ATNF News

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The first-known double pulsar discovered at Parkes!

About 100 of the 1500 known pulsars are members of binary systems, but only in six or seven of these is the companion star believed to be a second neutron star. Most other systems, originating from lower-mass stars, have white dwarf or low-mass helium-core companions. Up to now, searches of the double-neutron-star systems to detect the second neutron star as a pulsar have proved fruitless. This is not too surprising, since the detected pulsar has been through a "recycling" process, accreting matter from its evolving companion, which both spins it up to millisecond periods and reduces its magnetic field. As a result of these changes, the first-born pulsar has a very long lifetime, typically 10^9 years or more, although gravitational decay may further limit the lifetime in short-orbital-period binary systems. The second-born pulsar, on the other hand, is a "normal" pulsar, typically with a surface magnetic field of 10^{12} Gauss, which spins down and becomes undetectable in 10^7 years or so. Consequently, there is only a small chance of detecting the second neutron star as a pulsar in any given double-neutron-star system and even in any of the known systems.

An international team working at the Parkes radio telescope has beaten these odds by discovering the first known double-pulsar system! This system, PSR J0737-3039A/B, is outstanding, not only for the detection of the second pulsar, but also for its relativistic orbital motions. It was discovered in the Parkes High-Latitude Pulsar Survey, a collaborative project between groups at Jodrell Bank Observatory (UK), the Universita degli Studi di Bologna and INAF-Osservatorio Astronomico di Cagliari (Italy), Columbia

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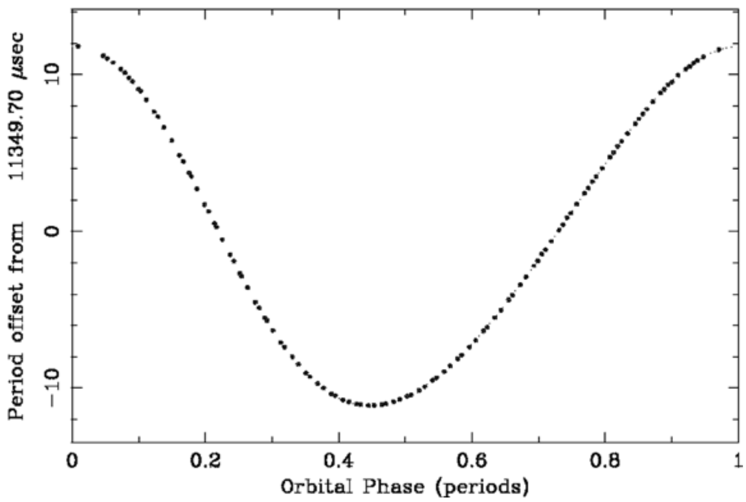

Figure1: Velocity curve for the relativistic binary pulsar PSR J0737-3039A. The mean orbital velocity is approximately 0.1% of the speed of light and the orbit eccentricity is 0.088.

Editorial

Greetings to all our readers. Welcome to the February 2004 ATNF Newsletter. For this issue we were delighted with the response to our call for article contributions! Once again there has been a tremendous interest and we would like to extend our sincere thanks to all.

This newsletter is packed with exciting science reports. The double-pulsar, "the jewel in the crown", is the subject of our cover-page article by co-discoverer, Dick Manchester. The article on page 20 describes the discovery, made with the Compact Array, of near-speed-of-light velocities of ejecta from a neutron star. In the article on page 21, Maxim Voronkov shows that the 25-GHz Class-1 methanol masers may not be as rare as previously thought, while on page 18, Bob Duncan introduces the enigma in the nebula G2.4+1.4. We also have an item highlighting the versatility of a telescope such as the Compact Array and one on the science from the Parkes multibeam receiver. An exciting new survey being undertaken with the Compact Array is described on page 6. You will find the Director's message on page 3. The observatory reports as always contain news, useful information and highlights. Recent happenings within the organization are reported in the news items. We hope you enjoy reading this newsletter, the first issue for the year 2004.

We are always happy to receive your contributions for the forthcoming issues. We also welcome your suggestions and comments! You can contact us at *newsletter@atnf.csiro.au*.

The web version of this newsletter can be found at *www.atnf.csiro.au/news/newsletter*.

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News

From the Director

At the beginning of February, I informed the ASTRON institute, MIT and NRL that Australia was withdrawing from negotiations with the Dutch on the direction in which they were taking the LOFAR program. Over the past few weeks, it has become increasingly clear that funding available for LOFAR in the Netherlands is entirely related to regional development objectives. It is not available for an international project on the site in Western Australia identified by the international LOFAR site evaluation committee to be the optimum location for the LOFAR telescope.

As a result of the highly successful LOFAR Options Paper process conducted over the past six months, in December the Australian community voiced a clear and unanimous message, endorsed by the National Committee for Astronomy, regarding the conditions for its desire to participate in the LOFAR project. A key condition was that the telescope was located at the optimum site.

The conditions of the Dutch funding now mean that a significant scientific facility will be built in the Netherlands. Based on the position of the Australian community, the ATNF has therefore decided not to proceed further with this project plan. We wish our Dutch colleagues well in building their telescope.

I am acutely aware of, and share in, the disappointment felt by many of our stakeholders at this outcome. Nevertheless, I believe there is much to take forward from our current position. As part of the LOFAR negotiations we have built up a strong and productive relationship with both the Government of Western Australia and our US colleagues at MIT and NRL. We are committed to continue working with MIT and NRL over the coming months to develop a clear vision, a new international radio astronomy facility in Australia by the end of the decade that is well aligned with our long-term objectives to maximize our participation in the SKA project.

As we look to progress this program, the support of the broader Australian community is essential. I look forward to working with all stakeholders; CSIRO, the Australian astronomy community, universities, industry, government and our international partners to achieve a common vision driven by the science outcomes.

Brian J Boyle
Director
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New Deputy Officer-in-Charge at Narrabri

In late 2003 the position of Deputy Officer-in-Charge at Narrabri was advertised both nationally and internationally. It is with great pleasure that we welcome Brett Hiscock to this position. Brett has been serving as the Electronics Group leader at Narrabri, and secured the position from a field of strong candidates.

Brett completed his BE degree in 1987 as an electronics engineer. After working for the Navy in Sydney for 13 years, Brett joined the ATNF at Narrabri in September 2002. Brett brought to the ATNF a broad wealth of experience in many electronic areas, having worked in radar, signalling and receiver systems in the Navy. He also brought experience managing a section of thirty engineers and technicians. In the immediate future, Brett will continue to lead the Electronics Group as well as take on some of his new roles. However the intention is that a new appointment will be made in Electronics to relieve Brett.

Photo: Tim Kennedy

Bob Sault
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How many pulsars are in 47 Tuc?

More pulsars have been found in 47 Tucanae than in any other globular cluster. All are fast spinning millisecond pulsars and many are in binary systems. Globular clusters are a favoured hunting ground for millisecond pulsars because they also host many of the progenitor systems – Low Mass X-ray Binaries (LMXB). The neutron-star member of the LMXB accretes matter from its evolving companion, causing it to spin up to millisecond spin-periods. From searches with the Parkes telescope, we know that 47 Tuc contains at least 22 pulsars, but at a distance of 4.5 kpc, perhaps only the brightest have been detected. This thought has led to the conjecture that the cluster may host up to 200 observable pulsars.

A measurement of the total radio flux from the cluster could allow us to estimate the total size of the pulsar population. Given the luminosity distribution of the pulsars already identified, and some assumptions about this distribution at lower luminosity based on studies of galactic pulsars, the total flux of the suggested pulsar population of 200 would be about 4 mJy at 1.4 GHz, easily measurable with the Compact Array. We have imaged 47 Tuc with the ATCA in 0.75 and 0.375-km configurations – the best match to the expected 1.2-arcminute size of the pulsar group. The resulting image is shown here (Figure 1) and indicates that no more than about 2.2 mJy is emitted from the cluster core. Attributing all this to pulsars, and after allowing for variability in flux caused by scintillation in the interstellar medium, we conclude that the cluster contains no more than thirty pulsars.

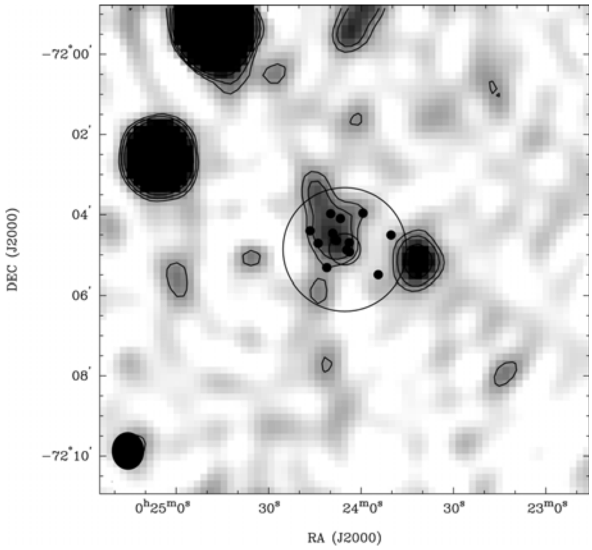

Figure 1: 1.4-GHz ATCA image of 47 Tuc.

To the smaller than expected population size corresponds a higher than expected lower-luminosity limit to the population. The X-ray emission of up to 90 pulsars has been identified in the cluster. This is consistent with a “beaming factor” of 1/3 – the fraction of pulsars whose radio beams sweep the Earth.

For a full account, see “The radio luminosity distribution of pulsars in 47 Tucanae”, McConnell, Deshpande, Connors and Ables, MNRAS (in press) and on astro-ph/0312107.

Dave McConnell
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Reducing ATCA millimetre observations

With the new observing bands at 12 and 3 mm, ATCA observers have an opportunity to exploit a unique instrument in the southern hemisphere. Coupled with this are new steps that need to be considered in the data reduction process. *MIRIAD* has a number of tasks and options that help with these steps. These are documented as new chapters in the current version of the *MIRIAD* Users Guide (available on the web in postscript or html formats). This article sketches some new post-observation considerations. Note also that different observing strategies and calibrations are needed at the shorter wavelengths: these are documented in the web-based observing guides to these new systems.

New monitoring data: The RPFITS file produced by an observation now contains weather measurements, antenna-pointing centre (in addition to delay centre), and a measure of the tracking error. In blustery conditions or when there are antenna drive problems, the tracking error may be a significant fraction of the 3-mm beam size. In this case, an observer can flag data based on excessive tracking error.

Opacity correction: At 3 and 12-mm wavelengths, the atmosphere can no longer be approximated as transparent. The current 3-mm method of determining the effective system temperature (a modified "chopper-wheel method") accounts for atmospheric opacity on-line. This is not the case, however, at 12-mm. An option has been added to the *MIRIAD* task, *ATLOD*, to make a first-order opacity correction based on weather data and a model of the atmosphere. This, along with a calibrator observed at a similar elevation, will largely correct for opacity.

3-mm initial fixes: The data measured at 3 mm still reflects some immaturity in our systems at these wavelengths. A *MIRIAD* task is available to apply a number of "standard" corrections. These include antenna-location correction; shadowing correction; gain/elevation-curve correction; and the application of the system temperature.

Absolute flux calibration: At short wavelengths, it is harder to find compact sources that can be used as absolute flux calibrators. At 12 mm, 1934-638 is still reasonably strong, and has proven to be constant over at least six months. Consequently it can be used as an absolute flux calibrator. 1934-638's flux density over the 12-mm band has been determined and is now built into the calibration software (see Figure 1).

At 3 mm, 1934-638 is far too weak: either Mars or Uranus serves as the best absolute flux calibrator. A number of tasks within *MIRIAD* assist in picking the appropriate planet and then bootstrapping with it.

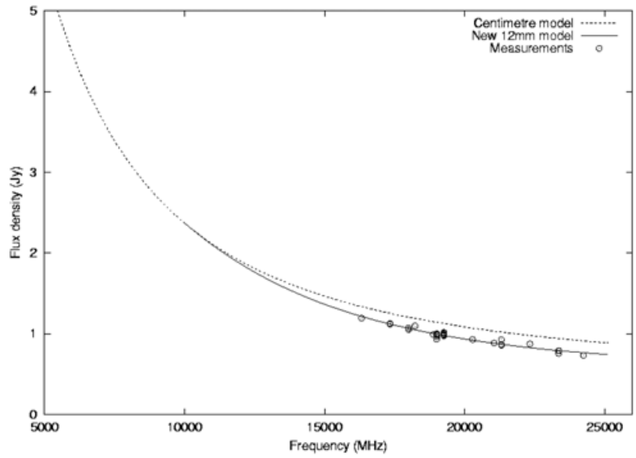

Figure 1: Flux density of 1934-638 at 12 mm. The dashed line shows the model of 1934-638's flux density determined from centimetre wavelengths. The solid line shows the new model to fit the observed 12-mm data.

Note that planets can be completely resolved out in some arrays, and so checking is needed before the observation.

Additionally, the 3-mm flux densities of a few calibrators will be monitored during the winter. Recent measurements of their flux densities could be used for absolute flux calibration purposes. Recent flux-density measurements are available on the ATCA-calibrator web pages.

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Third millimetre-science workshop

The ATNF held its third annual millimetre workshop on 8 December 2003 at the Marsfield site. Approximately thirty participants came to learn about recent developments at the Compact Array and Mopra, and to discuss future directions. There was a greater emphasis on Mopra than in previous years, reflecting the importance of the hardware and software upgrades in progress and the key role the telescope now plays as the only 3-mm single-dish facility in the southern hemisphere.

The day began with reviews of the current status of Mopra and the ATCA by Tony Wong and Stuart Robertson, followed by a review of star-formation studies with millimetre telescopes by Michael Burton, who drew heavily on the proceedings of the recent IAU Symposium 221 in Sydney. Next came a series of science talks, covering ATCA observations of star-forming regions (Jim Caswell, Tracey Hill and Maxim Voronkov), a search for biomolecules in the Sagittarius B2 cloud (Paul Jones), the Mopra survey of hot molecular cores (Cormac Purcell), and imaging of dense gas in the starburst galaxy NGC 4945 (Maria Cunningham). We also heard from Chris Wright and A-ran Lyo of UNSW@ADFA about projects involving infrared observations of young stars, which are in many ways complementary to millimetre studies.

The final session on future directions was led off by Ilana Klamer, who discussed an ongoing project to detect CO at high redshift with ATCA. Ned Ladd and Tony Wong then led a discussion on large "key" projects with Mopra, an idea that is presently attractive given the desire to increase the user base and scientific impact of the telescope, as well as focus energy on improving the usability of the instrument. A couple of projects, including a survey of a portion of the Galactic plane and mapping of the Chamaeleon molecular clouds, were suggested. Rounding out the day were Mark Wardle, who discussed theoretical aspects of massive star-formation, and John Storey, who presented various proposals for Australia to take part in a sub-millimetre telescope in Antarctica.

The slides for most of the presentations are available online at *www.atnf.csiro.au/whats_on/workshops/mm_science2003/*. For information about the workshop, or about the Mopra key science planned for 2004, contact Tony Wong *(Tony.Wong@csiro.au)*. Hope to see you next year!

Tony Wong
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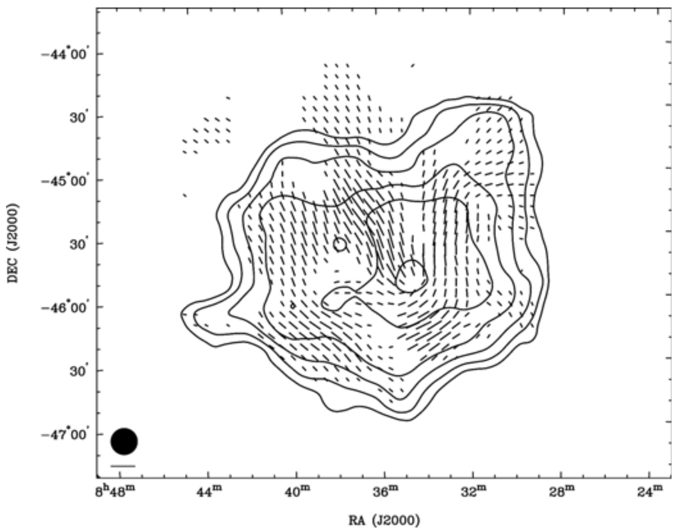
The Compact Array “multibeam” – a novel observing mode



This is a polarimetric image of the Vela supernova remnant made with the Compact Array configured as a set of six single-dishes – a kind of multibeam instrument. The observations were made as a “proof of concept” for project C1109, “Sky polarization at 5 GHz” (McConnell, Carretti, Subrahmanyan, Cortiglioni, Poppi and Sault). The aim of C1109 is to survey the sky polarization at 5 GHz in the Boomerang field to provide information about polarized foregrounds in future measurements of the polarized Cosmic Microwave Background (CMBP). Galactic synchrotron emission is a potential contaminant in the CMBP measurements. The expected peak in the CMBP spectrum around multipole ℓ = 1000 corresponds to the angular scales well matched to the 22-m ATCA antennas at 5 GHz. Observations are made as a series of drift scans, it being crucial to hold the antennas stationary during data collection because of the polarization offsets being strongly dependent on both elevation and azimuth.

The observation of the Vela region was made over a 3.5 × 3.5-degree patch for about 10 hours. Each drift scan measured a 0.25-degree band of sky with the six antennas spaced by 3 arcminutes in declination. The final resolution is 12 arcminutes.

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C1241: Going wide and deep to unravel the secrets of the obscured Universe

C1241 is a new ATCA project conducting the deepest wide-area survey ever attempted at 20 cm. The radio observations will be critical to understanding the nature and evolution of the “obscured” galaxy population which will be well-sampled by the SWIRE surveys (Lonsdale et al: *www.ipac.caltech.edu/SWIRE/survey*). Furthermore the radio data, combined with data from many other facilities, will also lead to important insights into the properties of star-forming galaxies and AGNs in the early Universe. This ambitious project will see the ATCA having a significant profile within the international “legacy” programs within the Great Observatories Origins Deep Survey (GOODs).

There are two major limitations to previous deep-field research – (i) they cover wavebands which are insensitive to dust-obscured systems and (ii) they have extents of << 1 square-degree so the results are biased by small sample sizes and cosmic variance. A combination of the new wide-area surveys, with the addition of wide-band submillimetre and far-infrared coverage, will address both and extend our knowledge of the deep-field Universe.

The ability to detect and study the physical processes in dust-obscured galaxies is now of major importance. There is increasing evidence that one or more populations of obscured galaxies contribute significantly to the total star-formation density of the Universe. Only the most luminous sources, the Ultra-luminous IRAS galaxies (ULIRGs) are well studied, yet there is good reason to believe that deep surveys in the submillimetre and far-infrared will detect many more obscured, highly “active” galaxies at a range of luminosities. These galaxies may be the source of the extragalactic background at these wavelengths and may also be linked with strong nuclear activity (i.e. AGN). This link may arise because of (a) the huge amounts of available accretion fuel and also (b) hints that dusty galaxies are strongly clustered, so that the increased likelihood of interactions and mergers would trigger AGN outbursts or flaring activity.

The Spitzer Space Telescope, formerly the Space InfraRed Telescope Facility (SIRTF) is now fully operational and observing with its IRAC camera (3.6 – 8 microns) and the MIPS camera (24 – 160 microns). Over the next two years, the Spitzer Wide InfraRed Extragalactic (SWIRE) surveys will image large regions of the sky, covering a total area of around 65 square-degrees. At longer wavelengths, the survey with the new ALMA-pathfinder facility, APEX, at 850 microns will cover at least one 3-square-degree region to a depth of 2 mJy.

To study the far-infrared and submillimetre sources they must be localized so that their counterparts can be easily identified. This is not directly possible from far-infrared or submillimetre data – dusty galaxies will be detected at high surface densities by Spitzer and APEX, yet their instrumental beam-sizes are tens-of-arcseconds. The most effective way to pin-point the source is to use the tight (although physically poorly understood) relationship between the far-infrared and radio continuum.

Over the two years, ATCA project C1241 will conduct deep, wide-area surveys of the SWIRE and APEX regions in the CDFs and ELAIS-S1 regions. Each area mapped by the ATCA at 20 cm will be 3-square-degrees and the rms sensitivity will approach 10 microJy. The project will be requesting a total of 130, 12-hour observing slots. By the end of the project we expect to catalogue of order 15,000 radio sources across these two fields, yielding not only the means to cross-identify sources at all other wavebands, but also important radio data on the astrophysics of these galaxies.

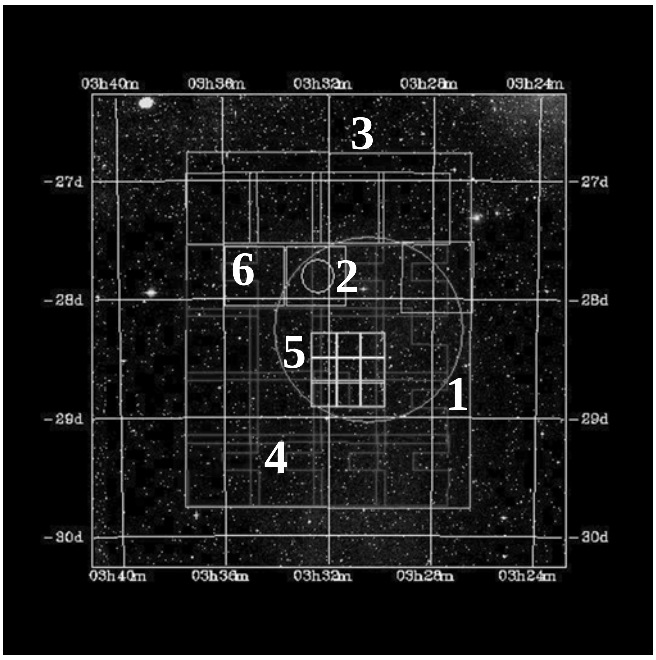

Figure 1: The region around the Chandra Deep Field south (CDFs) showing:

1. **Large circle: The 3-square-degree ATCA 20-cm mosaic region**
2. **Small circle: The Hubble ACS pointings of the CDFs (*www.stsci.edu/ftp/science/goods/*)**
3. **Large rectangle: The approximate border of the SWIRE Spitzer/SIRTF field (*www.ipac.caltech.edu/SWIRE/survey/*)**
4. **The regions indicated by the light lines are the KPNO mosaics with g'~25.7, r'~25, i'~24**
5. **The array of squares: Deep optical imaging with g'~27 r'~26, i'~25, U~26 and K_s~20.7**
6. **The two adjacent squares are the EIS fields (*www.eso.org/science/eis/*)**

Brian Boyle, Carole Jackson and Ray Norris (Brian.Boyle@csiro.au, Carole.Jackson@csiro.au, Ray.Norris@csiro.au)

Symposia and workshops   March 2004 to July 2004

Event	Date	Location	Web Information /Contact
AAO / ATNF Joint Symposium 2004	5 April 2004	Marsfield Lecture Theatre	*www.aao.gov.au/jsymp2004*
Gravity 2004	15 16 April 2004	University of Sydney	*www.astronomy.org.au*
Australia Telescope Users Committee meeting	15 16 June 2004	ATNF Marsfield Lecture Theatre	*Jim.Lovell@csiro.au*
Harley Wood Winter School	1 4 July 2004	University of Queensland	*www.astronomy.org.au*
ASA Annual Scientific meeting	5 8 July 2004	University of Queensland	*www.astronomy.org.au*

Radio astronomy at the short-lived Georges Heights field-station

Introduction

One of the features of Australian radio astronomy during the late 1940s, was the existence of a number of field stations maintained by the CSIRO's Division of Radiophysics (henceforth RP) at former WWII radar stations (Sullivan, 1988). The best-known of these was located at Dover Heights, but it is not widely known that RP also maintained a field station at Georges Heights in 1947 – 1948, and that this was involved in pioneering solar radio astronomy.

Solar monitoring at Georges Heights

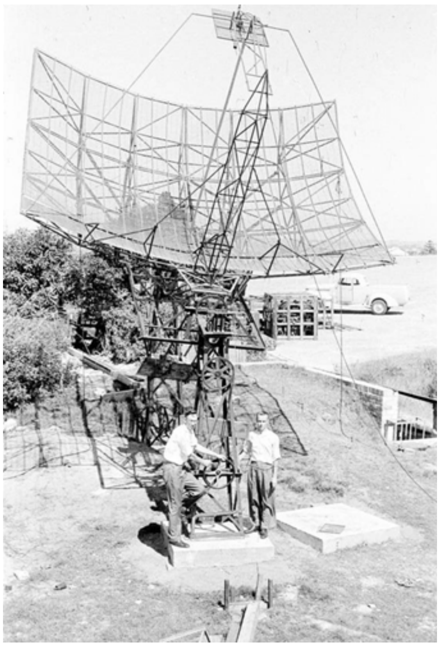

Figure 1: Joe Pawsey (left) and Don Yabsley (right) with the 4.3 × 4.8-m ex-radar antenna on 1 May 1947 (ATNF Historic Photographic Archive: B1031-9). The insert shows the 200, 600 and 1200-MHz dipoles (after Lehany and Yabsley 1949: Plate 2).

The Georges Heights radar-station occupied an attractive strategic position on Middle Head, overlooking the entrance to Sydney Harbour and during the war was home to a number of different radar antennas. One of these was an experimental unit featuring a 4.3 × 4.8-m section of a parabola with a cumbersome alt-azimuth mounting (Figure 1), and the only way it could be used for radio astronomy was to place the antenna ahead of the Sun, let the Sun drift through the beam, hand-crank the antenna ahead of the Sun again, and repeat the process throughout the day. This procedure produced a distinctive "picket fence" chart record. At this time, Payne-Scott and her collaborators were monitoring solar activity from Dover Heights, using 60, 100 and 200-MHz Yagis, and the Georges Heights antenna allowed the frequency-coverage to be extended to 1200 MHz.

Assigned to this antenna were two young RP radio engineers, Fred Lehany and Don Yabsley. New Zealand-born Lehany had a M.Sc. from the University of Otago, and during WWII was employed by AWA. Between 1945 and 1948 he worked at RP as a Senior Research Officer, before transferring to the National Standards Lab – where he eventually assumed the post of Director. Thus, his involvement with radio astronomy was short-lived, and his Georges Heights project "… came about in a typical 'Pawseyian way', before I knew what was happening.… there was an observing program and … Yabsley and I were a suitable pair to share not only the week days but also the weekend duty …" (Lehany, 1978).

His companion, Don Yabsley, joined RP as a Assistant Research Officer in 1944 after completing a B.Sc./B.Eng. at Sydney University, and worked on the LORAN project (Yabsley, 1978). Immediately after the War, he observed the Sun at Dover Heights with Ruby Payne-Scott, before transferring to Georges Heights in 1947. There he was responsible for designing and building the triple-feed system that allowed the ex-radar antenna to operate simultaneously at 200, 600 and 1200 MHz (see Figure 1 insert).

Meanwhile, Lehany's special contribution "… was the provision of a cavity filter at the input of both the 600 MHz and 1200-MHz mixer receivers, thereby suppressing the unwanted image frequency and higher frequency bands using harmonics of the local oscillator for frequency conversion. Thus each of these receivers was essentially monochromatic and this feature facilitated the achievement of accurate calibration of flux densities. He was also responsible for providing the matched hot loads used to perform the calibration." (Yabsley 1986).

Assisting Lehany and Yabsley in June-August 1947, mainly during the development of the receivers and feed systems and operational testing of the antenna, was a young Technical Assistant named Bruce Slee. Later Slee would establish an international reputation through his work at Dover Heights, Fleurs, Parkes and Culgoora (see Orchiston, 2004). A frequent visitor to Georges Heights during the developmental phase was one of RP's receiver "gurus", Lindsay McCready, and Slee recalls that Ruby Payne-Scott and Joe Pawsey (head of the radio astronomy group within RP) were occasional visitors. Pawsey and Yabsley are shown in Figure 1.

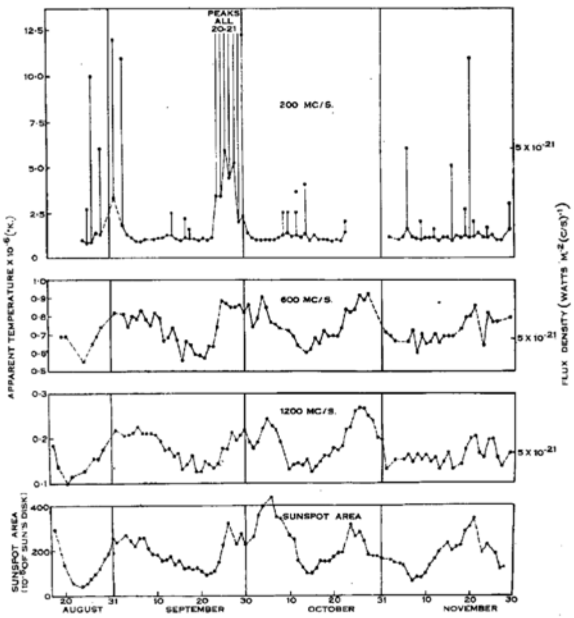

Figure 2: The correlation between sunspot area and solar flux at 600 and 1200 MHz in 1947 (after Lehany and Yabsley 1949: 56).

By August 1947 the equipment was fully operational and in the first instance solar monitoring was carried out for about two hours daily, from 18 August until 30 November, resulting in the detection of many bursts at 200 MHz. In contrast, bursts were rare at 600 and 1200 MHz, where the general flux variations with time were correlated with sunspot area (see Figure 2). This distinctive pattern was discussed by Lehany and Yabsley in papers published in *Nature* and the *Australian Journal of Scientific Research* in 1948 and 1949 respectively, along with those rare outbursts that would now be classed as Type II events.

During mid-1948 the Georges Heights field-station was used as a test-base for two portable 3-m dishes, that were constructed in order to observe that year's 1 November partial solar-eclipse from Rockbank (Victoria) and Strahan (Tasmania). One of these antennas is shown in Figure 3. Ironically, this eclipse was the death-knell for Georges Heights as a radio-astronomy facility: a decision was made to transfer the ex-radar antenna to the Potts Hill field-station, where it would be used to monitor the eclipse.

Concluding remarks

For less than a year, Georges Heights played a significant role in the early development of solar radio astronomy in Australia. Research carried out there by Lehany and Yabsley aided our understanding of the association of 200-MHz bursts and solar flares, and of the correlation between sunspots and radio emission at 600 and 1200 MHz.

It is interesting to note that Georges Heights provided Lehany with his sole research foray into radio astronomy, a field in which he admitted to having little interest (Lehany, 1978), whereas it proved the perfect radio astronomy training ground for a youthful Don Yabsley. Although he spent 1951 – 1961 working in the air navigation group at RP, Yabsley returned to radio astronomy once the Parkes Radio Telescope was commissioned, and was involved in a number of collaborative research projects and in the up-grading of the dish. His unexpected death late in 2003 robbed Australian radio astronomy of one of its pioneers.

What of the Georges Heights site? Consolidation of research at the Dover Heights field-station, and development of a new multi-facetted research facility at Potts Hill, saw the ending of radio astronomy at Georges Heights towards the end of 1948 – but not before the ex-radar antenna was transferred to Potts Hill, where it was used over many years for solar and galactic research, including the first Australian H-line observations.

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Figure 3: One of the simple 3-m diameter alt-azimuth-mounted "solar eclipse" antennas undergoing testing at Georges Heights in August 1948 (ATNF Historic Photographic Archive: B1511).

ATUC report

The most recent meeting of the Australia Telescope Users Committee was held on 3 – 4 November 2003. This was the first meeting for the new ATUC Chair and Secretary, Dr Steven Tingay (Swinburne University of Technology) and Dr Jim Lovell (ATNF), respectively. It was also the first ATUC meeting for the new ATNF Director, Prof Brian Boyle. ATUC warmly thanked the outgoing Chair, Dr Carole Jackson, and long-serving Secretary, Dr Vince McIntyre, for their ATUC efforts in recent times.

The first day of the ATUC proceedings consisted of Observatory reports, National Facility reports, and updates on the many current ATNF projects. The second day was taken up with the ATUC business session. Notable issues discussed by ATUC during the business session included:

1. Six-month observing terms for ATNF telescopes

The ATNF management made the decision to move ATNF telescope observing terms to six months, from four months, prior to the last ATUC meeting. At previous ATUC meetings, when six-month terms have been proposed, ATUC has advised against the idea since very little user support has ever existed in its favour. From a poll of users prior to the last ATUC meeting, little appears to have changed in this regard. ATUC thus again made a statement against six-month terms, but to no avail. Six-month observing terms have been implemented.

2. Key science projects for Mopra

ATUC suggested that the ATNF might facilitate some sizable Key Science Projects using the Mopra antenna, in order to boost its use. The mm-workshop in 2003 December included a session on new large projects using the Mopra antenna.

3. Mapping mode for Tidbinbilla

It was suggested that a mapping mode for the Tidbinbilla 70-m antenna would be a powerful use of this facility that is now open for proposals through the ATNF. Spectral-line and continuum mapping modes for Tidbinbilla will be explored by ATNF staff. This is a very positive development for the Tidbinbilla facility.

4. Replacement software for SPC

ATUC reiterated its recommendation that the spectral-line reduction software SPC be replaced. ATUC were very encouraged by progress by the ATNF on a plan to replace SPC in the near future.

5. Potential new projects

On 3 November the ATUC meeting heard presentations on a number of potential new projects which were discussed and commented on in the business session on 4 November.

The full ATUC report to the ATNF Director can be found at *www.atnf.csiro.au/management/atuc/2003nov/report.html*.

If, as a user, you wish to comment on the contents of the ATUC report, or any other issues relating to users of ATNF facilities, you can contact me or any other ATUC member, as listed at *www.atnf.csiro.au/management/atuc/*.

The next ATUC meeting is scheduled for 15 – 16 June, 2004, to be held as usual at ATNF, Marsfield.

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Distinguished visitor program

At the end of 2003, we enjoyed the company of Dr Brent Tully (Institute for Astronomy, Hawaii) and Dr Namir Kassim (NRL). Both visitors gave an excellent series of colloquia at the ATNF and at various Australian universities. We also continue to enjoy the company of Dr Ned Ladd until mid-2004.

Confirmed visitors for later in 2004 are Dr Eric Wilcots (University of Wisconsin-Madison) who will visit from September 2004 to January 2005 and Dr Joel Weisberg (Carleton College) who will visit from July 2004 to June 2005. We look forward to their visits.

Prospective visitors should get in touch with the Director, a staff collaborator or myself.

Lister Staveley-Smith
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ATNF graduate student program

It's a pleasure to introduce two new students who have started projects with ATNF co-supervisors:

- Antoine Bouchard (RSAA, ANU) has started a PhD project entitled "The Evolution of Dwarf Galaxies in Nearby Groups" with supervisors Dr Gary Da Costa (ANU), Dr Helmut Jerjen (ANU), Dr Juergen Ott (ATNF) and Dr Lister Staveley-Smith (ATNF). Antoine is familiar to ATNF staff from when he was a University of Montreal Masters student.

- Martin Leung (University of Sydney) has also commenced a PhD project. Martin's project is "The Development of a New Wideband Feed for a Cylindrical Reflector". His supervisory panel is Dr Anne Green (University of Sydney), Dr Bevan Jones (Argus Technologies), Dr Andrew Parfitt (CSIRO) and Dr John Kott (ATNF).

The CSIRO scholarship offers for 2004 have been made, and the results will appear in the next newsletter.

Some students may not be aware of new page charge funding arrangements which were introduced last year at the suggestion of the AT Users Committee. The new arrangements allow support of up to $500 for papers submitted by ATNF-affiliated students. For guidelines and more information, see the web page *www.atnf.csiro.au/education/graduate/scholars.html.*

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Astrofest-2003

The last Astrofest was held on 10 December (see *www.atnf.csiro.au/people/dpisano/astrofest_program.htm)* and witnessed the presentation of many exciting results. As 2003 was the 50th anniversary of the first detection of neutral hydrogen (HI) outside of the Milky Way, we had Brian Robinson, one of the pioneers, talk on his work on the detection of HI in the Magellanic Clouds. Brian graciously visited for this occasion and his talk and insightful questions throughout the day added greatly to the day's proceedings.

Brian's talk was followed by more recent, but no less exciting results from current staff, students, and visitors. HI was the theme at the beginning of the day with Baerbel Koribalski talking about HI in interacting galaxies, and Naomi McClure-Griffiths presenting evidence for a new spiral-arm in the Milky Way.

They were followed by a series of talks on observations of various types of stars with Rachel Deacon presenting her PhD research on OH masers in post-AGB stars, Gregory Tsarevsky talking about multi-wavelength studies of active stars, and Bob Duncan talking about a Wolf-Rayet star and its nebula. The morning ended with Martin Cohen, visiting from Berkeley, who summarized 30 years of studying the Red Rectangle.

After feasting on pizza, Wayne Orchiston talked about his recent historical research at ATNF and Tara Murphy gave a fascinating presentation on machine learning in astronomy. 2003 was also the 40th anniversary of the first detection of molecular lines in the microwave. On this theme, Tony Wong and Juergen Ott presented recent results on molecular-line observations around evolved stars and galactic nuclei obtained from the new 3-mm and 12-mm systems on the ATCA. Vince McIntyre ended this session talking about his ATCA monitoring of Gamma-Ray Bursts; a result which appeared on the cover of Nature.

Seventy years ago, Fritz Zwicky predicted the existence of neutron stars, making this year's Astrofest a welcome occasion for George Hobbs and Dick Manchester to present exciting new results on pulsars. George talked about the birth velocities of pulsars, while Dick presented the exciting discovery of a double binary-pulsar system by the Parkes multibeam-survey team. The day concluded with Chris Phillips and Roopesh Ojha talking about VLBI studies of masers and active galaxies. Perhaps some of the results presented at this year's Astrofest will be commemorated in future years.

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Reminiscing the multibeam: 1997 – 2003

On 21 January 1997, the Parkes multibeam receiver was installed into the focus cabin of the Parkes radio telescope.

On 22 October 2003, the multibeam receiver was removed for major refurbishment (see Figure 1). Aiding in the removal were Brett Dawson, David Catlin, Ken Reeves and Jon Crocker.

Due to the quality of the design and construction, the multibeam has essentially been running non-stop for nearly seven years! In that time, I estimate around 120 projects have been allocated time on the receiver!

The last two years revealed signs of ageing in the Low Noise Amplifiers (LNAs). One beam had a completely dead channel (10A), several had high Tsys or unstable gains and the central beam displayed intermittent faults. It was time to give the receiver a bit of R&R.

During 1997 – 2000, the HIPASS, ZOA and Pulsar projects were the principal research activities at the Parkes Observatory. Other major surveys during 1997 – 2003 include the DEEP HI surveys of the Centaurus, Fornax and Sculptor Galaxy clusters, the Southern Galactic Plane HI 21-cm Survey (SGPS) and the HIPARK drift-scan survey.

In general terms the HIPASS/ZOA surveys have detected some 7000 galaxies, with about 20 percent previously unknown. The pulsar surveys have found around 700 new objects, which is more than double the number known prior to 1997. The SGPS survey has possibly identified a new spiral arm to our galaxy, not to mention the identification of new galactic HI-shells and chimneys.

It is a good time to reflect on some of the world-class research the multibeam has produced. Below is an approximate timeline of not just science highlights, but software and hardware as well.

(Abbreviated) Parkes multibeam timeline

- **Feb 2004** Deep HIPASS catalog (HICAT) goes live on *http://hipass.aus-vo.org* (Meyer et al., Zwaan et al., MNRAS in press).
- **09 Jan 2004** Fastest-orbiting double pulsar announced (Lyne et al. 2004, Science, 303, 1153).
- **17 Dec 2003** A new spiral arm of the Milky Way identified? (McClure-Griffiths et al. 2003, ApJ submitted).
- **Jun 2003** The HI mass-function of the 1000 brightest HIPASS galaxies reveals low-surface brightness galaxies don't significantly contribute to the mass function (Zwaan et al. 2003, AJ, 125, 2842).
- **06 May 2003** Cosmic Dandruff: High velocity clouds found in HIPASS data may not be a form of dark matter, but scraps shed by satellite galaxies orbiting the Milky Way (Putman et al. 2003, ApJ, 586, 170).
- **29 Jan 2003** New pulsar catalogue with data on 1300 pulsars placed on the ATNF website.
- **Nov 2002** Properties of the 1000 brightest HIPASS galaxies (Ryan-Weber et al. 2002, AJ, 124, 1954).
- **11 Oct 2002** Southern ZOA spectra placed on the ATNF website.
- **14 Mar 2002** The PMSURV pulsar survey completed. About 700 new pulsars identified.
- **21 Feb 2002** First 16-MHz nearby galaxy-group survey (Pisano et al.).
- **09 Feb 2002** 16-MHz narrow-band filters commissioned.
- **17 Dec 2001** The Northern Extension of HIPASS completed.
- **30 Oct 2001** The HIPASS High Velocity catalogue released (Putman et al. AJ, 123, 873).
- **21 Oct 2001** First detection of ionized gas in a globular cluster (Freire et al. 2001, ApJ, 557, L105).
- **Aug 2001** Approximate completion date of the Southern ZOA Survey.
- **12 Jul 2001** Einstien's Theory of General Relativity confirmed with observations of pulsar J04037-4714 (van Straten et al. 2001, Nature, 412, 158).
- **03 Oct 2000** Northern and Bulge extension to the ZOA survey started.
- **13 May 2000** The first dataset from HIPASS placed on the web.

- **Mar 2000** Southern Galactic Plane Survey (SGPS) starts.
- **19 May 1999** The Unix Telescope Control System (TCS) software replaces TKMULTI (VMS).
- **17 Feb 1999** Magellanic System narrow-band survey commenced (Bruens et al. 2000).
- **13 Dec 1998** First narrow-band observations of the LMC (Staveley-Smith et al. 2003, MNRAS, 339, 87).
- **03 Dec 1998** Lister Staveley-Smith, Warwick Wilson, Malcolm Sinclair and Trevor Bird awarded CSIRO medals for work on the multibeam system.
- **05 Nov 1998** Parkes multibeam pulsar survey identifies 1000th known pulsar (J1524-5709).
- **22 Aug 1998** Narrow-band (4/8 MHz) upgrade installed (Wilson et al.).
- **20 Aug 1998** The Leading Arm, a counterpart to the Magellanic Stream is identified. The LMC and SMC appear to be tidally disrupted by the Milky Way (Putman et. al.1998, Nature, 394, 752).
- **Nov/Dec 1997** Realtime data processing program Livedata shifted from a DEC alphaserver to a Sun.
- **21 Aug 1997** The ATNF, Jodrell and Bologna Parkes multibeam pulsar survey (PMSURV) begins.
- **27 Feb 1997** HIPASS/ZOA: First data taken.
- **06 Feb 1997** Commissioning observations on the barred LSB galaxy, UKS1038-483.
- **21 Jan 1997** Multibeam receiver installed into the focus cabin.

Multibeam receivers galore!

The success of the multibeam receiver has caused several overseas institutions to seek collaboration with CSIRO/ATNF to build one of their own! At Jodrell Bank in the UK, a four-beam system is used at the 76-m Lovell Telescope. Commissioned in 2000, the receiver is primarily used for the HI Jodrell All Sky Survey (HIJASS), which will provide the northern equivalent to HIPASS with $\delta > +25$ degrees. See *www.jb.man.ac.uk/research/hijass/* for more information.

Figure 1: The Parkes multibeam receiver being removed from the focus cabin on 22 October last year. David Catlin can be seen working the hoist.

The Arecibo L-band Feed Array (ALFA) is a seven-feed system currently being constructed by CSIRO/ ATNF engineers for use on the 305-meter Arecibo Telescope in Puerto Rico. Operating near 1.4 GHz, ALFA will be used for pulsar, extragalactic and Galactic HI studies. Its anticipated delivery to Arecibo will occur sometime mid-year. See *http://alfa.naic.edu/* for more information.

Work on a 6 GHz, 7-beam multibeam receiver for Parkes is already in progress. It may be available towards the end of 2004. Stay tuned (no receiver pun intended).

What's next?

The Parkes receiver group (Brett Dawson and David Catlin) are characterizing the multibeam receiver. Their report will be produced at a later stage. The same LNAs built for the Arecibo 7-beam array (see above) are being produced and will replace those currently in the Parkes multibeam receiver. It is anticipated that the multibeam receiver will be back in the focus cabin by June this year – just in time for the start of the OCT04 semester!

Stacy Mader
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Large crocodiles + me = astronomy

In April last year I visited the Keck Observatory on the big island of Hawaii. After my first visit to the 4-km summit of Mauna Kea, I was feeling a little dizzy and got thinking about how I came to be involved in astronomy in the first place… I ended up giving my musings as a talk to the Keck community one wintry afternoon.

Photo: Stacy Mader

Figure 1: Not tempted by the chef's soufflé, Fred chose to have something with a bit more bite.

Having spent fifteen years of my childhood in the Kimberlies, living in close proximity to king brown snakes and crocodiles seemed natural. Going out on weekends and catching a fish which changed sex from male to female (the Barramundi), was simply fascinating. I had no doubt I would one day be a Marine Biologist.

After seeing the 1986 Giotto encounter with comet Halley, I asked my mother to buy a small 4-inch reflector telescope. Even though I was constantly bitten by mossies each time I took that telescope outside, I found the dark night sky full of surprises. My career path became less certain.

When I entered University, I started a double major in Physics and Zoology. At the end of my second year, a crocodile farm was being built back home in Wyndham. Looking for some summer pocket money and keen to get some experience, I was successful in applying for a job.

On my first day, the manager was showing me around and introduced me to a guy called Erik (alias "The Viking"). Erik started telling us that a count of hatchlings in one pen was about fifteen short. After a bit of looking around, we found they had gone down a storm water drain. Being the smallest, I was "chosen" to go in and flush them out. Concerned the light at the end of the tunnel might be their mother's eyes, I asked what I might protect myself with. Erik went into the storeroom and presented me with overalls and a broom. After crawling about ten metres in a dark drain, sweeping as I went, I managed to flush out a few "snappydiles" (as Erik called them). Their mother was (thankfully) nowhere to be seen.

A few weeks later, a landscaper from Kununurra came over to plant some shrubs near the waterline in the juvenile pond. About thirty crocs lived in this pond, some about two metres long. Again, I was asked to go in with the landscaper and watch over him as he put the shrubs into place. Although I survived the hatchling encounter, the thought of thirty hungry crocs constantly looking at us as a meal was not appealing. Thinking this was no job for a broom, I was keen to see what my next fear-invoking weapon might be... Again I was surprised to find another guy, Mike (aka "Lizard"), coming towards me with a long stick! So there I was on the edge of the pond, daring these crocs to come at me whilst I had a piece of wood in my hands. Later on I discovered the guys at work had come in early and fed the crocs before I arrived - thereby making the crocs less likely to charge. If they did approach me, I'm sure I would have set a new world pole-vaulting record as I sailed over the high fence surrounding the pond.

By this stage I realized why I was having second thoughts about a career in Marine Biology. In the proceeding weeks I discovered that hatchling crocodiles can easily bite through rubber wellington boots; you should never hold a hatchling by the tail, and just because crocodiles make a barking sound, it does not make them man's best friend. However, one of the highlights was feeding the crocodiles; I've included a picture of my favourite croc, "Fred", having a light snack.

In my last week at the farm, I was highly suspicious of what the guys at work might pull. I went through the first four days without incident, but on my last day they got me a beauty. I was handed a camera and told to take a picture of the entire staff (something for me to remember them by). Erik kept telling me to move back so I could get everyone in the picture. As a result, I bumped into a fence surrounding one of the breeding pens. Nothing unusual there I thought, so I refocused on taking the picture, leaning against the fence. What they didn't tell me was the female in that pen had laid a nest right next to where I was leaning. You can imagine my surprise when I felt the fence move as the female came up and hit the fence a few metres from where I was standing! Once I stopped having kittens, I realized all were in the joke and they didn't stop laughing for quite some time. After ten beers or so, I felt calm enough to have a laugh as well.

When I returned to University, I concentrated on Physics/Astronomy, trading the Zoology in for Physical Geography and Mathematics. No snappydiles were to be seen.

Whenever I'm back home fishing, any snappydile who feels the need to take a Barramundi off my fishing line will feel the force of my broomstick!

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ATNF outreach

Launch and lunch start Parkes Mars Tracks

Over the last few months, three space missions, NASA's two Rovers and Europe's Mars Express, have successfully assailed Mars. NASA had called upon Parkes to supplement its own Deep Space Network during this busy period. And so, on 31 October, the US ambassador to Australia, Tom Schieffer, visited the Parkes Observatory to launch this support tracking – the Parkes Mars Tracks.

In last October's newsletter John Sarkissian described how ATNF and Tidbinbilla staff had worked over the last two years to ready the telescope for this task. The ambassador's visit was an occasion to publicly thank those workers for their efforts, and to affirm the relationship between Parkes and NASA, which began when the telescope was being built. The eighty-strong crowd at the event was made up mainly of CSIRO and NASA staff, Tidbinbilla contractors, government representatives, and staff of the US embassy.

31 October was also, not coincidentally, the 42nd anniversary of the telescope's formal opening. That day had been hot and dry, the wind whipping up the dust on the then treeless site. For the ambassador's visit the wind once again rose to the occasion, but this time it was cold, and rain threatened most of the day.

The ambassador's party flew up from Canberra on the morning of the event and, before coming out to the Observatory, attended a civic reception in Parkes, organized by the Shire Council. The ambassador arrived at the Observatory more or less on time, and met local staff. But the people flying up from Sydney had not yet arrived. Their plane had caught on fire while landing at Mascot, and had had to be replaced by two smaller planes from Bankstown airport. Thus Warren King (Group Chair, CSIRO IT, Manufacturing and Services Group), who was to represent CSIRO at the launch, unexpectedly found himself driving a carload of people from Mascot to Bankstown, with a passenger navigating from the street directory.

After an hour's delay everyone was assembled at the Observatory and the formalities began, with John Reynolds officiating. Warren King spoke of the long relationship between Parkes and NASA; its record of success in supporting previous missions; and of the preparations for the tracking, such as the construction

Photo: John Sarkissian

Figure 1: Armed and dangerous, Ambassador Schieffer (left) and Parkes OIC John Reynolds pose for the cameras.

of the 8.4-GHz receiver. Neal Newman, NASA's representative in Australia, emphasized how the relationship between CSIRO and NASA depended on good relations between individuals. Ambassador Schieffer spoke about the value of exploring the Universe. He also told the story of how he'd been offered the position of ambassador by US President George Bush: after he'd accepted, he said, he and his wife saw "The Dish", and "that's when I knew coming to Australia was going to be fun".

In his best ship-launching style, the ambassador officially kicked off the tracking by smashing a bottle of champagne against one of the new panels used to upgrade the dish's surface (one not on the telescope, but mounted on the ground). Then it was time for a ritual exchange of wooden implements. In a nod to "The Dish", Warren King presented the ambassador with a handcrafted Australian cricket bat signed by ATNF staff. The ambassador, who in the 1990s had managed the Texas Rangers baseball club for George W. Bush and his buddies, reciprocated with a baseball bat.

The wind was keen, but not so strong as to prohibit the dish from tipping; twenty-odd VIPs and media were now whisked away for a hayride, while the ABC-news helicopter circled overhead. A couple of brave souls trekked to the focus cabin. Of the guests remaining on the ground, some fled for shelter from the wind; others toured the telescope or inspected the multibeam instrument, recently brought back to Earth. Camera crews bailed up people for interviews. Eventually everyone assembled at The Dish cafe for lunch, a stand-up affair that allowed lots of mingling. Local Federal MP John Cobb, who was representing the Minister for Science, proposed a toast to the telescope; the musicians played; the crowd sang "Happy Birthday" with varying degrees of gusto; everyone tucked into birthday cakes baked by Parkes staff. Then the ambassador set off for Parkes airport and a bumpy flight back to Canberra, and the event wound to an end.

The day was a credit to the Parkes staff, who'd coped with this influx of visitors with their usual efficiency and aplomb: despite the initial delay, everything ran smoothly. Special thanks were due to Lewis Ball and Gina Spratt, who'd done much of the organizing, and to those who'd taken care of the details, from testing the champagne bottles to setting up the PA system. Take a bow, folks.

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Summer vacation program

Each year the ATNF coordinates a summer vacation program for undergraduate students. This program has been running successfully since 1988. This year the program was held jointly with CSIRO Telecommunications and Industrial Physics (CTIP) and the recently formed CSIRO ICT Centre. Approximately 280 applications were received for 18 positions. Of these, the ATNF hosted eight students, with six working in Sydney and two at the Narrabri Observatory.

The summer vacation program began with a set of introductory lectures and tours. The students then worked for approximately 10 weeks on a research project, under the supervision of a research scientist or engineer. At the end of the program on 10 February, the students held a one-day symposium, coordinated by Annie Hughes, with excellent presentations given on their research projects. It was impressive to see how much the students achieved in a short time.

In addition to their main projects, in mid-January the students took part in an observatory trip where they spent four days working in small teams at either the Parkes or Narrabri Observatory. Each team was allocated approximately 12 hours of observing time for an astronomy or engineering project. As many of the students have little background in astronomy this was a challenging but rewarding experience. The observing trips were supported by Naomi McClure-Griffiths at Narrabri and D.J. Pisano at Parkes, who reported getting very little sleep.

We thank the many people who helped make this year's summer vacation program successful.

Jessica Chapman
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Photo: Shaun Amy

Figure 1: ATNF summer vacation students in 2003/2004. From left to right: Cliff Senkbeil, Shekhar Suresh Chandra, Ryan Clement, Marija Vlajic, Melissa Wals, Aeolyn Gwynne, David Jones and Annie Hughes

Outreach workshop

On 2 December 2003 an inaugural outreach workshop was held at the ATNF. This was an opportunity for ATNF staff from the Parkes, Narrabri and Marsfield sites to get together, share ideas and consider outreach objectives from an ATNF-wide perspective. Dr Fred Watson, from the Anglo-Australian Observatory, also attended the day to share his extensive outreach expertise with us.

The day began with a set of ten presentations on diverse topics that included a theoretical perspective, outreach at the ATNF Visitors Centres, plans for an outreach website, the SEARFE project, outreach opportunities with the SKA/LOFAR and general perspectives. The powerpoint files from these talks are available on the web at *www.atnf.csiro.au/education/workshop/workshop_talks.html*.

The afternoon was used for an intense brainstorming session around a set of questions dealing with current outreach/education issues. Many ideas were raised during this free-thinking discussion and these were consolidated in a set of recommendations that will help guide future outreach developments. Overall the day was very successful in bringing people together, confirming the ATNF's overall outreach objectives and planning for the future.

Jessica Chapman
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Summer at the ATNF

My housemate swore I'd never see the ocean, and it was true that even the Director's Office has no harbour views. But when I arrived at the ATNF Marsfield as a summer student last December, I had ten long weeks to explore Sydney's beaches and two much more pressing things to worry about. First, the observing trip was not a misprint. Someone was going to let me drive a national icon worth millions of dollars. Reversing down my aunt's driveway and over her agapanthus, this was a matter of some concern. Second my benign-sounding project, "Structural Analysis of Galaxy Images" was a portal to another world. Having once been assured by a certain notable pulsar astronomer that taking a square root was all the mathematics I would ever need, my supervisor Tony Wong handed me a shell script with more Fourier transforms than I could count with my fingers. "Well, here's where I calculate the power spectrum of the image by the basic Fourier method", he explained, "Next I do the wavelet transform. Maybe tomorrow you could implement the second-order structure function that Frick et al. refer to and we'll see how the analyses compare." And then Lister Staveley-Smith, very casual, three days later: "Of course, the structure function can be derived analytically from the autocorrelation function, can't it Annie?" Forget self-help, the best motivator for hard work is the terror of looking like an idiot... please God, not again.

Wavelets. In November, all I knew about wavelets was that they could be a Pet Hat or a Mexican Hat, which seemed strangely fashion conscious for the mathematical world. Type "wavelet" into Google and you will discover a cabal of seismologists, sound engineers, meteorologists, medical imaging technicians, defence specialists and mathematicians exchanging vitriol about a kind of reality you didn't know existed. For weeks I imagined Tony as the White Rabbit, rushing past my desk – "Oh me, oh my! I'm terribly late" – and teleporting me to the curiouser and curiouser world of the Daubechies Four Group (later in the project I discovered that although some wavelets are hats, others are more like Cold War political alliances).

Time too went weird in the wavelet world. It dilated terribly around the first few days of introductory tours and the long corridors of CTIP, and dragged interminably in the week before Christmas when I was convinced I would never understand wavelet transforms or escape to see my loved ones again. Mid-January I must have eaten a cake that said "EAT ME" because all of a sudden my weekends started to disappear in the Melting Pot. In the blink of an eye, the Symposium was five days away... then two... then three hours away and I was in a twilight zone where composing powerpoint slides at 5.50 am seemed a perfectly reasonable thing to do.

Did it go well? I know I had a wonderful time, that I learnt more than I thought my head could hold and that I met only dedicated, encouraging and inspiring people. Everyone at ATNF deserves a huge "thank you" for putting the Summer Vacation Program together and making us feel so welcome. But you'll have to get my full answer later. There's a few hours before I fly back to Melbourne and someone told me there was a beach around here somewhere...

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Articles

Compact Array image of the G2.4+1.4 nebula

G2.4+1.4 is a prominent ring nebula first observed at radio wavelengths by Milne (1970). It was at first considered to be a possible supernova remnant, but subsequent studies, among them those of Caswell and Haynes (1987) who detected the H109-α and H110-α radio recombination lines, showed that its emission is thermal.

In projection the spectacular Wolf-Rayet star WR 102 lies within the G2.4+1.4 nebula, and for this reason is almost universally accepted to be its cause. Wolf-Rayet stars are hot massive stars, which having exhausted their hydrogen, have moved on to helium burning. They typically have strong stellar winds and episodic, violent mass-ejections, and as a consequence are often surrounded by ring nebulae. Of all known Wolf-Rayet stars, WR 102 is perhaps the most extreme. It is one of only three known Galactic Wolf-Rayet stars that have passed the stage of core Helium burning, and advanced to Carbon burning (Dopita et al., 1990). Such stars are even hotter than helium-burning stars, and with a temperature of 150,000 K, and a dense stellar wind of velocity 5500 km/sec, WR 102 is the most extreme of the three (Barlow and Hummer 1982; Torres, Conti, and Massey 1986; Dopita et al., 1990). Hence WR 102 has the most violent stellar wind of any known Galactic Wolf-Rayet star, and must be amongst the hottest of any known Galactic star of any type. Its distance has been estimated by Dopita et al. to be 3 kpc.

We have imaged G2.4+1.4 at centimetric wavelengths with the Compact Array; and show the resulting image in Figure 1. On this image we have drawn a “star” to mark the position of the Wolf-Rayet star, WR 102, a circle to highlight the boundary of the nebula’s inner void, and an asterisk to mark the centre of this circle.

This image has two striking features. The first is the beautiful symmetry of the nebula about the position 17 45 47 -26 12 20 (marked with an asterisk in Figure 1). The central void has circular symmetry about this position, and the whole nebula has bilateral symmetry about an axis running 32^{o} east of north. This structure is what one might expect if, at some time in the past, a star at this centre of symmetry had suffered a large bipolar mass-ejection, and had subsequently swept out a circular void with a powerful stellar wind.

The second striking feature is the eccentric position of the star that is believed to be the source of the nebula, WR 102. This lies, not at the centre of the nebula, as one would expect, but on the northern edge of the central void. This eccentric position requires explanation.

The first thing one can say is that the apparent position of WR 102 must result from projection. WR 102 is an extremely hot star with one of the fastest, densest stellar winds known, yet is causing no obvious disturbance to a beautifully symmetrical bubble (Figure 1). The star cannot really be positioned in the wall of this bubble; it must be in the background or foreground.

Although WR 102 could be unrelated to the nebula, we will here assume that it is its cause. An active hot star is needed, both as an original source of the nebula, and as a current source of UV to keep the nebula ionized. We have searched for an active star at the centre of symmetry of the nebula (marked by an asterisk in Figure 1), but without success. We are left therefore with WR 102 as the only obvious candidate in these roles.

Therefore, our suggested explanation is that WR 102 was originally at the centre of the current nebula, but after a large mass-ejection that formed the nebula, ran away and is now outside the nebula, although still close enough to irradiate it with UV light. One could ask, “Why did WR 102 not destroy the symmetry of the nebula while travelling to its present position?”. The answer could be that it escaped so quickly, that it was within the nebula only during the time when the consequences of an initial giant mass ejection were dominant. Also, through edge brightening, we see only the section of the bubble wall that is in the plane of the sky. A runaway star that now appears by projection to be on this edge, but is in reality outside the bubble, would not have passed through this plane-of-the-sky edge, but instead through the undetected front or back walls of the bubble.This explanation retains WR 102 as the source of the initial mass-ejection that formed the nebula, and as the source of the UV needed to keep the nebula ionized, and explains why WR 102 is not currently distorting the wind-bubble.

To calculate the proper motion needed to move the star outside the nebula one needs to estimate the age of the nebula. Wolf-Rayet stars have an average age of 5 Myr (Moffet et al., 1998), but the nebula is almost certainly much younger than that. Hα images (Marston et al., 1994) show that G2.4+1.4 is encircled by two faint outer rings, strongly suggesting that the star has suffered repeated episodic mass ejections. Nebulae dissipate with age and are unlikely to remain bright for more than 100,000 years. Though it is little more than a guess, we will assume the age to be 100,000 years.

The G2.4+1.4 nebula has a radius (strictly a semi-major axis) of 5 arcminutes. If the star has moved outside the nebula to, say, a distance of, 10 arcminutes and is 100,000 years old, then this implies a proper motion of 6 mas/yr.

WR 102 is at a distance of about 3 kpc (Dopita et al., 1990), so that 10 arcminutes equates to a linear distance of 2.7×10^{14} km. Hence if the nebula was formed 100,000 years ago, the velocity needed to move it 10 arcminutes from the nebula centre would be 85 km/s. This is a very high velocity for a Wolf-Rayet star (Moffat et al., 1998), but perhaps not impossible.

The symmetrical central void perhaps looks not simply like the result of a past explosive mass ejection, but like the result of continuous sweeping by a subsequent stellar wind. But, as we have said, we have been unable to find a hot star at the bubble's centre.

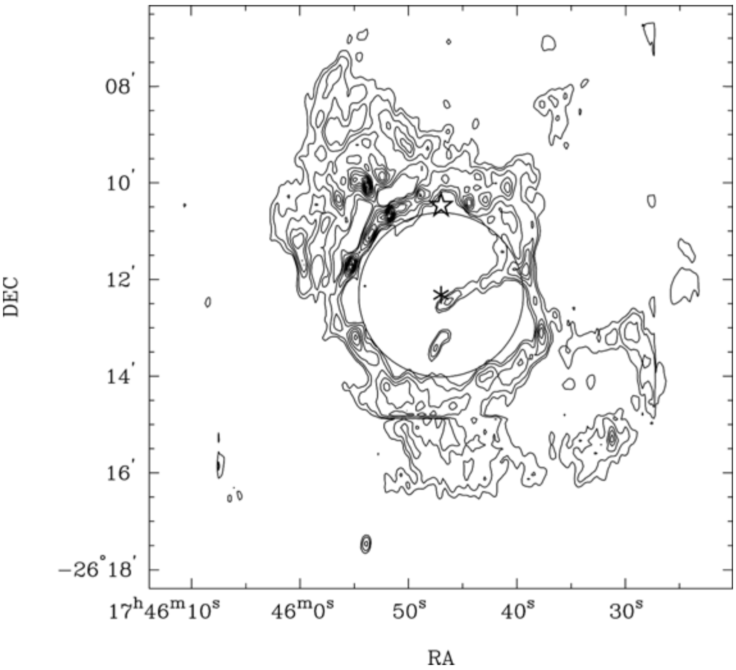

Figure 1: Centimetre-wavelength image of the G2.4+1.4 nebula. A "star" marks the position of the Wolf-Rayet star WR 102, a circle the boundary of the inner void, and an asterisk the centre of this circle.

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An ultra-relativistic outflow from Circinus X-1

Jets – collimated outflows most famously observed from Active Galactic Nuclei (AGN) and copious emitters of synchrotron radio emission – are one of the most significant yet poorly understood phenomena in high-energy astrophysics. New observations performed by our group using the Australia Telescope Compact Array, reported in *Nature* on 15 January (R.P. Fender et al., 2004, Nature 427, 222 – 224), provide clues as to the physics underlying such jets.

Until recently it had been widely assumed that highly relativistic (which we'll define here as having a bulk Lorentz factor $\Gamma = (1 - \beta^2)^{-1/2} > 2$) jets were only associated with accretion onto black holes in AGN, black hole X-ray binaries and, most dramatically, Gamma-ray Bursts. Consequently, it was speculated that the formation of such relativistic jets was related to black-hole-specific physics, such as the extreme curvature of spacetime just outside the event horizon, or the extraction of black-hole spin energy via coupling to the ergosphere. In our new observations (see Figure 1) we have found an outflow from an X-ray binary with a Lorentz factor $\Gamma > 15$, by far the fastest flow ever observed in our galaxy, and comparable to the highest speeds observed from the jets of AGN. The jet is also inclined within a few degrees of the line-of-sight, and increases dramatically in strength every 16.6 days (the orbital period of the binary system), providing us with a unique opportunity to schedule multiwavelength observations to "look down the barrel" of a galactic-jet source.

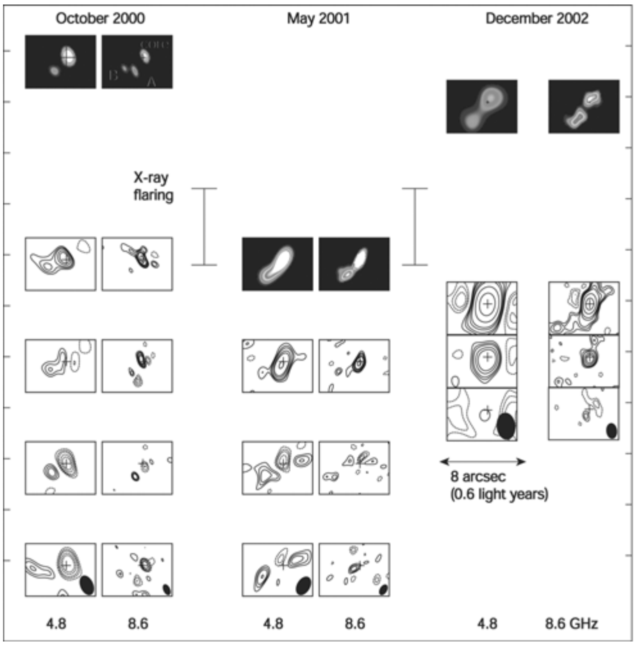

Figure 1: Three epochs of observations of Cir X-1 with ATCA revealing evidence for an ultra-relativistic ($\Gamma \geq 15$) outflow. At each of the three epochs the top (pixel) image at each frequency is the pre-outburst "reference image". The contour images below it correspond to subsequent maps with the reference image subtracted, in order to clearly illustrate changes in the radio structure. Solid lines indicate positive residuals, dashed lines indicate negative residuals; contour levels have been chosen to indicate the level of noise in each image. Structures up to 2.5 arcseconds from the binary core brighten within 3 – 5 days, corresponding to an apparent velocity of 15c (for a distance of 6.5 kpc) which in turn indicates a jet very close to the line of sight with ($\Gamma \geq 15$) . Solid ellipses in the lower right corners of the bottom panels indicate the size and shape of the synthesized beam at each epoch and frequency.

Most importantly however, the X-ray binary Circinus X-1 contains a *neutron star*, not a black hole! The formation of such an ultra-relativistic flow – unless black holes and neutron stars do it differently, flying in the face of Occam's razor – cannot therefore have to do with properties unique to black holes, but must rather be due to properties which accreting black holes and neutron stars have in common. The most likely candidate is a highly magnetized accretion disc/flow, common to both black holes and neutron stars accreting at high (probably close to Eddington) rates. It is the clearest evidence to date that, at least in the case of relativistic jets, outflows do not simply reflect the escape velocity of the central accreting object. We plan further studies of this object through 2004/5, proposing to observe simultaneously with multiple space- and ground-based observatories.

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Kinwah Wu – MSSL,University College London
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New Class-I methanol masers at 25 GHz

The methanol molecule is very rich for observable transitions and has by far the largest number of detected transitions, both in thermal and maser emission. This fact makes masers in this molecule very attractive for theoretical researches. Observationally, methanol masers were divided into two classes (Menten, 1991). Masers in Class-I transitions are usually seen apart from infrared sources and ultra-compact HII regions, while Class-II masers tend to associate with them. For bright methanol lines even a simple model can reproduce this classification (e.g., Cragg et al. 1992). The strong radiation from a nearby source quenches the Class-I maser transitions and increases the strength of the Class-II masers. However, when a large number of transitions is considered, such models are usually far from agreement. Recently, there has been a considerable progress in the theory of the Class-II methanol masers (e.g., Sobolev and Deguchi 1994). But the models of the Class-I masers still remain very crude, mostly due to poorly known collisional excitation rates. The most widespread Class-I methanol maser is that at 44 GHz. About a hundred maser sites are known. Less common maser lines were observed over a wide range of frequencies, from as low as 9.9 GHz up to 229 GHz. Among the Class-I methanol masers there is a series (J_2 - J_1 E) of transitions near 25 GHz. The strongest maser (about 100 Jy) at the J = 5 transition is observed towards the Orion molecular cloud (OMC-1) which is known to be the most famous Class-I source. This line was thought to be rare, although no comprehensive surveys with negative results were published. Sometimes, even theoreticians tried to explain the rareness of this line (e.g., Sobolev et al. 2003). Therefore, it would be a very interesting task to prove observationally that the line is really rare.

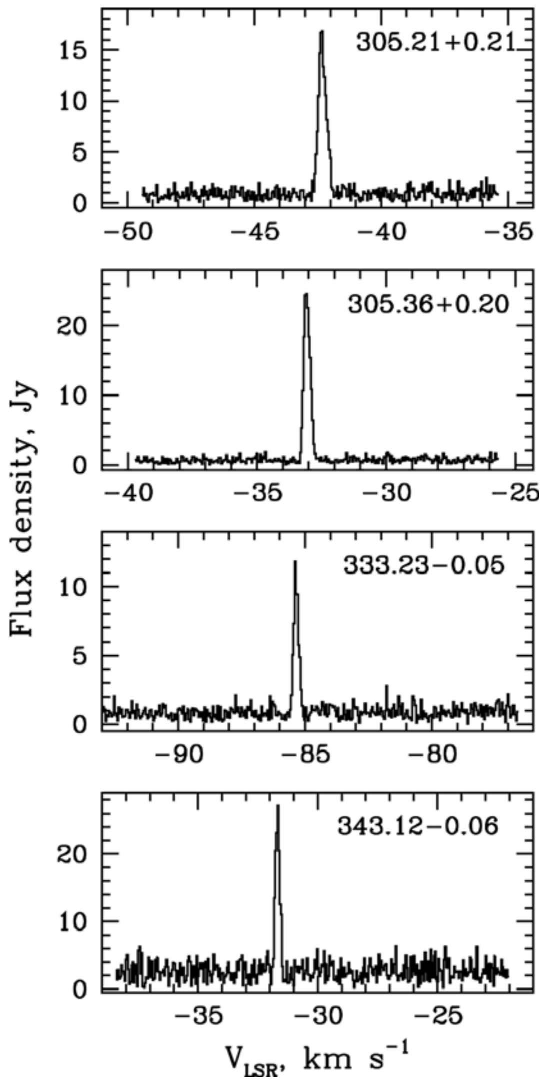

Figure. 1: Spectra of the newly detected 25-GHz methanol masers.

A search for new masers

The new 12-mm system at the ATCA provides a unique opportunity to search for 25-GHz masers in the southern sky. The southern sky is more attractive because of a massive Class-I methanol-maser survey of southern star-forming regions carried out at Parkes at 44 GHz (Slysh et al., 1994). This survey gives an excellent target list. About ten bright 44-GHz masers were examined for the presence of the 25-GHz maser (J = 5). Most observations were done in spring and summer, and therefore the phase stability was not very good. This resulted in a rather high flux-density limit of about 5 Jy for non-detections. In addition, there are no interferometric images for most southern Class-I methanol masers. As a result, the positions are known with single-dish accuracy only. Therefore, some weak masers may be missed. The line was detected in four sources 305.21+0.21, 305.36+0.20, 333.23-0.05 and 343.12-0.06. The phase was self-calibrated, thus removing the influence of unknown position and a poor phase-stability. After this it was possible to average together the data from all baselines, considerably reducing the noise level. The spectra of these masers after such data reduction are shown in Figure 1. Interestingly, all new detections at 25 GHz have very simple spectra containing a single feature, although corresponding 44-GHz masers may have multiple features. In addition, there is no straight correlation between the 44-GHz and 25-GHz flux densities. The brightest known 44-GHz maser, M8E (about 520 Jy), showed no emission at 25 GHz. An experiment to further investigate the 25-GHz methanol masers will be proposed for the next term.

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The first-known double pulsar discovered at Parkes!

Continued from page 1

University (USA), National Centre for Radio Astrophysics (India), Arecibo Observatory (USA) and the ATNF, which uses the Parkes multibeam receiver and filterbank receivers to search a region between Galactic longitudes of 220° and 260° and Galactic latitudes of -60° and 60°. The observing parameters were optimized for detection of millisecond pulsars (MSPs) with an integration time of 4 minutes and a sampling interval of 125 microseconds. Data were recorded on Digital Linear Tape and processed mainly using a computer cluster in Bologna using techniques similar to those employed in the Parkes multibeam pulsar survey (Manchester et al. 2001).

PSR 0737-3039A, a 22-ms pulsar, was detected in April, 2003. It was immediately evident that the pulsar was a member of a short-period binary system, which was quickly shown to have an orbital period of only 2.4 hours (Figure 1). Even more interesting was the fact that the mean orbital velocity was very high, about 0.1% of the velocity of light, which in turn implies that the minimum companion mass is about 1.25 solar masses. This and the eccentricity of the orbit meant that the system is very likely to be a double-neutron-star system. With the large orbital velocity, relativistic effects were expected to be large and, with just a few days observation, the relativistic precession of periastron was detected at the predicted value, approximately 17 degrees per year. This is four times the value for the Hulse-Taylor binary pulsar, PSR B1913+16, making PSR J0737-3039A, by far the most relativistic binary pulsar known. Already we have detected four different "post-Newtonian" effects (i.e., effects which require general relativity or a similar gravitational theory for interpretation) including variations in the gravitational redshift during the orbit and, interestingly, a strong Shapiro-delay signal. The Shapiro delay results when the signal path from the pulsar passes close to the companion, resulting in a deflection of the signal path and an extra delay in the time of pulse reception. In the case of PSR 0737-3039A, the extra delay is about 100 microseconds, implying that the orbit is seen nearly edge-on. The derived inclination angle is 87° with an uncertainty of about a degree.

The pulse profile and its polarization is shown in Figure 2. There are two main pulse components separated by about 60% of the pulse period (as plotted). The time-reversal symmetry of the pulse shape and polarization properties about pulse phase 0.5 strongly suggests that the emitted beam is a very wide cone emitted from magnetic-field lines associated with one magnetic pole. The almost constant position angles through both components are consistent with this idea.

One of the most interesting aspects of this system is that orbit decay due to emission of gravitational waves is expected to lead to merging of the two neutron stars in about 85 Myr. While this may seem like a long time, it is less than one-third the time required for PSR B1913+16 to merge. These merger events are one of the principal targets for

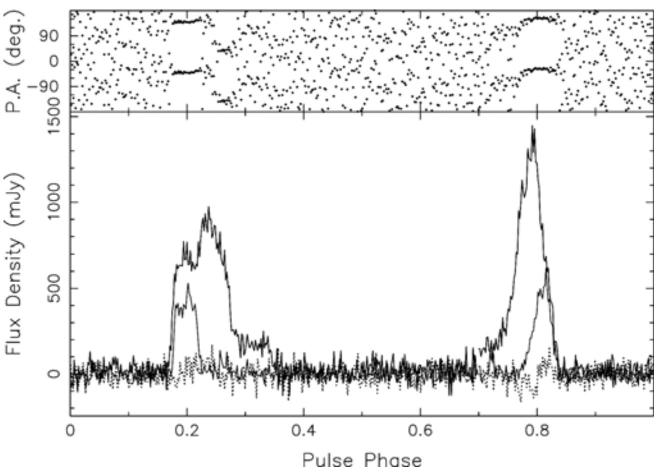

Figure 2: Pulse profile and polarization parameters for PSR J0737-3039A. In the lower part of the figure, the upper solid line is the pulse total intensity, the lower solid line is the linearly-polarized intensity and the dotted line is the circularly-polarized intensity ($V = I_L - I_R$). The position angle of the linearly-polarized component is plotted in the upper part. The zero of position angle is arbitrary.

gravitational-wave detectors such as LIGO and VIRGO. Previous estimates of merger rates, largely dominated by PSR B1913+16, gave intervals of order 100 years between events detectable by the present LIGO. Detection of the new system implies a merger rate about seven times greater, meaning that there is a reasonable chance of observing such an event in just a few years of observation with LIGO. The paper announcing the discovery of PSR J0737-3039A, Burgay et al. (2003), discussed both these results and the implications for tests of gravitational theories. Kalogera et al. (2004) give more refined estimates of the predicted rate of LIGO detections.

These results were exciting enough, but this system had another surprise in store. In October, Duncan Lorimer was at Parkes for one of the many pulsar observing sessions, and was testing a pulsar search program on a more-or-less randomly selected data file which happened to be a 20-min observation of PSR J0737-3039A. He was astounded to see a very strong signal at a period of 2.77 seconds and a dispersion measure equal to that of J0737-3039A. Further investigation showed this to have the reversed Doppler variation of PSR J0737-3039A – quite by accident he had discovered the companion to PSR J0737-3039A, making this the first-known double-pulsar system! Incidentally, Marta Burgay was planning a search for pulses from the companion, but Duncan beat her to it. The emission from this second pulsar, PSR J0737-3039B, is strongly modulated with orbital phase, being almost undetectable for all except two roughly 10-minute periods each orbit. As it happened, the initial discovery observation of PSR J0737-3039A was at an orbital phase when the B-pulsar was turned off!

Once the B-pulsar was discovered, it was possible to go back and re-analyse all previous filterbank data, folding at the longer period. This showed that the pulsar was a typical (albeit slow) relatively young "normal" pulsar with a surface-dipole magnetic field of about 10^{12} G, exactly in accordance with expectations based on the "recycling" model for MSP formation. For the first time it was possible to directly measure the mass ratio of the two stars from the relative amplitudes of the Doppler curves. The results were fully in accord with limits placed on the mass ratio from measurements of the post-Keplerian effects using the A-pulsar alone (Burgay et al. 2003). Figure 3 is a schematic diagram of the system. Not only do we have a highly constrained and highly relativistic double-pulsar system with enormous potential for tests of theories of gravitation, we also have a unique system where we can use the signals from both pulsars to probe the magnetospheric properties of the other. The discovery of the B-pulsar and these implications were announced by Lyne et al. (2004).

The new constraints on gravitational theories provided by the detection of the B-pulsar are dramatically illustrated in the so-called "mass-mass" diagram (Figure 4). The constraints on sin *i* (the so-called mass-function limits) already limit the masses to the white region in the upper right of the diagram. With the detection of the companion star as a pulsar, we have an entirely new constraint on the mass ratio (*R*). This constraint is important because it is largely independent of gravitational theories. Together with the constraint on the sum of the masses provided by the observed precession of periastron (interpreted within Einstein's general theory of relativity), we immediately determine the masses of the two stars to high precision: m_A = 1.337 +/- 0.004 M_{sun} and m_B = 1.251 +/- 0.004 M_{sun}. Constraints based on detection of other relativistic effects are fully consistent with these masses, providing new verifications of Einstein's theory. At present these

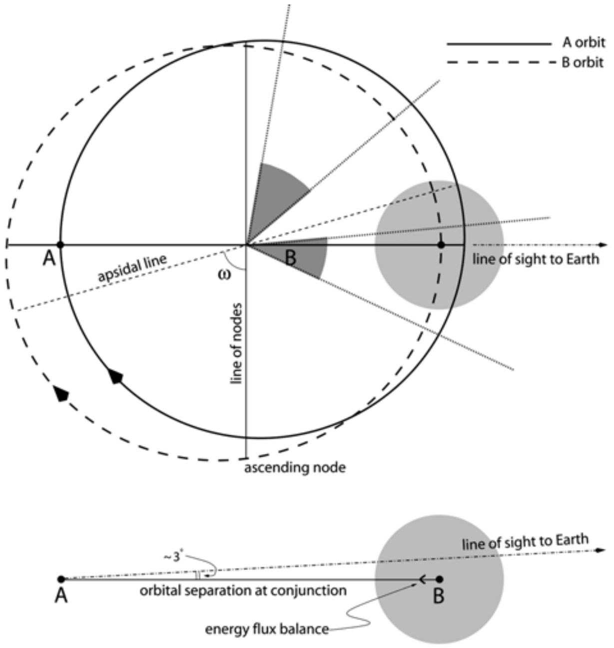

Figure 3: A schematic diagram illustrating the configuration of the PSR J0737-3039A/B double-pulsar system when the A-pulsar is at superior conjunction, that is, on the far side of the orbit as seen from Earth. Both stars orbit about the system barycentre (centre of mass) and, since they have similar masses, the orbits have similar sizes. The line of nodes is the intersection of the orbit plane and the plane of the sky and the apsidal line is the major axis of both orbits. The grey circle around the B-pulsar represents the size of the velocity-of-light cylinder (that for the A-pulsar is 100 times smaller). The lower part of the figure is the system viewed along the line of nodes. Since the orbit inclination is about 87°, the line-of-sight is nearly in the orbital plane and passes through the B-magnetosphere when the B-pulsar is at inferior conjunction. The dotted lines and grey sectors in the upper plot represent the orbit phases when the B-pulsar is strong. (Lyne et al. 2004)

limits are not very tight, but they will improve rapidly with time. We also expect additional relativistic effects to become detectable. For example, orbit decay due to emission of gravitational radiation from the system should be detectable within a year or so. With its highly relativistic properties, we also expect to be able to detect some previously unobserved effects. Geodetic precession of the rotation axes of the two stars is expected to have periods of about 75 years for A and 71 years for B. Not only is this likely to lead to changes in the observed pulse profiles, it will also very likely make possible detection of aberration effects due to the pulsar rotation. Higher-order relativistic terms, for example, variations in the observed orbit precession rate, are also likely to be detectable. There is no doubt that this system will result in manifold constraints on possible theories of gravitation. So far, Einstein is King. Will this still be true in five or ten years from now? A big question indeed!

Figure 5 illustrates the orbital variations in the emission from the B-pulsar. The pulsed emission is only strong for two intervals, each of about 10-minutes duration, when the pulsar is near inferior conjunction. Not only does the pulse intensity vary, but the pulse shape also changes! Especially near the start of the first burst, the trailing component is strong and there is a weaker leading component which fades during the burst. In the second burst, the two components are more equal in amplitude and more widely separated. These changes, which are unprecedented in the history of pulsar astronomy, repeat every orbital period and are largely achromatic, putting strong constraints on possible interpretations. A clue to the likely mechanism is shown in Figure 3. The relativistic wind from pulsar A is far more energetic than that from B, and penetrates far into the B-pulsar magnetosphere. Because of the changing aspect of the B-pulsar magnetosphere as seen from A, the degree of penetration will depend on both the B rotational-phase and the orbital phase. It is almost certain that this is greatly affecting the B-pulsar emission, but understanding the details of this process is going to require a lot more investigation.

As if all this was not enough, we have also detected an eclipse of the A-pulsar emission as it passes behind the B-pulsar. The eclipse is very short, lasting only about 30 seconds, is total within the uncertainties and again is largely achromatic. This interaction gives us an unprecedented probe of a pulsar magnetosphere. For example, we might expect changes in the polarization of the A-pulsar as the signal propagates through the B-magnetosphere. Because of the short timescales involved, such measurements are an observational challenge, one we are ready to take up!

To sum up, this system is a wonderful and unique laboratory for the investigation of a variety of astrophysical phenomena. The next few years are going to be interesting indeed!

We thank the Parkes Observatory staff who, as always, have provided outstanding support for our observations. We made extensive use of the PSRCHIVE pulsar analysis system developed by Aidan Hotan and Willem van Straten and we thank them for their efforts.

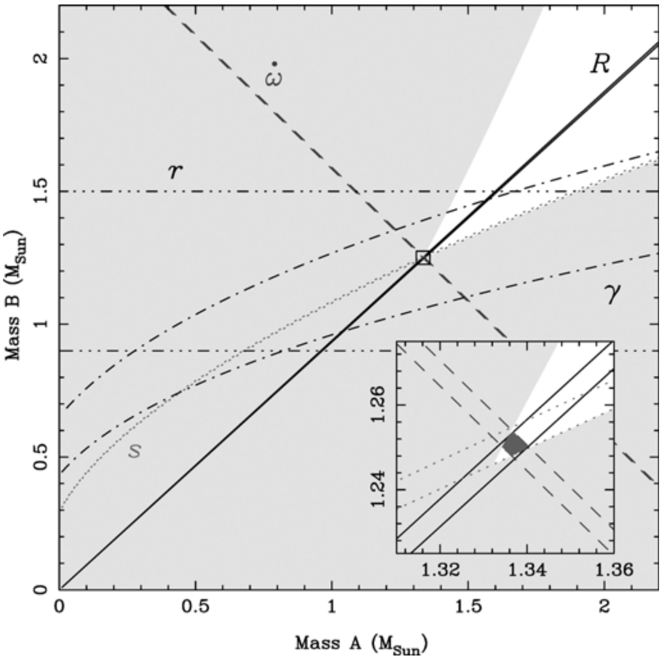

Figure 4: Constraints on the masses of the two neutron stars in the PSR 0737-3039A/B system. The grey regions are forbidden by the constraint that the sine of the orbit inclination angle cannot exceed unity; the lower-right region is from the A-pulsar and the upper-left region from the B-pulsar. The solid diagonal lines (marked *R*) define the limits on the mass ratio from the relative amplitudes of the Doppler curves for the two pulsars. Additional constraints are provided by the detection of relativistic effects in the timing of the A-pulsar, interpreted in the framework of general relativity. The diagonal dashed lines are limits on the sum of the masses based on the observed precession of periastron and the dot-dash lines are limits based on variations in time dilation as the pulsar moves around its somewhat eccentric orbit. The other two constraints, marked *r* and *s*, are based on the observed Shapiro delay. The inset shows an expanded plot of the region of intersection of the various constraints.

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Dick Manchester, on behalf of the Parkes High-Latitude Pulsar Survey team:
Marta Burgay, Fernando Camilo, Nichi D'Amico, Paulo Freire, Bhal Chandra Joshi, Michael Kramer, Duncan Lorimer, Andrew Lyne, Maura McLaughlin, Dick Manchester, Andrea Possenti, John Reynolds and John Sarkissian.
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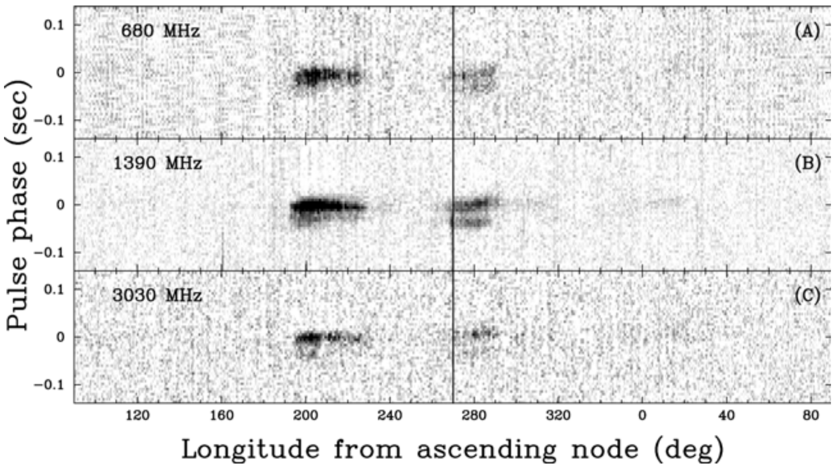

Figure 5: Orbital variations in the intensity and pulse shape of the B-pulsar. The vertical axis represents about one-quarter of the pulse period for observations at each of three frequencies as marked. The horizontal axis is orbital longitude (true anomaly) and the vertical line represents inferior conjunction of the B-pulsar, that is, when B is on the near side of the orbit and aligned with the A-pulsar. (Lyne et al. 2004)

Regular items

SKA/LOFAR program report

The last few months have been very exciting ones for the SKA/LOFAR program within ATNF.

Brian Boyle has commented in his Director's message about the recent developments with the LOFAR project. The realization of the current constraints of the Dutch funding for LOFAR has not diminished the enthusiasm within the international community for establishing a low-frequency radio astronomy observatory at a very radio-quiet site. The LOFAR site evaluation process established that Western Australia was the optimum site for implementation of such a telescope and ATNF, MIT, NRL and ASTRON are co-sponsoring an international meeting to be held towards the end of March, 2004 in order to progress development leading to such a facility. Several designs are being considered and an important purpose of the March meeting is to define a path forwards for IRQUA – the International Radio-Quiet Array.

Closer to home within ATNF, the Luneberg lens prototype is being tested and results of its performance should be known soon. A recent science meeting to discuss a new proposal for a cylindrical-reflector array telescope designed to tackle fundamental cosmological questions was well attended and produced lively discussion.

I am pleased to announce that Simon Johnston has kindly agreed to be Project Scientist for the next generation telescope programs. He will be spending a significant fraction of his time in this role, and will be gathering together a team of experts in the various science disciplines to ensure broad community representation in science discussions on future directions.

I would also like to take this opportunity to thank Frank Briggs and Carole Jackson for their outstanding contributions as ATNF LOFAR and SKA Project Scientists respectively. I hope that both Frank and Carole will be able to continue to contribute their expertise in both the national and international SKA science arenas.

Ray Norris
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Parkes Observatory report

Staff

Dion Lewis has joined the Operations Group for nine months to supplement the front-line support for observers, and assist with the computing facilities.

Tricia Trim and Terri Wilkie have joined us as casuals in the Visitors Centre, Jess Lees is our new administrative trainee on the front desk, Andrew Hockings, Colin Grover and Leslie Williams recently joined the Site Services pool of casual staff.

Bonnie Lanzarini has left after a year as a trainee on the front desk. We wish her well in her new home and job in Bondi.

Brett Preisig and Tom Lees received ATNF Divisional Awards in the Working Environment category for their pivotal contributions to the occupational health and safety (OH&S) culture at Parkes and thus to the ATNF as a whole. While the awards single out Brett and Tom, they are an endorsement of the efforts of all the staff at the Parkes Observatory to promote a safe OH&S culture.

US Ambassador visits

The US Ambassador Tom Schieffer visited the Parkes Telescope on 31 October 2003 to formally launch the Parkes tracking support for NASA. This support over the 2003/2004 period is to cover an exceptionally active time for deep-space missions, particularly with the number of craft arriving at Mars.

As has become almost customary at recent special events, the weather really turned it on, with strong winds reaching 50 km/h and spitting rain as well. Despite the elements the day was a big success.

Highlights of the day included the breaking of a bottle of Australian sparkling wine (Trilogy) on two new telescope panels (spares!), and a cricket game with John Reynolds bowling, Tom Schieffer batting, and Neil Newman (NASA representative to Australia) keeping wicket. The ambassador was in fine touch, despite the tennis ball seaming sharply in both directions. The men in dark suits talking into their sleeves and lapels remained unobtrusive, and there was a considerable media presence including the ABC TV helicopter and news crew.

A range of pictures of the event can be seen at *www.parkes.atnf.csiro.au/events/mars_ceremony/*. The tracking itself has proceeded with nary a hitch for up to ten hours each day over four months and is discussed in a separate article in the previous issue. In only one month has lost time exceeded the 3.75% threshold, that being in the particularly windy month of October.

Receivers

The massive 21-cm multibeam receiver was removed from the focus cabin in late October. This receiver has remained in place – and in operation – since it was installed in 1997. Its removal involved partial disassembly in the focus cabin, then winching to the ground in two parts, each of which was reverentially placed in the tray of the site ute for transport to the receiver lab.

Removal of the 21-cm multibeam was primarily to allow refurbishment of the package, but was timed to allow the new 10/50-cm dual-frequency receiver to be used over the period of the NASA tracking operations. All 26 low-noise amplifiers in the 21-cm multibeam will be replaced, in addition to a number of other minor repairs. The receiver will be ready for reinstallation around the middle of 2004.

With the multibeam offline for several months, all observing at 21 cm has fallen to the single-beam H-OH receiver. Parkes receiver staff effected a rapid upgrade of the H-OH receiver in December installing two new LNAs similar to those being built for the Arecibo multibeam project.

The upgrade has rendered a significant improvement in performance: about 20% increase in sensitivity at 1.4 GHz. The upgraded LNAs are not only more sensitive, but have flat gain and Tsys across the band, and appear to have eliminated intermittent stability problems with one of the channels. Credit for the work is due to Brett Dawson and Dave Catlin at Parkes, with the usual unstinting support from the Marsfield receiver group.

The new 10/50-cm dual-frequency receiver, designed primarily for pulsar observing, was successfully installed in the week of 27 October, slightly behind schedule. No serious problems were encountered and the receiver was in use at both frequencies within a few days. The receiver was immediately put to good use observing the newly discovered relativistic binary-pulsar system J0737-3039 (see cover page article).

The RFI environment at 50 cm, as expected, is far from ideal though for pulsar observing the degradation in performance at present is only moderate. With the reality of the environment degrading further over the next few years, RFI mitigation techniques at several levels are being actively pursued. Ultimately it may be necessary to shift the frequency band upwards, to escape the worst effects of the TV transmitters at Mt Canobolas and Mt Ulandra.

The 10-cm band appears to be in no such danger from encroaching RFI, and is at present very clear. The only significant problem yet to be solved at 10 cm is to remove a large slope across the bandpass, which arises partly in the receiver and partly in the down-conversion system. It is hoped that solutions currently in hand will remove this problem in the next month or two.

The 8-GHz receiver built as part of the NASA contract is performing extremely well and together with the surface upgrade (high performance surface extension to 55-m diameter) provides approximately 6dB of improvement over the old X-band system! The new receiver offers dual circular polarizations, a 500-MHz bandwidth and is of course available for astronomy. It has been used extensively of late for pulsar search and timing observations, where some low-level problems with audio-frequency modulation have appeared, apparently arising in the down-converter system. It is expected that replacing the power supplies in these commercial units will fix this problem.

Backends

The Wideband Correlator has been used extensively in the last few months, mostly at 256 and 512-MHz bandwidths with the refurbished H-OH receiver, and at 512 MHz and, more recently, 1-GHz bandwidth with the 10-cm receiver. Low-level artifacts in pulsar phase remain at the latter two bandwidths. This problem is being pursued actively.

Student visitors

The Observatory continues to host a steady stream of students, from High School work-experience kids through to groups of new postgraduate astronomy students from a variety of Australian universities. Recent visits include the students of the HSC Cosmology Distinction course, the three top students in first-year astronomy at Monash University, ATNF’s own vacation scholars, four students from Swinburne University filming a 3-D “virtual tour” of the telescope, and the members of the Talented Students Programme from the University of Sydney.

Operations

Observing operations have been largely trouble-free, with 0.7% of time lost to equipment faults in the year-to-date, and 3.2% of time lost to high winds, a typical figure.

There have been a few niggling drive-system faults over the past few months but to date they have proved more frustrating for staff than for users. The subsystem responsible for at least one of these elusive faults has been identified, and construction of a completely new design is underway, with replacement planned for May or June.

Computing

Two new Sun workstations, a Blade 1500 and a Blade 150, have arrived and will shortly be installed. The faster machine will be deployed in the control room as a “number cruncher”, while the other will go at the Quarters or in the common work area in the Library. The online Solaris file server (“sagitta”) will shortly be upgraded to a Sunfire V120.

The problems described in the last newsletter with the optic fibres installed on site as part of CSIRO’s CUP (Cable Upgrade Program) have been rectified. Many of the fibre runs exhibited excessive loss, and it transpires that the type of fibre used was more sensitive than expected to radius-of-curvature problems. Many thanks to Tarquin Beresford-Wylie and Tony Goodacre of Allied Technology for their great patience and tenacity! Most of the Observatory’s offline computers are now on the new network, and migration of the online systems will start in earnest as soon as the NASA tracking contract is concluded.

The new Dell Poweredge 4600 server running MS Exchange 2000 has arrived on site, and is a formidable sight, dwarfing any of our existing boxes. Migration of staff and visitor email to MS Exchange 2000 is nigh, probably early March, and staff are looking forward with trembling excitement to accessing email at close to light-speed!

Site changes

A new all-singing all-dancing sound/video/DVD system has been installed in the Quarters lounge, offering a whole new range of options for observers’ relaxation, even karaoke! Most users are able to master the basic operations of the remote control for this new system after just three or four days.

A significant milestone has been reached in the upgrading of the observers’ quarters, with the new ladies bathroom having been commissioned in early February, and the old one going the way of the sledge hammer. Work on new kitchen facilities is now progressing.

The revamped Library and computer workspace for visitors in the Opera House (the Admin building) is nearly completed. We apologize to observers and other visitors for the inconvenience, particularly for would-be users of the library. The restoration of normal service is a top priority!

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Compact Array and Mopra report

Operations

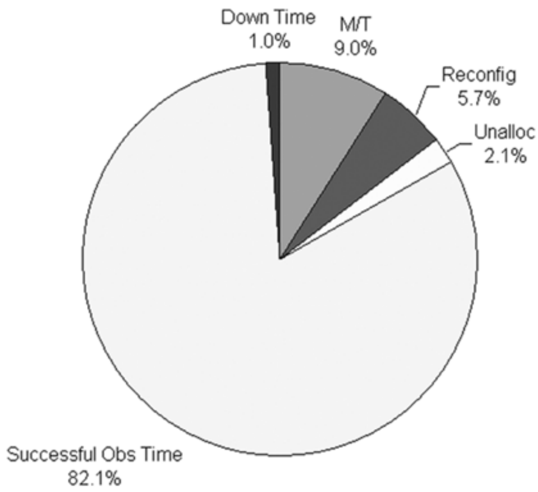

Figure 1: ATCA usage for September – December 2003 (2003SEPT)

We had a good September term, with very low lost time and comparatively high astronomical use. Half of the lost time was a result of spring weather: overall the weather was milder than normal (spring is usually the worst term for lost weather time). The new antenna control computers (ACCs) continue to show their value: lost time as a result of ACCs continues to decline to the point where it is no longer a significant contributor. Minor lingering issues continue to be ironed out. Less apparent in the lost-time statistics is the improvement in antenna monitoring and tuning that the new ACCs give us. These are helping us address and resolve long-term “hidden” problems.

One of the highlights of the term was the “christening” of the H214 array and station N14 on 16 October. This marked the completion of the North Spur and new antenna-station upgrade. The term also saw the installation of a new data-archiving workstation in the Control Room. Observers can now choose whether to burn their data onto CDROM or DVD.

Late in the term, a signal compression problem was discovered in the 12-mm systems. This problem has probably been there since June: it has caused a minor loss in sensitivity and has meant that noise diode effective flux-density varies with sky brightness. A temporary solution has been implemented. Following this, the noise diodes in the 12-mm system have been calibrated, and the raw “pseudo-Jansky” scale at 12-mm given by the on-line system is now more closely aligned with the true flux-density scale. A permanent solution to the compression problem awaits a shutdown in June.

With an eye to future pipeline and “virtual observatory” processing of ATCA data, there has been some thought given to understanding what extra data needs to be stored in the RPFITS output file to define the state of the telescope and observing environment at the time of the observation. Some extra data are already being saved (see the separate article on ATCA millimetre data), and more will be saved in the future. Observer suggestions about “what is missing in the RPFITS file” are welcome.

The Observatory’s on-line calibrator database is constantly being added to, with better flux and ancillary information, and occasionally with new calibrators. Contributions to this are always appreciated, particularly at 12- and 3-mm wavelengths.

Winter 2004 observing plans

A three-week shutdown of the Compact Array is planned during June to allow for the completion of the 12- and 3-mm upgrade of the ATCA. This upgrade will provide operation from 85 to 105 GHz on five antennas at Narrabri. Noise-diode and paddle calibration will be available on all antennas.

To give some robustness to 3-mm observing, the swap system of scheduling will be in use again this winter. Note that a component of the swap scheduling is that centimetre-wavelength observers can request that their project be considered for use as a swap partner. *Note that service observing is offered to the centimetre partner in a swap pair*. See the on-line documentation for more information.

Visitors Centre

Landscaping work at the Visitors Centre is nearly complete, with the new plantings taking hold. After a long period of being out-of-action (partly for safety reasons), the so-called People’s Telescope is back. This is a single dish operating at 20 cm that visitors can steer by hand, and "see" the strong radio emission when pointed towards the Sun. Thermal emission from nearby objects can also be detected.

A new video for the Visitors Centre is now in preparation.

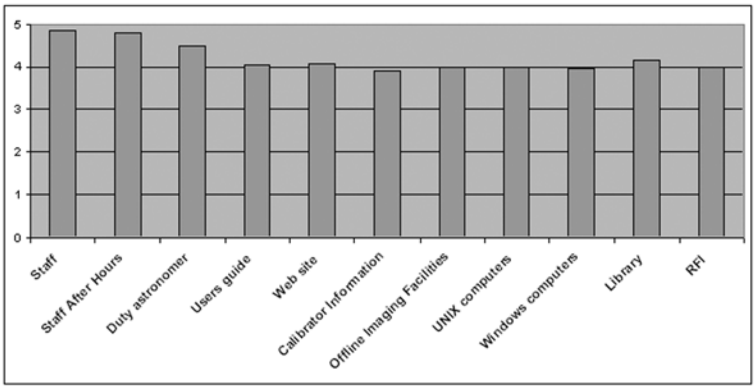

Figure 2: Observer feedback for 2003

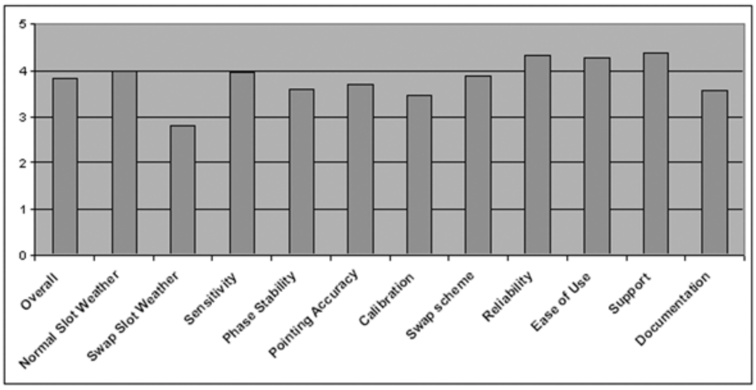

Figure 3: Observer feedback for millimetre systems for 2003

Observer feedback

I would like to thank all those who have taken the time to complete the web-based observer feedback form. These responses are taken seriously: by completing them, you are helping us understand the issues that are of concern, and helping us to respond. This is not to say that easy or quick solutions can be found to all issues!

Figures 2 and 3 summarize the results from the observer feedback questionnaires for 2003. Figure 2 is for all observers (77 responses), whereas Figure 3 shows the results specifically related to the new 3- and 12-mm systems (25 responses). Observers rate various aspects of the Observatory on a scale of 1 (poor) to 5 (excellent).

The "all observers" feedback shows no significant change between 2002 and 2003. The millimetre observers' responses show an approximately half-point improvement in all but one question. The one exception was the weather during the swap slot. This response suffers from luck and small-number statistics, as only two swaps were invoked!

Staff

There have been a number of staff changes since October 2003, with us farewelling some and welcoming others.

Ben Reddall, who has served in the Narrabri Electronics Group for over 11 years, has accepted a position working at Owens Valley in California on the construction of a new cosmic microwave background telescope. Ben's broad "historical" knowledge and experience of the electronics at Narrabri and Mopra will be missed. At about the same time that Ben resigned, Brett Hiscock has been offered and has accepted the position of deputy Officer-in-Charge at Narrabri (see separate article). We are currently working to fill the vacancies within the Electronics Groups that have resulted from Ben's departure and Brett's promotion.

Clive Murphy has resigned to pursue another job opportunity in the Narrabri area. We thank Clive for his work here and wish him the best of luck with this change.

After 15 months on leave at the South Pole, and 15 years of sterling service to the ATNF, Allan Day has resigned to allow him to return to the Pole for another winter. Allan had been the senior cryogenics technician at Narrabri for a number of years, and is well known for his meticulous skills and playful sense of humour. In his place on a short-term contract, we welcome Bruce Tough.

We also welcome Norm Webster, who joined us in November. Norm's primary responsibility is for the mechanics of the antennas and generators and making sure the motors and drive systems continue to operate smoothly.

During November, we hosted Nicholas Ebner for the professional experience component of his degree at RMIT. Nicholas worked with Ravi Subrahmanyan on frequency dependence of the optics at 12 mm.

With us during the summer as vacation scholars are Marija Vlajic and David Jones. Marija is working with Michael Dahlem on the halos of edge-on spirals, whereas David is working with Ravi Subrahmanyan on high-resolution imaging of a class of extended radio galaxies.

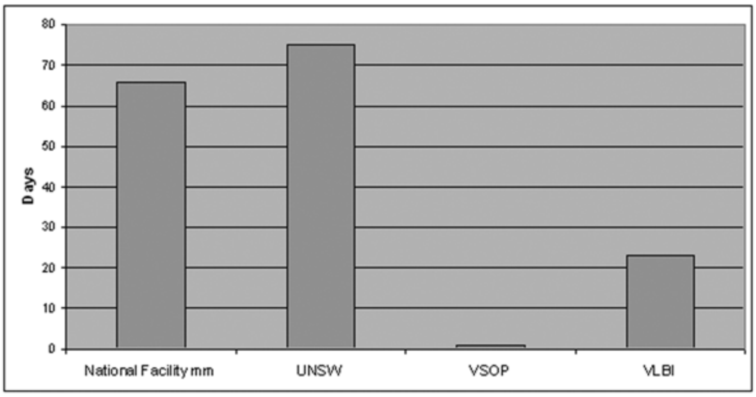

Figure 4: Mopra usage for 2003

Mopra operations

The usage statistics for Mopra for 2003 are given in Figure 4. Total usage increased by 25 days over 2002, with Mopra scheduled for observing for 165 days during 2003. This improvement is almost solely because of an increase in the national facility 3-mm time requested. In all but one case, these requests were from overseas observing teams. The overall usage increase was despite problems with the VSOP spacecraft, which have meant that VSOP observations have virtually ceased.

It is estimated that 25% of scheduled Mopra 3-mm time was lost, with 15% being caused by weather (rain, heavy cloud or wind) and 10% being a result of equipment failure or unscheduled maintenance override. This high weather lost time reflects the more stringent requirements of 3-mm observing and the windier site at Mopra. The seemingly large lost time as a result of equipment failure, etc., reflect the telescope's isolation and a difference in the scheduling and maintenance approach. During the winter virtually no maintenance is scheduled and problems are addressed as required.

Since the end of the 2003 millimetre season, a new ACC has been installed. "First light" was the detection of a methanol line on 27 November. Currently the ACC is undergoing final integration into the observing systems. The new ACC will allow reliable use of short cycle times which will cut down on a number of overheads in the telescope observing system.

Mopra is in the early stages of a wideband upgrade specifically aimed at the 3-mm system. A prototype of the new spectrometer will be available during the winter of 2004. The main upgrade, which includes a 4-GHz spectrometer and an ATCA-style 12/3-mm receiver package, will be installed after the end of the 2004 season.

See the time assignment information section for more information on Mopra's capability during the 2004 millimetre season.

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Time assignment information

Observing terms for 2004

As mentioned in the last issue of the *ATNF News*, the ATNF is implementing a change from three four-month observing terms per year to two six-month observing terms. The next deadline for telescope applications on all ATNF facilities will be on 1 June 2004 with semester dates as follows:

Semester	**Applications deadline**
October to March (OctS)	01 June
April to September (AprS)	01 December

Long observations

We advise observers that the maximum length of time an observer should spend working without a break is 16 hours. If your observations are scheduled for blocks of time that are longer than this then please arrange for at least two observers to be present.

Compact Array

In 2004MAYT, observing will be available with the standard 20, 13, 6, 3-cm and 12-mm systems on all six antennas.

During May, three antennas will be available with 3-mm systems, with the frequency range limited to two sub-bands of 84.9 – 87.3 GHz and 88.5 – 91.3 GHz. Following an upgrade in June, five antennas will be available with 3-mm systems and the frequency range will be 85.0 – 105.0 GHz.

For both the 3-mm and 12-mm systems, when observing at two simultaneous frequencies, the frequencies cannot differ by more than about 2.5 GHz (see on-line documentation for exact specification). Observing in the 3-mm band requires an observer to be present who has had previous experience with the ATCA 3-mm systems. Observations with the upgraded 3-mm systems will be on a shared-risk basis – the robustness may be less than observers are accustomed to with the Compact Array.

The swap method of flexible scheduling will be used for 3-mm projects. Service mode observing will be supported for centimetre projects which can be scheduled as swaps.

Future array configurations

The following table gives the array configurations for 2004 – 2006. These have been changed to accommodate the change to six-month semesters (see Figure 1).

	2004		2005		2006	
	MayT	OctS	AprS	OctS	AprS	OctS
6A	●	●	●	●	●	●
6B			●			●
6C	●			●		
6D		●			●	
1.5A			●			●
1.5B	●			●		●
1.5C		●		●		
1.5D		●			●	
750A			●			●
750B		●			●	
750C		●		●		
750D	●			●		●
EW367	●	●	●	●	●	●
EW352		●		●		●
EW214	●		●		●	
H214			●			
H168	●				●	
H75	●		●		●	

Figure 1: Array configurations for the new four-month observing terms

Director's time

Each term, typically 5 – 10% of time is unallocated in the initial Parkes and Compact Array observing schedules. This time has previously been allocated by the Officers-in-Charge according to a set of priorities that include target-of-opportunity observations, replacement for lost time, maintenance work and observing time for duty astronomers, local staff and visiting astronomers. A recent policy change is that unallocated time is now formally designated as "Director's time". In most cases the time will be allocated as before, according to the previously established priorities, but the ATNF Director will have overall authority for the time allocation.

Most blocks of unallocated time are for periods of typically a few hours that cannot be used by the scheduled programs. In future one or two longer blocks (11 – 12 hours) may be scheduled each month as Director's time. The allocation of time for these longer blocks will require Director's approval but the requests for the use of this time should be sent to the Officers-in-Charge.

Mopra

A new requirement for all Mopra observers is that when observing for three days or more, at least two people should be present and they should have access to a car.

For 2004MAYT, the Mopra radio telescope is available for requests using the 3-mm SIS receiver. Proposals for 12-mm and centimetre-wavelength observing may be considered where it can be demonstrated that Mopra offers a significant advantage over other facilities and/or where a substantial time is required.

In addition to the standard correlator-backend, a prototype of the new digital-filter-bank spectrometer will be available. This will be a dual-polarization system with a fixed bandwidth of 600 MHz, matching the available bandwidth of the 3-mm SIS receiver, with 512 channels per polarization.

Prior to the start of the season, a Mopra workshop will be held at the telescope to introduce observers to the telescope as a whole, and to the new observing systems.

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ATNF publications list

Publication lists for papers which include ATNF data are available on the web at: *www.atnf.csiro.au/research/publications*. This list includes published refereed articles and conference papers, including ATNF data, compiled since the October 2003 newsletter. Please send any corrections or additions to Christine van der Leeuw *(Christine.VanDerLeeuw@csiro.au)*.

Papers which include one or more ATNF staff are indicated by an asterisk.

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