ATNF News

The giant HII region NGC 3576

Cormac Purcell (University of Manchester, Jodrell Bank Observatory, UK)

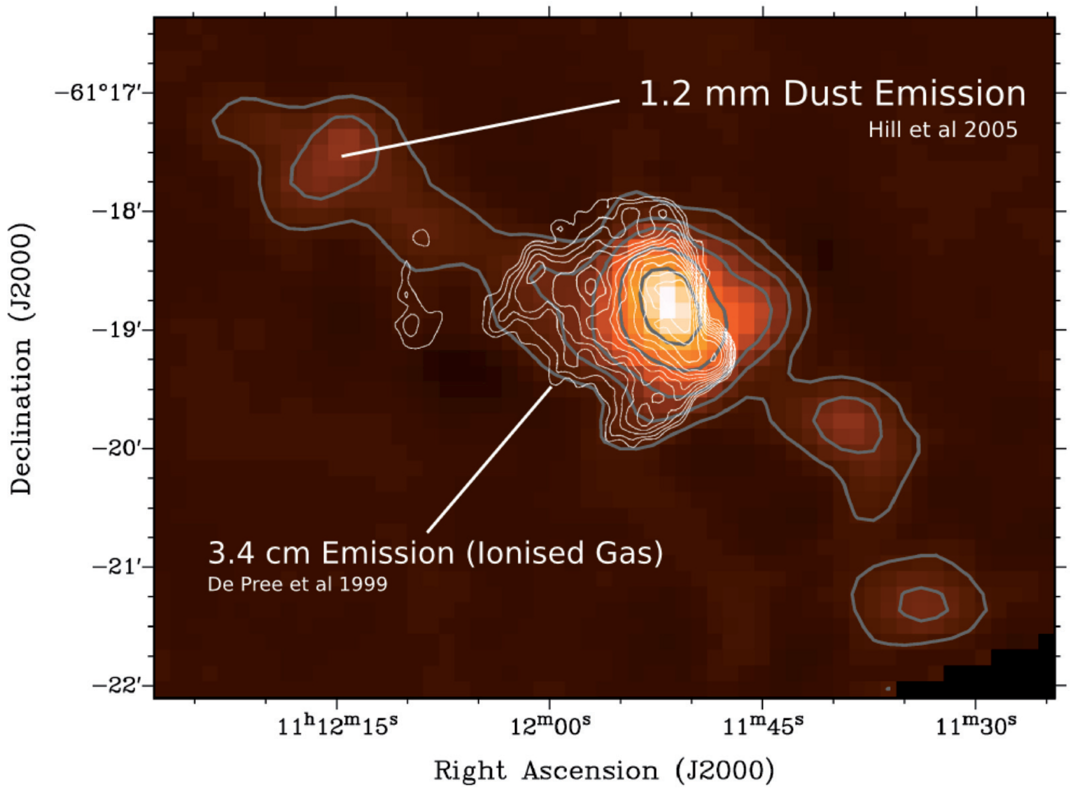

Figure 1: 1.2-mm continuum emission map (colour scale & grey contours, courtesy of Hill et al. 2005) showing the morphology of the dusty filament associated with the HII region NGC 3576. The 3.4-cm emission contours (De Pree et al. 1999) are over-plotted in white and show the extent of the ionised gas.

The environment of the giant HII region NGC 3576 is a wonderful laboratory in which to study the effect of feedback in massive star formation. NGC 3576 is one of the most luminous HII regions in the sky and has been extensively studied at radio and infrared wavelengths. De Pree et al. (1999) mapped the region at 3.4 cm using the Compact Array, revealing that the emission from the ionised gas peaks sharply in the west and gradually diminishes towards the east. Near- and mid-infrared studies (e.g., Persi et al. 1994) have revealed the presence of an embedded cluster of young stars coincident within the ionised gas. Intriguingly, the stars exhibit a colour gradient, implying that star formation began east, gradually moving towards the location of the strong radio peak in the west.

More extensive 1.2-mm SIMBA observations by Hill et al. (2005) have shown that the HII region and cluster are embedded at the heart of the dusty filament as shown in Figure 1. This discovery immediately spawns the question: Is the HII region triggering or inhibiting star formation in the arms of the filament? We have used the Mopra telescope and the Compact Array to undertake a multi-wavelength study of the region in an effort to determine if star formation has indeed commenced in the surrounding environment.

Mopra and Compact Array observations

The 23-GHz lines of ammonia (NH_3) are powerful tools for characterising the physical properties of

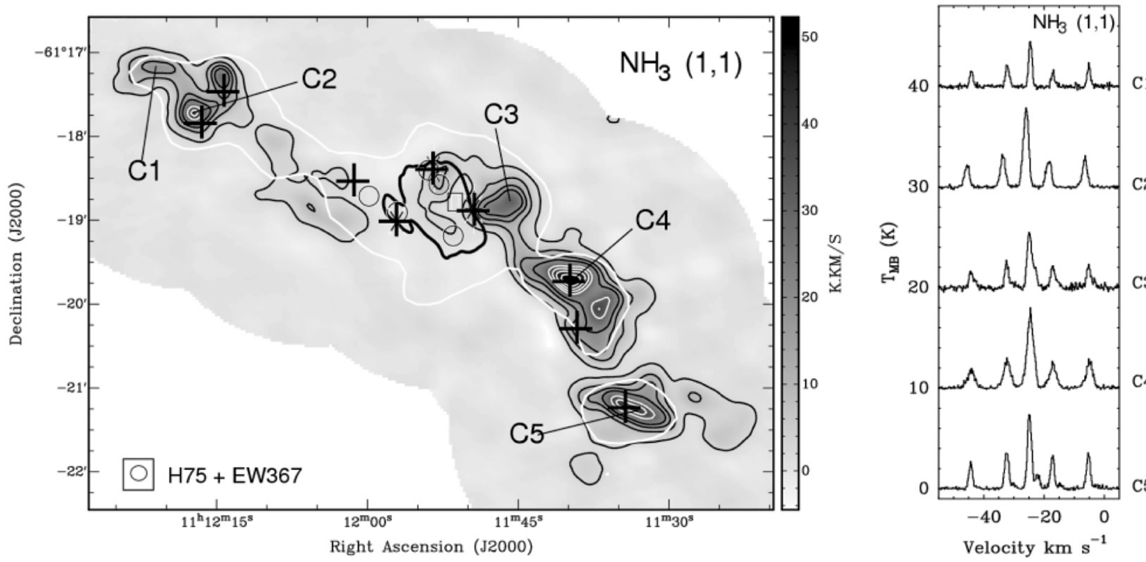

Figure 2: Left: Compact Array integrated intensity map of the NH_3 emission over the NGC 3576 region. The thin white contour outlines the dusty filament, while the black crosses mark sites of 22-GHz water maser emission. The thick black contour outlines the continuum emission from ionised gas detected at 23 GHz. Right: Sample spectra from positions C1 – C5.

molecular clouds. NH_3 emission tends to trace dense gas ($n > 10^5$ cm^{-3}), while the hyperfine structure of the (J,K) inversion spectrum allows independent measurement of optical depth and gas temperature.

Figure 2 displays the NH_3(1,1) integrated intensity map made using the Compact Array. Clearly visible are clumps of emission, corresponding roughly with the morphology of the dust imaged by SIMBA. Crosses show the positions of detected 22-GHz water masers. Water masers are thought to be collisionally excited, commonly occurring in outflows from young stellar objects, which strongly suggests that star formation has been initiated within the arms of the filament. Sample spectra (at right) have the classic five-finger hyperfine line profiles of NH_3 and appear to be optically thin. Complementary observations of the J,K=(1,1), (2,2) and (4,4) transitions allow the assembly of a kinetic temperature map, which is presented in Figure 3. A clear temperature gradient is visible in the arms. Adjacent to the HII region the temperature peaks at over 30 K, but decreases to 10 K at the extremities. The eastern arm displays a patchy morphology in the region overlapping the ionised gas. This is interpreted as being due to dissipation of the gas by the massive stars in the region.

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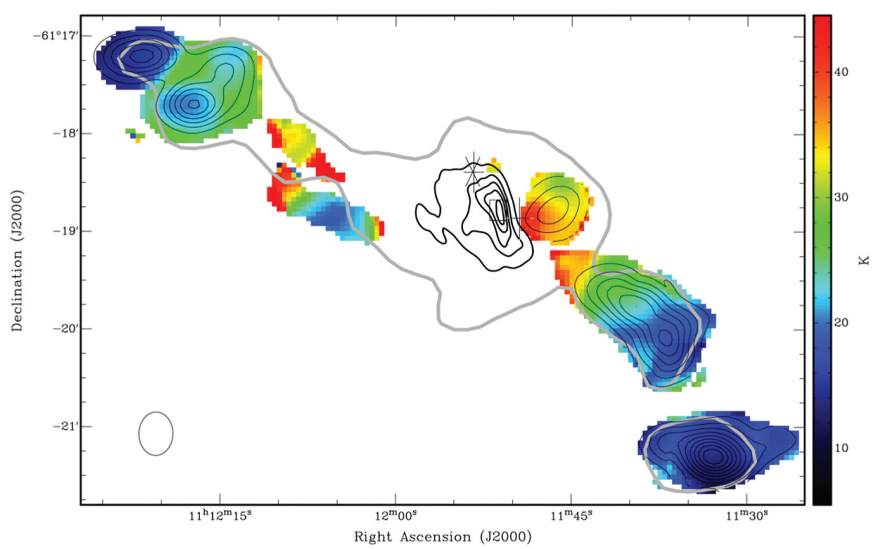

Figure 3: Kinetic temperature map of NGC 3576 made from the NH_3 spectra at each pixel.

Editorial

Welcome to the June 2007 edition of the ATNF News.

For this issue, the science article, by Cormac Purcell, features ammonia observations of the HII region NGC 3576 with Mopra and the Compact Array. There are also several science news items. The first science results obtained with the new 7-mm receivers at the Compact Array are described by Ilana Feain and Maxim Voronkov. Chris Phillips and his collaborators report on the first e-VLBI science results, and Jessica Chapman and Phil Diamond give highlights from IAU Symposium 242 held at Alice Springs. In another highlight, the first science result obtained with the new Parkes Digital Filterbank (PDFB2) is contained in the Parkes Observatory report.

In other news, George Hobbs introduces the new TEMPO2 pulsar timing software, while Phil Edwards and Jessica Chapman report on citation statistics for ATNF publications. Graeme Carrad reports on the successful installation of the new 7-mm receivers at the Compact Array, and Phil Crosby on an agreement between CSIRO and the National Astronomical Observatories of the Chinese Academy of Sciences.

This issue includes no less than four reports of awards associated with the ATNF and staff. Congratulations to all involved!

The newsletter team has extended the use of colour printing to four pages. From this issue we will include an outstanding colour photo or astronomical figure on the back cover page. All readers are invited to contribute their best photographs or astronomy figures, with a suggested caption, for selection for publication in a future issue. Please send your contributions to *newsletter@atnf.csiro.au*.

The web version of this and previous issues can be found at *www.atnf.csiro.au/news/newsletter*. From the February 2006 issue onwards the newsletter is available in both html and pdf formats. Previous issues are offered in html only.

Michael Dahlem, Jessica Chapman and
Joanne Houldsworth
The ATNF Newsletter Production Team

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News

From the Director

Brian Boyle, ATNF Director

The biggest news of recent months is the announcement by the Australian Minister for Education, Science and Training, the Hon Julie Bishop MP, as part of the Australian 2007 – 2008 budget, of $56.7 million funding for the Australian Square Kilometre Array Pathfinder (ASKAP). The funding includes $51.7 million to CSIRO for construction of the ASKAP and $5 million for Australian Government engagement in the international Square Kilometre Array (SKA) program.

This announcement further demonstrates the government's support for the strategic direction the CSIRO has been pursuing, following a carefully staged development path aimed at maximising Australia's involvement in the international efforts to realise the Square Kilometre Array. Combined with funding from the National Collaborative Research Infrastructure Strategy (NCRIS) and CSIRO, this raises the Commonwealth Government of Australia's investment in new radio astronomy infrastructure to over $100 million over the coming five years. To build ASKAP we will need to draw on a wide range of capabilities across CSIRO (e.g., ICT Centre, Mathematics and Information Science and the Energy Transformed Flagship), in the Australian university sector and from national and international industry partners.

The expansion in funding and scope of the new facility is tremendously exciting. It represents the start of a new cycle of regeneration of Australian radio astronomy infrastructure, some 20 years after the commissioning of the Australia Telescope Compact Array, itself started some 20 years after the commissioning of the Parkes radio telescope.

With the excitement and the opportunities come challenges and a degree of uncertainty. The ATNF is committed to operating four observatories by 2012, the three current facilities at Narrabri, Parkes and Mopra, plus the ASKAP in Western Australia. It needs to do so to maintain the scientific productivity of the Australian radio astronomy while ASKAP is commissioned and starts to contribute significant scientific results. In order to accommodate a fourth observatory without unrealistic expectations of a substantial increase in the ongoing operational funding for Australian radio astronomy, the ATNF will have to change the way that it operates the existing observatories. An extensive review of ATNF operations has been undertaken over the past 12 months, and the focus has now shifted to planning for the future operations. This process currently involves intensive input from two working groups, one led by Jessica Chapman (Head, National Facility Support Group) looking at Scientific Operations, and the other led by Brett Dawson (Deputy Officer-in-Charge, Parkes) looking at Engineering Operations. Supported by input from the community, we intend to have a clear view of future operations by the end of 2007, and to steadily implement the changes involved over the following three years.

In other news, I am delighted that following an open internal selection process, Graeme Carrad was appointed in May to the role of Assistant Director: Engineering. Graeme had been acting in this role since February. Michelle Storey has also joined the Leadership Team, in her role as Policy Strategist. Michelle continues to play a critical role at the interface between the ATNF and our colleagues in the Department of Education, Science and Training.

Finally I would like to note that the ATNF has recently undergone a Science Review, an exhaustive independent assessment of the quality of the astronomical and engineering research undertaken by ATNF staff, and of the capabilities within the ATNF. The draft report from the Science Review Committee, chaired by Prof Don Melrose has been received and circulated to staff. The report and response will be finalised once ratified by the CSIRO Board. The review committee was very positive about the ATNF's performance, its influence in the international astronomy and engineering research communities, its strategic direction and its ability to achieve its future goals, and recognised both the necessity of change and the associated risks. All ATNF staff should rightly feel proud of the outcome of this review.

IAU Symposium 242

Jessica Chapman (ATNF) and Phil Diamond (Jodrell Bank Observatory), Co-Chairs SOC, with thanks to the LOC and all the participants of IAU 242

Photo: Shaun Amy

PhD students at IAU 242: From left to right: James Green, Carlos Gonzalez-Fernandez, Edo Loenen, Steven Longmore, Daniel Wong-McSweeney, Daniel Tafoya, Paola Castangia, Tim Robishaw, Estaban Araya, Mayumi Sato, Korinne McDonnell, Shari Breen, Laura Richter, Alet de Witt, Kim McAlpine, Jack Hewitt, Rodrigo Parra, Koichiro Sugiyama

IAU Symposium 242 on *Astrophysical Masers and Their Environments* was held in Alice Springs on 12 – 16 March 2007. The meeting was attended by 125 participants who came to the Red Centre from around the globe for an intense week of talks and events. About 20 family members also came and enjoyed a social week with outings to the beautiful MacDonnell ranges and local attractions.

The meeting was notable for the strong contribution from younger scientists: 18 of the participants were PhD students and seven of these gave excellent oral presentations. Several of the students and postdocs commented that they had benefitted a great deal from meeting the more established scientists. It was also good to have strong participation from women who were well-represented as speakers and participants.

Astrophysical masers originate in a variety of different environments, but they are linked by common physics. The meeting addressed a broad range of astrophysical problems that included maser theory, star formation, stellar evolution, magnetic fields, Galactic structure, masers in other galaxies and cosmology. It was evident that maser research is currently very active. Several new maser research directions have emerged over the last few years, and many outstanding results were shown.

To mention just some of the science highlights:

- New discoveries of formaldehyde masers in the Galaxy have led to a much better understanding of this rare group of masers. These masers pin-point the dusty circumstellar disks around young protostellar objects. These masers may show recurrent flares and/or long-term variability, and from recent modelling appear to be collisionally excited.

- Methanol masers are an important tool for studying star formation regions. An intriguing result from a monitoring program is that 10% of the observed methanol masers have quasi-periodic variations with light curves showing periods of several hundred days. These are reminiscent of Mira-like pulsations but are so far unexplained.

- Magnetic fields play a critical role in star birth and star death. In evolved stars, magnetic fields always show ordered structures. From observations of the 22-GHz water transition, it has been shown that the bipolar outflows that turn on in post-asymptotic giant branch stars are highly likely to be magnetically collimated. Of great interest was the recent detection of the Zeeman effect in OH megamaser galaxies. Very high-resolution imaging of the galaxies has shown compact, well separated maser components with milliGauss fields.

- Masers also offer a powerful tool for studies of Galactic structure. Their positions and velocities can be measured with extremely high precision, while absolute positions can be determined from parallaxes and proper motions. Micro-arcsec astrometry is now being obtained with the VLBA and this has been used to identify with great precision the position of SgrA* in the centre of the Galaxy. Galactic masers are being used to map out the spiral arm structure of the Milky Way, and to investigate the properties of the Galactic nuclear bar.

- There has been a tremendous increase in the number of water masers detected from active galactic nuclei of external galaxies. The masers allow high-precision measurements of the galactic nuclei and disks, and in some cases can be used for cosmological distance estimates, with a goal of measuring H_0 to 3% within the next five years.

- A new branch of maser research is emerging with the first results from the Sub-Millimetre Array (SMA). Many new maser transitions can now be detected. As an example, there are now many water maser lines that can be observed that are at least as strong as the 22-GHz water maser line, which has been studied now for many years and is a prime maser transition observed in star formation regions, evolved stars and galaxies. These masers are likely to become as commonly observed as the centimetre masers have been.

- Looking to the future, the new generation of telescopes, including ALMA and the SKA, will allow increasingly sensitive surveys and use of masers for cosmological studies.

The conference proceedings will be published by Cambridge University Press later this year.

A 30-year milestone for radio astronomy naming standards

Jessica Chapman

Congratulations to Mike Kesteven from the ATNF and Alan Bridle from the National Radio Astronomy Observatory (NRAO), who received a special award in February from the Institute of Engineering & Technology “in recognition of the 30th anniversary of the beginning of astronomical designation formatting”.

In 1977 Kesteven and Bridle published a paper giving an *Index of extragalactic radio-source catalogues* (Royal Astronomical Society of Canada, vol 71, p 21). This provided a guide to over 50 catalogues of extragalactic radio sources. At the time, around 30,000 astronomical radio sources were known. These were listed in the catalogues and other publications with a chaotic range of naming conventions that made it difficult to compare objects listed in one catalogue with those in another. For example, the source NGC 1265 was variously listed as 3C 83.1, NRAO 131, LHE 83, 4C41.06, VRO 41.03.01, OE 425 and BDFL 0315+41.

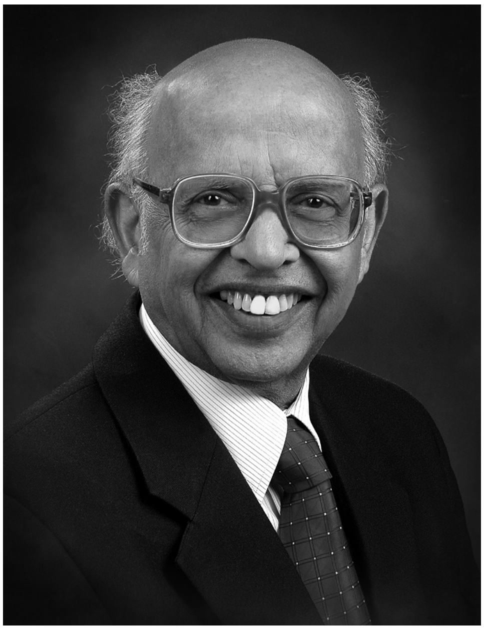
The Kesteven-Bridle paper made an important contribution to clarifying this muddle by listing all the major known catalogues with a simple formatting scheme that summarised how the catalogues had listed their objects. They also advocated that future surveys should use a convention, proposed by the IAU in 1973, whereby sources are listed using the format HHMM±DDD to give the right ascension and declination of the source position, with an additional prefix, such as “PK” for Parkes, to indicate the survey origin.

In 1983 an entire issue of Astronomy and Astrophysics Supplement Series (vol 52, no 4) was dedicated to *The First Dictionary of the Nomenclature of Celestial Objects* (Solar system excluded). This acknowledged the groundwork done by Kesteven & Bridle and provided a scheme for catalogue designations that is still in use.

In the current era of “Virtual Observatories”, where astronomers have access to huge databases obtained from many institutions, it is still essential to have well-defined standards for data formatting. It is good to look back at the early stages of doing this.

2007 Grote Reber Medal to Professor Govind Swarup

Dave Jauncey



Professor Govind Swarup

The 2007 Grote Reber Medal for lifetime, innovative achievement in radio astronomy is to be awarded to Professor Govind Swarup of the National Centre of Radio Astrophysics at the Tata Institute of Fundamental Research (TIFR) in India.

The Grote Reber Medal is awarded annually for innovative lifetime contributions to radio astronomy, and commemorates the pioneering work of Grote Reber, the first radio astronomer. The medal is administered by the Queen Victoria Museum in Launceston, Tasmania, in cooperation with the University of Tasmania, the Australia Telescope National Facility and the National Radio Astronomy Observatory. The award of the Grote Reber Medal is made possible through funds provided by the Grote Reber Foundation.

Professor Swarup has had a long and productive career and he remains as dynamic and energetic as ever. India entered radio astronomy research with the construction of a large, steerable radio telescope at Ootacamund, in the Nilgiri hills of south India, which came to be known as “the Ooty telescope”. The telescope was designed and built by Professor Swarup. The innovative 530 m x 30 m Ooty radio telescope commenced operation in 1970.

The telescope was designed to use the technique of lunar occultations, the same technique that led to the discovery of the first quasar, to survey selected regions of the sky. This enabled the Ooty telescope to determine the angular structure and precise position of many faint radio sources with a precision and angular resolution not achievable by any other telescope at that time. One of the most successful programs was the determination of the angular structure and precise position of many distant radio galaxies and quasars, and the application of these results to cosmology.

Professor Swarup’s most significant contribution to radio astronomy has been through the major and innovative radio telescopes whose design and construction he has spearheaded in India. More recently, he has achieved considerable success and international recognition with the design and construction of the Giant Metrewave Radio Telescope (GMRT), near Pune, completed in 1997. The GMRT consists of 30 fully steerable parabolic dishes each of 45 m diameter, spread over distances of up to 25 km. The GMRT is one of the most challenging experimental programs in basic sciences undertaken by Indian scientists and engineers.

At the time of construction Professor Swarup said “GMRT is a marriage of the world’s two big radio telescopes, the Very Large Array in New Mexico, and Arecibo in Puerto Rico, with the advantages of both”. It is the largest telescope in the world for its wavelength range, and is used by astronomers from all over the world. The GMRT leads the world in the search for high-redshifted hydrogen and is actively involved in the search for the epoch of reionization.

By designing and building such distinctive and innovative telescopes Professor Swarup has shown immense determination and far-sightedness. He continues to produce remarkably innovative concepts and designs for new radio telescopes that address some of the most important scientific problems in astronomy; at the moment he is working on designs for the next generation international radio telescope, the Square Kilometre Array.

VSOP Certificates of Appreciation

Philip Edwards

The ATNF has recently been awarded with Certificates of Appreciation for its involvement in the VLBI Space Observatory Programme (VSOP). The Japanese-led project conducted Very Long Baseline Interferometry (VLBI) observations on baselines to the orbiting HALCA spacecraft between 1997 and 2003. With the mission formally ending at the end of the 2005/2006 Japanese financial year (on 31 March 2006) the Institute of Space and Astronautical Science prepared certificates to acknowledge the efforts of ground telescopes, other institutions and people who played key roles in the project.

Photo: Greg Boyd

Miriam Baltuck, Dave Jauncey, with Jim Lovell holding the Certificate of Appreciation to the Tidbinbilla Deep Space Network station.

The opportunity to present these arose in March this year, when a one-day meeting was held in the Marsfield Lecture Theatre on 9 March 2007 to discuss planning for the VSOP-2 mission, a next generation space VLBI project. The VSOP Project Scientist, Prof "Hirax" Hirabayashi, presented four certificates of appreciation at the beginning of the meeting. The first, awarded to the ATNF as a whole, was presented to Dave McConnell, Assistant Director: Operations, in Brian Boyle's absence. It was quite appropriate that Dave was able to accept the award as he had been Officer-in-Charge at Narrabri during the early years of the mission and had been instrumental in the scheduling (and re-scheduling!) of VSOP observations during the mission's busiest years.

Certificates of Appreciation for Narrabri and Mopra were then awarded by Hirax to Phil Edwards, current Officer-in-Charge at Narrabri. These were presented in recognition of the fact that the Compact Array had participated in 80 VSOP observations and Mopra as many as 190, a significant fraction of these as part of the VSOP Survey Program. Finally, a Certificate of Appreciation was presented to Dave Jauncey, who had been Co-chair of the VSOP International Science Council since 1994, serving in this capacity as Co-chair of the Science Review Committee, and also playing an instrumental role in the development of the VSOP Survey Program. Hirax presented these certificates with his usual mix of seriousness and levity, at one point likening the cylinders containing the certificates to samurai swords!

The certificates read "For outstanding contributions toward the realization of a radio telescope bigger than the Earth, through observations with the HALCA satellite and ground radio telescopes, as part of the VLBI Space Observatory Programme (VSOP) of the Institute of Space and Astronautical Science [ISAS], Japan Aerospace Exploration Agency."

There was significant ATNF involvement in the awarding of the Certificate of Appreciation from ISAS to the Tidbinbilla Deep Space Network station. Tidbinbilla operated one of the five dedicated tracking stations for the VSOP mission, which uplinked a suitably Doppler-shifted reference tone to the satellite (which did not have a hydrogen maser on board!), and received and recorded the 128 megabit per second VLBI data downlink. In addition, the Tidbinbilla 70-m dish participated in 50 VSOP observations at a wavelength of 18 cm. The certificate was, fittingly, presented to the station by Miriam Baltuck, the Station Director, after a farewell event for Jim Lovell (see photo).

Jim Lovell joined the ATNF in 1999 as a joint ATNF/CSIRO Industrial Physics position to provide support at Tidbinbilla, and was involved in VSOP and Long Baseline Array observing as well as host country single-dish observing at Tidbinbilla.

Before joining the ATNF, Jim was a "Japan Society for the Promotion of Science" fellow at ISAS, so his connections with the mission actually date back to HALCA's launch! Jim gave a presentation to Tidbinbilla staff about VSOP and his experiences in Japan, which was very well received. Jim has recently taken up a position as Project Scientist for the NCRIS-funded AuScope VLBI array for geodesy, and is now based at the University of Tasmania, which was also a recipient of an ISAS Certificate of Appreciation for its contributions to the VSOP mission with the Hobart and Ceduna telescopes.

Following the presentations of the certificates on 9 March, the meeting proper got underway with an overview of the VSOP-2 mission by Hirax. VSOP-2 will yield gains of an order of magnitude in angular resolution and sensitivity over the VSOP project, with observation bands at 8 GHz, 22 GHz and 43 GHz. Subsequent presentations reviewed the current status and future plans of the VSOP-2 project, and considered southern hemisphere contributions to the project. A number of presentations from the workshop are available from *www.narrabri.atnf.csiro.au/people/Philip.Edwards/vsop2workshop.html*.

Degrees to Andrew Brown and Alex Dunning

Graeme Carrad

Two members of the Engineering Development Group have recently reaped the benefits of years of dedicated effort. Andrew Brown and Alex Dunning have completed their degrees at the University of Technology with great distinction.

Andrew was awarded the Bachelor of Engineering in Computer Systems Engineering Diploma in Engineering Practice with First Class Honours and a University Medal.

Alex was awarded the Bachelor of Science (Applied Physics) with First Class Honours and the Australian Institute of Physics Prize.

The ATNF is indeed lucky to have such talented young people within its ranks and we look forward to many years of creativity from both Andrew and Alex.

(Andrew may also have scooped the pool in the "longest name for a degree" competition, but this is yet to be confirmed.)

ATNF distinguished visitors

Robert Braun (on behalf of the Distinguished Visitors Committee)

Two long-term visitors are approaching the end of their productive stays at the ATNF: Andrea Lommen (Franklin & Marshall College, USA), at the end of June 2007, and Ger van Diepen (ASTRON, the Netherlands), at the end of August 2007. Several short-term visitors have been with us in the past months. Andrei Sobolev (Ural State University, Russia) and Georgij Rudnitskij (Sternberg Astronomical Institute, Russia), visited in conjunction with IAU Symposium 242, the astrophysical masers meeting held in Alice Springs in March. Martin Cohen (Berkeley, USA) visited in April and will return in August 2007.

Several other visitors will be joining us in the coming months. Igor Karachentsev (Special Astrophysical Observatory, Russian Academy of Sciences, Russia) will visit in conjunction with the *Galaxies in the Local Volume* conference in July 2007. Ralf-Jürgen Dettmar (Bochum University, Germany) will join us in August 2007. Later this year Phil Kronberg (Los Alamos National Laboratory/University of Toronto) will be visiting the ATNF and the University of Sydney for three months from September 2007 and again for three months in 2008.

Details of the ATNF visitor program can be found at the URL *www.atnf.csiro.au/people/distinguished_visitors.html*.

Visits are partially funded by the Distinguished Visitors and the Federation Fellows programs.

CSIRO – China agreement opens way for breakthrough science in astronomy

Phil Crosby, ATNF Business Strategist

Photo: Dr Jin Chengjin

Dr Richard Manchester (ATNF) and Dr Jin Chengjin (NAOC), Project Leaders

Last month saw the signing of an "Agreement to Cooperate" between CSIRO's Australia Telescope National Facility (ATNF) and the National Astronomical Observatories of the Chinese Academy of Sciences (NAOC).

Established under an existing memorandum of understanding between CSIRO and China's Ministry of Science, the agreement sets out an array of potential projects related to the future science and engineering challenges of radio astronomy. In particular, it provides for a closer and practical working relationship to develop new instrumentation for a number of proposed radio telescopes in China, as well as closer scientific cooperation between astronomers in both countries.

Under the agreement, researchers from both nations can pursue funding from their respective Australia – China government programs to facilitate exchange visits, workshops and meetings to determine and plan specific areas of collaborative research.

Supervised by Dr R Manchester (ATNF) and Dr J Chengjin (NAOC), joint engineering projects are likely to concentrate in the areas of more sensitive receiver designs and more powerful digital processors. Collaborative observations using linked radio telescopes in Australia and China will enable new far-reaching astrometry experiments.

Outcomes from this joint research are anticipated to benefit the development of new Chinese telescopes such as the 500-m FAST instrument, as well as the Australian Square Kilometre Array Pathfinder (ASKAP) that will be built in Western Australia and New South Wales. These "next generation" instruments will maintain Australia's position at the forefront of astronomical science and leading the exploration of the universe.

The Agreement to Cooperate was signed by Prof Brian Boyle, ATNF Director, and Prof Ai Guoxiang, Director, NAOC.

ATNF graduate student program

Bärbel Koribalski, ATNF Graduate Student Convener

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

- Janine van Eymeren (University of Bochum) — *Gas Kinematics in the Halos of Nearby Irregular Dwarf Galaxies* with supervisors Prof Ralf-Jürgen Dettmar (University of Bochum) and Dr Bärbel Koribalski (ATNF).
- Daniel Yardley (University of Sydney) — *Pulsar Timing Arrays and their Applications* with supervisors Prof Bryan Gaensler (University of Sydney) and Dr George Hobbs (ATNF).
- Shari Breen (University of Tasmania) — *Masers as evolutionary tracers of star formation* with supervisors Dr Simon Ellingsen (University of Tasmania) and Dr James Caswell (ATNF).

Congratulations to Sebastian Gurovich on the successful submission of his Australian National University PhD thesis on *An Observational Study of the Baryonic Tully-Fisher Relation* and to Jess O'Brien on the successful submission of her Australian National University PhD thesis on *Dark Halos of Thin Edge-on Galaxies*.

TEMPO2: The world's most powerful pulsar timing package

George Hobbs

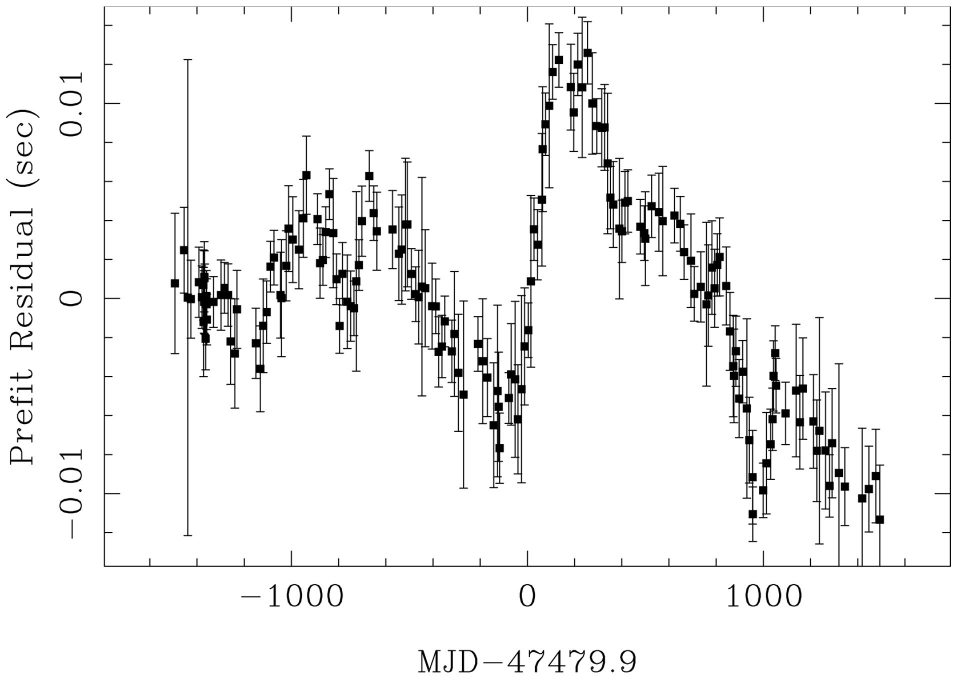


Figure 1: Using TEMPO2 to view timing residuals dominated by a simulated gravitational wave background.

The technique known as "pulsar timing" has already led to numerous important scientific results. For instance, the discovery and timing of the first binary pulsar system, PSR B1913+16, and the testing of Einstein's general theory of relativity led to the award of the 1993 Nobel Prize in physics to R Hulse and J Taylor. During the year 1990, Alex Wolszczan was studying the pulse arrival times from PSR B1257+12 and managed to deduce the existence of the first planetary companions to a star detected outside of our solar system. More recently, by timing the double pulsar PSR J0737-3039A/B, the Parkes pulsar multibeam survey team obtained the most stringent tests to date of the theory of general relativity (Kramer et al. 2006). The basic pulsar timing idea is very simple. We create a model of the pulsar and then compare the actual pulse arrival times with the times expected from this model. Any discrepancies imply that there is a problem with our model, which can subsequently be improved. The accuracy with which this technique allows us to measure pulsar parameters is outstanding. For instance, the rotational period of PSR J0437-4715 was 0.005757451840111090 seconds on 14 January 2006, with an uncertainty of 4 in the last quoted digit.

Pulsar timing predictions are required for almost all pulsar observations made worldwide. For instance, the new ATNF digital filterbank folds the data from the telescope on-line and requires knowledge of the pulsar phase and pulse-period at the time of the observation. Huge increases in signal-to-noise ratio are obtained for VLBI pulsar observations by recording data only when a pulse is expected to arrive. Again, this technique requires pulsar timing software in order to enable such predictions.

New high-precision pulsar timing experiments, such as the Parkes Pulsar Timing Array (PPTA) project, are pushing the standard pulsar timing code (TEMPO) beyond its limit. This older program cannot predict arrival times accurately enough for our requirements for the on-line hardware, nor model all the phenomena that affect the pulse signal at the levels required. TEMPO is also limited in that the algorithms implemented are not compatible with International Astronomical Union (IAU) 2000 resolutions and it can only analyse one pulsar at a time. In order to detect gravitational waves we need a more powerful and updated software package.

We have now produced a new package, unimaginatively called TEMPO2. This is the most powerful pulsar timing software available and takes into account all known issues that can affect the pulsar signal at the 1-ns level. This involves, for example, correcting for the delay that the signal experiences as it passes by the limb of Jupiter, polar motion, propagation effects in the Earth's atmosphere and the solar wind. TEMPO2 can analyse multiple pulsars simultaneously allowing global signatures that are common between pulsars to be detected, thereby making pulsar timing array experiments realisable. TEMPO2 uses International Celestial Reference System (ICRS) coordinates and is fully compliant with recent IAU resolutions that require updated precession and nutation models. The software also includes numerous visualisation and analysis tools.

TEMPO2 has already been used to place the most stringent limits to date on the existence of predicted gravitational-wave backgrounds (Jenet et al. 2006), detect non-Kolmogorov turbulence in the interstellar medium (You et al. 2007) and is now being used on-line for our PPTA observations. Already adopted internationally, TEMPO2 will supersede all existing pulsar timing packages and provide the accuracy needed for pulsar timing into and beyond the SKA era. More details on this easy-to-use software can be found in our papers (e.g., Hobbs, Edwards & Manchester 2006) and from our web-site: *www.atnf.csiro.au/research/pulsar/tempo2*.

References:

Hobbs, Edwards & Manchester 2006, MNRAS, 369, 655

Jenet et al. 2006, ApJ, 653, 1571

Kramer et al. 2006, Science, 314, 97

You et al. 2007, MNRAS, in press

ASKAP developments

Helen Sim and Michelle Storey

Since the February 2007 edition of the *ATNF News*, there have been major developments in the CSIRO-led project to build a pathfinder instrument for the SKA. Previously known as MIRANdA, this project has again increased significantly in scope and as discussed below is now part of the project called the Australian Square Kilometre Array Pathfinder (ASKAP).

New funding in Commonwealth budget

As part of the Commonwealth Government's 2007–2008 budget, the Minister for Education, Science and Training, the Hon Julie Bishop MP, announced $56.7 million for ASKAP. The funding has two components: $51.7 million for the construction of the ASKAP telescope — an enhanced version of MIRANdA — and $5 million for Australian Government engagement in the SKA program. The new funding comes on top of the approximately $49.2 million already committed for the telescope through Minister Bishop's portfolio, taking the Australian Government's contribution to ASKAP to $100.9 million over the next four years. It expands the technical options for the telescope in the following ways:

- the focal-plane array receivers for the telescope's dishes will be cooled;
- the number of dishes for the telescope will increase from 30 to perhaps as many as 45;
- a remote array-station for the telescope will be built in NSW and linked to the WA site by optical fibre. This will demonstrate the feasibility of the real-time long-baseline observing crucial to the SKA's operations; and
- key infrastructure and operations resources, which will demonstrate the feasibility of the WA site for the SKA, can be put in place. These include a high-bandwidth optical fibre link between Geraldton and the WA telescope site, characterisation and maintenance of the radio-quiet zone, and the development of appropriate power supplies for the remote site.

These changes will increase the scientific impact of the pathfinder telescope, giving it a survey speed five times that originally planned for MIRA. ASKAP will also provide opportunities for school students to work with a world-leading telescope.

Site developments

ASKAP will be sited on Boolardy Station, a 350,000 hectare cattle property. The site is within a region protected from new mining under Section 19 of the WA Mining Act. A "heritage survey" of the likely radio astronomy site on Boolardy, to identify areas of archeological and cultural significance, was undertaken on 21 – 24 May 2007. The process was carried out by representatives of the Native Title Claimants, and archeologists and anthropologists engaged by the Native Title Claimants' legal representative body, Yamatji Marlpa Barna Baba Maaja Aboriginal Corporation. The results of the study will be used to constrain the placement of the pathfinder telescope's dishes.

Technical developments

The 12-m antenna destined for Parkes (see *ATNF News*, February 2007) is being developed on schedule, and site preparations are advancing rapidly. The antenna foundation has been completed, and most of the required underground service ducts to the 64-m telescope have been installed, along with the large air pipes that will be used to provide cooling in the pedestal. Three-phase power has been installed at the site, and building 3 (the "Woolshed") has been refurbished to become the antenna's control room and associated office space.

As mentioned in the previous issue of *ATNF News*, CSIRO has been developing a chequerboard linear phased array. This has now been completed and some initial tests done. Key questions of interest are to determine how closely the numerical modelling matches the performance of the physical device and whether the results point to aspects of the structure that may affect the final performance.

In March the ATNF hosted a very successful three-day meeting to review and discuss the technical challenges of focal-plane arrays as applied to pathfinder instruments for the SKA. The meeting incorporated the *Third International Focal Plane Array Workshop*, and was sponsored by the International SKA Project Office, the ATNF, and the CSIRO ICT Centre. The meeting attracted 96 participants: astronomers, engineers and industry representatives from Australia, Europe, Canada, the USA, South Africa and New Zealand. The meeting has led to ongoing discussions between the ATNF and other interested parties on focal-plane array development, and sharing of tools, data and modelling.

Science with SKA pathfinders

Following the Focal Plane Array Workshop described above, a two-day science meeting was held to discuss design priorities for the SKA pathfinder instruments in Australia, South Africa and the Netherlands, in light of the key science drivers identified by the astronomy community.

The meeting was attended by more than 70 scientists and engineers from 14 institutions around the world. Five main science topics were addressed: neutral hydrogen, pulsars and transients, continuum observations, magnetism, and synergies. These topics are closely aligned with the SKA Key Science Goals. The meeting gave an excellent overview of the scientific community's requirements for the pathfinder instruments, and triggered extremely useful discussions among the Australian, European, South African and Canadian participants. A comprehensive science case, prepared for MIRANdA, is available at *www.atnf.csiro.au/SKA/newdocs/MIRANdAscience_may1.pdf*

Staff

Many new staff members will be added to the ASKAP project over the next two months as the project continues to ramp up: some will be from the CSIRO ICT Centre, while others will be new positions. The positions are in the areas of mechanical engineering, data transfer, project support and management of the WA site. An office for the project is to be established in Geraldton in the near future.

Australian SKA industry cluster

The Australian SKA industry cluster has finished its inaugural year of briefings, having held eight workshops around the country. The SKA technologies roadmap — a review of Australian SKA-related research and development and industry opportunities — was launched at an SKA briefing workshop in Melbourne on 17 May 2007, while the Australian SKA industry capability statement that preceded it was launched in Canberra on 19 February 2007. These initiatives were funded by a grant from the Commonwealth Government under the Industry Cooperative Innovation Program, and were an endorsed project of the Electronics Industry Action Agenda.

7-mm receiver installation at the Compact Array

Graeme Carrad

On the afternoon of Friday 11 May 2007 a signal at 32 GHz, transmitted from a small space probe called Cassini that is orbiting the planet Saturn, was intercepted by the six antennas of the Compact Array and focussed to the new 7-mm feeds in the recently upgraded 3/12-mm receivers. The signal was guided by the new input waveguide components to cooled amplifiers. The amplifiers did their job and spat the signal out of the dewar to the new conversion module. The conversion module produced a 4 – 12 GHz intermediate frequency (IF) signal that the Compact Array conversion rack could transform into something the samplers digitised. After being transported to the control building the digitised signal popped up on the correlator display; it appeared at the output of the interface box between the array adder and the equipment Jet Propulsion Laboratory (JPL) engineers and Compact Array staff had installed in the correlator room. The JPL instrumentation also detected it. It was transmitted to the USA via Tidbinbilla and compared to the signal the Goldstone 34-m antenna was receiving, and there it was pronounced by JPL's project leader as "a wonderful result".

And a wonderful result it was after the effort that so many ATNF staff put in under Project Leader Warwick Wilson to upgrade the 3/12-mm receivers to have 7-mm capability. The timelines were always tight and to deliver within 18 months has been quite an achievement. In this time much had to be done — development work of the receiver components and their manufacture by the Marsfield workshop staff including a prototype receiver to prove the system, a phase rotator module upgrade, a non-blanking observing scheme and an interface box to make the array signal compatible with the JPL equipment. A week or so prior to the detection of Cassini's beacon, the first astronomy results were presented with great enthusiasm. These showed the system was not just good for telemetry signals at 32 GHz, but was more than useful over the full 30 – 50 GHz band.

There were two phases to the receiver work in the final stages of this project that occupied February and March and a fair bit of April. The first was a refitting phase where the 3/12-mm receivers were moved from the antennas and worked on in

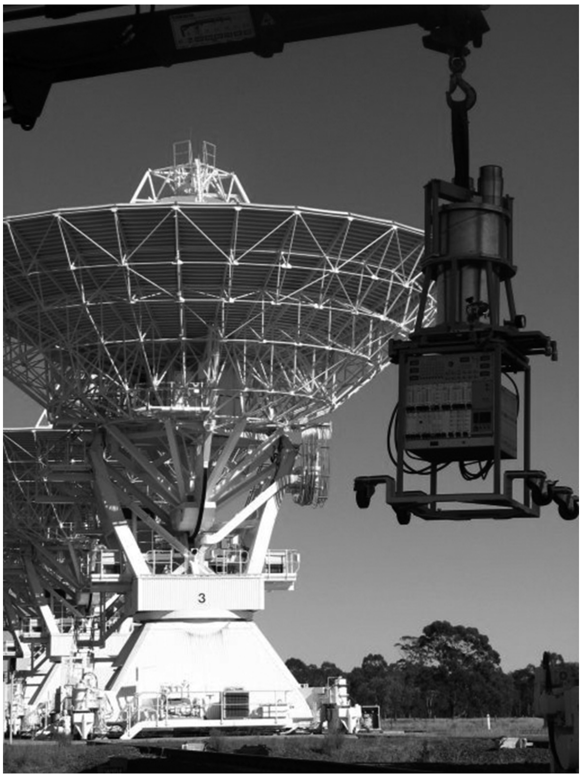


Photo: Graeme Carrad

Figure 1: Transfer of the refitted receiver to the telescope.

Photo: Graeme Carrad

Figure 2: Manoeuvring the receiver on an antenna.

Photo: Graeme Carrad

Figure 3: Serious stuff when re-assembling.

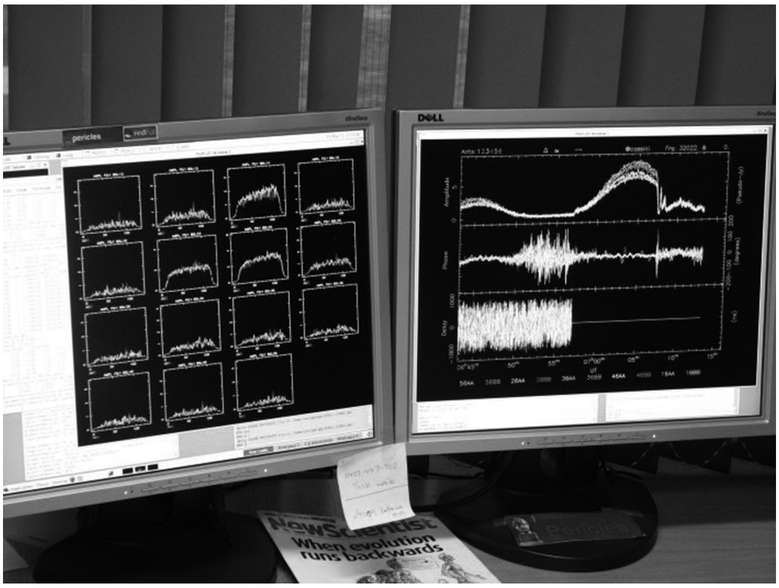


Photo: Graeme Carrad

Figure 4: The "popped-up" signal and track trace details.

the lab. Each was disassembled, fitted with new components, reassembled, evacuated, cooled and tested. The second was an installation phase during which the array was shut down for four weeks to allow the receivers to be reinstalled on the antennas, aligned, evacuated, cooled and tested. Teams from Marsfield and Narrabri coalesced to form a critical mass that was able to provide enough energy to complete both these stages to schedule.

Narrabri staff were particularly accommodating in all aspects; providing lab space and tireless personnel, catering to the whims and dietary requirements of visiting staff, and removing snakes that wanted to be part of the action. Thanks to them, again, for being so good.

The culmination of all this was a little space probe signal popping up on a screen but you all know that story.

First light at 7 millimetres

Ilana Feain and Maxim Voronko

As of April 2007, the Compact Array has receiving capabilities in the range 30 – 50 GHz on all six antennas. The ATNF and NASA's Deep Space Network for spacecraft tracking have jointly funded the system. It is expected that the DSN program will be allocated around 10 hours per week over the next few years.

Towards the end of the four-week shutdown, we ventured up to the Compact Array to test the science-readiness of the system. For the first few days, we watched while the engineers worked tirelessly to complete the installation on schedule. When they finished late on the last night of the shutdown, and we were able to get our hands on the array, we found a beautifully working system with excellent characteristics! Figure 1 shows the receiver temperatures (upper panel) and the system temperatures (lower panel) as measured with a spectrum analyser for one polarisation (A) on one of the antennas (CA03). The characteristics are slightly different on each antenna and for each polarisaton. System temperatures of order 50 – 60 K are expected near the lower end of the band rising, due to the pressure-broadened atmospheric oxygen line at around 60 GHz, to around 100 K toward the upper edge of the 7-mm band. The sensitivity of the array for Fourier synthesis imaging may be

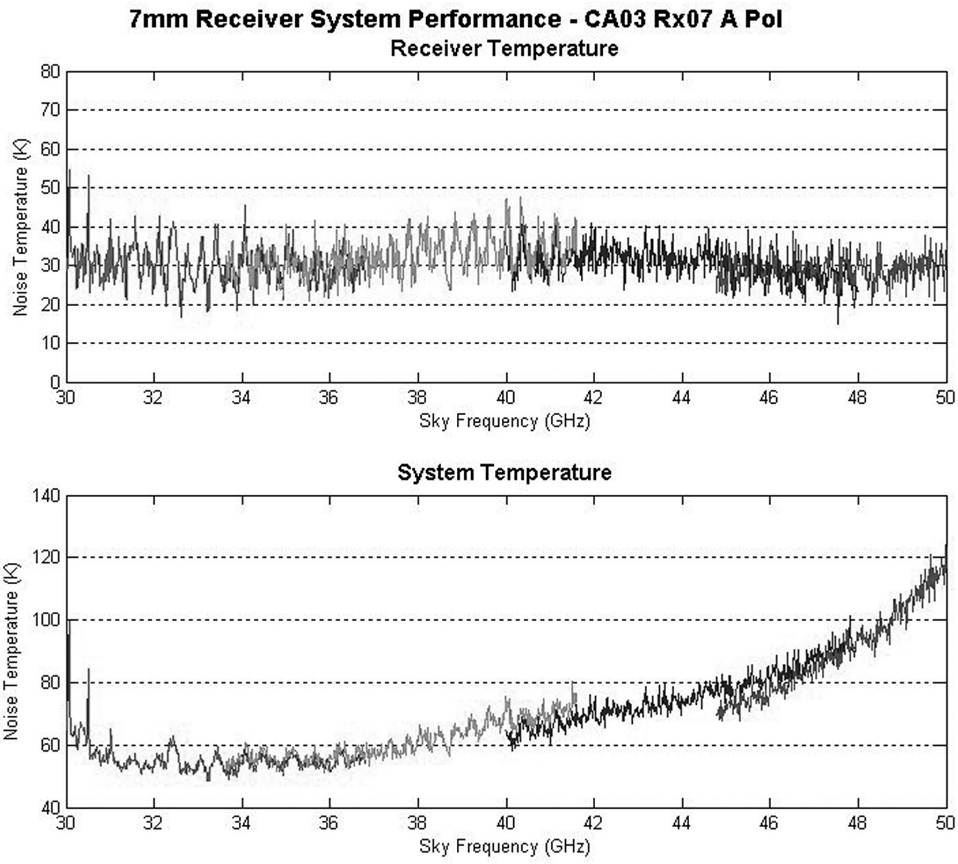


Figure 1: 7-mm receiver and system temperatures.

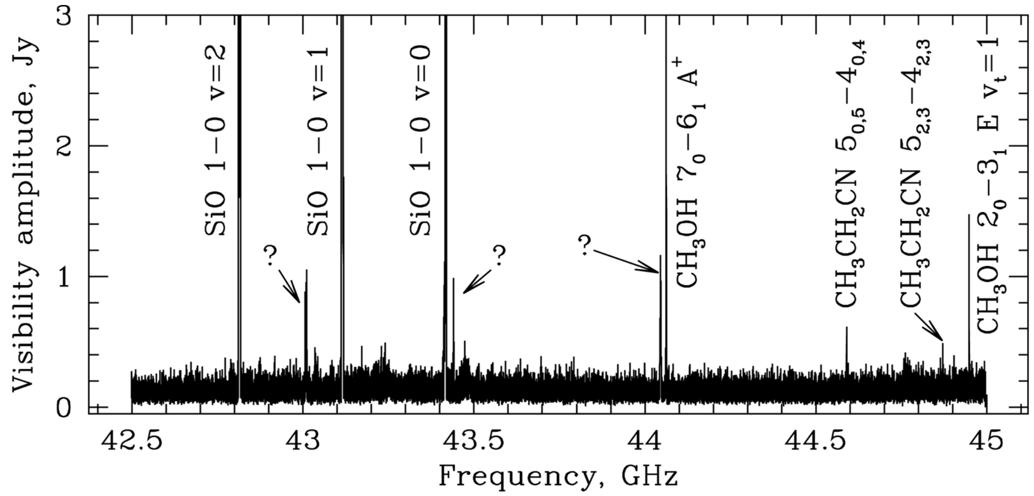


Figure 2: A 7-mm spectrum showing emission from silicon monoxide, methanol and ethylcyanide.

estimated using the online sensitivity calculator (*www.atnf.csiro.au/observers/docs/at_sens/*), which also accounts for atmospheric opacity.

We observed many objects across a range of frequencies and correlator configurations over the weekend to test the system. But really, we could have just as well been observing at 12 mm because we didn't notice the difference — the system was superbly stable and absolutely ready for science! So thank you to Warwick Wilson, Graham Moorey and Graeme Carrad (the Project Leader, Engineer and Manager, respectively) as well as the ATNF receiver and workshop groups for this wonderful new facility.

Demonstration science

As a good demonstration of the system, we made a shallow spectral scan of the Kleinmann-Low (KL) nebula in Orion Molecular Cloud 1 (OMC-1). This source is known to be an abundant reservoir of molecular gas. The scan covered the sky frequencies from 42.5 to 45 GHz contiguously, with an effective integration time of 1.5 minutes. We used a correlator configuration that provided 256 spectral channels over a bandwidth of 16 MHz, for each of two frequencies. It took 96 separate receiver tunings to cover the whole scanned frequency range. The central frequencies of each 16-MHz window were set at 13-MHz intervals to provide some overlap required for a smooth stitching of the spectra. Each 16-MHz window was processed the same way, starting from calibration using the continuum source 0539–057 with an assumed flux density of 1.44 Jy at 43 GHz and a spectral index of –0.3. Then, a strong continuum associated with OMC-1 was subtracted off and all baselines (except those to the distant antenna 6) were averaged together. The amplitude spectra obtained for each 16-MHz window were "stitched" together using a weighted (with 1/bandpass factors) gridding procedure with the Gaussian kernel (FWHM is approximately 20% of the channel width). This gave an effective spectral resolution of about 0.5 km/s.

The resulting spectrum is shown in Figure 2. The spectrum is dominated by the strong SiO and methanol lines. Thermal transitions of ethylcyanide can also be reliably identified. However, we were unable to identify three spectral lines clearly present in the data (the rest frequencies are around 43016.7, 43447.7 and 44053.2 MHz). These transitions are not listed in the 2002 revision of the National Institute of Standards and Technology (NIST) recommended rest frequencies database (*Lovas & Dragoset; physics.nist.gov/PhysRefData/Micro/Html/contents.html*) and therefore their detection in star forming regions has probably never been reported before. It seems unlikely that these spectral features are high-velocity components of known strong transitions because velocities in excess of 100 km/s would be required. The 43016.7 and 44053.2 MHz spectral features could be caused by highly excited transitions of SO_2. The third unidentified transition remains a mystery. New Compact Array observations are required to confirm the detection. In addition, imaging could help in associating this transition with one of the cores and, hence, in narrowing down the list of candidate species because the chemistry differs from core to core in OMC-1.

LBA e-VLBI first science results

Chris Phillips (ATNF), Adam Deller (Swinburne), Shaun Amy (ATNF), Steven Tingay (Swinburne) and Tasso Tzioumis(ATNF)

The LBA has made its first e-VLBI science observations! VLBI with signals from several antennas were sent over broadband network links and correlated in "real-time" with great success. For a total of 16 hours during 23 – 25 March 2007, data from Parkes, Mopra, the Compact Array and the University of Tasmania's antenna near Hobart were streamed to Parkes, where it was processed using the DiFX software correlator developed by Swinburne University of Technology, running on the CPSR2 cluster of PCs.

This has been made possible by the 1 Gigabits per second (1-Gbps) network links that connect the CSIRO observatories in NSW to Sydney. Installed in 2006, these links were funded by CSIRO and provided by the Australian Academic and Research Network (AARNet).

Observations were made at 1.6 and 8.4 GHz of the X-ray binary Circinus X-1, which is producing recurrent radio flares, last seen during 1975 – 1985. Observations started about 10 hours after the predicted peak of a radio flare, and revealed a 10-mJy source with a size of 60 mas at 1.6 GHz and significantly smaller at 8.4 GHz. This detection result was submitted within weeks to MNRAS and is currently in press.

e-VLBI is now being offered as a standard LBA observing mode, on a shared-risk basis, for Parkes, Mopra, the Compact Array and Hobart (no other

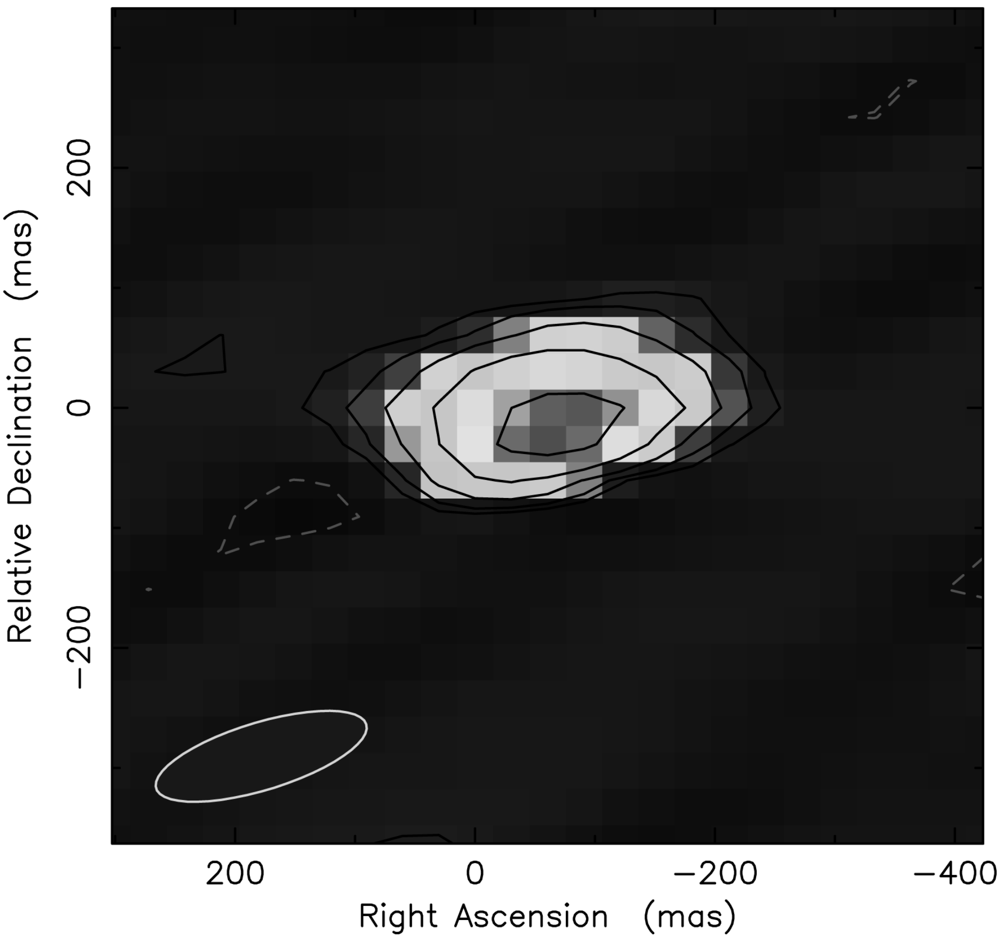


Figure 1: e-VLBI image of Cir X-1 at 1.6 GHz from combined data of 23/24 March 2007. The peak flux density is 7.1 mJy/beam with a beam of 183 milliarcseconds (mas) x 56 mas at a position angle of –73 degrees. The contour levels are at 0.35, 0.70, 1.40, 2.80, 5.60 mJy/beam.

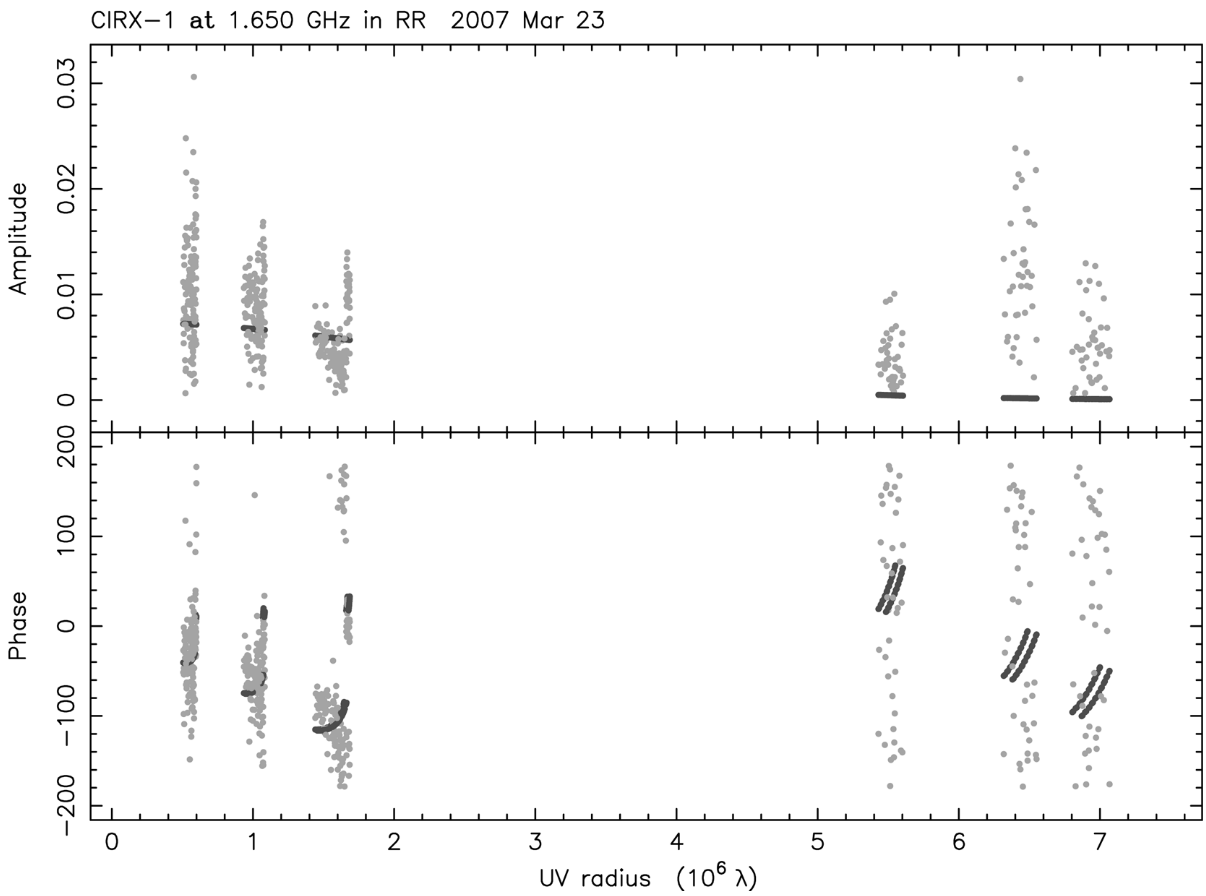


Figure 2: Flux in Jy (top panel) and phase in degrees (bottom panel) plotted against distance in the u,v-plane. A model fit for a circular Gaussian is shown against the data.

telescopes are currently available due to limited broadband connectivity). We have tested data rates of up to 256 Megabits per second (Mbps; a total of 64 MHz bandwidth). For the October 2007 observing semester we plan to offer 512 Mbps rates (128 MHz bandwidth) from Parkes, the Compact Array and Mopra, and 128 Mbps (32 MHz bandwidth) from Hobart, which is limited by the bandwidth across Bass Strait. In a recent test observation the observer was able to download the correlated data within hours of the end of the experiment. Web-based monitoring of the correlated data is available, allowing the astronomers to see their visibilities in real time. We are also actively exploring how to increase the data rate to 1 Gbps. A 1-Gbps Parkes – Compact Array baseline looks likely and will fill the niche previously filled by the Parkes – Tidbinbilla interferometer, but with greater sensitivity.

In a related field the ATNF, AARNet and the Joint Institute for VLBI in Europe (JIVE) are collaborating in the EXPReS project. EXPReS is a project funded by the European Union to develop production e-VLBI for the European VLBI Network (EVN). One part of the project is to demonstrate real-time e-VLBI from Parkes, Mopra and the Compact Array, with the data being sent over international network links to the EVN VLBI data processor located at JIVE in the Netherlands. Given the long distance involved and the huge data rate requirement this is a challenging undertaking. AARNet intend to provide dedicated 1-Gbps connections from the ATNF telescopes to the Netherlands. This work will provide an important demonstration for long-haul data transport needed for future ASKAP and SKA developments.

Where do we publish? How often are we cited?

Philip Edwards and Jessica Chapman

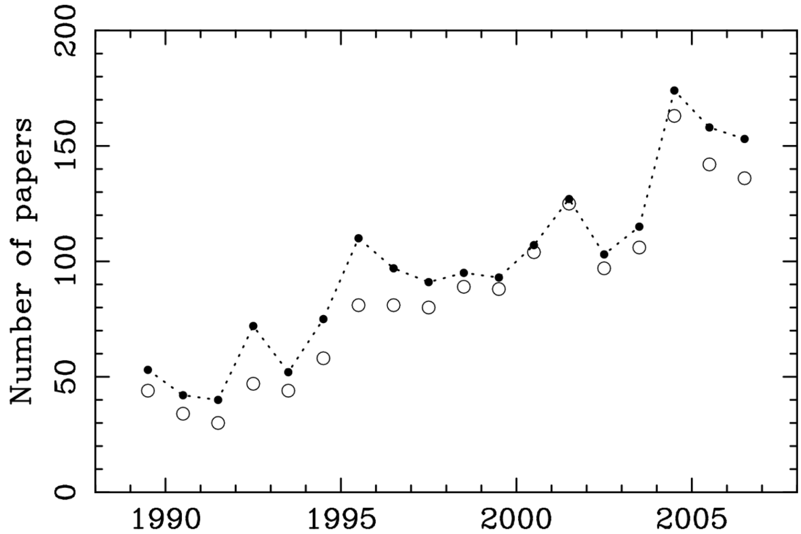


Figure 1: Number of papers published for each year in the ATNF database of refereed publications. Solid points are for all papers, open circles are those papers in the 40 selected journals for which ADS gathers citations, which are discussed in more detail in the text.

So, you've slaved over an observing proposal, been awarded the time, taken the data, carefully reduced it, and written it up into a succinct report with an insightful interpretation. Where do you submit it for publication? And how often is it likely to be cited?

These are questions that have been looked at in the past, but as part of a review of ATNF operations we have revisited them, basing our investigation on refereed papers in the ATNF publications database from 1989 to 2006, and using the Smithsonian/NASA Astrophysics Data System (ADS) to determine the citations to those papers.

Before outlining some of the trends evident in the data, some caveats: the ATNF publications database attempts to list all refereed papers using ATNF data, and any other refereed papers with an ATNF-affiliated author; we have counted all citations to these papers (including citations from both refereed and non-refereed papers), keeping in mind the caution that the ADS Citation Database is not complete (see, e.g., Kurtz et al. 2000). A description of how ADS gathers citation counts is given by Accomazzi et al. (2006).

There are 1757 such papers published between 1989 and 2006 (inclusive) in the database, with the number per year steadily increasing from an average of 45 per year in the first three years to 162 per year in the final three years – a factor of 3.5 increase (see Figure 1).

To compare against other bibliometric studies, Pearce (2004) noted there were roughly 15,000 astronomy papers being published per year, compared with 10,000 papers 10 years earlier, and 8500 papers 20 years earlier. At face value, ATNF has become more prolific more quickly, though a complete analysis would factor in the changing staff levels over this period.

Where are these papers published? The 1757 refereed papers in the ATNF database were published in 130 different journals! (Here ApJSupp, for instance, is taken to be distinct from ApJ, but ApJ includes main journal and letters.) However, the "top 10" journals account for 80% of the published papers. MNRAS alone accounts for 26%, with the others in the top 10 being, in order of rank, ApJ, A&A, AJ, PASA, A&ASupp, Nature, ApJSupp, JEEEA (Journal of Electrical and Electronics Engineering, Australia), and Ap&SS.

We looked at the number of citations each paper had accumulated as a function of year. As ADS does not include in its records all 130 journals in the ATNF database, we limited further study to the 40 journals for which ADS recorded at least one citation, which left us with 1550 papers. The number per year of these "potentially ADS cited" is also plotted in Figure 1. As expected, the average number of citations per paper tends to increase with time

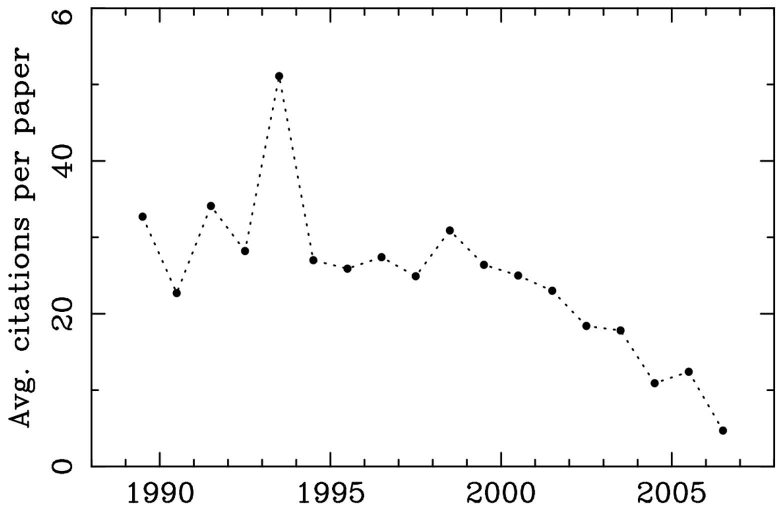


Figure 2: The average number of citations per paper for each year, as derived from the ADS. The peak in 1993 is explained in the text.

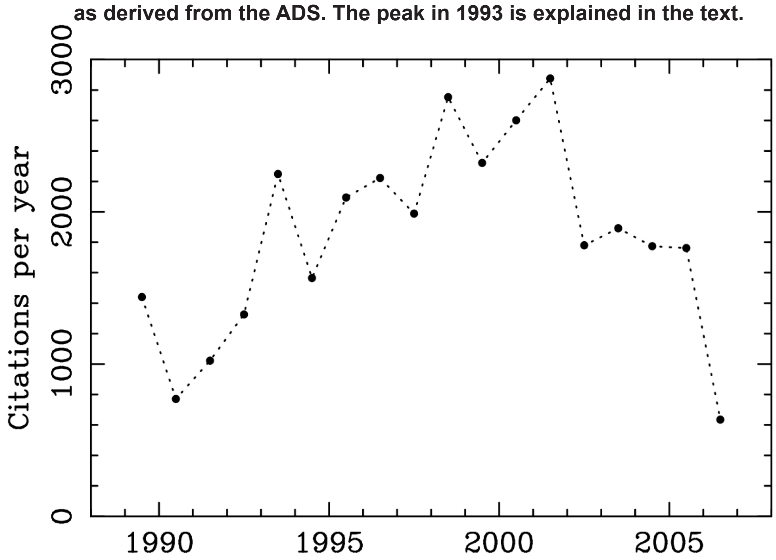


Figure 3: Total number of citations for papers published in each year – the product of the dotted points in Figure 1 with the average in Figure 2.

since publication: the 1989 to 1991 papers have averaged 30 citations per paper, whereas the 2003 to 2005 papers had averaged nine citations per paper to date (see Figure 2). The peak number of citations to papers published in a given year typically occurs two or three years after the year of publication.

A “fairer” comparison is to look at the number of citations in, say, the first two years from publication (recognising that there could be a significant variation depending on whether a paper is published in January or December of that year). Interestingly, here the trend is reversed. The 1989 to 1991 papers averaged 3.6 citations per paper in the first two years after publication (i.e., the year of publication and the following year), compared to 5.7 citations per paper for papers in 2005 to 2006 (and noting that papers published in 2006 have not yet had a full two years in which to be cited!). The biggest contributor is a factor of around three increase in the number of citations in the year of publication, and this can be attributed at least in part to more rapid availability of papers once they are published (or accepted, or submitted, depending on journal), the astro-ph preprint server, and the now widespread use of email for rapid distribution of preprints and reprints.

So if the number of papers is increasing with time but the number of citations per paper is lower for recent years, which year has accumulated the most citations? Not surprisingly, it’s somewhere in the middle, with 2597 citations to papers published in 2001 at the time of writing (see Figure 3).

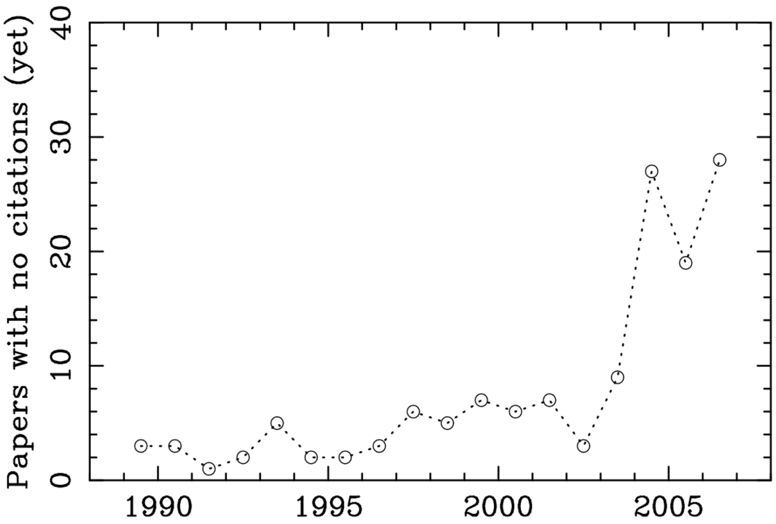


Figure 4: The number of papers for which no citations are (yet) recorded by ADS, from the 40 selected journals described in Figure 1.

So how do papers in the ATNF database compare with others? One measure is the surprising claim by Meylan, Madrid, & Macchetto (2003), that about one third of all refereed papers in astrophysics are never cited! This is substantiated by Pearce (2004). Of the 1425 papers in the ATNF database considered here, only 9% have never been cited, with, as expected, over half of these being papers published in the last three years, many of which will be cited in coming years (see Figure 4). Excluding these three years, only 6% of papers have not been cited. For the record, easily the most cited paper in the ATNF database is the 1993 *Catalog of 558 pulsars* by Taylor, Manchester and Lyne (1993), published in ApJSupp, which has amassed over 630 citations. This paper alone accounts for the peak seen in the average citations per paper for that year in Figure 2.

Finally, we can look at the citations per paper (for papers in the ATNF database) in the "top 10" journals. Nature pips ApJSupp at the post with an average of 60 citations per ATNF paper. The ApJSupp result is skewed by the Taylor et al. pulsar catalog, but even excluding that paper, ApJSupp is a clear second with an average of 38 citations per paper. Of the "top 10" journals Astrophysics and Space Science has the lowest number of citations per paper, at 1.6, a factor of 4.5 less than PASA.

How can you increase your chances of being cited? Schwarz & Kennicutt (2004) and Metcalfe (2005) report that papers posted to astro-ph are cited roughly twice as often as those which are not posted. (Of course it does not follow that this is cause and effect.) And although this study has not differentiated papers using ATNF data from those published by ATNF staff, we can fairly safely conclude that taking your data with an ATNF telescope (which boils down to convincing the Time Allocation Committee (TAC) that your proposal is worthy) is also a good way to ensure your contributions to science will not go unacknowledged!

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ATNF outreach

Robert Hollow, ATNF Education Officer

Photo: Robert Hollow

Figure 1: Students at Cue Primary School observing the Moon during the day

Wildflowers in the Sky

The *Wildflowers in the Sky* project is part of the Australian School Innovation in Science, Technology and Mathematics (ASISTM) program. This project began in June 2006 and has involved astronomers and educators from the ATNF and partner organisations working with schools in the mid-west region of Western Australia.

In March 2007 ATNF staff members George Hobbs and Rob Hollow, together with Lena Danaia from Charles Sturt University Bathurst, visited the partner schools for the second set of visits during the project. Arriving on the tail end of cyclone George, Meekatharra was cloudy, cool and windy, but fortunately the skies cleared for the first viewing night on the Monday. The weather then held up for the rest of the week, though the final viewing night at Geraldton was accompanied by lightning in the distance.

Daytime activities at each school involved practical activities, daytime lunar observing and talks with the students and some professional development for the teachers. A highlight of the trip was at Pia Wadjarri Remote Community School, where all the students and teachers from Yalgoo Primary School visited on an overnight excursion to share in the project. Another interesting experience involved George giving a great "on-air" lesson to the Meekatharra School of the Air students about pulsars and the search for gravitational waves. The students' questions were certainly challenging.

Project partners, including some teachers from John Willcock College, will be running a workshop session at the World Conference on Science and Technology Education in Perth in July. The *Wildflowers* project has also been selected as one of 16 ASISTM projects to be highlighted as exemplars in a report for DEST.

Photo: Robert Hollow

Figure 2: Teachers on the Dish at Parkes.

ATNF teacher workshops

Parkes once again hosted the three-day *Astronomy from the Ground Up!* teacher workshop in May. Teachers from NSW, the ACT, Victoria and Queensland listened to a range of talks by ATNF staff and other presenters, took part in practical activities and learned how to conduct a viewing night and use remote telescopes via the internet. Despite heavy rain the night before, the clouds cleared to allow the teachers to ride on the Dish and have a wonderful viewing night. Several teachers brought along their school's telescopes to try out.

The one-day workshop *Astrophysics for Physics Teachers* held at Marsfield in June provided teachers of HSC-level *Physics* with the content and practical activities to effectively tackle the *Astrophysics* option and *Cosmic Engine* core module. Ilana Feain and Erik Muller talked about their research and its relevance to the syllabus.

Early in May, Rob Hollow presented a one-day *Victorian Certificate of Education Astrophysics* workshop at the new Victorian Space Science Education Centre (VSSEC) in Melbourne. This was our first collaboration with VSSEC and was highly successful. Two of the teachers involved immediately signed up for the Parkes event a few weeks later.

Parkes Observatory report

John Reynolds, Officer-in-Charge, Parkes Observatory

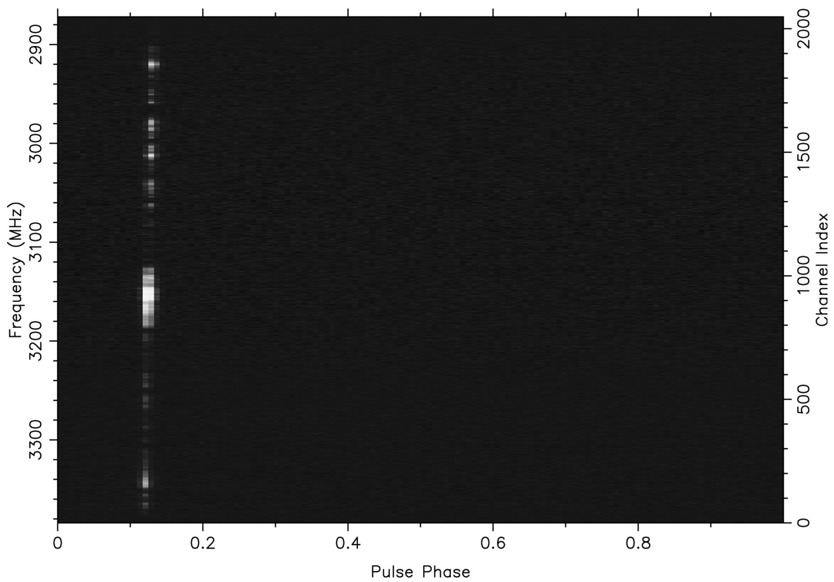

Figure 1: The first astronomical observation at Parkes with the new CABB-based digital filterbank, PDFB2, on 16 March 2007. The pulsar J1752-2806 shows strong scintillation across the 512-MHz band. Interstellar dispersion has not been removed in this plot and is clearly visible.

Operations

Operations have continued smoothly and successfully throughout the year without serious interruption. Scheduled observing time lost in the year-to-date is 0.9% for equipment faults and 2.6% to high wind, most of which was lost early in the year.

The highlight of recent operations was the delivery in March 2007 of the new pulsar Digital Filterbank (PDFB2). This new machine uses one of the first production Compact Array Broadband Backend (CABB) boards and represents a significant advance in capabilities over the prototype filterbank (retrospectively dubbed PDFB1). The new filterbank was commissioned with a bandwidth of 512 MHz, an improvement over the prototype by a factor of two (see Figure 1). It also has greatly improved time resolution over the prototype at short folding periods. On 5 June 2007 a CABB board with higher-performance chips replaced the original board, to allow a 1-GHz bandwidth. The PDFB2 is now in regular use, though with some minor snags that are in the process of being ironed out. Thanks go to Warwick Wilson and his team for another fine product.

The fully-functional filterbank, PDFB3, with two CABB boards and four intermediate frequency (IF) inputs, is expected later in the year. This version will allow direct low-level data connection to external instruments, principally to the ATNF/Parkes/Swinburne Recorder (APSR), a baseband recorder capable of a bandwidth of 1 GHz with all four Stokes polarisation products. This 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 slowly but surely, with approximately 1.6 TB of the 5 TB survey now archived at Parkes. It is planned to complete the duplication this year.

Receivers

The 20-cm Multibeam receiver was successfully returned to service in May following completion of the second half of its refurbishment. The receiver is working perfectly, with no evidence of the microphonic instabilities seen on some beams prior to its removal in November 2006. These instabilities were particularly deleterious for pulsar searching and appear to have been caused by a defect in the original manufacturing of the ortho-mode transducers (OMTs). Indeed, it is quite possible that problems with low-level RFI-like modulation at periods of ~200 Hz in beam 8A, and possibly others seen shortly after original commissioning in 1997, have finally been solved.

The refurbished receiver also has modified cryogenics, with the original CTI 1020 refrigerator units replaced by model 1050 units and the cold fingers re-designed. This change is still under evaluation, but initial indications are that it has significantly improved the cool-down time.

Congratulations to Brett Dawson, Ken Reeves and Jeffrey Vera at Parkes, and Henry Kanoniuk and Pat Sykes from Marsfield for the outstanding success of this work.

New receiver cabin hoist

A new focus cabin hoist was successfully installed on the roof of the 64-m focus cabin during May. The old hoist had given twenty-plus years of reliable service, but was no longer maintainable. The new hoist has a higher-rated capacity (650 kg vs 500 kg) allowing the heaviest load (the 20-cm Multibeam) to be lifted with a generous margin. The new hoist also has variable speed control, rather than two-speed, and an option for hand-held radio remote control, which is currently under evaluation. This facility is potentially very useful when lifting large loads which require an observer standing well back from the telescope to check clearances as the load approaches the focus cabin. The new winch has a double-layer wrap to save space and weight, rather than the single-layer drum in the original. Also included is an overspeed brake mounted on the drum itself for extra safety. The total weight of the new hoist at 220 kg is significantly less than the original at 240 kg.

The successful design and manufacture of this hoist represents a triumph of perseverance for Tim Wilson. After a year or more of fruitless negotiations with a previous company, the contract was subsequently passed to Australian Winch and Haulage who have produced a fine product. Barry Turner undertook testing and installation of the hoist, successfully avoiding the dreaded situation of two inoperable hoists on the focus cabin and no way back!

Compact Array and Mopra report

Phil Edwards, Narrabri and Mopra Officer-in-Charge

The highlight of the last few months has been the addition of the 7-mm band receivers to the Compact Array. This was achieved during a four-week shutdown of the array from 26 March to 23 April 2007, which is described in more detail below.

Noteworthy events

The ATNF Steering Committee this year held their annual meeting at Narrabri in May. The first day of their meeting happened to coincide with an array reconfiguration, and so the committee was treated to morning tea on the alidade level of antenna 5 as it was driven the 1.2 km from its 1.5C station post to its H214 site, just a stone's throw from the Visitors Centre where the Steering Committee meeting was held.

In recent months we have also had visits from the ATNF's Equal Employment Opportunity officer, Vicki Drazenovic, who addressed staff at a morning tea to remind them of ATNF's duty of care to all staff and visitors, and from our new divisional safety manager, Paul Gale. Paul is working with local staff to trial an on-line site safety induction system for visitors in the near future.

A successful *Deconstruction Derby* was held in the Visitors Centre in early June. John Smith rounded up old laptops and electrical equipment from several sites, including a sizeable contribution from CSIRO Plant Industry at Myall Vale, and a couple of dozen enthusiastic volunteers reduced each item to its constituent parts.

We welcomed Dilini de Silva, a vacation student at the Compact Array last summer, back to Narrabri for her Industrial Affiliates Program placement as part of her engineering degree. Dilini worked in the electronics group for four months, developing a test rack for both manual and automated testing of the dataset units used for control and monitoring throughout the array. The only major hurdle Dilini encountered was an unfortunately timed bout of chicken pox in the week before her project report was due! We also enjoyed having Damien Labbé visit from France for an internship as part of his Masters of Astrophysics. Damien worked with Michael Dahlem on Compact Array data reduction, and was able to fit in visits to Mopra and Parkes during his stay.

Shutdown for 7-mm installation

Although primarily for the 7-mm installation, the shutdown provided the opportunity to carry out a number of other larger projects on the array. This included the rapid changeover of one on-line computer, installation of the last two shielded racks in the antenna pedestal rooms, replacement of three antenna uninterruptible power supplies and, in four weeks of activity, the installation of five receiver translators and outfitting of all six antennas with 7-mm receivers! The efforts of Narrabri and Marsfield staff in achieving all this were outstanding.

Ilana Feain (nee Klamer) and Maxim Voronkov made good use of the new receivers in the final week of the shutdown, making observations across the 7-mm band of spectral lines and continuum sources and ensuring the scheduled programs for the April semester would have no problems in their set-ups. The first scheduled 7-mm observations were for the project C007 (Compact Array calibrators) carried out by Michael Dahlem, and the calibrator database has already been updated with these results.

Several observers have enquired as to whether it is possible to observe at 12 mm and 7 mm simultaneously – this is not possible as there are separate feeds for the 12-mm and 7-mm receivers (unlike the coaxial feeds for the 20- and 13-cm bands, and for the 6- and 3-cm bands). Previously, to bring a different feed horn on axis required a rotation of the turret. In order to keep the millimetre dewar to a reasonable size, bringing the 7-mm feed horns on axis requires first rotating the turret to the 12-mm position, then translating the 7-mm receivers a little over 12 cm to the antenna focus. A lot of care is being taken to ensure redundancy in the software and hardware checks of the feed positions, as rotating the turret with the 7-mm feeds still on axis will bring the millimetre package and the vertex room wall into a physical union that could be prejudicial to the continued performance of both! The translation from 12 mm to 7 mm takes about two minutes. Observers should be aware that changes to and from 7 mm will take longer than changes to other bands.

NASA tracking

Following the installation of the 7-mm receivers, we have undertaken several tracking passes for NASA's Jet Propulsion Laboratory (JPL) to demonstrate the system performance. The 32-GHz tests have been made using the Ka-band beacon on the Cassini satellite, in orbit around Saturn. During the first pass, on 11 May 2007, we were able to demonstrate that the array performance exceeded the specification that it should give equivalent performance to a Deep Space Network (DSN) 34-m antenna. This might seem straightforward, given that the total collecting area of the array is equivalent to a 54-m diameter dish, but the broad band 30 – 50 GHz receivers, designed to optimize our astronomical requirements, do not match the performance of the narrow-band 32-GHz feeds on the DSN 34-m antennas. There are also small losses in phasing up the array, which must be done in near-real-time with no downlink data loss by self-calibrating on the satellite signal. Subsequent tracking passes have been, and will continue to be, used to test all aspects of the operations and data flow to JPL (via Tidbinbilla) in readiness for satellite tracking next year. The successful demonstration of the array's ability to track, phase-up, and transfer data is due to significant contributions from Warwick Wilson, Mark Wieringa, and the electronics and receiver groups. The assistance of Tidbinbilla and JPL staff in testing and debugging also deserve acknowledgement.

Mopra developments

The Mopra millimetre observing season kicked off on 29 April. In response to some concern about the script to determine pointing offsets, Mike Kesteven has been leading a detailed study of the robustness of the script and associated hardware, which has led to improvements in the application of pointing offsets. Balt Indermuehle started as the Millimetre Operations Scientist in June, and he has been learning the ropes to provide assistance to Mopra observers. With the assistance of Nadia Lo, the Mopra User Manual has been given an overdue overhaul — suggestions for further additions and improvements are always welcomed.

Time assignment information

Jessica Chapman and Arkadi Kosmynin

OPAL and the ATOA

OPAL (see *http://opal.atnf.csiro.au*) is a web-based application that is used to prepare and submit telescope applications to the ATNF. OPAL was developed at the ATNF and has since been used for four rounds of proposal applications. For the October 2007 observing semester (2007OCTS) we received 125 proposals, with about 80 of these submitted in the 24 hours before the deadline.

It has been an interesting challenge to provide a robust and easy-to-use proposal system that can handle a large number of submissions in a short period of time. We track all suggestions and issues reported by users and user-reported problems are mostly resolved within a few hours.

We have made a number of upgrades to OPAL since the initial release. Version 2.1 was released on 7 May 2007. This has several new features for proposers:

- OPAL now accepts applications for the Tidbinbilla 34-m antenna.

- The OPAL Users Guide contains new information on writing the science case including recommendations from the ATNF Time Assignment Committee.

- OPAL now accepts proposals for “large projects”. These are projects that will require a total observing time of 400 hours or more.

- The OPAL cover sheets identify authors using a search by surname instead of by email address. It is now easier to edit the list of authors using “up”, “down” and “delete” buttons.

- OPAL has a new facility to allow access to the proposal cover sheets for all proposals submitted from 2006APRS onwards.

- The submission of proposals has been made more flexible. From 2007OCTS, any member of a team may submit, update or withdraw a proposal.

We have also been working on a new version of the Australia Telescope Online Archive (ATOA – see *http://atoa.atnf.csiro.au*), which provides access to the Australia Telescope Compact Array archive data files for observations taken between 1990 and 2007.

Version 2 of the ATOA was released on 3 July 2007. This now uses the OPAL registration system to identify a user before access is given to the data archive. In most cases, this authentication allows the ATOA to determine immediately whether requested files should be restricted (for an 18-month period) or made available. Version 2 also has a “quick-look” summary with a list of scans taken at the Compact Array and observing information given in a compact format that is easier to print and read than the full data-files listing.

Over the coming months we plan to further improve both OPAL and the ATOA. For OPAL we will be working on making the observations and source tables easier to use. For the ATOA we plan to automate the transfer of data files using high-speed links and to improve and speed up the loading of file-related information into the back-end database. This will help keep the archives up-to-date. We will then start upgrading the ATOA to include Mopra as well as Compact Array data.

Comments and suggestions for OPAL and the ATOA are always welcome and should be sent to Jessica Chapman.

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 February 2007 newsletter. Papers which include one or more ATNF staff members are indicated by an asterisk.

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The Giant HII region NGC 3576 (cont'd)

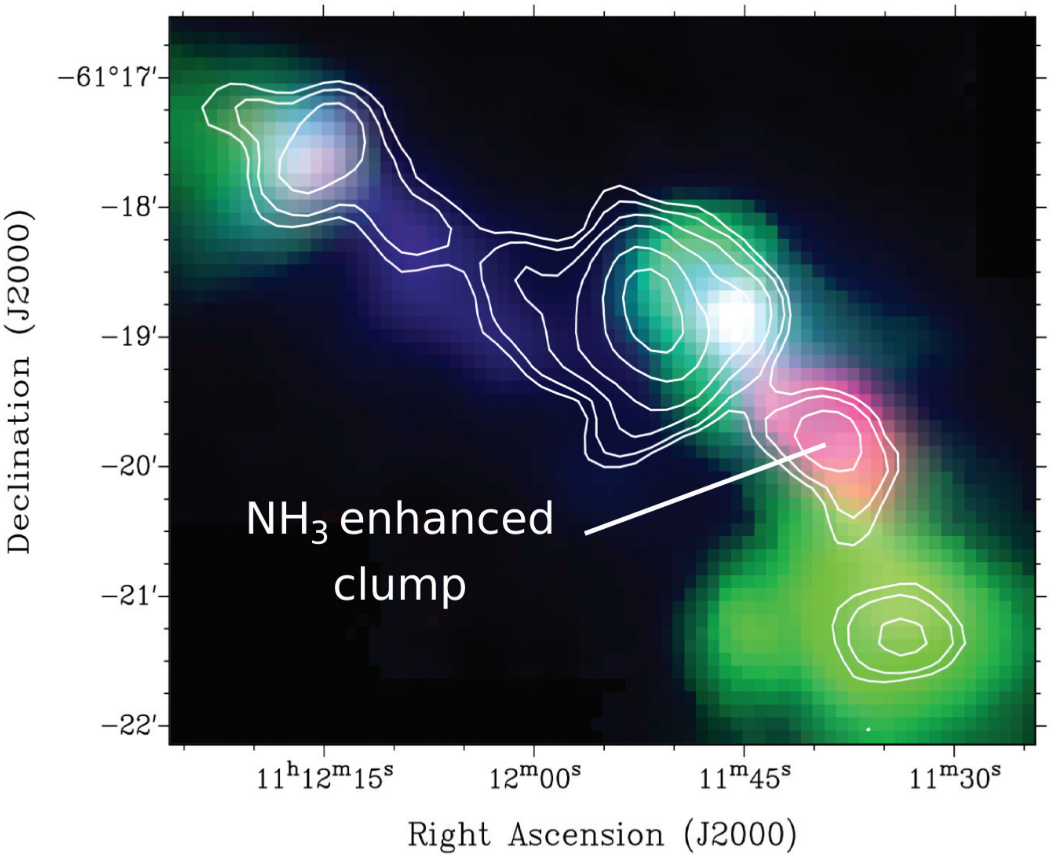

Figure 4: Three-colour Mopra image of molecular emission around NGC 3576. The image was made from column density maps of CO (green), CS (blue) and N_2H^+ (red). One SIMBA clump is coloured pink due to enhanced N_2H^+ emission.

Continued from page 2

Mopra has been used to paint a picture of the chemistry in the filament, utilising the (then new) on-the-fly (OTF) mapping procedure to observe isotopomers of CO, CS and N_2H^+ towards the cloud. Comparative chemistry between the molecules has the potential to reveal the evolutionary state of the clumps. Figure 4 is a three-colour image displaying the column density of CO as green, CS as blue and N_2H^+ as red. One clump stands out as being enhanced in N_2H^+ and deficient in CO. This is a classic signature of a very dense and cold region, where the CO has desorbed onto the dust. It is possible that this clump is in the process of collapsing, making it a very interesting candidate for follow-up observations.

The data outlined above strongly suggests that star formation has begun in the filament. However, further observations are necessary to determine likely masses and evolutionary phases of any protostellar objects.

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Full moon rising above the antennas of the Compact Array during sunset on 7 April 2007. Photo: Graeme Carrad

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