CSIRO ASTRONOMY AND SPACE SCIENCE
www.csiro.au

ATNF News

Issue No. 72, April 2012
ISSN 1323-6326

CSIRO Astronomy and Space Science — Undertaking world-leading astronomical research and operator of the Australia Telescope National Facility.

Editorial

Welcome to the April 2012 edition of *ATNF News*.

Regular readers will have noticed that this edition has a fresh new appearance. We are in the process of updating the 'visual identity' of all CSIRO communications including *ATNF News*, a flagship publication of CSIRO Astronomy and Space Science (CASS). While the newsletter's appearance has changed, we will continue to bring you news and research results related to CSIRO's Australia Telescope National Facility.

We start this edition by acknowledging Michelle Storey and George Hobbs, two CASS staff members who have recently received external awards for their contributions to radio astronomy.

We then feature the recent progress that has been made on the construction of ASKAP and the Murchison Widefield Array, and CSIRO's contribution to the next phase of planning for the international Square Kilometre Array project.

In other news, we report on the progress being made to develop a flexible new backend for the Parkes radio telescope's multibeam receiver, the signing of an agreement that will see CASS engineers investigate the feasibility of a multibeam receiver for the Chinese FAST radio telescope, and the successful launch and first observations of the Russian space VLBI telescope RadioAstron which is carrying an 18-cm receiver designed by CSIRO.

We also report on the launch of an online shop to complement the Parkes Observatory Visitors Centre store and forthcoming changes to the ATNF website. We review two recent workshops held at ATNF headquarters in Marsfield and we welcome our newest postdoctoral staff.

Four science articles give a snapshot of the latest radio astronomy research being conducted with the ATNF. These include:

- An investigation into the neutral gas of the blue compact dwarf galaxy NGC 5253 by Ángel R. López-Sánchez and Bärbel Koribalski
- A report on constraining the fundamental constants of physics through astronomical observations of rotational transitions of methanol by Simon Ellingsen and collaborators
- An ATCA survey of molecular gas in high-z radio galaxies by Bjorn Emonts and collaborators, and
- Ray Norris' account of witnessing the birth of a quasar.

We conclude with our regular contributions on education and outreach activities, ATNF operations and recent publications.

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

Gabby Russell and Tony Crawshaw

The *ATNF News* Editorial Team
(*newsletter@atnf.csiro.au*)

Front cover image

Antennas that will make up CSIRO's Australian Square Kilometre Array Pathfinder (ASKAP) radio telescope at the Murchison Radio-astronomy Observatory (MRO) in Western Australia. There are 32 of ASKAP's 36 antennas on site at the MRO (in various states of construction) and the remaining four are expected to arrive from Shijiazhuang, China by the end of April. Credit: Terrace Photographers.

Contents

From the Chief of CSIRO Astronomy and Space Science

PHIL DIAMOND (CHIEF OF CASS AND ATNF DIRECTOR)

It has been an especially busy period since publication of the last edition of *ATNF News*.

While Australia and New Zealand remain very much part of the confidential Square Kilometre Array (SKA) site negotiation and decision-making process, it is a pleasure to report in this edition of *ATNF News* on achievements that will have impact into the future. Among these achievements are significant and impressive progress on the construction of the Australian Square Kilometre Array Pathfinder (ASKAP), the Murchison Widefield Array and supporting infrastructure at the Murchison Radio-astronomy Observatory (MRO), and the start of construction of the MRO Support Facility in Geraldton. On the original timescale we would have expected to know the decision of the SKA Organisation's Board on the location of the SKA before now; however, the process, as one might expect for such a significant and far-reaching decision, has taken longer than planned. I look forward to the decision and the start of the four-year pre-construction phase, which will lead to the detailed design of the SKA.

This issue also highlights the continued strength and breadth of research conducted by CASS staff and others using the ATNF, international acknowledgement of CASS expertise in technology development for radio astronomy, and the recognition of two of our own, Michelle Storey and George Hobbs, for their significant contributions to radio astronomy.

Further progress has also been made towards planning for operational changes to the Parkes and Mopra radio telescopes, and the creation of the ATNF Science Operations Centre at Marsfield.

Finally, I welcome the Australia Telescope Steering Committee's appointment of new ATUC Chair, John Dickey, and TAC Chair, Michael Drinkwater, and thank the previous ATUC and TAC Chairs, Sarah Maddison and Lisa Harvey-Smith (respectively), for their contributions to the National Facility through leading the work of these two important committees.

In late, breaking news it gives me pleasure to report that CSIRO has allocated an additional $4 million to ASKAP from 1 July 2012; these funds will be used to build six additional 'Mark II' phased array feeds.

Outstanding SKA service awarded

TONY CRAWSHAW (CASS)

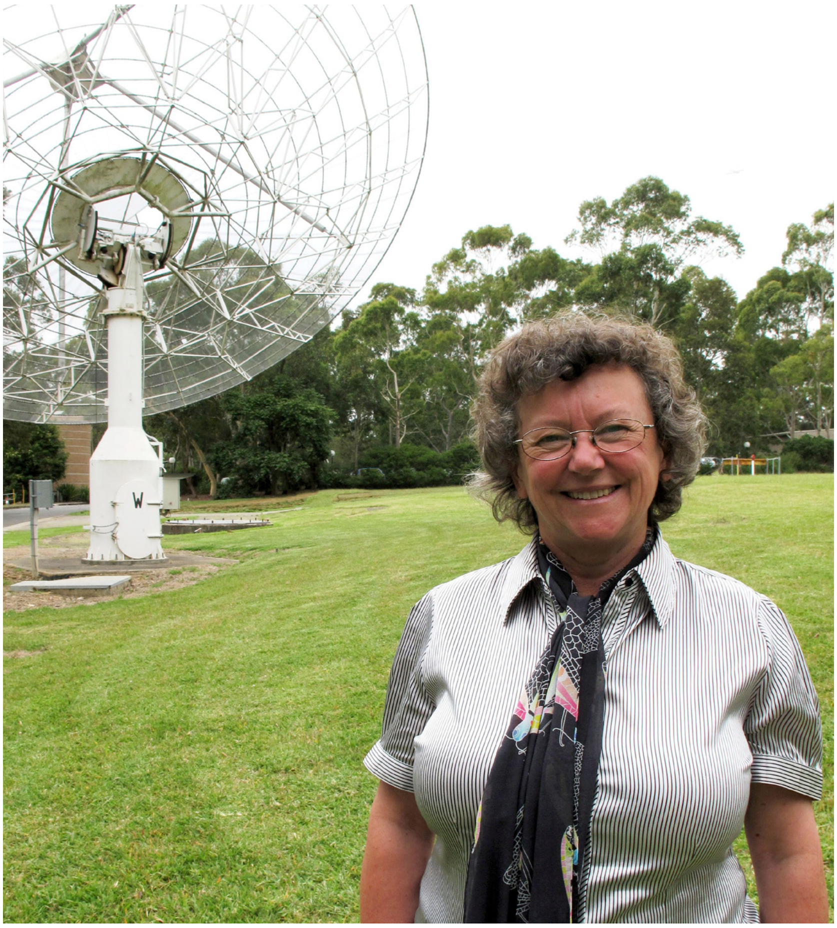
CSIRO's SKA Executive Officer Dr Michelle Storey was awarded a Public Service Medal in this year's Australia Day Honours list. The medal recognises outstanding service of employees across the Commonwealth, state, territory and local governments.

Michelle was granted the award for her exceptional and tireless efforts in supporting CSIRO's radio astronomy objectives and, more specifically, in working with the Australian, Western Australian and New Zealand governments in their bid to host the future A$2.5b Square Kilometre Array (SKA) radio telescope project; this also involved the establishment of the Murchison Radio-astronomy Observatory (MRO) in the Mid West of Western Australia.

Working on SKA-related activity for CSIRO since 1999, a large part of Michelle's work has involved the provision of scientific advice to the governments, inputting into government policy and strategy, and working with a wide range of stakeholders.

She has also worked extensively on the Australian Square Kilometre Array Pathfinder (ASKAP) radio telescope project, a precursor SKA instrument currently being built by CSIRO. Her work has particularly focused on the establishment of the MRO, including the establishment of the Mid West Radio Quiet Zone surrounding the MRO. The MRO is the site for ASKAP and is Australia and New Zealand's candidate core site for the SKA.

Michelle commented, "I'm immensely proud to have been recognised with this award. But more importantly, the Australia – New Zealand SKA team is committed to showing the international community just how exceptional the MRO site is for radio astronomy. I think we have a compelling case to host the SKA here."



Dr Michelle Storey, CSIRO SKA Executive Officer. Credit: Tony Crawshaw, CSIRO.

George Hobbs wins top Tall Poppy prize

HELEN SIM (CASS)

CSIRO astronomer Dr George Hobbs was recognised in late 2011 as NSW Young Tall Poppy of the Year.

The Young Tall Poppy Science Awards, given each year by the Australian Institute of Policy and Science, recognise excellent early career research and passion in communication and community engagement. The awards for NSW were presented at the Powerhouse Museum in Sydney on 3 November 2011.

George was chosen from a field of eleven Young Tall Poppies to receive the top honour. Based in Sydney at CSIRO Astronomy and Space Science, he leads a program on CSIRO's Parkes radio telescope to search for gravitational waves, using pulsars as markers. George is also the co-creator of the 'PULSE@Parkes' outreach program, which allows students to control the Parkes telescope over the Internet and use it to observe pulsars.

CSIRO will use the experience of PULSE@Parkes to develop remote-observing education programs for the Australian Square Kilometre Array Pathfinder radio telescope now under construction in Western Australia, and then for the international Square Kilometre Array telescope itself.

At a recent PULSE@Parkes session students had the thrill of watching a pulsar turn its signal on and off while they watched: a very rare phenomenon, occurring in just a handful of the 2000-odd known pulsars.

"Then I and the other scientist stood in front of the students and offered quite different ideas about why this might be happening," George said. "They were seeing real science in action."

In addition to these activities, George also finds time to do other research, including developing a pulsar-based timescale, developing methods to support space-probe navigation using pulsars and looking for new objects in our Solar System.

In 2011 George was also named by the Chinese Academy of Sciences as an International Young Scientist of China, for his collaborative work with institutions in X'ian, Urumqi and Beijing, and received the CSIRO Medal for Support Excellence as a member of the Parkes Observatory Pulsar Data Archive Team.

Dr George Hobbs receiving his NSW Young Tall Poppy of the Year award. (Left to right) Dr George Hobbs (CSIRO), Professor Margaret Harding (UNSW), Professor Jill Trewhella (University of Sydney) and Professor Stephen Thurgate (Macquarie University). The Prize is sponsored by UNSW. Credit: Daniel O'Doherty, 247 Studios.

George at CSIRO's Parkes radio telescope. Credit: John Sarkissian, CSIRO.

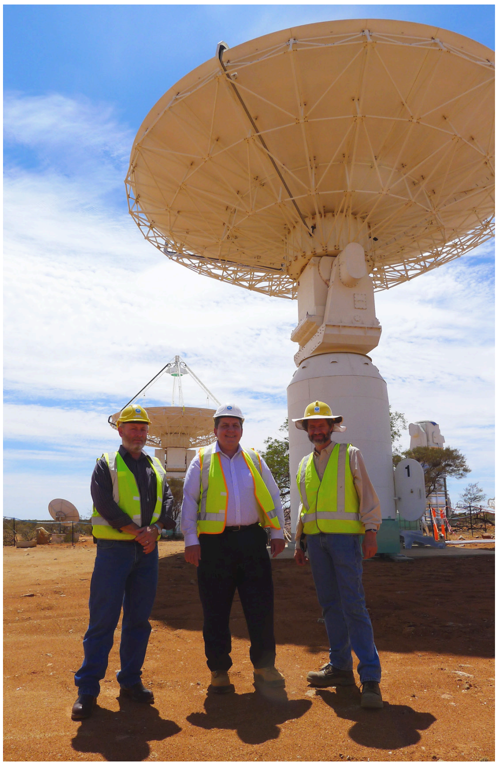
ASKAP and SKA news

FLORNES CONWAY-DERLEY (CASS), SARAH PEARCE (CASS), CAROLE JACKSON (CASS), LISA HARVEY-SMITH (CASS) AND STEVEN TINGAY (ICRAR)

In the six months since the last edition of *ATNF News*, development and construction of the Australian Square Kilometre Array Pathfinder (ASKAP) project has progressed significantly. At the time of writing, there are 32 ASKAP antennas on site at the Murchison Radio-astronomy Observatory (MRO), with the final four due at the MRO by the end of April.

In January, the MRO welcomed Senator the Hon. Chris Evans, the new Minister for Tertiary Education, Skills, Science and Research. On his visit, Senator Evans was impressed by the significant progress made on the infrastructure construction and assembly of antennas at the site, as well as the first full-sized phased array feed (PAF) receiver that was installed on an ASKAP antenna in October 2011. The minister was impressed to see the SKA-ready broadband infrastructure that has been laid at the site.

According to CSIRO's ASKAP Director, Antony Schinckel, "Senator Evans showed considerable interest in the cutting-edge technical design that has gone into ASKAP, but also the potential for technology spin-offs and the amazing science that will be possible once the project is complete."



MRO Site Manager Barry Turner, Senator Chris Evans and CSIRO ASKAP Director Antony Schinckel at the MRO. Credit: Alex Bonazzi.

Update from the MRO

Support infrastructure construction works at the MRO are now ramping down, as contractors McConnell Dowell begin to remove their construction camp from the site. Construction involved several kilometres of access roads and tracks, power and data infrastructure, a central control building and 30 concrete antenna foundations, as well as ancillary works.

An aerial photo of the Murchison Radio-astronomy Observatory. The MRO Control Building is in the foreground and ASKAP antennas can be seen under construction in the background. Credit: Lisa Harvey-Smith, CSIRO.

MRO CONTROL BUILDING

The MRO Control Building was delivered to site in October 2011 by 13 trucks, each carrying a 15-metre hi-tech steel module from Lonsdale, South Australia. The radio frequency interference-shielded building is designed to be thermally efficient, will act as a base for MRO support staff and visitors, and house complex digital systems including ASKAP beamformers and correlator.

Within two layers of welded steel shielding, the building will include space for offices, electronics repair laboratories, an operations control room, a small mechanical workshop, stores and general amenities.

Most importantly, the Control Building will house the complex digital systems of ASKAP and other international projects at the MRO, as well as termination points for fibre links coming in from the ASKAP antennas and out to the MRO Support Facility in Geraldton.

Designed to stringent requirements, the MRO Control Building requires innovative energy efficiency solutions and building techniques to preserve the radio-quiet environment of the MRO.

Final phases of commissioning are underway, but formal testing of various facility characteristics is required before the official handover to CSIRO can take place.

MRO SUPPORT FACILITY STARTS CONSTRUCTION

In Geraldton, construction of the new MRO Support Facility (MSF) has begun. The MSF will be located within the Geraldton University Centre and will provide remote operations services for CSIRO's ASKAP telescope and other projects under construction at the MRO, as well as office space for technical, maintenance and research staff. It will also feature a dedicated room for Geraldton-based researchers who have been awarded computing time on iVEC's Pawsey Centre supercomputers.

High-speed internet connections are already in place to link the MSF with the MRO (a distance of 370 km) and the Pawsey Centre in Perth (450 km). CSIRO installed the optical fibre connection between Geraldton and the MRO as an integral part of the MRO development, while the Geraldton–Perth link is part of the National Broadband Network. AARNet is also playing a key role in providing data communications services from the MRO to the Pawsey Centre.

CSIRO awarded the contract for construction of the MSF to Merym Pty Ltd (trading as EMCO Building) following a public tender process. EMCO is expected to complete construction of the new support facility in November 2012.

ASKAP technologies

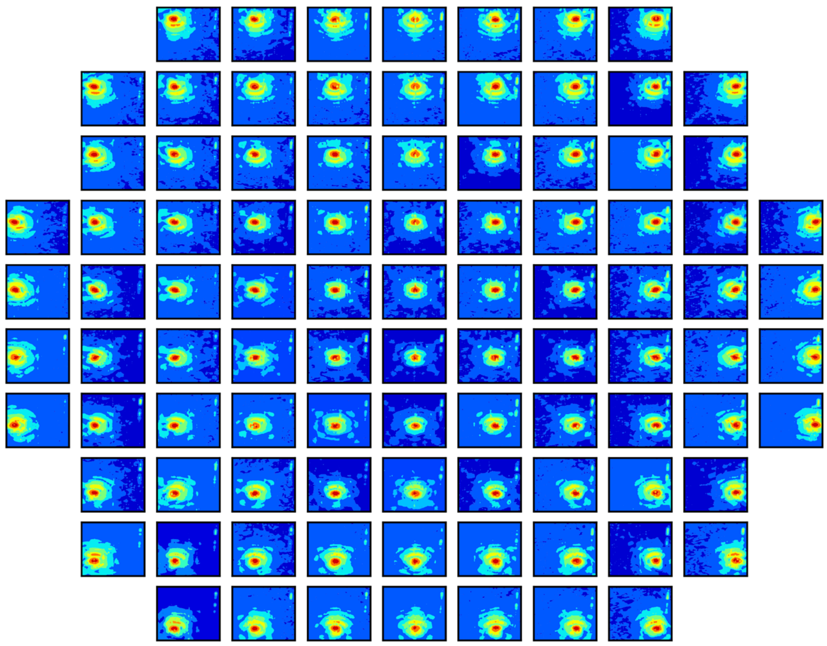
END-TO-END BETA PAF SYSTEM DEVELOPMENT

As mentioned in the previous edition of *ATNF News*, 'first light' was achieved with the first full-sized prototype phased array feed (PAF) receiver installed on the 12-m Parkes Testbed Facility (PTF). In December 2011, an image was released that represented the first time detailed tests on the entire system, from the antenna to the digital signal processing hardware, had ever been performed for a 'chequerboard' PAF.

The image was formed from raw port patterns of the PAF (installed at the prime focus of the PTF), produced while observing the powerful radio galaxy Virgo A, and demonstrated the robust basic functionalities of the system.

Back at the MRO, on 23 October the first PAF built for ASKAP was lifted into place on Antenna 3, one of six antennas that will make up the Boolardy Engineering Test Array (BETA). This milestone was the culmination of effort from the entire ASKAP team and included foundation construction, assembly, testing and commissioning of the antenna, installation of grouting, floors, power distribution board and cable trays, and installation of cabling and the cooling system to the new receiver.

The ASKAP PAF is the first chequerboard planar phased array specifically built for radio astronomy, with 188 active elements to allow the reconstruction of many separate, simultaneous beams. It will provide ASKAP with a wide field-of-view and allow it to map the sky far more quickly than alternative technologies.



This image was produced by correlating each of the 188 ports of the 12-m Parkes Testbed Facility antenna with the central horn of the Parkes 64-m radio telescope's 20-cm multibeam receiver. The two polarisations of the central beam of the 20-cm multibeam receiver on the 64-m telescope were connected to ports 189 and 190 of the beamformer, using an 'RF-over-fibre' link. Credit: Aidan Hotan, CSIRO.

COMPUTING CORRELATOR AT THE MRO

The ASKAP Computing Team recently developed a software correlator able to process signals from three different ASKAP antenna receivers in 'real time' at the MRO. With this set of receivers it is now possible to use the software correlator for end-to-end system testing before the next set of PAFs arrive at the MRO.

First fringes were achieved between a beamformed beam on a PAF and a high performance L-band (single pixel feed) receiver on two separate ASKAP antennas at the MRO in February. The team was also able to capture baseband data for the two antennas simultaneously through the same beamformer and verify fringes with the software correlator.

The system is a real time, three-baseline software correlator, an interim measure to allow testing of 16 1-MHz bands spanning 300 MHz in bandwidth.

Once PAFs are installed on six ASKAP antennas, the Science Commissioning Team will use this engineering testbed (known as BETA, or Boolardy Engineering Test Array) to prepare for the full fit-out of the full 36-antenna ASKAP radio telescope.

ASKAP DESIGN ENHANCEMENTS PROGRAM

The ASKAP Design Enhancements (ADE) Program is currently underway, based on following up the rapid development of technologies associated with the PAF. The ADE is currently engaged in the detailed research and development of signal transport using 'RF-over-fibre' and direct sampling of the radio frequency signal rather than using a heterodyning approach.

The program includes research and development into the next generation of phased array feed receivers and will undergo a Critical Design Review in June 2012. More details on this program will be available in the next edition of *ATNF News*.

ASKAP science

EPIC SCIENCE SIMULATIONS

Having been accepted as 'early adopters' of the iVEC Pawsey Centre 'Epic' supercomputer, ASKAP's Computing Team has been testing the processing capabilities of the Pawsey 1A system since July 2011. The team was granted one million hours on the Pawsey 1A system in the second half of 2011, and eight million hours in the first half of 2012. With this time the team was the first to use Epic to simulate how ASKAP data will be processed to create images of the radio sky for the ASKAP Survey Science Projects. The 'mega simulations' generated more than 1.5 terabytes of data, producing images and cubes that covered 10 square degrees of sky (a third of ASKAP's field-of-view) and up to 4,096 channels (one quarter of that possible with ASKAP).

SKA activities

UPDATE ON SKA PRE-CONSTRUCTION PHASE

The international SKA project became a new legal entity at the end of 2011 — an independent, not-for-profit UK company limited by guarantee with founding members the UK, The Netherlands, Italy, China, Australia, New Zealand and South Africa. Canada has since joined as the eighth member.

The office of the SKA Organisation, the SKA Project Office (SPO), will be located in new headquarters to be built at Jodrell Bank Observatory during 2012–2013. The SPO will manage the next phase of the SKA, the four-year pre-construction phase (2012–2016), which is outlined in the Project Execution Plan (PEP).

The PEP sets out the major work packages, building on the exploratory technology of the European PrepSKA Work Package 2 (WP2) program. CSIRO contributed to a number of the PrepSKA WP2 technology tasks including digital systems design, computing, dish and receivers, and signal transport, and is well placed to continue significant involvement in the PEP phase. The latter stages of this phase will involve development and validation of prototype SKA elements, ready to be built as Phase I of the SKA from 2016.

Since November 2011, engineers and scientists from CASS and the CSIRO ICT Centre have participated in the following activities, led by the SPO:

- Definition of the work breakdown structure and statements of work for PEP Stage 1— this is approximately the first year of the pre-construction phase, and leads to the Systems Requirements Reviews in mid-2013, and
- Commencement work on the top-level system engineering requirements documentation, coordinated by SPO Systems Engineer Tim Stevenson.

A team of nine from CASS and the CSIRO ICT Centre travelled to the SPO in Manchester for a working week at the end of January, drawing on their experience with ASKAP and other instruments to provide significant input to this process, and to ensure that the scientific activities are well aligned with the technology development path set out by the SPO.

Led by CASS Deputy Chief Sarah Pearce, CSIRO convened a number of Australia – New Zealand PEP strategy discussions so that all stakeholders are ready to participate in the various consortia which will form to complete the SKA PEP work. These discussions included representatives from universities, research institutes, industry, the Australian Department of Innovation, Industry, Science, Research and Tertiary Education, and other stakeholders. While the content of the work packages is yet to be finalised, these discussions have enabled some initial consortia-building activity to proceed.

KOREAN CONNECTION MAKES 8,000 KM TELESCOPE

Australian and Korean radio telescopes were linked for the first time in March to form a system acting as a gigantic telescope more than 8,000 km across and with 100 times the resolving power of the Hubble Space Telescope.

The telescopes involved in the linkup were the Australia Telescope Compact Array and Mopra radio telescope, the University of Tasmania's telescope near Hobart, and two telescopes operated by the Korean Astronomy and Space Science Institute: one in Seoul and a second near Ulsan.

The telescopes observed the same target simultaneously for five hours, with data streamed in real time over optical fibre links to Curtin University in Perth and processed 'on the fly' at the International Centre for Radio Astronomy Research

The first full-sized phased array feed receiver was installed on an ASKAP antenna at the MRO in October 2011. Credit: Image courtesy of DIISRTE.

(ICRAR). Data were sent from each telescope at the rate of 64 MB/s. The high-speed data links for the observations were provided by AARNet and its Korean counterpart, Kreonet.

Combining signals from widely separated telescopes in this way is the technique that will underlie the international SKA telescope. "Australia has many decades of experience with these long-distance linkups," said CASS Chief Phil Diamond, "and we are committed to scientific partnerships with countries in our region and elsewhere."

Collaborator projects

MWA ENTERS FINAL CONSTRUCTION PHASE AT THE MRO

In February, the 32-antenna Murchison Widefield Array (MWA) prototype, which has operated at the MRO for the past two years, was de-commissioned. Known as '32T' (for 32 tiles), the prototype was used as an engineering and science testbed in preparation for the final MWA instrument (a 128-antenna array with a maximum baseline of 3 km and operational frequency of 80–300 MHz).

After de-commissioning the 32T, the MWA Team commenced the final stage of MWA construction. Trenching and reticulation of power and fibre for the MWA was carried out by the Geraldton Electrical Company. From mid-2012, 128 antennas and 16 receivers will be deployed to the field and connected to the MRO Control Building. Within the central building will be housed the MWA correlator and real-time imaging and calibration system, based on a 24-node IBM iDataPlex cluster with 48 high-end GPUs. The MWA Team recently took delivery of the IBM machines and is preparing them for installation later in the year.

Science commissioning of the 128-antenna array will commence in August and is due to be complete in November. Final commissioning of the 128-antenna instrument will be complete in early 2013, with the initial operational phase to commence by approximately mid-2013.

The Murchison Widefield Array Team. Credit: ICRAR.

Parkes HIPSR backend progresses

**DANNY PRICE (UNIVERSITY OF OXFORD) AND
LISTER STAVELEY-SMITH (ICRAR)**

Since the October 2011 issue of *ATNF News* ('A new backend for Parkes'), work has continued on HIPSR — a flexible new backend for the Parkes multibeam receiver and anticipated future replacement for the existing multibeam correlator and BPSR/APSR.

The HIPSR (HI-pulsar) spectrometer will have greater instantaneous bandwidth, finer spectral resolution and improved dynamic range as well as provide increased processing power for pulsar observations. It also has the potential to unify many of the existing signal processing backends into a reconfigurable system.

HIPSR comprises a bank of digitiser cards and field-programmable gate arrays (FPGAs) connected via a 10 Gb Ethernet switch to a powerful (20 TFlops) graphics processing unit accelerated server cluster. The FPGAs provide the low-level, high-bandwidth digital signal processing, with the server cluster providing the flexible computing power needed to achieve, among other things, pulsar de-dispersion and radio frequency interference mitigation. The unit fills out the remainder of the Parkes telescope equipment rack space shared with CASPSR, space that was formerly occupied by the decommissioned CPSR-2 pulsar backend.

Since October 2011, the installation and testing of the HIPSR hardware has been successfully completed, with much assistance from Parkes staff, and 'first light' observations have been conducted, most recently in March 2012, using all 13 beams of the Parkes multibeam receiver.

HIPSR was put to the test in March during the galaxy evolution commissioning project (Parkes observing program P669), when data was taken in parallel with the existing multibeam correlator in a 21-cm neutral hydrogen stacking experiment on a GAMA field. It was also used in April by the High Time Resolution Universe Survey team (P630), who ported over their code from the existing BPSR/APSR backend.

Danny Price (PhD student and project manager/engineer) and HIPSR at Parkes in March 2012. Credit: Erik Lensson, CSIRO.

HIPSR is still in its commissioning phase and is not likely to be available for general use for several months. In the near future, however, HIPSR is likely to take over the capability of one or more of the existing backends. Prospective users are therefore encouraged to discuss their requirements with CASS staff.

HIPSR is a collaborative development between the International Centre for Radio Astronomy Research, Swinburne University of Technology, the University of Oxford and CSIRO under an Australian Research Council Linkage Infrastructure, Equipment and Facilities grant (Lead Investigator: Lister Staveley-Smith) with additional resources provided by CAASTRO, the ARC Centre of Excellence for All-sky Astrophysics.

Feasibility study for FAST multibeam receiver

GRAEME CARRAD (CASS)

FAST under construction in Guizhou, China. Credit: NAOC.

CSIRO's expertise in radio astronomy engineering is being called on for the development of the world's largest single dish radio telescope.

On 16 January, CASS Chief Dr Phil Diamond and a representative of the National Astronomical Observatories Chinese Academy of Sciences (NAOC) signed an agreement to conduct a feasibility study for a multi-pixel receiver for the Chinese Five-hundred metre Aperture Spherical Telescope (FAST) project.

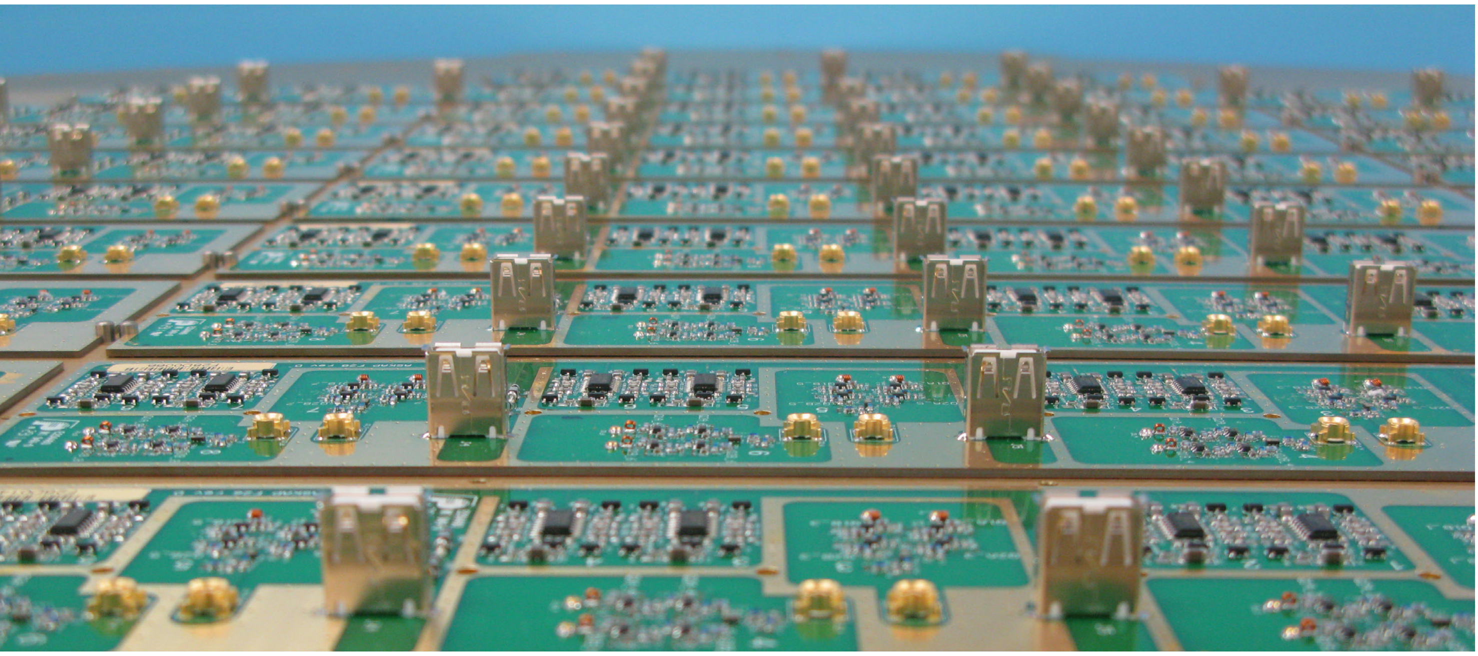
FAST will be the world's largest single radio telescope and is under construction in Guizhou, China. The CSIRO–NAOC contract is for the provision of a feasibility study for a 19-pixel receiver operating in the 1–1.5 GHz band.

Most currently operating telescopes utilise single pixel receivers, which can only see one piece of sky at a time. CASS has a proven track record in designing and building multi-pixel receivers including the 13-beam receiver on the Parkes radio telescope and the advanced phased array feeds for the Australian Square Kilometre Array Pathfinder (ASKAP), currently under construction in the Mid West region of Western Australia.

Despite CSIRO's experience in multi-pixel receivers, this project will require innovative elements to achieve the design specifications. The feasibility study will be the first step towards an instrument for new science.

The University of Manchester's Jodrell Bank Centre for Astrophysics in the UK is conducting a parallel study and these contracts will bring together world experts in radio astronomy engineering to assess the feasibility of the FAST multibeam receiver.

Low noise amplifiers for one of ASKAP's innovative phased array feeds. Credit: Russ Bolton, CSIRO.



VLBI observing underway with RadioAstron

YURI KOVALEV (RADIOASTRON MISSION SCIENTIST, ASTRO SPACE CENTER OF THE LEBEDEV PHYSICAL INSTITUTE, MOSCOW) AND DAVID JAUNCEY (CASS/MOUNT STROMLO OBSERVATORY)

An artist's impression of RadioAstron in orbit. The orbit has an apogee height of 310,000–360,000 km giving a maximum resolution of 7 mas at 1.3 cm wavelength. Credit: Lavochkin Association and Astro Space Center of the Lebedev Physical Institute.

RadioAstron, the Russian 10-m space radio telescope, was successfully launched from Baikonur Cosmodrome in Kazakhstan at 02:31 UTC on 18 July 2011 carrying CSIRO-designed receiver technology. This brings to fruition an international space very long baseline interferometer (VLBI) project that has been underway for several decades and has survived the transition from the former Soviet Union to present-day Russia. The RadioAstron project is led by the Astro Space Center of the Lebedev Physical Institute in Moscow.

The 10-m antenna was successfully unfolded on 23 July and, while still undergoing in-orbit tests, has started its first scientific observations. The on-board hydrogen maser is operational; the system temperatures at 92, 18, 6 and 1.3 cm are as specified; single-dish pointing is fine; the continuum, maser and pulsar observing modes have been tested; and fringes have been found at 92, 18 and 6 cm, but not yet at 1.3 cm, on several pulsars as well as on several strong, compact active galactic nuclei. Updates on mission status and details are available through the RadioAstron newsletters at www.asc.rssi.ru/radioastron.

CSIRO and Australia have been active participants since the earliest days of the RadioAstron project. The telescope's 18-cm receiver, designed by CSIRO and built by British Aerospace Australia and Mitec, is performing as specified and Australian astronomers are already active users of RadioAstron.

VLBI observations have been conducted with ground radio telescopes including the Australia Telescope Compact Array, Mopra and Hobart in Australia, as well as telescopes in the Ukraine, Germany, Italy, Spain, The Netherlands, USA and Japan together with the Russian Quasar Network. Most excitingly, RadioAstron, has successfully detected fringes at 92 cm from individual pulses from the pulsar B0950+08 on a projected baseline of 220,000 km. These successes demonstrate the excellent status of the spacecraft, and reflect its readiness for early science observations.

The RadioAstron Early Science Program (ESP) started in February and will last 12 months. The ESP aims to achieve high quality, high profile scientific results to bridge the current 'experimental' mode of operation and routine operations that will start after the ESP. Observing time with RadioAstron and ground radio telescopes around the world has been committed for the ESP observations, and these are being co-ordinated by several international Early Science Working Groups.

The RadioAstron spacecraft carries a plaque, provided by the Grote Reber Foundation, in memory of Grote Reber. Credit: Grote Reber Foundation.

The rocket carrying RadioAstron blasting off from Baikonur Cosmodrome, Kazakhstan on 18 July 2011. This image frame has been taken from the live television broadcast of the launch. Credit: Center for Ground-Based Space Infrastructure Facilities Operation.

The successful launch of RadioAstron was made possible through the vision and foresight of its Project Leader, Professor Nikolay Kardashev. Over more than half a century Professor Kardashev has continued to make innovative contributions to astronomy and for these he has been awarded the 2012 Grote Reber Medal (see www.qvmag.tas.gov.au/?articleID=539 for more information). The successful RadioAstron launch is the culmination of his efforts, and it is fitting that the RadioAstron spacecraft carries a plaque, provided by the Grote Reber Foundation, in memory of Grote Reber. The 10-m RadioAstron antenna in space is virtually the same diameter as Grote Reber's 32-foot telescope in Wheaton, Illinois, the first dedicated radio astronomy dish.

Parkes Observatory shop now online

CHRIS HOLLINGDRAKE (CASS)

A 10% discount on Parkes Observatory online shop purchases is available to ATNF News readers until 30 June 2012. When placing your order use the coupon code 'ATNF News April 2012' to receive your discount.

Wherever you are in Australia, you can now purchase a range of astronomy and space science educational resources and souvenirs from the Parkes Observatory online shop at www.parkesdishshop.com.

The new online shop makes some of the most popular items from the Parkes Observatory Visitors Centre shop — including books, DVDs, science kits, posters, toys, puzzles and souvenirs — available to budding scientists, amateur astronomers and 'Dish' enthusiasts around Australia. All the high-quality products available online are selected by Parkes Observatory staff.

The online shop is being trialled with a limited selection of stock until mid-2012, after which time the range of products will be expanded to include most of those available in the Parkes Observatory Visitors Centre store. Delivery is currently available across Australia, but not internationally.

Visit the Parkes Observatory online shop at www.parkesdishshop.com.

ATNF website changes

GABBY RUSSELL (CASS)

Over coming months the ATNF website is to be given a 'facelift' to make it easier to use and manage. The site is going to be updated with a fresh new appearance, a more comprehensive navigational menu, quick links to our most popular pages and a search facility will appear on all pages. Behind the scenes a new content management system will also be introduced.

The ATNF website is an important resource for telescope users, the astronomy community, teachers and CASS staff, so we'll be working to ensure the transition has minimal impact on site visitors. Proposed changes have been developed in consultation with staff representatives and user testing will be conducted to help us reach the best outcomes for the site.

From mid-2012 you'll start to notice changes to the main sections of the site (www.atnf.csiro.au, www.narrabri.atnf.csiro.au and www.parkes.atnf.csiro.au) followed by changes to the outreach section (www.outreach.atnf.csiro.au). The appearance of related sites including OPAL (http://opal.atnf.csiro.au) and ATOA (http://atoa.atnf.csiro.au) will also be updated.

You can provide feedback on the website changes via our online form at www.atnf.csiro.au/feedback or by contacting CASS Communication Officer Gabby Russell (*Gabby.Russell@csiro.au*).

Australian ALMA Community Workshop

JILL RATHBORNE (CASS)

Close-up view of the ALMA antennas on the Chajnantor Plateau, at an altitude of 5,000 metres. The antennas are designed to withstand the harsh conditions at the high site, where the extremely dry and rarefied air is ideal for ALMA's observations of the Universe at millimetre- and submillimetre-wavelengths. Credit: ESO.

The second Australian Atacama Large Millimeter/submillimeter Array (ALMA) Community Workshop was held on 6 and 7 February at CSIRO Astronomy and Space Science headquarters at Marsfield. The workshop was extremely successful, attracting more than 60 participants from across Australia.

The workshop began with Dr Lewis Ball, ALMA's Deputy Director, presenting an overview of the current status and capabilities of ALMA. With early science operations in full swing and the constant commissioning and verification of new antennas as they arrive at the Operations Support Facility, the support staff at ALMA are keeping very busy! Recently, ALMA reached a milestone: 33 of the 66 antennas are now on the high site and are being integrated into the array.

During the first day of the workshop we also heard talks from key international ALMA experts — Sachiko Okumura (East Asian ALMA regional centre), Lister Staveley-Smith (ICRAR), Scott Schnee (North American ALMA regional centre), Diego Mardones (UChile), Leonardo Testi (ESO), Nicolas Reyes (UChile) — on the Atacama Compact Array (ACA), the ALMA Time Allocation Committee processes, face-to-face support and ALMA's future plans. The day ended with a group discussion of options for an Australian-based ALMA support centre.

Day two of the workshop focused on ALMA science: 14 science talks were presented that covered a broad range in potential ALMA science projects, from those addressing long-standing questions in star and galaxy formation to those describing the role ALMA will play in the era of the Australian Square Kilometre Array Pathfinder and the Square Kilometre Array. While some of the early science projects have already been observed, many of the teams are eagerly awaiting their ALMA data. ALMA's first results will be published very soon: a conference discussing ALMA results will be held in Santiago, Chile, 12–15 December 2012.

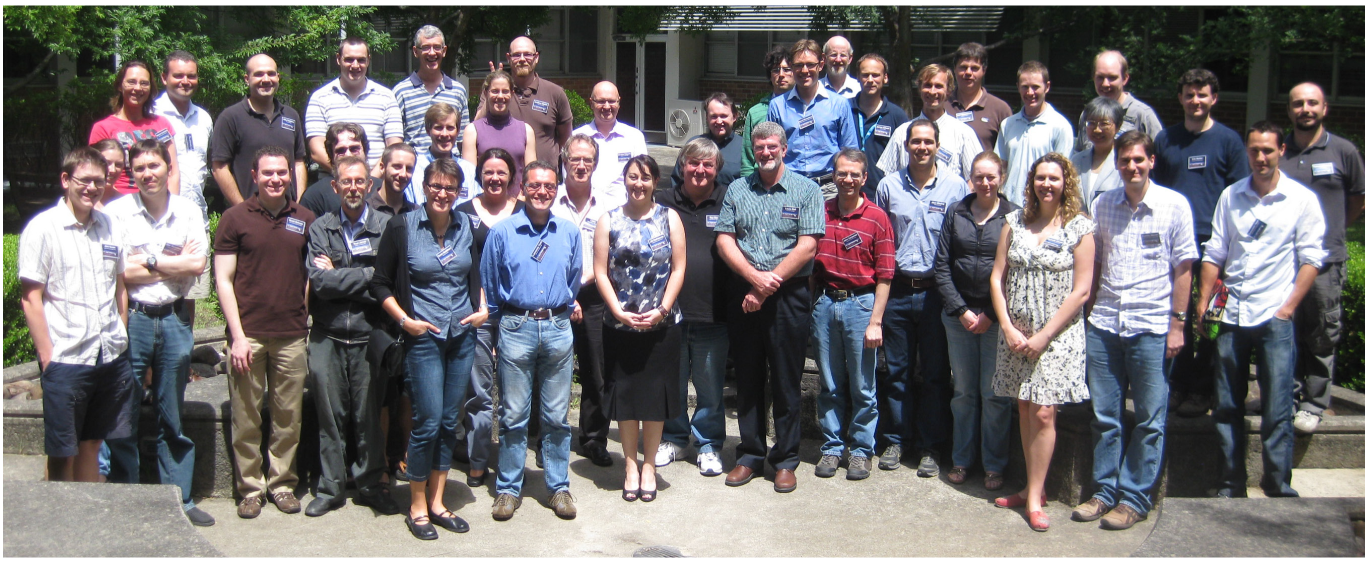
Details on ALMA's capabilities for Cycle 1 will be released in April, with the proposal deadline expected mid-July. We hope to hold another workshop in 2013, before the Cycle 2 call for proposals.

All talks from the workshop are available from the workshop website at www.atnf.csiro.au/research/workshops/2012/ALMA/ALMA_workshop.html

The workshop was possible thanks to funding from CSIRO and Astronomy Australia Limited.

Members of the Organising Committee were Jill Rathborne, Kate Brooks, Bjorn Emonts, Michelle Cluver and Ankur Chaudhary.

Participants in the second Australian ALMA Community Workshop.
Credit: Shari Breen, CSIRO.



Alan Duffy and Klaus Dolag in front of the Marsfield OptIPortal, which is displaying a 16k x 16k pixel image of one of Klaus' magnetohydrodynamic simulations of the Universe. Credit: Gabby Russell, CSIRO.

Simulations Fest 2011

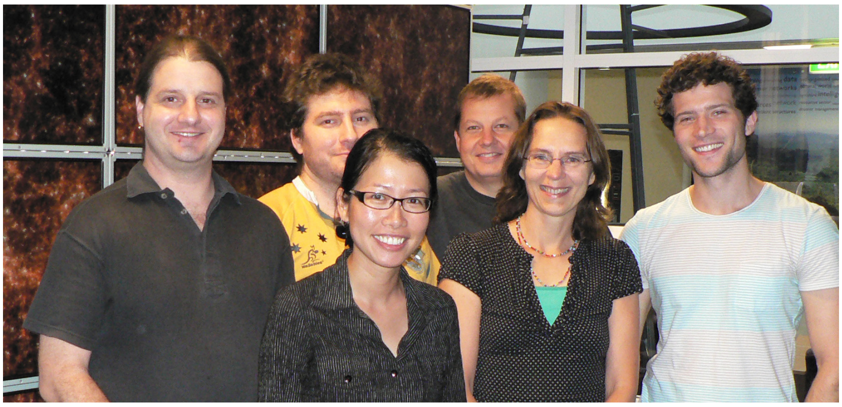
BÄRBEL KORIBALSKI AND RUSSELL JUREK (CASS)

Exploring the Universe using advanced visualisation technologies was the focus of a 'Simulations Fest' hosted by the WALLABY research team at CSIRO Astronomy and Space Science headquarters at Marsfield, 21–23 November 2011.

WALLABY, the Australian Square Kilometre Array Pathfinder (ASKAP) HI All-Sky Survey, is one of ten large survey projects allocated observing time in the first five years of ASKAP's operation. The Simulations Fest, which had a strong focus on hydro- and semi-analytical simulations of galaxies and large-scale structure, was part of a series of regular WALLABY science meetings.

About 40 people from numerous Australian universities, CSIRO, the Australian Astronomical Observatory and several overseas institutions participated in the meeting, which was financially supported by Bärbel Koribalski's 2011 Newton Turner Award ('CSIRO astronomer receives Newton Turner Award', *ATNF News* October 2011). International participants included Barbara Catinella, Guinevere Kauffmann and Klaus Dolag from Germany, Gyula (Josh) Józsa from The Netherlands and Tom Jarrett from the USA.

(From left) Josh Józsa, Russell Jurek, Ivy Wong, Klaus Dolag, Bärbel Koribalski and Alan Duffy in front of the Marsfield OptIPortal. Credit: Gabby Russell, CSIRO.



The three-day meeting featured a full schedule of talks and demonstrations including Mark Calabretta's 'fly through' of the HIPASS volume and Klaus Dolag's '4D Universe'. It was also an opportunity to explore the visualisation hardware currently available to CASS: the OptIPortal (a high resolution visualisation system made up of 25 30-inch LCD screens) located at Marsfield, a small tiled display and a stereoscopic projector were made available for the attendees to visualise large images and movies.

The scientific organisers of the Simulations Fest were Chris Power and Bärbel Koribalski. The local organisers were Ivy Wong and Russell Jurek.

We thank Peter Tyson and Justin Baker (CSIRO IM&T) for their continuing collaboration with respect to 3D visualisation, the loan of stereo equipment and ongoing help with visualisation on multi-tiled displays; Keith Bengston and Daniel Legovich (CSIRO ICT Centre) for their assistance in accessing and setting up the OptIPortal; and Nathan Pope, Vince McIntyre and Shaun Amy (CASS) for their help with running a range of visualisation packages on different platforms as well as collaboration in creating our own tiled display.

For further information on WALLABY and the Simulations Fest, see www.atnf.csiro.au/research/WALLABY.

Another Simulations Fest is planned for late 2012.

Welcome to new postdoctoral staff

GABBY RUSSELL AND SIMON JOHNSTON (CASS)

In 2011, seven new postdoctoral staff joined CASS. We asked each of them to tell us, in their own words, about their research interests — it is fantastic to see this diverse group of people passionate about their science. Please join us in welcoming Julie, Keith, Tom, Yiannis, Sebastian, Alex and Ivy.

JULIE BANFIELD

CSIRO Office of the Chief Executive Postdoctoral Fellow
PhD: University of Calgary, Canada, 2011

"My research interests are galaxy formation and evolution centred on active galactic nuclei and cosmic magnetism. I am a member of the ATLAS and EMU teams whose data will look into these subjects."

KEITH BANNISTER

Bolton Fellow
PhD: The University of Sydney, 2011

"I'm interested in radio transients — things that go BANG in the night (and in the day!). I'll be working on commissioning ASKAP to do a survey for radio transients as well as following up some variable sources detected by the Molonglo Observatory Synthesis Telescope."

TOM FRANZEN

Australian Research Council Super Science Fellow
PhD: University of Cambridge, UK, 2011

"My research interests are Sunyaev-Zel'dovich imaging and galaxy cluster physics, extended radio emission in galaxy clusters, anisotropies in the CMB, the extragalactic high-radio-frequency source population, radio galaxy surveys and data reduction software, particularly imaging and source extraction."

YIANNIS GONIDAKIS

Postdoctoral Fellow in High Resolution Science
PhD: University of Manchester, UK, 2005

"My basic research interests cover masers, asymptotic giand branch (AGB) and post-AGB stars (Mira variables, in particular), radio and sub-millimetre wavelength astronomy and very long baseline interferometry. More specifically, I am interested in understanding the properties of circumstellar envelopes in AGB stars and study their dynamics, kinematics and magnetic fields. The mechanisms of mass-loss and pulsation are of particular importance in order to reveal the properties of circumstellar envelopes."

SEBASTIAN HAAN

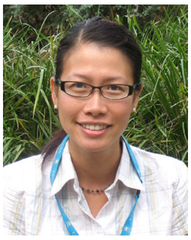
CSIRO Office of the Chief Executive Postdoctoral Fellow
PhD: MPIA – Heidelberg University, Germany, 2008

"My research focuses on the formation and evolution of galaxies, in particular their dynamics, interaction, and the relation to their central supermassive black hole."

ALEX HILL

CSIRO Office of the Chief Executive Postdoctoral Fellow
PhD: University of Wisconsin-Madison, USA, 2011

"I am broadly interested in the structure, dynamics, and energy transport (which inevitably means turbulence) in the diffuse interstellar medium of our Milky Way Galaxy. I am particularly interested in the ways in which feedback — primarily supernova explosions and ionising radiation — from massive stars drives the warm ionised medium. My research involves both numerical simulations and optical and radio observations."



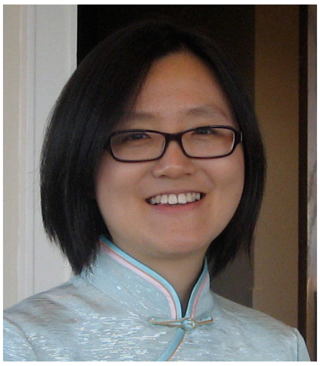
IVY WONG

Australian Research Council Super Science Fellow
PhD: University of Melbourne, 2008

"I use multiwavelength observations to study the processes governing how many stars are formed and the mechanisms surrounding the cessation of star formation within nearby galaxies. My fellowship here at CASS affords a close collaboration with the WALLABY survey (the next generation all-sky census of atomic hydrogen within the nearby Universe) using the pre-SKA pathfinder instrument, ASKAP."

Elizabeth Mahony

Laura Bonavera



Sui-Ann Mao

Graduate Student Program

BÄRBEL KORIBALSKI (CASS)

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

- Hayden Rampadarath (Curtin University) — *Application of wide-field VLBI*, with supervisors Dr Steven Tingay (Curtin University) and Dr Tasso Tzioumis (CASS)
- Peter-Christian Zinn (Bochum University, Germany) — *New avenues in galaxy evolution studies*, with supervisors Professor Ralf-Juergen Dettmar, Dr Enno Middelberg (both at Bochum University) and Dr Ray Norris (CASS)
- Craig Anderson (The University of Sydney) — *Radio polarimetry and rotation measure synthesis as probes of inner AGN structure*, with supervisors Professor Bryan Gaensler (The University Sydney) and Dr Ilana Feain (CASS).

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

- Laura Bonavera (SISSA, Italy) — *Spectra of extragalactic radio sources after Planck*
- Sui-Ann Mao (Harvard University, USA) — *Magnetic fields in the Milky Way and the Magellanic Clouds*
- Keith Bannister (The University of Sydney) — *Radio transients: surveys and techniques*
- Elizabeth Mahony (The University of Sydney) — *Unveiling the high-frequency radio source population*
- Andres Guzman (Universidad de Chile, Chile) — *Ionised jets and molecular outflows in high-mass young stellar objects*

Dr Laura Bonavera is now a postdoctoral researcher at the University of Cantabria, Spain; Dr Sui-Ann Mao is now a Jansky Fellow at the University of Wisconsin, USA; and Dr Keith Bannister is now a Bolton Fellow at CASS. Dr Elizabeth Mahony recently started as a postdoctoral researcher at ASTRON in The Netherlands, and Dr Andres Guzman will soon start his postdoctoral position at CFA in Boston, USA.

Tye Young (Australian National University) completed his Honours thesis — *Mapping ammonia emission in star forming regions* — and is about to start on a PhD project.

Well done!

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

Distinguished Visitors

SIMON JOHNSTON (CASS)

Over the past months we have enjoyed working visits from Bill Coles (University of California, San Diego), Xiao-Peng You (South Western University, China), Ken Kellerman (National Radio Astronomy Observatory), Tom Jarrett (California Institute of Technology) and Ue-Li Pen (Canadian Institute for Theoretical Astrophysics). In addition we hosted Daniel Yardley, Dominic Schnitzeler and Elizabeth Mahony.

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

For more information on the Distinguished Visitors Program see www.atnf.csiro.au/people/distinguished_visitors.html.

Prospective visitors should contact the local staff member with the most similar interests, or the Chair of the Distinguished Visitors Committee, Naomi McClure-Griffiths.

The intriguing neutral gas of the blue compact dwarf galaxy NGC 5253

ÁNGEL R. LÓPEZ-SÁNCHEZ (AUSTRALIAN ASTRONOMICAL OBSERVATORY/MACQUARIE UNIVERSITY) AND BÄRBEL KORIBALSKI (CASS)

Abstract

With the aim of understanding the origin and nature of starbursts in dwarf galaxies we have performed a multiwavelength analysis of a sample of these objects. One of the most puzzling galaxies is the blue compact dwarf galaxy NGC 5253. We obtained HI and 20-cm radio continuum data of this starburst galaxy as part of the Local Volume HI Survey (LVHIS) project using the Australia Telescope Compact Array (ATCA). Our low-resolution HI maps show, for the first time, the disturbed morphology of the neutral gas in this galaxy, which includes tails, plumes and detached HI clouds. We confirm that the kinematics of the neutral gas in NGC 5253 are highly perturbed and do not follow a rotation pattern. Taking into account all available multiwavelength data, we conclude that NGC 5253 is probably experiencing the infall of a diffuse, low-metallicity HI cloud along the minor axis of the galaxy. The infall of this independent HI cloud, which probably started more than 100 million years ago, is comprising the interstellar medium and triggering the powerful starburst in NGC 5253. The origin of this HI cloud may be related to a strong interaction between NGC 5253 and the late-type spiral galaxy M 83 in the past. This analysis has been published in López-Sánchez et al. (2012).

Introduction

Multiwavelength analyses of local dwarf galaxies provide the opportunity to investigate the impact of star formation activity on both the interstellar medium (ISM) and the surrounding intergalactic medium (IGM), study the dynamics of galaxy evolution at both high and low spatial scales, and explore the triggering mechanisms of low-mass starbursting systems. We performed a multiwavelength analysis of a sample of these objects that combined both deep optical and radio data, and ultraviolet and infrared data when available, to address these issues and, in particular, understand the origin a nature of starbursts in dwarf galaxies.

One of the best examples of such starbursts is the blue compact dwarf galaxy NGC 5253. This galaxy lies at 4.0 Mpc, within the Centaurus A group. Figure 1 shows a colour image of this dwarf galaxy combining ultraviolet, optical, infrared and radio data. As seen in optical wavelengths (green colour), NGC 5253 resembles an elliptical dwarf object. Its starbursting nature is revealed via observations in the Hα line (red), which traces the ionised gas of the galaxy. This warm gas shows a filamentary structure that is extending perpendicular to the optical major axis of the galaxy and reaches beyond the stellar distribution (Calzetti et al. 2004; Meurer et al. 2006). The star-formation activity is very intense in this galaxy and, indeed, its radio spectral energy distribution is almost entirely dominated by thermal emission (Beck et al. 1996; Turner, Ho and Beck 1998). Therefore, NGC 5253 is considered to be one of the youngest starbursts of the Universe. Ultraviolet observations using data from the GALEX satellite (cyan) show that the centre of the galaxy hosts a very important population of young, hot, massive stars. Some of these massive stars are classified as Wolf-Rayet stars, and they are polluting their surroundings with chemical elements (nitrogen and helium) released by their strong stellar winds (López-Sánchez et al. 2007).

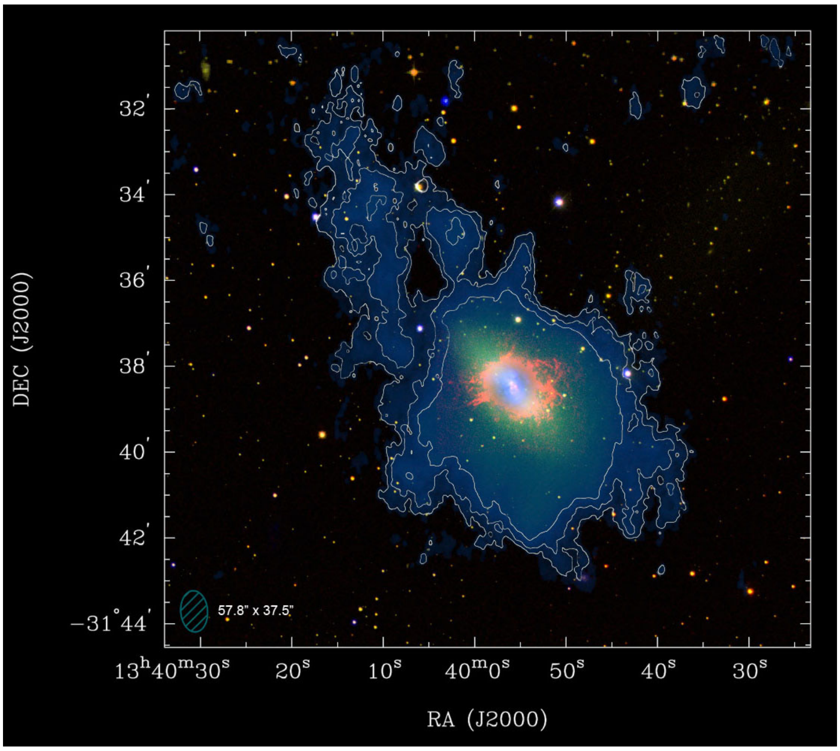


FIGURE 1:
Colour image of the blue compact dwarf galaxy NGC 5253 obtained combining data in *FUV* and *NUV* (cyan, GALEX), *R*-band (green) and Hα (red), NIR *J*-band from 2MAS (orange) and our ATCA low-resolution HI map (dark blue). The synthesised beam of the HI map is 57.8 x 37.5 arcsec^2.

The plotted contour levels are 0.10 ~3σ), 0.18 and 0.3 Jy beam^{-1} km s^{-1}.

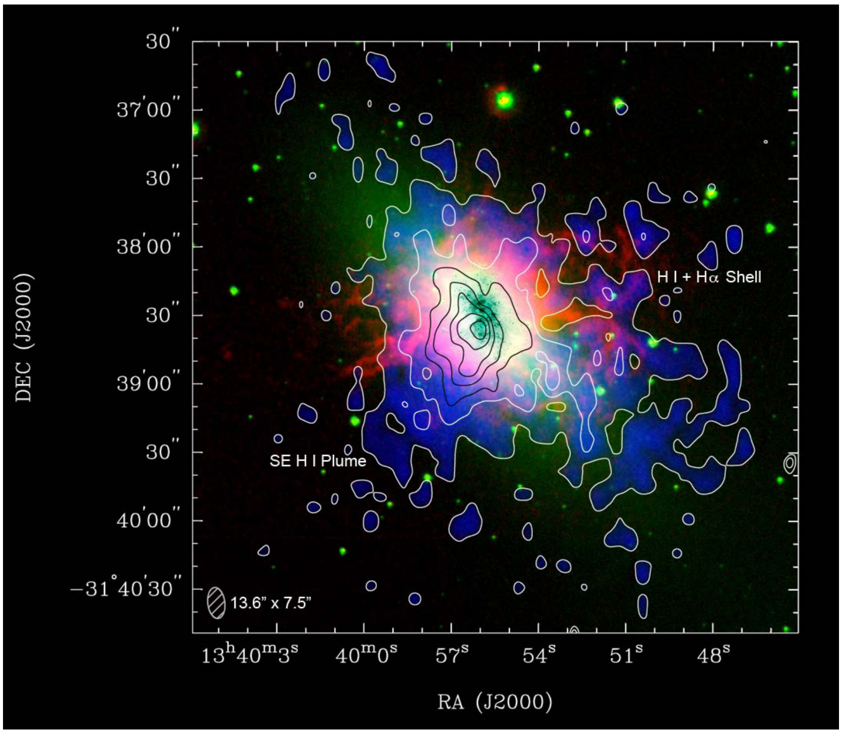


FIGURE 2:
Contours of the high-resolution HI map overlaid onto a colour image which combines R-band and FUV-band (green), Hα (red) and the ATCA high-resolution HI map (blue). The synthesised beam (13.6 x 7.5 arcsec²) is displayed at the bottom-left corner. The contour levels are 0.032 (3σ), 0.12, 0.22, 0.32, 0.42, 0.52 and 0.62 Jy beam⁻¹ km s⁻¹. Note the HI shell surrounding the NW Hα.

HI morphology

No clear interaction processes had been detected in NGC 5253 until radio data collected using the Australia Telescope Compact Array (ATCA) interferometer were obtained (dark blue). Our radio data, which forms part of the Local Volume HI Survey (LVHIS; Koribalski 2008, Koribalski et al. 2012), has allowed us to trace the cold, neutral gas component of galaxies, which is nearly always more extended than the stellar component and, hence, more easily disturbed by gravitational forces.

Figure 1 shows our low-resolution HI map, which traces the large-scale structures of the neutral gas of the galaxy. The atomic hydrogen gas is more extended than the optical size of the galaxy (11' x 6' = 12.8 kpc x 7 kpc, that is, 2.2 x 3.2 times its optical size) and shows a peculiar and filamentary structure at the north of the galaxy. This suggests the existence of tidally disturbed material surrounding NGC 5253. We derive a total HI mass of (1.6 ± 0.1) x 10^8 $M_\odot$ for this galaxy. The agreement between the global HI line spectrum as obtained from the HI Parkes All Sky Survey (HIPASS; Barnes et al. 2001; Koribalski et al. 2004) and LVHIS is quite good (our interferometric data recover almost 96% of the single-dish HI flux), suggesting that very little HI emission has been filtered out in our interferometric observations.

We also analysed the high-resolution HI map of NGC 5253 obtained from our ATCA data, as it traces the highest density neutral gas corresponding to the small-scale structures. Figure 2 displays the HI contours overlaid onto a multiwavelength colour picture which combines the Hα image of the galaxy (red) with the *R*-band and *FUV*-band images (green), and our high-resolution HI map. This map agrees quite well with the HI map presented by Kobulnicky and Skillman (2008) using Very Large Array (VLA) data and recovers the main HI features reported by these authors: a 'SE HI plume' that extends beyond the optical component of the galaxy and an HI+Hα shell at the NW. This latter structure is related to an expanding bubble in ISM, but it will almost certainly not originate a galactic wind.

The HI kinematics of NGC 5253

Kobulnicky and Skillman (1995, 2008) previously noticed that the neutral gas of NGC 5253 is not rotating about the optical minor axis of the galaxy, as should be expected, but moves radially along the minor axis. Our data allowed us to perform a more detailed analysis of this issue, as we detected HI gas in the external areas of the galaxy. Figure 3 shows our low-resolution HI channel maps of NGC 5253: the HI distribution is asymmetric and does not show any clear rotational pattern.

We studied the outflow and infall scenarios to explain such disturbed kinematics and proposed that the very peculiar HI morphology and kinematics of NGC 5253 can be explained by an interaction scenario in which the infall of an independent HI cloud along the minor axis of the galaxy is disturbing the existing neutral gas and triggering the powerful starburst. Both entities now seem to be in a process of merging, but the interaction probably started a long time ago, as we detect tidal gas at the northern regions of the galaxy and it seems that previous starbursts have occurred in the system. However, our HI data alone do not allow us to definitively confirm the proposed infall scenario as some features (the long disturbed neutral gas at the NE and the compressed HI edge at the SW) may have also originated as the result of ram pressure stripping from moving through a dense IGM.

Other peculiarities of NGC 5253

The observed multiwavelength properties of NGC 5253 are not typical of those expected for a star-forming dwarf galaxy. NGC 5253 does not obey the Schmidt-Kennicutt scaling laws of star formation, as it seems to be slightly metal-deficient in comparison with starburst galaxies of a similar baryonic mass (López-Sánchez 2010) and it possesses a very low HI mass-to-light ratio (MHI/LB) for its stellar mass (see Figure 4). The hypothesis of the infall of an HI cloud in NGC 5253 will naturally explain all this evidence. Indeed, the situation of NGC 5253 is very similar to that observed in galaxies which seem to be in interaction with diffuse HI clouds (IC 10, IC 4662, NGC 625, NGC 1705) and almost identical to that seen in a galaxy which is certainly known to be experiencing an interaction event with an independent HI cloud (NGC 1569). Furthermore, our observational hypothesis agrees very well with the theoretical models recently presented by McKernan, Maller and Ford (2010), who predicted that the accretion of warm halo clouds will produce a nuclear starburst of low-metallicity stars in the centre of galaxies.

Conclusions

Taking into account all available observational data and the comparison with similar starbursting galaxies, we conclude that NGC 5253 is very probably experiencing the infall of a diffuse, low-metallicity HI cloud along its minor axis. The infall of this independent HI cloud is comprising the ISM and triggering the powerful central starburst. Both entities seem to be now in a process of merging, but the interaction probably started some time ago, as we detect tidal gas at the northern regions of the galaxy and it seems that previous starbursts have occurred in the system. Perhaps the origin of this low-metallicity HI cloud is related to the very asymmetric tidal HI arm detected in the nearby spiral galaxy M 83 (Koribalski 2005; Koribalski et al. 2012). This late-type galaxy lies at a radial distance of only ~600 kpc, being their projected separation ~130 kpc, and hence both galaxies may have experienced a strong interaction in the past. Actually, the main disturbances in the HI distribution of NGC 5253 are precisely aligned in the direction to the long HI tidal arm found in M 83. This study reinforces the conclusions reached by López-Sánchez (2006, 2010), who suggested that interactions with or between dwarf galaxies or HI clouds trigger the star formation activity in many dwarf and normal starburst galaxies. However, usually the independent, interacting diffuse objects are only detected when deep optical images and radio observations are obtained.

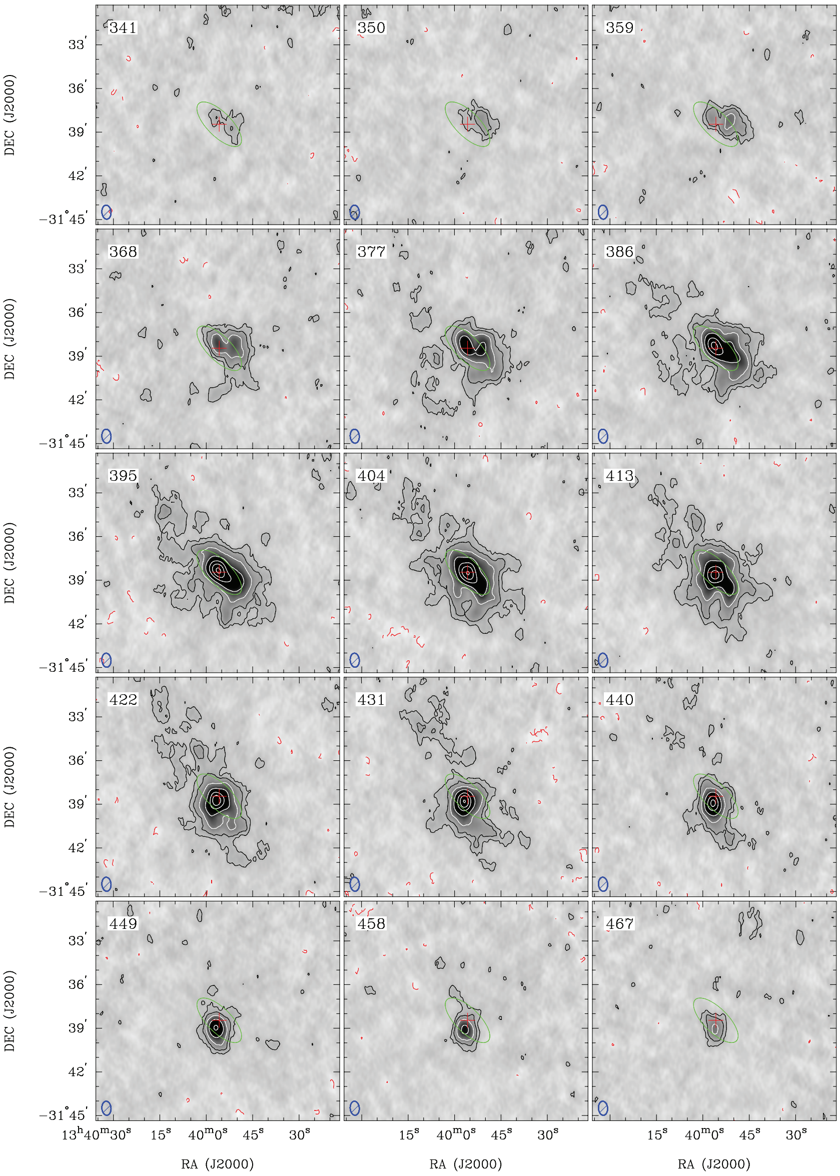


FIGURE 3:
HI channel maps, in steps of 9 km s⁻¹, of NGC 5253 as obtained from the ATCA, using our low-resolution data cube. The contour levels are -3 (dashed red contours), 3 (~2.8σ), 6, 12, 24, 45, 65 and 85 mJy beam⁻¹. The galaxy centre is marked with a red cross, while the green ellipse corresponds in size to the optical appearance of the galaxy. The centre velocity of each channel is displayed at the top-left and the synthesised beam (57.8 x 37.5 arcsec²) at the bottom-left corner of each panel.

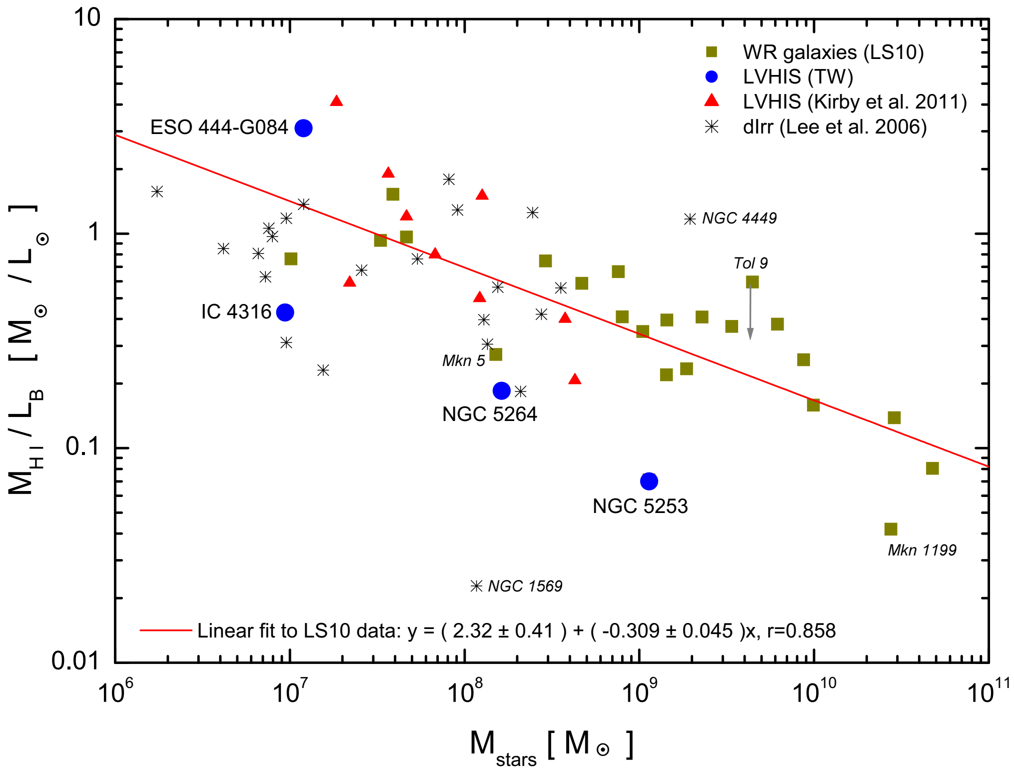


FIGURE 4:
Comparison between the stellar mass, M_{stars}, and the HI mass-to-light ratio for NGC 5253 and its nearby dwarf galaxies (blue circles). We compare with the sample of nearby dwarf irregular galaxies analysed by Lee et al. (2007), with the sub-sample of the LVHIS galaxies studied by Kirby et al. (2012) (red triangles), and with the sample of strong star-forming (WR) galaxies analysed by López-Sánchez (2010) (dark yellow squares), which included NGC 5253. The red solid line shows a linear fit to the López-Sánchez (2010) data.

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Constraining the fundamental constants of physics through astronomical observations of rotational transitions of methanol

SIMON ELLINGSEN (UNIVERSITY OF TASMANIA), MAXIM VORONKOV (CASS), SHARI BREEN (CASS), JIM LOVELL (UNIVERSITY OF TASMANIA)

The existence of four fundamental forces of nature which are the same at all times and places are among the basic assumptions on which modern physics is founded. Numerous careful laboratory experiments conducted on Earth have produced results consistent with these assumptions. However, testing their validity in the early Universe, or at locations far-removed from the Earth, can only be achieved through astronomical observations. The frequency of a particular spectral line depends upon the difference in energy between different electronic, vibrational or rotational quantum states, which in turn depend upon the specific values of one or more physical constants (for example, electron mass, proton mass, Planck's constant).

Different atomic and molecular transitions have varying sensitivity to changes in physical constants. Early work in this field focused on using observations of electronic transitions in quasar absorption line spectra to look for changes in the fine-structure constant

$$\alpha = \frac{e^2}{\hbar c}$$

More recently, however, attention has focused on observations of rotational transitions of molecules at radio frequencies. The rotational transitions are sensitive to changes in

$$\mu = \frac{m_p}{m_e}$$

the proton-to-electron mass ratio. This ratio will change either if the relative strength of the electromagnetic and strong-nuclear forces were to vary, or if chameleon-like scalar fields are the mechanism responsible for dark energy. In the first case we would expect to be most likely to observe evidence for differences in μ at cosmological distances. For the second case we expect μ to show density dependence, and hence a different value in the very low densities of interstellar gas compared with that measured in the laboratory. The attention on rotational transitions has come about because theoretical investigations have revealed some molecules are unusually sensitive to changes in μ. $K\mu$ is the sensitivity coefficient for a particular

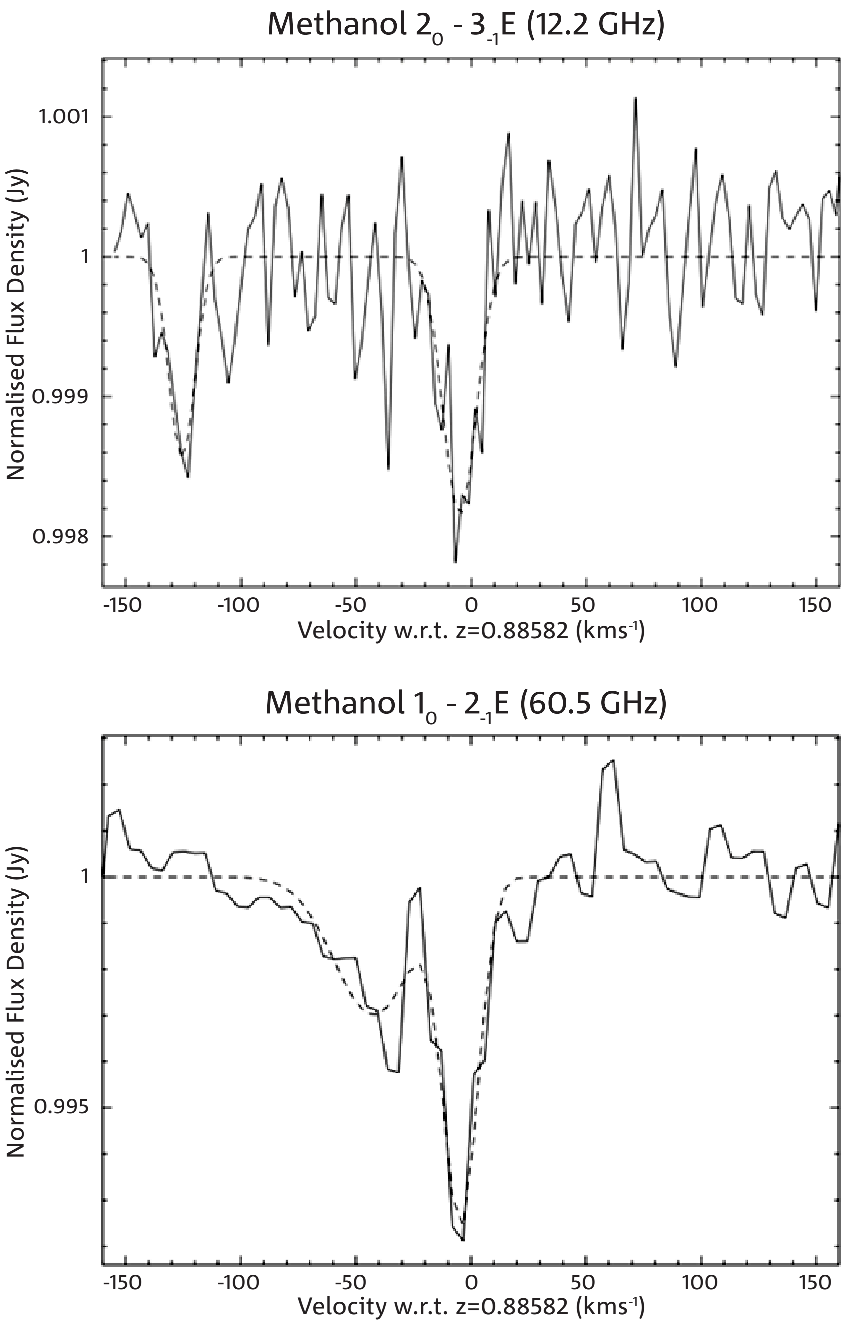

FIGURE 1:
(Top) The absorption from the 12.2 GHz transition of methanol toward PKS B1830–211 (Ellingsen et al. 2012); (Bottom) The absorption from the 60.5 GHz transition over the same velocity range as the 12.2 GHz transition (Muller et al. 2011).

transition to changes in μ, and for most rotational transitions this is 1, while inversion transitions of ammonia (NH_3) have been shown to have $K\mu \approx 5$.

Recent theoretical investigations of the methanol (CH_3OH) molecule by Jansen et al. (2011) and Levshakov et al. (2011) have shown that the hindered internal rotation exhibited by this molecule is not only responsible for a very rich microwave spectrum, but also makes it 1–2 orders of magnitude more sensitive to changes in μ than other molecules. One of the difficulties that plagued previous astronomical studies searching for changes in μ has been that they have required observations of different molecules. If the emission from the different molecules arises in slightly different locations, then differences in the line-of-sight component of velocity are very difficult to disentangle from changes in the relative frequency of the two transitions. However, the different transitions of methanol have varying sensitivity to changes in μ, so observations of a single molecule can be used to significantly reduce a major source of uncertainty in the method. Ellingsen et al. (2011) have used observations collected as part of the Methanol Multibeam Survey with the Parkes radio telescope at 6.7 GHz and follow-up observations (also with the Parkes telescope) of the 12.2 GHz methanol masers to limit changes (3-σ) in the proton-to-electron to

$$\left|\frac{\Delta\mu}{\mu}\right| < 8.1\times10^{-8}$$

in Galactic star formation regions. The density in these regions is of the order 10^{-14} kgm^{-3}, much lower than that achieved in the laboratory, which significantly limits the strength of possible chameleon-like scalar fields.

The recent detection of methanol absorption in the z=0.89 molecular absorbing galaxy in the PKSB 1830-211 gravitational lens system by Muller et al. (2011) has allowed the first cosmological constraints on μ from observations of methanol. Ellingsen et al. (2012) have used Australia Telescope Compact Array (ATCA) observations to make the first measurements of absorption from the 12.2 GHz methanol transition in PKSB 1830-211 (Figure 1). This, combined with the observation of absorption from the 60.5 GHz transition by Muller et al. (2011) (made also with the ATCA), have allowed us to constrain (3-σ) changes in μ at the redshift of the molecular absorption system (look-back time 7.24 billion years), to be

$$\left|\frac{\Delta\mu}{\mu}\right| < 6.3\times10^{-7}$$

This limit is comparable to the best previous cosmological constraints on changes in the proton-to-electron mass ratio, and is inconsistent with a number of observations which found marginal evidence for changes in

$$\left|\frac{\Delta\mu}{\mu}\right|$$

at levels above 10^{-6}. Future observations of the methanol absorption in this system with higher signal-to-noise and including additional transitions are expected to achieve an order of magnitude better sensitivity than that achieved to date.

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Molecular gas in high-z radio galaxies: an ATCA/CABB survey

BJORN EMONTS (CASS) ON BEHALF OF THE CO-INVESTIGATORS*

ATCA/CABB and millimetre astronomy

With the start of the first observations of the Atacama Large Millimeter/submillimeter Array (ALMA), millimetre astronomy is expected to boost over the next years. This includes advances in our knowledge about molecular gas in the early Universe. In the southern hemisphere, the Australia Telescope Compact Array's Broadband Backend (ATCA/CABB) also provides exciting new possibilities for studying molecular gas in distant galaxies. In the past, observations of high-z molecular emission lines (focused mainly on the strongest tracer, ^{12}CO) were severely hampered by the relatively narrow bandwidths of available correlators, generally not much wider than the accuracy of the redshifts or the velocity-width of the CO lines at high observing frequencies. The large instantaneous CABB bandwidth has overcome this problem, making reliable and unbiased studies of molecular gas in high-z galaxies possible.

A crucial advantage of the ATCA over most other millimetre observatories is its capability to observe below 50 GHz. This allows one to deviate from studying the traditionally targeted higher order rotational CO(*J, J-1*) transitions — which trace dense and thermally excited gas, mainly in the central starburst/AGN region — and start looking for the ground-transition CO(1-0) [ν_{rest} = 115 GHz] at z > 1.3. Because the strength of CO(1-0) is least affected by the excitation conditions of the gas, it is the most robust tracer of the overall molecular gas content, including the widespread, low-density gas that may be sub-thermally excited (for example, Papadopoulos et al. 2000, 2001, Daddi et al. 2010, Carilli et al. 2010, Ivison et al. 2010, Riechers et al. 2011)

We utilised the ATCA/CABB broadband receivers at 7mm (30–50 GHz) to perform the first survey of molecular CO(1-0) gas in a sample of high-redshift radio galaxies (HzRGs).

Molecular gas in high-z radio galaxies

High-z radio galaxies (HzRGs) are among the most massive galaxies in the early Universe (for example, Miley and De Breuck 2008). They are typically surrounded by proto-clusters, with properties as expected from the ancestors of rich local clusters. HzRGs and surrounding proto-cluster gas and galaxies often interact with one another and are therefore excellent laboratories for studying the formation and evolution of galaxies and clusters, as well as to investigate the relationship between early star formation and AGN activity. A main ingredient for star formation and AGN activity is cold molecular gas, which makes this a key element for studying the evolutionary processes of these massive proto-cluster systems.

In order to study the molecular gas content of HzRGs, we observed the CO(1-0) emission-line in 13 HzRGs with the ATCA between 2009 and 2012. The observations were done with the ATCA's most compact, hybrid (that is, 'T-shaped') H75 and H168 array configurations in order to minimise the effect of atmospheric phase fluctuations (which worsen with increase in baseline length and decrease in elevation). Our sample was selected to contain all HzRGs which (i) have dec < -10°; (ii) are observable with the ATCA 7mm band (30–50 GHz), resulting in a redshift coverage of 1.3 < z < 2.9; (iii) have Hubble Space Telescope and Spitzer data available (in order to maximise our scientific output; Pentericci et al. 2001, De Breuck et al. 2010). The average on-source integration time per object was ~15h.

We detected CO(1-0) in three HzRGs from our sample of 13, namely MRC 0114-211, MRC 0152-209 (Emonts et al. 2011b) and the 'Spiderweb Galaxy' MRC 1138-262 with respective molecular gas masses of M_{H2} =

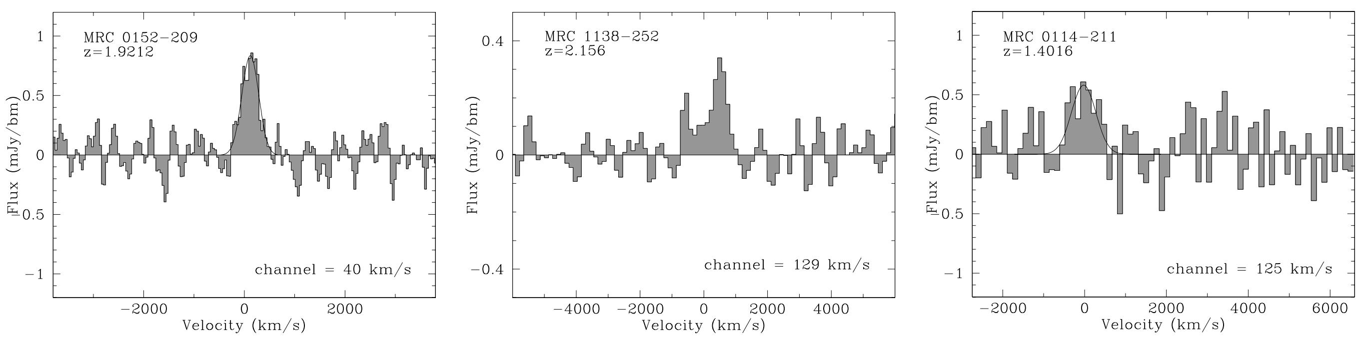

FIGURE 1:
CO(1-0) spectra of the three detections among our sample of HzRGs. The molecular gas masses derived from these spectra are: $M_{H2} = 5 \times 10^{10}\ M_\odot$ for MRC 0152-209 (z=1.92; Emonts et al. 2011b), $M_{H2} = 5 \times 10^{10}\ M_\odot$ for MRC 1139-262 (z=2.16) and $M_{H2} = 3 \times 10^{10}\ M_\odot$ for MRC 0114-211 (z=1.40), assuming $X_{CO}=M_{H2}/L'_{CO} = 0.8$. A fourth, tentative, detection for MRC 0943-242 ($M_{H2} = 6 \times 10^{10}\ M_\odot$) is published in Emonts et al. (2011a).

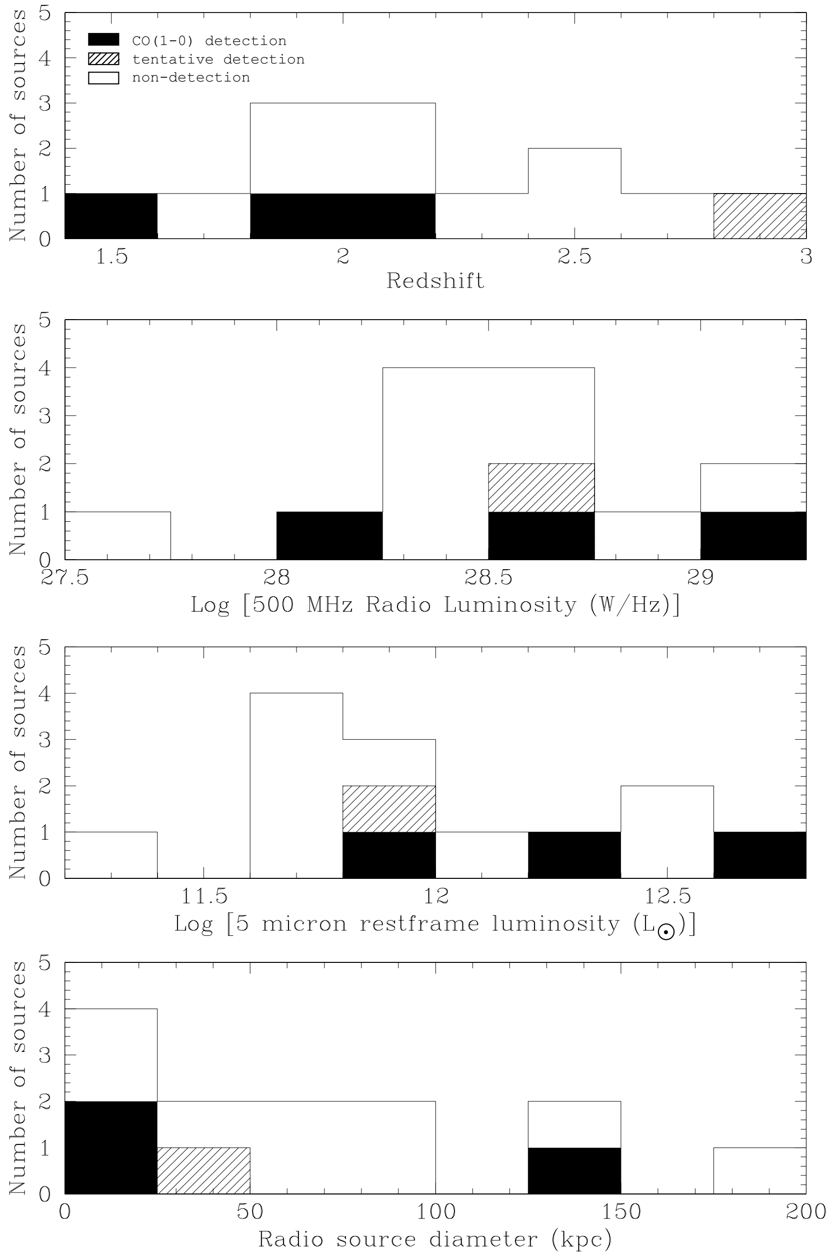

FIGURE 2:
Number of HzRGs with CO(1-0) detections (black), tentative detection (grey) and non-detections (white) as function of redshift, $P_{500\,MHz}$, $L_{rest}(5\mu m)$ and radio source size (Carilli et al. 1997, Pentericci et al. 2000, De Breuck et al. 2010).

3, 5 and 5 x 10^{10} $M_{\odot}$ (assuming a conversion factor of $X_{CO}=M_{H2}/L'_{CO}$ = 0.8). Figure 1 shows these detections. A fourth, tentative, CO(1-0) detection was found for MRC 0943-242, which was observed at the extreme edge of the CABB band (see Emonts et al. 2011a). For the remaining nine HzRGs we derived 3σ upper limits of M_{H2} < 1–3 x 10^{10} $M_{\odot}$. Our method for observing and calibrating the ATCA 7-mm band spectral-line data, as well the derivation of molecular gas masses, is described in detail in Emonts et al. (2011a).

The CO(1-0) detection rate among our representative sample of HzRGs is 25% (or 31% when taking the tentative detection in MRC 0943-242 into account). In Figure 2 the CO(1-0) content of our sample sources is compared with some of their physical properties. While the low-number statistics do not reveal clear evidence for correlations, it is interesting to note that we detected CO(1-0) in 50% of the HzRGs with a small radio source (< 25 kpc), while only one (15%) of the galaxies with a large radio source (>50 kpc) was detected. A similar trend was found by van Ojik et al. (1997) in studies of the Lyα emitting gas, with small radio sources showing more frequent deep Lyα absorption of neutral hydrogen gas and higher Lyα velocity dispersion than extended radio sources. It would be interesting to verify and further investigate this possible trend in CO(1-0), for example to examine whether CO(1-0) is predominantly found in regions not yet affected by the propagating radio jets, or whether it can be created when the radio jets plough through the host galaxy's interstellar medium (for example, Klamer et al. 2004). Figure 2 also shows that our CO(1-0) detected HzRGs are relatively infrared (IR) bright at 5μm. More interesting would be to compare the CO(1-0) content of our HzRGs with their far-IR (FIR) luminosity. The FIR emission is generally dominated by star-formation activity, while molecular gas is the raw ingredient for star formation. As a result, correlations between FIR and CO luminosity have been observed among various types of high- and low-z objects (for example, Evans et al. 2005, Greve et al. 2005). Whether a similar FIR/CO correlation exists for HzRGs can be investigated once FIR (for example, Herschel) data become available. Finally, we note that the fact that our three detections are all found in the low redshift half of the sample is not likely a sensitivity bias, because the corresponding closer luminosity distance is counter-balanced by a somewhat lower CABB sensitivity in the high-frequency (that is, low redshift) part of the 7-mm band.

Widespread CO(1-0) in MRC 0152-209 (z=1.92)

The CO(1-0) signal in MRC 0152-209 (Emonts et al. 2011b) is the highest known among HzRGs to date. We are using the more extended ATCA 1.5km and 750m array configurations to map the CO(1-0) emission. A preliminary image (Figure 3) shows that the CO(1-0) appears to be resolved. The bulk of the CO(1-0) is aligned with the bright SE peak of the radio continuum. If this is the radio jet hot-spot (as suggested by its steep spectral index of $\alpha_{8.2/4.7}$ = -1.4; Pentericci et al. 2000), it is likely that the CO(1-0) peaks offset from the centre of the host galaxy, at the location of a tail-like HST feature towards a small south-eastern companion (although the HST astrometry is not accurate enough to verify this). If this is the case, the CO(1-0) may either be tidal debris, or it may perhaps be formed when the propagating radio jets trigger the formation of molecular star-forming clouds (for example, Klamer et al. 2004).

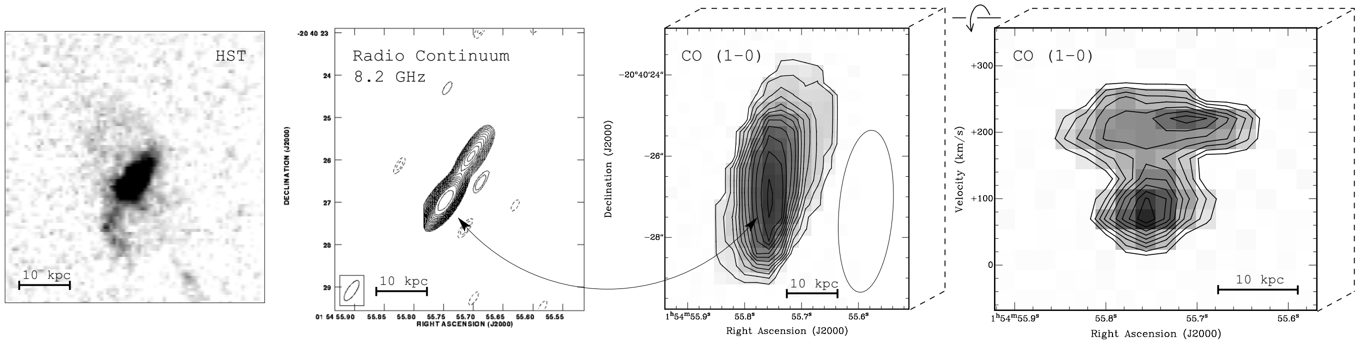

FIGURE 3:
MRC 0152-209 (z=1.92). Shown are the HST/NICMOS image (Pentericci et al. 2001), the 8.2 GHz radio continuum (Pentericci et al. 2000) and two preliminary total intensity images of the high-resolution ATCA CO(1-0) data (one where the signal was integrated along the velocity axis, the other along the declination axis). All plots have approximately the same scale. The CO(1-0) map in the middle plot (contour levels: 10–120 in steps of 10 mJy/beam x km/s) shows that the peak of the CO(1-0) coincides with the bright, steep-spectrum ($\alpha_{8.2/4.7}$ = -1.4) SE peak of the radio continuum (the astrometry of the HST image is not accurate enough for an overlay with the CO and radio continuum). Additional ATCA time has been allocated to verify the total extent of the CO(1-0) emission.

High-z CO studies

Our ATCA study is the first comprehensive survey for CO(1-0) in HzRGs. Ultimately, comparison with CO(1-0) studies of other types of high-z galaxies, such as sub-millimetre galaxies (SMGs), quasars/QSOs and massive star-forming (the colour-band selected BzK/BX) galaxies (see EVLA studies by Ivison et al. 2011, Riechers et al. 2011, Aravena et al. 2011), will allow studying possible evolutionary links between these objects. Figure 4 shows a summary of various post-2004 high-z CO studies. The CO(1-0) luminosities of our three detected HzRGs are comparable to those of SMGs. However, the bulk of our HzRGs have significantly lower CO(1-0) luminosities, with merely upper limits on $L'_{CO(1-0)}$ in the range where many massive star-forming galaxies are detected in CO(3-2) (Tacconi et al. 2010). Unfortunately, literature results are often biased towards pre-selection of IR-bright objects, towards a variety in used CO transitions and towards a tendency to not publish non-detections, which makes a good comparison difficult. We argue that unbiased surveys of CO(1-0), and other molecular transitions and species, in various types of high-z objects are essential for studying the role of the cold molecular gas in galaxy evolution in the Early Universe.

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Acknowledgements

We would like to thank the local ATCA staff in Narrabri, without whom these and other ATCA/CABB observations would not have been possible. A special thanks also to Mark Wieringa, who implemented crucial updates to the MIRIAD software that allowed us to maximise our millimetre data reduction.

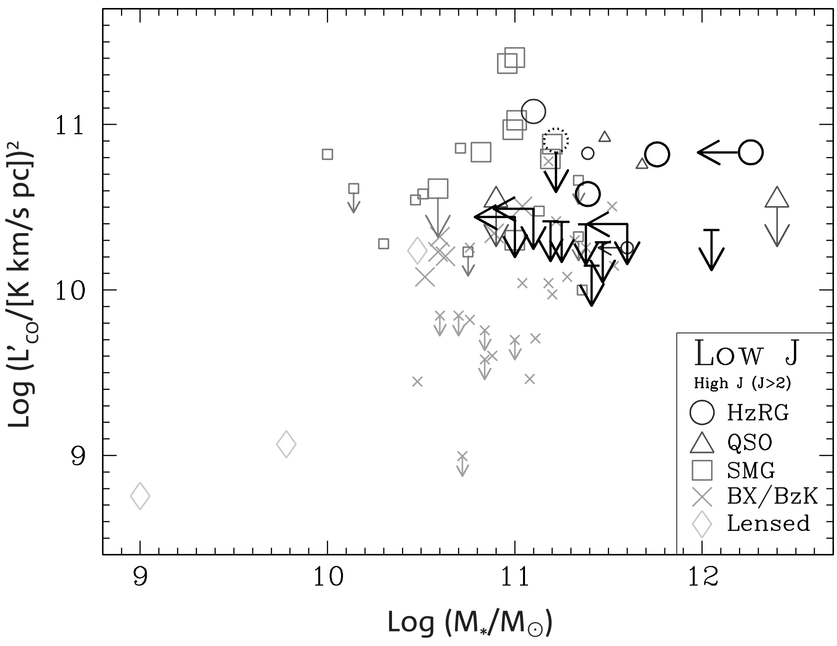

FIGURE 4:
Summary of CO studies in various types of high-z galaxies in the era of broadband millimetre backends. Large symbols indicate the lower CO(1-0) and CO(2-1) transitions, while small symbols reflect the higher transitions (J ≥ 3); the different galaxy types are indicated in the lower right side of the plot. The stellar masses have been taken directly from the literature (without checking for consistency in their derivation between the different studies) and, hence, have to be taken with caution. References: Greve et al. (2004, 2005), Kneib et al. (2004, 2005), De Breuck et al. (2005), Klamer et al. (2005), Tacconi et al. (2008, 2011), Nesvadba et al. (2009), Aravena et al. (2010), Coppin et al. (2010), Daddi et al. (2010), Ivison et al. (2010, 2011), Riechers et al. (2010, 2011), Swinbank et al. (2010), Danielson (2010), Lacy et al. (2011), Hainline et al. (2011), Polletta et al. (2011), Martinez-Sansigre et al. (2011).

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Witnessing the birth of a quasar

RAY NORRIS (CASS)

When I were a lad, shortly after the Bronze Age, the IRAS satellite discovered a number of unexpectedly bright far-infrared (FIR) sources. A number of groups around the world, including ours at ATNF and AAO (Allen et al. 1985), quickly found that they were also at high redshifts, and thus of enormous total luminosity, rivalling and even exceeding that of quasars. We called them ELFs (Extremely Luminous FIR sources) and another group called them ULIRGs (Ultra-Luminous IR Galaxies). Sadly, the acronym ULIRG stuck, and the world was deprived of papers with titles debating the relationship between ELFs and Giants.

The archetype of these ULIRGs was Arp220, with a luminosity of $10^{12}L_{\odot}$, and only 80 Mpc from Earth. But the most luminous was a source romantically named F00183-7111 (aka 00183). At a redshift of 0.3276 (Roy and Norris 1997), it had a luminosity of $10^{13}L_{\odot}$, making it the most luminous object then known in the Universe. A debate raged whether such ULIRGs were powered by star formation or active galactic nuclei (AGN).

In the case of 00183, both infrared and optical observations showed unequivocally that it was dominated by an intense starburst. But it was also a strong radio source, lying far above the radio-FIR correlation, suggesting that at radio wavelengths it was dominated by an AGN. High-resolution radio observations with the Australia Telescope Compact Array showed an unresolved radio dot, whilst IR and optical observations showed a fuzzy blob with no hint of an AGN, although subsequent X-ray observations, and most recently mid-infrared observations (for example, Spoon et al. 2009), also supported the suggestion of an AGN. But at radio wavelengths, a series of VLBI observations were plagued by technical problems, and 00183 slowly migrated to our back burner.

Last year we pulled it back onto the front burner, and produced a new VLBI image (Figure 1) that at last showed clearly what was going on. At the centre of 00183 lies a powerful radio galaxy, whose radio power of ~6.10^{25} W/Hz places it in the class of the most luminous (FRII) radio galaxies. However, while most such galaxies have lobes spanning hundreds of kpc, the lobes of 00183 are only ~1kpc across. Its spectrum gives us a clue to its age, with a constant spectral index of -1.49 from 86 GHz down to a few GHz, and then turning over at around 1 GHz. Such a spectrum is characteristic of the sources know as CSS/GPS (compact steep-spectrum/gigahertz-peaked spectrum: Randall et al. 2011) which are widely thought to represent an early stage of AGN formation.

With 20/20 hindsight, we now realise that the standard model of AGN formation predicts sources such as this, caught at the earliest stages of AGN formation, and paint the following scenario. Two gas-rich spirals have merged, and the resulting heap of debris is undergoing an enormous starburst, seen at optical and IR wavelengths. At the centre of the merging spirals are one or more black holes, which have merged or are merging, and are being fed prodigious amounts of cold gas from the spirals (in 'quasar accretion mode' in the terminology of Croton 2006), producing the high-luminosity jets that we see in the VLBI image. However, this process is invisible at optical and IR wavelengths, being hidden from us by the hundreds of magnitudes of extinction by the dust surrounding the nucleus.

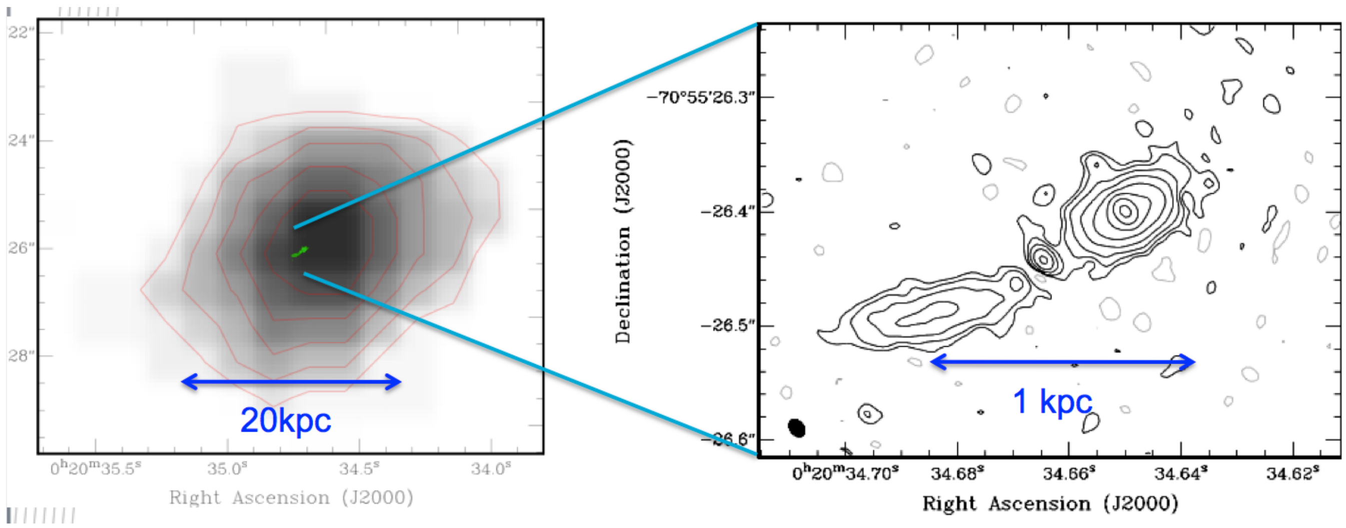

FIGURE 1: (Left) The R-band image of 00183, from the UK Schmidt telescope. (Right) The VLBI image of F00183-7111, taken from Norris et al. (2012). The entire radio source is just over 1 kpc in extent, but is embedded in a dusty starburst some 20kpc in extent.

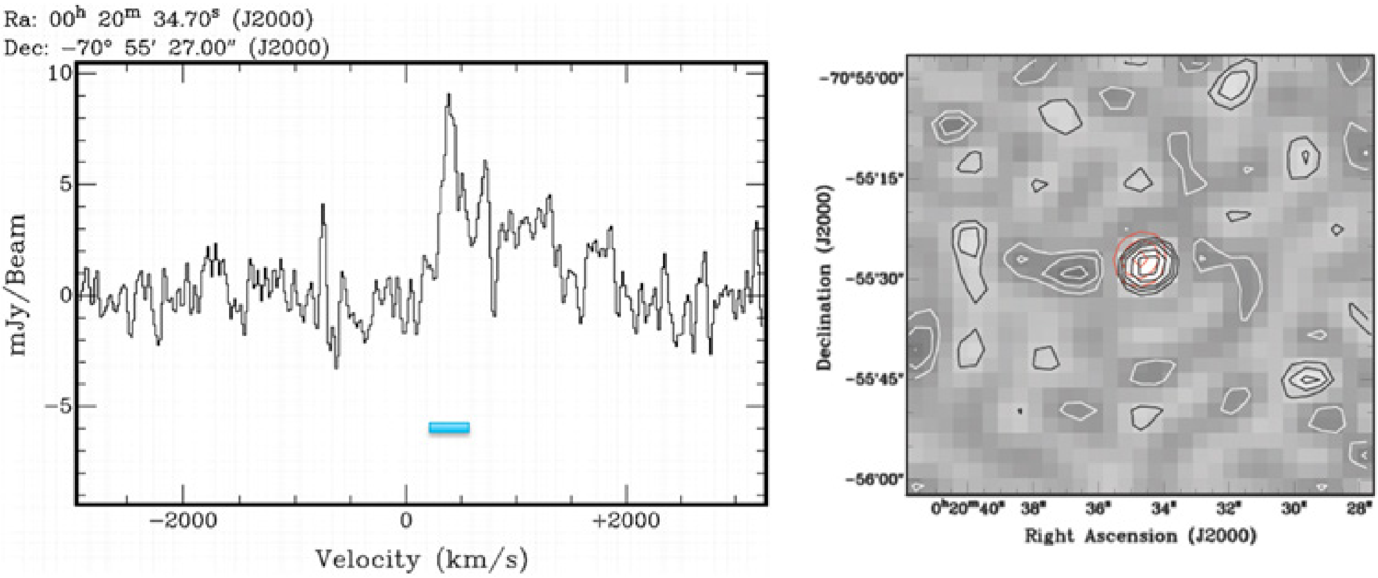

FIGURE 2:
(Left) The ATCA spectrum of CO in 00183. The blue bar shows the total bandwidth of the pre-CABB ATCA observations. (Right) Image of the CO emission from 00183, with contours of the continuum emission shown in red. Image courtesy of Bjorn Emonts.

This same dense dust and gas envelops the jets, preventing them from bursting out of the galaxy, and so the jets are gradually boring their way through the cold gas, heating and disrupting the material as they do so. Eventually they will burst out, heating the gas, and quenching the starburst. The source will then become a radio-loud quasar (or radio galaxy, depending on orientation), and will eventually settle down to radio-mode accretion (that is, fuelled by hot gas).

In 00183 we are probably witnessing a brief transition period between starburst-driven ULIRG and a quasar. Although models are not yet sufficiently sophisticated to predict the length of this transition phase, the rarity of objects like 00183 (it is still the most extreme ULIRG known) attest to its brevity. So it's important to use every technique at our disposal to understand this object.

Given all this dust and gas, shouldn't we able to detect CO emission from 00183? We tried in 2007 with the ATCA, and obtained a clear detection of the 2-mJy continuums from the nucleus, but only a marginal detection of a CO line. Further observations of the CO gave confusing results, as the CO flux seemed to vary in a strange way as we changed the observing frequency. We suspected that we had detected a broad CO line, but decided not to publish, as the results were confusing. With the advent of the Compact Array Broadband Backend (CABB) upgrade, we obtained much better data which confirmed our detection, shown in Figure 2, implying a molecular gas mass > 2.4 x 10^{10} $M_{\odot}$. These new data also showed why our earlier results had been so confusing, as the line was many times wider than the pre-CABB ATCA bandwidth.

We also submitted a proposal for Cycle 0 ALMA observations. The proposal was ranked in the second tier, and we were told in early February 2012 that it would probably be observed shortly. Alas, delays in the observations pushed 00183 out of the window of opportunity, but we still hope to obtain ALMA observations of this source in late 2012. Eventually we hope to use CO and other molecules, using the long baselines available in later ALMA phases, to peel away the layers of obscuring gas and understand the kinematics of even the deepest layers surrounding the nucleus. Then, perhaps, we will start to understand the processes that turn merging spirals into quasars, and build the massive black holes at their centres.

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Education and outreach

ROB HOLLOW (CASS)

Education and outreach activities

Providing professional development for science teachers has continued to be a focus for CASS Education Officer Rob Hollow. In late 2011, Rob delivered invited presentations and workshop sessions at the Science Teachers' Association of Victoria (STAV) and Science Teachers' Association of New South Wales (STANSW) conferences in Melbourne and Sydney. Rob also presented at the STAV/Australian Institute of Physics Teachers' Conference in Melbourne in February and gave an invited talk at the first STANSW 9–12 Physics Network Conference at the Powerhouse Museum in March.

In addition, Rob and CSIRO Square Kilometre Array (SKA) Director Dr Brian Boyle visited the new Quantum Victoria education centre in February to discuss possible collaborations using CASS data and resources for new programs for school students visiting the centre. Several exciting possibilities were considered and the Quantum Victoria team is now developing a module based around the Australian Square Kilometre Array Pathfinder (ASKAP).

PULSE@Parkes

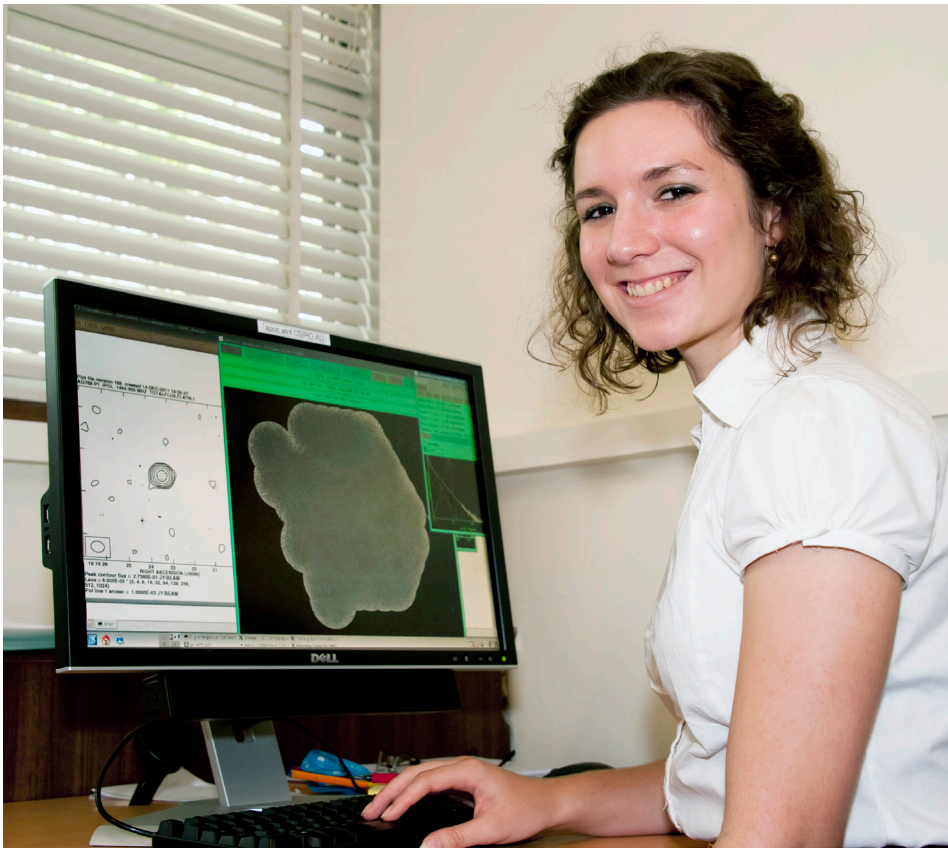
'PULSE@Parkes' sessions saw several schools visit Marsfield during recent months. In a first for the program, a school holiday session was held in January in conjunction with CSIRO Education's Double Helix science club. Double Helix members were treated to a great day of hands-on science and the chance to meet professional astronomers. The success of this event has encouraged the team to plan similar events in the future.

Project Coordinator Rob Hollow also gave an invited talk about PULSE@Parkes and student investigations in radio astronomy at the inaugural IAU Office of Astronomy for Development Stakeholder Meeting in Cape Town, South Africa, in December 2011. His presentation generated a lot of interest and discussion about the potential for school science engagement in the ASKAP and SKA era.

CASS Summer Vacation Program

The CASS Summer Vacation Program 2011–2012 involved nine scholars from Australia and one from New Zealand working on a diverse range of projects under the supervision of CASS staff. One student was based at Parkes, one at Narrabri and the rest in Sydney although some also used other facilities including Tidbinbilla. The students visited the Australia Telescope Compact Array in January to undertake short observing projects of their own choosing.

In early February, the CASS students participated in CSIRO's 'Big Day In' student program at Macquarie University with other summer students from the CSIRO Information Sciences Group. The program concluded with a joint CASS/Australian Astronomical Observatory student symposium held at Marsfield.



Claire-Elise Green, a second-year Advanced Science student from the University of New South Wales, studied active galactic nuclei with CSIRO astronomer Julie Banfield during the CASS Summer Vacation Program. Credit: Chris Taylor.

Operations

DOUGLAS BOCK, PHIL EDWARDS, ERIK LENSSON, JESSICA CHAPMAN, DAVE MCCONNELL AND ETTORE CARRETTI (CASS)

The October 2011 issue of *ATNF News* described the operational changes that are planned beginning with the October 2012 Semester. The main changes are for the Parkes and Mopra radio telescopes.

In recent months, our focus has been on defining future instrumentation for Parkes. In the longer term (2–5 years) we will seek to replace the large suite of current receivers with broadband single-pixel feeds and a low-frequency (1.4-GHz band) phased array feed, eliminating routine receiver changes. New funding is required.

In the interim we will also need to prioritise maintenance, support and compatibility upgrades among the current receivers. A previous report, *ATNF Science Priorities: Science in 2010–2015* (November, 2008), identified the instrumentation expected to be responsible for the highest impact science with Parkes: the HI multibeam and 10/50cm receivers.

At an extraordinary Australia Telescope Users Committee (ATUC) meeting in mid-February, ATUC reviewed options for limiting receiver changes and instrumentation. ATUC recommended that Parkes instrumentation, as far as possible, be determined based on the Time Assignment Committee (TAC) review of proposals. We intend to follow this recommendation. Since it will not be possible to offer every receiver each semester we intend to guide proposers on which receivers are likely to be available, for example to inform planning for student projects. An evaluation of future science with other receivers (by the CASS Astrophysics group) will supplement the TAC outcomes in guiding the scheduling.

Parkes instrumentation will be considered further when ATUC meet in July. In the meantime, users are invited to discuss their needs and ideas with Parkes System Scientist, Ettore Carretti.

We are presently evaluating the expressions of interest to fund or operate Mopra that were received in January. Additional expressions of interest are still welcome. The outcome for Mopra operations from October 2012 will be announced mid-year on the ATNF website.

New ATUC and TAC Chairs

The Australia Telescope Steering Committee has appointed new ATUC and TAC Chairs. The new ATUC Chair, Professor John Dickey (University of Tasmania), commenced his term in January 2012, while the new TAC Chair, Professor Michael Drinkwater (University of Queensland), commenced his term in November 2011. Both appointments are for a three-year period.

April 2012 time assignment

The TAC met over three days in early February to review and grade the 257 proposals received for the 2012 April Semester (2012APRS). The deadline for Mopra proposals was extended by one month, to 16 January, in order to be able to provide proposers with information on the status of Mopra beyond October 2012, and the TAC was able to review these in a timely manner. In addition, an international millimetre expert, Dr John Carpenter (Caltech, USA), attended the TAC for this meeting to provide additional advice on the Mopra proposals. Schedules for the ATCA, Parkes and Mopra were released at the beginning of March, with release notes accompanying the schedules describing instrument availability and plans for maintenance blocks.

As noted in the last *ATNF News*, the proposal deadline time of day has been brought forward to 5pm AEST to ensure that technical support is on hand to deal with any last-minute problems.

Remote observing with Parkes

CASS is working to enable remote and unattended observing on the Parkes telescope under the Remote Access to the Parkes Telescope (RAPT) project, led by Dave McConnell.

Observers have been able to use both Mopra and the Compact Array remotely for many years, but the rules for operation of the Parkes telescope have required at least one observer to be present in the telescope whenever it is in use. This rule has been deemed necessary to protect the telescope from conditions than can only be detected by the human operator. A major component of the remote access project is a telescope protection system. This will integrate a number of existing and new mechanisms to allow detection and response to conditions dangerous to the telescope including adverse weather, power failure and faults in the drive system which at present are usually only detected by observers.

Another challenge for remote observing is the provision of observer support. While at the telescope, local staff can assist observers and often do so by working with them in the telescope's control room. Support can be more difficult if observers and staff are not co-located. RAPT will simplify the user interface to the telescope observing systems to the point that it can be shared remotely on a small number of virtual-desktop screens. RAPT will build on the experience gained with the Mopra online monitoring display (TOAD), and make accessible monitoring and system alarms through specially developed pages in a web browser.

Work on the user interface changes has begun, as has the design and construction of the telescope protection system. In May a new uninterruptible power supply will be installed that will allow stowing of the telescope in the absence of mains power. Most aspects of RAPT will be nearing completion in about September, giving time for testing of the system before general remote access becomes available in 2012 OCTS.

Remote observing will be supported by an ongoing program of power infrastructure renewal at Parkes.

Science Operations Centre

Detailed design of facilities for the ATNF Science Operations Centre at Marsfield has begun. Four control rooms, creative/interaction space, and visitor desks will be accommodated in the 'old Library' and nearby space. Work is scheduled to be complete by 30 June. Accommodation upgrades to improve daytime sleeping are also planned for this year.

Staff notes

There have been several changes to Operations staff in recent months. In particular in December we said farewell to Andrew Hunt who retired after a 40-year career and also said goodbye to Joanne Houldsworth who is leaving Narrabri after many years of service to move to the coast. We wish them both well.

CASS was saddened by the death of Parkes Engineering Operations staff member, Alan Laing, who died from cancer last October. Alan was a popular and highly respected member of staff. He will be remembered by observatory staff for being able to help out at the drop of a hat, having a vast knowledge of things both quirky and useful, and for his sense of humour.

Publications

The following list of publications includes published refereed papers that use ATNF data or are by CASS authors; the list has been compiled following publication of the October 2011 issue of *ATNF News*. Papers that include CASS authors are indicated by an asterisk. Please email any updates or corrections to this list to *Julie.Tesoriero@csiro.au*.

Publication lists for papers that include ATNF data or CASS authors are also available on the ATNF website at *www.atnf.csiro.au/research/publications*.

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CSIRO's Australian Square Kilometre Array Pathfinder Antenna 3 (with phased array feed) at the Murchison Radio-astronomy Observatory, April 2012. Credit: Barry Turner, CSIRO.

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