ATNF News

Parkes Observatory Open Day

John Reynolds (ATNF, Parkes Officer-in-Charge)

Photo: Shaun Amy

John Reynolds explaining to a tour group how the telescope gears work.

On 22 and 23 September 2007 an Open Weekend was held at the Parkes Observatory, the first such event since 2004. The weekend was an outstanding success, with over 3500 visitors to the Observatory over the two days.

Once again, the highlight for many visitors was a conducted tour of the 64-m tower. Groups of 12 to 15 visitors were led through the control room and diverse nooks and crannies of the telescope that are generally inaccessible to the public. Interest in the tours was simply staggering, with the queue to join a tour exceeding an hour in waiting time at several busy points in the weekend. It was invigorating and gratifying to see at first hand the public's appetite to learn more of what we do and to see the Observatory operating close-up. This enthusiasm was clear from their patience and good humour in waiting, and from the continuous stream of excellent questions with which they peppered their guides during, before and after their tour.

Normal observing was continued throughout the weekend, giving visitors a chance to see real astronomers at work in the control room, and to get a sense of the telescope in action. Altogether almost 2000 visitors "took the tour", spread over some 150+ individual groups.

Other attractions over the Weekend featured a well-attended program of scientific talks in the Visitors Centre, and an "ask an expert" marquee where ATNF staff were on hand to answer visitors' detailed questions on Life, the Universe and Astronomy. As on previous Open Weekends, helicopter joyrides provided by Heli Services of Newcastle ran continuously over both days, taking visitors on a short overflight of the telescope. Once again this attraction proved to be extremely popular.

On Saturday night a public screening of the movie *The Dish* was held in the paddock adjacent to the Visitors Centre. It proved not possible to arrange

Photo: John Sarkissian

A view of the queue from the telescope.

moonrise to occur from behind the screen at the critical moment in the story, as we managed to do in 2001, but the audience of about 300 were nonetheless well entertained and enjoyed the experience. (Parkes has been without a commercial cinema for some years).

A new feature of the weekend was an outside broadcast by ABC Radio on the Saturday morning, with well-known local presenter Bruce Reynolds interviewing several members of staff, and visiting astronomer Willem van Straten, on details of their research and of Observatory operations. This broadcast proved not only an outstanding success in itself but provided valuable promotion of the event. Earlier in the day, John Smith had led ABC listeners through a "virtual tour" of the telescope, which also served to generate awareness of the Weekend's events.

Another innovation was participation by a number of local community groups and vendors who set up stalls and displays. Feedback from the whole event has been excellent and almost universally very positive.

The success in staging this significant piece of CSIRO outreach depended on the efforts of a

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Photo: Tom Lees

Staff members Julia Hockings and John Smith prepare another group of visitors for a tour of the telescope tower. Some 150 tour groups, totalling almost 2000 members of the public, took "the tour" over the Parkes Open Weekend

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Editorial

Welcome to the October 2007 edition of the ATNF News.

The ATNF has a strong outreach and education program and this is strengthened by the high profile and strong public interest of astronomy in Australia. Our programs aim, in particular, to attract young people into science and to build good relations with local communities. In this issue our front-page report describes a recent and extremely popular Open Weekend at the Parkes radio telescope. We also describe a new education project where ATNF staff and high school students will work together to use the Parkes radio telescope remotely for pulsar research programs, while Andrew Roberts from Muswellbrook High School describes the impact of the ATNF teacher workshops and programs on science teaching at his school. Our back cover shows a beautiful “Emu in the Sky” photograph taken by Barnaby Norris for a project, with Ray Norris, on Aboriginal Astronomy.

Our telescope facilities support a broad range of astronomical research. This issue includes reports from two major international conferences, with a week-long meeting on galaxies in the local volume, and a shorter meeting on the Magellanic System — see the article from Bärbel Koribalski on local volume galaxies. Other science reports discuss an innovative Compact Array experiment to search for neutrinos, the amazing discovery of a millisecond radio burst from an extragalactic origin, and results from the Compact Array southern sky 20-GHz survey.

The ATNF is looking ahead to the time when we will operate four major facilities, including ASKAP. See the ASKAP update by Helen Sim, and the Director’s report on planning for our future operations.

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

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News

From the Director

Brian Boyle (CSIRO ATNF Director)

One of the most pressing issues for the Australia Telescope National Facility today is to plan and implement the changes to operations necessary to implement the strategies for radio astronomy outlined in the 2006 Australian Astronomy Decadal Plan and the CSIRO Strategic Plan for 2007 – 2011. Expressed in terms of the overarching goal of the ATNF Vision Statement 2007 – 2012:

> By 2012, the Australia Telescope National Facility will be operating four world-class observatories ensuring its continued status as a leading global contributor to the understanding of the universe.

The development of a future operations model has drawn heavily on the skills and experience of ATNF staff. Two working groups in Science Operations (Chair: Jessica Chapman) and Engineering Operations (Chair: Brett Dawson) have provided extensive input to the ATNF Leadership Team. Their reports have formed the basis for decisions on the future operations model. The Leadership Team has now determined that the key elements of the future operations model will be to establish integrated operations of all four ATNF Telescopes, through:

- Restructuring operations into Science Operations and Engineering Operations. These will be set up as functional rather than regional groups;

- Establishing a Science Operations Centre (SOC) at a central location — initially at Marsfield with fully supported observing available at the SOC only;

- Streamlining supported observing modes according to scientific priorities. This will involve balancing costs against availability of observing hours, instrumentation and support.

These elements are generally consistent with the reports from the Working Groups, though in some respects the differences between current and future operations will be greater than envisaged by the Working Groups.

Having made these decisions, this marks the point when the ATNF moves from reviewing the operation of its facilities to detailed planning and implementation of the new way of operating. Detailed planning will be complete by the end of Q1 2008, with implementation beginning in mid-2008. The goal is to have the proposed operations model fully in place by mid-2010.

As we plan for the next phase of these telescopes, it is encouraging to note the continued outstanding productivity and impact of the ATNF telescopes in the recent study of astronomical publications and citations by Trimble and Ceja, reported elsewhere in this Newsletter. Maintaining this productivity while at the same time both changing the way we operate and building the Australian SKA Pathfinder is an exciting challenge for the ATNF. The key to our success is our people — the committed and passionate staff we already have, and those who are soon to join us — and also our partners and collaborators. The ATNF is currently recruiting actively, and will be seeking to fill around fifteen vacancies over the next couple of months, primarily in engineering and technical roles, project management, computing and software development. We operate in a highly competitive market place for people with these skills and as a result we will be using a variety of means including feature advertising in Australian and international media to promote interest in what we believe are some of the most challenging and rewarding jobs available.

Finally, I would like to acknowledge the scope of achievements detailed in this newsletter; the exciting and innovative scientific results, the outreach and education activities and the hosting of highly successful international conferences. Without doubt, this is an exciting time for our science in Australia. I consider myself privileged to be part of such an outstanding team.

UHE neutrino detection using the Compact Array

R A McFadden (on behalf of the whole team):
R D Ekers (ATNF), N D R Bhat (Swinburne), C W James (University of Adelaide), S J Tingay (Swinburne), P P Roberts (ATNF), C J Phillips (ATNF), R J Protheroe (University of Adelaide)

The origin of the most energetic particles observed in nature, ultra high energy (UHE) cosmic rays (CR) which have energies extending up to at least 2 x 10^20 electron Volt (eV), is currently unknown. Finding the origin of these particles will have important astrophysical implications and the key lies in observations of UHE neutrinos. A promising method for the detection of UHE neutrinos is the Lunar Cherenkov technique, which uses Earth-based radio telescopes to detect the coherent Cherenkov radiation emitted when a UHE neutrino interacts in the outer layers of the Moon. We are using the Australia Telescope Compact Array fitted with custom-built hardware to try and detect this Cherenkov emission.

Lunar Cherenkov emission produces an extremely narrow pulse (of sub-nanosecond duration) which travels through the ionosphere and experiences a frequency-dependent time delay resulting in pulse dispersion. As Cherenkov radio pulses are much shorter in time than any signals normally encountered in radio astronomy, real time de-dispersion and detection requires broadband technology and innovations to the current instrumentation.

We are taking dual polarization 600 MHz bandwidth (1.2 – 1.8 GHz) signals from the 20-cm receiver monitor point in the antenna and sampling it directly with the prototype 2-GHz Compact Array Broadband Backend (CABB) sampler board in the antenna. The first stage of our alternative signal path corrects the ionospheric pulse dispersion to maximise the received signal to noise ratio for threshold detection (Hankins et al. 1996). Signal de-dispersion is performed in analog microwave filters with a fixed dispersion characteristic. These filters were designed by Paul Roberts using a new method of planar microwave filter design based on inverse scattering (Roberts & Town 1995).

Our signal then passes into an analog-to-digital conversion (ADC) board which was developed for the CABB upgrade. The ADC board has two inputs, sampled at 2.048 Gigasamples/s, which we use to import two linear orthogonal polarisations of the 600-MHz radio frequency signal. The sampled inputs are multiplexed into parallel 512-MHz data streams for input into a Xilinx field-programmable gated array (FPGA), which performs pulse detection. Detection is performed via thresholding on both polarisation streams. The sampled data is buffered and candidate events are sent back to a central processing site via a Gigabit ethernet connection for off-line processing. The de-dispersion filters and CABB sampler boards were installed on three antennas so that coincidence testing and direction of arrival discrimination can be performed during off-line processing.

Our observations were during the nights of 5, 6 and 7 May 2007. These dates were chosen to ensure that the Moon was at high elevation (particularly during the night-time hours of ionospheric stability) and positioned such that we would be sensitive to UHE particles from the galactic centre. We are still investigating our last few candidate events and, although no detection has been made yet, the experiment was definitely a success in terms of getting our preliminary system working!

References

Hankins, T. H., Ekers, R. D., & O'Sullivan, J. D. 1996, MNRAS, 283, 1027
Roberts, P. P. & Town, G. E. 1995, IEEE Trans. Microwave Theory and Techniques, 43(4), 739

A bright millisecond radio burst of extragalactic origin

Duncan Lorimer (West Virginia University, USA), Matthew Bailes (Swinburne University), Maura McLaughlin (West Virgina University, USA), David Narkevic (West Virginia University, USA) and Fronefield Crawford (Franklin & Marshall College, USA)

Transient radio sources are difficult to detect, but can potentially provide insights into a wide variety of astrophysical phenomena. Radio pulsar surveys offer one of the few opportunities to monitor even a small fraction (~10^{-5}) of the radio sky for impulsive burst-like events with millisecond durations. Motivated by the recent discovery of rotating radio transients (neutron stars which exhibit only occasional sporadic bursts of emission) in the Parkes multibeam pulsar survey data, a team led by Duncan Lorimer at West Virginia University has been searching for transient events in a recent Parkes survey of the Magellanic Clouds. The raw data are de-dispersed to produce times series at multiple trial dispersion measures. For each time series, events which exceed six times the local standard deviation are saved for visual inspection. A highly significant signal with a peak flux of 30 Jy shown in Figure 1 was found by student David Narkevic in late 2006. The burst was so strong that it saturated the digitizers and was detected in three out of the 13 beams of the multibeam system!

Due to the anomalously high amount of dispersion, it is highly unlikely that the burst is associated with our Galaxy or the Small Magellanic Cloud, located three degrees away on the sky (Figure 2). No counterparts have been found at other wavelengths and the source has not been observed to repeat, despite an intensive 40-hour observing campaign in April 2007 led by Matthew Bailes. The lack of an optical counterpart to the burst implies that it is at least 600 Mpc distant. Using models of intergalactic dispersion, the delay we observe in Figure 1 is consistent with a cosmological event up to 1 Gpc away. The source therefore appears to represent the *first millisecond radio burst ever detected from outside our Galaxy.*

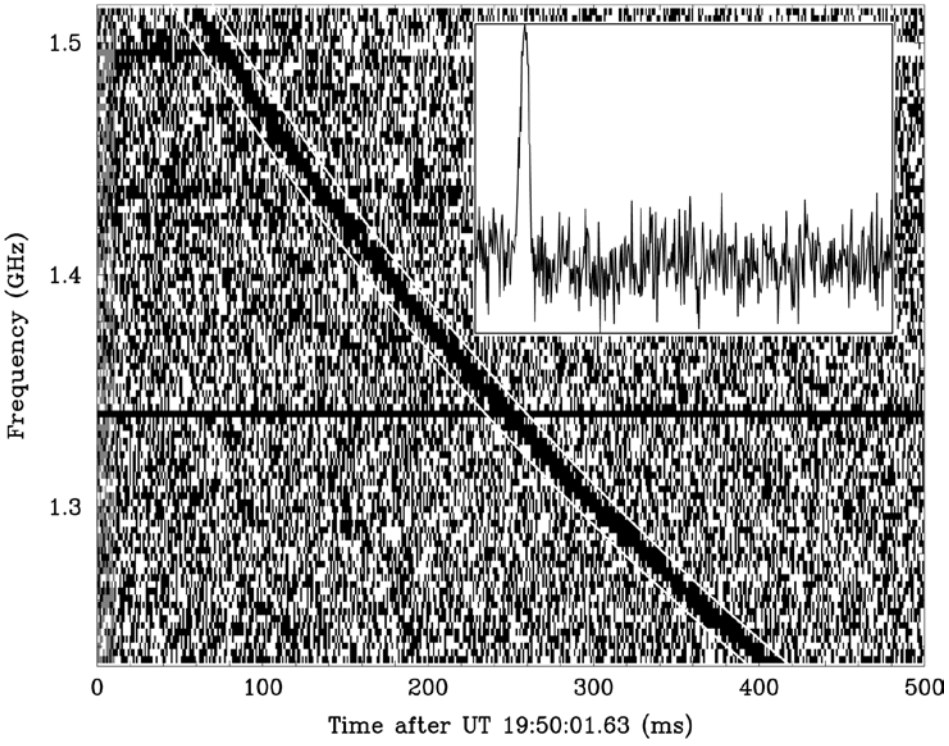

Figure 1: Frequency evolution and integrated pulse shape of the radio burst shown as a two-dimensional "waterfall plot" of intensity as a function of radio frequency versus time. Pulse dispersion is clearly seen as a quadratic sweep across the frequency band, with broadening towards lower frequencies due to scattering. The two white lines separated by 15 ms that bound the pulse show the expected behaviour for the cold-plasma dispersion law. Inset: the total-power signal after a dispersive delay correction. The time axis on the inner figure also spans the range 0 – 500 ms

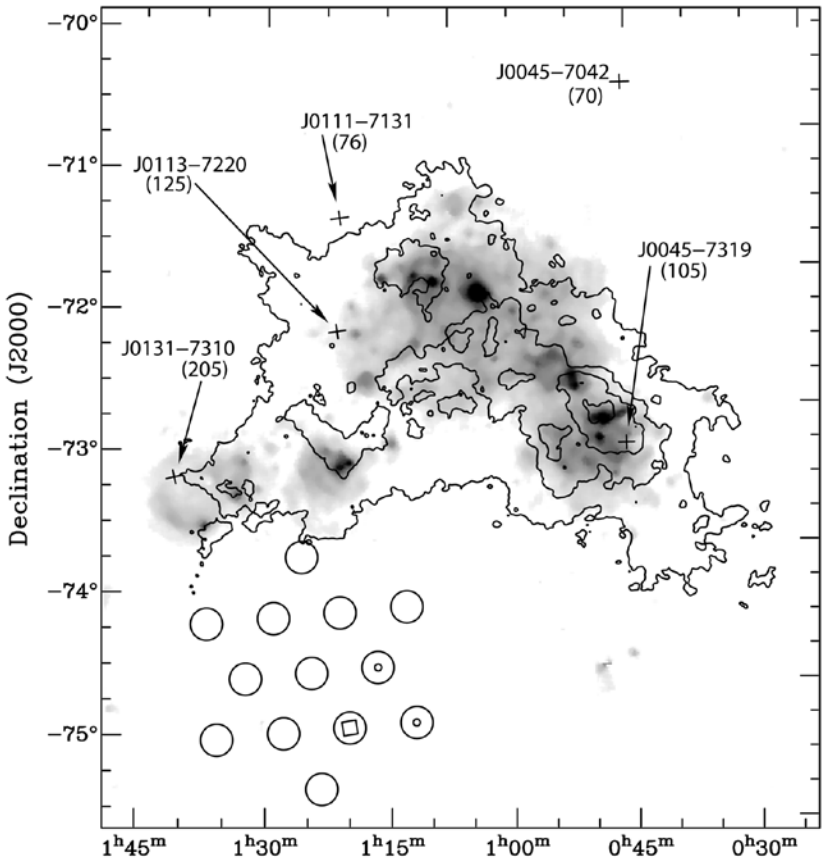

Figure 2: Multi-wavelength image of the field surrounding the burst. The grey scale and contours respectively show Hα and HI emission associated with the Small Magellanic Cloud. Crosses mark the positions of the five known radio pulsars in the Small Magellanic Cloud. Open circles show the positions of the 13 beams in the original survey pointing, with squares showing the beams in which we detected the burst.

The origin of the source is currently unclear. The energy release and brightness temperature of such a source at 1 Gpc would be ~ 4 x 10^{40} erg and ~ 10^{34} K respectively. Light-travel-time arguments limit the source size to <1500 km. These results imply, for a non-relativistic source, a coherent emission process from a compact region. Possible scenarios are that we are seeing the radio counterpart of a gamma-ray burst, or the radio signatures of a coalescing neutron star binary. One recent paper (Popov & Postnov 2007, astro-ph/0710.2006) posits that the burst could be a hyperflare from a magnetar (a neutron star with a 10^{14}- 10^{15} G magnetic field).

A key implication of the new discovery is that *many hundreds of similar bursts should be detectable each day, but the small field of view and limited temporal and spectral resolution of most radio telescopes has thus far rendered them largely invisible.*

We are currently searching archival data sets for further examples, and a team led by Matthew Bailes is using the Parkes telescope to monitor the sky in this mode by piggybacking on other observations.

Perhaps the most intriguing feature of this burst is its 30 Jy strength. While this has allowed us to make a convincing case for its extraterrestrial nature, the fact that it is over 100 times our detection threshold makes its uniqueness puzzling. Often, astronomical sources have a flux distribution that would naturally lead to many burst detections of lower significance; such events are not observed in our data. If, on the other hand, this burst was a rare standard candle, more distant sources would have such large dispersion measures that they would be both significantly red-shifted to lower radio frequencies and outside our attempted dispersion trials. If redshifts of their host galaxies are measurable, the potential of a population of radio bursts at cosmological distances to probe the ionized intergalactic medium is very exciting, especially given the construction of wide-field instruments in preparation for the Square Kilometre Array.

ASKAP update

Helen Sim (ATNF)

Coordination developments

In September the Commonwealth and Western Australian Governments jointly established a new intergovernmental body, the Australian SKA Coordination Committee (ASCC). The ASCC Secretariat sits within the Commonwealth Department of Education, Science and Training (DEST). Brian Boyle (CSIRO ATNF) and Peter Quinn (University of Western Australia) are ASCC members, representing the astronomical community. The Commonwealth and WA Governments have now signed a Memorandum of Understanding that formalises their commitment to work together, through the ASCC, to present a unified Australian position on the Square Kilometre Array (SKA).

In her statement announcing the new body, the Hon Julie Bishop, Minister for Education, Science and Training, also launched a new Australian SKA Project (ASKAP) website (*www.ska.gov.au*), which will be the public face of the project. She also announced funding of $350,000 for Questacon and Scitech (the Perth science centre) to develop education resources related to the SKA.

First-stage protection for radio quietness

The Australian Communications and Media Authority has authorised a Radiocommunications Assignment and Licensing Instruction (RALI MS 32) for the Murchison Radioastronomy Observatory (MRO) site. This RALI took effect on 24 September 2007 and provides the first stage of regulatory protection for radio-quietness over an area out to 260 km from the Observatory.

The RALI defines a Mid West Radio Quiet Zone (RQZ): in the inner zones of the RQZ (defined in terms of frequency and distance from a central point), new frequency assignments for licensed transmitters will not generally be permitted, while in the outer zones they will be coordinated to ensure adequate radio-quietness. Details can be found in the pdf file at *www.acma.gov.au/webwr/radcomm/frequency_planning/frequency_assignment/docs/ms32.pdf* .

CSIRO will work with local communities to encourage the voluntary reduction of existing radio interference. It will also monitor RFI generated by the radio astronomy projects in the RQZ and seek to enforce appropriate standards for such self-interference.

Early radio astronomy at the Murchison Radio Observatory

The new Australian SKA Coordination Committee is overseeing procedures to establish the Murchison Radioastronomy Observatory in the long term. Meanwhile, CSIRO has been provided with a Deed of License by the WA Government that will allow it to conduct and supervise low-impact radio-astronomy activities on an Early Research Area within the candidate SKA site. Archeological and anthropological surveys have been conducted over the Early Research Area with the assistance of members of the local indigenous community, and the traditional land claimants have expressed support for the deployment of the various experiments on the site. Temporary huts and other equipment to be used for these deployments were moved from the ATNF's Sydney site in October and are now safely ensconced at the MRO.

CSIRO has been working with the Murchison Widefield Array (MWA) team to plan a staged deployment of the MWA. The first 32 MWA tiles (ground planes and dipoles only) are to be set up on the site in November, and "first light" for the instrument is expected by early 2008.

Technical developments

Parkes test antenna

Components of the pedestal for the 12-m test antenna are now en route from the USA to United Infrastructure in Taree, NSW, where they will be

assembled before being shipped to Parkes. Site preparations are almost complete, with final cables and conduits to be installed in November. The antenna will be erected in mid or late December, and is expected to be functioning in March 2008.

Computing

The ASKAP computing team recently completed CP test 2, a simulation of 1 TB of the data that would come from ASKAP (about one per cent of the total), using simulated random fields as input. It followed on the heels of CP test 1, which used only a single ASKAP beam: CP test 2 used 32 beams. This latest test showed that the processing has scaled up well. The next goal is to simulate 10 TB of data. At some point it will be necessary to change the internals of the processing algorithm, both to increase its speed and to keep the operating costs of ASKAP computing reined in.

General developments

Analysis of design options for the ASKAP antennas — the mounting, focal ratio, optical design, size and material — is continuing. A series of white papers on the options will be written within the next few weeks, and we will then begin discussing the options with industry. Similarly, before the end of the year we will be engaging industry in discussion about the options for deploying optical fibre.

Feeds and amplifiers are now being integrated. The integrated components will be tested on the New Technology Demonstrator (NTD) and then on the new 12-m antenna at Parkes. Initial tests on the prototype feed at Marsfield show good performance that matches the modelling.

The project master plan for ASKAP will be in place by the end of this year, along with a first draft of the project book that will begin to assemble the detailed workpackages needed for the construction.

Australian SKA Industry Consortium

The Australian SKA Industry Cluster has been re-formed as the Australian SKA Industry Consortium. The consortium now comprises 14 sponsoring companies, who have agreed on an agenda of promotional activities for industry and Australia's SKA bid over the coming year.

On Monday 22 October 2007, 16 members of the Australian SKA Industry consortium, along with two key CSIRO ATNF operations staff (Dave McConnell and Brett Dawson) visited the JORN coordination facility, at RAAF base, Edinburgh in South Australia. Noel Wainwright (RLM) kindly arranged for the special tour of the nerve centre of Australia's major marine radar surveillance system. All participants agreed it was a very interesting facility, demonstrating Australia's ability to build, operate and maintain complex, remote infrastructure.

After the tour, RLM generously hosted lunch at their headquarters. A full consortium discussion meeting followed, with much interest on the new ASCC committee and the formalisation of the MOU between the Federal and WA State Government.

Later that afternoon, an open industry briefing session was held at the Technology Park's Conference Centre in Mawson Lakes. This event was attended by more than 60 industry personnel, many of whom are network members of the event sponsor, the Defence Teaming Centre. Air Vice-Marshall Roxley McLennan AO gave the key note address noting the similarities between Defence mega-projects and the technological pay-back in designing and operating the SKA over a 30+ year lifetime. All presentations from this session are available on-line at *www.atnf.csiro.au/projects/ska/cluster_presentation.html.*

Galaxies in the Local Volume

Bärbel Koribalski (ATNF)

The international conference "Galaxies in the Local Volume" focussed on the distribution, kinematics and star formation of galaxies that reside within 10 Mpc. This included high-resolution multi-wavelength ISM studies as well as simulations of individual galaxies and galaxy groups.

The conference was held on 8 – 13 July 2007 at the Australian National Maritime Museum in Darling Harbour, Sydney. The venue is located in close proximity to the Sydney Convention & Exhibition Centre, where the IAU General Assembly was held in July 2003.

About 130 participants from around the world provided an exciting and enjoyable forum for presentations and discussions of the latest results on all aspects, observational & theoretical, of nearby galaxies. A big THANK YOU to the SOC and all participants.

The Proceedings of the symposium, including most talks and posters, have been submitted to Springer and will be published early in 2008.

For the meeting website please see *www.atnf.csiro.au/research/LVmeeting/*.

Photo: Ángel R. López-Sánchez

Participants at the conference: From left to right — Helmut Jerjen, Brent Tully, Emma Kirby and Patrick Woudt.

The Elizabeth and Frederick White conference on the Magellanic System

Erik Muller (ATNF)

Photo: Ángel R. López-Sánchez

Group photo of the attendees of the conference.

Following hot on the heels of the 2007 Astronomical Society of Australia and the Galaxies in the Local Volume conference was the "Elizabeth and Frederick White Conference on the Magellanic System". This was hosted at the ATNF on 16 – 17 July 2007 and funded by the Australian Academy of Science. The conference drew together approximate 60 delegates from around the world to report on their latest research of the Magellanic System.

Studies over a wide range of observable wavelengths were reported, with some focus given by invited speakers to present some reviews or particularly unique projects (e.g., observations by the LMC-SAGE consortium). To keep the spirit of controversy alive, the conference also included a number of theoretical reports, upsetting our ideas of the origins and evolution of the Magellanic System.

The conference would not have happened without the generosity of the Elizabeth and Fred White funding, which was much appreciated. Thanks go to all attendees, and especially the invited speakers. Also the SOC, the LOC, Shaun Amy for taking time out to help with the Lecture Theatre and Sylvia for providing delicious lunches.

A number of reports by the key speakers will be published in PASA. Most of the presented talks are available online at *www.atnf.csiro.au/research/LVmeeting/mag_program.html*.

New ATNF postdoctoral fellows

Bärbel Koribalski (ATNF)

We are pleased to announce the arrival of six new postdoctoral fellows at the ATNF. Tobias Westmeier is the new Bolton Fellow, while Patrick Weltevrede and Ángel López-Sánchez are the new OCE (Office of the Chief Executive) Postdoctoral Fellows. Neeraj Gupta, Hiroyuki Nakanishi and David Champion are working with the Science Leaders and Federation Fellow, Dick Manchester, respectively.
Welcome !

Dr Tobias Westmeier (Bolton Fellow)

Tobias Westmeier has been awarded the 2007 ATNF Bolton Fellowship and joined the Astrophysics Group in July. Tobias defended his PhD in June 2007 at the University of Bonn, Germany. He is an expert on High Velocity Clouds (HVCs) and plans to search for these around nearby galaxies. Tobias is well known for his multi-frequency work on HVCs in the Galaxy, Andromeda (M31) and M33.

Dr Patrick Weltevrede (OCE Postdoctoral Fellow)

Patrick Weltevrede has been awarded an OCE Postdoctoral Fellowship for pulsar research. He joined the ATNF Astrophysics group in July 2007, having recently obtained his PhD from the University of Amsterdam. His project is to obtain regular timing observations of young and energetic pulsars in support of the NASA GLAST (gamma-ray) mission. With the help of the radio observations, the mission should increase the number of known gamma-ray pulsars from seven to over 100. He will be working in close collaboration with Simon Johnston and Dick Manchester.

Dr Ángel R López-Sánchez (OCE Postdoctoral Fellow)

Ángel R López-Sánchez has been awarded an OCE Postdoctoral Fellowship to work on the "Evolution of Galaxies". He joined the ATNF Astrophysics group in June 2007. Ángel will be working on a multi-wavelength analysis (optical, infrared and radio) of starburst and interacting galaxies and will study the evolution of galaxies in close collaboration with Dr Bärbel Koribalski, Prof Ron Ekers and Prof Brian Boyle. He recently joined the "Local Volume HI Survey" (LVHIS) project, led by B Koribalski, and helped with the organization of the "Galaxies in the Local Volume" symposium. Angel completed his PhD in December 2006 at the University of La Laguna and the IAC on Tenerife, Spain.

Dr Neeraj Gupta

Dr Neeraj Gupta joined the ATNF in August 2007, immediately after obtaining his PhD from the Tata Institute of Fundamental Research, India. His research interests include topics related to active galactic nuclei and their environments, quasar absorption lines and outflows, and radio astronomy techniques. At the ATNF he is working with Dr Simon Johnston as part of the ASKAP team to optimise the design and configuration of the telescope principally through simulations of the telescope's response to a number of key astronomical science targets.

Dr Hiroyuki Nakanishi

Dr Hiroyuki Nakanishi joined the ATNF in June 2007 as a postdoctoral fellow working with Naomi McClure-Griffiths. Hiroyuki's research interests are in the area of atomic and molecular gas disks in the Milky Way and nearby galaxies. Hiroyuki completed his PhD at the University of Tokyo in 2005 and held a postdoctoral position at Nobeyama Radio Observatory before coming to the ATNF. Shortly after joining the ATNF, Hiroyuki was offered a position as Assistant Professor at Kagoshima University in Japan. He left ATNF in October to take up this position. We wish Hiroyuki well in his new position and look forward to continuing our collaboration on the Galactic All-Sky Survey

Dr David Champion (Pulsar Postdoctoral Fellow)

David Champion obtained his PhD from Manchester University (Jodrell Bank), UK in August 2005. He had a postdoctoral fellowship at McGill University, Canada before joining the ATNF in September 2007. David is working with Dick Manchester and George Hobbs on the Parkes Pulsar Timing Array project to detect gravitational radiation using pulsars.

Tobias Westmeier

Patrick Weltevrede

Ángel R. López-Sánchez

Neeraj Gupta

Hiroyuki Nakanishi

David Champion

ATNF Distinguished Visitors

Robert Braun (ATNF)

Over the past months we have enjoyed working visits from Igor Karachentsev (SAO Russia) in July, Martin Cohen (UC Berkeley) in July/August and Ralf-Juergen Dettmar (Ruhr-University Bochum) in August/September. Current visitors include Bill Coles (UC San Diego), Phil Kronberg (University of Toronto/LANL) and Marijke Haverkorn (NRAO/UC Berkeley) all through December 2007.

The Distinguished Visitors program remains a very productive means of enabling collaborative research projects with local staff, adding substantially to the vitality of the ATNF research environment. Prospective visitors should contact the local staff member with most similar interests for more information.

The Emu in the Sky and other stories

Ray Norris (ATNF)

When Europeans arrived in Australia in 1788, their navigators probably knew less about the southern sky than many of the Aboriginal people that they drove from their land. Sadly, nobody thought to ask. The British occupying force wasn't interested in the many rich and vibrant Aboriginal cultures, each with its own customs, folklore, and language. Only recently have most of us appreciated the deep vein of astronomy threading through the Aboriginal stories and ceremonies.

For example, many Aboriginal groups have stories about the "Coalsack" — the famous dark cloud next to the Southern Cross. Some see it as the head of a lawman, or a possum in a tree, but many groups tell stories of a great emu whose head is the Coalsack, and whose neck, body, and legs are formed from dust lanes stretching across the Milky Way. It's easy to make out the emu in a dark autumn sky, and once you've seen it, the Milky Way will never look the same again. This "Emu in the Sky" has became an icon of the Australian SKA Pathfinder (ASKAP) project.

The Aboriginal Astronomy project aims to study stories like this in a systematic way, and to explore the importance of astronomy in Aboriginal cultures. The project has two parts. One is to examine the culture of Aboriginal people, such as the Yolngu people in Australia's top end, whose culture is thriving, and who can tell us about the role that astronomy plays in their culture. A few weeks ago we were privileged to be invited to visit the remote Yolngu community of Dhalunbuy. There, an elder told us a story of the evening star, whose appearance signals the time to collect Raika nuts, and showed us an "evening star rope" made of stringy vine and possum fur decorated with the nuts. It was a memorial made at the time of death of his grandmother, and is still used in modern funeral ceremonies to establish contact with ancestors. Little of this is known to western science or ethnology.

The other part of the project is to study the artefacts of those Aboriginal cultures whose culture was badly damaged by the arrival of Europeans 200 years ago. As part of this project, we are studying a 50-metre stone circle in Victoria which appears to be aligned on the equinox and solstice sunsets, and we are trying to understand a possible lunar calendar in South Australia. Closer to home are thousands of rock engravings around Sydney, most notably in Ku-ring-gai Chase National Park, just 20 km north of Sydney. Amazingly, many Sydneysiders are unaware of this beautiful sacred art on their doorstep, showing animals, people, creator spirits, and strange symbols whose meaning is unknown. It has been suggested that some engravings may be astronomical, and may even represent constellations.

However, while many sites have been recorded, few have been reliably surveyed, and most records consist of no more than a hand-drawn sketch, inevitably reflecting the preconceptions of the recorder. For example, a crescent may be drawn by an archaeologist as a boomerang, and by an astronomer as a crescent moon. Instead, a serious study needs an unbiased photographic record. Such a record also has value for future generations who may not be able to see the real thing, as the engravings are rapidly being destroyed by acid rain.

However, photographing them is tricky. The grooves are shallow and frequently obscured by natural undulations in the rock. Received wisdom is to photograph them at sunrise or sunset, when the low angle of the Sun outlines the grooves with shadows. But we can't always wait for sunset, and even then the resulting photo is likely to be marred by shadows of nearby trees.

Instead, Barnaby Norris and I decided to replace the Sun by a 1000 Joule studio flash (emitting something like 1MW of light), together with batteries and an inverter for use at remote sites. Three telescopic pool poles were used to construct a tripod five metres high, from which we suspend a remotely-operated digital SLR camera vertically above the engraving. Further image processing, sometimes including spatial filtering, then clearly shows up the engravings.

One of the most beautiful sites in Ku-ring-gai Chase National Park, close to the Elvina Track, features a finely engraved emu. A few years ago, Hugh Cairns of Sydney University pointed out that this engraving looks more like the Emu in the Sky than a real emu. Furthermore, the Aboriginal artists oriented the engraving to line up with the Emu in the Sky just when real-life emus are laying their eggs. To illustrate this, we decided to take a photo of the engraving with the Emu in the Sky correctly positioned above it. Our low-angle flash technique took care of the engraving, but what about the sky?

Since the night sky at the Elvina Track site is now ruined by the streetlights of Sydney, we decided to photograph it from Siding Spring Mountain.

A further challenge is that the emu stretches half-way across the sky, so doesn't fit in the field of view of a normal lens. A fish-eye lens on an equatorial mount would do the trick, but would distort the image, preventing a realistic comparison with the engraving. So instead we made a mosaic of smaller images that could be stitched together in software. Furthermore, by taking a series of short exposure images, we wouldn't need an equatorial drive, as we could correct for sky rotation in software.

Having taken the photos, Barnaby spent two months stitching the hundreds of images together, working out how to correct for the distortions and sky rotation while keeping the shape true to the projection seen by the human eye from the Elvina Track site. The result was magnificent (see back cover of this newsletter) and in August won Barnaby a $2000 prize in the New Scientist Eureka science prizes.

More information on the Aboriginal Astronomy project and on the Sydney Rock Engravings can be found on *www.atnf.csiro.au/research/AboriginalAstronomy/* and *www.atnf.csiro.au/people/rnorris/SydneyRockArt/* respectively.

Articles

The Local Volume HI Survey (LVHIS)

Bärbel Koribalski (ATNF), Nic Bonne (RSAA, ATNF), Emma Kirby (RSAA, ATNF), Janine van Eymeren (University of Bochum, Germany; ATNF), Angel Lopez-Sanchez (ATNF), Erwin de Blok (University of Capetown, South Africa), Helmut Jerjen (RSAA), Igor Karachentsev (SAO, Russia), Jürgen Ott (NRAO, USA), and Lister Staveley-Smith (UWA)

Introduction

The "Local Volume" — the sphere of radius ~10 Mpc centered on the Local Group — includes at least 500 known galaxies. The fact that we can obtain (a) accurate velocities and independent distances for all its member galaxies, (b) the most detailed and sensitive multi-frequency observations, and (c), as a result, a complete census of the Local Volume (LV) galaxies and their properties makes this volume very special. Together these data allow us to create a dynamic 3D view of the Local Universe, leading to a thorough understanding of, e.g., the local Hubble flow and its dispersion as well as the local matter and star formation density. Interferometric HI measurements in particular give us a detailed view of the overall matter distribution (baryonic and non-baryonic) in the Local Volume and are crucial to accurately define the low-mass end of the HI mass function.

Reliable, independent distance estimates for LV galaxies are being gathered either from the luminosity of Cepheids, the tip of the red giant branch, or surface brightness fluctuations. These are listed in *A Catalog of Neighboring Galaxies* by Karachentsev et al. (2004) together with the optical and HI properties of 451 LV galaxies. As more local galaxies are discovered regularly, this number is steadily increasing and closer to 550 LV galaxies at the time of writing this report. To expand and deepen our knowledge of the nearby Universe several teams are currently targeting LV galaxies. In the following we list the currently on-going interferometric HI surveys of nearby galaxies. Their aims and latest results were presented by the respective Principal Investigators at the symposium on *Galaxies in the Local Volume* (Sydney, July 8-13, 2007).[1]

- the Local Volume HI Survey (LVHIS; PI: Bäerbel Koribalski);
- the *Faint Irregular Galaxies GMRT Survey* (FIGGS; PI: Ayesha Begum);
- The *HI Nearby Galaxy Survey* (THINGS; PI: Fabian Walter);
- *Little THINGS* (PI: Deidre Hunter); and
- the VLA-ANGST HI Survey (PI: Jürgen Ott).

The *Westerbork HI survey of spiral and irregular galaxies* (WHISP; Swaters et al. 2002, Noordermeer et al. 2005) contains good HI data for around 60 Local Volume galaxies.

LVHIS observations and results

Using the Australia Telescope Compact Array (ATCA), the LVHIS team is producing detailed HI distributions, mean HI velocity fields and 20-cm radio continuum maps for a complete sample of more than 70 southern galaxies selected from HIPASS (see, eg., Koribalski et al. 2004). Each galaxy is typically observed for 3 x 12 hours in total, using different array configurations, to achieve good *uv*-coverage (out to 1.5 km baselines), medium resolution ~ 40", 4 km s^{-1}) and high sensitivity (1 mJy $beam^{-1}$). In some cases we will be able to make high-resolution (~10") images using all ATCA baselines to 6 km. The low-resolution ATCA observations are now complete and the results, in particular the HI moment maps of all observed galaxies, are displayed on the web at *www.atnf.csiro.au/research/LVHIS*.

The LVHIS project goals are:

(1) Investigation of **local galaxy environments**: using HI synthesis observations we trace the faint outer envelopes of the known LV galaxies as well as detect their low-mass companions down to HI

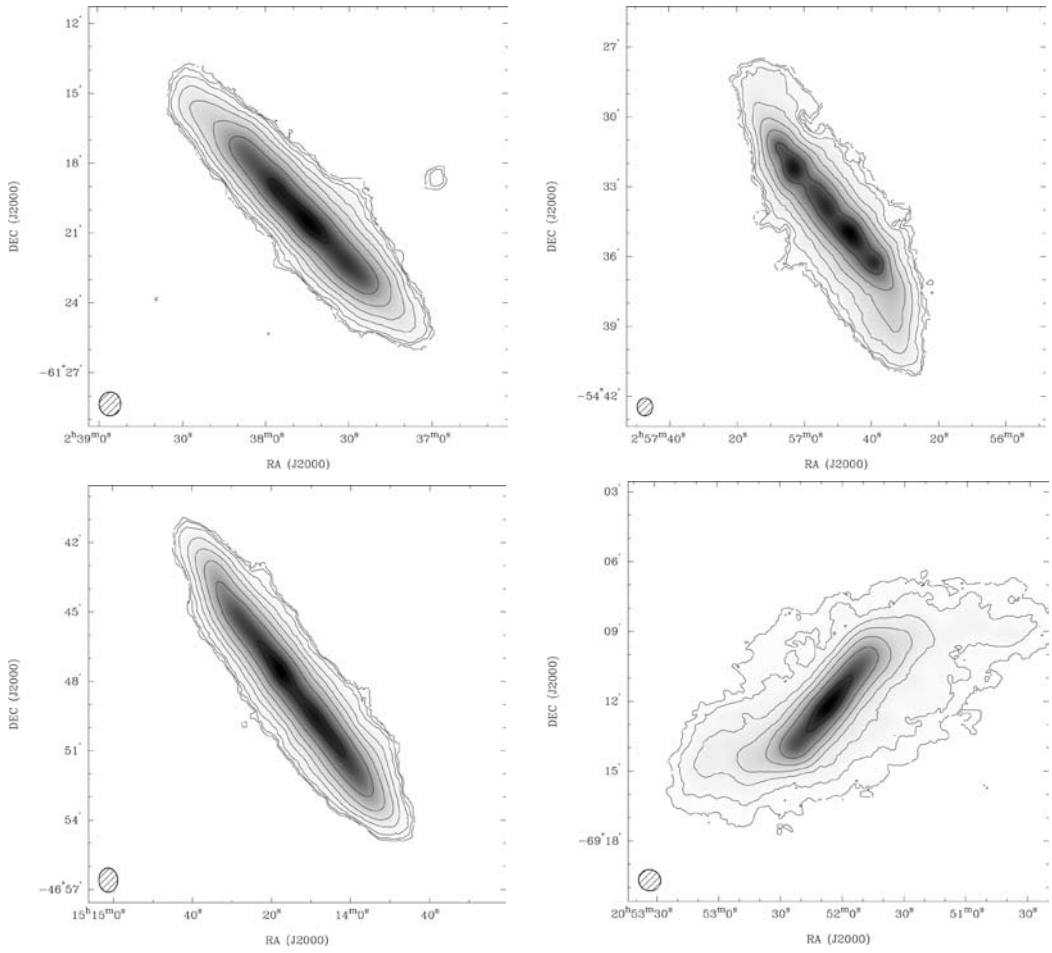

Figure 1: ATCA HI distributions of four nearby, edge-on galaxies obtained as part of the LVHIS project: ESO115-G021 (top left), ESO154-G023 (top right), ESO274-G001 (bottom left), and IC 5052 (bottom right).

mass limits of 10^4 x D^2 $M_\odot$ (see, e.g., Figure 1). We are also searching for neutral gas that is not taking part in the regular galaxy rotation, e.g., high velocity clouds and tidal streams. So far, only a few previously uncatalogued galaxies have been found while asymmetric gas envelopes are common. Several results have been shown in Koribalski (2006).

(2) Determination and analysis of HI **rotation curves**: these will allow us to estimate the total mass and therefore the dark matter content of individual LV galaxies and trace virtually all of the galactic dark matter in the Local Volume. We will take into account the influence of non-circular motions on the shape of rotation curves and explore a variety of models that optimally fit the best-determined curves. This work is carried out by Nic Bonne and collaborators.

(3) Determination of the true **Tully-Fisher** (TF) relation (including the baryonic TF): this will be achieved using independent distances, well-determined HI rotational velocities and a homogeneous set of optical and infrared magnitudes. The analysis of deep AAT H-band images, so far obtained for 56 LV galaxies, and the determination of the TF relations is carried out by Emma Kirby and collaborators.

(4) Determination of the HI **mass function** for the Local Volume: by obtaining accurate HI masses for a complete sample of nearby galaxies with well established distances, we can significantly improve our knowledge of the faint end of the HI mass function (see also Kovac 2007).

(5) Estimate of accurate **star formation rates** (or upper limits) for the sample from the 20-cm radio

continuum flux density to equally faint limits (2×10^{-5} D^2 $M_\odot$ yr^{-1}). These will be compared to SFR estimates obtained from SINGS (Kennicutt 2003) and enable us to investigate on which scales the radio-infrared correlation breaks down. We will be able to estimate the overall SFR density at z = 0 and compare it with values measured at other wavelengths.

In Figure 1 we show the HI distributions of four edge-on galaxies in the Local Volume, observed with the Australia Telescope Compact Array (ATCA) as part of the LVHIS project. A detailed analysis of these galaxies will be published shortly by Koribalski and collaborators.

ESO115-G021 (HIPASS J0237–61, D = 4.66 Mpc) is a beautiful edge-on galaxy with significant star-formation along its thin disk. We note that the main concentration of stars is offset (to the NE) from the galaxy centre. In the deep ATCA HI images we detect a dwarf companion (v_{sys} = 508 km s^{-1}; M_{HI} = 4.5×10^5 $M_\odot$) at a projected distance of 6.0 arcmin or ~8 kpc. Some disturbance of the ESO115-G021 disk can be seen in the vicinity of the companion, possibly indicating tidal interaction.

ESO154-G023 (HIPASS J0256–54, D = 5.55 Mpc) is another remarkable galaxy. It shows a double-sided warp which commences outside the optical disk. The SINGG Hα image reveals HII regions in the inner disk.

ESO274-G001 (HIPASS J1514–46, D = 3.02 Mpc) is a large edge-on galaxy, slightly obscured by Galactic dust and foreground stars (A_B = 1.1 mag at b = 9.3 degrees). The HI distribution and velocity field of this galaxy are remarkably symmetric.

IC 5052 (HIPASS J2052–69, D = 6.03 Mpc) is the most surprising galaxy in this sample of nearby edge-on galaxies. While optical and infrared images show a rather flat, edge-on disk, the observed HI distribution indicates an extended and highly warped gaseous disk.

Given the similarity and relative isolation of all four galaxies, it will be interesting to investigate what determines the extent and shape of their gaseous disks and the location of star forming regions.

In summary, we have briefly outlined the goals and status of the "Local Volume HI Survey" (LVHIS) project, and shown a few examples of the gaseous disks of nearby edge-on galaxies. The main characteristic of the LVHIS project is the delivery of homogeneous HI and radio continuum datasets for a **complete** sample of Local Volume galaxies (D < 10 Mpc). These datasets have high sensitivity, moderate to high angular resolution, and excellent velocity resolution. We are investigating the environments of the LV galaxies, their HI rotation curves and overall mass distribution, their star formation rates, as well as the (baryonic) Tully-Fisher relation and the HI mass function.

ATCA observations for the survey are on track to be finalised in 2008, but further observations with the GMRT, WSRT and the VLA are needed to complete the census of Local Volume galaxies. All-sky and deep HI surveys planned with the Australian SKA Pathfinder (ASKAP), a large interferometer to be located in Western Australia (see Johnston et al. 2007) will provide the next step in our understanding of the Universe.

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[1] The proceedings of the symposium on *Galaxies in the Local Volume,* eds. B.S. Koribalski & H. Jerjen, Springer Astrophysics & Space Science are in press.

The Australia Telescope 20 GHz (AT20G) Survey: The Bright Source Sample

Marcella Massardi (SISSA/ISAS, ATNF) and Ronald D Ekers (ATNF): on behalf of the AT20G group

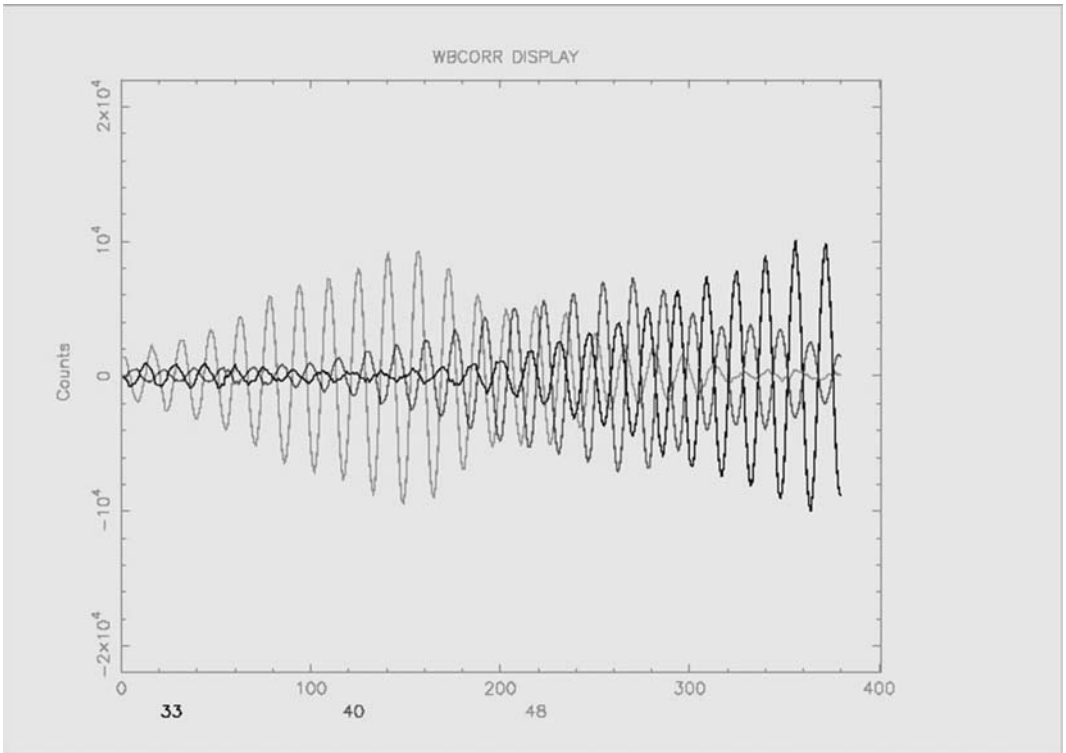

Figure 1: Fringes from a transit calibrator during the AT20G blind scan runs

The AT20G Survey: A blind scan of the Southern sky

The Australia Telescope Compact Array (ATCA) has recently completed a blind survey of the whole southern sky at 20 GHz. This is called the AT20G Survey.

Knowledge of high-frequency radio source populations has been limited and mainly based on extrapolation of low-frequency surveys, small-area surveys, or whole-sky, low-sensitivity observations. High-frequency, high-sensitivity surveys are usually very time-consuming.

The AT20G survey exploited the ATCA's fast scanning capabilities and used an 8-GHz bandwidth analogue correlator installed on three ATCA antennas (the use of the wideband analogue correlator for the 20-GHz survey was discussed by Staveley-Smith and Wilson in the *ATNF News* October 2002). The scanning strategy was unusual because the wideband correlator had no pathlength compensation and all scans were made along the meridian, orthogonal to the East-West baselines used.

10- or 15-degree wide declination strips were scanned using a whole Earth rotation to cover all the right ascensions in a zig-zag pattern. Each declination strip required several days to be completely covered by moving the scanning path half a beamwidth apart from day to day. Scans were made at a rate of 15 degrees per minute. Along each scan a sample is collected every 54 ms (corresponding to 3 samples per beam), reaching an rms noise of 12 mJy. Since we were operating like a transit telescope we could not break the scan to calibrate without leaving a gap in the sky coverage. Hence once per day between scan changes we inserted a "transit" calibrator which produced fringes

sequentially in each delay channel as it transited through the beam (see Figure 1). This event was the most exciting time every day! In subsequent processing the calibration was improved in a boot-strapping process using the data of all known calibrators found serendipitously in the blind scans. Candidate sources in the scans are identified using special purpose software.

Shortly after the end of each declination zone we generated candidate source lists and conducted follow-up observations at 20 GHz using the normal ATCA digital correlator and one of the hybrid telescope configurations. Within a couple of weeks, we also observed all the confirmed sources at 4800 MHz and 8640 MHz to study their radio spectral properties before they had time to vary.

We have developed a fully automated custom analysis pipeline based on Miriad tasks to edit, calibrate, and reduce the data for all the follow-up observations. This procedure has been developed to ensure consistent data quality in the final catalogued data. After an initial manual inspection of the data to flag any bad periods, the pipeline generates the calibration solutions, calibrates the data and estimates source parameters and errors. The final result is a list of confirmed sources with all the available information and images in total intensity and polarisation for each epoch and for each frequency.

The survey began in 2004 and now covers the whole southern sky, down to a flux limit of 50 mJy at 20 GHz. In its final form it will include about 6000 sources south of declination 0 degrees. Our analysis of the last observed declination strip, -15 deg < δ < 0 deg, which was just completed, is still on-going.

A number of related projects studying several aspects of the properties of extragalactic and galactic 20-GHz sources are underway. Ultra-compact HII regions have been identified among the galactic sources, and 3- and 7-mm ATCA observations have been obtained (Murphy et al., in preparation). For the extragalactic sources we also have 7- and 3-mm

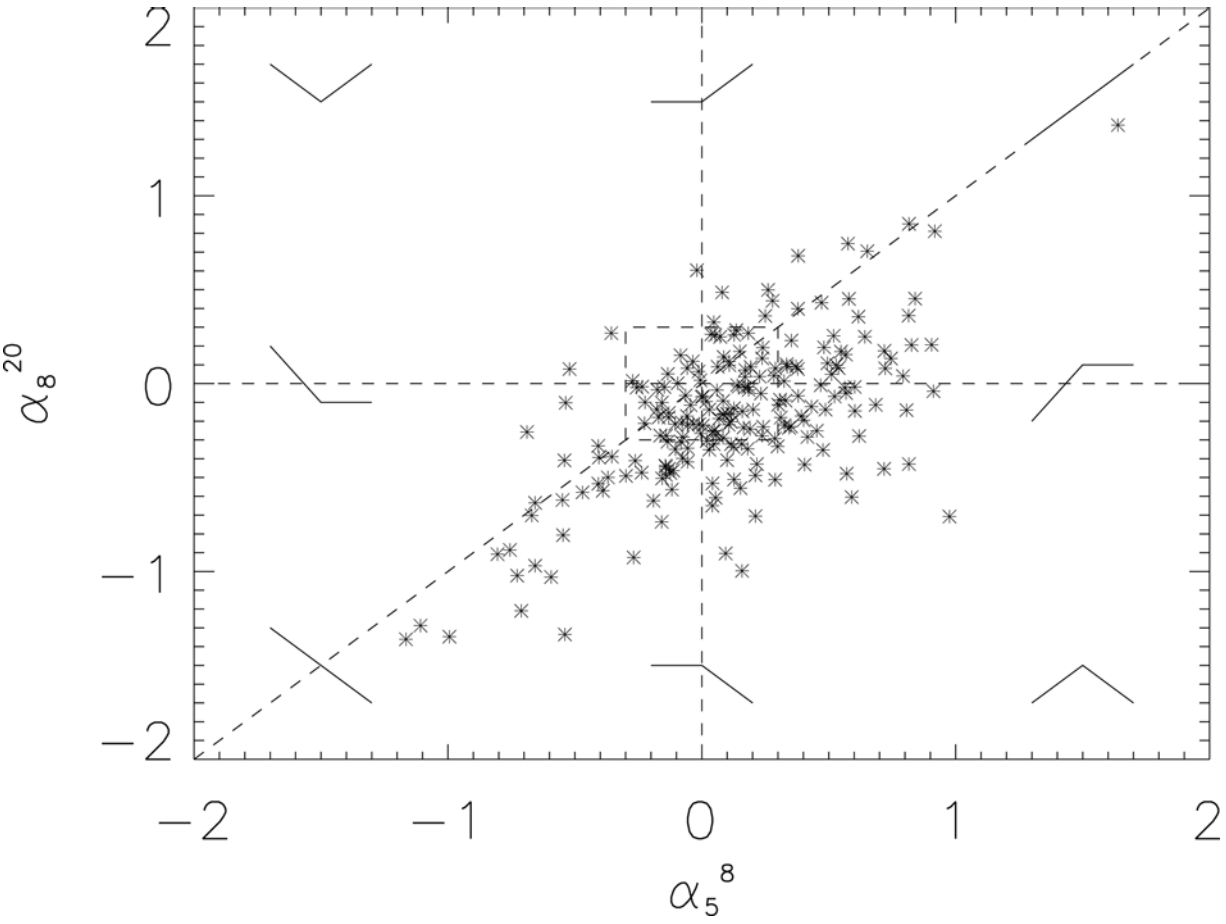

Figure 2: Colour-colour radio plot for the 218 sources with 20-GHz flux densities of > 0.5 Jy with near-simultaneous observations at 20, 8 and 5 GHz.

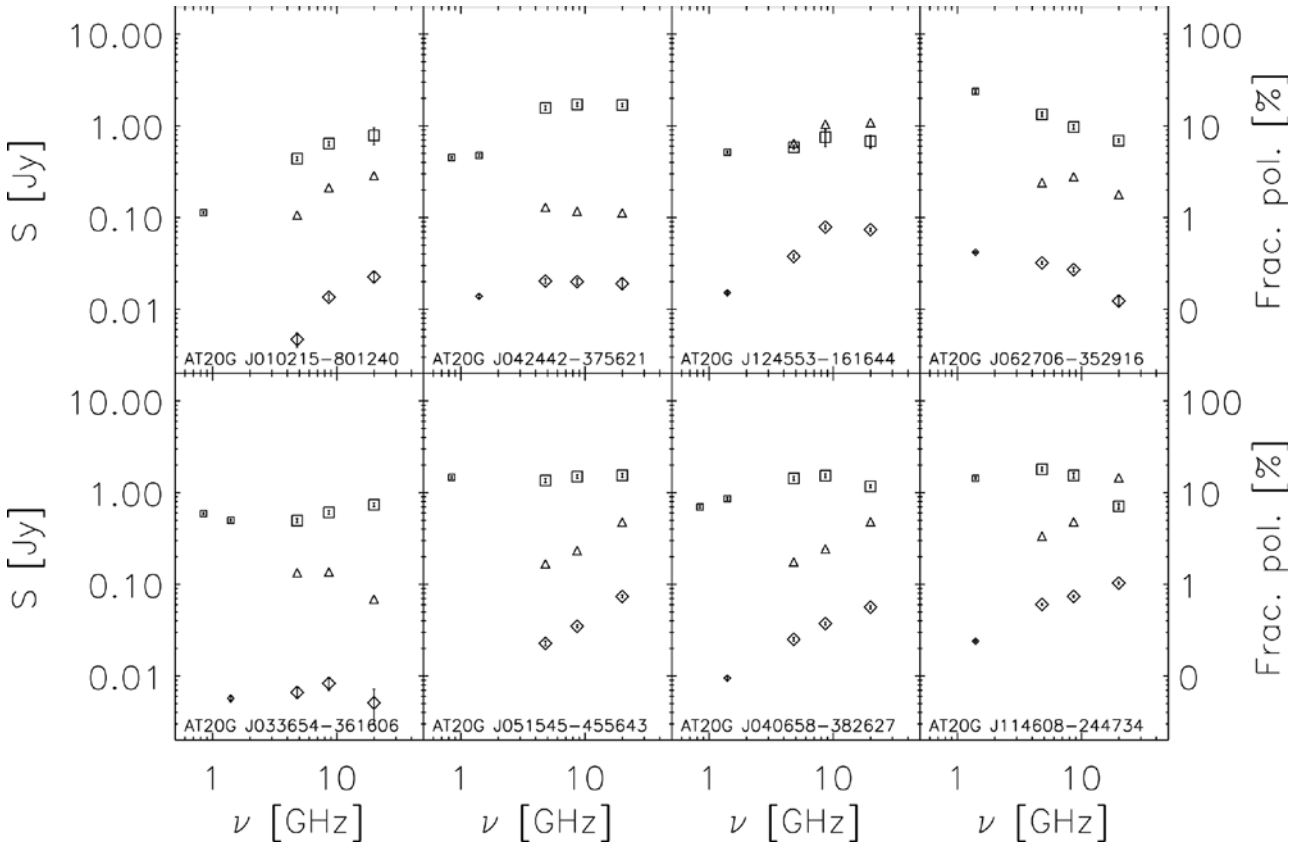

Figure 3: Some spectra as examples of the large variety of spectral behaviour in total intensity (squares) and polarisation (diamonds) for a set of point sources. The triangles correspond to the fraction of polarisation. The low-frequency values refer to data from the SUMSS (0.843 GHz) and NVSS (1.4 GHz) catalogues in total intensity (small squares) and, where available, polarisation (small diamonds)

observations (Sadler et al., 2007), and we are studying their polarisation properties (Burke et al., in preparation) and variability. A paper describing the methods for the blind scan observations and a web access tool to the survey results for any position on the southern sky are in progress. The full sample will be published next year.

The Bright Source Sample

The Bright Source Sample (BSS) is a complete and flux-limited subsample of 320 extragalactic (|b| >1.5 deg) radio sources south of declination -15 degrees which have 20-GHz flux densities above 0.5 Jy. We have analysed this subsample in detail before embarking on the full 6000 source sample. For 218 sources we have near-simultaneous observations at 4.8 and 8.6 GHz (for a more detailed description see Massardi et al. 2007).

The colour-colour plot (Figure 2) is the comparison of spectral indices (α, assuming $S \propto \nu^{\alpha}$) at low and high frequencies: it shows the variety of radio source spectral behaviours. The broad distribution of sources in the diagram is also clear evidence of the unreliability of simple extrapolation to high frequency using low-frequency spectral indices only and assuming a simple power law spectrum.

The sample is composed mainly of flat-spectrum sources (85% of them have α (8.6 – 20 GHz) > –0.5). A small fraction have normal spectra and extended lobes at 20 GHz. There is an overall steepening towards the higher frequencies (see the large number of sources with α (8 – 20 GHz) < α(5 – 8 GHz) in Figure 2).

213 of the BSS sources had a polarisation detection at 20 GHz. The median fractional polarisation for this 20-GHz sample increases with frequency from 1.7 and 2.0% at 4.8 and 8.6 GHz, respectively, up to 2.5% at 20 GHz. The spectra obtained simultaneously (Figure 3) show that there is no clear relation between the spectral properties of the

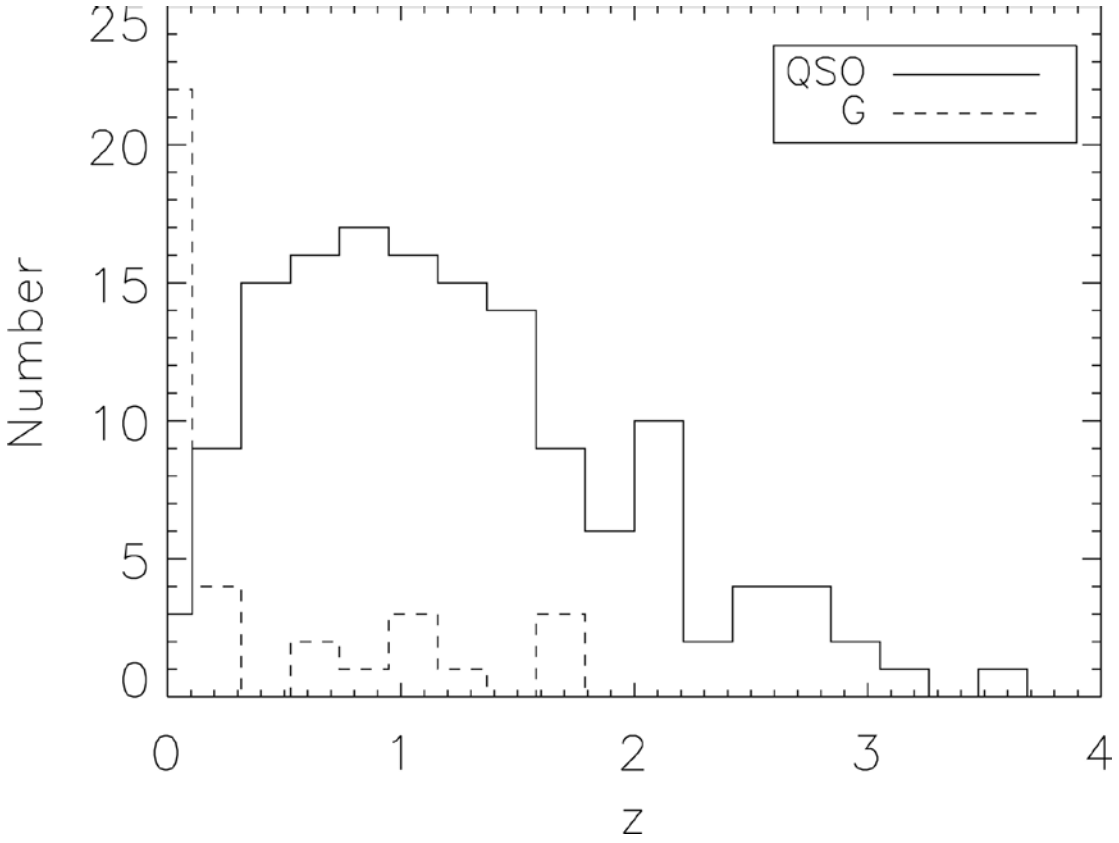

Figure 4: Redshift distribution

sources and their polarised flux. A number of different mechanisms are involved: Faraday depolarisation, multiple components with different spectra and optical depth.

240 BSS of the 251 sources with |b| > 10 degrees have an identification in optical bands (SUPERCosmos database) and a redshift estimate is available for 186 sources. The median redshift of the BSS is 1.20 for QSOs and 0.13 for galaxies (Figure 4).

This survey will be of crucial interest for the next generation telescopes, to provide good calibrators, and for the CMB-targeted missions, as a test for point source detection techniques, as a help in point-source removal in any component separation exercise and as a list of candidate pointing, flux and possibly polarisation calibrators.

The AT20G team

The AT20G is a large collaboration linking, through its people, many institutions all around the world. The main team comprises: Ronald D Ekers (ATNF), Marcella Massardi (SISSA-ISAS, Italy, and ATNF), Tara Murphy (University of Sydney, Australia), Roberto Ricci (University of Calgary, Canada), Elaine M Sadler (University of Sydney, Australia), Sarah Burke (Swinburne University of Technology, Australia), Gianfranco De Zotti (INAF-OAP, Italy), Philip G Edwards (ATNF), Paul J Hancock (University of Sydney, Australia), Carole A Jackson (ATNF), Michael J Kesteven (ATNF), Elizabeth Mahony (University of Sydney, Australia), Christopher J Phillips (ATNF), Lister Staveley-Smith (University of Western Australia, Australia), Ravi Subrahmanyan (Raman Research Institute, India), Mark A Walker (MAW Pty Ltd, Australia), Warwick Wilson (ATNF) and Paul Roberts(ATNF).

Further information is available on the webpage *www.atnf.csiro.au/research/AT20G/*

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Regular items

Time assignment information

Phil Edwards and Jessica Chapman (ATNF)

New version of OPAL

A new version of OPAL, the ATNF on-line proposal system, was released in November 2007. New editing options have been added to the source tables and observations tables to make these easier to edit. It is now possible to sort the tables by RA order, to move selected rows up or down, and to add, delete or insert rows. The source list editor now includes links to the Australia Telescope Online Archive (ATOA). The ATOA can be used to find out whether a list of sources has been previously observed with the Compact Array, and to access and download the data files.

The format of the Compact Array and LBA observations tables has been changed to make these easier to use. Note that previously saved tables can be read but should be saved again in OPAL before the proposal is submitted. For the Compact Array, each row of an Observations table can include several observing bands. Finally, several changes have been made to the LBA cover sheets, following recent changes to the LBA observing facilities, including the use of disk recording and eVLBI real-time data correlation.

Proposers for multi-source observations are reminded that it is extremely useful for the justification to include a clear statement about how the observations can be optimally scheduled. A statement along the lines of "six blocks of ten hours duration scheduled anywhere between 4:00 and 16:00 LST" both indicates to the TAC that you have carefully thought about the scheduling of your proposed observation, and makes the scheduling of the observations much easier.

Compact Array millimetre observations

Kate Brooks, the Millimetre Astronomy Research Scientist, has recently updated the documentation on the ATCA website for observing in the 12-, 7- and 3-mm bands. Observers are also reminded to check the ATCA Current Issues web page. This page contains details of the new *chklev* command to assist millimetre observers.

As noted in the ATCA/Mopra report, the translation of the new 7-mm receivers on axis now happens automatically. Proposers are reminded that there is a larger overhead in moving to and from 7 mm, as the translation takes approximately two minutes, on top of the turret rotation to the 12-mm/7-mm position, if required. Proposers are also reminded of the requirement that turret rotations occur on intervals of greater than 15 minutes.

NASA tracking

The ATCA is undertaking a series of tracking demonstration and proficiency tests in readiness for use of the array as a NASA downlink station. It is expected that the array will ultimately be used, on average, for around 10 hours a week for tracking, with occasional periods of up to 50 hours per week. These will be included in the regular ATCA scheduling process and appear in the ATCA schedule as "NASA Tracking" blocks. There will also be provision for NASA to request use of the array at short notice for emergencies, which, should they arise, will have an impact on scheduled observations. As with any Target of Opportunity type observation, where possible, observations displaced by such an emergency will be rescheduled.

CABB upgrade

Preparations for the Compact Array Broadband Backend (CABB) upgrade are gathering pace. It is currently envisaged that a single (dual-polarization) 2-GHz IF will be made available on five antennas in May/June 2008, an interim version of CABB which will run in parallel to the existing system. This CABB system will initially be restricted to the 12-, 7- and 3-mm bands, with the modifications required to feed 20/13cm and 6/3cm signals into CABB following several months later. Refer to the ATCA CABB webpage at *www.narrabri.atnf.csiro.au/observing/CABB.html* for more details.

Compact Array and Mopra report

Phil Edwards (Narrabri and Mopra Officer-in-Charge)

This year's millimetre season has been a successful one, with observers very pleased with the new 7-mm receivers. The continuation of dry conditions may not have helped the local farming community, but has resulted in few interruptions to the scheduled millimetre observing. "Automatic" translation of the receiver package to and from 7 mm is now available and is working well. The millimetre season ran a little longer than usual this year due to demand from observers. A maintenance block in mid-October was used to replace the millimetre package on CA02 with a new system, which included a 3-mm noise diode. This will allow 3-mm polarisation observing, and the first such observations are being conducted as this article is being written!

An article by Virginia Trimble and Jose Ceja in the July 2007 NRAO news (available from the NRAO website) examines the productivity of radio astronomical facilities for papers published in 2001 and 2002 and cited between 2002 and 2005. The Compact Array is second to the VLA in number of papers published, and third, after the VLA and Parkes, in number of citations, confirming the high quality of science the ATNF telescopes are producing.

Narrabri systems and developments

In the time since the last report we have welcomed to the Observatory Balt Indermühle, the new millimetre operations scientist, and Christoph Brem, visiting as an occupational trainee for a year from Switzerland. In August we bid farewell to Eric Darcey, who has moved on to a position in TAFE. We have also hosted visits from the ATNF Leadership Team in June, ASKAP industry partners in August, and from CSIRO's Chief Executive, Geoff Garrett, in October. Geoff spoke to staff about CSIRO's new strategic plan, and took a keen interest in chatting with visiting observers while on site.

Installation of dry air systems on the antennas is now complete. Dry air is piped into the 12-mm receiver horn to eliminate problems that had been experienced with moisture build-up in the past. In addition, dry air is fed into the millimetre conversion box to prevent the possibility of moisture degradation of the indium phosphide MMICs.

Set-up for Compact Array millimetre observing has been simplified by a new *caobs* command, *chklev*, which provides automatic level setting of the millimetre splitter module power levels and the coarse attenuators. More details are given on the Current Issues web page – see *www.narrabri.atnf.csiro.au/observing/CurrentIssues.html*.

The Compact Array calibrator database continues to be updated following C007 observations. Over the coming months we will be assessing the suitability of ultra-compact HII regions as flux density calibrators at 3 and 7 mm. The AT20G team are thanked for passing these candidates on to us. Preparations for the installation of the Compact Array Broadband Backend (CABB) are proceeding, with CA01 and CA05 being the first antennas equipped. The final CABB installation will take place during a ~ six week shutdown in mid 2008.

Spacecraft tracking

A series of engineering tests were made for NASA by tracking the 32-GHz beacon on the Cassini spacecraft, in orbit around Saturn. These tests indicated that self-calibrating on the satellite signal with a four second cycle time worked well most of the time, but that there were still occasional short fluctuations that appeared to NASA as dropouts in the signal. After a number of quickly arranged trials, it became possible to reduce the correlator cycle times to one second to keep up with atmospheric phase variations at 32 GHz. Satellite tracking operational procedures were also tested using the Mars Reconnaissance Orbiter and Odyssey spacecraft in orbit around Mars. The October semester schedules have recently been updated to accommodate some additional Cassini and Mars tracks for the purposes of demonstrating the Compact Array's readiness for spacecraft tracking.

Mopra developments

The Mopra millimetre season ended successfully in mid-October. Some pointing issues early in the season were quickly resolved and observers (and staff!) were able to enjoy a relatively trouble-free season. A number of calibration and characterisation

tests will be carried out over the coming weeks. Over the summer, the Mopra UPS will be replaced, and we plan to install a 7-mm receiver on Mopra in time for next year's mm season.

Mopra and the Compact Array have participated in a number of eVLBI tests and demonstrations in recent months. During observations of the bright equatorial quasar 3C273, fringes were detected between Mopra and the Darnhall telescope in the UK. The 12,300-km
Mopra-Darnhall baseline is one of the longest earth baselines ever used for VLBI, and the eVLBI demonstration as a whole marked the culmination of considerable progress in data streaming between a number of network providers.

Safety inductions

It is a requirement that new visitors to the site undergo a safety induction. We have recently made these available on-line, with web information pages and multiple choice question-and-answers. The on-line induction system has the advantages of enabling visitors to complete an induction in their own time and at their own pace, and without the need for staff to track down each visitor. The option for a personal induction is still available. The on-line system is being tweaked with feedback from users, and further comments and suggestions are welcomed.

"Generating" income!

Outfitting of the antennas with synchronisers, enabling seamless transfer between mains and generator power, has allowed us to take advantage of periods of peak energy demand across NSW in June and July. Turning on the site generators during such periods means we simultaneously take ourselves off the mains grid, easing overall demand, give the generators a short work-out at full load, as required from time to time anyway, and gain some reimbursement for our efforts. With predictions for more periods of high demand in the coming summer months, planning for ongoing arrangements with energy retailers may be made.

Parkes Observatory report

John Reynolds (Officer-in-Charge Parkes Observatory)

Operations

Scheduled observing has continued successfully since the last report with about 1.0% of observing time lost to system faults and about 3.4% lost to high wind, over the last 12 months.

The latest piece of pulsar hardware, PDFB2 (Pulsar Digital Filterbank #2) is now working very smoothly, thanks to the efforts of Grant Hampson, Andrew Brown, and their colleagues in the Marsfield Engineering group.

Delivery of PDFB3, with higher time resolution and four IF inputs is expected shortly. This instrument will be coupled with another new piece of instrumentation, APSR — the "ATNF Parkes Swinburne Recorder" — to provide a new baseband recorder capable of recording 1 GHz bandwidth at 16 Gb/s. Hardware for the APSR has arrived and will be assembled over the next few months. The APSR development is being led by Professor Matthew Bailes of Swinburne Institute of Technology, in collaboration with the ATNF.

Duplication of the entire Parkes 20-cm Galactic Pulsar Survey (P268) database is continuing, with most of the survey data now received at Parkes on DLT-S4 tape and being transferred to RAID disk.

Parkes has played an important role in recent successful trials of eVLBI, including real-time fringes over the longest baseline ever attempted with such a technique — Mopra to Darnhall (UK). Work is proceeding well in integrating eVLBI equipment at Parkes to streamline this mode of operation under the banner of "PAMHELA" — the Parkes-ATCA-Mopra-Hobart-Electronic-Longbaseline-Array. This will utilise the baseband recorder clusters at Parkes (CPSR2 and APSR) to achieve 512 Mb/s sustained bit rates between the mainland sites and 1 Gb/s on a single baseline. Higher bandwidths await upgrading of the broadband links to the Swinburne clusters.

ATNF publications list

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

This list includes published refereed papers compiled since the June 2007 Newsletter. Papers which include ATNF staff are indicated by an asterisk.

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ATNF outreach

A teacher's perspective on the ATNF teacher training programs

Andrew Roberts (Muswellbrook High School)

Photo: Andrew Roberts

The moon rising near Venus at Parkes

Parkes: Astronomy from the Ground Up! (May 2007)

I heard about this workshop at the 2006 Science Teachers Association of NSW (STANSW) annual conference, and having visited the Dish when I was a third-year physics student, I was very excited to have the opportunity to spend time there with other teachers and astronomers. Another science teacher from Muswellbrook High School, Elisabeth Moore, had also attended one of Rob Hollow's workshops at the STANSW conference and was keen to learn more about the teaching of astronomy.

On arrival at the workshop (onsite at the Parkes Visitor Centre), we collected our stash of resources from Rob and settled into the sleek lecture theatre for the first of many sessions. It was stimulating and refreshing to receive talks that were designed to educate us in current astronomy research, regardless of whether it was material that we would use in the classroom or not. The topics included detecting gravitational waves with pulsars, computing in astronomy and dark matter.

The highlights of the workshop were the observing night and the *Dish* tour. Having experienced a "hay ride" once before, the observing night stood out for me – receiving tips on setting up and using my own (new) telescope was invaluable. Elisabeth and I also enjoyed the time away from school with other teachers, in a very scenic, comfortable and stimulating environment.

Astrophysics for Physics Teachers workshop at Epping (June 2007)

The floods of June in the Hunter didn't stop me going to Sydney for the Astrophysics workshop. As in the "Astronomy from the Ground Up!" workshop, we heard from ATNF astronomers about their research, keeping us up-to-date in areas such as star formation and active galaxies.

As is always the case with ATNF teacher workshops, I came away with some great resources (including original star charts) and practical ideas for teaching astrophysical concepts. Rob made a point of showing us a plethora of hands-on activities

and supplying us with the tips and aids necessary to carry them out in our classrooms.

Changes at school

As a result of my experience at Parkes and the resources available through the ATNF Outreach website, I used the total lunar eclipse on 28 August 2007 as an opportunity to run an observing night at our school. We had around a dozen students (from years 7 – 11) and an equal number of parents and teachers for a wonderfully clear evening. We set up a number of telescopes not only to take in the fabulous views of the moon, but also to marvel at Jupiter and other objects, such as the binary star of α Centauri.

An especially pleasant consequence of my participation and interaction at the above teacher workshops is the opportunity for Muswellbrook High School to be involved in the Pulse@ Parkes project. This will mean that students from Muswellbrook will be involved in the pilot program to observe pulsars remotely using the Dish. I have been educating my students on the status and operation of the Parkes radio telescope, and spreading the word to staff and parents about the involvement of the school in such an exciting step forward in astronomy education.

Photo: Andrew Roberts

Star trails in the Parkes night sky

Pulse@Parkes

George Hobbs (ATNF), R Hollow (ATNF), J Chapman (ATNF), D Champion (ATNF), S Amy (ATNF), S Burke (University of Swinburne), W van Straten (University of Swinburne), F Jenet (University of Texas)

Pulse@Parkes is a new project that will allow high-school students to carry out pulsar timing observations with the Parkes radio telescope from remote destinations. Initially the project will involve ATNF staff working with high school students from schools in New South Wales and aims to have both educational value for the students and scientific value for the astronomical community. Later, it may be extended to include students from other parts of Australia and overseas. We are working closely with high-school teachers and members of the education departments in order to develop, implement and analyse the educational goals for this project.

The use of the Parkes telescope for remote observing was first demonstrated by high-school students in Brownsville, Texas who took observations for the Parkes Pulsar Timing Array project on 16 Feb 2007. The success of this has inspired us to develop an ongoing program for students to observe with the Parkes telescope. Over the next few months, two groups of school students from Kingswood High

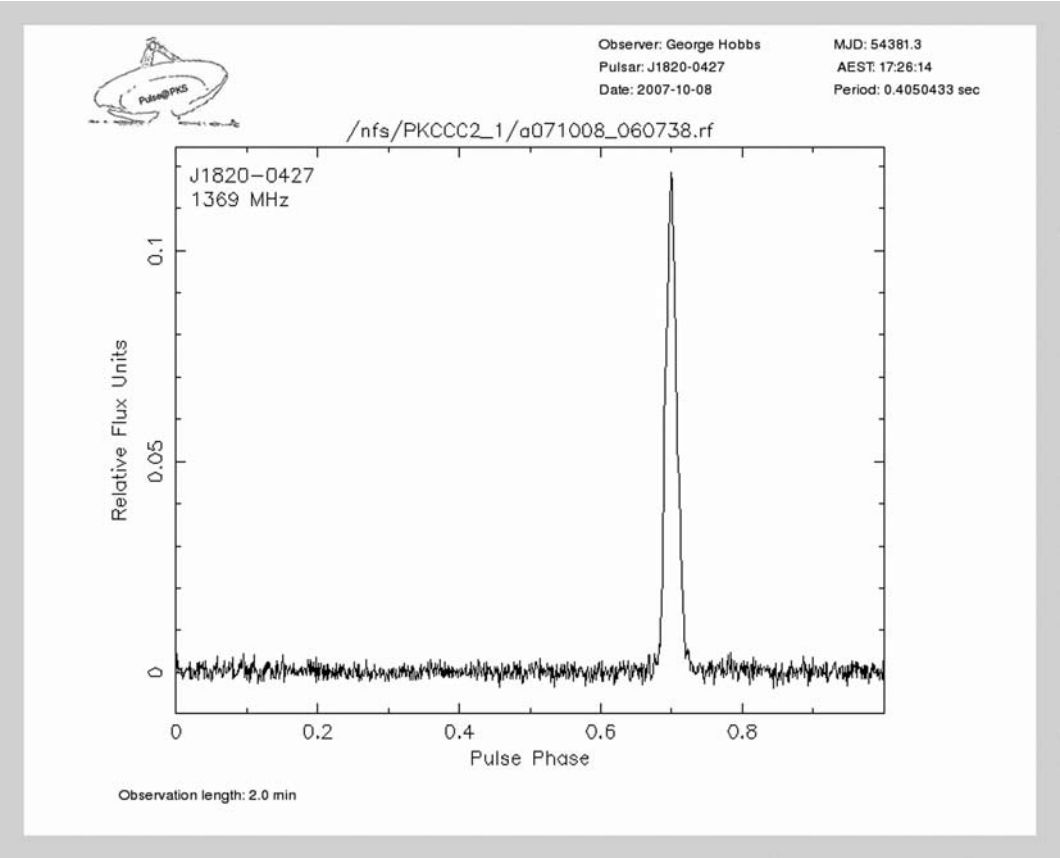

Figure 1: This profile of the young pulsar J1820-0427 was obtained by Rob Hollow in Marsfield remotely controlling the Parkes telescope. This observation will subsequently be used as part of the young pulsar timing program necessary for the GLAST mission.

School and Muswellbrook High School will visit the ATNF Marsfield site (Sydney) where they will control the telescope remotely.

For these observations the ATNF lecture theatre will be set-up to display various monitoring programs such as web-cameras of the telescope and control room, real-time data and the standard Parkes control software. An astronomer situated at the Parkes Observatory will communicate with the students via a video-conference link. The students will control the telescope and observe a sample of bright pulsars selected from several different pulsar science programs: i) GLAST timing program, ii) high-precision millisecond pulsar timing experiments and iii) glitch/timing-noise studies.

From the observing session, and from talks by ATNF staff and post-processing of their observations, the students will learn about pulsars, radio telescopes and observing issues (such as the weather and radio interference). After observing they will be able to access their data and will learn how to measure pulsar dispersion measures and hence estimate pulsar distances, determine how pulse shapes change with frequency, look for glitches in young pulsars and determine spin-down parameters and, hence, obtain estimates of the pulsar's age and magnetic field strength.

Looking ahead we envisage that this project will be extended to become a high profile outreach program that will involve many high schools and students. The program will directly benefit the ATNF by building up our experience with Parkes remote observing, by involving the students in active research projects, and as a prototype for future outreach programs with ASKAP and the SKA.

Parkes Observatory Open Day

Continued from page 2

great many staff and their families. John Smith and Julia Hockings deserve special mention for their organisation, as does Barry Turner and his site services team for site preparations and logistics. Many thanks also to the observers JinLin Han, Willem van Straten and Alessandro Corongui for their enthusiastic cooperation in adding to the tour experience, and for their patience in the extra RFI data-flagging that the heightened activity inevitably required.

Photo: Tom Lees

John Sarkissian with a group in the Control Room.

Photo: John Sarkissian

Climbing up to the next level via the outside steps.

The Visitors Centre with its tireless front-desk staff of Lyn Milgate, Tricia Trim, Karin Unger and Bev Wilson was again the "Rock of Gibraltor" on which the whole event rested. Shaun Amy's technical wizardry with communications technology drew high praise from the ABC reporter – "the best set-up OB (outside broadcast) I've been involved with". Jo Houldsworth, one of several ATNF staff from other sites who generously gave up their entire weekend for the event, summed it up sweetly as "a great effort from Team Parkes".

Images from the day, including time-lapse Webcam sequences showing the procession of tours, can be found on the Parkes website under the Open Weekend link.

Photo: John Sarkissian

Watching the famous cricket scene from *The Dish* movie.

Photo: ©Barnaby Norris

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