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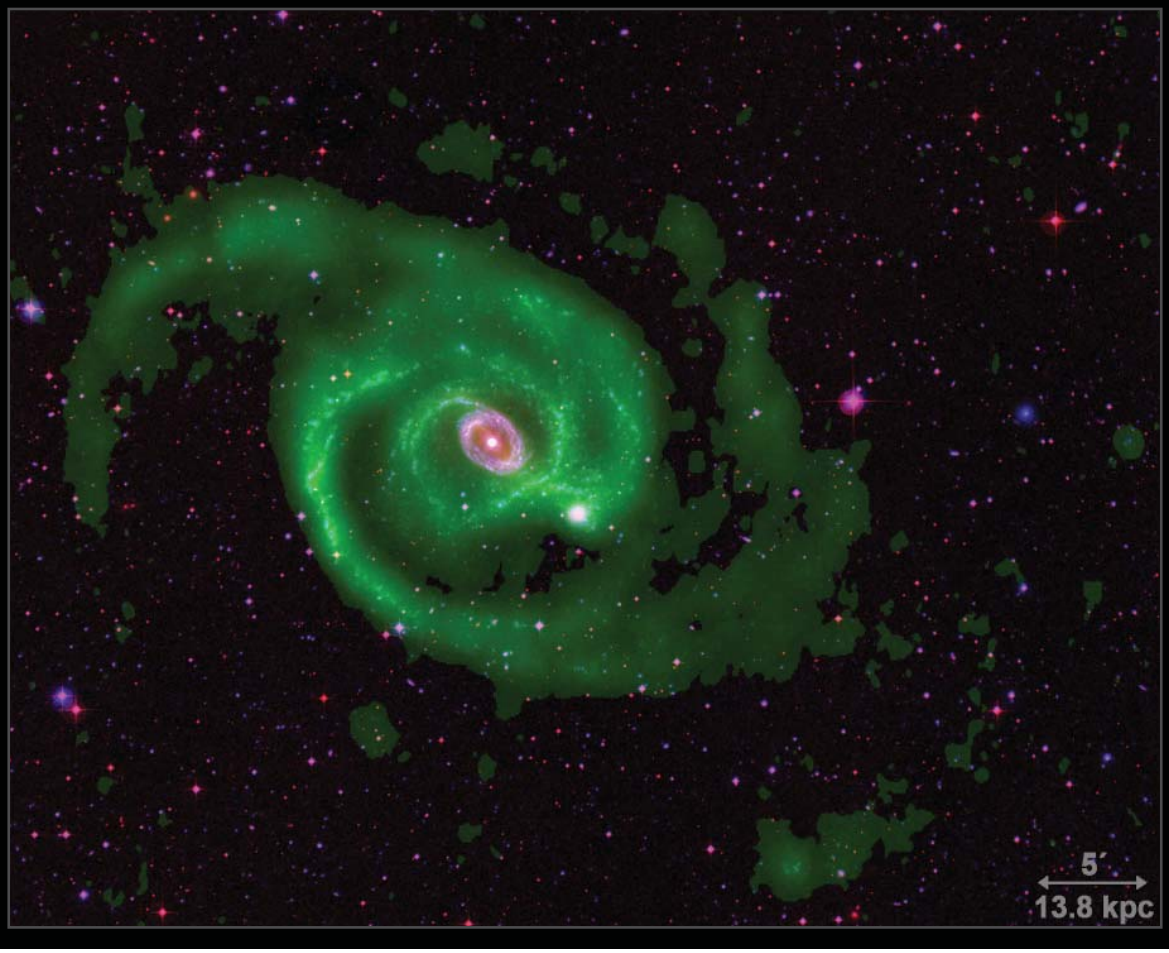
Galaxy Pair NGC 1512 / NGC 1510



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ATNF News

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Questacon "astronaut" street performer and visitors at the Parkes Open Days 2009. Credit: Shaun Amy, CSIRO.

Cover page image

Cover Figure: Multi-wavelength color-composite image of the galaxy pair NGC 1512/1510 obtained using the Digitised Sky Survey R-band image (red), the Australia Telescope Compact Array HI distribution (green) and the Galaxy Evolution Explorer NUV -band image (blue). The Spitzer 24μm image was overlaid just in the center of the two galaxies. We note that in the outer disk the UV emission traces the regions of highest HI column density. See article (page 28) for more information.

Contents

Editorial

Welcome to the October 2009 edition of the ATNF News.

In this issue we feature a number of articles, with several referencing CSIRO's new Australia Telescope Compact Array Broadband Backend upgrade (or CABB as it is popularly known). This includes an article by Elizabeth Mahoney and collaborators that employs CABB to explore the radio bimodality of QSOs while Bjorn Emonts and team examine our nearest powerful radio galaxy NGC612 and provide first science results with the CABB C/X-band. Our final science article looks at gas dynamics and star formation in the galaxy pair NGC 1512/1510, contributed by Ángel López-Sánchez and Baerbel Koribalski.

In other news, we report on the creation of the CSIRO Astronomy and Space Science business unit in which current ATNF activities will reside, and we acknowledge ATNF's own Warwick Wilson who was recently awarded the CSIRO Medal for Lifetime Achievement for his inspirational contributions to radio astronomy.

We also provide a review of our extremely successful Parkes Open Days which attracted record numbers, we report on the first CSIRO Radio Astronomy School at the Parkes Radio Telescope, we chat with Pat Sykes who has recently retired from the ATNF following 36 years of service and we provide an update on recent changes relevant to the Time Assignment Committee (TAC).

In addition to this, we present our regular ASKAP and SKA activity update. We also feature a special article by ASKAP Project Scientists Ilana Feain and Simon Johnston that looks at the ASKAP Survey Science Projects that have now entered the Design Study Phase.

Finally, we feature the obituary of John Masterson who died on 9 April 2009. John was an esteemed and highly respected photographer within the CSIRO Division of Radiophysics for over 40 years. He leaves behind a magnificent photographic archive that records the events, facilities and people that make up the history of CSIRO Radiophysics and the ATNF since the earliest days. He will be greatly missed.

Please note that if you would like to contribute to later editions of the ATNF News, you can contact the newsletter team. We hope you enjoy the issue.

Tony Crawshaw, Joanne Houldsworth

The ATNF Newsletter Production Team

(newsletter@atnf.csiro.au)

From the Director

Lewis Ball

ATNF Acting Director

This newsletter comes at a time of significant achievement and change for the ATNF.

In recent months the Australian Commonwealth Government has announced A$80M of new funding for the Pawsey Centre for SKA supercomputing in Perth, A$88M in funding for Australia's membership of the Giant Magellan Telescope program, and in announcements associated with the budget in May it identified ***Space Science and Astronomy*** as one of three ***Super Science*** areas which are its highest priorities. All of these announcements are tremendous news for Australian astronomy, and continue to reinforce this as a decade of unprecedented political visibility and support for astronomy in Australia.

CSIRO has recently announced that it will create a new business unit, to be known as CSIRO Astronomy and Space Science (CASS) incorporating the ATNF and its NASA Operations activities, the most significant of which is the Canberra Deep Space Communications Centre (CDSCC or Tidbinbilla). At the end of February 2010 the CDSCC activities will sit entirely within CSIRO, concluding a very successful period during which Raytheon Australia have operated Tidbinbilla for CSIRO under a subcontracting arrangement. CSIRO Astronomy and Space Science will come into being on 1 December 2009, and the process to recruit the person who will be Chief of CASS and ATNF Director is underway.

In July the Australia Telescope Steering Committee (ATSC) met at Marsfield and provided timely advice to the CSIRO Executive — represented by Alex Zelinsky, and to myself in my role as the ATNF Acting Director. After a period of some uncertainty regarding the status of the Steering Committee, Minister Carr reaffirmed the role of the ATSC in providing strategic advice to CSIRO on its radio astronomy activities, and appointed five new members. While CSIRO had already determined its intention to bring the ATNF and NASA Operations together and create the new CASS Division, the Steering Committee provided very valuable advice regarding the need to continue to focus on the key challenges of delivering ASKAP, restructuring Operations to position the ATNF for the future, and maximising Australia's role in the SKA, including promoting its candidate SKA site in Western Australia.

A personal highlight over recent months has been the selection of the 10 ASKAP Survey Science Projects that has been so ably led by the ASKAP Project Scientists, Ilana Feain and Simon Johnston. The engagement and commitment of such a large international community in ASKAP science provides tremendous incentive for ATNF staff to maintain their energy over the next three years as we deliver this innovative world-class instrument. The successful factory acceptance of the first ASKAP antenna, a bare 10 months after CSIRO signed the contract with CETC54 to design and build the 36 antennas required, marks the substantive shift from planning to construction and rollout. Spare a thought for the CETC54 and ATNF staff who will work through Christmas and New Year at the Murchison Radio-astronomy Observatory to install Antenna 1 as soon as possible after its delivery at the end of November.

The science highlights in this newsletter include early results from the Compact Array's new Broadband Backend system, the brainchild of Warwick Wilson and a tribute to the very talented team from ATNF's Engineering group that have worked tirelessly over recent years on this major project. It is fitting that on the day that I am writing this Warwick will receive a CSIRO Medal for Lifetime Achievement, a token of recognition for his outstanding contributions to radio astronomy.

CSIRO Medal Winners

Tony Crawshaw (ATNF)

Graeme Carrad, Warwick Wilson and Lewis Ball at the CSIRO Awards event in Melbourne. Credit: Meg Rive, CSIRO

ATNF's Senior Principal Research Engineer Dr Warwick Wilson was recently awarded the CSIRO Medal for Lifetime Achievement for his inspirational contributions to radio astronomy at a special CSIRO event in Melbourne.

The Lifetime Achievement Medal is awarded to an individual who has a record of sustained and meritorious achievement over a prolonged period of CSIRO service.

Warwick, recognised internationally for his outstanding contributions to the field of radio astronomy, especially for his work in correlator development and in receiver systems design and development has been part of CSIRO for 27 years.

His efforts have not only kept CSIRO observatories at the forefront of the world's radio astronomy instruments but have also enhanced the capabilities of other observatories around the world.

Of particular note is the pioneering work that he undertook in the design and construction of the "AT Correlator" an innovative wideband correlator for the Australia Telescope Compact Array (ATCA) that received its first signal in 1988.

Warwick has also played a major role in the development of the ATCA Compact Array Broadband Backend (CABB) upgrade. Ably leading the CABB project team, the recently installed upgrade has maintained ATCA's position at the forefront of radioastronomy instrumentation by vastly increasing the instrument's bandwidth and sensitivity.

The legacy of Warwick's work is an assembly of advanced radio telescopes that are, on a daily basis, generating new research results by a large international community of radio astronomers.

Also recognised at the Melbourne event were the Wireless LAN (WLAN) team who were awarded the major CSIRO prize, the Chairman's Medal. The team received this medal for delivering major technical benefits to Australia and the world via wireless local area networking technology now underpinning wireless communication systems in over 800 million products worldwide.

Interestingly, the A4 chip which formed a key enabling step in the development of the WLAN technology was closely aligned with the development of the AT correlator chip. Radiophysics staff collaborated on both projects with both chips going through a similar design process. John O'Sullivan who led the original WLAN research team played an important early role in the initial conception of the Australia Telescope receiving systems within the Division of Radiophysics.

CSIRO Astronomy and Space Science Unit Formed

Tony Crawshaw (ATNF)

CSIRO has recently announced the creation of the CSIRO Astronomy and Space Science (CASS) business unit which will reside within the Information Sciences Group.

This new Business Unit brings together CSIRO's radio astronomy capabilities (the ATNF) and other space science activities (notably the operation of the Canberra Deep Space Communications Complex or Tidbinbilla), as well as CSIRO Space Sciences and Technology (formerly known as COSSA).

The enlarged business unit will encompass radio astronomy, space science coordination, advanced aerospace business development and national/international facilities management. It is consistent with CSIRO's strategy of consolidating its structural units to achieve appropriate scale and also mirrors the increasing alignment of astronomy and space science within Australia.

The new business unit will — together with the ICT Centre — provide the staff responsible for commissioning the Australian SKA Pathfinder, and will facilitate relationships with major partners in the space domain, including space agencies and members of the Australian and international space industry.

For the meantime CSIRO's intention is to maintain the operation of Tidbinbilla as a separate entity from its radio astronomy activities. Opportunities for synergies between space science activities and astronomy will be explored in the longer term.

Currently, a process is taking place to recruit the person who will lead the ATNF and CASS with the open advertisement of the role of Chief of CSIRO Astronomy and Space Science - ATNF Director. The Chief of CASS will be responsible for both radio astronomy activities and space science, will report to the Group Executive for Information Sciences, and will work closely with the CSIRO SKA Director, Brian Boyle.

ATNF Distinguished Visitors Program

Robert Braun (ATNF)

Over the past months we have enjoyed working visits from Leo Blitz (University of California Berkeley, USA), Phil Kronberg (Los Alamos National Laboratory / University of Toronto), Alberto Sesana (Pennsylvania State University, USA), Rick Jenet (University of Texas Brownsville, USA), Martin Cohen (University of California Berkeley, USA), Jayanne English (University of Manitoba, Canada), Lordes Verdes-Montenegro (Instituto de Astrofísica de Andalucía, Spain), Daniel Espada Fernandez (Harvard-Smithsonian Center for Astrophysics , USA), Ravi Subrahmanyan (Raman Research Institute, India), Marcella Massardi (International School for Advanced Studies, Italy) and Joel Weisberg (Carleton College, USA). Current visitors include DJ Saikia (Tata Institute of Fundamental Research, India). Upcoming visitors we expect include Paula Benaglia (Instituto Argentino de Radioastronomía), Jean-Luc Starck (CEA Saclay, France) and Daniel Pfenniger (University of Geneva, Switzerland).

The Distinguished Visitors program remains a very productive means of enabling collaborative research projects with local staff, adding substantially to the vitality of the ATNF research environment. Visits can be organised for periods ranging from only a few weeks up to one year. For more information please see *www.atnf.csiro.au/people/distinguished_visitors.html*. Prospective visitors should contact the local staff member with the most similar interests.

ATNF Graduate Student Program

Baerbel Koribalski (ATNF)

We welcome the following students into the ATNF co-supervision program:

- Jay Blanchard (University of Tasmania) — *Linking the Radio and Gamma-ray properties of Blazars* with supervisors Dr Jim Lovell, Prof John Dickey (both University of Tasmania) and Dr Phil Edwards (ATNF);
- Justin Bray (University of Adelaide) — *Ultrahigh-energy neutrinos and their detection with the lunar Cherenkov technique* with supervisors Prof Ray Protheroe (University of Adelaide) and Prof Ron Ekers (ATNF);
- Stefan Oslowsky (University of Swinburne) — *High-precision pulsar timing and the formation and evolution of binary pulsars* with supervisors Prof Matthew Bailes, Dr Willem van Straten (both University of Swinburne), and Dr George Hobbs (ATNF);
- Marion Wienen (University of Bonn, Germany) — *Understanding the earliest, cold phases of high-mass star formation* with supervisors Prof Karl Menten, Dr Friedrich Wyrowski (both Max-Planck-Institut für Radioastronomie Bonn, Germany), Prof Pavel Kroupa (University of Bonn, Germany) and Dr Baerbel Koribalski (ATNF);
- Kitty Lo (University of Sydney) — *Star formation and magnetic fields in nearby galaxies* with supervisors Dr Bryan Gaensler (University of Bonn) and Dr Baerbel Koribalski (ATNF);
- Vicky Lowe (University of NSW) — *The environments of massive star formation* with supervisors Dr Maria Cunningham, Prof Michael Burton (both University of NSW) and Dr James Urquhart (ATNF).

Congratulations to:

- Aaron Chippendale on the successful submission of his University of Sydney PhD thesis on *Detecting Cosmological Reionisation on Large Scales through the 21 cm HI Line*;
- Nadia Lo on the successful submission of her University of NSW PhD thesis on *A Multi-molecular Line Study of an Entire Giant Molecular Cloud*;
- Katherine Newton-McGee on the successful submission of her University of Sydney PhD thesis on *Radio Polarimetry as a Probe of Interstellar Magnetism*; and
- Joris Verbiest on the successful submission of his University of Swinburne PhD thesis on *Long-Term Timing of Millisecond Pulsars and Gravitational Wave Detection.*

Dr Aaron Chippendale continues to work at ATNF, Dr Nadia Lo is now a postdoctoral fellow at Saclay, France, Dr Joris Verbiest is a postdoctoral fellow at the University of West Virginia, USA, and Dr Katherine Newton-McGee now works in Canberra.

The following students recently submitted their PhD Thesis:

- Leith Godfrey (Australian National University) — *Multi-wavelength Studies of X-ray Bright Extragalactic Jets;*
- Attila Popping (University of Groningen) — *Diffuse Neutral Hydrogen in the Local Universe;*
- Rebecca McFadden (University of Melbourne) — *UHE Neutrino Detection using the Lunar Cherenkov Technique.*

Well done !

Obituary — John Masterson

Helen Sim (ATNF)

The photographic collection of the Radiophysics Laboratory contains more than 13,000 sets of items. Although the names of the photographers were not always recorded, many, perhaps most, were the work of photographer John Masterson, who died in April this year, aged 73. Forty of those 73 years were spent working for the CSIRO Radiophysics Laboratory and its offshoots, the Division of Cloud Physics, the ATNF and the precursors of the ICT Centre. And they were forty years of, not just work, but of service.

John Masterson in 1982. Credit: CSIRO

John joined the Laboratory in June 1957, at the age of 22. The Radiophysics Laboratory, created in 1940, was then still in its original home, the Madsen building at the University of Sydney. During the war, every piece of equipment the Laboratory produced had been photographed, says Phil Sharp, site coordinator for Property Services at Marsfield. The practice persisted into peacetime, and there was enough work for four photographers and an assistant. John started work as a Technical Assistant, level 1. He had completed the only photographic course available at the time, that of the School of Applied Photography in Sydney. One of the attractions of the Radiophysics position was that the Laboratory's Senior Photographer, Ken Nash, offered a system of training similar to that for newspaper cadets: a mixture of technical reading, practical instruction, and on-the-job training. During 1960–1963 John was called up to do a wider range of tasks for Radiophysics and, increasingly, for other CSIRO Divisions. In this period he was awarded The Sun Trophy at the Sydney International Exhibition of Photography, for the best entry by

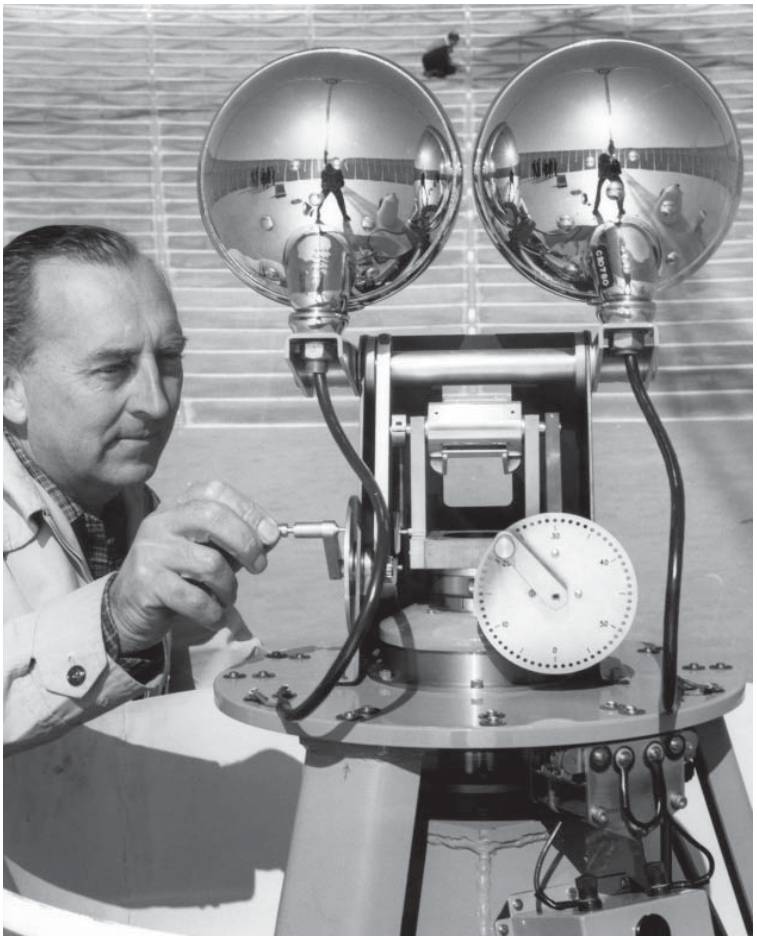
A DC3 used by the Division of Radiophysics for experiments on clouds. The photographer is not recorded, but John Masterson was responsible for photographing Radiophysics' cloud seeding and cloud physics experiments. Notice how the photographer has captured the sun shining through two aligned windows of the plane.

an Australian. By 1963 John was second-in-charge of the department, and had sole responsibility for the photographic coverage of the new observatory and radioheliograph near Narrabri, now the home of the Compact Array.

When Radiophysics moved to its Marsfield site in 1968, the photolab was located in what is now Wing G. Ken Nash's health was deteriorating, and John took increasing responsibility for running the photolab, finally becoming its head in 1974 when Nash retired.

With respect to his craft, John was a professional from beginning to end. Ken Nash — an "artsy" type, according to former ATNF Assistant Director John Brooks — believed in making images that were beautiful as well as technically informative: John learned a lot from him, and was influenced by his style. He always knew what was wanted, what a photograph needed to show, according to Phil Sharp. "Some of the stuff we had photographed was very tricky, with small components. He'd spend hours working on that," said Mal Sinclair, a former head of the ATNF Receiver Group. "The work John did for the Division of Cloud Physics, photographing experiments in cloud chambers, was extremely difficult." In the course of his career John had to devise photographic solutions to a diverse range of problems, from counting and grading ice crystals to making high-speed studies of cutting tools on experimental lathes, 24-hour monitoring of weather radar results, and the printing of complex colour outputs from spectrographs. An important part of his work in the 1980s was reduction photography of circuit layouts for solid-state devices.

In its early days, Radiophysics had operated a number of field stations, such as the one at Dapto, and John made frequent trips to those. He worked with Ken Nash to capture



Dr Harry Minnett surveying the surface of the Parkes telescope in 1964. John Masterson and Ken Nash shared the work of photographing Parkes in its early days, and it's not recorded which of them took this photo. The image is typical of the beautifully composed black and white photographs of Parkes in the Radiophysics photo archives.

the construction and early days of the Parkes telescope. Later, when the Compact Array was being built, he took essentially all of the still photographs recording its construction. For the Compact Array, he was called upon to record engineering techniques such as stretch forming, panel fabrication and feed horn construction in black and white, on colour slides, negatives, and video tape. The artwork for electronics had to be photographically reproduced with great accuracy, to exact reduction ratios. As well as all the technical and recording photography he needed to produce a constant stream of illustration for the media, displays and presentations. "John would work 20 hours a day if he had to," said Phil Sharp.

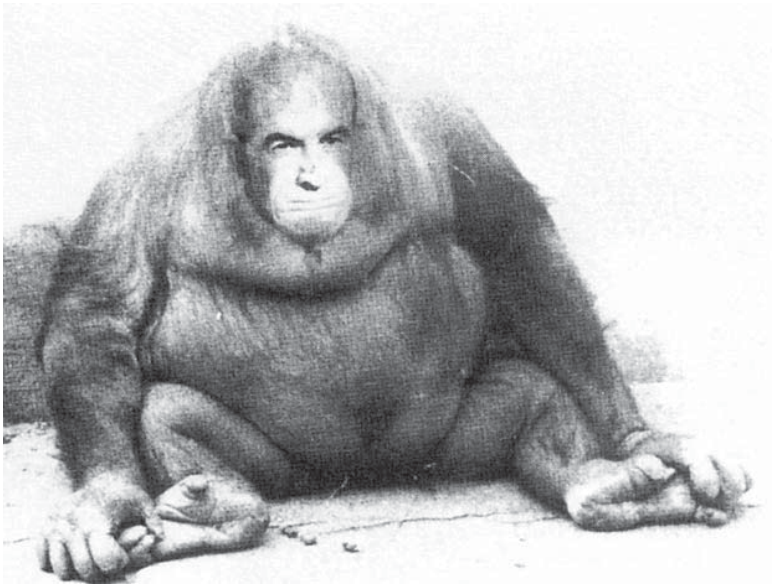
John's own description of photographing at night antennas three, four and five of the Compact Array during their construction indicates the amount of trouble he took:

The aim was to isolate the antennas from the mass of cable drums, compressors, containers and generally confusing items at ground level, give a good view of the profile and the under-structure of the dish, and produce a good stand-alone illustration of the progress on site. The site was in total darkness except for a single bulb mounted on a pole adjacent to antenna five. Because of the large areas and long distances involved I elected to wait until late evening and "paint" the two front dishes and some of the background using a single handheld electronic flash unit. With the camera lens open and set to an appropriate aperture I was able to traverse a carefully calculated path around the dishes and expose them to many individual flashes to achieve the result desired. This single exposure is made up of over 130 flashes. The photograph was just what I had anticipated and has been in great demand. (See back page image.)

This care and attention to detail were appreciated:

Despite the fact that CSIRO and this Division have only recently paid much heed to personal credits on published photographs quite a few people sought me out by name and congratulated us on the quality and obvious professionalism of the work coming from the Radiophysics' Communication Group.

"John was not an empire builder," said Shaun Amy, Head of Computing Infrastructure for the ATNF, and himself a keen photographer. "He recognised he was in a service role, and dedicated himself to that." John knew a lot, and was pleased to share that knowledge, Shaun says. Over the years John's services and advice were called upon not only by Radiophysics but also by several other CSIRO Divisions, a range of departments at the University of Sydney (Civil, Electrical and Aeronautical Engineering; Geography and Tropical Medicine), Lewisham Hospital, and even the NSW Forestry Department. In the mid 1970s John was instrumental in forming the NSW Photographers Group, and helped organise the first national conference for CSIRO photographers.



The photomontage of Dr Dick McGee referred to in the text. McGee had oversight of the Photolab.

Photography was one vehicle for John's sly sense of humour. John Brooks recalls the time he and colleague Bob Batchelor had asked John to take head shots to accompany a paper they were submitting for publication. When Brooks was supplied with his photo, something about it puzzled him: "It was me alright, but he'd made me look really ugly". When he compared notes with Batchelor, the penny dropped: Brooks' photo had been subtly distorted by stretching it vertically, while Batchelor's had been stretched horizontally. "We went round to tell Masterson what a bastard he was," said Brooks. John would just have grinned. A more overt joke was his photomontage that put the face of Dick McGee, who oversaw the Photolab, on the body of an orang-utan. When this appeared on the noticeboard, McGee is said to have quipped "Ah, but that was when I had a full body of hair!" According to Brooks, John was able to photographically turn an innocuous technical item such as a feedhorn "into a UFO about to disgorge aliens".

John was a quiet man, but extremely sociable: "he knew everyone, could talk to everyone", said Phil Sharp. He liked a drink, liked his jazz — he used to frequent the Sydney Jazz Club, then housed in the Ironworkers Building in Sydney's George Street — and was a fanatical support of the Rabbitohs (the South Sydney Rugby League team). He was dogged — for instance, as a union representative in the mid 1970s — and he was generous, devoting great time and energy to charitable causes associated with his church. And, above all, he was devoted to his family: his wife Clare, whom he'd met when they both worked at the University of Sydney, and their children — Katherine, Michael, Peter, Sean, Paul, Bernadette and Matthew. Tragically, Sean was killed as a young man. It was after that that an incident occurred which was "the only time I ever knew John to lose his temper", said Graham Moorey, another former head of the Receiver Group. At a railway station, someone had tried to steal John's wallet: he put the bloke in a headlock and left him the worse for wear. That incident was an exception, however.

John retired in September 1997. For the Radiophysics Laboratory, he had created a body of work recording four decades of its history: for himself, he had attained

[l]ong experience in micro/macro/ scientific/industrial/portrait/field/ aerial and illustrative photography, cine and video techniques including editing and audio mixing [,] and … experience in what the Division needs in the application of these techniques

while still retaining

an openness to and keen interest in the need for constant reappraisal and change where necessary.

In his community, John worked for many, and made himself known and loved: more than 200 people came to his funeral. His most important legacy, however, is in the lives of his family: his wife, children, grand-children and great-grand-children.

Australian Square Kilometre Array Pathfinder (ASKAP)

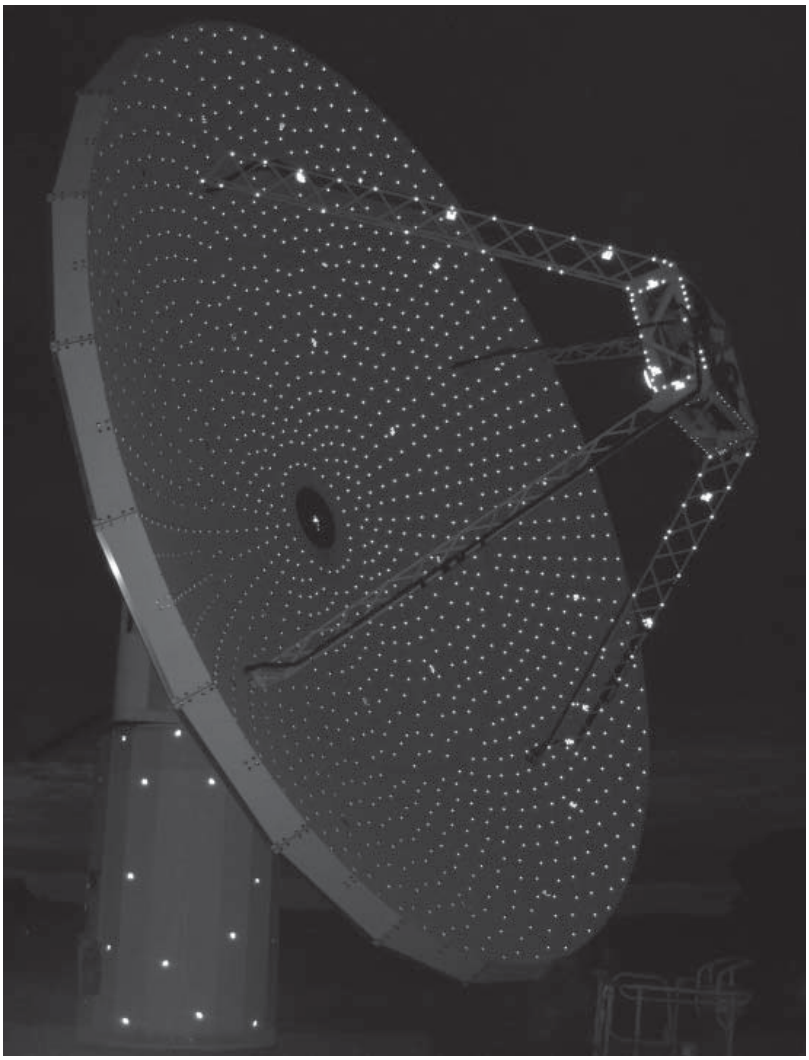
Gabby Russell and Carole Jackson (ATNF)

Survey Science Projects Announced

Ten major science projects, representing 363 unique authors from 131 institutions, have been selected to use ASKAP during the first five years of the telescope's operation. A full report can be seen on page 16 of this newsletter.

First Antenna on Track

Manufacture of ASKAP's first antenna has progressed well. CSIRO and contractor CETC54 have jointly finalised the full factory and site acceptance test plan that describes the procedures, tests and pass conditions for every aspect of the antenna. The factory acceptance tests took place in late September to ensure timely delivery of the antenna to the Murchison Radio-astronomy Observatory in late November. In preparation for factory and site acceptance testing the ASKAP antenna team has been trained to use the VSTARS photogrammetry system, which will be used to measure the parabolic surface of the dish to ensure it meets the 10 GHz upper frequency specification. A full outline of the ASKAP antenna performance specifications can be found at *www.atnf.csiro.au/projects/askap*.



Reflective dots have been applied to the 12-metre antenna at the Parkes Testbed Facility, which has been used by the ASKAP team for training in photogrammetry. Credit: Carole Jackson, CSIRO.

Technology Update

As the development of ASKAP progresses, the project has met several key technological milestones:

The analog system has progressed from concept to design phase. The electrical and mechanical design of the phased array feed is well under way, as is the design of the conversion modules and rack that will be located in the pedestal of the antenna.

Prototype hardware has been delivered for the entire ASKAP beamformer, which includes digitiser, backplane, control and power boards (to be located at each antenna) and a digital signal processing and rear transition board (to be installed in the central building as part of the beamformer).

Software version 1.0 for monitoring and controlling the Parkes Testbed Facility's 12-metre antenna (used to test ASKAP's systems) has been released.

The first simulated ASKAP 30-square-degree image has been made to the expected noise depth by using the SKA Design Studies' Simulated Skies model, which demonstrates that the imaging and analysis software is working.

Significant progress has been made with the development of several low-cost synthesiser units required in each of ASKAP's 36 antennas.

Testing of ASKAP's prototype phased array feed has been undertaken to characterise its performance when equipped with improved design low-noise amplifiers.

Murchison Radio-astronomy Observatory (MRO) Plans Progress

In June 2009 CSIRO became the official leaseholder of Boolardy Pastoral Station and the MRO's Indigenous Land Use Agreement (ILUA) was executed after all the required signatures were obtained.

The next stage in the process is for the ILUA to be formally registered, a process which is underway at the time of writing.

A tender for the design of support infrastructure at the MRO was published on the AusTender website in June 2009 and, following evaluation, Aurecon was selected as the successful tenderer. Two further requests for tenders, for a telehandler (a specialised type of crane) to be used for antenna assembly, testing, and maintenance, and transportable building (donga) supply and installation, were published on the AusTender website at the end of August 2009. Design of the Boolardy Homestead accommodation improvements has started with a Geraldton-based company, Eastman Poletti Sherwood Architects.

Industry Engagement News

On 10 July 2009, CSIRO hosted its second special ASKAP and SKA technical discussion session. Over two and a half hours, ASKAP computing leaders Tim Cornwell and Ben Humphreys provided a thorough overview of ASKAP computing challenges and the development of SKA systems for the 12 industry participants. The third in the discussion series is being planned and will focus on the development of sensitive, ultra-wideband receivers for radio astronomy.

A new quarterly publication, ASKAP Technical Update, has been introduced to keep industry and other interested stakeholders informed on the progress of the ASKAP project. The first two editions are available online at *www.atnf.csiro.au/projects/askap.*

Reaching Out in Geraldton

A recent visit to the MRO by a group of Indigenous artists and scientists (reported in ATNF News April 2009) has been the inspiration for an art exhibition, Ilgarijiri — things belonging to the sky. The group spent three days together and made a special visit to the MRO, located on Wajarri Yamatji land, which produced a collection of more than 90 artworks connecting the land, culture and astronomy. Organised by the International Centre for Radio Astronomy Research and Yamaji Art Indigenous art cooperative, and sponsored by CSIRO, the exhibition was officially launched at the Geraldton Regional Art Gallery on 12 June 2009. More information on the artworks and exhibition can be found at *http://ilgarijiri.wordpress.com.*

In August, Geraldton celebrated National Science Week with a wide range of astronomy-themed activities for school students and the wider local community. Coordinated by CSIRO's Priscilla Clayton, highlights included Geraldton amateur theatre club Theatre Eight's production The Life of Galileo, exhibitions at the Western Australian Museum —

Geraldton, and public lectures by Western Australian Government Astronomer Dr James Biggs and Australian National University's Dr Charley Lineweaver. The Murchison region also took part with astronomy outreach activities held at Yalgoo Primary School and Meekatharra School of the Air.

ASKAP on Display

Visitors to the Parkes Open Days on 18 and 19 July were able to take the "ASKAP Walk" to the 12-m testbed antenna, talk with an ASKAP team member and visit a small display including a model of the focal plane array.

ASKAP has also been represented at many astronomy events in Australia and internationally. In early June 2009, a small delegation attended the 214th American Astronomical Society meeting in Pasadena where the ASKAP exhibition stand was very successful in attracting interest among the 1600 astronomers and other meeting participants. Presentations on ASKAP have been delivered at annual meetings of the Astronomical Society of Australia and the Royal Astronomical Society of New Zealand, the International Astronomical Union General Assembly in Rio de Janeiro, the SKA Design Studies Training School in Paris, and at a Panoramic Radio Astronomy meeting in The Netherlands.

SKA-related News

Australia's bid for the SKA was boosted in August 2009 by the signing of a collaborative arrangement with New Zealand. The arrangement was signed by New Zealand's Minister for Economic Development,

Ron Koenig at the ASKAP display during the Parkes Open Days. Credit: Tony Crawshaw, CSIRO.

Signing of the Australia–New Zealand arrangement for a joint SKA bid by Senator Kim Carr and Minister Gerry Brownlee. CSIRO SKA Director Professor Brian Boyle (far left) and Scott McHardy from the New Zealand High Commission (far right) are also pictured. Credit: Photocall.

the Hon. Gerry Brownlee, and Australia's Minister for Innovation, Industry, Science and Research, Senator the Hon. Kim Carr. Under the arrangement, Australia and New Zealand will together offer the international community the opportunity to develop the SKA across the two countries, with a maximum baseline of around 5,000 km.

CSIRO has engaged BAE Systems Australia to provide critical analyses that will help guide the design decisions for the SKA antennas. This is the first engagement of a major system integration company to work on strategic SKA design issues in Australia. A small team of engineers at BAE Systems will work alongside CSIRO staff to analyse the performance of CSIRO's phased array feed receivers within the proposed SKA antenna design. The first phase of this analysis will be completed in time for a major PrepSKA Work Package 2 (SKA Design) workshop to be held at the University of Manchester, UK in October 2009.

As part of PrepSKA Work Package 3 (Site Characterisation and Selection) activity, CSIRO has continued working with Aurecon on geographic information system analysis to help determine SKA array station placement and standards for site characterisation.

CSIRO staff have also continued to actively participate in SKA design and development discussions, ranging from system engineering, antenna optics design, front-end receiver options, digital systems and SKA outreach activities, led by the SKA Project Development Office.

ASKAP Survey Science Projects enter Design Study Phase

Ilana Feain and Simon Johnston (ATNF)

Since 2008, an open and international process to determine the major Survey Science Projects (SSP) to be conducted by the Australian SKA Pathfinder (ASKAP) telescope has been proceeding. The results of this process were announced on Friday 4 September 2009.

This follows recommendations provided by the ASKAP Survey Science Project Assignment Committee, a committee made up of a broad range of international experts. Projects that were successful were chosen according to their scientific merit and operational feasibility.

Ten Survey Science Project proposals were successful. These projects were prioritised into one of three categories: an A group for which the ATNF will provide full support, an A- group for which the ATNF will make all reasonable efforts to support and a Strategic Priorities (SP) Group for which the ATNF will work to ensure that capabilities are enabled to the extent possible.

A breakdown of the membership of the 10 Survey Science Projects illustrates the international interest in the ASKAP program. There are 363 unique team members from 131 institutions. The breakdown of team members by region is 33% Australia and New Zealand, 30% North America, 28% Europe and 9% rest of world.

Successful Principal Investigators (PIs) were invited to a one-day SSP Design Study kick-off meeting held at the ATNF headquarters in Sydney on 21 October. The meeting brought PIs together with ASKAP engineers and project scientists to determine how the Design Studies should proceed over the next few years, in terms of management, processes and working groups.

The ASKAP Survey Science Projects are listed in Table 1 and each is briefly described below:

EMU: Evolutionary Map of the Universe — PI Norris

EMU is a deep (10 μJy/beam rms) radio continuum survey of 75% of the entire sky. EMU will probe typical star forming galaxies to redshift 1, powerful starbursts to even greater redshifts, Active Galactic Nuclei to the edge of the Universe, as well as undoubtedly discovering new classes of rare objects. The key science goals for EMU are to trace the evolution of star forming galaxies and massive black holes throughout the history of the Universe and to explore large-scale structure. EMU will

Table 1: The Eight ASKAP Survey Science Projects and Two Strategic Priorities

A	EMU	Evolutionary Map of the Universe
A	WALLABY	Widefield ASKAP L-Band Legacy All-Sky Blind Survey
A-	FLASH	First Large Absorption Survey in HI
A-	VAST	An ASKAP Survey for Variables and Fast Transients
A-	GASKAP	The Galactic ASKAP Spectral Line Survey
A-	POSSUM	Polarisation Sky Survey of the Universe's Magnetism
A-	CRAFT	The Commensal Real-Time ASKAP Fast Transients Survey
A-	DINGO	Deep Investigations of Neutral Gas Origins
SP	VLBI	The High Resolution Components of ASKAP: Meeting the Long Baseline Specifications for the SKA
SP	COAST	Compact Objects with ASKAP: Surveys and Timing

create the most sensitive wide-field atlas yet made, and provide a long-lasting legacy survey.

WALLABY: Widefield ASKAP L-Band Legacy All-Sky Blind Survey — PIs Koribalski & Staveley-Smith

WALLABY is an extragalactic neutral hydrogen survey over 75% of the entire sky and will detect up to 500,000 galaxies to a redshift of 0.26. The fundamental aims of WALLABY are to examine the HI properties and large-scale distribution of these galaxies in order to study galaxy formation and the missing satellite problem in the Local Group, evolution and star formation of galaxies, the role of mergers and galaxy interactions, the HI mass function and its variation with galaxy density, the physical processes governing the distribution and evolution of cool gas at low redshift, cosmological parameters relating to gas-rich galaxies and the nature of the cosmic web. WALLABY will provide the largest, most homogeneous HI sample of galaxies yet made, and will be an important pathfinder for key SKA science.

First Large Absorption Survey in HI (FLASH) — PI Sadler

FLASH is a blind HI absorption-line survey that uses background radio continuum sources to identify and characterise foreground neutral hydrogen. FLASH science outcomes are focused on both the neutral gas content of galaxies and the cosmic HI mass density in the redshift range $0.5 < z < 1.0$ where the HI emission line is too weak to be detectable in individual galaxies. The observations will increase the total number of absorption line systems by an estimated two orders of magnitude, representing a significant data set to study gas assembly and galaxy formation during a time in the history of the Universe that is largely unstudied thus far.

An ASKAP Survey for Variables and Slow Transients (VAST) — PIs Murphy & Chatterjee

VAST gives unprecedented opportunities to investigate the sky at radio wavelengths for transients with a timescale as short as five seconds. ASKAP's wide-field survey capabilities will enable the discovery and investigation of variable and transient phenomena from the local to the cosmological including flare stars, intermittent pulsars, X-ray binaries, magnetars, extreme scattering events, intra-day variables, radio supernovae and the orphan afterglows of gamma-ray bursts. VAST will probe unexplored regions of phase space where new classes of transient sources may be detected.

GASKAP, the Galactic ASKAP Spectral Line Survey — PI Dickey

The GASKAP survey is a high spectral resolution study of the HI and OH lines in the Milky Way and Magellanic Systems. Compared with existing data, GASKAP will achieve about an order of magnitude improvement in both brightness sensitivity and in angular resolution.

GASKAP will detect and map OH masers from evolved stars and star formation regions, diffuse emission from molecular and atomic clouds, HI absorption toward background continuum sources and the structures in the gas that trace the effects of stellar winds and supernova explosions. The Magellanic Clouds will show all these processes as they appear in two other, very different environments. GASKAP will provide stunning images of the interstellar medium that will be indispensible for astronomers working at other wavelengths.

Polarisation Sky Survey of the Universe's Magnetism (POSSUM) — PIs Gaensler, Taylor & Landecker

Understanding the Universe is impossible without understanding magnetic fields. Magnetic fields are key to the non-thermal Universe, yet it is unclear how large-scale magnetic fields are generated and maintained. POSSUM will use radio source polarisation, in particular the technique of rotation measure (RM) synthesis, to perform a wide-field survey that will yield a grid of RMs over a substantial fraction of the sky. The science outcomes

of POSSUM will revolutionise our understanding of the ordered components of the Milky Way's magnetic field, test dynamo and other models of magnetic field generation in galaxies and clusters, and carry out a comprehensive census of magnetic fields as a function of redshift in galaxies, active galactic nuclei, galaxy clusters and the intergalactic medium.

The Commensal Real-time ASKAP Fast Transients Survey (CRAFT) — PIs Dodson & Macquart

CRAFT is a purely commensal survey for transient sources with time-scales shorter than five seconds. Short-timescale transients are associated with the most energetic and brightest single events in the Universe. They provide Nature's ultimate laboratory; their emission is generated by matter under extreme conditions whose properties probe physical regimes far transcending the range achievable in terrestrial experiments. Fast timescale transients open new vistas on the physics of high brightness temperature objects, extreme states of matter and the physics of strong gravitational fields. In addition, the detection of extragalactic transients affords us an entirely new and sensitive probe on the huge reservoir of baryons in the intergalactic medium.

DINGO: Deep Investigation of Neutral Gas Origins — PI Meyer

DINGO will study the evolution of neutral hydrogen (HI) from the current epoch to redshift about 0.5, providing a legacy dataset spanning cosmologically representative volumes.

Measurements will be made of key cosmological distributions, including ΩHI, the HI mass function and the halo occupation distribution function. ASKAP data will be combined with optical data to enable a thorough study of the co-evolution of the stellar, baryonic and dark matter content of galaxies.

The High Resolution Components of ASKAP: Meeting the Long Baseline Specifications for the SKA - PI Tingay

ASKAP, in combination with the existing Australian Long Baseline Array, high speed data recording equipment, innovative software correlation facilities and high speed data transport networks provides a high resolution capability that is unmatched in terms of SKA demonstrators around the world. Science outcomes include proper motion and parallax of pulsars, high resolution imaging of Active Galactic Nuclei, follow-up of transient radio sources and distances and proper motions of OH masers.

Compact Objects with ASKAP: Surveys and Timing (COAST) — PI Stairs

COAST will undertake an observational program of pulsar timing aimed at high profile issues in astrophysics. This includes limits on, or the detection of, a background of gravitational waves, stringent tests of the predictions of General Relativity and other theories of strong gravity and the studies of binary stellar evolution. In addition to pulsar timing, blind searches for pulsars will also be carried out which will lead to a better understanding of the Galactic neutron star population, the pulsar emission mechanism and the structure and magnetic field of the Galaxy.

2009 CSIRO Radio Astronomy School

Jimi Green and Mike Keith (ATNF)

The ATNF held a CSIRO Radio Astronomy School at the Parkes Radio Telescope for the first time in the last week of September. The ATNF has for many years run a Synthesis Imaging School at the Australia Telescope Compact Array in Narrabri, typically every other year. However, this year the ATNF took the step of moving towards an annual school, alternating between the synthesis imaging theme, held in Narrabri, and a primarily single-dish radio astronomy focussed school, held at Parkes. The program featured a range of topics, including: details of the illustrious history of Parkes; the core principles of radio astronomy; the range of single-dish radio astronomy observations; and placing radio astronomy in the wider context. It also contained one day dedicated to interferometric considerations. Three afternoon sessions were used for group tutorials, consisting of a site tour, an ATNF Spectral Analysis Package data reduction tutorial, and an observing session. Unfortunately, persistent strong winds resulted in the dish being wind-stowed for the first two tutorial sessions and the "practical observing" tutorial becoming a theoretical exercise! For lighter entertainment the school had two evening talks, *Making Beer in Space* by Andrew Walsh and *Aboriginal Astronomy* by Ray Norris, both proving very popular, and included tours of "The Dish", even allowing some students to walk on the dish (although not to play cricket!). The school was well attended by almost 30 students from across Australia as well as further afield. The organising committee would like to heartily thank the local staff at Parkes and the staff at the Dish Cafe for helping make the week a success. Copies of the presentations given at the School have been posted on the webpage at *www.atnf.csiro.au/research/radio-school/2009/*.

The 2009 CSIRO Radio Astronomy School. Credit: John Sarkissian, CSIRO

CSIRO Parkes Observatory Open Days

Chris Hollingdake (ATNF)

The CSIRO Parkes Observatory celebrated the International Year of Astronomy and the 40th anniversary of the Apollo 11 moon landing by giving members of the public a rare opportunity to tour the Parkes radio telescope.

Parkes open days visitors. Credit: Tony Crawshaw, CSIRO

The open days, showcasing the achievements of the Observatory as a world-leading astronomical telescope as well as its roles in supporting some of the most significant space missions in history, took place on the weekend of 18 – 19 July.

A record crowd of more than 6,500 visitors visited the Observatory over the weekend with ATNF volunteers guiding 3000 visitors through the 64-m telescope on tours. This was 100% more than previous records achieved on Open Weekends. Takings were also well up at the Visitors Centre with each day's takings about twice the previous record daily revenue.

Notably, our most distant visitors travelled from London for the event, while the first visitors in the queue on Saturday morning had driven especially from Townsville!

As well as telescope tours of "The Dish", the future of radio astronomy was highlighted through tours of the 12-m ASKAP testbed antenna, and through expert talks, brochures and interactions with staff. From a public relations perspective, the Open Days were also a resounding success with extensive media coverage generated on TV and radio, and in print and online mediums.

In total around one hundred staff and volunteers were involved, and helped to make the weekend run smoothly.

More than 3,000 people toured the 64-m telescope during the CSIRO Parkes Radio Telescope Open Days 2009. Credit: Shaun Amy, CSIRO.

The ATNF collaborated with CSIRO Education, Questacon – The National Science and Technology Centre, the Central West Astronomical Society, the Wireless Institute of Australia, HeliWest, the NSW State Emergency Services and various other community groups. The diversity of groups present offered a variety of activities for families to enjoy. Feedback from these groups was very positive and it is likely we will be able to build on these relationships for future events.

A world-class line up of speakers also featured and included the following presentations:

David Malin, Astrophotographer, who spoke on *Galileo's astronomical legacy*.

Jill Tarter, Director of the Centre for SETI Research, whose talk was titled *SETI: Science Fact, Not Fiction*.

Wayne Lee and Erissa Hines, NASA engineers, who spoke on NASA's plans to return to the moon.

David Cooke and Neil Mason, former Parkes staff, who spoke on their recollections of the Apollo missions.

The public attention that Open Days at the ATNF Observatories generate is very important in ensuring that the great work conducted with our radio telescopes is recognised throughout Australia. These days would not be possible without the support of the ATNF staff and their families.

Thank you, one and all!

CSIRO ATNF says Farewell to Pat Sykes

Tony Crawshaw (ATNF)

ATNF News Editor Tony Crawshaw spoke with Pat Sykes, ATNF's leading cryogenics specialist and Marsfield research team leader of engineering, in the weeks before his retirement. In the thirty-six years that Pat spent working for CSIRO, he designed, developed and maintained a wide range of cryogenic cooling systems and ancillary technology, utilised by microwave receiving systems on both ATNF and international antenna systems. This is an edited transcript of that conversation.

So Pat, you've been with the CSIRO for over 36 years. How did it all start?

Well, it all goes back to my time at Kulnura (30 miles west of Gosford) where I was brought up on a citrus farm. It was pretty remote. The nearest neighbour was two miles away and it was all dirt roads. I'd start the day working on the farm. Then I'd make my way to school (a three mile bike ride to the bus stop, and then a bus into town). Then I'd have the journey in reverse, and work some more on the farm. Well, that was where I got my interest in machinery. I enjoyed working with the tractors and all of the farming implements so it seemed to make sense to apply for an apprenticeship. So, I did and was lucky enough to pick one up with CSIRO as a fitter and machinist. It wasn't the ATNF back then; it was the Division of Radio Physics.

What do you remember about these early years?

Well, I remember there was a fair amount of study involved going to tech at night. I actually started a mechanical engineering certificate at the same time that I was completing the apprenticeship. In those days, apprenticeships were Government funded and there was no guarantee that you'd get a full time job with the organisation that you'd apprenticed at. From what I could see within the Division it all looked

Pat Sykes with the Parkes 13-beam multibeam receiver ready for final assembly in the Marsfield cryogenic lab.

pretty interesting, so I thought I'd better pick up as many skills as possible. I finished my apprenticeship and applied for my first formal CSIRO role (as draftsman). That was in 1977 and I worked on various projects at Marsfield before moving to Parkes several years later on.

What did you do at Parkes?

I was working on the T.E.S.T (Two Element Synthesis Telescope) project under Jon Ables which involved the refurbishing of the 18-m Telescope, modifying a telescope service tower to be a telescope transporter and the construction of two temperature controlled receiver packages. I also did the surveying for the 400m of rail track and then supervised the laying as well. I did a bit of everything at Parkes and have really fond memories of my time there. Then that project finished and I returned to Sydney to take up the position of Cryogenic Technician.

So this was where you got your cryogenic grounding?

Yes — that was the commitment to building the K-band maser (which was about 60% complete at the time). The construction of the 4K receiver cryogenic system was done by John Griffiths to whom I was assigned for a training in Cryogenics. After finishing the maser, John moved on to work in the digital electronics area. That left me as responsible for Cryogenics in the Division and I was fortunate enough to be able to create the first cryogenic lab in the basement here at Marsfield. It was a proper leap forward to have a proper lab. Initially the cryogenics work had been done with nothing more than an ordinary bench top — I was rebuilding compressors on my desk!

You've been involved in a number of exciting projects. What stands out?

Well the AT (Australia Telescope) was a major project. The AT was a bicentennial project and my job was to fit out all the antennas with all the cryogenics and to set up a world class lab in Narrabri. That was a busy time, looking after all the plumbing on the antennas, designing equipment and running a team of people installing all of the machinery. I was based in Narrabri for two and a half years and to be in on the ground floor setting it all up was a once in a life time opportunity and absolutely fantastic.

And another project highlight?

Another was moving to the University of California, Berkeley in the early 1990s where I worked on the design and construction of the Berkeley-Illinois-Maryland Array particularly the 2.5-Kelvin receiver. Through Rick Forster I found out they needed a cryogenic person so I applied for the job. This was in the early stages and there were no antennas yet on site. CSIRO gave me a technical transfer; I took leave without pay and worked on all things cryogenic. This was a real eye opener for me. Everyone I worked with was a pure researcher. I was the hands-on person with the practical experience but I'd never worked in a university before. To be surrounded by the students and the thinking and discussions that would take place was amazing. At the antenna completion stage I was working on site at Hat Creek (Northern California). The summers were hot and the winters were blistering cold. I remember trying to solder up connectors with three heater blowers on full blast, just to get the solder to melt!

Then back to Sydney?

This was the start of designing and building a two-stage Helium scroll compressor to run the SIS mm receiver. It was a huge success and was the building block for our single stage compressors to follow, that have been running trouble free since 1997. A result I am very proud of.

The next big project was working on the 13-beam multibeam receiver for Parkes. No one had ever built a receiver that big at that frequency. I designed the cryogenic package and all the mechanical components

that went into the receiver. The receiver was installed February 1997 and is still operational. We actually won the CSIRO medal for that. It turned out to be a huge success and I think, led directly, to ATNF getting the contract to create ALFA — a 7-beam receiver in Arecibo [the Arecibo L-band Feed Array].

Can you tell me a bit more about ALFA?

What I remember most about ALFA was flying out to Arecibo in Puerto Rico with Graeme Carrad, who was at that time the Project Manager. Graeme and myself went across there to do the installations and commissioning. It was very exciting and an ordeal at the time but something pretty special. We had to overcome a huge number of challenges — the heat, the climate, language difficulties, living onsite and there was absolutely no escape from work. In one month we transported, then totally rebuilt and installed the receiver, teaching the local technicians along the way. The receiver's been a huge success and has been virtually trouble free. It was a pretty satisfying experience, due I think to the huge effort that we all had to put in i.e. the whole receiver group and workshop. It all worked out really well though — an experience that I will always treasure.

You've obviously had a number of highlights in your career. What's the one thing that really stands out?

As airport traffic co-ordinator at Narrabri for the opening of the Australia Telescope Compact Array (ATCA) in 1988 I had to greet the Prime Minister Bob Hawke at the airport. He was there to open the Australia Telescope. He emerged from the plane surrounded by minders, read my name tag and said "G'day Pat let's go open this big thing". To represent CSIRO and to be involved in something that was worth the PM coming out to see was an incredible experience. The whole opening went really well with the PM driving the telescope up and down the track. We'd put 1800 helium balloons into the telescopes so that they could all be released at the same time. It looked very spectacular and then we had a huge party on-site. That was a very special day.

You've obviously worked with a huge range of people during your time with CSIRO. Who would you say has been the biggest influence on your career?

Well it's been more than one person. I'd have to say John Brooks who went on to be project manager for the ATCA and then assistant director at the ATNF. John always had the time to spend with you whether it was to discuss your issues or to celebrate your successes. He was dedicated to his job and a pretty inspiring bloke that you didn't want to let down. I'd also say Mal Sinclair who was in charge of the receiver group. He was just a wealth of knowledge and a great bloke as well. Both have played a major role in my work life.

Any final thoughts?

Just that CSIRO has been really good to me. I'd never have a bad thing to say about the organisation. I've always been proud to explain my cryogenic work and people have always been fascinated with the projects that I've worked on over the years. I've been quite chuffed about that. I'd have to say that looking back, it's been a pretty steep learning curve. There's been a whole host of issues and challenges that have had to be overcome. These though, have been the ones that I've enjoyed the most. It's the adventurous projects that have brought out my best work. I can honestly say that I've had the best job in the world for me.

Thanks for your time Pat

My pleasure and all the best for the ATNF in the upcoming years!

The Nearest Powerful Radio Galaxy NGC612: First Science Results with the CABB C/X-band

Bjorn Emonts, Minnie Mao and Jamie Stevens

NGC 612 is the nearest radio galaxy in the southern hemisphere with a truly powerful and extended radio source. One of its radio jets shows a clear hot-spot, typical for Fanaroff & Riley type-II radio sources. The proximity of NGC 612 allows us to study this radio source and its host galaxy in great detail. This gives us a unique look into the physical processes associated with powerful radio galaxies, which are often too far away to be studied in detail. We observed the rich radio-continuum source of NGC 612 as part of the commissioning of the 2 GHz Compact Array Broadband Backend (CABB). Results obtained from these observations show the great potential of CABB, as well as the challenges faced in the data reduction over a full 2-GHz frequency range.

Powerful radio galaxies are among the most active galaxies in the Universe. Their bright radio continuum can often be traced out to very high redshifts and act as beacons to trace the most massive galaxies in the Early Universe, which are often too faint to be studied in detail at other wavelengths. A thorough study of powerful radio galaxies in the nearby Universe — although rare — will provide crucial information about the host galaxy properties and possible formation history of these active systems.

The nearest powerful radio galaxy with extended radio continuum jets in the southern hemisphere is NGC 612 ($z = 0.03$; e.g. Ekers et al. 1978). Although the host galaxies of nearby radio sources are generally elliptical systems, NGC 612 has been identified as an archetypal S0 galaxy with a disc of optical emission-line gas (Véron-Cetty & Véron 2001; Goss et al. 1980). Star formation has been detected along its optical disc (Holt et al. 2007). In collaboration with scientists at ASTRON and the University of Sheffield, we recently discovered that NGC 612 contains an enormous disc of neutral hydrogen (HI) gas. Figure 1 shows the HI observations that we did with the Australia Telescope Compact Array. The HI disc around NGC 612 has a diameter of 140 kpc and a total HI mass of 1.8×10^9 $M_\odot$ (Emonts et al. 2008). A medium-deep optical image of NGC 612 shows indications for faint shell-like structures within the extent of the HI disc. In addition, a faint bridge-like structure of HI gas stretched from NGC 612 along a total distance of 400 kpc towards the nearby gas-rich galaxy NGC 619 (see Figure 1). From optical studies, it has been suggested that at least a significant fraction of powerful radio galaxies are triggered by gas-rich galaxy mergers or collisions and that the radio source may be fuelled by the cold gas associated with these events (e.g. Heckman et al. 1986, Baum et al, 1992; see also Hardcastle et al. 2007). Our HI observations provide the first direct evidence that NGC 612 indeed contains a large reservoir of cold gas, possibly deposited by a past galaxy merger or collision. NGC 612 is one of only a handful of powerful radio galaxies for which we can study directly the properties of the cold HI gas with the sensitivity of current-day telescopes.

First CABB results on NGC 612

The complex and bright structure of the radio continuum source also makes NGC 612 an excellent target to image with the new 2-GHz Compact Array Broadband Backend (CABB). On 9 and 10 April of this year, NGC612 was the first science target observed with the C/X-band system of the new CABB system, using the hybrid H168 array configuration. Over the following months, we repeated these observations at three additional epochs in the two most compact hybrid array configurations (H168 and H75). CABB provides two IFs, each with a 2-GHz bandwidth with 2048 channels and full stokes polarisation. In C/X-band, observations at 6 and 3 cm can be done simultaneously by tuning the individual 2-GHz bands across a total frequency range of 8 GHz.

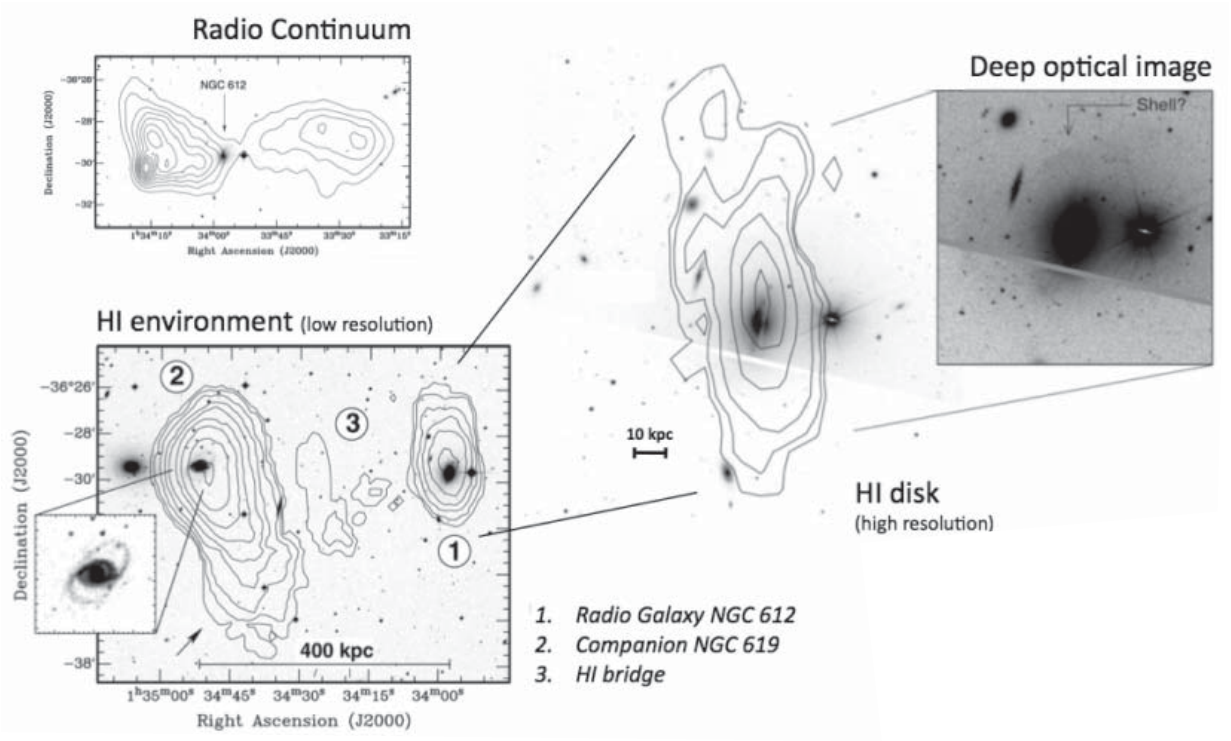


Figure 1: Radio Galaxy NGC 612 (from Emonts et al. 2008). Top-left: contours of the 20-cm radio continuum of NGC 612 (also known as PKS 0131-36). Bottom-left: HI-rich environment of NGC 612 and its companion NGC 619 (contours represent the total intensity of the HI gas; levels: 0.2, 0.4, 0.7, 1.1, 1.7, 2.3, 3.4, 4.5, 5.7×10^{19} cm^{-2}). Middle: High-resolution contour plot of the HI disc around NGC 612 overlaid on to an optical image of the S0 host galaxy (contour levels: 0.8, 1.1, 1.5, 1.9, 2.8, 4.0, 5.1, 6.5, 7.8 ×10^{19} cm^{-2}). Left: Medium-deep VLT acquisition image of NGC 612 (10 sec integration time on an 8m VLT telescope).

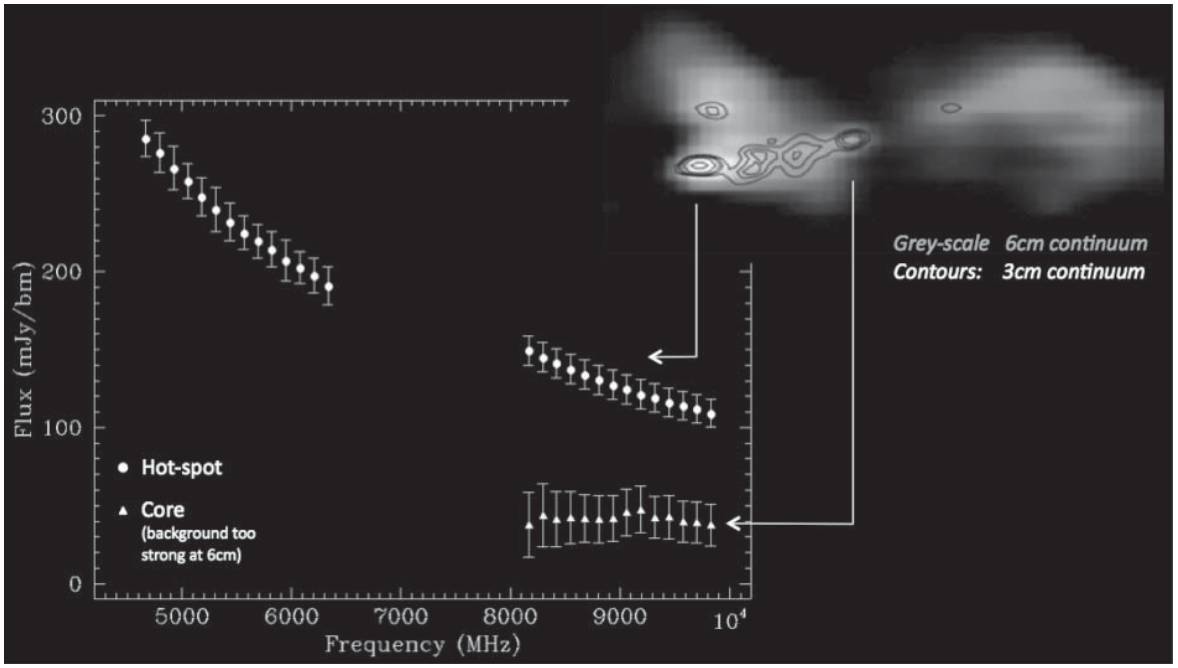


Figure 2: Radio-continuum Spectral Index of NGC 612. ***Top-right:*** Preliminary radio continuum image of NGC 612 at 6 cm (greyscale) and 3 cm (contours) with CABB. ***Left:*** Spectral Index of the eastern hot-spot (dots) as well as the nucleus (triangles) of NGC 612 across the full 2 GHz range of the C- and X-band.

Figure 2 shows preliminary results obtained from these CABB observations. A total intensity image of the radio continuum of NGC612 is displayed at 6 cm (grey-scale) and 3 cm (contours). The diagram in Figure 2 shows the spectral index of both the hotspot as well as the nucleus. Each individual data point was obtained by extracting a 128 MHz part of the 2-GHz CABB-band (i.e. the same width as the old pre-CABB backend of the Compact Array). We performed a full standard reduction on each separate 128 MHz part of the data (bandpass, phase and flux calibration) and derived the flux from the cleaned image by fitting a Gaussian to the hot-spot and nucleus. The same result is obtained when performing a reduction over the full 2-GHz band and splitting up the data only at the final stage of imaging, provided that the bandpass is derived from a calibrator with known spectral index (such as PKS 1934-638). The preliminary image of the radio continuum structure in Figure 2 is obtained by combining the individual "128 MHz" images over the entire 2-GHz band at 6 and 3 cm (with only one observing epoch in both the H168 and H75 array configuration included so far). However, in reality the continuum structure changes significantly over the full 2 GHz range.

Figure 2 clearly shows the steep spectral index of the radio hot-spot, while the nucleus shows a roughly flat spectrum (note that at 6 cm the continuum of the inner radio lobes becomes too bright to clearly distinguish the resolved nucleus). These results appear to be in agreement with continuum observations at 20 GHz by Burke-Spolaor et al. (2009) and at 843 MHz by Jones & McAdam (1992). The spectral index properties of NGC 612 are typical for powerful radio galaxies with an unresolved nuclear continuum source and bright radio hot-spot.

We have also obtained polarisation data for NGC612. Preliminary analysis of this data shows that the hotspot is highly polarised (~25%) at 6 cm. This is the first test of CABB's polarisation capabilities, and it indicates that calibration is possible with the new wide-band system.

However, our understanding of the data reduction associated with the new CABB system is continuously progressing. Many new challenges are faced regarding the reduction of data over these large bandwidths, which will become standard in the next generation radio telescopes. A full understanding of the effects related to science observations using large bandwidths is essential for assuring the data quality obtained with these new instruments. Nevertheless, our preliminary CABB results indicate the excellent performance of the new broadband system at the Compact Array and show the great potential for broadband technology in radio interferometry.

Acknowledgements: We would like to thank Warwick Wilson and his team, the people in Narrabri and all others involved in the CABB project for their hard work to make CABB a great success. Also thanks to Maxim Voronkov for his help with the observations during the commissioning period of CABB

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Gas Dynamics and Star Formation in the Galaxy Pair NGC 1512/1510

Ángel R. López-Sánchez and Baerbel Koribalski (CSIRO / ATNF)

Abstract

As part of the *Local Volume HI Survey* (LVHIS) project, we obtained HI line and 20-cm radio continuum data of the nearby galaxy pair NGC 1512/1510 using the Australia Telescope Compact Array (ATCA). The results are stunning: we found a very large HI disk that is ~4 times the optical diameter of the barred galaxy NGC 1512, with two pronounced spiral/tidal arms. Both the HI morphology and the distribution of the star-forming regions are affected by gravitational interaction with the neighbouring blue compact dwarf galaxy NGC 1510. The two most distant HI clumps are likely tidal dwarf galaxies (TDGs). We complemented the study with GALEX UV-, SINGG Hα- and Spitzer MIR images, comparing the distribution and kinematics of the neutral atomic gas with the localisation, star-formation activity and ages of the stellar clusters in multiple regions of the system. This multi-wavelength analysis suggests that the galaxy pair NGC 1512/1510 is in the first stages of a minor merger having started around 400 Myr ago.

Introduction

Hydrogen is the most abundant element in the Universe, the main fuel for star formation and a powerful tracer of galaxies in various stages of their evolution. The *Local Volume HI Survey* (LVHIS; Koribalski et al. 2008, *www.atnf.csiro.au/research/LVHIS*) will expand our knowledge of the nearby Universe via HI line (21-cm) and radio continuum observations of all gas-rich galaxies in the Local Volume (D < 10 Mpc). More than 70 southern galaxies previously detected in the *HI Parkes All-Sky Survey* (HIPASS; Koribalski et al. 2004) have been observed with the ATCA.

The galaxy pair NGC 1512/1510 is located in the outskirts of the Local Volume, at around 9.5 Mpc. The barred, double-ring spiral galaxy NGC 1512 and the blue compact dwarf (BCD) galaxy NGC 1510 are an interacting galaxy pair, separated by only ~5' (13.8 kpc).

HI morphology and kinematics

Figure 1 shows that the NGC 1512/1510 system possesses a huge amount of neutral gas. Our deep ATCA HI mosaic reveals a very extended HI distribution, spanning a diameter of ~40' (or 110 kpc). Two prominent spiral arms, which appear to wrap around ~1.5 times, are among the most remarkable HI features. Disturbances in the outer disk of NGC 1512 are likely caused by tidal interaction with and accretion of the dwarf companion, NGC 1510. Individual HI clouds are found out to projected radii of 30' (~83 kpc). The velocity gradient detected within the extended clumps agrees with that of the neighbouring spiral arms, suggesting that they are condensations within the outermost parts of the disk. The two most distant HI clumps are likely *tidal dwarf galaxies* (TDGs), as the GALEX UV images indicate relatively recent (150 – 300 Myr) star formation activity in them.

Figure 2 displays the HI velocity field of the galaxy pair NGC 1512/1510 which indicates a relatively regular rotating inner disk of NGC 1512 and a more disturbed outer disk. The fitting of the rotation curve indicates important deviations near the position of NGC 1510 and in the outer spiral/tidal arms.

20-cm radio continuum emission

The 20-cm radio continuum emission towards the galaxy pair NGC 1512/1510 and its surroundings is shown in Figure 3. Both galaxies are clearly detected. The field contains a large number of unresolved radio sources as well as a few head-tail and wide-angle tail radio galaxies. The barred spiral galaxy NGC 1512 shows extended continuum emission (~5'×3') and a

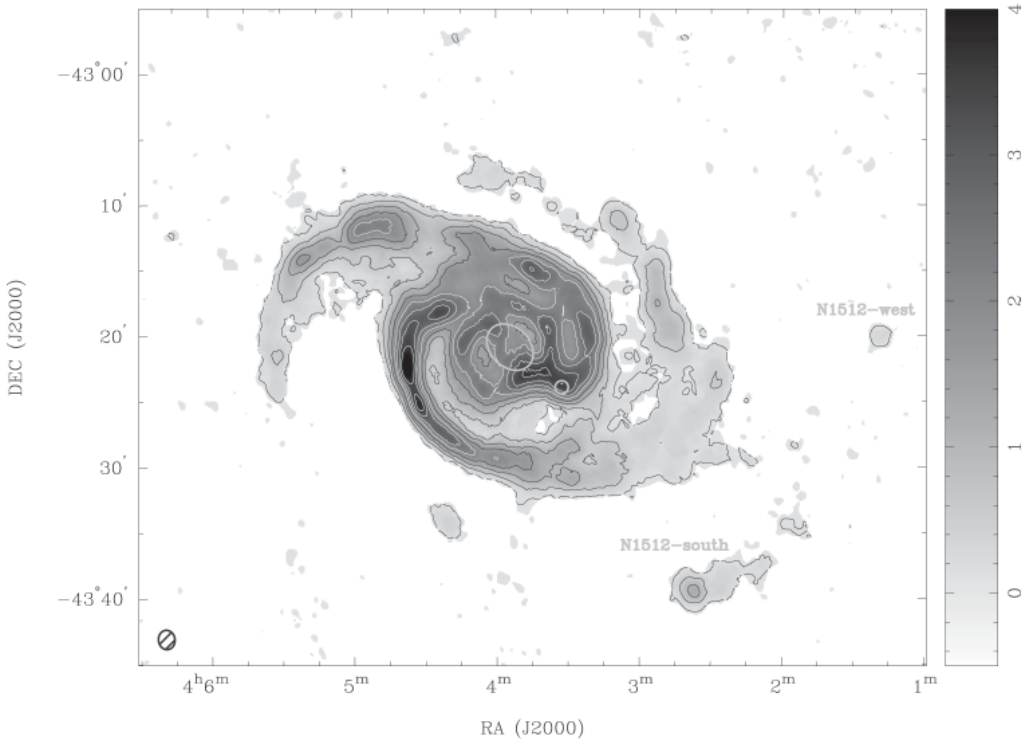

Figure 1: ATCA HI distribution in the galaxy pair NGC 1512/1510. The ellipse (center) and the circle (~5' towards the SW) mark the position of NGC 1512 and NGC 1510, respectively. The two TDG candidates are also labelled.

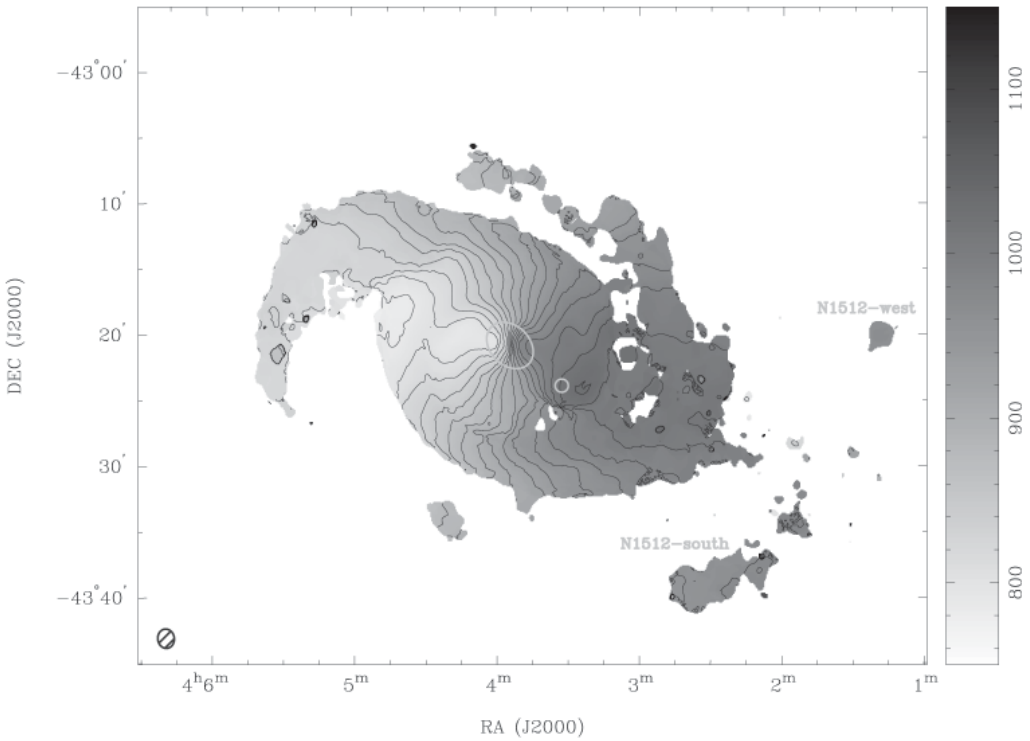

Figure 2: ATCA HI velocity field of the galaxy pair NGC 1512/1510.

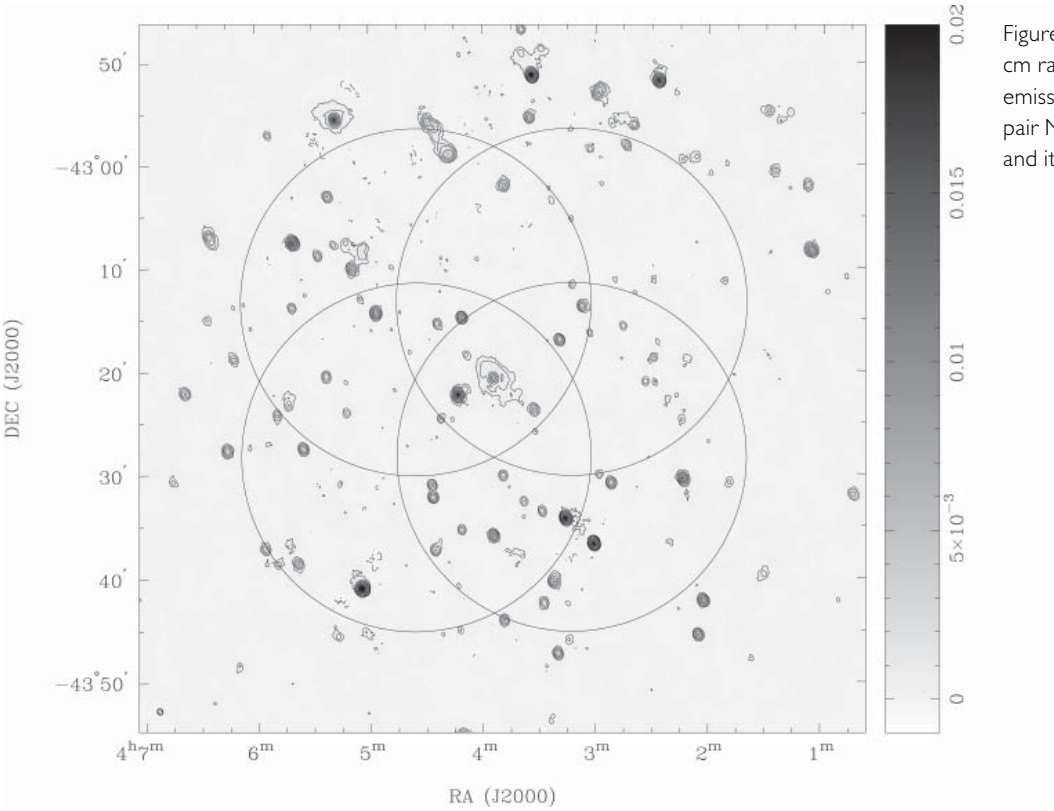

Figure 3: ATCA 20-cm radio continuum emission of the galaxy pair NGC 1512/1510 and its surroundings.

bright core while the much smaller BCD galaxy NGC 1510 appears unresolved at 30" resolution. The "fish" shaped radio continuum emission is due to enhanced star-formation in the region between the two galaxies which corresponds to the tail of the fish. Using the radio-continuum flux, we derive a star formation rate (SFR) of 0.11 and 0.012 MO yr^{-1} for NGC 1512 and NGC 1510, respectively.

Notice that both the HI and the continuum images are similar to those that will be provided by the *Widefield ASKAP L-band Legacy All-sky Blind surveY* (WALLABY) project using the Australian SKA Pathfinder (ASKAP). The *Evolutionary Map of the Universe* (EMU) project using the ASKAP will provide even higher resolution (10") images.

UV – HI comparison

The combination of the large-scale HI distribution with deep optical and UV emission maps is an excellent way to highlight the locations of star formation within the gaseous disk (see cover figure). NGC 1512's HI envelope is four times larger than its optical size and about twice as large as the stellar extent measured from Malin's deep optical image and from the GALEX UV images. Furthermore, the correspondence between regions of high H I column density and bright UV emission is excellent throughout the extended disk of NGC 1512 (apart from the central area which must be rich in molecular gas). The large majority of the observed UV -complexes lie in regions where the HI column density is above 2 × 10^{21} atoms cm^{-2}. Deep GALEX images of nearby galaxies show that the UV profiles of many spiral galaxies extend beyond their Hα or B_{25} optical radius (Thilker et al. 2005; Gil de Paz et al. 2005, 2007) and it seems that these XUV-disks exist in ~30% of the local spiral galaxy population (Zaritsky & Christlein, 2007). We contend that these spectacular XUV –disks must be located within even larger HI envelopes, here called 2X-HI disks, which provide the fuel for continued star formation.

Star formation activity

We derive the ages of the UV-rich star clusters using the GALEX FUV and NUV images and find a color gradient along the spiral arms and other regions of the NGC 1512/1510 system, indicating that younger clusters are usually located closer to the inner regions. We investigated if the UV-rich clusters do obey the Schmidt-Kennicutt scaling laws of star formation (Kennicutt 1998) and found that generally only the youngest UV clusters are associated with high HI column densities, while in older UV clusters only diffuse HI gas is detected. This might suggest that as the hydrogen gas depleted, star formation stopped in the latter regions. As a consequence we expect to detect Hα emission

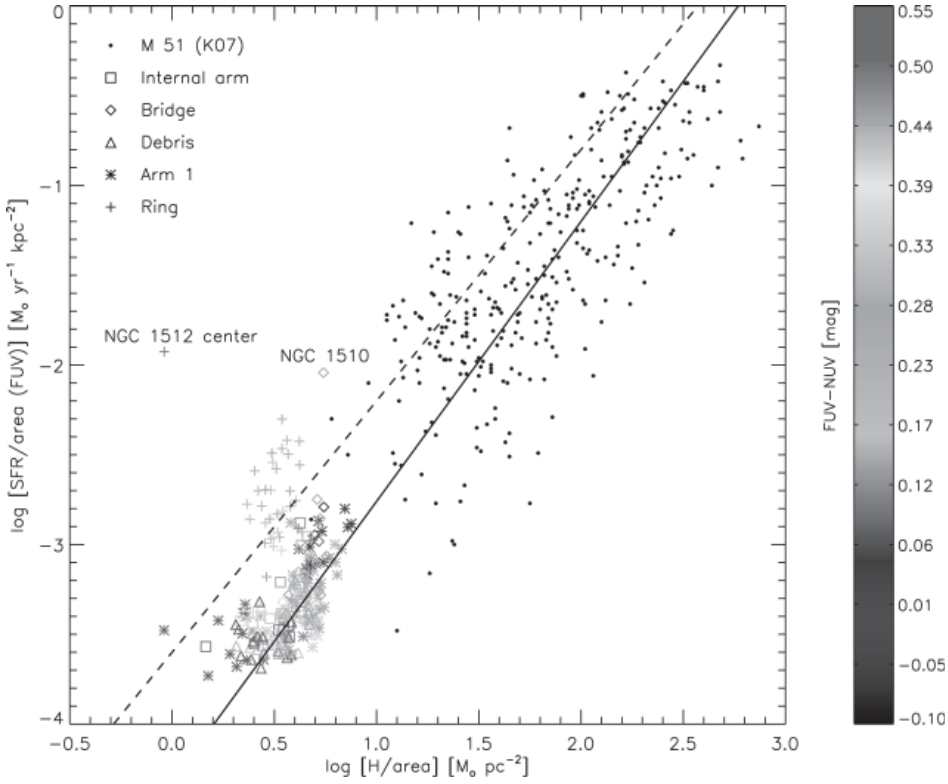

Figure 4: Relation between FUV-based SFR density and the HI gas density for UV-rich clusters in the NGC 1512/1510 system (symbols) and the galaxy M51 (black dots, from Kennicutt et al. 2007). The solid line is the best fit to the M51 data (Kennicutt et al. 2007); the dashed line is the relation for whole galaxies derived by Kennicutt (1998).

in all high density HI regions or equivalent in all young UV clusters.

Figure 4 shows the FUV-based SFR density versus the gas density for UV-rich clusters in the NGC 1512/1510 system and in the nearby Sbc galaxy M 51 (Kennicutt et al. 2007; for r <_ 8 kpc). Because no molecular data are currently available for NGC 1512, only the HI gas density is shown. The solid line is the best fit to the data obtained by Kennicutt et al. (2007) in the analysis of the independent star-forming regions within M 51 and includes the molecular data, that are found to be essential for the observed correlation. As we see, UV-rich clusters within the NGC 1512/1510 system generally agree with the relation followed by the star-forming regions within M 51 and not with the whole galaxies. Regions within the inner star-forming ring of NGC 1512 (located at r = 90´´) are significantly offset from this relation, suggesting a large amount of molecular gas is present.

Conclusions

We analysed the distribution and kinematics of the HI gas as well as the star formation activity in the galaxy pair NGC 1512/1510 and its surroundings. Our study supports a scenario in which the interaction between the BCD galaxy NGC 1510 and the large spiral galaxy NGC 1512 has triggered star formation activity in the outskirts of the disk and enhanced the tidal distortion in the HI arms. The system is probably in the first stages of a minor merger which started ~400 Myr ago. The results of our study will be published in MNRAS (Koribalski & López-Sánchez, 2009).

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Exploring the Radio Bimodality of QSOs with CABB

Elizabeth Mahony (University of Sydney / ATNF), Elaine Sadler (University of Sydney), Scott Croom (University of Sydney), Ron Ekers (ATNF), Ilana Feain (ATNF) and Tara Murphy (University of Sydney).

Quasars (QSOs) are often classified into two broad categories; radio-loud and radio-quiet, but the underlying distribution of radio luminosity has long been debated in the literature. Using the new Compact Array Broadband Backend (CABB) we are observing a large sample of X-ray selected QSOs at high radio frequencies as a new way of tackling this issue.

Although the first QSOs were discovered by their radio emission, it was soon realised that the majority are radio-quiet (Sandage 1965). Since then, there have been numerous studies of the radio luminosity distribution of QSOs or Type 1 active galactic nuclei (AGN). There are two opposing views on this issue. The first is that the distribution of radio-loudness is bimodal, i.e. there are distinct radio-loud and radio-quiet populations, with 10-20% of QSOs being radio-loud (Kellermann et al. 1989). The second is that there is a broad, continuous distribution with no clear dividing line between radio-loud and radio-quiet QSOs (Cirasuolo et al. 2003).

Clarifying this issue would shed light on some of the intrinsic properties of nearby QSOs. A bimodal distribution in radio luminosities suggests that there are two intrinsically different classes of QSOs, only one of which is able to become a strong radio source. Alternatively a continuous distribution suggests that all QSOs have low-luminosity radio sources which become stronger during episodes of unusually high activity. One reason why different studies have produced contradictory results is that previous radio studies have used QSO samples which span a wide range in redshift and a relatively narrow range in optical magnitude. This introduces a strong and spurious correlation between redshift and luminosity, which in combination with the rapid cosmic evolution of the QSO population introduces selection effects which greatly complicate any interpretation of the data.

Here we report on an on-going observing program to investigate the high frequency radio luminosity distribution of QSOs with the Australia Telescope Compact Array (ATCA). Earlier attempts to investigate the radio luminosity distribution of QSOs generally used 1.4 GHz radio observations (e.g. Cirosuolo et al. 2003, Jiang et al. 2007) due to the fact that most large area radio surveys are carried out at this frequency. There are also a few at 5 GHz (Kellermann et al. 1989, Stocke et al. 1992) and 8 GHz (Hooper et al. 1995, Goldschmidt et al. 1999). By observing at 20 GHz we pick up the central core component of the AGN and hence see the most recent activity. At lower frequencies the observed emission includes the radio lobes, which could be relics of past activity integrated over large timescales. It has been shown in the recent release of the *Australia Telescope 20 GHz* (AT20G) *survey* that the 20 GHz source population is dominated by flat spectrum cores, which is significantly different from what is seen in low frequency surveys (Murphy et al. 2009).

In our program we selected QSOs from the *ROSAT ALL Sky Survey* (RASS) *Bright Source Catalogue* (Voges et al. 1999) that were observed as part of the 6dF Galaxy Survey (6dFGS; Jones et al. 2009). Details of this catalogue are presented in Mahony et al. 2009. Sources were selected if the 6dFGS spectrum exhibited broad emission features indicative of a QSO or Type 1 AGN. We also set a redshift cutoff of $z<1$ to minimise any evolutionary effects. We then searched the AT20G survey for any known 20 GHz radio sources which were excluded from our target list. This leaves a final sample of 1138 sources spread across all Right ascensions (RAs) in the southern sky. Example 6dFGS spectra and corresponding 20 GHz observations are shown in Figure 1. Since this is a large, low-redshift QSO sample which spans a wide range in optical luminosity and is not strongly affected by evolution within the sample volume, we believe that it can provide a definitive test of whether the $z<1$ QSO population is bimodal in its high frequency radio properties. Selecting sources that have 6dFGS spectroscopic information not only provides a uniform sample, but will also give

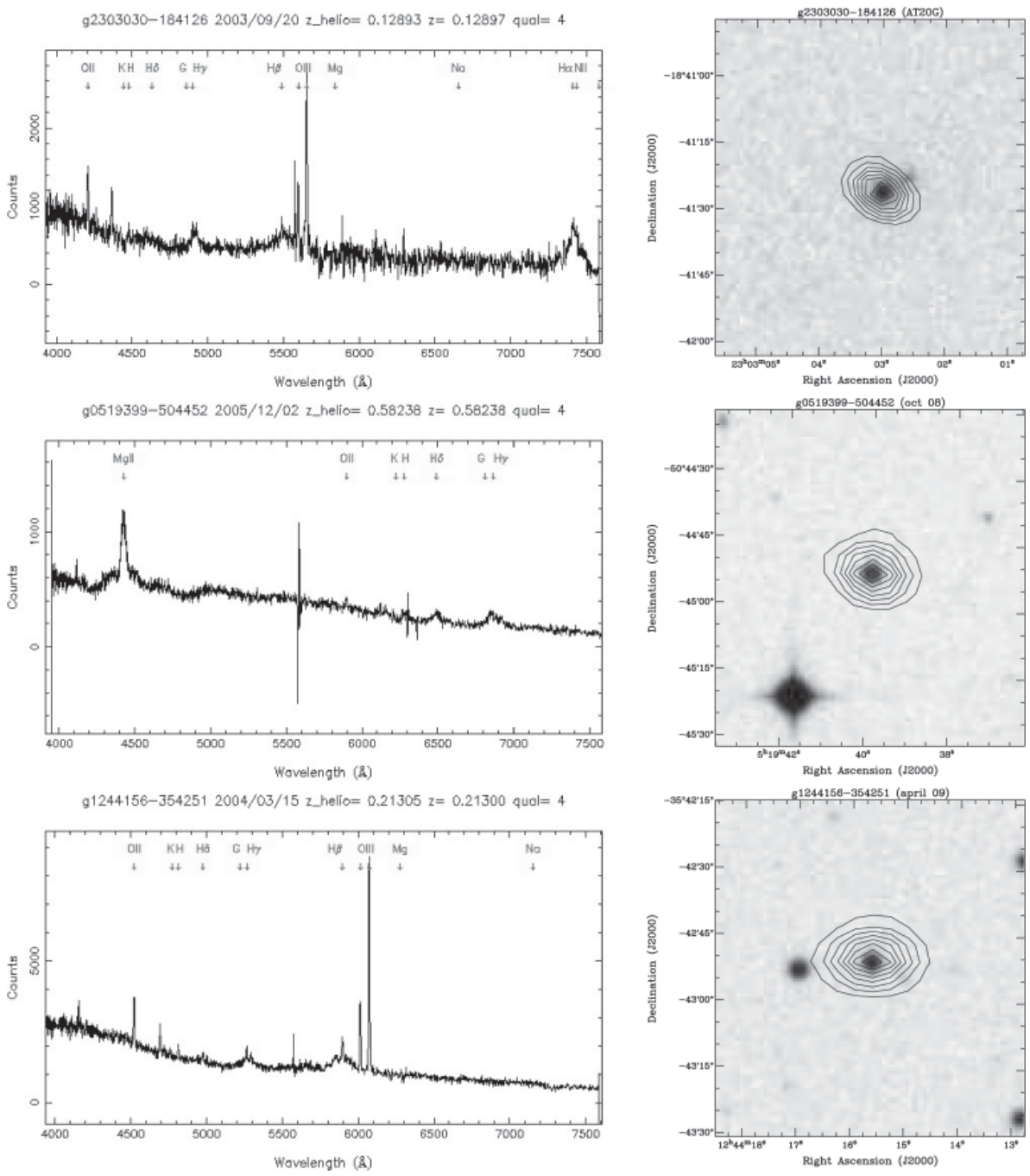


Figure 1: Example RASS selected QSOs. The left image shows the 6dFGS spectrum. The arrows denote where spectral features would occur at that redshift, but not all of these are necessarily observed. On the right are the corresponding optical (B-band) images with 20 GHz contours. The top source appears in the AT20G survey with a flux of 665 mJy while the others were observed as part of this program. The middle source was observed in October 2008 (15.0 mJy) and the bottom source in April 2009 (5.27 mJy). In each of these images the contours represent the 20% – 90% levels in steps of 10%.

us a wealth of extra information. Hence we can also study the optical spectral line properties, black hole masses, multiwavelength properties (X-ray — optical — radio) and how these vary with redshift.

Our first observing run was in October 2008, using the old 2x256 MHz correlator on the Compact Array with central frequencies of 18752 and 21056 MHz. To obtain good-quality images with high sensitivity, we used the H168 configuration. We observed a total of 135 sources for 80s (2 x 40 second cuts) which gave a final rms of 0.6 mJy. This run resulted in 15 (11%) detections at the 5 sigma threshold. We then had another run in April 2009 shortly after the commissioning of the new Compact Array Broadband Backend (CABB). Using the same configuration and exposure times we were able to

Figure 2: 20 GHz flux density against redshift for the RASS QSOs observed as part of this program. The dots are the sources that had matches in AT20G, pluses were those sources detected in the October 2008 run with the old correlator and crosses those detected in April 2009 with CABB. The triangles denote upper limits from the sources that weren't detected in each of the October and April runs.

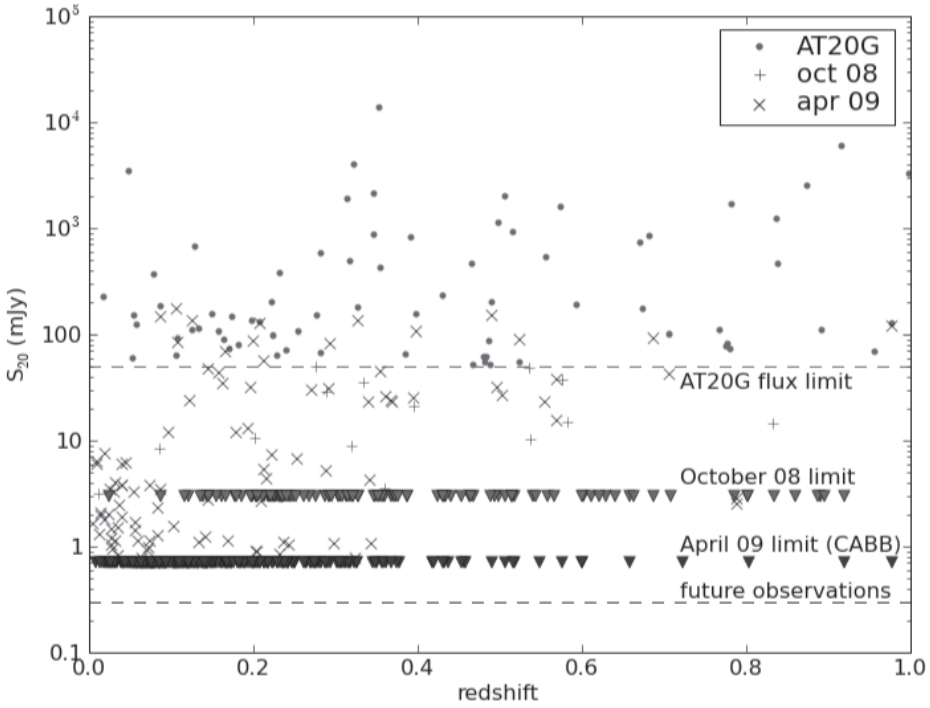
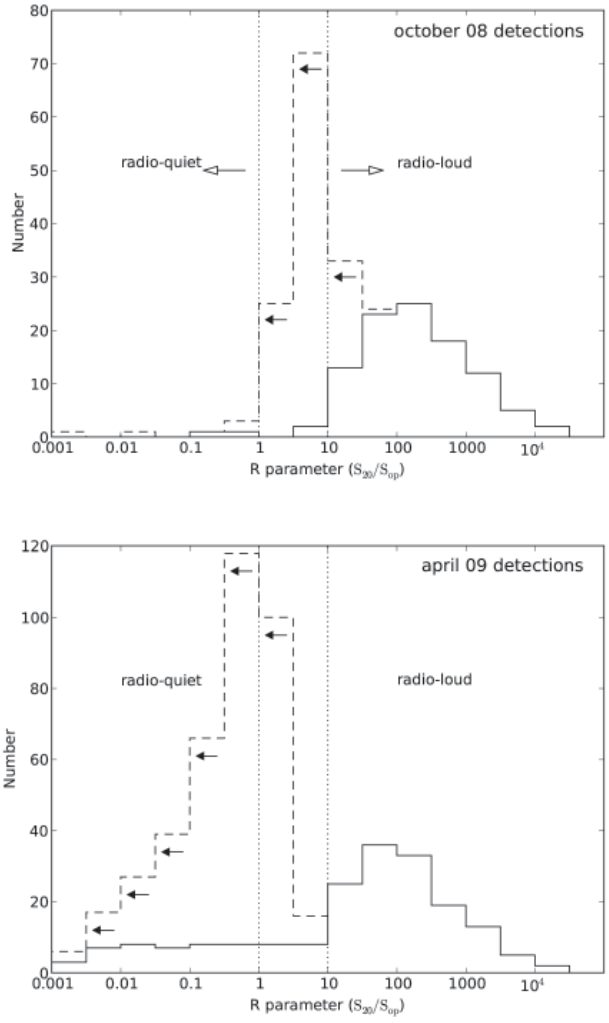


Figure 3: "Radio-loudness" distribution for the targets observed in October 2008 (Left) and with CABB in April 2009 (Right). The dashed histogram denotes the upper limits for the non-detections in each run and the dotted lines are the dividing lines between radio-loud and radio-quiet. AT20G detections are also included in both plots. With CABB we are starting to push down to smaller R parameters and further into the radio-quiet regime.



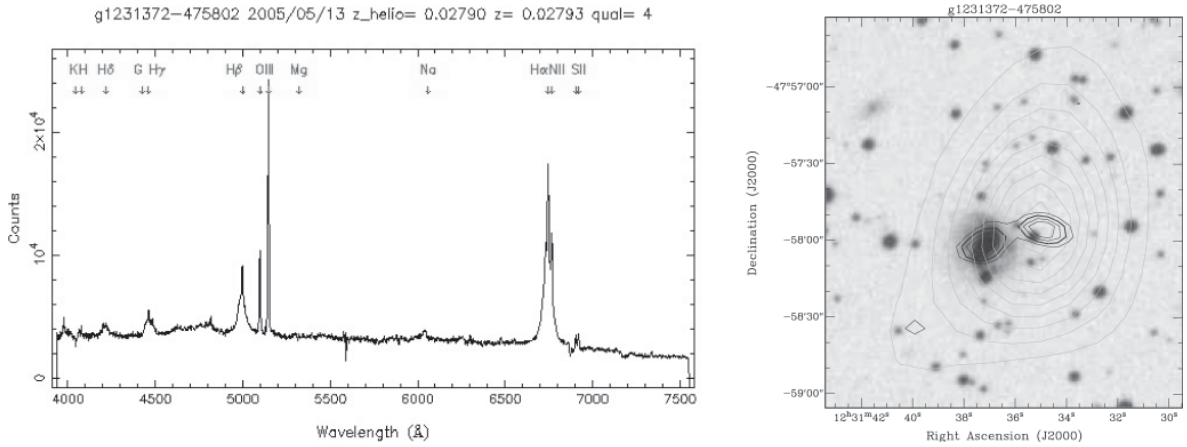


Figure 4: RASS-6dFGS source g1231372-475802. The greyscale is a SuperCOSMOS B-band image with the 20 GHz emission overlaid in black and 843 MHz SUMSS source overlaid in grey. There are two components at 20 GHz, each with a peak flux of ~1.2 mJy (contour levels are at 0.4, 0.6, 0.8 and 1 mJy). One of these peaks is centred on the 6dFGS position, corresponding to the core of the nearby (z=0.28) AGN, while the other component is at the position of the SUMSS source which has a peak flux of ~40 mJy (contours are at 4 – 36 mJy in steps of 4 mJy).

observe another 417 sources. The central frequencies were chosen to be 19000 and 21000 MHz to be consistent with the previous observations. By observing at 20 GHz we are able to take advantage of the full 2-GHz bandwidth and reach an rms of 0.15 mJy. Setting a 5 sigma detection threshold of 0.75 mJy revealed that 103 sources (25%) are detected at 20 GHz. Figure 2 shows the current detections of these sources from both of these observing runs as well as the small number of RASS QSOs that have known 20 GHz counterparts in the AT20G survey. The horizontal lines marked refer to the detection limit of each set of observations. This highlights the increased sensitivity between the October and April runs achieved by the increased bandwidth with the upgrade to CABB.

To investigate any possible bimodality, Figure 3 shows the distribution in the R parameter. This is the ratio of radio to optical luminosity, first proposed by Kellermann et al. 1989 as a measure of "radio-loudness". The dividing line between the radio-loud and radio-quiet regimes is generally taken to be between 1 and 10, denoted by the dotted lines. As the project is less than 20% complete (in terms of observing time) we do not, at present, have enough data to conclusively say whether the distribution is bimodal or not. However, this figure shows that with CABB we can push down to smaller R parameters and detect more radio-quiet objects.

An example RASS QSO detected at 20 GHz is shown in Figure 4. This particular source clearly shows two 20 GHz components, one aligned with the core of a nearby (z=0.028) Type 1 AGN (characterised as such due to the broad emission lines observed in the 6dFGS spectrum). The other component corresponds to a 40 mJy *Sydney University Molonglo Sky Survey* (SUMSS) sources, perhaps implying the presence of a steep spectrum jet (α=-0.85).

We plan to complete observations for the full sample during the upcoming observing semester (weather permitting). This involves observing the rest of the sample (586 objects) down to the detection threshold of 0.75 mJy. Sources that have not been detected to this limit will then be re-observed, this time for a total of 10 mins (2 x 5min cuts) reaching an rms of 85 μJy.

By selecting a large and well defined sample of QSOs with homogeneous spectra we are free from the kinds of systematic effects which limited earlier work. The increased bandwidth of CABB also allows us to push down to fainter flux limits. As such, we will be able to conclusively say whether the 20 GHz radio distribution of X-ray selected QSOs at redshifts less than 1 is bimodal or not, providing new insights into the physical properties of nearby active galaxies.

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National Facility Operations

Graeme Carrad (ATNF)

Changes to Operations Staff

A recruitment process for three senior positions has been successfully completed. This was prompted by the departure of Brett Dawson, Head of Engineering Operations / Parkes Site Manager, and the stepping down of David McConnell from the Assistant Director of Operations. The role undertaken by Brett Dawson was of a scale better served by two people and, in July, we welcomed Erik Lensson to the position of Head of Engineering Operations and Malcolm Smith to the position of Site Manager, Parkes. Malcolm had been acting Site Manager since Brett's departure and is well known at Parkes. The Site Manager role is to ensure the smooth day to day operation of the Parkes Observatory site. Erik (pictured) has a background in telecommunications and spectrum management. He comes to us from the Australian Communications and Media Authority (ACMA) and already has a great understanding of the spectrum issues surrounding our observations. Erik will be leading the 35 engineering and technical staff responsible for engineering maintenance, operations and upgrades for all ATNF radio astronomy observatories.

Appointed but not yet "on deck" is Douglas Bock who will take up the role of Assistant Director of Operations to lead the delivery of the radio astronomy facilities to astronomers from around the world. Douglas's previous experience in operations and engineering on the Combined Array for Research in Millimetre-wave Astronomy (CARMA) project will be invaluable as a transition is made to accommodate ASKAP operations. It is anticipated he will begin on the first working day of 2010. In the meantime Graeme Carrad is the acting Operations Theme Leader.

Operations

The installation of the Compact Array Broadband Backend (CABB) hardware and its commissioning was certainly not the end of the story for CABB. It is inconceivable that such a complex piece of instrumentation could be expected to operate flawlessly from "day one" and effort continues to bring functionality to the system whilst ironing out little "bugs". Provision of zoom modes, specifically a 1 MHz mode, is the current focus and is proving to be a significant challenge. It is estimated that this capability will be available in a limited form by the end of October with a more comprehensive version in place by year's end. Experience gained with the implementation of the first mode will lay the foundation for provision of further modes with a consequent reduction in development time. The system is being used to great effect in its current form and exciting results are being reported demonstrating the utility of the instrument.

The installation of CABB has direct implications for our NASA tracking commitments. The ATCA gained certification as a NASA Deep Space Station after the commissioning of the 7-mm receiver system. A recertification process is required after major changes to the facility and CABB certainly qualifies as a major change. To attain recertification, the array is required to complete four successive spacecraft tracks to NASA specifications. These tests are now underway with tracking opportunities spaced throughout the coming months.

Erik Lensson. Credit: CSIRO

Three Development Projects which support the automation and remote operation of Parkes, as well as rationalising the Parkes receiver suite, are currently undergoing significant planning. Erik Lensson takes the Project Leader role in two of these and Tasso Tzioumis in the other. The obvious similarities between the aims of these projects and the aims of the Technologies for Radio Astronomy theme based in Marsfield will lead to a sharing of the resources between the themes. The determination of the timelines and priority of the projects will be the subject of meetings through October.

Time Assignment Information

Phil Edwards and Jessica Chapman (ATNF)

The Time Assignment Committee (TAC) met on 23 – 24 July to review proposals for the 2009 October semester. The July meeting was the last with Andrew Hopkins (AAO) serving as TAC chair. Andrew has been a thorough and dedicated TAC chair and the ATNF thanks him for his efforts as Chair over the last two years and his leadership and support for introducing changes to the TAC.

The next Call for Proposals will be made on 16 November 2009 with a deadline for the 2010 April semester on Tuesday, 15 December 2009. The semester will run from 1 April to 30 September 2010.

Compact Array

The Compact Array configurations to be offered for this semester are 6A, 6C, 1.5D, 750C, EW352, H214, H168 and H75. Array configurations will only be scheduled if there is sufficient demand.

The recently installed Compact Array Broadband Backend (CABB) will ultimately offer several zoom modes that provide high spectral resolution. The first zoom mode will be the CFB 1M–0.5k mode, available from approximately end-October 2009. This has a bandwidth of 2 GHz with 2048 x 1-MHz channels, and an additional, optional zoom capability that provides for one to four spectra, each with 2048 spectral channels across a bandwidth of 1 MHz.

For the latest information on available zoom modes for the 2010 April semester, please see the web links provided with the Call for Proposals.

Mopra

Good progress is being made toward the implementation of a "fast mapping" mode with the Mopra telescope. Further testing will be made during October 2009: please consult the Call for Proposals about the expected availability of this mode for the 2010 April semester.

Parkes

The Caltech Parkes Swinburne Recorder Mark 2 (CPSR2), used at the Parkes Observatory for pulsar observations, is expected to be phased out in 2010, once the ATNF Parkes Swinburne Recorder (APSR) baseband system is fully commissioned and has been run in parallel with CPSR2 for a six-month overlap period. This new recorder uses the digital filterbank, DFB3, as a front-end to sample a single pair of inputs (two polarisations, single frequency) of up to 1-GHz bandwidth and record the baseband data at an aggregate rate of up to 8 Gbit/s. Proposers are reminded that the standalone Wide Band Correlator and the older filterbanks, DFB1 and DFB2, are now effectively decommissioned — these may continue to be used where their need is clearly justified, but maintenance and repair of these is now a low priority.

VLBI

The Long Baseline Array (LBA) uses a disk-based recording system for all recorded VLBI observations and very high data rates, up to 1 Gbps, can now be achieved. All recorded observations will be correlated at the software correlator running on the Curtin University of Technology supercomputer. The software correlator is capable of correlating the high data rate observations at high spectral resolution with arbitrary correlator integration times.

Real-time e-VLBI observations are also offered, using the ATNF antennas connected together via high-speed links and a version of the Swinburne software correlator running at Parkes, or on a new Curtin computer cluster installed at Narrabri. Data-rates on the e-VLBI system are limited to 512 Mbps from each antenna. Single baseline observations between Parkes and ATCA are available at 1 Gbps. Real-time eVLBI capabilities to the Hobart antenna are also available. Currently the data rates to Hobart are limited to 128 Mbps or less due to limited network speeds to Tasmania. Users are invited to propose shared-risk observations suitable for such real-time observations that include Hobart.

Tidbinbilla

A limited amount of time may be available on the 70-m and 34-m antennas at Tidbinbilla for single-dish use in the 2010 April semester, as in previous semesters. As usual, proposals may be submitted and will remain in a pool for up to one year. Any available time will be used in a service observing mode.

Changes to the ATNF Time Assignment Committee

Jessica Chapman (ATNF), Andrew Hopkins (AAO), Arkadi Kosmynin (ATNF) and Phil Edwards (ATNF)

Each semester the ATNF Time Assignment Committee (TAC) reviews the proposals submitted through *OPAL* for observing time with the Australia Telescope Compact Array (ATCA), the Parkes radio telescope, the Mopra radio telescopes and the Long Baseline Array. Service proposals for the Tidbinbilla 70-m antenna are also assessed. Time is allocated on the basis of scientific merit. Typically 140 proposals are received for the summer semester, while 200 proposals are received for the winter semester when observations at millimetre wavelengths are optimal. The TAC has eight members, appointed by the ATNF Steering Committee, who meet in Sydney each semester to review the proposals. The meetings are also attended by the Head of Science Operations (Phil Edwards) and the Operations Research Program Leader (Jessica Chapman). Technical assessments are provided by ATNF staff including Phil Edwards.

The TAC processes have evolved since National Facility operations began in 1990 and have generally worked well. However, the number of proposals received has significantly increased over the last five years and the work load on individual TAC members became very high, with each TAC member asked to provide proposal grades for around 80 proposals per cycle, and detailed comments on a subset of these. A further concern has been that, although the TAC members are selected to cover a broad range of expertise, it can be difficult for a small number of individuals, to have sufficient expertise to cover all of the many areas of scientific research discussed in proposals. Looking ahead, from late 2012 the ATNF TAC will also review ASKAP Guest Science Proposals and it was hard to see how this extra workload could be managed without some changes to the TAC processes.

To address these issues, and after consulting with the user community, several changes have recently been introduced to the ATNF TAC processes. A summary of TAC operations is as follows:

The eight TAC members are supported by a group of approximately 16 TAC "readers" who are appointed by the ATNF Director, usually for a term of three years, drawing in astronomers from Australian and overseas institutions. The readers do not attend meetings but send their grades and comments on a subset of the proposals as input to the meetings. Unlike the TAC members, who have full access to all proposals, the TAC readers have access only to the subset of proposals that they review.

The TAC members and readers are assigned on a proposal-by-proposal basis. Proposals are assigned using a scheme that makes use of science keywords. The cover sheets of ATNF proposals now ask proposers to select one or more options from a list of 14 science keywords that best describe their proposals. The TAC members and readers identify their areas of expertise from the same set of keywords. An automated algorithm is then used to solve a "combinatorial assignment problem": in this case, to assign a set of proposals to a team of reviewers. This algorithm belongs to a class of algorithms known as "greedy" that do not guarantee finding the optimal solution, but instead produce acceptable, though possibly less-than-optimal solutions, in reasonable time.

Each proposal is assigned to at least one TAC member and two TAC readers. Prior to a TAC meeting, each member and reader provides pre-grades and comments for a subset of the proposals. The TAC meetings are held twice a year and include a discussion on the scientific merits of each proposal as well as any technical issues that may arise. The TAC member assigned to a proposal is responsible for compiling the final comment that is sent back to the proposers, based on the information provided prior to the meeting, together with any additional information discussed at the meeting. Shortly after the TAC meeting is held, an email with the TAC comment and grade is sent to the principal investigator and all co-authors for each proposal.

To support the changes to the TAC, in particular to coordinate the input received prior to and during TAC meetings, and to control access permissions for different groups, several software tools have been added into the ATNF proposal applications system, *OPAL*.

The changes to the TAC were introduced in July 2009 for the

2009 OCT semester. The proposal reviewing and the TAC meeting ran smoothly. It was much appreciated at the ATNF that all reviewers submitted their reports (almost) on time! The TAC members responded very positively to the changes and, not surprisingly, prefer having a smaller number of proposals to review. Following the experience gained at this meeting some further software improvements have been implemented in OPAL, in particular to improve the proposal assignments tool. These are being tested now for use with the next proposal cycle. The TAC greatly appreciates the ability to manage the whole process on-line, from initial grades and comments, through revisions during the TAC meeting, to the generation of the final comments, as well as on-line access to electronic versions of the proposals. Theise features streamlines and simplifyies the process of proposal review immensely. With continued improvements and innovations, the ATNF TAC, through OPAL, can efficiently manage the growing number of proposals for existing facilities as well as incorporating ASKAP proposals in the future.

ATNF Publications List

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

This list includes published refereed papers compiled since the April 2009 newsletter. Papers which include one or more ATNF staff are indicated by an asterisk.

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Education and Outreach

Rob Hollow (ATNF)

2009 has been a busy year for ATNF Education and Outreach. The International Year of Astronomy has led to increased demand for ATNF staff as speakers and involvement in many other events and programs.

Teacher Workshops and School Events

ATNF's Education Officer, Rob Hollow, has run teacher workshops across much of Australia over recent months. This year's *Astronomy from the Ground Up,* an annual three-day event at Parkes was a great success in May. Over 25 teachers, some from as far afield as Exeter in Tasmania, Townsville and Geraldton participated. Many ATNF staff gave up their weekend to give talks and to help run the sessions. Collaborations with other organisations also continue to grow, allowing more teachers across Australia to undertake professional development in astronomy education. Workshops were held at Scienceworks in Melbourne in collaboration with the Victorian Space Science Education Centre, in Perth as part of Astronomy WA's Space Camp and in Brisbane and Townsville. Shorter sessions were also held in Launceston at CONASTA, the National Conference for Australia Science Teachers, at the NSW Science Teachers' Association Annual Conference and in Geraldton during National Science Week. In addition, several ATNF staff have been active as part of the *Scientists in Schools* program that has included giving talks to students and supporting viewing nights.

National Science Week

ATNF staff at Narrabri conducted a series of well-attended public events in town, including public viewing nights with optical telescopes. Professor Ray Norris was involved in many events in Darwin as part of the Tope End Science Festival. Rob Hollow was active in the Mid West region of Western Australia with talks to students at Nagle Catholic College and Meekatharra School of the Air, teacher professional development for Geraldton teachers, a viewing night for students from Yalgoo Primary School, Pia Wadjarri Remote Community School and Sandstone Public School at Yalgoo and a pre-performance talk about the life and science of Galileo at Theatre Eight's production of Brecht's *The Life of Galileo.*

This year's resource book; *Astronomy: Science Without Limits* for National Science Week was launched at Mount Stromlo Observatory in May. Featuring input from ATNF staff and PhD students, Rob Hollow worked with the writing team from the Science Teachers' Association of NSW in developing the resource. A copy of the book was provided free to every school in Australia and every science teacher who is a member of their state association.

ATNF staff also contributed to the concept and development of the *Big Aussie Star Hunt*, the National Project for this year organised by the ABC. The sky survey component of the project saw over 1,200 observations on sky brightness logged from people across Australia.

Window to the Universe

This is a new teaching resource providing over 20 lessons on astronomy, optics, the electromagnetic spectrum and Australian science for students in Years 9 and 10 within the context of the SKA. It was developed as part of the Questacon-Scitech SKA Education project by an experienced team of science teachers from the Science Teachers Association of NSW and coordinated by Rob Hollow from CSIRO Australia Telescope National Facility. Copies are available free to all high schools in Australia.

Staff from CSIRO work with students at Strathmore Secondary College who are remotely operating the Parkes Telescope. CSIRO's Robert Hollow and students Katie Pearce and Elizabeth Pollard pictured. Credit: David Crosling

PULSE@Parkes

This innovative ATNF program has had monthly observing sessions with students from many high schools across NSW. The first run in Victoria was held at the Victorian Space Science Education Centre in August with students from four schools taking part. Another session with students from five schools was held at SPICE in Perth in September. As part of the Melbourne session, broadcasting observations were made using *twitter* (@PULSEatParkes). This experiment was a great success and will now be incorporated into all future observing runs, allowing people around the world to read live updates and pose questions. The first science paper from the project has been accepted for publication in PASA and an education paper is nearing completion.

One of the most often requested photos of the Compact Array, taken by John Masterson.

For further information:

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