III, pp.125–161

Bolatto, A. et al. 2007, ApJ, 655: 212-232

Bolatto, A. et al. 2008, ApJ, 686:948-965

Fukui, Y. et al. 2008, ApJS, 178:56–70

Glover, S. & Clark, P., astroph/1105.3073

Gruendl, R. & Chu, Y. 2009, ApJS, 184:172–197

Hirota, A. et al. 2011, ApJ, 737, Issue 1, article id. 40.

Hughes, A. et al. 2010, MNRAS, 406:2065-2086

Imara, N. & Blitz, L., 2011a, ApJ, 732: 78

Imara, N., Bigiel, F. & Blitz, L. 2011b, ApJ, 732: 79

Kim, S., et al. 2003, ApJS, 148:473–486

Koda, J. et al. 2006, ApJ, 638:191–195

Koornneef, J. 1984, IAUS 108:333-339

Krumholz, M., McKee, C. & Leroy, A. 2011, ApJ, 731: 25

Larson, R. B. 1981, MNRAS, 194:809–826

Lequeux, J. 2005, The Interstellar Medium. Berlin: Springer, 2005

Leroy, A. et al. 2007, ApJ, 658:1027-1046

Meixner, M. et al. 2006, AJ, 132: 2268–2288.

Minamidani, T. et al. 2008, ApJS, 175:485-508

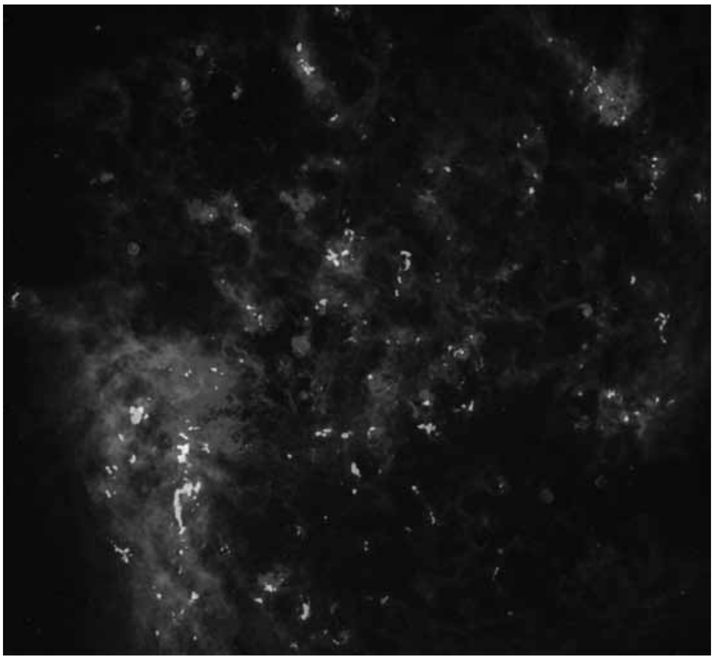
Mizuno, N. et al. 2001, PASJ, 53:45-L49

Mizuno, Y. et al, 2010, PASJ, 62:51-67

Muller, E. et al. 2010, ApJ, 712:1248-1258

Phillips, J. 1999, A&AS, 134:241-254

Pineda, J. et al. 2009, ApJ, 703:736-751



See front cover for colour version of this image.

Figure 3: A three-colour image of the ionised, atomic and molecular gas phases in the Large Magellanic Cloud. Red is the integrated intensity HI emission from the ATCA+Parkes HI survey (Kim et al. 2003), blue is Halpha emission by MCELS (Smith et al 1999), and green is CO integrated intensity from the recently completed MAGMA survey (Wong et al 2011).

Roman-Duval, J. et al. 2010, A&A, 518, L74

Rosolowsky, E. et al. 2003, ApJ, 599:258-274.

Rosolowksy, E. & Leroy, A. 2006, PASP, 118:590-610

Rubio, M. et al. 1993, A&A, 271:1+

Sheth, K. et al. 2008, ApJ, 675:330-339

Smith, R. C. et al. 1999, in IAU Symposium, Vol. 190, New Views of the Magellanic Clouds, ed. Y.-H. Chu, N. Suntzeff, J. Hesser, & D. Bohlender, 28–31

Solomon, P. et al. 1987, ApJ, 15:730-741

Stanimirovic, S. et al. 1999, MNRAS, 302:417-436

Taylor, C., Kobulnicky H. & Skillman, E. 1998, AJ, 116:2746-2756

van Dishoeck, E. & Black, J. 1988, ApJ, 334:771-802

Wilson, C., 1994, ApJL, 434:L11-L14

Wong, T. et al., astroph/1108.5715

Young, J. S. & Scoville, N. Z. 1991, ARA&A, 29:581–625

Complex Faraday Rotation Measure Structure of Active Galactic Nuclei as Revealed by Broadband Radio Polarimetry

S P O'Sullivan, S Brown, T. Robishaw, D H F M Schnitzeler, N M McClure-Griffiths, I J Feain, A R Taylor, B M Gaensler, T L Landecker, L Harvey-Smith, E Carretti

Results using the Australian Telescope Compact Array (ATCA) with the newly upgraded 1.1 to 3.1-GHz receivers have shown that the Faraday rotation measure of unresolved Active Galactic Nuclei (AGN) may be a lot more complicated than we previously thought.

Radio-loud AGN eject powerful jets of relativistic plasma from their nucleus, with a supermassive black hole at the centre of the galaxy considered as the engine providing the power. They have been detected across the entire electromagnetic spectrum from radio to gamma-rays and are the most powerful steady emitters of radiation in the Universe. Their jets emit polarised non-thermal synchrotron radiation which is readily detected in the radio and provides an important avenue to study their emission structure and magnetic field properties. Of further importance is that the polarised emission can also be used as a probe of magnetic fields along the entire line of sight between us and the source through an effect known as Faraday rotation. The Faraday effect causes rotation of the plane of polarisation of an electromagnetic wave as it propagates through a region with free electrons and a magnetic field. In the simplest case, the effect is manifest as a linear dependence of the observed polarisation angle with wavelength squared. However, in some cases complicated distributions of polarisation intensity and polarisation angle with wavelength squared can be observed. One way in which this occurs is if there are multiple regions of polarised emission with different Faraday rotation measures on scales smaller than the resolution provided by our telescope beam.

Many studies have used AGN as background sources to study the strength and structure of magnetic fields in our Galaxy, other galaxies and in galaxy clusters. Future studies on new revolutionary instruments such as the Australian Square Kilometre Array Pathfinder (ASKAP) and the Square Kilometre Array (SKA) will rely on these background sources to probe the strength, structure and evolution of cosmic magnetism in unprecedented detail. As part of the planned Polarisation Sky Survey of the Universe's Magnetism (POSSUM) on ASKAP we have been developing efficient algorithms to accurately extract the polarisation and rotation measure (RM) properties of individual sources. POSSUM will measure the RMs of ~3 million extragalactic radio sources across the entire Southern sky requiring automated techniques that need extensive testing on real datasets. The data from the Compact Array Broadband Backend (CABB) on the ATCA using the upgraded receivers covering 1.1 to 3.1 GHz is an ideal instrument for this purpose, whilst also providing new and unique insights into the RM and polarisation structure of extragalactic sources due to its wide-bandwidth and high spectral resolution.

Figures 1 and 2 display data from two AGN (PKS B1610-771 and PKS B1039-47 respectively) that are spatially unresolved with the ATCA but whose polarisation and RM structure has been spectrally resolved for the first time. Through modelling of both the polarisation angle and degree of polarisation we find that the PKS B1610-771 data are best described by two regions of polarised emission with different RMs (ie. two RM components) while for PKS B1039-47 we find that the data are best described by a three RM-component model. The most likely origin for the additional RM components in both these AGN is from the compact inner jet regions on parsec scales. This leads us to suggest that RM time-variability in unresolved AGN might be due to the evolving polarised jet structure on parsec scales which illuminates different parts of an inhomogeneous magneto-ionic medium in the immediate vicinity of the jet. Follow-up observations of these particular sources using the high spatial resolution of the Australian Long Baseline Array

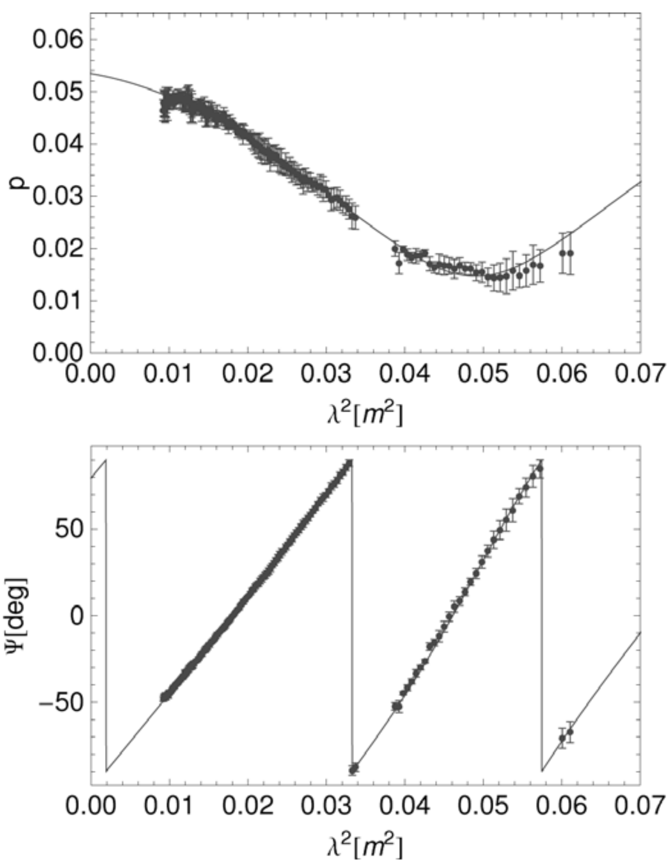


Figure 1: Polarisation data for PKS B1610-771, with the corresponding best-fit two RM-component model (RM_1 = +107.1 +/- 0.2 rad/m^2 and RM_2 = +78.7 +/- 0.4 rad/m^2). The top panel shows the degree of polarisation versus wavelength squared while the bottom panel shows the polarisation angle data versus wavelength squared, where in both cases the data are over-plotted with a solid line corresponding to the best-fit model.

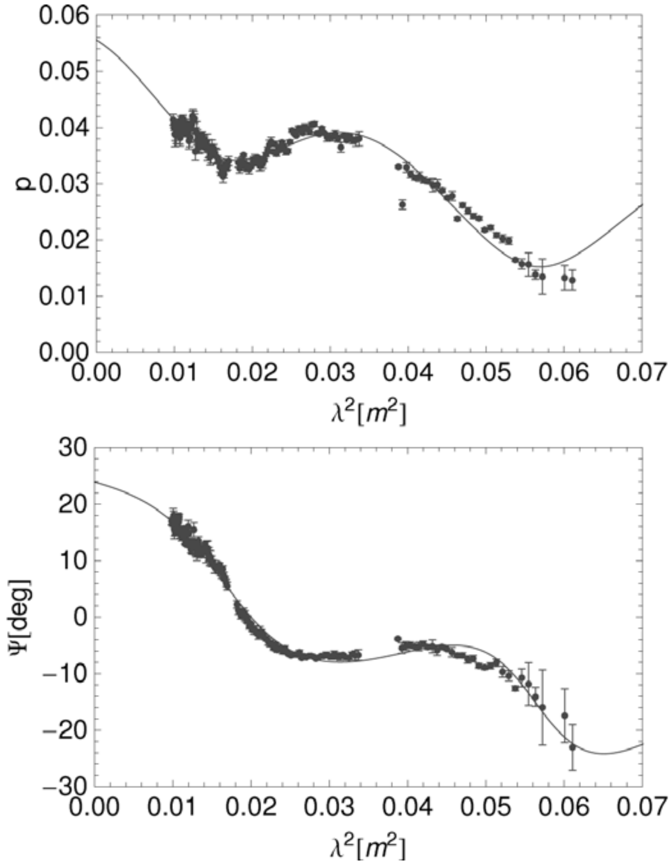


Figure 2: Polarisation data for PKS B1039-47, with the corresponding best-fit three RM-component model (RM_1 = -13 +/- 1 rad/m^2, RM_2 = -30 +/- 2 rad/m^2 and RM_3 = +68 +/- 2 rad/m^2). Layout as described in Figure 1.

will enable us to directly test our predictions. If the results from both these types of observations can be linked then we can open up a new area of study using multi-epoch polarisation observations with wide-bandwidth facilities like the ATCA to map out the parsec-scale evolution of polarised components as well as the Faraday rotating environment in AGN jets. In the near future, combining data from the pristine radio quiet environment of ASKAP from 0.7 to 1.8 GHz with data from the ATCA at higher frequencies can provide an exquisite probe of the polarisation properties of a much larger sample of AGN.

References

Gaensler B. M., Landecker T. L., Taylor A. R., POSSUM Collaboration 2010, in BAAS Vol. 42, p.470.13

O'Sullivan S. P., Brown S., Robishaw T., Schnitzeler D., McClure-Griffiths N. M.,

Feain I.J., Taylor A. R., Gaensler B., Landecker T., Harvey-Smith L., Carretti E.,

MNRAS, 2011, submitted

Giant "Pulsar" Studies with the Compact Array

Vikram Ravi (University of Melbourne and CASS)

Abstract

I present recent results from work at the ATCA on stellar pulsars. Five objects, including the Ap star CU Vir and a set of ultracool dwarfs have been found to emit periodic radio pulses that are up to 100% circularly polarised. I followed up a selection of these with the ATCA, more recently with the Compact Array Broadband Backend. Initial results show intriguing wide-band properties. I hope to discover more such objects through a volume-limited survey of southern ultracool dwarfs. This field offers a unique and highly important window onto stable structures and physical processes in the magnetospheres of a variety of stars.

Introduction

Studying stars as a population of radio sources is hard. To begin with, the menagerie of stellar radio emitters is large and vociferous: objects from cool dwarfs to giants to pre-main sequence T Tauri stars to the hotter Ap and Bp stars, to Wolf-Rayet stars all exhibit fascinating radio properties (Güdel 2002). Add to this the generally small samples of sources of any one particular type, and exceptional variability on many timescales, and one is left with a field that inspired Güdel (2002) to quote Albert Einstein:

"…all our science, measured against reality, is primitive and childlike: and yet it is the most precious thing we have."

This article shall be restricted to stellar radio transients. The project was begun by a group of pulsar astronomers venturing into greener pastures: hence, it may be assumed that these transients are periodic, or *stellar pulsars*. Isolated radio flares of few-minute durations, non-thermal brightness temperatures and almost total circular polarisation have been observed from stars of almost all types with spectral classes F or cooler. Non-thermal radio emission from stars is associated with energetic plasmas propagating through magnetic fields. The plasmas are accelerated as parts of stellar winds, or through magnetic field reconfiguration events. The physics of stellar flares is mainly understood through radio observations of the Sun. Indeed, various types of solar and stellar flares were shown by Güdel & Benz (1993) to all have the same ratio of X-ray to radio luminosities. Flares from stars besides our Sun, however, are many orders of magnitude more spectacular than those from the Sun: a recent X-ray flare from the nearby M-star EV Lac briefly increased its total energy output by a factor of ~3 (Osten et al. 2010). We could not live very long close to such a star!

Stellar pulsars offer a new dimension to the study of stellar magnetic environments: stability. Without modulation of the radio signal from a star, and without extremely high-resolution radio imaging, nothing can be said about the structure of the magnetic environments, or *magnetospheres*, of stars. Optical studies of periodic variability, while excellent for studying stellar surfaces, are only weakly affected by the surrounding magnetospheres. Periodic radio emission from stars, originating in the magnetospheres themselves, offer a unique insight into stable structures and physical processes in stellar magnetospheres. This is hugely important, because the magnetic fields of many stars are little understood. Magnetic fields are crucial to stellar evolution, from the highly magnetised Ap/Bp stars that

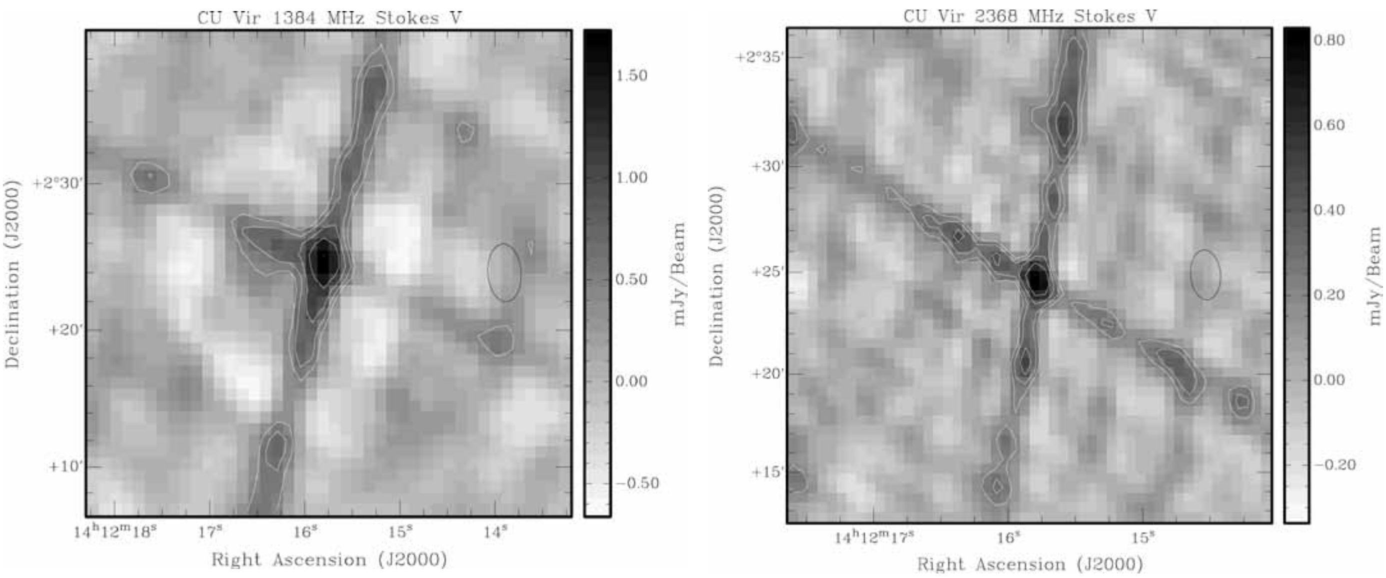


Figure 1: Stokes V ATCA images of CU Vir at 1384 MHz (*left*) and 2638 MHz (*right*). The peak flux densities in the images are 1.72 mJy/beam and 0.83 mJy/beam. Contours begin at a fourth of the peak fluxes and increase in factors of 1.4. The synthesised beam FWHM are displayed to the right of the images, and the greyscale bars beside the images give the flux density scale in mJy/beam. Image credit: Vikram Ravi

evolve into neutron stars, to very low-mass stars and brown dwarfs at the planet/star transition that exhibit significantly different magnetic properties to higher mass stars.

Only a few stellar pulsars have been discovered to date. Stellar pulsars are different from stars with always present, but modulated, radio emission properties in that the pulsed component is not present for the entirety of a rotation period. Known stellar pulsars include the main-sequence star CU Vir (Trigilio et al. 2000), and four ultracool dwarf stars (Hallinan et al. 2007, 2008; Berger et al. 2010) just massive enough to sustain nuclear fusion. It is striking that in all cases, the pulses are highly circularly polarised, with fractional Stokes V percentages of between 60% and 100%. While this is not uncommon in solar and stellar (and even planetary!) radio astronomy, this might sound absurd to an astronomer used to measuring circular polarisation fractions of a few tenths of a percent from active galactic nuclei.

Here, I shall outline our investigations of CU Vir and a sample of ultracool dwarfs with the Australia Telescope Compact Array (ATCA) undertaken since 2008. In the process, I hope to convince the reader of the fascination of studying both big stars that chug and chug, and little stars that could.

CU Vir: I Can Be a Pulsar Too!

CU Vir is a magnetic chemically peculiar (MCP), CP2 α^2 CVn A0 (and sometimes B9) star (Deutsch 1952). What this means in practical terms is that it is a hot, highly magnetised star with unusual surface spots of silicon and helium. Cu Vir is the fastest rotating star of its type, with a rotation period of ~12.5 hours (Pyper et al. 1998). This implies a surface velocity more than three times that of a pulsar! The magnetic field of CU Vir approximates an offset dipole with a polar field strength of 3000 G (Trigilio et al. 2000).

Twin peaks of completely circularly polarised radio emission per rotation period were discovered by Trigilio et al. (2000) at an observing frequency of 1425 MHz with the Very Large Array. This was later confirmed by Trigilio et al. (2008) using the ATCA. The dual L and S band observing mode of the ATCA also enabled the discovery of pulsed emission at 2496 MHz: however, only a single peak was seen at this frequency. I observed CU Vir in October 2008 with the ATCA simultaneously at 1384 MHz and 2638 MHz (Ravi et al. 2010), as part of a project to search for transient emission from isolated white dwarfs (none was found). The resulting images at both frequencies in circular polarised intensity (Stokes V amplitude) are shown in Figure 1.

And don't they look weird! While similar features in synthesis images sometimes represent calibration errors, the clear association with the source is a telltale sign of them being celestial in origin. They are in fact artefacts of the emission peaks. The instantaneous beam of a linear interferometer like the ATCA in its extended six-kilometre configurations is a series of strips tapered by the primary beam response. If the source only exists for a short part of a track, only a few instantaneous beams are added in the image, creating the "fan beams" evident in Figure 1.

Two sets of fan beams at similar position angles are evident at both observing frequencies. These represent two peaks of 100% right-circularly polarised emission at both frequencies. An analysis of the arrival time of the peaks I observed in relation to those seen previously confirmed an intriguing result reported by Trigilio et al. (2008). The radio observations of CU Vir indicate that its period decreased abruptly in 1998 by 2.2 seconds with respect to previous the optical rotation ephemeris. A smaller period change occurred in 1985 (Pyper et al. 1998). The cause of these period changes is as yet unknown, but could be linked to violent mass-loss from the magnetosphere (Trigilio et al. 2008).

I averaged the ATCA observations of Trigilio et al. (2008) with mine to produce the average pulse profiles shown in Figure 2. Strikingly, the higher frequency peaks appear at slightly offset pulse phases to the lower frequency peaks. This effect, first pointed out by Trigilio et al. (2008), offers a key to understanding the structure of the magnetosphere.

Every good model needs some nice, believable assumptions, followed by some not-so-believable ones that are being tested. First, it is highly likely that the emission mechanism is an electron cyclotron maser (ECM). ECM emission has been directly studied in the Earth's atmosphere in the form of the Auroral Kilometric Radiation, and in the laboratory (Melrose & Dulk 1982). It is a coherent mechanism, which produces circularly polarised emission in a cone nearly perpendicular to magnetic field lines. ECM emission occurs in an extremely narrow band about the local cyclotron frequency, which scales linearly with the magnetic field strength. ECM emission is hence extremely useful as a precise magnetic field strength indicator, and as a tracer of regions of constant magnetic field strength.

I showed that simulated pulse profiles generated using a model with a simple dipolar magnetic field could not reproduce the observed pulses. Trigilio et al. (2011) suggested that the pulses are refracted in a dense region of the magnetosphere close to the star. In contrast, Lo et al. (2011, submitted to MNRAS) suggest that the emission is instead ducted through cavities along the field lines to higher emission heights, and then radiated. Further wide-band observations are required to distinguish between these models. Such observations are being carried out using the new Compact Array Broadband Backend (CABB) at the ATCA.

Not Just Cool, But Ultracool Dwarfs

I have completed a survey of all 15 known ultracool dwarfs within 10 pc in the Southern hemisphere with CABB at the ATCA. Our sample was chosen from stars that straddle the hydrogen-burning star and brown dwarf divide, with spectral types ranging from M7 to L. Since 2001, 14 ultracool dwarfs have been detected in flaring, pulsing or quiescently emitting states (Berger et al. 2010). Notably, all violate the radio/X-ray relation mentioned above. Furthermore, changes in the type of emission on timescales of years, and surface magnetic field strengths of many-kiloGauss, both make for one confusing bunch of stars.

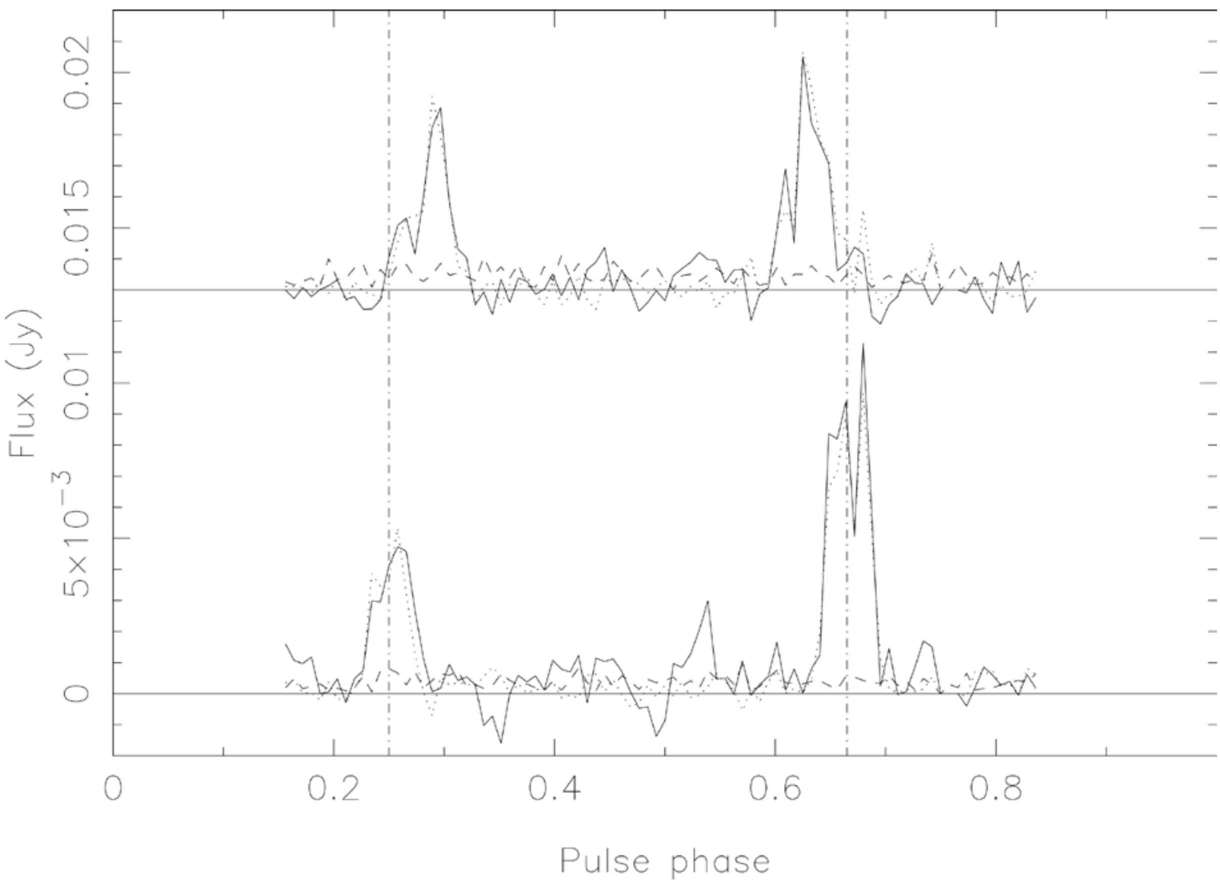


Figure 2: Average pulse profiles in the S-band (*top*, offset by 13mJy) and L-band (*bottom*) obtained by aligning and averaging the pulses observed by Trigilio et al. (2008) and us. We plot Stokes I (solid curves), Stokes V (dotted) and linear polarised intensity (dashed). The vertical dot-dashed lines represent the centres of the pulses at 20 cm. Image credit: Vikram Ravi

As a precursor to the survey, I observed the ultracool dwarf DENIS-P J104814.9− 395604 (DENIS 1048) with the ATCA in August 2009 at 5500 MHz, 9000 MHz, 18000 MHz and 24000 MHz (Ravi et al. 2011). Burgasser & Putman (2005) had previously detected 100% circularly polarised flares each at 4800 MHz and 8640 MHz and quiescent emission from DENIS 1048. The flare was attributed to an ECM mechanism, and our observations were intended to study the wide-band characteristics of any emission observed.

To my mild despair, I detected no flares. I did however find a strong, stable source with a strikingly regular power-law spectrum (Figure 3). Circular polarisation percentages of up to 40% were also detected. The results were consistent with an incoherent emission mechanism, as opposed to partially-depolarised ECM emission as was previously suggested for ultracool dwarfs (Hallinan et al. 2008). In an ECM model, the lack of modulation, combined with the detection at 18000 MHz would suggest that a region of magnetic field strength of ~6400 G would have to cover most of the stellar surface. This is inconsistent with optical measurements of the surface field strength (Berger et al. 2010). I modelled the emission as originating from the co-rotation radius in the magnetosphere, and

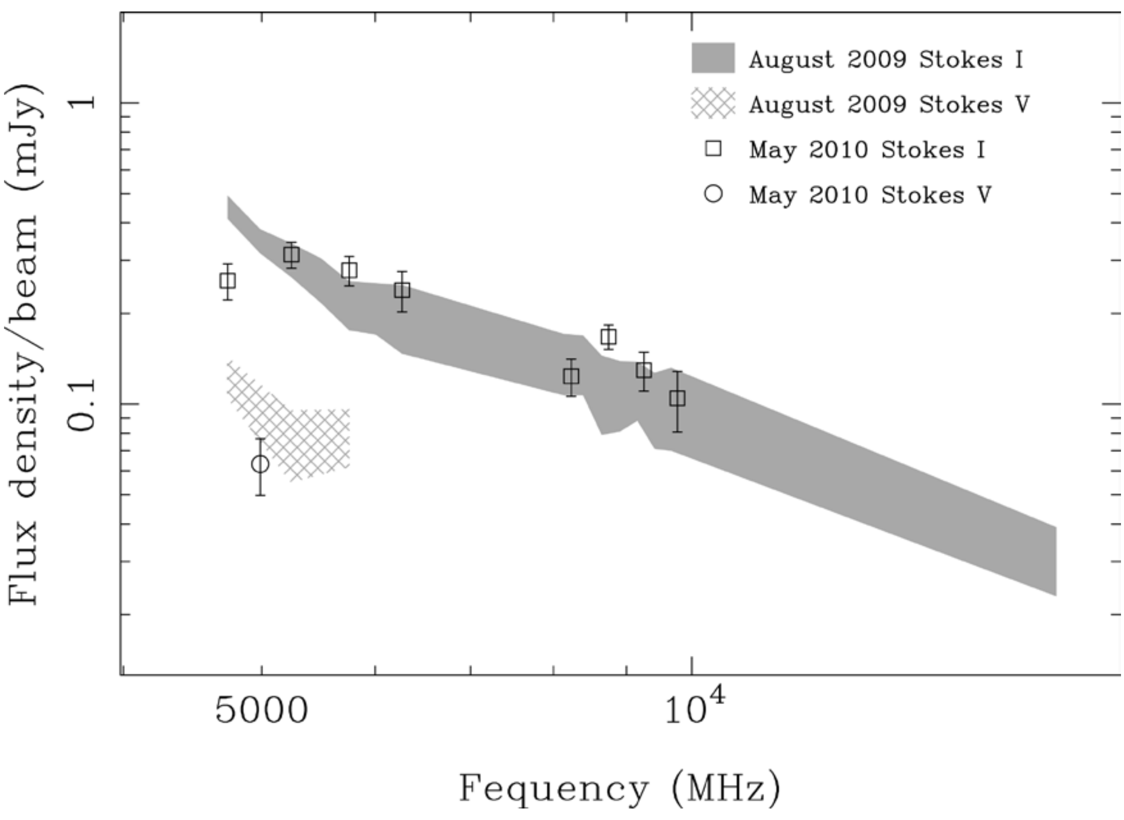


Figure 3: The wideband spectrum of DENIS 1048 obtained on two epochs with ATCA-CABB. The 1σ error range August 2009 spectrum is shown as shaded (total intensity) and cross-hatched (circular polarisation) regions. The squares and circles represent the May 2010 spectrum in total intensity and circular polarisation respectively. Image credit: Vikram Ravi

limited this, the relativistic electron density and the magnetic field strength in the emission region.

Preliminary results from the ultracool dwarf survey are promising. An analysis of data on DENIS 1048 obtained in May 2010 show that the radio emission properties appear much the same (see Figure 3), besides a possible dip in the emission at the lowest frequency. Broadband images achieve sensitivities of 8 μJy or better. The goals of this survey are to attempt to increase our sample of ultracool dwarf radio sources, particular pulsing ones. The large CABB bandwidths will enable fantastic dynamic spectra of any time-variant emission to be made. I will also stack all non-detections to understand whether any residual radio emission is present. Together, these results will begin to characterise the various states of this enthralling class of sources.

Concluding Remarks

Can we refer to stars that show periodic radio emission with fractional duty cycles as pulsars? A quick search of the ATNF Pulsar Catalogue (Manchester et al. 2005) will not reveal either CU Vir or any of the periodically emitting dwarfs. A pulsar, however, is nothing but a radio source — neutron star or not — that emits radio pulses which fit a rotation model. By this definition, CU Vir and the ultracool dwarfs are certainly pulsars. Neutron star pulsars, though, are more than just lighthouses. They have characteristic pulse profiles that are stable on long timescales, which are used to study the pulse emission region and in pulsar timing. The dynamics of neutron star pulsar magnetospheres are primarily influenced by the rotation, and the emission is coherent and beamed. The stellar pulsars share these properties. To stretch the analogy, CU Vir appears to undergo the analogue of pulsar glitches. Looking to the future, then: if stellar pulsars can reveal anywhere near as much about their hosts as neutron star pulsars, the field looks set to be quite exciting indeed. Two Nobel prizes? Who knows!

References

Berger, E., et al. 2010, ApJ, 709, 332

Burgasser, A. J., & Putman, M. E. 2005, ApJ, 626, 486

Deutsch, A. J., 1952, ApJ, 116, 536

Güdel, M., & Benz, A. O. 1993, ApJ, 405, L63

Hallinan, G., et al. 2007, ApJ, 663, L25

Hallinan, G., et al. 2008, ApJ, 684, 644

Osten, R. A. et al. 2010, ApJ, 721, 785

Manchester, R. N. et al. 2005, AJ, 129, 1993

Melrose D. B., Dulk G. A., 1982, ApJ, 259, 844

Pyper D. M. et al., 1998, A&A, 339, 822

Ravi et al. 2010, MNRAS, 408, L99

Ravi et al. 2011, ApJL, 735, L2

Trigilio C. et al., 2000, AA, 362, 281

Trigilio C. et al., 2008, MNRAS, 384, 1437

Trigilio, C. et al. 2011, ApJL, 739, L10

Acknowledgments

I would like to thank my supervisors and collaborators in this work, particularly George Hobbs and Dayal Wickramasinghe. Also, a big thank-you to the ATCA staff who keep the telescope working so well, and who helped with the observations.

Tracing the Inner Galaxy with 6.7-GHz Methanol Masers: New Insights into Galactic Structure

Jimi Green, James Caswell, Naomi McClure-Griffiths and the MMB survey team*

Studies of the structure and dynamics of the Milky Way have been complicated by our location within it, and the difficulty this has posed for observations. Early descriptions of the structure of our Galaxy were inferred from star counts and positioning of objects with photometric distances, but current revisions have been largely based upon the kinematics of atomic and molecular tracers, such as HI and CO. The sinusoidal distribution of velocities with Galactic longitudes has established the approximately circular and symmetric rotation of the Galaxy and both tracers have been used to develop dynamical models. However, this approach has limitations. HI is detected throughout the Galaxy in such great abundance that only the highest or lowest velocities along a given line of sight (the terminal velocities and spiral arm tangent deviations) can be used to constrain dynamical modeling. CO is more concentrated in the major structural features of our Galaxy, but surveys of CO have lacked sensitivity to material on the far side of the Galaxy. Nonetheless, observations and models based on the HI and CO have established that our Galaxy has a grand spiral structure, with four spiral arms, two major and two minor, and structures in the inner Galaxy, such as long and short bars and the 3-kpc arms. However, major questions remain, such as the starting points of the spiral arms and the nature of the 3-kpc arms.

An alternative tracer of the Galactic structure and dynamics is now available: the population of 6.7-GHz methanol masers. These have the advantage of only being observed towards regions of high-mass star formation (e.g. Minier et al. 2003), thereby defining the spiral arms, and their strong and narrow emission is well correlated with the velocity of the star forming regions they inhabit (Szymczak et al. 2007). They are also found in abundance throughout the Galaxy (e.g. Pestalozzi et al. 2005, Green et al. 2009) and have been detected to the outer edges of the Galaxy (e.g. Honma et al. 2007). The 6.7-GHz methanol masers are excellent measures of the kinematic behaviour of the structure of our Galaxy within the terminal velocities outlined in HI and CO. The Methanol Multibeam (MMB) survey, using the Parkes and Australia Telescope Compact Array Radio Telescopes, has recently produced the largest and most complete catalogue of Galactic 6.7-GHz methanol masers, detecting over 900 sources throughout the Galaxy (Caswell et al. 2010, Green et al. 2010, Caswell et al. 2011).

In a recent study (Green et al. 2011) we explored how 6.7-GHz methanol masers trace the major star forming structures of the inner Galaxy, specifically: the Galactic bar, the 3 kpc arms, and the origins of the spiral arms. We examined the distribution and density of 6.7-GHz methanol masers in the longitude-velocity domain (the position of the sources within the Galactic plane against their line-of-sight velocity relative to our own motion within the Galaxy). The longitude-velocity distribution demonstrates the presence of structures on small (less than 0.03 degrees) and large (greater than 3

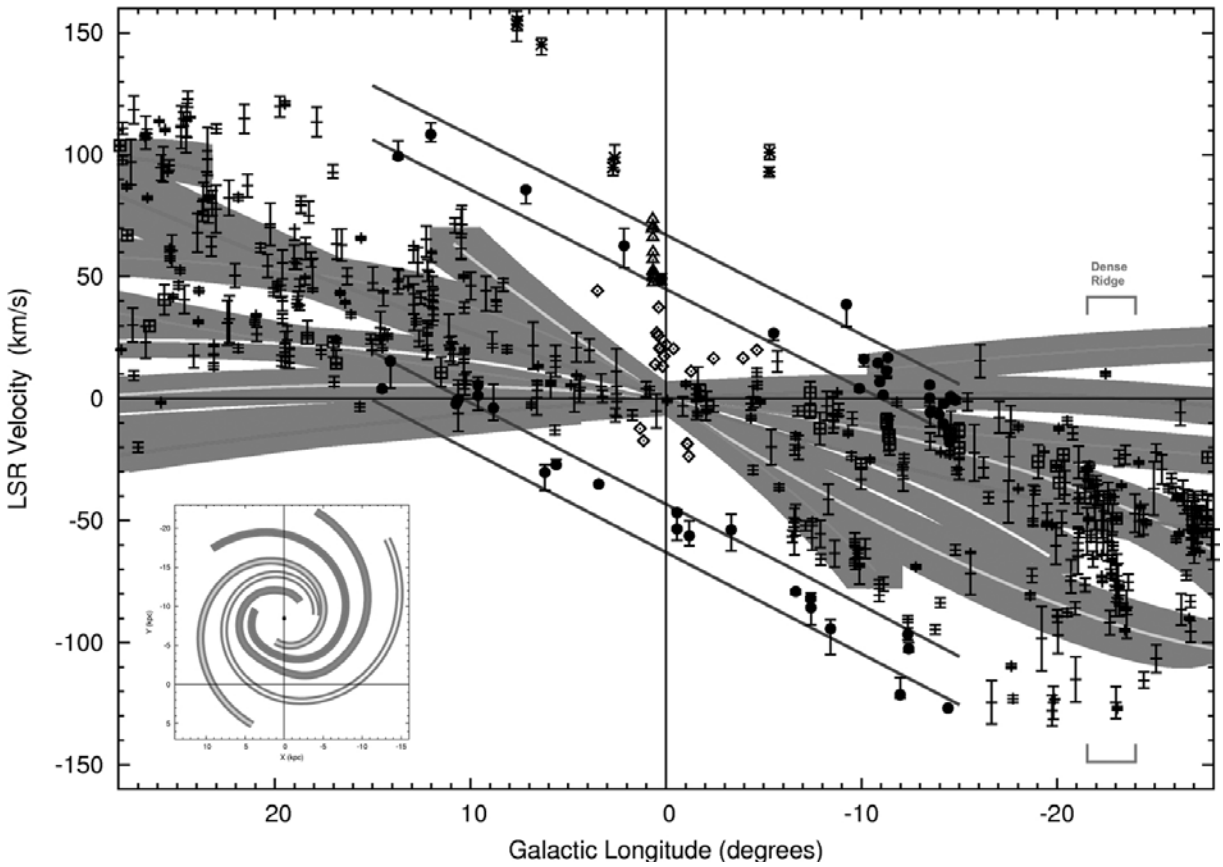


Figure 1: The distribution of 6.7-GHz methanol masers in Galactic Longitude and Local Standard of Rest velocity within longitudes ±28 degrees overlaid with example spiral arm loci (coloured loci). The grey shading represents an arm thickness of 1 kpc and a velocity tolerance of ±7 km/s. Yellow loci represent the Perseus spiral arm; Purple: Carina-Sagittarius; Orange: Crux-Scutum; Green: Norma. The blue lines delineate the region identified in CO emission as the 3-kpc arms. Crosses show 6.7-GHz methanol masers of the MMB survey. Circles are masers associated with the 3-kpc arms. Diamonds are masers which are interior to the 3-kpc arms, primarily candidates for belonging to the Galactic Centre Zone. Triangles are masers associated with the Sagittarius B2 complex. Stars are masers associated with the Galactic bar. Crosses enclosed in squares are masers with high latitudes (and therefore likely to be closer to us than 4.5 kpc). The starting points of the spiral arms have been adjusted to match the results of this study. The red brackets highlight the longitude range of the dense ridge of sources associated with the 3-kpc arm tangent.

For a colour version of this image see the inside back cover page.

degrees) scales. Through smoothing the density distribution on the small scales and binning on the large scales we identified dense regions of masers indicative of enhanced high-mass star formation within Galactic scale structures.

Using the maser distribution we gain new insight into the location of the ends of the long bar, the full 3-kpc arm structure and the starting points of the four spiral arms. The association of methanol maser emission with the long thin bar and the lack of methanol emission from a short bar implies the two Galactic bars represent different ages: the short "boxy bulge" bar is an older structure, and the long thin bar a younger structure, undergoing current high-mass star formation. We identify a prominent tangent of the 3-kpc arms near –22 degrees longitude and find the maser distribution of the 3-kpc arms is readily associated with a continuous ring structure in the longitude-velocity domain. For the first time high densities of masers identify the approximate starting longitudes of the spiral arms: the major arms, Crux-Scutum at +26 degrees and Perseus at –22 degrees, slightly offset from the bar ends; the minor arms, Norma at +12 degrees and Carina-Sagittarius at -8 degrees, possibly branching from the major arms (Figure 2).

The 3-kpc arm ring and spiral arm origins, combined with the spiral arms themselves, account for essentially all the 6.7-GHz methanol masers and their density enhancements within longitudes ±28 degrees. 6.7-GHz methanol masers clearly delineate many of the important structures of our Galaxy and provide a new observational basis to constrain dynamical models. Multi-wavelength studies and astrometric distances through Very Long Baseline I will further enhance the importance of this species of maser as a tool in understanding the structure of our Galaxy.

Figure 2: Cartoon schematic of the structure of the inner Galaxy as viewed from above the Galactic plane. The black and red bars represent the long and short Galactic bars respectively, the blue ellipse the 3-kpc arm ring and the four coloured loci the starts of the four spiral arms (with colours as per Figure 1).

For a colour version of this image see the inside back cover page.

References

Caswell et al., 2010, MNRAS, 404, 1029

Caswell et al., 2011, MNRAS, IN PRESS

Green, J. A., et al., 2009, MNRAS, 392, 783

Green, J. A., et al., 2010, MNRAS, 409, 913

Green, J. A., et al., 2011, ApJ, 733, 27

Honma, M., et al., 2007, PASJ, 59, 889

Minier, V., et al., 2003, A&A, 403, 1095

Pestalozzi, M.R., Minier, V., Booth, R.S., 2005, A&A, 432, 737

Szymczak, M., Bartkiewicz, A., Richards, A.M.S., 2007, A&A, 468, 617

MMB Survey Team

J L Caswell, G A Fuller, J A Green, A Avison, S L Breen, K Brooks, M G Burton, A Chrysostomou, J Cox, P J Diamond, S P Ellingsen, M D Gray, M G Hoare, M R W Masheder, N M McClure-Griffiths, M Pestalozzi, C Phillips, L Quinn, M A Thompson, M A Voronkov, A Walsh, D Ward-Thompson, D Wong-McSweeney, J A Yates, and R J Cohen

Education and Outreach

Rob Hollow (CASS)

Outreach Activity

The popular *Astronomy from the Ground Up* three day teacher workshop was held at Parkes Observatory in May. Teachers came from across Australia and were joined by our first international teacher, from Vietnam, for the event. CASS Education Officer Rob Hollow ran other teacher workshops at the CSIRO Education Centre in Brisbane as part of the *Discover the SKA* program in June and at *Scienceworks* in Melbourne in collaboration with the Victorian Space Science Education Centre (VSSEC) in April. Rob also presented workshop sessions at the national science teacher conference, CONASTA, in Darwin in July.

The *Discover the SKA* initiative saw CASS staff give presentations around Australia including Brisbane, Sydney, Melbourne, Canberra Perth and Geraldton reaching a wide and diverse audience.

As part of our long-term involvement in education and outreach in the Mid West region of Western Australia, Rob toured three Murchison schools at Sandstone, Mount Magnet and Mullewa in May and June. Daytime sessions with students and teachers were followed by viewing nights at Mount Magnet and Sandstone that had strong community response. Rob also participated in the Mid West Youth Science Forum in Geraldton and gave an on-air lesson at the Meekatharra School of the Air. In July Rob presented a well-received invited talk giving an overview of CASS outreach and education at the Asia Pacific Regional IAU Meeting in Chiang Mai, Thailand.

Scientists in Schools is a major national scheme administered by CSIRO for the Australian Government. Two recently appointed CASS staff, Dr Julie Banfield and Dr Ivy Wong have been actively involved with partner schools in Sydney over recent months as part of the program.

PULSE@Parkes

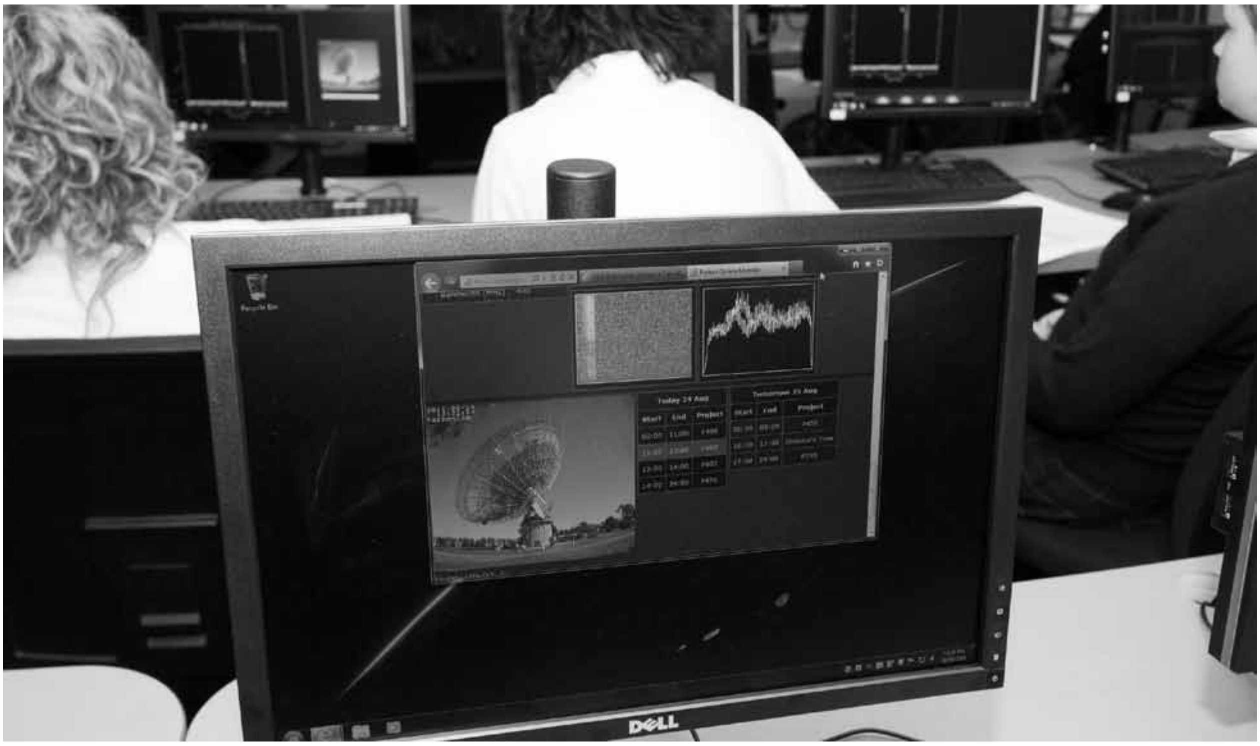
The third international session of *PULSE@Parkes* was held at the University of Oxford in April following the *DotAstronomy 3* conference. As it was school holiday time in the UK the participating students all volunteered and came from a range of schools. Project Coordinator Rob Hollow was assisted by former CASS staff member, Dr David Champion, now at Bonn. The session was a great success and wonderfully supported by the University. It elicited keen interest from Astrophysics staff at Oxford.

Our collaboration with the Victorian Space Science Education Centre continued with the third Melbourne-based *PULSE@Parkes* session in August involving students from three schools including a rural school where the students left home at 3am to take part in the session!

One innovative feature of the program is the online monitor developed by team member Jonathan Khoo and viewable by anyone using a web browser. It allows them to see the data stream live during any observing session. Combined with the live *twitter* feed people around the world can now view a live session and ask questions of the students or astronomers.

National Science Week Activities

National Science Week actually goes for almost a fortnight and this year involved CASS staff across Australia. Rob Hollow spent a day at *Science Alive* in Adelaide speaking



Students study pulsars during *PULSE@Parkes* outreach program.

to 1,700 students about the SKA and ASKAP, repeating his talk at the formal launch of Science Week in South Australia that night. He also spent a day working with students at the Australian Science and Mathematics School in Adelaide. The following week he spent two days at Ogilvie High School in Hobart discussing the SKA with the students and running a professional development session for staff. He then staffed the stall at the NSW Science Week launch in Martin Place in Sydney. Other CASS staff gave talks at other venues during National Science Week.

A highlight of National Science Week was the inaugural Murchison Astrofest held at Murchison Roadhouse in the Mid West of WA. Over 200 people attended the event, organised by Murchison Shire with a great effort contributed by CASS Regional Manager Priscilla Clayton. CASS speakers included Dr John O'Sullivan, Dr Ant Schinkel, Dr Shane O'Sullivan and Rob Hollow. The weather obliged with a wonderfully clear night sky for some stargazing led by the new, keen amateur Geraldton Astronomy Group. Shane also gave his first School of the Air lesson prior to heading out from Geraldton whilst Rob used the visit to run some teacher professional development in town too.

Operations

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

Just in the last few days we have seen the first light from HIPSR, a new backend for Parkes that will be a major enhancement to the multi-beam capability. HIPSR is a collaboration between UWA, Swinburne, Curtin, Oxford, and CSIRO. We anticipate offering this as a national facility supported instrument following commissioning. Elsewhere in this issue Danny Price describes HIPSR.

Another significant recent event was the award of the CSIRO Medal for Support Excellence to a team led by George Hobbs and Jessica Chapman of CASS and Daniel Miller and James Dempsey of CSIRO's Information Management and Technology division. The medal was awarded "For the development of a ground-breaking new archive for pulsar radio astronomy data from the CSIRO Parkes radio telescope and making this available for scientific research and education."

A review of the data reduction packages available for processing ATCA data in the CABB era has been undertaken, led by Mark Wieringa. Miriad will continue to be the main data reduction package and will be suitable for the majority of ATCA observations, and is continuing to be enhanced to improve its capabilities for handling CABB data. For projects requiring multi-frequency, multi-scale cleaning, both the ASKAPsoft and CASA packages have some advantages, and ATNF staff have been gaining experience in the use of these packages so that advice can be provided for observers needing to make use of these capabilities.

Dave McConnell has conducted a review to consider the changes in both hardware and software in order for Parkes to be able to be used for remote observing. Recent upgrades to the Parkes drives and control and monitoring have brought the telescope to the brink of remote observing, but further changes are required to ensure the safety of the telescope in all conceivable situations.

At Marsfield, the bathrooms in the lodge have been refurbished.

Congratulations to Balt Indermuehle, who recently submitted his PhD thesis on water vapour radiometers for the ATCA. Over the coming months we will be determining how best to make the system available to users.

October 2011 Time Assignment

The TAC met over two days in late July to review and grade the 138 proposals received for the 2011 October Semester (2011OCTS). Schedules for the ATCA, Parkes and Mopra were released at the end of August, with release notes accompanying the schedules describing instrument availability and plans for maintenance blocks. The last two proposal deadlines have seen minor glitches in the last hours before the proposal cut-off, which is late in the evening in eastern Australia.

Consideration is being given to revising the proposal deadline time of day to, e.g., 5pm AEST to ensure all required technical support is on hand to deal with any last-minute problems. This was outlined at the June ATUC meeting, and will be further discussed at the ATUC meeting in late October.

Notes on the Compact Array

The upgrading of the ATCA 20 and 13-cm receivers into a single 16-cm band spanning 1.1 to 3.1 GHz has now been completed, with new ortho-mode-transducers offering a significant improvement in polarisation purity at the top end of the band. The receiver group is now gearing up for a similar undertaking for the 6-cm and 3-cm bands, to be replaced by a single 4 to 12-GHz band. The first prototype receiver is slated for installation later this year.

The ATCA forum, set up last year to enable discussion and debate among users on the best way to reduce datasets, continues to see flurries of activity. The forum, initially hosted externally, has now been brought in-house, with the experience gained in doing so paving the way for the establishment of similar forums in the future. Each advance with CABB requires the on line CABB scheduler to be extended to enable the new modes to be appropriately scheduled. The scheduler has also been modified so that it no longer requires an ATNF account to access the scheduler: new users (without an account) can now use the scheduler and save their files to their local disk while planning observations.

The optical fibre connection between the AARNet trunk fibre along the Newell Highway and the Paul Wild Observatory Observatory has suffered significant attenuation in several places as the reactive soil in the area has shifted with changes between wet seasons and prolonged dry periods. AARNet has arranged some temporary fixes that have kept the links alive, but more work will be required in the coming year to provide a longer-lasting solution to these problems.

The 2011OCTS will commence with the "standard" CABB 1MHz continuum mode available, and with up to 16 zoom bands per IF available in the 1M-0.5k mode. The 64-MHz CABB mode currently provides 32 channels of 64-MHz bandwidth, with a single 64-MHz zoom band having 2048 channels across it, in each IF. It is expected that the 64-MHz mode will be expanded with more zoom bands available in each IF during the semester.

Notes on Parkes

A three-week shutdown was undertaken at Parkes in May/June, primarily to allow refurbishment of the focus cabin rails used to move receivers on and off axis. It was 15 years since the rails had been given a thorough overhaul, and close inspection indicated the shutdown had been well timed as there was appreciable wear and tear evident in some parts of the system. The Parkes team have also been busy helping the ASKAP group get the first phased array feed (PAF) initially characterised on the ground at Parkes, and then installed on the 12-m Parkes Testbed Antenna, with fringes to the 64-m dish having successfully been found.

The 2011OCTS schedule for Parkes has a three-day shutdown, from Monday 21 to Wednesday 23 November, primarily for generator change-over work. There is also a one week shut-down from Monday 30 January to Friday 3 February for further Parkes upgrade work. Observing will continue over Christmas/New Year, with limited observing support for all but matters affecting the safety of the telescope or people on site during this time. The new ATNF Operations model will not impact observing in the current semester and only minor changes in instrumentation are expected in the 2012APR semester.

Notes on the LBA

The Long Baseline Array (LBA) team have made good use of the first ASKAP antenna for VLBI observations, first conducting a VLBI run at 8 GHz with a receiver cobbled together by the engineering group, then performing real-time “eVLBI” observations at 1.4 GHz with the ASKAP antenna, the Warkworth telescope in New Zaland, and a number of the regular LBA dishes in between. The eVLBI made use of the temporary provision of the fibre link between the ASKAP site and Perth, and was reprised for a real-time demonstration during the SKA forum in Canada in early July. The fibre links will become fully available once the legal formalities have been completed.

Notes on Mopra

In response to requests from users, the Mopra observatory has been equipped with an all-sky web-camera. As all Mopra observing is now remote from the site, observers were understandably keen to assess sky conditions, in particular for survey projects that had some flexibility in where they observed. The new camera minimises saturation effects from the Sun during the day, but is sensitive enough to see stars at night, allowing observers to infer the degree and location of cloud cover at any time.

As described earlier in this issue, we may be entering the last year for National Facility operation of Mopra. The implications of this will be discussed in detail with ATUC.

Finally

And finally, congratulations to Andrew Hunt, who may have been the first person ever to control the Parkes telescope by wireless LAN (for the *Opera at The Dish* event). This method will not be offered routinely this semester.

Publications List

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

This list includes published refereed papers compiled since the April 2011 issue of ATNF News. Papers which include CASS authors are indicated by an asterisk.

*Abadie, J.; Abbott, B.P.; Abernathy, M.; et. al.; Hotan, A. and 99 co-authors. "Beating the Spin-down Limit on Gravitational Wave Emission from the Vela Pulsar ". ApJ, 737, 93 (2011).

*Abdo, A. A.; Ackermann, M.; Ajello, M.; Allafort, A.; Ballet, J.; Barbiellini, G.; Bastieri, D.; Bechtol, K.; Bellazzini, R.; Berenji, B.; Blandford, R. D.; Bonamente, E.; Borgland, A. W.; Bregeon, J.; Brigida, M.; Bruel, P.; Buehler, R.; Buson, S.; Caliandro, G. A.; Cameron, R. A.; Camilo, F.; Caraveo, P. A.; Cecchi, C.; Charles, E.; Chaty, S.; Chekhtman, A.; Chernyakova, M.; et al.; Manchester, R. N.; et. Al. "Discovery of High-energy Gamma-ray Emission from the Binary System PSR B1259-63/LS 2883 around Periastron with Fermi ". ApJ, 736, L11 (2011).

Aragona, C., McSwain, M.V. & Roberts, M.S.E. "The stellar wind of LS 5039". Societe Royale des Sciences de Liege, Proceedings of the 39th Liege Astrophysical Colloquium, Liege 12-16 July, 2010, 80, 115-119 (2011).

*Aravena, M.; Wagg, J.; Papadopoulos, P.P.; Feain, I.J. "Unveiling the mask on the ULIRG-to-QSO transition object [H89]1821+643 at z=0.3: a gas-poor/gas-rich galaxy merger and the implications for CO-based dynamical mass estimates". ApJ, 737, 64 (2011).

*Assaf, K.A.; Diamond, P.J.; Richards, A.M.S.; Gray, M.D. "The 43-GHz SiO maser in the circumstellar envelope of the asymptotic giant branch star R Cassiopeiae ". MNRAS, 415, 1083-1092 (2011).

Aversa, A.G., Johnson K.E., Brogan, C.L., Goss, W.M.; Pisano, D.J. "Very Large Array and ATCA Search for Natal Star Clusters in Nearby Star-forming Galaxies". AJ, 141, 125 (2011).

Barnes, P.J.; Yonekura, Y. Fukui, Y.; Miller, A.T.; Muhlegger, M.; Agars, L.C.; Miyamoto, Y.; Furukawa, N.; Papadopoulos, G.; Jones, S.L.; Hernandez, A.K.; O'Dougherty, S.N.; Tan, J.C. "The Galactic Census of High- and Medium-mass Protostars. I. Catalogs and First Results from Mopra HCO+ Maps". ApJS, 196, 12 (2011).

*Blake, C.; Brough, S.; Colless, M.; Contreras, C.; Couch, W.; Croom, S.; Davis, T.; Drinkwater, M.J.; Forster, K.; Gilbank, D.; Gladders, M.; Glazebrook, K.; Jelliffe, B.; Jurek, R.J.; Li, I.-Hui; Madore, B.; Martin, D.C.; Pimbblet, K.; Poole, G.B.; Pracy, M.; Sharp, R.; Wisnioski, E.; Woods, D,; Wyder, T,K.; Yee, H.K.C. "The WiggleZ Dark Energy Survey: the growth rate of cosmic structure since redshift z=0.9". MNRAS, 415, 2876-2981 (2011).

*Blake, C.; Davis, T.; Poole, G.; Parkinson, D.; Brough, S.; Colless, M.; Contreras, C.; Couch, W.; Croom, S.; Drinkwater, M.J.; Forster, K.; Gilbank, D.; Gladders, M.; Glazebrook, K.; Jelliffe, B.; Jurke, R.J.; Li, I-H.; Madore, B.; Martin, C.; Pimbblet, K.; Pracy, M.; Sharp, R.; Wisnioski, E.; Woods, D., Wyder, T.; Yee, H. "The WiggleZ dark energy survey: measuring the growth of cosmic structure with redshift-space power spectra". MNRAS, 415, 2892-2909 (2011).

Bojicic, I.S.; Parker, Q.A.; Frew, D.J.; Vaughan, A.E.; Filipovic, M.D.; Gunawardhana, M.L.P. "A pilot study of the radio-continuum emission from MASH planetary nebulae". Astronomische Nachrichten, 332, 697 (2011).

*Bonavera, L.; Massardi, M.; Bonaldi, A.; Gonzalez-Nuevo, J.; de Zotti, G.; Ekers, R.D. "The Planck-ATCA Coeval Observations project: the faint sample ". MNRAS, 416, 559-566 (2011).

*Braun, R.; Popping, A.; Brooks, K.; Combes, F. "Molecular gas in intermediate-redshift ultraluminous infrared galaxies". MNRAS, 416, 2600-2606 (2011).

*Bray, J.; Ekers, R.; James, C.; Roberts, P.; Brown, A.; Phillips, C.; Protheroe, R.; Reynolds, J.; McFadden, R.; Aartsen, M. "Searching for ultra high-energy neutrinos through nanosecond-scale radio pulse detection". 11th Asian-Pacific Regional IAU Meeting, Chiang Mai, Thailand, 26-29 July, 2011 (2011).

*Breen, S.L.; Ellingsen, S.P. "Constraining the properties of 1.2-mm dust clumps that contain luminous water masers". MNRAS, 416, 178-204 (2011).

*Breen, S. L.; Ellingsen, S. P.; Caswell, J. L.; Green, J. A.; Fuller, G. A.; Voronkov, M. A.; Quinn, L. J.; Avison, A. "Statistical properties of 12.2 GHz methanol masers associated with a complete sample of 6.7 GHz methanol masers". ApJ, 733, 80 (2011).

Brown, M.J.I.; Jannuzi, B.T.; Floyd, D.J.E., Mould, J.R. "The Ubiquitous Radio Continuum Emission from the Most Massive Early-Type Galaxies". ApJ, 731, L41 (2011).

*Brown, S. & Rudnick, L. "Diffuse radio emission in/around the coma cluster: beyond simple accretion". MNRAS, 412, 2-12 (2011).

*Burgay, M.; Joshi, B. C.; D'Amico, N.; Possenti, A.; Lyne, A.G.; Manchester, R.N.; McLaughlin, M.A.; Kramer, M.; Camilo, F.; Freire, P.C.C. "Erratum: The Parkes High-

Latitude pulsar survey". MNRAS, 412, 2816 (2011).

*Burke-Spolaor, S.; Bailes, M.; Johnston, S.; Bates, D.; Bhat, N.D.R.; Burgay, M.; D'Amico, N.D.; Jameson, A.; Keith, M.J.; Kramer, M.; Levin, L.; Millia, S.; Possenti, A.; Stappers, B.; van Straten, W. "The High Time Resolution Universe Pulsar Survey - III. Single-pulse searches and preliminary analysis". MNRAS, 416, 2465-2476 (2011).

*Calvelo, D. E.; Fender, R.; Broderick, J.; Tzioumis, T. "ATCA-CABB non-detections of T Pyx in outburst". Astronomer's Telegram, 3310 (2011).

*Cameron, A.D., Keith, M., Hobbs, G., Norris, R.P., Mao, M.Y., Middelberg, E. "Are the infrared-faint radio sources pulsars?" MNRAS, 415, 845-848 (2011).

Carozzi, T.D.; Woan, G. "A fundamental figure of merit for radio polarimeters". IEEE Transactions on Antennas and Propagation, 59, 2058-2065 (2011).

*Caswell, J. L.; Kramer, B. Hutawarakorn; Reynolds, J. E. "Magnetic fields from OH maser maps at 6035 and 6030 MHz at Galactic sites 351.417+0.645 and 353.410-0.360". MNRAS, 414, 1914-1926 (2011).

*Caswell, J.L.; Kramer, B. Hutawarakorn; Reynolds, J.E. "Maser maps and magnetic field of OH 337.705-0.053". MNRAS, 415, 3872-3878 (2011).

Chen, X.; Ellingsen, S.P.; Shen, Z.-Q.; Titmarsh, A.; Gan, C.-G. "A 95 GHz Class I Methanol Maser Survey Toward Glimpse Extended Green Objects (EGOs)". ApJS, 196, 9 (2011).

*Cognard, I.; Guillemot, L.; Johnson, T. J.; Smith, D. A.; Venter, C.; Harding, A. K.; Wolff, M. T.; Cheung, C. C.; Donato, D.; Abdo, A. A.; Ballet, J.; Camilo, F.; Desvignes, G.; Dumora, D.; Ferrara, E. C.; Freire, P. C. C.; Grove, J. E.; Johnston, S.; Keith, M.; Kramer, M.; Lyne, A. G.; Michelson, P. F.; Parent, D.; Ransom, S. M.; Ray, P. S.; Romani, R. W.; Saz Parkinson, P. M.; Stappers, B. W.; Theureau, G.; Thompson, D. J.; Weltevrede, P.; Wood, K. S. "Discovery of Two Millisecond Pulsars in Fermi Sources with the Nancay Radio Telescope". ApJ, 732, 47 2011).

*Corbel, S.; Rodriguez, J.; Tzioumis, T.; Tomsick, J. "Radio emission from IGR J17091-3624 observed with the ATCA". Astronomer's Telegram, 3167 (2011).

*Corbel, S.; Tzioumis, T. "Radio emission from IGR J17091-3624 observed with the ATCA ". Astronomer's Telegram, 3246, (2011).

*Corbet, R.; Coe, M.J.; Edwards, P.G.; Filipovic, M.D.; Payne, J.L.; Stevens, J.; Torres, M.A.P. "Discovery of the new gamma-ray binary 1FGL J1018.6-5856". In: The X-ray Universe, 2011, Berlin, Germany 27-30 June 2011 (2011).

*Corbet, R.H.D.; Cheung, C.; Kerr, M.; Dubois, R.; Donato, D.; Caliandro, G.A.; Coe, M.J.; Edwards, P.G.; Filipovic, M.D.; Payne, J.L.; Stevens, J. "1FGL J1018.6-5856: a New Gamma-ray Binary". Astronomer's Telegram, 3221 (2011).

Cordiner, M.; Charnley, S. "Organic Chemistry of Cha-MMS1 and IRAS 15194-5115 Probed by Microwave Spectroscopy". The Molecular Universe, Posters from the Proceedings of the 280th Symposium of the International Astronomical Union held in Toledo, Spain, May 30-June 3, 2011 (2011).

*Coriat, M.; Corbel, S.; Prat, L.; Miller-Jones, J.C.A.; Cseh, D.; Tzioumis, A.K.; Brocksopp, C.; Rodriguez, J.; Fender, R.P.; Sivakoff, G.R. "Accretion-outflow connection in the outliers of the ``universal'' radio/X-ray correlation". IAU 260: Jets at all Scales, Buenos Aires, Argentina, 13-17 September, 2010, 275, 255-259 (2011).

*Coriat, M.; Corbel, S.; Prat, L.; Miller-Jones, J.C.A.; Cseh, D.; Tzioumis, A.K.; Brocksopp, C.; Rodriguez, J.; Fender, R.P.; Sivakoff, G.R. "Radiatively efficient accreting black holes in the hard state: the case study of H1743-322". MNRAS, 414, 677-690 (2011).

*Coriat, M.; Tzioumis, Tasso; Corbel, S.; Fender, R.; Brocksopp, C.; Broderick, J.; Casella, P.; Maccarone, T. "Radio detection of MAXI J0556-332 with the ACTA". Astronomer's Telegram, 3119 (2011).

*Courtois, H. M.; Tully, R.B.; Makarov, D.I.; Mitronova, S.; Koribalski B.; Karachentsev, I.D.; Fisher, J.R. "Cosmic flows: Green Bank and Parkes HI observations". MNRAS, 414, 2005-2016 (2011).

*Curran, S.J.; Whiting, M.T.; Murphy, M.T.; Webb, J.K.; Bignell, C.; Polatidis, A.G.; Wiklind, T.; Francis, P.; Langston, G. "Redshifted HI and OH absorption in radio galaxies and quasars". MNRAS, 413, 1165-1173 (2011).

*Deller, A.T.; Brisken, W.F.; Phillips, C.J.; Morgan, J.; Alef, W.; Cappallo, R.; Middelberg, E.; Romney, J.; Rottmann, H.; Tingay, S.J.; Wayth, R. "DiFX-2: A More Flexible, Efficient, Robust, and Powerful Software Correlator". PASP, 123, 275-287 (2011).

*Doye, L.R., McCowan B., Johnston, S. & Hanser, S.F. "Information theory, animal communication, and the search for extraterrestrial intelligence". Acta Astronautica, 68, 406-417(2011).

*Dunham, M.K.; Robitaille, T.P.; Evans, N.J., II; Schlingman, W.M.; Cyganowski, C.J.; Urquhart, J. "A mid-infrared census of star formation activity in Bolocam galactic plane survey sources". ApJ,731, 90 (2011).

*Eatough, R.P.; Kramer, M.; Lyne, A.G.; Keith, M. "Results from the latest re-analysis of the Parkes multi-beam pulsar survey". In *Radio pulsars: an astrophysical key to unlock the secrets of the Universe,* AIP Conference Proceedings, 1357, 58-59 (2011)

Elson, E.C., de Blok. W.J.G., Kraan-Korteweg, R.C. "Three-dimensional modelling of the H i kinematics of NGC 2915". MNRAS, 415, 323-332 (2011).

*Emonts, B.H.C.; Feain, I.; Mao, M. Y.; Norris, R. P.; Miley, G.; Ekers, R. D.; Villar-Martin, M.; Rottgering, H. J. A.; Sadler, E. M.; Rees, G.; Morganti, R.; Saikia, D. J.; Oosterloo, T. A.; Stevens, J. B.; Tadhunter, C. N. "Molecular CO(1-0) Gas in the z ~ 2 Radio Galaxy MRC 0152-209". ApJ, 734, L25 (2011).

*Emonts, B.; Norris, R.; Feain, I.; Miley, G.; Sadler, E.; Villar-Martin, M.; Mao, M.; Oosterloo, T.; Ekers, R.; Stevens, J.; Wieringa, M., Coppin, K.; Tadhunter, C. "CO observations of high-z radio galaxies MRC 2104-242 and MRC 0943-242: spectral-line performance of the Compact Array Broadband Backend". MNRAS, 415, 655-664 (2011).

*Esposito, P.; Israel, G.L.; Turolla, R.; Mattana, F.; Tiengo, A.; Possenti, A.; Zane, S.; Rea, N.; Burgay, M.; Gotz, D.; Mereghetti, S.; Stella, L.; Wieringa, M.H.; Sarkissian, J.M.; Enoto, T.; Romano, P.; Sakamoto, T.; Nakagawa, Y.E.; Makishima, K.; Nakazawa, K.; Nishioka, H.; Francois-Martin, C. "Long-term spectral and timing properties of the soft gamma-ray repeater SGR 1833-0832 and detection of extended X-ray emission around the radio pulsar PSR B1830-08". MNRAS, 416, 205-215 (2011).

*Farnsworth, D.; Rudnick, L.; Brown, S. "Integrated Polarisation of Sources at lambda ~ 1m and New Rotation Measure Ambiguities" AJ, 141, 191 (2011).

*Feain, I.J.; Cornwell, T.J.; Ekers, R.D.; Calabretta, M.R.; Norris, R.P.; Johnston-Hollitt, M.; Ott, J.; Lindley, E.; Gaensler, B.M.; Murphy, T.; Middelberg, E.; Jiraskova, S.; O'Sullivan, S.; McClure-Griffiths, N.M.; Bland-Hawthorn, J. "The Radio Continuum Structure of Centaurus A at 1.4 GHz". ApJ, 740, 17 (2011).

*Ferrigno, C.; Stevens, J.; Bozzo, E.; Belloni, T.M.; den Hartog, P.R.; Fontani, F.; Kreykenbohm, I.; Papitto, A.; Rodriguez, J. "ATCA radio non-detection of IGR J17361-4441". Astronomer's Telegram, 3617 (2011).

*Frew, D.J.; Stanger, J.; Fitzgerald, M.; Parker, Q.; Danaia, L.; McKinnon, D.; Guerrero, M.A.; Hedberg, J.; Hollow, R.; An, Y.; Bor, S.H.; Colman, I.; Graham-White, C.; Li, Q. W.; Mai, J.; Papadakis, K.; Picone-Murray, J.; Hoang, M.V.; Yean, V. "K 1-6: An Asymmetric Planetary Nebula with a Binary Central Star". PASA, 28, 83-94 (2011).

*Garsden, H.; Lewis, G.F.; Harvey-Smith, L. "The water maser in MG 0414+0534: the influence of gravitational microlensing". MNRAS, 413, 1537-1547 (2011).

Ghirlanda, G.; Ghisellini, G.; Tavecchio, F.; Foschini, L.; Bonnoli, G. "The radio-g-ray connection in Fermi blazars". MNRAS, 413, 852-862 (2011).

*Giroletti, M.; Paragi, Z.; Bignall, H.; Doi, A.; Foschini, L.; Gabanyi, K.E.; Reynolds, C.; Blanchard, J.; Campbell, R. M.; Colomer, F.; Hong, X.; Kadler, M.; Kino, M.; van Langevelde, H. J.; Nagai, H.; Phillips, C.; Sekido, M.; Szomoru, A.; Tzioumis, A. K. "Global e-VLBI observations of the gamma-ray narrow line Seyfert 1 PMN J0948+0022". A&A, 528, L11 (2011).

*Granet, C.; Bowen, M.; Reynolds, J.; Davis, I.M.; Kot, J.S.; Pope, G.. "Design of a compact H/OH horn for the Parkes radio telescope".Proceedings of the 5th European Conference on Atennas and Propagation (EUCAP), Rome, Italy, 11-15 April 2011, 918-920 (2011).

*Green, J.A.; Caswell, J.L., McClure-Griffiths, N.M.; Avison, A.; Breen, S.L., Burton, M.G., Ellingsen, S.P.; Fuller, G.A.; Gray, M.D.; Pestalozzi, M.; Thompson, M.A.; Voronkov, M.A. "Major structures of the inner galaxy delineated by 6.7 GHz methanol masers". ApJ, 733, 27 (2011).

*Grondin, M.-H.; Funk, S.; Lemoine-Goumard, M.; Van Etten, A.; Hinton, J. A.; Camilo, F.; Cognard, I.; Espinoza, C.M.; Freire, P.C.C.; Grove, J. E.; Guillemot, L.; Johnston, S.; Kramer, M.; Lande, J.; Michelson, P.; Possenti, A.; Romani, R.W.; Skilton, J.L.; Theureau, G.; Weltevrede, P. "Detection of the Pulsar Wind Nebula HESS J1825Ð137 with the Fermi Large Area Telescope". ApJ, 738, 42 (2011).

*Guzman, A.E.; Garay, G.; Brooks, K.J.; Rathborne, J.; Gusten, R. "A Hot Molecular Outflow Driven by the Ionised Jet Associated with IRAS 16562-3959". ApJ, 736, 150 (2011).

*Hamacher, D.W., Norris, R.P. "Comets in Australian Aboriginal Astronomy". J. Astron. History & Heritage, 14, 31-40(2011).

*Hampson, G., Tuthill, J., Brown, A., Neuhold, S., Bateman, T., Bunton, J. "Xilinx FPGAs beam up next-gen radio astronomy". Xcell Journal, 75, 30-35 (2011).

Harvey-Smith, L.; Madsen, G.J.; Gaensler, B.M. "Magnetic fields in large-diameter HII regions revealed by the faraday rotation of compact extragalactic radio sources" ApJ, 736, 83 (2011).

*Hay, S.G.; O'Sullivan, J.D.; Mittra, R. "Connected patch array analysis using the characteristic basis function method". IEEE

Transactions on Antennas and Propagation, 59, 1828-1837 (2011).

Higdon, J.L.; Higdon, S.J.U.; Rand, R.J. " Wheels of Fire. IV. Star Formation and the Neutral Interstellar Medium in the Ring Galaxy AM0644-741 ". ApJ, 739, 97 (2011).

*Hill, A.B.; Szostek, A.; Corbel, S.; Camilo, F.; Corbet, R.H.D.; Dubois, R.; Dubus, G.; Edwards, P.G.; Ferrara, E.C.; Kerr, M.; Koerding, E.; Koziel, D. & Stawarz, L. "The bright unidentified gamma-ray source 1FGL J1227.9-4852: Can it be associated with a low-mass X-ray binary?" MNRAS, 415, 235-243 (2011).

*Hobbs, G.; Miller, D.; Manchester, R.D.; Dempsey, J.; Chapman, J.M.; Khoo, J.; Applegate, J.; Bailes, M.; Bhat, N.D.R.; Bridle, R.; Borg, A.; Brown, A.; Burnett, C.; Camilo, F.; Cattalini, C.; Chaudhar, A.; Chen, R.; D'Amico, N.; Kedziora-Chudczer, L.; Cornwell, T.; George, R.; Hampson, G.; Hepburn, M.; Jameson, A.; Keith, M.; Kelly, T.; Kosmynin, A.; Lenc, E.; Lorimer, D.; Love, C.; Lyne, A.; McIntyre, V.; Morrissey, J.; Piennar, M.; Reynolds, J.; Ryder, G.; Sarkissian, J.; Stevenson, A.; Treloar, A.; van Straten, W.; Whiting, M.; Wilson, G. "The Parkes Observatory Pulsar Data Archive". PASA, 28, 202-214 (2011).

*Hurley-Walker, N.; Brown, M.L.; Davies, M.L., Feroz, F., Franzen, T.M.O., Grainge, K., Hobson, M.P., Lasenby, A., Olamaie, M., Pooley, G., Rodriguez-Gonzalvez, C., Saunders, R.D.E., Schammel, M.P., Scaife, A.M.M. Scott, P.F., Shimwell, T., Titterington, D., Waldram, E. "Further Sunyaev-Zel'dovich observations of two Planck ERCSC clusters with the Arcminute Microkelvin Imager". MNRAS, 414, L75-L79 (2011).

*Jackson, C. "Engaging industry with the SKA: the Australian ASKAP experience". SKA-Japan Workshop, Tokyo, Japan, 4-5 November, 2010 (2011).

*Jenkins, L.P.; Brandt, W.N.; Colbert, E.J.M.; Koribalski, B.; Kuntz, K.D.; Levan, A.J.; Ojha, R.; Roberts, T.P.; Ward, M.J.; Zezas, A. "Investigating the nuclear activity of barred spiral galaxies: the case of NGC 1672". ApJ, 734, 33 (2011).

Kalberla, P.M.W. "RFI mitigation for the Parkes Galactic All-Sky Survey (GASS)". PoS, RFI Mitigation Workshop - RFI2010, March 29-31, 2010, Groningen, The Netherlands, 38 (2011).

*Kanekar, N.; Braun, R.; Roy, N. "An H I column density threshold for cold gas formation in the galaxy". ApJ, 737, L33 (2011).

*Karastergiou, A.; Roberts, S.J.; Johnston, S.; Lee, H.; Weltevrede, P.; Kramer, M. "A transient component in the pulse profile of PSR J0738-4042 ". MNRAS, 415, 251-256 (2011).

*Keith, M.J.; Johnston, S.; Levin, L.; Bailes, M. "17- and 24-GHz observations of southern pulsars". MNRAS, 416, 346-354 (2011).

*Keith, M.J.; Johnston, S; Ray, P.S.; Ferrara, E.C.; Saz Parkinson, P.M.; Celik, O.; Belfiore, A.; Donato, D.; Cheung, C.C.; Abdo, A.A.; Camilo, F.; Freire, P.C.C.; Guillemot, L.; Harding, A.K.; Kramer, M.; Michelson, P.F.; Ransom, S.M.; Romani, R.W.; Smith, D.A.; Thompson, D.J.; Weltevrede, P.; Wood, K.S. "Discovery of millisecond pulsars in radio searches of southern Fermi Large Area Telescope sources". MNRAS, 414, 1292-1300 (2011).

*Keith, M.J.; Jameson, A.; van Straten, W.; Bailes, M.; Johnston, S.; Kramer, M.; Possenti, A.; Bates, S. D.; Bhat, N.D.R.; Burgay, M.; Burke-Spolaor, S.; D'Amico, N.; Levin, L.; Milia, S.; Stappers, B.W. "The High Time Resolution Universe: The latest survey for pulsars at Parkes". Radio pulsars: an astrophysical key to unlock the secrets of the Universe, AIP Conference Proceedings, 1357, 19-22 (2011).

Kim, Han-Seek; Baugh, C. M.; Benson, A. J.; Cole, S.; Frenk, C. S.; Lacey, C. G.; Power, C.; Schneider, M. "The spatial distribution of cold gas in hierarchical galaxy formation models". MNRAS, 414, 2367-2385 (2011).

*Koch, P.M.; Raffin, P.; Huang, Yau-De; Chen, Ming-Tang; Han, Chih-Chiang; Lin, Kai-Yang; Altamirano, P.; Granet, C.; Ho, P.T.P.; Huang, Chih-Wei L.; Kesteven, M.; Li, Chao-Te; Liao, Yu-Wei; Liu, Guo-Chin; Nishioka, H.; Ong, Ching-Long; Oshiro, P.; Umetsu, K.; Wang, Fu-Cheng; Wu, Jiun-Huei Proty "1.2 m Shielded Cassegrain Antenna for Close-Packed Radio Interferometer". PASP, 123, 198-212 (2011).

Lakicevic, M.; van Loon, J. Th.; Patat, F.; Staveley-Smith, L.; Zanardo, G. "The remnant of SN 1987A revealed at (sub-)mm wavelengths". A&A, 532, L8 (2011).

*Law, C. J.; Gaensler, B. M.; Bower, G. C.; Backer, D. C.; Bauermeister, A.; Croft, S.; Forster, R.; Gutierrez-Kraybill, C.; Harvey-Smith, L.; Heiles, C.; Hull, C.; Keating, G.; MacMahon, D.; Whysong, D.; Williams, P. K. G.; Wright, M. "Spectropolarimetry with the Allen Telescope Array: Faraday Rotation Toward Bright Polarised Radio Galaxies. "Three Millisecond Pulsars in Fermi LAT Unassociated Bright Sources". ApJ, 728, 57- (2011).

Lazaridis, K.; Verbiest, J. P. W.; Tauris, T. M.; Stappers, B. W.; Kramer, M.; Wex, N.; Jessner, A.; Cognard, I.; Desvignes, G.; Janssen, G. H.; Purver, M. B.; Theureau, G.; Bassa, C. G.; Smits, R. "Evidence for gravitational quadrupole moment variations in the companion of PSR J2051-0827". MNRAS, 414, 3134-3144 (2011).

*Lemoine-Goumard, M.; Zavlin, V. E.; Grondin, M.-H.; Shannon, R.; Smith, D. A.; Burgay, M.; Camilo, F.; Cohen-Tanugi, J.; Freire, P. C. C.; Grove, J. E.; Guillemot, L.; Johnston, S.; Keith, M.; Kramer, M.; Manchester, R. N.; Michelson, P. F.; Parent, D.; Possenti, A.; Ray, P. S.; Renaud, M.; Thorsett, S. E.; Weltevrede, P.; Wolff, M. T. "Discovery of gamma- and X-ray pulsations from the young and energetic PSR J1357-6429 with Fermi and XMM-Newton". A&A, 533, 102 (2011).

*Li, F., Brown, S., Cornwell, T. & De Hoog, F. "The application of compressive sampling to radio astronomy 2: Faraday rotation measure synthesis". A&A, 531, 126 (2011).

*Li F.; Cornwell, T.; De Hoog, F. "The application of compressive sampling to radio astronomy. I. Deconvolution". A&A, 528, A31 (2011).

*Lo, N., Redman, M.P., Jones, P.A., Cunningham, M.R., Chhetri, R., Bains, I., Burton, M.G. "Observations and radiative transfer modelling of a massive dense cold core in G333". MNRAS, 415, 525-533 (2011).

Lu, T-N., Kong, A.K.H. "Radio continuum observations of 47 tucanae and omega centauri: hints for intermediate-mass black holes?" .ApJ, 729, L25 2011).

*MacKenzie, T. Braglia, F.G.; Gibb, A.G.; Scott, D.; Jenness, T.; Serjeant, S.; Thompson, M.; Berry, D. Brunt, C.M.; Chapin, E. Chrysostomou, A.; Clements, D.; Coppin, K.; Economou, F.; Evans, A.; Friberg, P.; Greaves, J.; Hill, T.; Holland, W.; Ivison, R.J.; Knapen, J.H.; Jackson, N.; Joncas, G.; Morgan, L.; Mortier, A.; Pearson, C.; Pestalozzi, M.; Pope, A.; Richer, J.; Urquhart, J.S.; Vaccari, M.; Weferling, B.; White, G.; Zhu, M. "A pilot study for the SCUBA-2 'All Sky' Survey". MNRAS, 415, 1950-1960 (2011).

*Manchester, R.N. "Pulsar Timing Arrays and their applications".AIP Conference Proceedings for the Pulsar Conference 2010, Sardinia, Italy, October 2010, 1357, 66-72 (2011).

*Manchester, R.N.; Hobbs, G. "A giant glitch in PSR J1718-3718". ApJ, 736, L31 (2011).

*Mao, M.; Huynh, M.; Norris; R., Dickinson, M.; Frayer, D.; Helou, G.; Monkiewicz, J.A. "No Evidence for Evolution in the Far-infrared-Radio Correlation out to z ~ 2 in the Extended Chandra Deep Field South". ApJ, 731, 79 (2011).

*Massardi, M. Bonaldi, A.; Bonavera, L.; Lopez-Caniego, M.; de Zotti, G.; Ekers, R.D. "The Planck-ATCA Co-eval Observations (PACO) project: the bright sample". MNRAS, 415, 1597-1610 (2011).

*Massardi, M., Ekers, R.D., Murphy, T.; Mahony, E.; Hancock, P.J.; Chhetri, R.; de Zotti, G.; Sadler, E.M.; ., Burke-Spolaor, S., Calabretta, M., Edwards, P.G., Ekers, J.A., Jackson, C.A., Kesteven, M.J., Newton-McGee K., Phillips, C., Ricci, R., Roberts, P., Sault, R.J.; Staveley-Smith, L.; Subrahmanyan, R. Walker, M.A.; Wilson, W.E. "The Australia Telescope 20 GHz (AT20G) Survey: analysis of the extragalactic source sample". MNRAS, 412, 318-330 (2011).

*McClure-Griffiths, N.; Stevens, J.; Bowen, M.; O'Sullivan, S.; Dunning, A.; Kanoniuk, H.; Chung, Y.; Reilly, L.; Castillo, S. "The Australia Telescope Compact Array L/S receiver upgrade. The new 16cm receiver". Astronomical Society of Australia, Annual Scientific Meeting, Adelaide, Australia, 4-8 July, 2011, (2011).

*Melchiori, A.G.; Barnes, D.G.; Calabretta, M.R.; Webster, R.L. "Calibration for the HIPASS Continuum Catalogue". Radio Science, 46, RS2019 (2011).

*Middleberg, E.; Deller, A.; Morgan, J.; Rottmann, H.; Alef, W.; Tingay, S.; Norris, R.; Bach, U.; Brisken, W.; Lenc, E. "Wide-field VLBA observations of the Chandra deep field South". A&A, 526, A74 (2011).

*Miller, J.; McLaughlin, M.; Rea, N.; Keane, E.; Lyne, A.; Kramer, M.; Manchester, R.; Lazaridis, K. "Multiwavelength Studies of Rotating Radio Transients". In: Radio pulsars: an astrophysical key to unlock the secrets of the Universe, AIP Conference Proceedings, 1357, 161-164 (2011).

*Miller-Jones, J. C. A.; Tzioumis, A. K.; Sivakoff, P. G. Jonker. G. R.; Maccarone, T. J.;Nelemans, G. "ATCA radio observations of MAXI J1543-564". Astronomer's Telegram, 3364 (2011).

*Moin, A.; Reynolds, C.; Miller-Jones, J.C.A.; Tingay, S.J.; Phillips, C.J.; Tzioumis, A.K.; Nicholson, G.D.; Fender, R.P. "e-VLBI observations of Circinus X-1: monitoring of the quiescent and flaring radio emission on AU scales". MNRAS, 414, 3551-3556 (2011).

*Molden, J.; Johnston, S.; Ribo, M.; Paredes, J.M.; Deller, A.T. "Discovery of Extended and Variable Radio Structure from the Gamma-ray Binary System PSR B1259-63/LS 2883". ApJ, 732, L10 (2011).

*Mottram, J.C.; Hoare, M.G.; Davies, B.; Lumsden, S.L.; Oudmaijer, R.D.; Urquhart, J.S.; Moore, T.J.T.; Cooper, H.D.B.; Stead, J.J. "The RMS Survey: The Luminosity Functions and Timescales of Massive Young Stellar Objects and Compact H II Regions". ApJ, 730, L33 (2011).

*Muller, C.; Kadler, M.; Ojha, R.; Wilms, J.; Bock, M.; Edwards, P. G.; Fromm, C. M.; Hase, H.; Horiuchi, S.; Katz, U.; Lovell, J. E. J.; Plštz, C.; Pursimo, T.; Richers, S.; Ros, E.; Rothschild, R. E.; Taylor, G. B.; Tingay, S. J.; Zensus, J. A. "Dual-frequency VLBI study of Centaurus A on sub-parsec scales. The highest-resolution view of an extragalactic jet ". A&A, 530 L11 (2011).

Muller, S.; Beelen, A.; Guelin, M.; Aalto, S.; Black, J. H.; Combes, F.; Curran, S.; Longmore, S.; Theule, P. "Absorption line surveys at intermediate redshift". The Molecular Universe, Proceedings of the 280th Symposium of the International

Astronomical Union held in Toledo, Spain, May 30-June 3, 2011 (2011).

*Ng, C.-Y.; Potter, T.M.; Staveley-Smith, L.; Tingay, S.; Gaensler, B. M.; Phillips, C.; Tzioumis, A.K.; Zanardo, G. "First VLBI Detection of the Radio Remnant of Supernova 1987A: Evidence for Small-scale Features". ApJ, 728, L15 (2011).

*Norris, R.P.; Afonso, J.; Cava, A.; Farrah, D.; Huynh, M.T.; Ivison, R. J.; Jarvis, M.; Lacy, M.; Mao, M.; Maraston, C.; Mauduit, J.-C.; Middelberg, E.; Oliver, S.; Seymour, N.; Surace, J. "Deep spitzer observations of infrared-faint radio sources: high-redshift radio-loud active galactic nuclei"? ApJ, 736, 55 (2011).

*Norris, R.P. & Hamacher, D.W. "The astronomy of Aboriginal Australia". In: IAU 260 : The Role of Astronomy in Society and Culture, Paris, France, 19-23 January, 2009, 260, 39-47 (2011).

*Noutsos, A.; Abdo, A.A.; Ackermann, M.; et. al.; Johnston, S. et.al. "Radio and gamma-ray Constraints on the Emission Geometry and Birthplace of PSR J2043+2740". ApJ, 728, 77 (2011).

*O'Sullivan, S. P.; Gabuzda, D. C.; Gurvits, L. I. ."Multifrequency polarisation properties of 10 quasars on decaparsec scales at z > 3". MNRAS, 415, 3049-3064 (2011).

*Palfreyman, J.L.; Hotan, A.W.; Dickey, J.M.; Young, T.F.; Hotan, C.E. "Consecutive bright pulses in the Vela pulsar". ApJ, 735, L17 (2011).

Paradis, D.; Paladini, R.; Noriega-Crespo, A.; Lagache, G.; Kawamura, A.; Onishi, T.; Fukui, Y."Spitzer Characterisation of Dust in the Ionised Medium of the Large Magellanic Cloud". ApJ, 735, 6 (2011).

*Perlman, E.S.; Georganopoulos, M.; Marshall, H.L.; Schwartz, D.A.; Padgett, C.A.; Gelbord, J.; Lovell, J.E.J.; Worrall, D.M.; Birkinshaw, M.; Murphy, D.W.; Jauncey, D.L. "Deep Multiwaveband Observations of the Jets of 0208-512 and 1202-262". ApJ, 739, 65 (2011).

*Petrov, L.; Phillips, C.; Bertarini, A.; Murphy, T.; Sadler, E.M. "The LBA calibrator survey of southern compact extragalactic sources - LCS1". MNRAS, 414, 2528-2539 (2011).

*Petrov, L., Phillips, C., Tzioumis, T., Stansby, B., Reynolds, C., Bignall, H., Gulyaev, S., Natusch, T., Reynolds, J., Amy, S., Wayth, R., Tingay, S. "First geodetic observations using new VLBI stations ASKAP-29 and WARK12M". PASA, 28, 107-116 (2011).

*Popping, A.; Braun, R. "The WSRT Virgo HI filament survey II. Cross correlation data". A&A, 528, A28 (2011).

*Popping, A.; Braun, R. "Diffuse neutral hydrogen in the H i Parkes All Sky Survey". A&A, 533,A122 (2011).

*Randall, K. E.; Hopkins, A. M.; Norris, R. P.; Edwards, P. G. "An unbiased sample of bright southern compact steep spectrum and gigahertz peaked spectrum sources". MNRAS, 416, 1135-1151 (2011).

*Ransom, S.M.; Ray, P.S.; Camilo, F.; Roberts, M.S.E.; ,Celik, O.; Wolff, M.T.; Cheung, C C.; Kerr, M.; Pennucci, T.; DeCesar, M.E.; Cognard, I.; Lyne, A.G.; Stappers, B.W.; Freire, P.C.C.; Grove, J.E.; Abdo, A.A.; Desvignes, G.; Donato, D.; Ferrara, E.C.; Gehrels, N.; Guillemot, L.; Gwon, C.; Harding, A.K.; Johnston, S.; Keith, M.; Kramer, M.; Michelson, P.F.; Parent, D.; Saz Parkinson, P.M.; Romani, R.W.; Smith, D.A.; Theureau, G.; Thompson, D.J.; Weltevrede, P.; Wood, K.S.; Ziegler, M. "Three Millisecond Pulsars in Fermi LAT Unassociated Bright Sources". ApJ, 727, L16-L16 (2011).

"Ravi, V., Hallinan, G., Hobbs, G. & Champion, D." "The magnetosphere of the ultracool dwarf DENIS 1048-3956". ApJ, 735, L2 (2011).

*Ray, P.S.; Kerr, M.; Parent, D.; Abdo, A.A.; Guillemot, L.; Ransom, S.M.; Rea, N.; Wolff, M.T.; Makeev, A.; Roberts, M.S.E.; Camilo, F.; Dormody, M.; Freire, P.C.C.; Grove, J.E.; Gwon, C.; Harding, A.K.; Johnston, S.; Keith, M.; Kramer, M.; Michelson, P.F.; Romani, R.W.; Saz Parkinson, P.M.; Thompson, D.J.; Weltevrede, P.; Wood, K.S.; Ziegler, M. "Precise gamma-ray timing and radio observations of 17 fermi gamma-ray pulsars". ApJ, 194, 17 (2011).

Rigby, E.E.; Best, P.N.; Brookes, M.H.; Peacock, J.A.; Dunlop, J.S.; Rottgering, H.J.A.; Wall, J.V.; Ker, L. "The luminosity-dependent high-redshift turnover in the steep spectrum radio luminosity function: clear evidence for downsizing in the radio-AGN population". MNRAS, 416, 1900-1915 (2011).

*Romani, R.W.; Kerr, M.; Craig, H.A.; Johnston, S.; Cognard, I.; Smith, D.A. "Sub-luminous gamma-ray pulsars". ApJ, 738, 114 (2011).

*Roshi, D.A., Briggs, F., Bunton, J., Deshpande, A.A., Gopalakrishna, M.R., Hampson, G., Kamini, P.A., Kocz, J., Kumar, D., Madahavi, S., Pathikulangara, J., Prabhu, T., Sault, R.J., Shankar, N. Uday, Srivani K.S. & Waterson, M. "A digital receiver for the Murchison widefield arrays". IAU XXVII General Assembly, Rio De Janeiro, 3-14 August, 2009, 23 (2011).

Ruggiero, M.L.; Capolongo, E.; Tartaglia, A. "Pulsars as celestial beacons to detect the motion of the Earth". In.J.Mod.Phys., 20, 1025-1038 (2011).

Ruggiero, M.L.; Capolongo, E.; Tartaglia, A. "Pulsars as celestial beacons to detect the motion of the earth". IJMPD, 20, 1025-1038 (2011).

*Ryder, S. D.; Amy, S. W.; Stockdale, C. J.; Immler, S.; Stevens, J.; Weiler, K. W. "Radio Detection of the Type IIb Supernova 2011cb in ESO 109-21". Astronomer's Telegram, 3370, (2011).

Sajina, A.; Partridge, B.; Evans, T.; Stefl, S.; Vechik, N.; Myers, S.; Dicker, S.; Korngut, P. "High-frequency Radio Spectral Energy Distributions and Polarisation Fractions of Sources in an Atacama Cosmology Telescope Survey Field". ApJ, 732, 45 (2011).

*Sarkissian J., Carretti, E. & Van Straten, W. "The Parkes pulsar backends". Pulsar Conference 2010, Sardinia, Italy, 10-15 October 2010, 1357, 351-352 (2011).

*Simpson, C.E.; Hunter, D.A.; Nordgren, T.E.; Brinks, E.; Elmegreen, B.G.; Ashley, T.; Lynds, R.; McIntyre, V.J.; O'Neil, E.J.; Ostlin, G.; Westpfahl, D.J.; Wilcots, E.M. "VII Zw 403: H I Structure in a Blue Compact Dwarf Galaxy". ApJ, 142, 82 (2011).

Stupar, M.; Parker, Q. A.; Filipovic, M. D. "The putative nebula of the Wolf-Rayet WR 60 star: a case of mistaken identity and reclassification as a new supernova remnant G310.5+0.8". Ap&SS, 332, 241-248 (2011).

*van Cappellen, W.; de Vaate, J.; Warnick, K.; Veidt, B.; Gough, R.; Jackson, C.; Roddis, N. "Phased Array Feeds for the Square Kilometre Array". In: XXX URSI General Assembly and Scientific Symposium, Istanbul, Turkey, 13-20 August, 2011, 1-4 (2011).

*Van Eck, C.L.; Brown, J. C.; Stil, J.M.; Rae, K.; Mao, S.A.; Gaensler, B.M.; Shukurov, A.; Taylor, A.R.; Haverkorn, M.; Kronberg, P.P.; McClure-Griffiths, N.M. "Modeling the Magnetic Field in the Galactic Disk Using New Rotation Measure Observations from the Very Large Array". ApJ, 728, 97 (2011).

*Vasyunina, T., Herbst, E., Linz, H., Henning, T., Beuther, H., Zinchenko, I., Voronkov, M. "What molecular lines can tell about early stages of massive stars". International Symposium on Molecular Spectroscopy, 66th Meeting, Ohio, US, 20-24 June, 2011, Abstract #ETF08 (2011).

*Vasyunina, T.; Herbst, E.; Linz, H.; Henning, T.; Zinchenko, I.; Beuther, H.; Voronkov, M. "Chemical composition of infrared dark clouds: observations vs modeling". IAU 280: The Molecular Universe, Toledo, Spain, 30 May-3 June, 2011 (2011).

Vlemmings, W.H.T.; Torres, R.M.; Dodson, R. "Zeeman splitting of 6.7 GHz methanol masers on the uncertainty of magnetic field strength determinations". A&A, 52, A95-A95 (2011).

*Voronokov, M.A., Walsh, A.J., Caswell, J.L., Ellingsen, S.P., Breen, S.L., Longmore, S.N., Purcell, C.R. & Urquhart, J.S "Discovery of the new class I methanol maser transition at 23.4 GHz". MNRAS, 413, 2339-2344 (2011).

*Walsh, A.J.; Breen, S.L.; Britton, T.; Brooks, K.J.; Burton, M.G.; Cunningham, M.R.; Green, J.A.; Harvey-Smith, L.; Hindson, L.; Hoare, M.G.; Indermuehle, B.; Jones, P.A.; Lo, N.; Longmore, S.N.; Lowe, V.; Phillips, C.J.; Purcell, C.R.; Thompson, M.A.; Urquhart, J.S.; Voronkov, M.A.; White, G.L.; Whiting, M.T. "The H2O Southern Galactic Plane Survey (HOPS) - I. Techniques and H2O maser data". MNRAS, 416, 1764-1821 (2011).

*Warren, S.R.; Weisz, D.R.; Skillman, E.D.; Cannon, J.M.; Dalcanton, J.J.; Dolphin, A.E.; Kennicutt, R.C., Jr.; Koribalski, B.; Ott, J.; Stilp, A.M.; Van Dyk, S.D.; Walter, F.; West, A.A. "The Formation of Kiloparsec-scale H I Holes in Dwarf Galaxies". ApJ, 738, 10 (2011).

*Webster N. "A study of the aircraft hazards from an 80kW transmitter, model development and analysis". Australasian Radiation Protection Society, 35th Annual Conference, 17-20 October, 2010, Adelaide, Australia (2011).

*Weltevrede, P.; Johnston, S.; Espinoza, C.M. "The glitch-induced identity changes of PSR J1119-6127". MNRAS, 411, 1917-1934(2011).

*Wilson, W,E.; Ferris, R. H.; Axtens, P.; Brown, A.; Davis, E.; Hampson, G.; Leach, M.; Roberts, P.; Saunders, S.; Koribalski, B.S.; Caswell, J. L.; Lenc, E.; Stevens, J.; Voronkov, M. A.; Wieringa, M. H.; Brooks, K.; Edwards, P.G.; Ekers, R. D.; Emonts, B.; Hindson, L.; Johnston, S.; Maddison, S.T.; Mahony, E.K.; Malu, S.S.; Massardi, M.; Mao, M.Y.; McConnell, D.; Norris, R.P.; Schnitzeler, D.; Subrahmanyan, R.; Urquhart, J.S.; Thompson, M.A.; Wark, R.M. "The Australia Telescope Compact Array Broadband Backend: description and first results".MNRAS, 416, 832-856 (2011).

Wong, G. F.; Filipovic, M. D.; Crawford, E.J.; de Horta, A.Y.; Galvin, T.; Draskovic, D.; Payne, J.L. "New 20-cm Radio-Continuum Study of the Small Magellanic Cloud: Part I - Images". SerAJ, 182, 43-52 (2011).

Yan, W.M ; Manchester, R.N.; Hobbs, G.; van Straten, W.; Reynolds, J.E.; Wang, N.; Bailes, M.; Bhat, N.D.R.; Burke-Spolaor, S.; Champion, D.J.; Chaudhary, A.; Coles, W.A.; Hotan, A.W.; Khoo, J.; Oslowski, S.; Sarkissian, J.M.; Yardley, D.R.B. "Rotation measure variations for 20 millisecond pulsars". Ap&SS, 335, 485-498 (2011).

*Yan, W.M.; Manchester, R.N.; van Straten, W.; Reynolds, J.E.; Hobbs, G.; Wang, N.; Bailes, M.; Bhat, N.D.R.; Burke-Spolaor, S.; Champion, D. J.; Coles, W.A.; Hotan, A.W.; Khoo, J.; Oslowski, S.; Sarkissian, J.M.; Verbiest, J.P.W.; Yardley, D.R B. "Polarisation observations of 20 millisecond pulsars". MNRAS, 414, 2087-2100 (2011).

*Yardley, D.R.B.; Coles, W.A.; Hobbs, G.B.; Verbiest, J.P.W.; Manchester, R.N.; van Straten, W.; Jenet, F.A.; Bailes, M.; Bhat, N.D.R.; Burke-Spolaor, S.; Champion, D.J.; Hotan, A. W.; Oslowski, S.; Reynolds, J. E.; Sarkissian, J. M "On detection of the stochastic gravitation-wave background using the Parkes pulsar timing array". MNRAS, 414, 1777-1787 (2011).

* Zhu, W. W.; Kaspi, V. M.; McLaughlin, M. A.; Pavlov, G. G.; Ng, C.-Y.; Manchester, R. N.; Gaensler, B. M.; Woods, P. M. "Chandra Observations of the High-magnetic-field Radio Pulsar J1718Ð3718". ApJ, 734, 44 (2011).

From page 36 — Tracing the Inner Galaxy With 6.7-GHz Methanol Masers: New Insights Into Galactic Structure

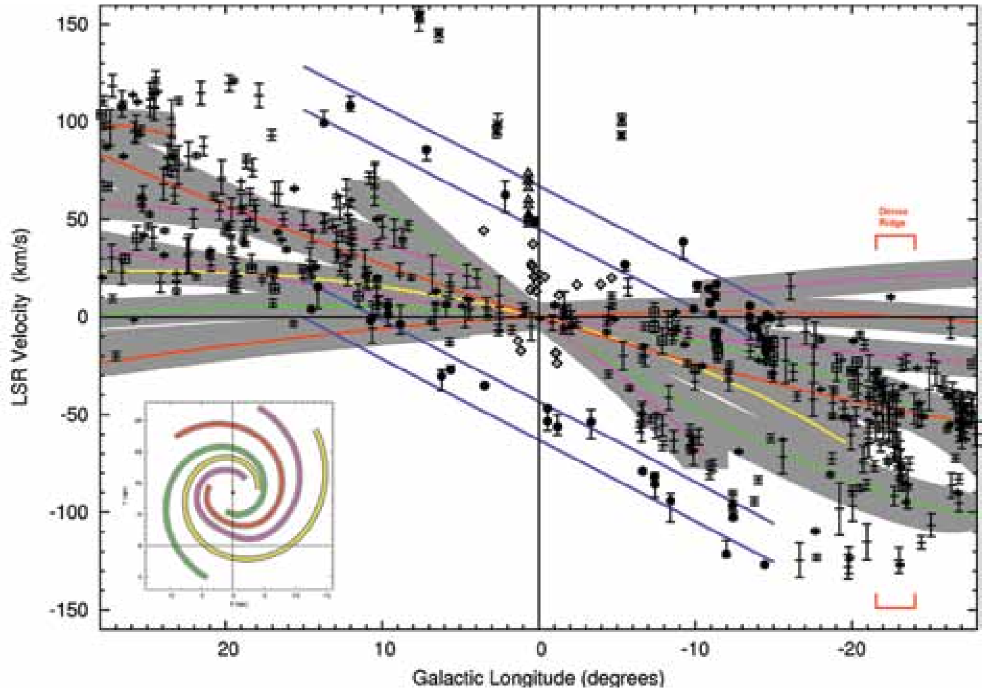


Figure 1: The distribution of 6.7-GHz methanol masers in Galactic Longitude and Local Standard of Rest velocity within longitudes ±28 degrees overlaid with example spiral arm loci (coloured loci). The grey shading represents an arm thickness of 1 kpc and a velocity tolerance of ±7 km/s. Yellow loci represent the Perseus spiral arm; Purple: Carina-Sagittarius; Orange: Crux-Scutum; Green: Norma. The blue lines delineate the region identified in CO emission as the 3-kpc arms. Crosses show 6.7-GHz methanol masers of the MMB survey. Circles are masers associated with the 3-kpc arms. Diamonds are masers which are interior to the 3-kpc arms, primarily candidates for belonging to the Galactic Centre Zone. Triangles are masers associated with the Sagittarius B2 complex. Stars are masers associated with the Galactic bar. Crosses enclosed in squares are masers with high latitudes (and therefore likely to be closer to us than 4.5 kpc). The starting points of the spiral arms have been adjusted to match the results of this study. The red brackets highlight the longitude range of the dense ridge of sources associated with the 3-kpc arm tangent.

Figure 2: Cartoon schematic of the structure of the inner Galaxy as viewed from above the Galactic plane. The black and red bars represent the long and short Galactic bars respectively, the blue ellipse the 3-kpc arm ring and the four coloured loci the starts of the four spiral arms (with colours as per Figure 1).

Over 2000 people attended *Opera at The Dish* as part of Parkes Observatory 50th Anniversary celebrations. Image credit: Tony Crawshaw

For further information:

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

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