Astronomy Australia Ltd.

2017/18 ANNUAL REPORT

Astronomy Australia Limited

Vision

Australian-based astronomers will have access to the best astronomical research infrastructure.

Mission

Astronomy Australia Limited (AAL) will achieve its vision by engaging with astronomers in support of the national research infrastructure priorities of the Australian astronomy Decadal Plan, working with relevant infrastructure providers, and advising the Australian Government on the investments necessary to realise those priorities.

Values

AAL is committed to equity and diversity and endeavours to create an environment in which every individual is treated with dignity and respect.

Principles

1. Access to major astronomical research infrastructure should be available to any Australian-based astronomer purely on scientific merit.
2. The concept of national astronomical research infrastructure includes participation in international facilities.
3. AAL recognises the roles of other organisations in Australia that manage components of the national astronomical research infrastructure.

Who we are

AAL is a non-profit organisation whose members are all the Australian universities and research organisations with a significant astronomical research capability. AAL works with Australia's national observatories, relevant infrastructure providers, astronomers at Australian universities, and the Australian Government to advance the infrastructure goals in the Australian Astronomy Decadal Plan 2016–2025, "Australia in the era of global astronomy".

What we do

Since its incorporation in 2007, AAL has coordinated the Australian astronomy response to, and managed the funding for, a number of national schemes and projects, including the Australian Government's investments in astronomy infrastructure through the National Collaborative Research Infrastructure Strategy (NCRIS). AAL-administered funding has enabled construction, instrumentation development, upgrades, maintenance and operations across a portfolio of world-class astronomy facilities and projects. In this era of global astronomy, AAL also plays a key role representing Australia's interests in a number of major international projects and partnerships.

AAL members during 2017/18

Astronomy Australia Ltd.

Australian Government | NCRIS National Research Infrastructure for Australia

Part of the NCRIS network

Australian National University

CSIRO

Curtin University

MACQUARIE University SYDNEY·AUSTRALIA

MONASH University

SWINBURNE UNIVERSITY OF TECHNOLOGY

THE UNIVERSITY OF ADELAIDE AUSTRALIA

THE UNIVERSITY OF MELBOURNE

UNSW THE UNIVERSITY OF NEW SOUTH WALES

THE UNIVERSITY OF QUEENSLAND AUSTRALIA

UNIVERSITY OF SOUTHERN QUEENSLAND

THE UNIVERSITY OF SYDNEY

UTAS

THE UNIVERSITY OF WESTERN AUSTRALIA *Achieve International Excellence*

WESTERN SYDNEY UNIVERSITY

Front cover image: Large-Sized Telescopes (LST)
Image Credit: Cherenkov Telescope Array Observatory.

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A message from THE CHAIR

It is my pleasure to introduce the Astronomy Australia Limited (AAL) Annual Report for the 2017/18 financial year. The report covers a year of great change for Australian astronomy and as you leaf through the pages you will see the key role that AAL played in supporting a smooth transition of the Australian Astronomical Observatory (AAO), whilst keeping the best interests of all areas of Australian astronomy in mind. It has also been a year of growth for AAL, with the opening of a Sydney office, four new staff, and an expansion of AAL's role to include responsibility for a number of international engagements. The science of astronomy also made a great leap forward, with the first observation of gravitational waves from a neutron star merger made by telescopes across the globe on 17 August 2017.

Australia's strategic partnership with the European Southern Observatory (ESO) saw access for Australian astronomers to ESO facilities at La Silla and Paranal beginning in April 2018. Instead of the steady ramp-up in applications and success-rate seen in other countries when joining ESO, Australia's researchers hit the ground running, securing time on the four 8 metre telescopes of the Very Large Telescope (VLT) in ESO's Period 101 allocation at a rate in alignment with our nominal share in the facilities. I am delighted in this success, and it is a real testament to the global competitiveness of Australian astronomy.

The Australian Government's strategic partnership with ESO has required structural change within the Australian astronomical community, with the AAO moving out of the Australian Government Department of Industry, Innovation and Science and into the research sector. AAL played a pivotal role in this transition, both in the establishment of the AAT Consortium which manages and funds operations of the AAT, and in supporting and funding the transition of the previous Sydney-based AAO instrumentation group to Macquarie University, along with the establishment of a national optical instrumentation capability: an unincorporated joint venture between Macquarie, the Australian National University, the University of Sydney and AAL. The AAL Board are actively engaged to support the success of both endeavours, for the benefit of Australian-based astronomers.

The past year has seen AAL's role as a representative of the Australian astronomical community in international projects expand significantly. The ARC Centre of Excellence in All Sky Astrophysics (CAASTRO), signed several international agreements to negotiate access to international astronomical facilities. CAASTRO however, reached the end of its seven year life in 2018. AAL agreed to take responsibility for agreements with the Large Synoptic Survey Telescope (LSST) and eROSITA, and to become the Australian secretariat for the Australia China Consortium for Astrophysical Research (ACAMAR). In addition, AAL became a share holder in the management company of the Cherenkov Telescope Array Observatory (CTAO gGmbH). These four new responsibilities add to AAL's existing role on the Board of founders of the Giant Magellan Telescope. This shift in activities is no more than a reflection of the change foreshadowed in the Astronomy Decadal Plan, namely that we are moving from an era of national astronomical facilities to an age where leading facilities are constructed and operated as international collaborative efforts.

The AAL Board welcomed Professor Len Sciacca as our newest member in November 2017. Len is currently Enterprise Professor – Defence Technologies at the University of Melbourne, after having been Chief of Partnerships and Engagement at the Defence Science and Technology Group. Len brings a wealth of corporate experience and a passion for entrepreneurship that has invigorated our industry engagement program. The Board also offers thanks to Sue Russell, who retired as AAL Company Secretary (and Finance Manager) in February this year. We are fortunate however, to be able to welcome Catherine Andrews to the Company Secretary role.

The May Federal budget included a significant announcement for all the NCRIS capabilities, with funding confirmed to June 2023. The change from one or two year grants, to a grant running for five years, positions AAL to return to medium-term planning for important facilities that are part of the astronomy NCRIS programme.I look forward to a change in the nature of Board discussions in the coming year, as AAL becomes able to take a more strategic view of its investment in astronomy research infrastructure.

Professor Rachel Webster
Chair

SCIENTIFICALLY PRODUCTIVE

269 refereed journal papers were published in 2017/18 from collaborative research projects using AAL-supported facilities. Publication numbers continue to grow as evidence of the increasing scientific output of Astronomy-NCRIS facilities. AAL-funded facilities have produced over 1600 publications since 2008.

A message from THE CEO

The Australian Government's support for a ten-year strategic partnership with ESO, announced in May 2017, was promptly followed with the execution of the Australia-ESO agreement in July 2017. AAL's primary focus during 2017/18 was to support the implementation of the ESO partnership, including the associated changes to the AAO.

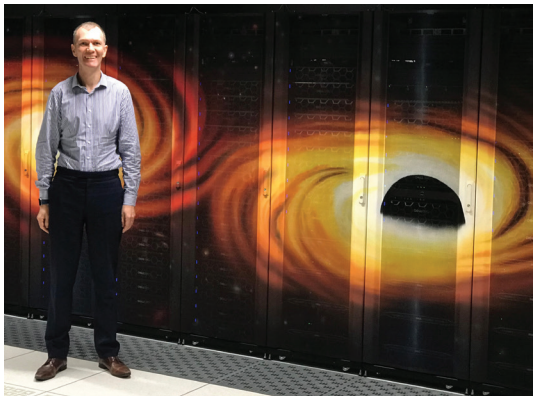
The Australian Government's partnership with ESO, in particular the access to the VLT, achieved the requirement of 30% of the time on an 8 metre-class telescope from semester 2018A. Until then, AAL had been providing access to large optical telescopes via a portfolio involving Gemini, Magellan, Keck and Subaru. AAL worked with those observatories to terminate the Gemini and Keck access at the end of 2017B, and Magellan at the end of 2018B. The arrangements with Subaru involved access to that telescope, reciprocal access to the AAT, and technical collaborations designing potentially new capabilities for Subaru. While the formal AAL-funded Subaru access arrangement will cease at the end of 2018B, I am hopeful that the collaboration with Subaru will continue in some form.

It is important to acknowledge the scientific productivity enabled by those observatories over the years, including more than 650 papers in refereed journals (16 of them in Nature), and more than 20 PhD theses. In addition, countless new collaborations with astronomers at a number of the major international astronomy institutions were established, which would not have been possible if Australia was not in a position to offer or compete for time on these facilities. This has laid a firm foundation for future collaborative use of ESO and the Giant Magellan Telescope (GMT).

The ESO partnership also triggered the closure of the AAO on 30 June 2018, and the transfer of its capabilities to two newly formed consortia. AAL played a key role in the establishment of these new arrangements, and is now actively engaged in the management of both consortia. There were a number of other projects and facilities that AAL worked to advance during the year, details of which are included in this annual report.

To position AAL to successfully undertake its expanded responsibilities, I implemented a number of changes during 2017/18, including opening an office in Sydney, employing four new members of staff, appointing a new audit firm, implementing a new advisory committee structure, and changing a number of internal processes. AAL has also commenced the process of revising its vision and mission statements, to better reflect its role. For a small company which started 2017/18 with approximately four full-time equivalent staff, these were significant changes.

Mark McAuley visits the OzSTAR supercomputer based at Swinburne University of Technology.



AAL has a long standing commitment to equity and diversity; however, like many small organisations AAL does not always have formal written policies to explicitly define those arrangements. Such formal policies can be useful, especially with a slightly larger team across two locations, and the number of people who participate on AAL committees. Therefore in October 2017 AAL introduced a Flexible Working Policy to confirm support for a balance between the work, personal and family needs of all staff members. A Committee Complaints Procedure was also recently introduced to guide committee members on how to report issues or make suggestions without risk or repercussions. AAL will continue to develop policies and seek new opportunities that promote an equitable workplace.

During the year I had to say good-bye to Sue Russell, AAL's Finance Manager and Company Secretary for the previous six years. While AAL prides itself in offering an engaging and supportive work environment, we could not compete with Sue choosing to retire after becoming a grand-mother! Sue was a highly effective member of staff and a pleasure to work with, and I wish Sue well for her future adventures.

Finally, I would like to thank the members of AAL's previous advisory committees for their time, effort and valuable advice over many years. It was also reassuring to review the results of the exit survey which AAL conducted with the members of those committees: 50% of the committee members undertook the survey, and the vast majority of respondents indicated that they were comfortable contributing at AAL committee meetings, felt listened to, and were treated properly and with respect. AAL will endeavour to ensure its science advisory and project oversight committee members feel supported and empowered to express their opinions, which will be critical to help AAL deliver value for Australian-based astronomers.

Mark McAuley
Chief Executive Officer

THE YEAR IN HIGHLIGHTS

European Southern OBSERVATORY

The European Southern Observatory (ESO) operates the world's largest, and most powerful suite of optical/infrared telescopes in Chile from its headquarters near Munich in Germany. From just 5 countries in 1962, ESO has now grown to 15 member states. ESO manages the 3.6 metre telescope and New Technology Telescope at La Silla Observatory; the four 8 metre Unit Telescopes that comprise the Very Large Telescope (VLT) at Paranal Observatory, together with the VLT Interferometer, the 4 metre Visible and Infrared Survey Telescope for Astronomy (VISTA), and the 2.6 metre VLT Survey Telescope (VST); and in partnership with other organisations, the Atacama Pathfinder Experiment (APEX) 12 metre dish and the Atacama Large Millimeter/submillimeter Array (ALMA) on Chajnantor. ESO has commenced construction of the 39 metre European Extremely Large Telescope (E-ELT) on Cerro Armazones, which will be the world's largest optical/infrared telescope when it sees first light in the mid-2020s.

As reported in the 2016/17 AAL Annual Report, the Australian government signed a 10 year Strategic Partnership with ESO, thereby fulfilling one of the key goals of the 2016–2025 Australian Astronomy Decadal Plan. Under this partnership Australian astronomers gain access to the facilities of the La Silla and Paranal Observatories (with the exception of APEX); the opportunity to bid for new instrumentation on the VLT and industry contracts; preferential consideration for ESO Fellowships and Studentships; and ESO sponsorship of scientific meetings and workshops in Australia. As the signatory to the partnership agreement, the federal Department of Industry, Innovation and Science (DIIS) funds and leads the engagement with ESO, while AAL assists and advises DIIS on ESO matters and liaises with the Australian user community.

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Australian appointees to ESO Committees and Council

Under the Strategic Partnership between Australia and ESO, Australia is entitled to representation on four ESO governance bodies: the ESO Council, Finance Committee, Scientific Technical Committee (STC), and Users Committee (UC). On behalf of DIIS, AAL called for nominations from Australian-based astronomers to represent Australia on the STC and the UC. The AAL Board considered and recommended applicants to the DIIS, who in turn presented the ESO Council with three Australian astronomer nominations per committee. The ESO Council then selected one representative for each committee to meet its needs, and ensure adequate coverage of relevant astronomical techniques and disciplines. AAL issued a separate call for nominations from astronomers to serve as an observer on the ESO Council, and made a recommendation to the DIIS who then informed the ESO Council of their chosen designate. The term of appointment for all ESO positions is three years.

The successful candidates were:

- ESO Council: Prof. Matthew Colless (ANU)
- STC: A/Prof. Michael Ireland (ANU)
- UC: Dr Caroline Foster (Sydney University)

Independently, DIIS appointed Deputy Secretary Ms Sue Weston as its representative on the ESO Council, and Chief Financial Officer Mr Brad Medland to the ESO Finance Committee.

ESO Director General visits Australia

A delegation composed of Prof. Xavier Barcons (ESO Director General), Dr Michèle Péron (Director of Engineering), Dr Andreas Kaufer (Director of Operations), and Ms Laura Comendador-Frutos (ESO Cabinet), accompanied by Ms Clare McLaughlin (DIIS) toured Australia in the week of 12 February 2018. The delegation visited Sydney (AAO, Macquarie University), Siding Spring Observatory, Canberra (ANU and DIIS), and Perth (UWA).

ESO User training

ESO held a La Silla Paranal Users Workshop in Garching from 12–14 March 2018. No Australian-based users were able to attend in-person, so the AAO's International Telescopes Support Office (ITSO) coordinated remote participation using video-conferencing. These were recorded and made available to ESO to go on the workshop website.

The 2018 ITSO/AAO Observational Techniques Workshop included 1.5 days devoted to ESO facilities and data reduction tutorials. ESO arranged for Lowell Tacconi-Garman (Deputy Head of the User Support Department), Martino Romaniello (Head of the Back-end Operations Department), and Wolfram Freudling (Head of the Science Data Products Group) to travel to Australia to lead these activities for the benefit of the more than 40 participants.

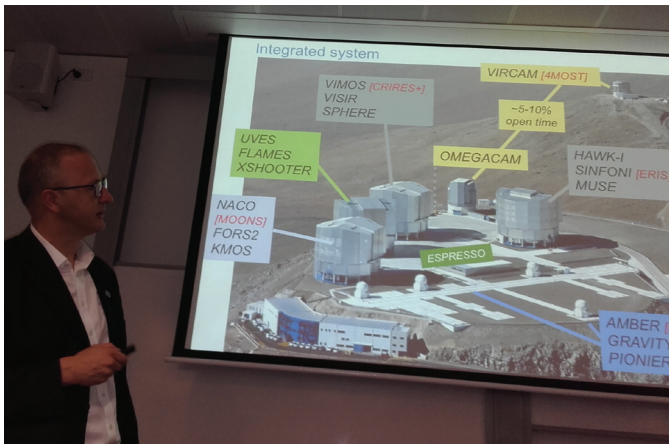
Australian astronomers spectacularly successful in first round of ESO proposals

With the signing of the 10 year Strategic Partnership between ESO and the Australian government on 11 July 2017, Australian-based astronomers became eligible to apply for observing time with the facilities of ESO's La Silla Paranal Observatory beginning with Period 101 (April–Sep. 2018). In the lead-up to the proposal deadline of 28 September 2017, the ITSO's Dr Stuart Ryder accompanied ESO staff on a series of "Community Days" around Australia to promote the new opportunities enabled by the Strategic Partnership. ESO's Director for Science Dr Rob Ivison, and the Head of the Observing Programs Office at ESO Dr Ferdinando Patat, provided a comprehensive overview of the current and future observing facilities available, as well as the proposal preparation, submission, and assessment process.

In Period 101 a total of 55 proposals were submitted by Australian-based Principal Investigators (6.1% of all proposals received), requesting a total of 79 observing runs using particular telescope/instrument combinations to suit each proposal's science case. A total of 163 astronomers from 11 AAL member institutions were involved as PIs or Co-Investigators on ESO proposals. ESO convened their Observing Programmes Committee (OPC) consisting of multiple panels spanning 4 science categories to make recommendations on which proposals should be allocated time in either service mode (a queue-based system for execution) or visitor mode (where the PI travels to the observatory in Chile on designated nights to perform the observations themselves).

Typically, a new ESO member will take several Periods to ramp up to a share of observing time on the showcase Very Large Telescope (VLT consisting of 4 × 8 metre telescopes), which then tends to stabilize at a level roughly proportional to the member's GDP. In Australia's case that would equate to 7.5%, so it is truly remarkable that Australian-led proposals were allocated 8.1% of VLT time in their very first Period. This equates to over 400 hours of VLT observing time, more than 1/3 of it in Visitor Mode that enables researchers (including students) to experience first-hand the powerful facilities and spectacular site conditions that ESO offers.

ESO Director for Science Rob Ivison presents the extensive range of instrumentation available at the Paranal Observatory.
Image Credit: Stuart Ryder/AAL.



The 4 sodium laser guide stars that make up the Adaptive Optics Facility on UT4 of ESO's Very Large Telescope at the Paranal Observatory.
Image Credit: Dilyar Barat/ANU.

Transition of the capabilities of the AUSTRALIAN ASTRONOMICAL OBSERVATORY

In the May 2017 Federal Budget, the Australian Government announced their "Maintaining Australia's Optical Astronomy Capability" measure. Other than the 10 year strategic partnership with ESO, the measure also included significant changes to domestic optical astronomy institutional structure in Australia.

The capability of the Australian Astronomical Observatory (AAO), previously a division of the Australian Government's Department of Industry, Innovation and Science, has been transferred to the Australian University sector as of the 1 July 2018. AAL has played a pivotal role in the establishment of new arrangements for both the operations of the Anglo-Australian Telescope (AAT) and the transfer of the previous AAO instrumentation group to Macquarie University and the establishment of coordinated national capability in optical instrumentation: the new Australian Astronomical Optics.

Operations of the Anglo-Australian Telescope

Located at the Siding Spring Observatory, the 3.9 metre AAT is Australia's largest optical telescope. It has been fundamental to Australian optical astronomy over the past 40 years, and a suite of world-class instruments will continue to see it undertaking competitive science in the coming years.

The AAT was operated by the AAO until the end of June 2018, when funding and oversight of its operations passed to thirteen Australian universities forming the AAT Consortium. The AAT Consortium will be governed by the AAT Council, with representation from all of the contributing university partners. AAL will act as Manager of the Consortium, with the telescope to be operated by the Australian National University.

Open access to the AAT continues to be available to all Australian-based astronomers.

The AAT Consortium includes: The Australian National University (operator), The University of New South Wales, The University of Sydney, Macquarie University, Western Sydney University, The University of Melbourne, Swinburne University of Technology, Monash University, The University of Queensland, The University of Southern Queensland, Curtin University, The University of Tasmania and The University of Western Australia, with AAL as Consortium Manager.

Inside the dome of the AAT.
Image credit: Ángel R. López Sánchez

The AAT at night.
Image credit: James Gilbert

Australian Astronomical Optics

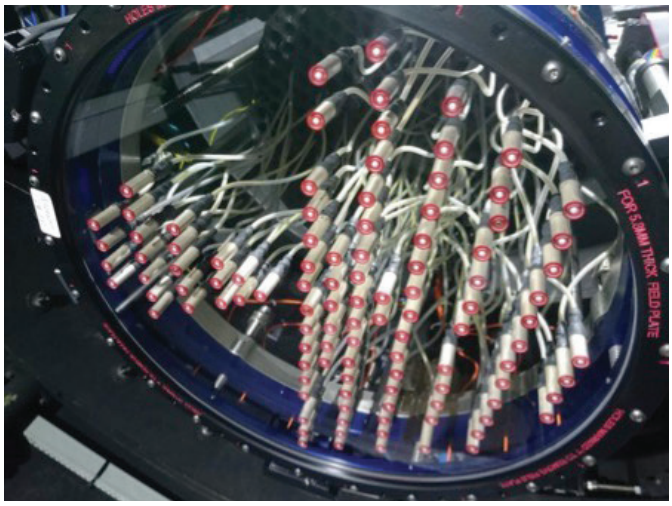
The AAO had a long history of excellence in optical astronomy instrumentation. In 45 years of operation the group developed and built over forty precision astronomical instruments, including for many of the world's largest telescopes. The group specialized in fibre optics and positioning systems; designing and building instruments that make simultaneous observation of hundreds of astronomical objects. This massively increases the productivity and flexibility of telescopes, enabling astronomers to undertake large and comprehensive spectroscopic galaxy and stellar surveys.

An example of innovative instrumentation developed at the AAO is the Starbugs fibre positioning technology, initially designed for the TAIPAN survey. TAIPAN is a multi-object spectroscopic galaxy survey that started observations in early 2018. It will be the most comprehensive spectroscopic survey of the southern hemisphere ever undertaken, by obtaining spectra for over 1 million galaxies in the local Universe over 4 years. The Starbugs enable parallel repositioning of 150 fibres at once.

The AAO instrumentation capability transferred to Macquarie University from the 1 July 2018, operating as AAO-Macquarie. The acquisition complements Macquarie's existing expertise in lasers and photonics, optical micro- and nano-fabrication and optical sensing technologies.

In addition, AAO-Macquarie, the Australian National University (AAO-Stromlo) and the University of Sydney (AAO-USydney) have partnered with AAL to form Australian Astronomical Optics – a collaborative national capability in optical instrumentation. The combined, complementary capabilities of the three largest Australian instrumentation groups will strengthen Australia's ability to bid and deliver on large and complex international contracts at leading observatories world-wide. AAL will support the new Australian Astronomical Optics through a $20 million commitment of astronomy NCRIS funds over an initial 4 years.

A close-up of over 100 Starbugs inside the TAIPAN instrument.
Image Credit: David Brown/AAO.



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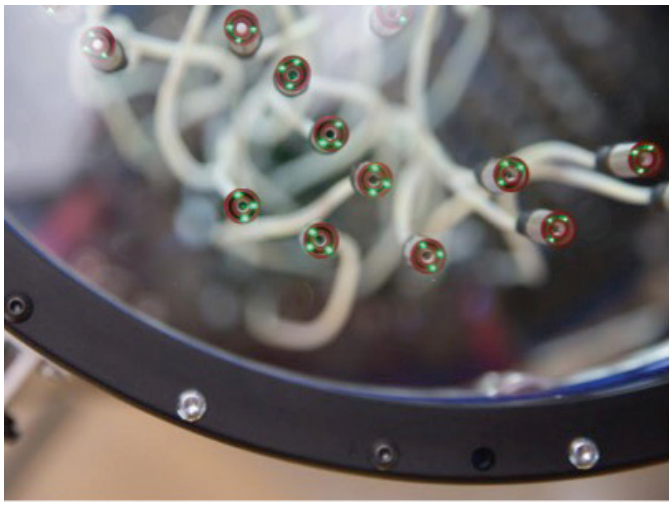
Starbugs deployed inside the TAIPAN instrument, showing the metrology fibres.
Image Credit: Andy Green/AAO.



8 Metre-class TELESCOPES

Over the past decade NCRIS funding and supplemental government grants have helped ensure Australian astronomers have competitive and collaborative access to each of the Gemini, Magellan, Keck, and Subaru telescopes. AAL has backed up this access with observer travel funding to enable successful applicants (and their students) to travel to the telescopes to make observations when required, even though queue mode and remote observing are now common on some of these telescopes.

A total of 91 Australian-based astronomers (including students) from 10 AAL member institutions used these telescopes in 2017/18. More than 80% of programs included international collaborators, and almost half involved more than one AAL member institution. The overall subscription rate for these telescopes averaged 270%, but on occasion exceeded 400%. In total 136 refereed publications from these observatories included 1 or more Australian authors.

Gemini Telescopes

The Gemini Observatory operates two nearly identical 8 metre telescopes on Mauna Kea in Hawaii, and on Cerro Pachon in Chile. It is operated by Associated Universities for Research in Astronomy (AURA) on behalf of an international partnership consisting of the USA, Canada, Argentina, Brazil, and Chile. Australia was a member of the Gemini partnership from 1998–2015, and retained a "limited term" partnership in 2016 and 2017 providing 7 nights per year of "classical" (i.e. non-queue) observing. Although Australian access to the Gemini telescopes has now ended, Australian engagement with Gemini continues through a number of ongoing technology projects, including ANU's development of a new wavefront sensor system for the Gemini Multi-conjugate Adaptive Optics system; and AAO's leadership of the Gemini High-resolution Optical SpecTrograph (GHOST) project, in partnership with ANU and NRC-Herzberg in Canada.

Magellan Telescopes

The Carnegie Institution for Science operates the twin 6.5 metre Magellan telescopes at Las Campanas Observatory in Chile, on behalf of a number of US universities and research institutions. The Magellan telescopes offer wide-field and high spectral resolution optical and infrared instrumentation not available on the Gemini telescopes. Since 2007 AAL has secured 15 nights per year of classical observing on the Magellan telescopes, and although this access was slated to continue through to 2020, Australian access to ESO from 2018 led AAL to terminate Magellan access at the end of 2018 by mutual agreement with Carnegie. Australia's involvement with Magellan has resulted in over 200 refereed publications with at least 1 Australian-based author, and helped establish collaborations with Magellan partner instititutions, many of which are also partners in the GMT.

Keck Telescopes

The W. M. Keck Observatory (WMKO) in Hawaii operates the twin 10 metre Keck segmented mirror telescopes on Mauna Kea on behalf of Caltech and the University of California. For several years Swinburne University of Technology (SUT) has had 15 nights per year on the Keck telescopes through a collaborative agreement with Caltech, and more recently ANU has secured a similar amount through WMKO. In 2016 and 2017 AAL purchased a further 15 nights per year in conjunction with ANU's access, bringing Australia's collective total Keck access to 45 nights per year in each of 2016 and 2017. SUT, ANU, and AAL agreed to pool these nights for maximum impact, with the time to be awarded by a joint Keck Time Allocation Committee (KTAC) with representatives from each organisation. Although AAL's contribution of nights to the KTAC pool came to an end after Semester 2017B, both SUT and ANU felt the KTAC process had been so successful in enhancing collaboration and improving scheduling flexibility that they agreed to retain it for Semester 2018A.

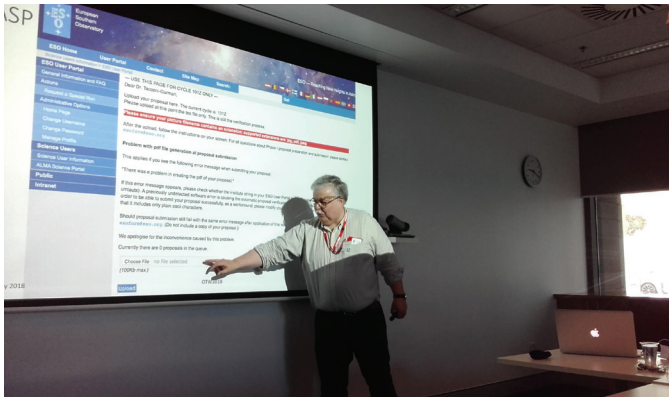
Subaru Telescope

The National Astronomical Observatory of Japan (NAOJ) operates the 8.2 metre Subaru telescope on Mauna Kea in Hawaii. AAL negotiated 10 nights of access to the Subaru telescope in 2018, as part of a joint program which includes technical contributions by ANU and AAO and access to the AAT for Japanese astronomers. Under this arrangement the Australian proposals would be ranked by Subaru's own time assignment committee, with input from the ATAC Chair during the meeting to convey ATAC's view on the relative merits of each. After Australia's guaranteed allocation of 5 nights per semester was exhausted, any Australian-led proposals still above the cutoff for scheduling would receive Open Time, and in fact for Semester 2018A a total of 7 nights were awarded to Australian proposals.

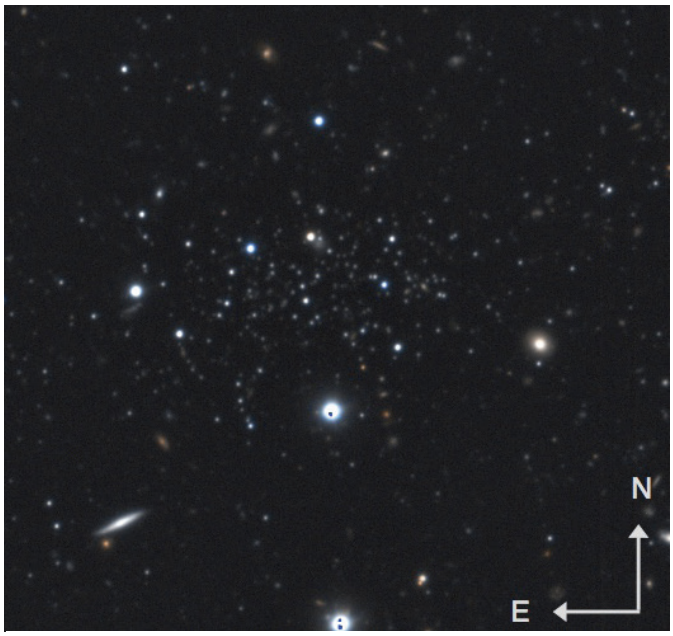
8 METRE TELESCOPES: KECK, SUBARU, MAGELLAN, GEMINI.

A total of 91 Australian-based astronomers (including students) from 10 AAL member institutions used AAL funded 8 metre-class telescopes in 2017/18. More than 80% of programs included international collaborators, and almost half involved more than one AAL member institution. The overall subscription rate for these telescopes averaged 270%, but on occasion exceeded 400%. In total 136 refereed publications were produced in 2017/18 with a combined total of 650 publications in the last decade.

Dr Lowell Tacconi-Garman, Deputy Head of the ESO User Support Department, demonstrates to participants at the 2018 ITSO Observational Techniques Workshop how to submit ESO observing proposals.
Image Credit: Stuart Ryder/AAL.



Gemini GMOS colour image of the ultra-faint dwarf galaxy candidate DES1, the small overdensity of stars in the centre of this field. Conn et al. (2018) find DES1 and similar overdensities to be more similar to loose stellar clusters than to dwarf galaxies.
Image Credit: Gemini Observatory/AURA.



International Telescopes Support Office

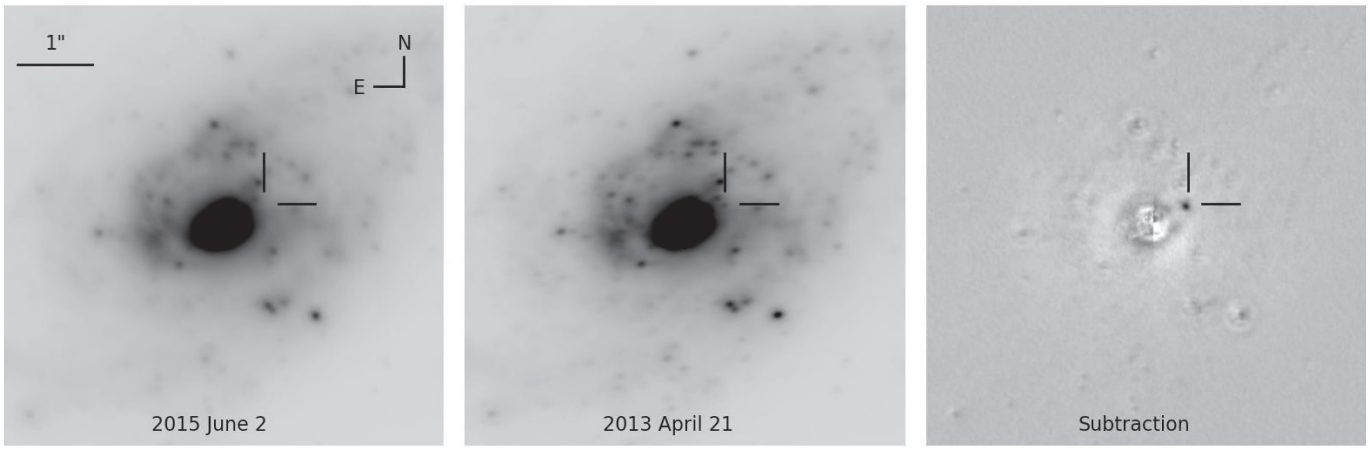
Australia's usage of these offshore telescopes was coordinated by the AAO's International Telescopes Support Office (ITSO) under contract to AAL. This includes distributing calls for proposals; technical assessment and scheduling of proposals on behalf of ATAC; arranging reimbursement of observer travel; workshops and symposia; and public outreach via social media. ITSO also manages the 10 nights per year on the Blanco 4 metre telescope in Chile, which comes about via a time exchange agreement between the AAO and the US National Optical Astronomy Observatories. In 2017/18 ITSO organised the 2018 ITSO/AAO Observational Techniques Workshop, and commenced supporting the ESO engagement through a series of ESO Community Days, as well as providing a detailed breakdown of community demand for, and success in being awarded ESO time to stakeholders including DIIS and AAL member institutions.

Science Highlights

Using observations with GMOS-S on Gemini, Blair Conn (ANU) and colleagues found that three ultra-faint dwarf galaxy candidates (DES1, Eridanus III, and Tucana V) appear in fact to be loose clusters of stars, and not dwarf galaxies (Conn et al. 2018, ApJ, 852,68). A complete census of true Milky Way satellite galaxies is important for testing theories of dark matter as well as the origin of our Milky Way galaxy.

AAO and Macquarie University PhD student Erik Kool discovered and analysed 3 supernovae (+1 candidate) in Luminous Infrared Galaxies using GeMS+GSAOI on Gemini South (Kool et al. 2018, MNRAS, 473, 5641). None of these supernovae were picked up by wide-field optical supernova surveys due to dust obscuration and spatial resolution limitations within their host galaxies. Measuring the total supernova rate in galaxies is the only direct way to confirm estimates for their star formation rates, so accounting for these "missed" supernovae is crucial.

Below: Infrared images of the Luminous Infrared Galaxy IRAS 18293-3413 obtained with the Gemini Multi-conjugate Adaptive Optics system (GeMS) and Gemini South Adaptive Optics Imager (GSAOI) in June 2015 (left) and April 2015 (centre). Careful alignment and subtraction of the 2015 image from the 2013 image reveals Supernova 2013if (right), which is not readily apparent in either image. Figure from Kool et al. (2018).
Image Credit: Erik Kool, AAO/Macquarie University.



FACILITY HIGHLIGHTS

ASKAP

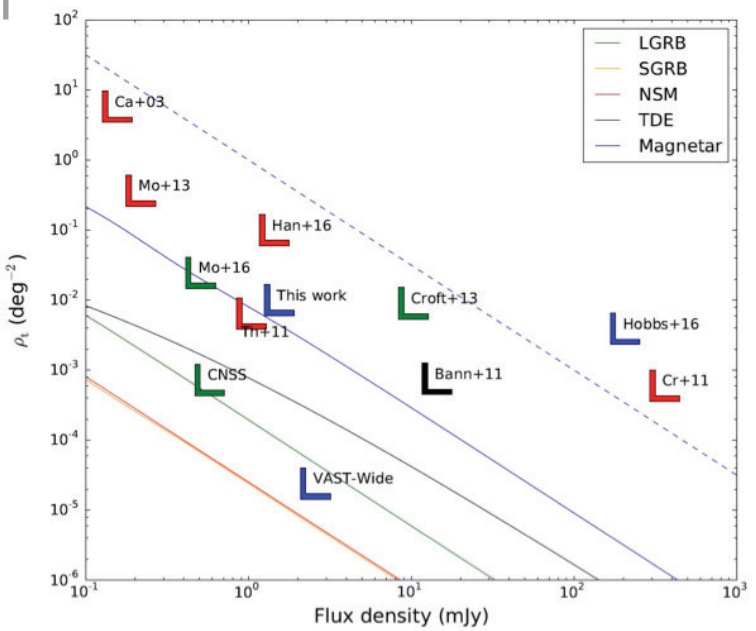
Explosions and flares, pulses and twinkles, come and go in the Universe. Individual cases can tell us about the physics involved. But we also want to know how frequently various kinds of events occur, to understand the role they play in shaping their host galaxies – how much energy they transfer, for instance.

A team led by Shivani Bhandari (Swinburne University of Technology/CSIRO) has undertaken a pilot search for variable and transient sources at 1.4 GHz with CSIRO's powerful new radio telescope, the Australian Square Kilometre Array Pathfinder (ASKAP). Until now, few radio surveys have been able to regularly monitor large areas of sky with great sensitivity. But because of its large field of view ASKAP is well placed to do this. ASKAP will carry out two large surveys for transients and variables: CRAFT (Commensal Real-time ASKAP Fast Transients) and VAST (Variables and Slow Transients). CRAFT is designed to find phenomena that change on short timescales (up to a few seconds) while VAST will pick up changes over longer periods of hours or days.

Because of the volumes of data involved in these surveys detecting these transients requires a real 'paradigm shift' in the way astronomers analyse their data. No longer can they afford to examine the data by eye – automated processing pipelines are required. The pilot study is important work in laying the foundations for the full VAST survey to commence in 2019.

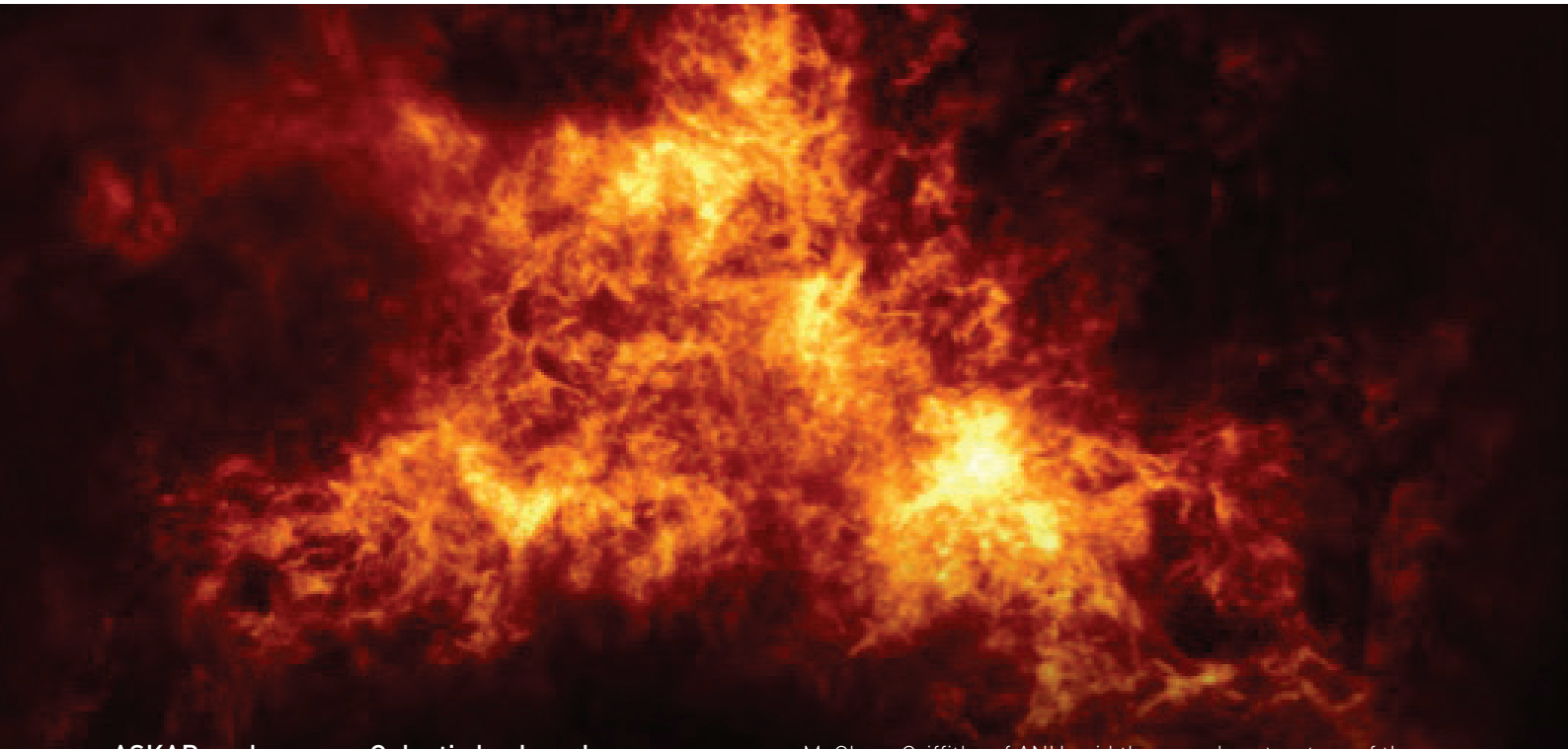
Shivani and her collaborators carried out a pilot survey for VAST, observing at 1.4 GHz. Using data taken with 12 ASKAP dishes as part of the ASKAP Early Science program, they searched a 30 deg^2 area centred on the galaxy group NGC 7232. In total they found 1,653 radio sources brighter than 1.5mJy in all 8 epochs of observing, of which the VAST processing pipeline identified 52 as potentially variable. Closer inspection reduced this number to 9. Follow-up observations on the Australia Telescope Compact Array indicate most of these sources are 'twinkling' – scintillating due to the interstellar medium – but the source J220833–453600 showed long-term change: it had strengthened dramatically since 2003, when it was recorded in the SUMSS (Sydney University Molonglo Sky Survey) catalogue of radio sources. This change appears to be intrinsic to the AGN. More importantly, it has tested the processing pipeline which once in full swing will be handling hundreds of "snapshot" images per day.

ASKAP dishes in "fly's eye" mode hunting for Fast Radio Bursts, under the Milky Way.
Image Credit: Alex Cherney / CSIRO



Left: Limits on the surface density of transient radio sources, from current and planned surveys performed at 1.4 GHz (red), 3 GHz (green), and 843 MHz (black). Blue symbols indicate ASKAP surveys: the pilot survey discussed in the text; a survey by Hobbs et al. 2016 at 863.5 MHz; and VAST-Wide which will be the most sensitive yet undertaken. The dashed blue line shows the relation for a Euclidean source population. Other lines show the upper limits for models of neutron star mergers, magnetars, long and short gamma-ray bursts and tidal disruption events. The lines for neutron star mergers and short gamma-ray bursts coincide (Metzger et al. 2015).
Image Credit: Shivani Bhandari

Below: Image of neutral Hydrogen in the Small Magellanic Cloud combining a new ASKAP image with Parkes images.
Image Credit: Naomi McClure-Griffiths



ASKAP explores our Galactic backyard

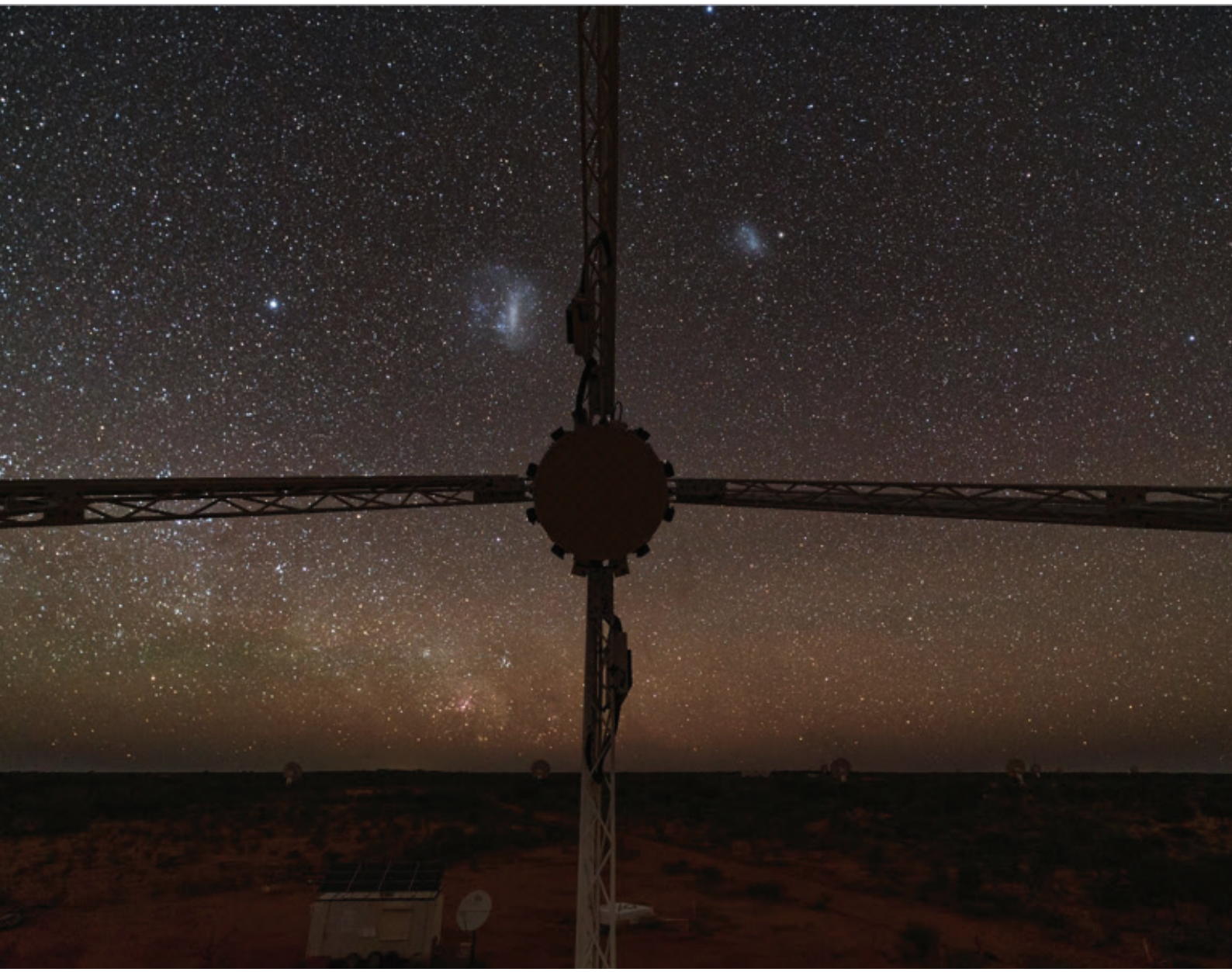
Astronomers at ANU have created the most detailed radio image of one of the Milky Ways' nearest neighbours, the Small Magellanic Cloud, giving insights into how it formed and how it is likely to evolve. This stunning image, taken with ASKAP, is a perfect demonstration of the wide field capability, and augurs well for the telescope's full operation in 2019.

The Small Magellanic Cloud is tiny compared to our own Milky Way but easily visible to the naked eye in the southern sky. The new ASKAP image reveals features three times smaller than have been seen in previous radio images, allowing astronomers to probe the detailed interaction between the galaxy and its environment. Team member Professor Naomi McClure-Griffiths of ANU said the complex structure of the dwarf galaxy likely resulted, in part, from interactions with its companion, the Large Magellanic Cloud, and the Milky Way. "The outlook for this dwarf galaxy is not good, as it's likely to eventually be gobbled up by our Milky Way" she said.

The Small Magellanic Cloud has been studied extensively in the past few years by infrared telescopes such as NASA's Spitzer Space Telescope and ESA's Herschel telescope, which study the dust and stars within the galaxy. Dr McClure-Griffiths says that the ASKAP radio image has finally reached the same level of detail as those infrared images, but on a very different component of the galaxy's make-up: its hydrogen gas, which is the fundamental building block of all galaxies."

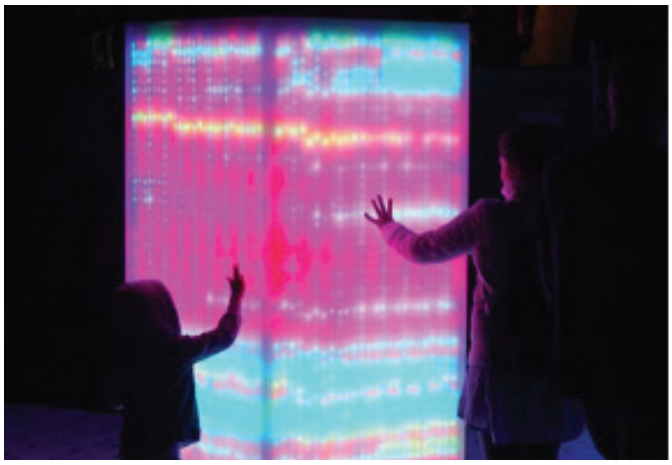
Left: Postdoctoral astronomer Shivani Bhandari (left) with Jocelyn Bell Burner (right), the discoverer of pulsars.
Image Credit: CSIRO

Below: View of the ASKAP Phased Array Feed (PAF) receiver seen from the dish surface, with the Magellanic Clouds as a backdrop.
Image Credit: Alex Cherney / CSIRO



ASKAP electronics technician James Hanna and students from the Pia Wadjarri Remote Community School in the workshop at the Murchison Radio Observatory (MRO) control building.
Image Credit: Rob Hollow.

RFI expert Balthasar Indermuehle and partner Aly made science into art at Vivid Sydney in June 2017. Their interactive display Connections visualises the RFI from the mobile phones of passer's by.
Image Credit: Balthasar Indermuehle.



On 21 November 2017 the very last receiver was installed on ASKAP – meaning each of the 36 antennas now bears a second generation phased array feed.
Image Credit: Brett Hiscock.

CSIRO maintains a close relationship with the traditional owners of the MRO, the Wadjarri Yamatji. As part of the MRO Indigenous Land Use Agreement, students from the Pia Wadjarri Remote Community School get to visit the observatory.
Image Credit: Rob Hollow.

CSIRO Engineer Mia Baquiran debugs ASKAP digital signal processing equipment.
Image Credit: Wheeler Studios.

Elvis at the Dish is a popular part of the annual Parkes Elvis Festival.
Image Credit: John Sarkissian.

MWA Phase II EXPANSION

The completion of works to make the Murchison Widefield Array (MWA) telescope ten times more powerful was officially celebrated at Curtin University on 23 April 2018. The expansion, called 'Phase II', doubled the number of antennas used by the radio telescope, which is situated at CSIRO's Murchison Radio-astronomy Observatory on the traditional lands of the Wadjarri Yamatji people.

The Phase II rollout began in mid-2016 with the deployment of 1,152 antennas, arranged in a regular hexagonal configuration that became operational in October that year. The remainder of the rollout – 896 additional antennas at much further distances – began at the start of 2017, with industry partners and MWA staff joining forces to lay each antenna by hand between July and October.

The Phase II launch was attended by Federal Minister for Jobs and Innovation, the Hon Michaelia Cash and Parliamentary Secretary Chris Tallentre representing WA Minister for Innovation and ICT, the Hon Dave Kelly. The event included a live feed to MWA Operations team members on-site at one of the new antenna groups, who explained how they had 'hacked' into the array's network to attend the launch, without compromising the radio quiet environment of the observatory.

The telescope's improved capabilities were revealed with side-by-side comparison images taken by the array, and the increase in potential science cases and radio astronomy research outputs were discussed in presentations by the MWA Director and the executive lead of the Curtin Institute of Radio Astronomy.

From left to right: Operations team members Kim Steele, Mia Walker and Luke Horsley, watching the live feed of the launch event from the middle of a long baseline tile.
Image Credit: Brett Hiscock/CSIRO

MWA Director, Melanie Johnston-Hollitt, speaks to three Operations team members who attended the launch remotely from a long baseline tile at the MRO.
Image Credit: Curtin University

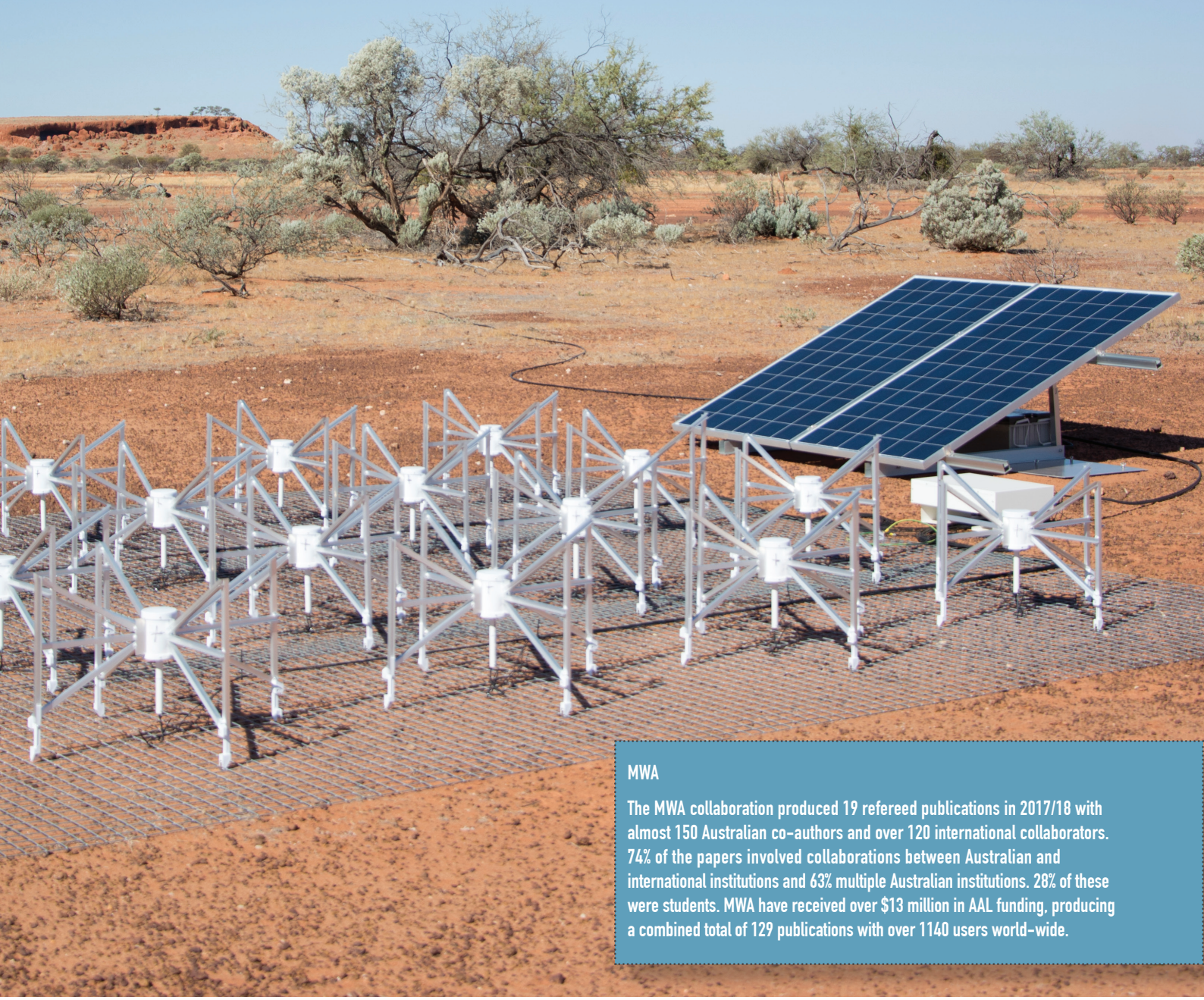
MWA used in gravitational wave investigation

On 17 August 2017, LIGO detectors picked up on a small ripple in space-time, the fifth example of gravitational waves recorded in history. This signal was followed up immediately with observations from over 50 telescopes around the world, causing its origin to be observed for the first time: the merger of two neutron stars. The MWA responded automatically to the detection and its data was used in conjunction with other Australian facilities to confirm that there was no radio source from the merger detected down to 40μJy. This result was published in the PASA as 'Follow up of GW170817 and its electromagnetic counterpart by Australian-led observing programs', Andreoni et al, 16 October 2017.

MWA observes interstellar visitor

MWA data has been used in the Breakthrough Listen initiative, a large-scale SETI research program, to observe the interstellar asteroid 'Oumuamua as it flew towards the Sun in early December 2017.

No artificial signals were detected from the object; instead, the search highlighted the ease of conducting SETI experiments using interferometers such as the MWA (and in future, the SKA). More can be found in "A Serendipitous MWA Search for Narrowband Signals from 'Oumuamua", Tingay et al. (2018).



MWA

The MWA collaboration produced 19 refereed publications in 2017/18 with almost 150 Australian co-authors and over 120 international collaborators. 74% of the papers involved collaborations between Australian and international institutions and 63% multiple Australian institutions. 28% of these were students. MWA have received over $13 million in AAL funding, producing a combined total of 129 publications with over 1140 users world-wide.

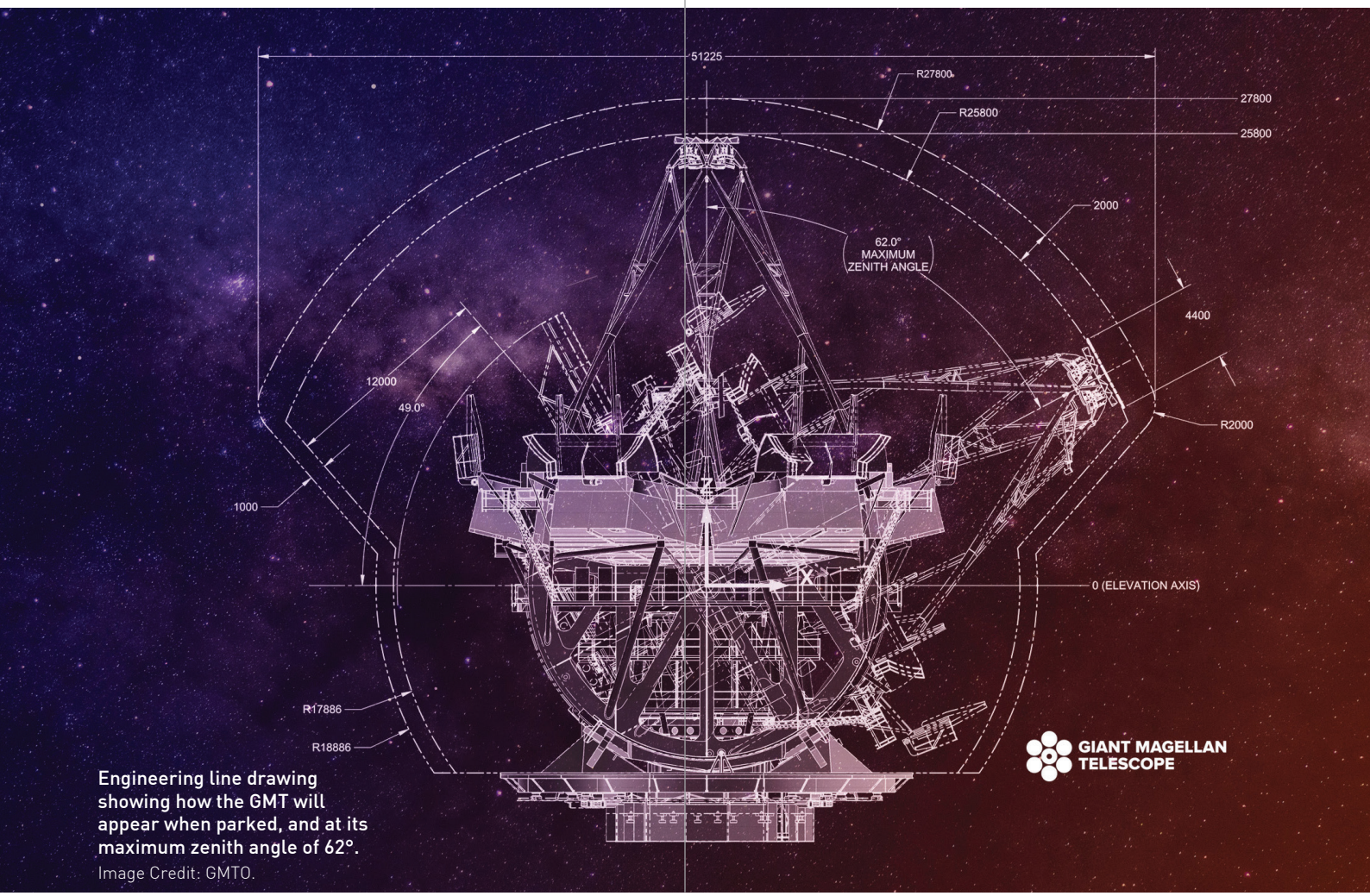
Giant Magellan TELESCOPE

The GMT is a next generation optical and infrared ground-based telescope that promises to revolutionise our view and understanding of the Universe. It will be situated at Las Campanas Observatory in Chile, which is owned by the Carnegie Institution for Science. Perched at an elevation of over 2,400 m (8,000 ft) in the Andes mountain range, the site is known for clear weather, excellent image quality, and dark skies.

The GMT's unique design uses seven segmented 8.4 metre mirrors that will form a single optical surface of 24.5 metres in diameter, enabling it to resolve detail 10 times sharper than the Hubble Space Telescope. First light and commissioning for the telescope is expected by 2024. The GMT will be critical in enabling Australian-based astronomers to tackle many of the key science questions identified in the 2016–2025 Decadal Plan for Australian astronomy. Australian contributions to the GMT project include GMTIFS, a near-IR imager and integral-field spectrograph, together with the Laser Tomography Adaptive Optics facility (both under development at the ANU's Advanced Instrumentation and Technology Centre); and MANIFEST, a multi-object fibre positioner system that builds upon the AAO's Starbugs technology developed for TAIPAN on the UKST.

The GMT Organisation

The GMT Organisation (GMTO) is an independent organisation created by an international consortium of leading academic and research institutions, with the mission of funding, engineering, constructing and operating one of the world's largest optical telescopes. Australia is a 10% partner in the GMT, via the ANU and AAL, which are both 5% partners. The Australian Government has invested ~$93 million of Commonwealth funding in the billion-dollar GMT project, which has positioned Australia to play a leadership role in GMT science and instrumentation. During 2017/18, AAL funding supported continued engagement in GMT governance, including representation on the GMTO Board and the GMT Science Advisory Committee.



Engineering line drawing showing how the GMT will appear when parked, and at its maximum zenith angle of 62°.
Image Credit: GMTO.

Progress and highlights

- The first of GMT's seven primary mirror segments has been moved out of the Richard F. Caris Mirror Lab at the University of Arizona into a temporary storage facility near the Tucson International Airport, as the first step on its journey towards its ultimate destination at the GMT site in Chile. Casting of the 5th mirror segment occurred on 4 November 2017, and after several months of careful cooling the mirror was removed from the furnace in February 2018.
- The fifth annual GMT Community Science Meeting was held from 17–20 September 2017 at Tarrytown, New York. The meeting focused on the chemical evolution of the Universe and was attended by an international group of 90 astronomers, from graduate students to faculty, including 6 from Australia.
- Incoming GMTO President Robert Shelton visited Australia in September 2017. AAL organised for him to meet with a range of Australian stakeholders, including the then Minister for Industry, Innovation and Science, Senator the Hon. Arthur Sinodinos. He also toured the ANU's AITC, Sydney University SAIL labs, the AAO labs at North Ryde, and Siding Spring Observatory.
- Arizona State University (ASU) became the 12th GMTO partner in November 2017. ASU's School of Earth and Space Exploration brings to the partnership particular expertise in exoplanets as well as science with the James Webb Space Telescope.
- Two companies have been selected to work with GMTO to advance the design of the 1,000 tonne mount for GMT. Spanish company IDOM and German company MT Mechatronics have extensive experience with observatory and other large-scale engineering projects. The two teams will produce firm fixed price proposals for the final mount design and build, after which a competitive down-select will occur for the final design, fabrication and site installation in Chile.

GMT primary mirror segment 1 on the back of the transporter on its way from the Richard F. Caris Mirror Lab to Tucson Airport.
Image Credit: Damien Jemison/GMTO

ANU PhD student Anshu Gupta presents her research at the 5th GMT Community Science Meeting in New York.
Image Credit: Damien Jemison/GMTO.

AAT Fibre UPGRADE

An optical fibre conduit system feeds light collected from the Anglo-Australian Telescope (AAT) to its spectrographs. Deployment of the telescope's Two-Degree Field (2dF) robotic fibre positioner with either the dual channel AAOmega or quad channel HERMES spectrograph is a very common instrument configuration. The former unwieldy, unstable fibre conduit and furcation system has now been upgraded to promote smooth operation of the telescope for the coming years.

Monolithic Fibre Cable System

The former AAT optical conduit system ran the HERMES / AAOmega dual fibre cable (800 fibre pairs) down a single common conduit. This massive, single-legged system was problematic for two reasons:

- During extended operations, friction between the conduit and furcation tubes would cause bunching, risking fibre exposure and damage.
- It was difficult for staff to take it on and off the telescope without subjecting it to handling accelerations potentially damaging to fibres.

Redesigned Fibre Cable System

Multi-Conduit System

This upgrade project saw design and installation of a new fibre cable system featuring three conduits. Internal components were refurbished, furcation tubes untangled, and broken fibres and split furcation tubes repaired. The multi-conduit system reduces the risk of near- term fibre breakage compromising the AAT.

HERMES Slit Legs

The project also saw replacement of the slit leg conduit for the HERMES spectrograph. This conduit had proved insufficiently robust for past telescope operations, and was thus replaced during this upgrade project.

Supporting Optical Components

Deficient or deteriorating optical components at the 2dF end of the fibre cable, and within the fibre assembly, were also replaced during the system upgrade.

The upgrade project was completed in mid-2018. The new optical fibre cable system, 2dF, and the two spectrographs have all since returned to service.

AAT Fibre Upgrade. The new fibre cable legs being rewound onto the 2dF cable drums.
Image Credit: Mick Edgar/AAO.

Installation of the new fibre feed system on the AAT. The three black conduits replace the former single, overloaded conduit that threatened fibre breakage. This project was an initiative of the Australian Government conducted as part of the NCRIS and administered by AAL.
Image Credit: Mick Edgar/AAO.

PLATO

The long-running PLATO-A (plateau observatory) project at Antarctica's remote Dome A finally powered down in 2018. Deployed in 2012, PLATO-A has validated PLATO technology as a reliable platform for providing power to, and logging data from, isolated telescopes. An exemplar of a successful scientific collaboration between Australia and China, this project provided long-term operational support for the AST3 series of unmanned 0.5 metre optical telescopes.

Remote Observatory Support System

The AAL-supported (via CRIS and NCRIS) PLATO-A facility housed a diesel generator, providing critical site power in the freezing Antarctic conditions. Third party renewables (both wind and solar) provided supplementary power supply, though not to the level of reliability of PLATO-A. The PLATO-A enclosure also housed a data logging computer for the site telescopes, connected to the outside world via an Iridium satellite system. The supervisory computer systems of PLATO-A were similarly reliable, exhibiting flawless on-site uptime, and indeed facilitating remote restoration to service of unresponsive secondary (non-PLATO) site instrument computers.

The power and computing robustness of the PLATO platform was critical to the site. Antarctic traversal missions were executed by project partners from the Polar Research Institute of China (PRIC), wherein the platform was re-supplied with fuel, site maintenance performed, and data disks collected. These arduous Antarctic traversals were practical at most annually, during the relatively benign conditions of the Antarctic summer. Infrastructure failures could thus have left the site telescopes idling for many months.

One of a select set of robotic PLATOs deployed to isolated Antarctic sites, PLATO-A was the product of a significant collaboration between Australian and Chinese stakeholders comprising the Australian Antarctic Division, Australian Astronomical Observatory, Australian Research Council, Macquarie University, National Astronomical Observatory of the Chinese Academy of Sciences, Nanjing Institute of Astronomical Optics and Technology, Purple Mountain Observatory, PRIC, University of New South Wales and of course, AAL.

During the constant darkness of the Antarctic winter, the AST3 telescopes are well suited to fast-response time-domain astronomy. They were amongst the first to take follow-up imaging of the 2017 gravitational wave event GW 170817 generated by merging binary neutron stars. Shown here is i-band imaging of the GW source in the nearby galaxy NGC 4993 at 24.51, 25.58 and 26.32 hours after the LIGO trigger (Hu et al., 2017, Science Bulletin, 62, 21).

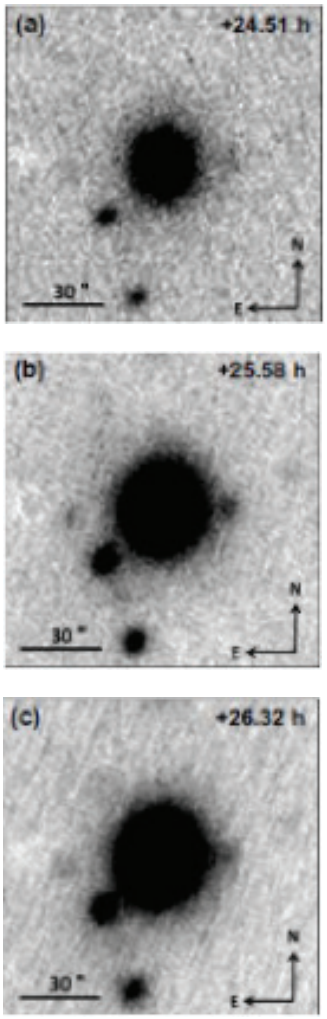


Image Left: Interior of the new power module designed for PLATO deployment, featuring a Hatz 1D-90V engine and 18 kW alternator.
Image Credit: Jon Lawrence/AAO.

Subaru TELESCOPE

The Subaru Telescope is a 8.2 metre optical telescope situated in Hawaii, owned and operated by the National Astronomical Observatory of Japan (NAOJ). In early 2017, AAL entered into a short-term collaboration agreement with the NAOJ which has seen Australian-based astronomers have access to ten nights on the telescope in 2018.

Australia has funded this access through a combination of financial support, technical contributions to the telescope from ANU and the AAO, and access to time on the AAT for Japanese astronomers.

Subaru Beam Switcher Design Project (AAO)

As part of the Subaru Telescope Operation Improvement Program, the AAO and NAOJ have agreed to undertake a collaborative project to design a beam-switcher instrument for the Nasmyth focus of the Subaru Telescope. A beam-switcher instrument will simplify the process of preparing a Nasmyth instrument for observation on the Subaru Telescope. Currently this is a labour-intensive manual operation which requires multiple Operations Staff to perform. The proposed beam-switcher instrument will allow the telescope beam to be automatically routed to up to 4 instruments.

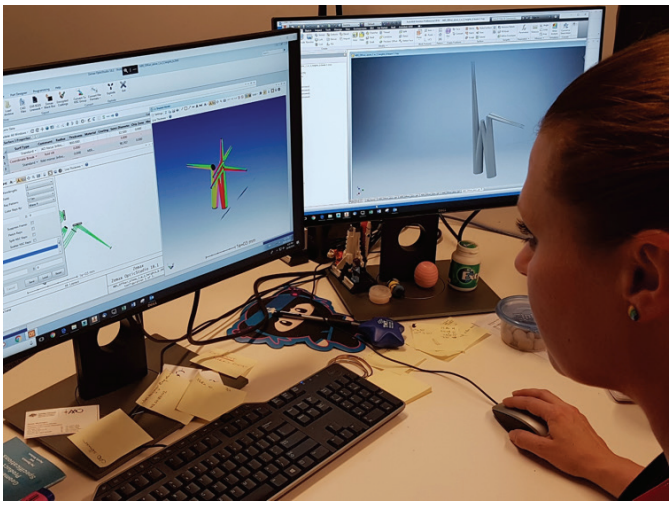
Project Status

During 2017/18, the Subaru Nasmyth Beam-Switcher project commenced. This included the initial administrative and setup phase, as well as the commencement of technical work, mostly of the optical and mechanical design.

Subaru ULTIMATE GLAO Conceptual Design (ANU)

The ANU RSAA AITC is collaborating with the Subaru Telescope team on the conceptual study for the ULTIMATE Ground Layer Adaptive Optics. ANU is providing expertise and manpower for part of the conceptual study, including numerical performance simulations, functional and performance requirements, operational concepts requirements, overall design architecture, laser guide star facility and the natural and laser wavefront sensor adaptor flange.

AAO-MQ Mechanical Engineering Manager, Helen McGregor, working on the design for the Subaru beam switcher.
Image Credit: S. Smedley.



DEMAND FOR FACILITIES

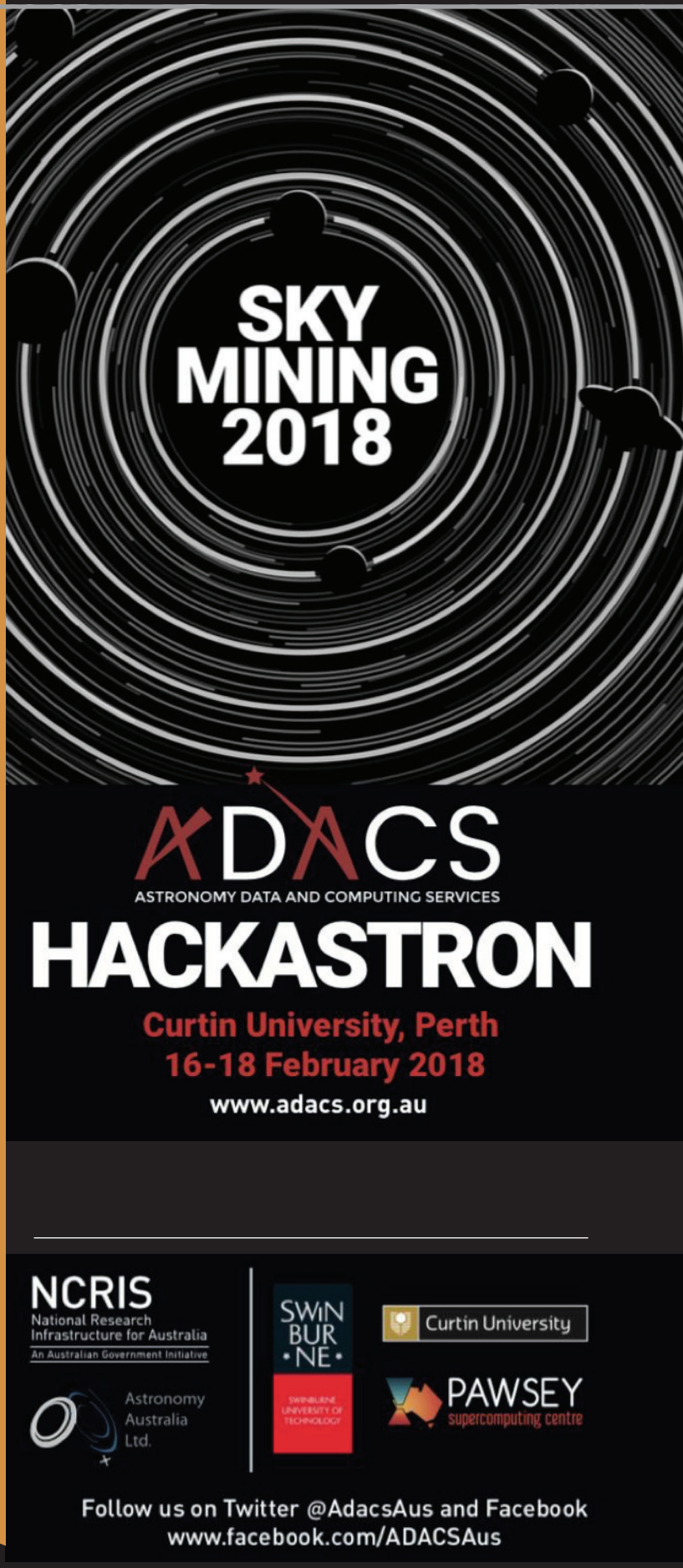
Over 2670 astronomers used AAL funded facilities in 2017/18, of whom more than half were Australian-based researchers and almost 50% were international collaborators. 20% of Australian users were students, demonstrating the importance of these resources in building the skills and expertise of the next-generation of world-leading scientists.

ADACS

Astronomy Data and Computing Services (ADACS) was established in early 2017 by AAL to empower the national astronomy community to maximize the scientific return from data and eResearch infrastructure. ADACS is delivered by a partnership between Swinburne University of Technology, Curtin University and the Pawsey Supercomputing Centre.

In the 2017/18 financial year more than 300 researchers made use of ADACS services. The two merit allocation rounds for software support had a subscription rate greater than 300%. 60 weeks of software developer time was expended across five projects. Seven face to face training sessions were held, including programs at the 2017 and 2018 Annual Scientific Meetings of the Astronomical Society of Australia (ASA). In addition six webinars were created that introduced astronomers to a range of data and computing concepts, and a data intensive astronomy workshop was held in Melbourne in August 2017.

For members of the Perth public, ADACS ran the day long "Cloudy Skies" outreach event in association with Scitech Planetarium and Perth Observatory.



Cloudy Skies Outreach event

A group of 40 people from Perth took the opportunity to explore our solar system's greatest planet, Jupiter and its cloudy skies, during an event organised by ADACS and hosted by Scitech, Flux Core Innovation Hub and the Perth Observatory.

The aim of this special event was to give a taste of the reality of space exploration and the roles of astronomers, and perhaps inspire the astronomers of the future. During the session, attendees had the opportunity to find out about NASA's Juno probe, learn some scientific image processing skills and apply them to images from the probe's JunoCam, and finally observe Jupiter live from the observatory's telescopes.

Jupiter is the largest planet in the Solar System, more than 1,300 Earth will fit inside it. The planet is mostly made up of hydrogen and helium gas and it is covered by thick colourful clouds, which gives the impression of stripes.

Ilias Delis, a chemistry student from Curtin University, enjoyed the opportunity to move "from a molecular level to the astronomical", she also said that "it was thoroughly interesting throughout the day."

Organisers were bombarded with positive feedback from the participants, who found the experience "educational and informative." Sishir Sharma found the afternoon "was enjoyable and there was much knowledge that was taken home". The participants produced 68 images as a result of their processing experience with JunoCam. The images are currently displayed on the interactive Science Wall at SciTech and have been well received by both young and old visitors to the exhibition.

DATA AND COMPUTING STATS

More than 300 researchers have utilised ADACS services over the past 12 months from 31 Australian institutions and 7 international institutions. This included 53% of students and over 35% of female users. 2017/18 saw the delivery of seven face-to-face training events, including programs at the 2017 and 2018 Annual Scientific Meetings of the ASA, the creation of six webinars introducing astronomers to a range of data and computing concepts, the first Cloudy Skies outreach event, hosting of the first Data Intensive Astronomy workshop, further development of the ASVO-MWA node and 60 developer weeks of effort contributed across five software support projects.

Interactive Science Wall at SciTech

ADACS Data Intensive Astronomy workshop

The first ADACS Data Intensive Astronomy workshop was held in Melbourne, 7-9 August 2017. Featuring 26 talks, two Birds-of-a-Feather sessions and around 75 attendees this was a very successful meeting which generated much productive discussion within the data science community. The program included presentations from ANDS, NeCTAR and RDS representatives, as well as contributions from each of the ASVO nodes. The keynote was delivered by Ada Nebot from the Centre des Donnees Astronomique de Strasbourg (CDS). Ada talked about the International Virtual Observatory and how this initiative is managed by the CDS. Other invited speakers included Julie Banfield (ANU), Elaina Hyde (AAO), Eric Thrane (OzGrav/Monash) and Andreas Wicenec (ICRAR/UWA).

Astropy Chat at the ASA Annual Scientific Meeting.

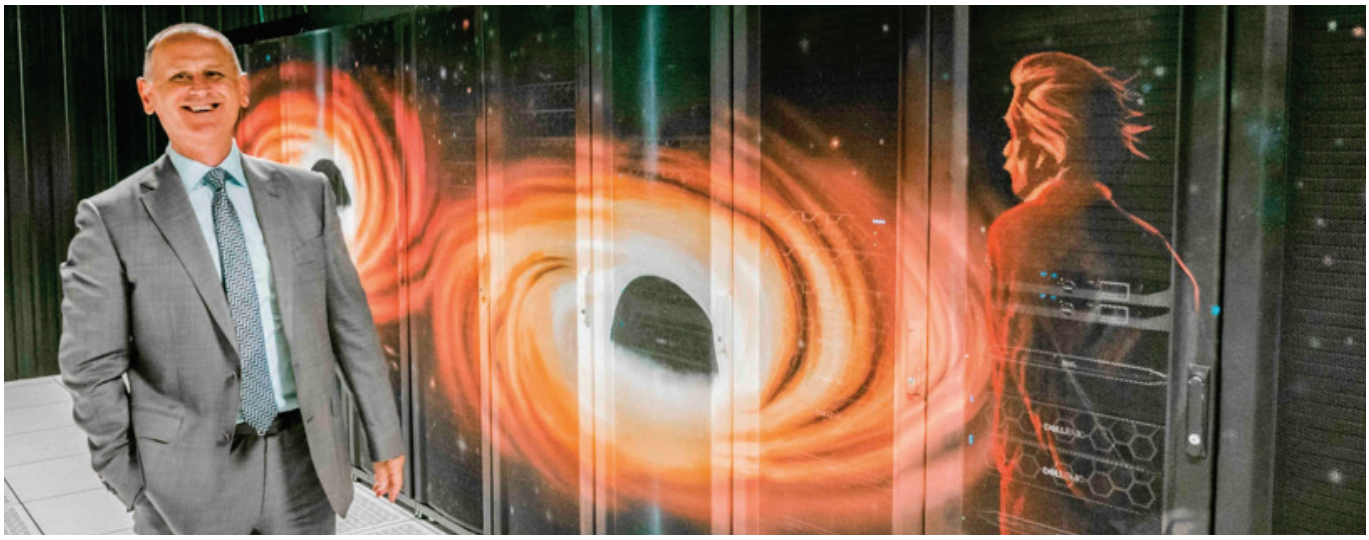
OzSTAR

The GPU Supercomputer for Theoretical Astrophysics Research (gSTAR) program, funded by AAL, is a key national facility for Australian based theoretical astrophysicists. This facility received a major refresh with the launch of the OzSTAR supercomputer on the 7 March 2018 by Swinburne Deputy Vice-Chancellor (Research), Professor Aleks Subic, at a function attended by representatives from the national astronomy community, the technology industry and AAL. As well as continuning the gSTAR program, OzSTAR will underpin the computational efforts of the Centre of Excellence in Gravitational Wave Discovery (OzGrav). The OzSTAR name for the new Swinburne supercomputer is a natural marriage of these two national efforts.

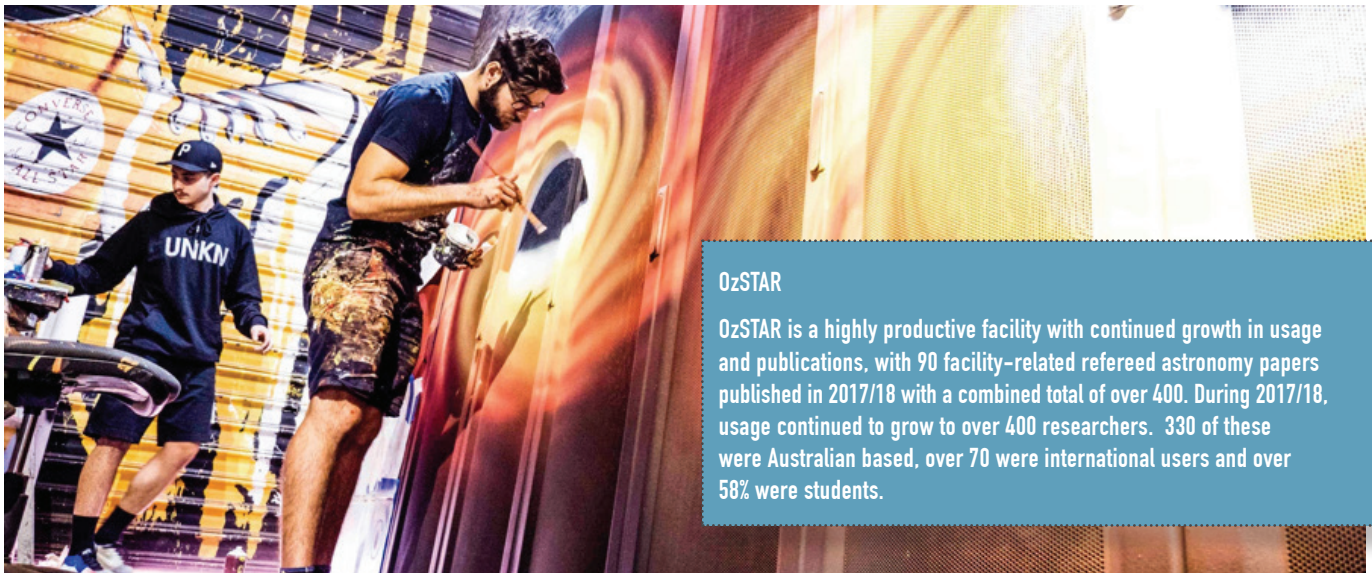
Professor Aleks Subic (Swinburne Pro-Vice Chancellor, Research) at the OzSTAR launch.
Image Credit: OzGrav.

The OzSTAR machine has:

- 115 compute nodes each comprising a Dell R740 14G server with two Intel Xeon Gold 6140 18-core processors and two NVIDIA P100 12GB PCI-e GPUs (totaling 4140 cores and 230 GPUs);
- 107 compute nodes with 192GB RAM each ("standard" compute nodes);
- 4 compute nodes with 384GB RAM each and 4 with 768GB RAM each, with all 8 having a 2TB NVMe flash drive;
- 100 Gbps OmniPath non-blocking network;
- 5.2 petabyte (usable) storage system



OzSTAR gets its artwork.
Image Credit: OzGrav.



OzSTAR

OzSTAR is a highly productive facility with continued growth in usage and publications, with 90 facility-related refereed astronomy papers published in 2017/18 with a combined total of over 400. During 2017/18, usage continued to grow to over 400 researchers. 330 of these were Australian based, over 70 were international users and over 58% were students.

INTERNATIONAL ENGAGEMENT

Cherenkov Telescope Array OBSERVATORY

The Cherenkov Telescope Array Observatory (CTAO) is planned to be the largest and most advanced gamma-ray detection observatory in the world. With over 100 telescopes spread over two sites, the CTAO is designed to be ten times more sensitive than current gamma-ray instruments and to be capable of observing higher energy photons than ever before. With this new window on the Universe, scientists hope to investigate the nature of dark matter and survey some of the most energetic processes in the Universe.

The CTAO is one of eleven physical science priorities listed in the European Strategy Forum on Research Infrastructures (ESFRI) Roadmap, where it is described as "one of the magnificent seven observatories that promise to contribute to establishing the multi-messenger paradigm as the new avenue unifying astronomy and astroparticle physics".

A northern hemisphere array is to be built at the Roque de los Muchachos Observatory on La Palma. It will consist of four Large-Sized Telescopes (LSTs) and fifteen Medium-Sized Telescopes (MSTs) and also incorporate the two telescopes of the existing MAGIC (Major Atmospheric Gamma Imaging Cherenkov Telescopes) system. The MSTs provide coverage of the core energy range (150 GeV to 5 TeV), whilst the LSTs extend the sensitivity to lower frequencies. A second, southern hemisphere array will be much larger, comprising 4 LSTs, 25 MSTs and 70 Small-Sized Telescopes (SSTs) spread across nearly 16 square kilometres of the Atacama desert near the European Southern Observatory in Paranal, Chile.

In 2016, AAL commissioned a working group to report on multi-messenger astronomy investment options. The working group ranked participation in CTAO as a top priority for Australian multi-messenger astronomy. AAL then entered negotiations with CTAO gGmbH (the German not for profit company that manages preconstruction of the observatory), and became a 2% shareholder in January 2018. As a shareholder, AAL is entitled to 2 seats on the governing body of the gGmbH, CTAO Council. These seats are currently held by James Murray (AAL) and Gavin Rowell (University of Adelaide). AAL is focused on securing cost effective access to CTAO for Australian-based astronomers.

> One of the magnificent seven observatories that promise to contribute to establishing the multi-messenger paradigm as the new avenue unifying astronomy and astroparticle physics.

eROSITA

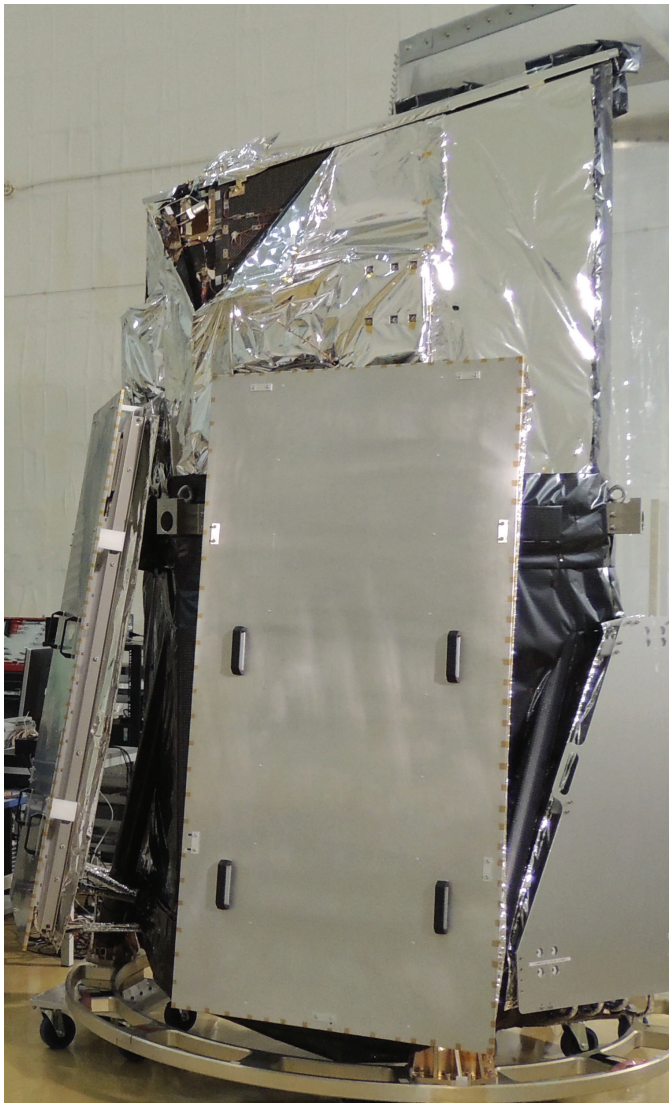
eROSITA is a German X-ray telescope due to be launched on the Spectrum-Roentgen-Gamma satellite in 2019. Its main scientific goals are to:

- detect the hot intergalactic medium of 50-100 thousand galaxy clusters and groups and hot gas in filaments between clusters to map out the large scale structure in the Universe for the study of cosmic structure evolution,
- detect systematically obscured accreting Black Holes in nearby galaxies and many (up to 3 million) new, distant active galactic nuclei and
- study in detail the physics of galactic X-ray source populations, like pre-main sequence stars, supernova remnants and X-ray binaries.

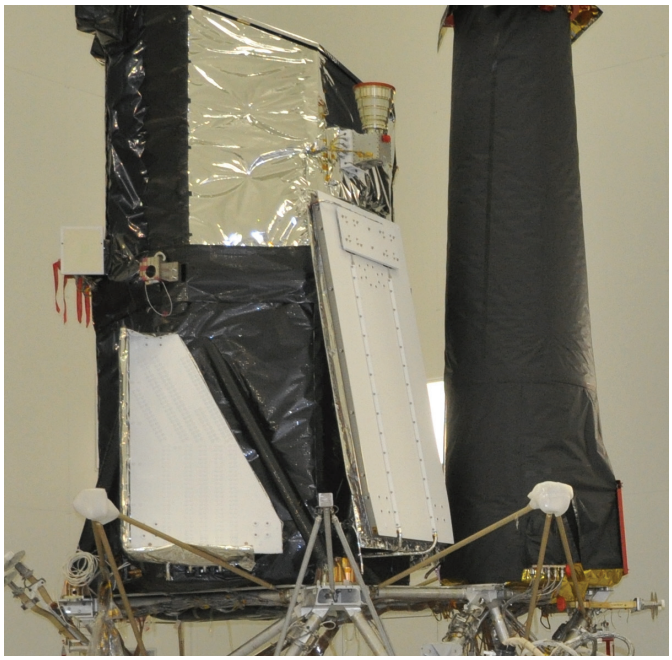
eROSITA will take four years to build a deep survey of the entire X-ray sky, followed by three and a half years of open access time.

The ARC Centre for Excellence for All-Sky Astrophysics (CAASTRO) and the German eROSITA consortium signed a memorandum of understanding in 2013 that describes the method by which Australian-based astronomers and eROSITA researchers collaborate, share data and publish papers on scientific topics of common interest. In January 2018 AAL took over management responsibility for the Australian side of this relationship.

AAL hosted an eROSITA session at the ASA Annual Scientific Meeting in June 2018 with the aim of promoting to Australian astronomers the opportunity to participate in a new era of X-ray science. Professor Kirpal Nandra, director of the Max Planck Institute for Theoretical Physics, and Dr Mara Salvato, chair of the eROSITA followup working group, visited Melbourne for the event.



The eROSITA instrument in the clean room at the Max Planck Institute for Theoretical Physics



Large Synoptic Survey TELESCOPE

The Large Synoptic Survey Telescope (LSST) aims to construct the deepest, widest image of the Universe ever produced. Following commissioning in 2021/22 it will conduct a ten year survey of the sky using a specially designed 8.4 metre telescope on Cerro Pachon in Chile with an extremely wide (3.5°) field of view. The LSST surveys are designed to address four science areas:

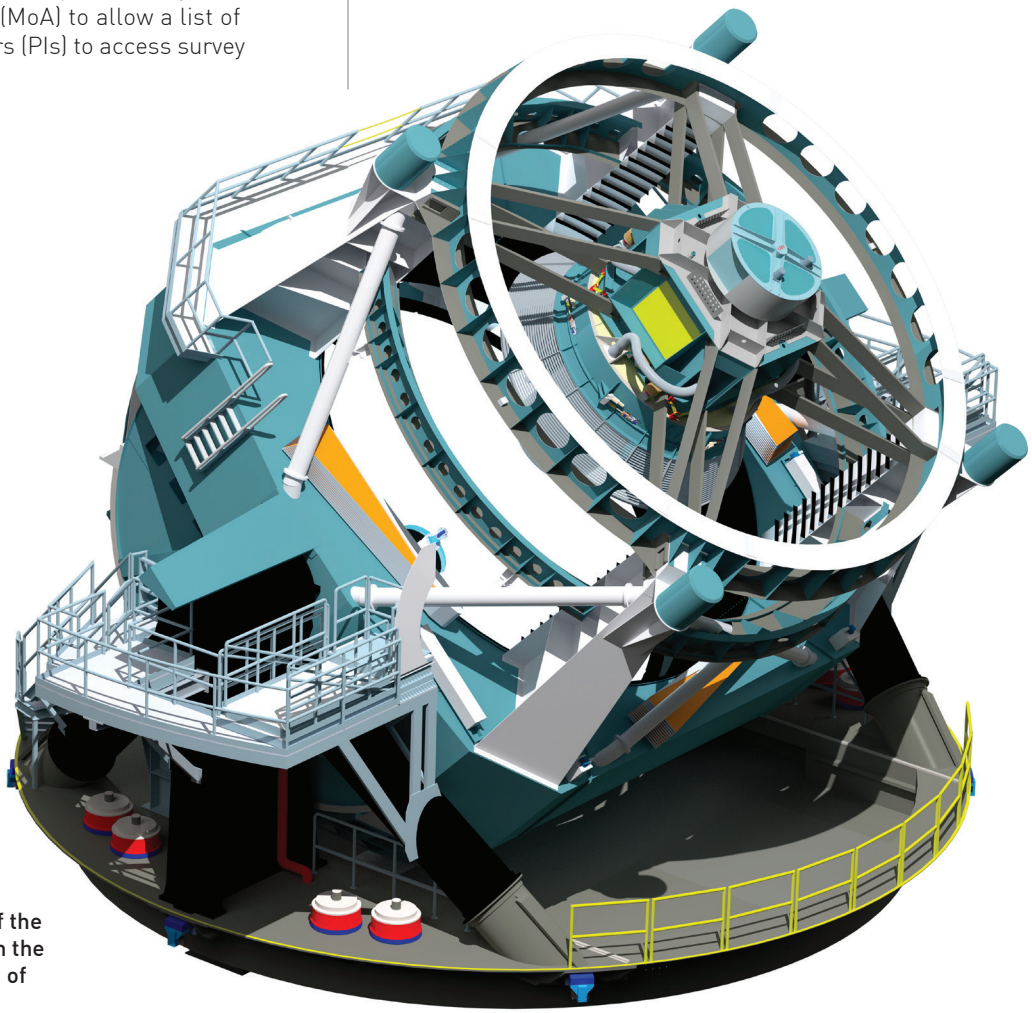
- Understanding the Nature of Dark Matter and Dark Energy
- Hazardous Asteroids and the Remote Solar System
- The Transient Optical Sky
- The Formation and Structure of the Milky Way

Real-time alerts of transient objects will be publicly released immediately. However access to deep LSST survey data prior to eventual public release is available only to scientists in the US and Chile, and to international institutions that are supporting LSST operations.

In 2015, CAASTRO and the LSST Corporation signed a memorandum of agreement (MoA) to allow a list of Australian Principal Investigators (PIs) to access survey data from the LSST.

Following the end of the CAASTRO program in early-2018, AAL has now novated the agreement and represents Australian astronomers wishing to participate in the LSST project. Independently, the International Centre for Radio Astronomy Research (ICRAR) have signed a similar MoA with the LSST Corporation.

Participation under this program costs USD(2013)$20,000 per PI per year over a 10-year period. There is also an additional data access fee. While AAL has not committed to funding Australia's LSST participation, it will help coordinate the Australian PIs as they seek to secure funds for access to LSST, primarily expected to be through ARC Linkage Infrastructure, Equipment and Facilities (LIEF) and university grants. The original MoA allowed for 10 named PIs, each of whom can have four associated junior researchers who will also have rights to LSST data. AAL will refresh the current list of named PIs in 2018/19 via an open call for nominations.



A three dimensional rendering of the baseline design for the LSST with the telescope pointed at an elevation of about 45 degrees.
Image Credit: LSST Project/NSF/AURA.

ACAMAR

ACAMAR is a joint China-Australia research centre between the Chinese Academy of Sciences, the Australian Department of Industry, Innovation and Science, and AAL to collaborate on areas of common interest within astronomy, astrophysics and cosmology. AAL provides the secretariat for ACAMAR.

ACAMAR aims to build upon existing arrangements to maximise the scientific return on investment in astronomy infrastructure; develop human capital in the field of astronomy; and enhance our common scientific understanding of the Universe.

The 4th ACAMAR workshop was held from 6-8 June 2018 in Chengdu, China. The 3-day workshop was attended by 21 Australian astronomers and 55 Chinese researchers. The workshop covered the following astronomy research topics: antarctic astronomy; radio astronomy and SKA; optical instrumentation and big data technologies.

Mr Christopher Lim (Australian Consul-General in Chengdu) made the opening remarks, and affirmed the outstanding research achievements in astronomy and hoped astronomers from both countries could continue to carry out in-depth academic collaborations.

Professor Rachel Webster (Chair, AAL Board) also attended the ACAMAR4 workshop and commented "it is clear that the collaboration with the Chinese colleagues is developing rapidly, with strong support from senior people on both sides. With new astronomy facilities (e.g. FAST, ASKAP and MWA) coming online from both sides, ACAMAR has huge potential for better astronomy collaborations".

Rachel Webster (Chair, AAL Board) inviting participants to the ACAMAR 5 workshop to be held in Melbourne's Yarra Valley in April 2019.

ACAMAR 4: Australia-China Workshop on Astrophysics

June 5-8, 2018
Chengdu, China

AAL ORGANISATION AND GOVERNANCE STRUCTURE

Information about Directors

Prof. Matthew Bailes
BSc(Hons), PhD

Special responsibilities – until 30 June 2018, a member of the Multi Messenger Astronomy Advisory Committee.

Prof. Matthew Bailes is an ARC Laureate Fellow at Swinburne University of Technology. Prof. Bailes leads the ARC Centre of Excellence for Gravitational Wave Discovery (OzGrav) and is a director of OzGrav Innovations Pty Ltd. His main scientific interests concern the discovery and high precision timing of millisecond radio pulsars and the discovery of extragalactic fast radio bursts (FRBs). He is the chair of the advisory board for the Collaboration for Astronomical Signal Processing and Electronics Research (CASPER) and serves on the Steering Committee for the Australia Telescope National Facility. He collaborates extensively with MPIfR, the University of Manchester, the Cagliari Radio Observatory, Caltech and the CSIRO. Matthew is leading the redevelopment of the Molonglo Radio Observatory's correlator so that it can time pulsars and search for FRBs. He is the Australian lead of the Breakthrough Listen project to search for Alien transmissions with the Parkes radio telescope and a Principal Investigator on the MeerTime pulsar timing project on the South African Square Kilometre Array pathfinder MeerKAT.

Dr. Rosalind Dubs
BSc(Hons), Dr ès Sc, FTSE, FAICD

Special responsibilities – Deputy Board Chair, Chair of the Audit and Risk Management Committee, a member of the Industry Engagement Working Group and a member of the Executive Remuneration Committee.

Dr Rosalind (Ros) Dubs is a professional company director, currently serving on the boards of government shipbuilder ASC Pty Ltd, the Academy of Technology and Engineering (ATSE) and ANU Enterprise Pty Ltd and is a former director of Aristocrat Leisure Limited. Her diverse business career has spanned a range of industries in publicly listed, private and government companies in Germany, France and Australia. For Thales SA, she was managing director of a company delivering state-of-the-art navigational aids to 65% of the global aviation market, served as COO of the world's largest exporter of air traffic management systems, and sold mission-critical software and communications systems to the Australian Defence Force. At Airservices Australia, as director of operations support, she was responsible for all engineering operations across Australia. Dr Dubs was appointed to CSIRO's senior executive service in 1983. Within universities, she was Registrar of the ANU from 1985-1991, and Deputy Vice-Chancellor (External Relations) at UTS from 2007-2009. Dr Dubs chaired the Australian Space Industry Innovation Council during 2010-2012, served on the Australian Astronomical Observatory Advisory Committee during 2011-15, and was elected a Fellow of the Australian Academy of Technology and Engineering in 2014.

Prof. Rachel Webster
BSc(Hons), PhD

Special responsibilities – Board Chair, Chair of the Executive Remuneration Committee and a member of the Audit and Risk Management Committee.

Prof. Rachel Webster is a Professor at The University of Melbourne in the School of Physics where she leads the Astrophysics research group. She has had a stellar career teaching and researching astronomy for over 20 years. Originally gaining her doctorate thesis at Cambridge University, she has spent productive years honing her skills in Canada at the University of Toronto, both teaching and doing research. Her work has been recognized with internationally prestigious scholarships. She was also the inaugural AIP Woman in Physics Lecturer. She is a key member of an international consortium involving Australian, American, Indian and New Zealand astrophysicists to help design and build a new low frequency radio telescope (Widefield Array) at Mileura in Western Australia aiming to detect the first luminous sources in the Universe. Rachel is a member of the International Astronomical Union, and an Honorary Fellow of the Astronomical Society of Australia, and a Fellow of the Royal Society of Victoria, and the American Astronomical Society. Rachel is also a Fellow of the Australian Academy of Science.

Prof. Karl Glazebrook BSc(Hons), PhD, FASA, FAA

Special responsibilities – until 30 June 2018, a member of the Optical Telescope Advisory Committee.

Prof. Karl Glazebrook is a Distinguished Professor at Swinburne University of Technology and Director of the Centre for Astrophysics & Supercomputing. His career has spanned the U.K., U.S. and Australia including Professorships at Johns Hopkins University and Swinburne and the award of a prestigious Packard Fellowship. His most notable scientific accomplishments are the development of the 'nod and shuffle' spectroscopic technique, characterising the bimodal colour and environmental distributions of local galaxies, the study of the morphological and spectroscopic evolution of galaxies across cosmic time using Gemini, Hubble and Keck telescopes and the development of innovative cosmological techniques such as 'Baryonic Acoustic Oscillations'. He has been an official ISI "Highly Cited Researcher" and has won the Muhlmann Award for his work on instrumentation. He was elected to the Australian Academy of Science for his research accomplishments in May 2017 and has been a member of the Australian Research Council College of Experts. He has also served as Chair of the International Facilities Working Group of the Australian Astronomy Decadal 2016-2025 Plan and on the Keck Scientific Steering Committee, the Gemini Science and Technology Advisory Committee and the GMT Instrument Development Advisory Committee.

Prof. Naomi McClure-Griffiths BA(Hons), PhD (Astrophysics)

Special responsibilities – until 30 June 2018, a member of the Radio Telescope Advisory Committee.

Prof. Naomi McClure-Griffiths is a Professor and ARC Future Fellow at the Research School of Astronomy and Astrophysics (RSAA) at The Australian National University. Prior to this, Naomi spent 13 years at CSIRO holding various roles, including OCE Science Leader and Head of National Facility Science for the Australia Telescope National Facility. Naomi's area of research is in the structure and evolution of gas and magnetic fields in our own Milky Way and the nearby Magellanic System. Her research group uses radio telescopes, including the Australia Telescope Compact Array, Parkes Radio telescope and Green Bank telescope. Naomi co-leads the Galactic ASKAP survey (GASKAP) and the Polarisation survey (POSSUM) and has roles in SKA science planning, including membership on two SKA Science working groups (HI and The Galaxy), the SKA Science and Engineering Advisory Committee, Australia New Zealand SKA Coordination Committee (ANZSCC) and ANZSCC's Science Advisory Committee. Naomi is a Fellow of the Astronomical Society of Australia and a Member of the International Astronomical Union. Naomi completed her PhD in Astrophysics at the University of Minnesota in Minneapolis, MN USA. She received the 2006 Prime Minister's Malcolm McIntosh Prize for Physical Scientist of the Year and the 2015 Pawsey Medal from the Australian Academy of Science.

Prof. Chris Tinney BSc(Hons), PhD, GAICD

Special responsibilities – a member of the Industry Engagement Working Group and until 30 June 2018, a member of the Astronomy eResearch Advisory Committee.

Prof. Chris Tinney is a Professor at UNSW Sydney in the School of Physics, where he heads the Exoplanetary Science at UNSW research group. He obtained his PhD from the California Institute of Technology, and has been an active researcher in the field of exoplanets and brown dwarfs for over 25 years. He has worked in both the research infrastructure and University sectors, spending almost 12 years with the Anglo-Australian Observatory as a Research Astronomer, heading the IRIS2 instrument project and becoming Head of Astronomy. He moved to UNSW as a Professorial Fellow in 2007 and was Associate Dean (Research) for UNSW Science from 2013-2017.

Prof. Len Sciacca BEng, PhD, FTSE, FIEAust

Special responsibilities – Chair of the Industry Engagement Working Group and a member of the Audit and Risk Management Committee.

Len Sciacca is a Professor at the University of Melbourne, School of Engineering having been the Chief Partnerships and Engagement for DST Group leading university, industry and community engagement, research partnerships and collaborations. Len has over 30 years research and industrial experience in engineering and senior management roles in Government and industry sectors. He has worked for CSIRO, The Universities of Melbourne and Newcastle and Defence Science Technology Group. Len has extensive experience in forming collaborations and partnerships between stakeholders to form multidisciplinary teams in professional, scientific and engineering environments. He has led several large research and development programs with large teams of scientists and engineers in partnership with universities and industry. Len is a Director of the registered charity Scientific and Support Staff Benevolent Association Ltd, a Fellow of Engineers Australia and a Fellow of the Academy of Technological Sciences and Engineering.

AAL Organisational & Governance Structure 2017/18

Members

AAL is very proud that its membership comprises all insititutions in Australia with a significant astronomy research program. In the 2017/18 financial year there were 16 institutional members of AAL. Each member organisation has a nominated representative who attends the Annual General Meeting to elect Board Directors. Member representatives are also consulted throughout the year on key astronomy infrastructure and investment decisions.

Committees and other Advisory Bodies

In the 2017/18 financial year AAL had four advisory committees, a Board Industry Engagement Working Group and a supercomputer time allocation committee. Committee members are appointed to provide the relevant breadth of expertise, and an appropriate mix of gender, seniority and institutional diversity. AAL advisory committees met quarterly during 2017/18 to: monitor the progress of AAL funded projects; assess key performance measures; and advise on opportunities to collaborate and improve project outcomes. In late 2017 AAL began a process to restructure the advisory committees. That process was completed in July 2018.

A Working Group of the AAL Board was formed to advise Board on all aspects of Industry Engagement. The Working Group first met in February 2018 and meets quarterly.

Board

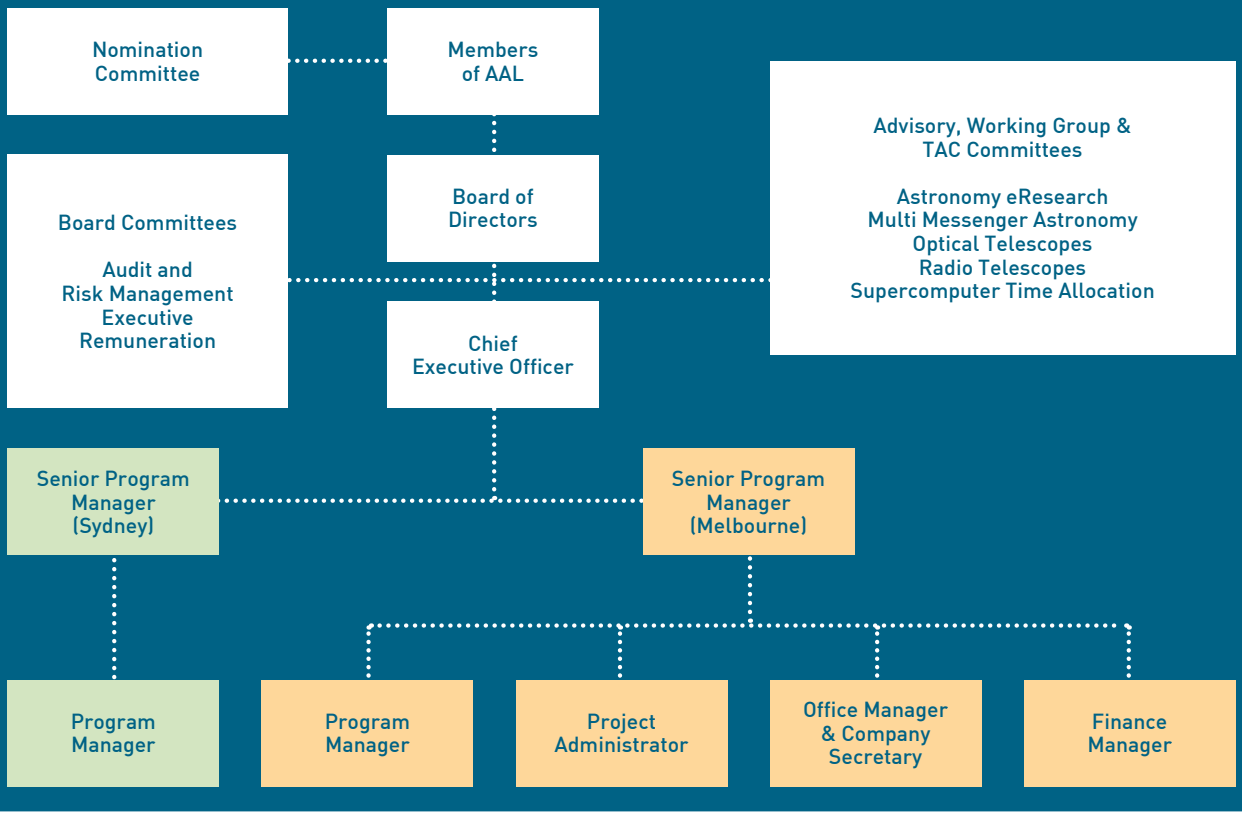
The independent, skills-based Board of Directors comprises seven individuals with a breadth of expertise in astronomy, management and finance.The Board meets quarterly to: review progress of programs under AAL's contractual arrangements; set strategic goals; and approve financial allocations. The AAL Board makes key decisions about projects based on the recommendations of its advisory committees, its own considerable and diverse expertise, and in consideration of the priorities and recommendations in the Australian Astronomy Decadal Plan.

Staff

AAL executive and staff have responsibility for: financial management and oversight of the programs under AAL's contractual arrangements; reporting to the AAL Board on the status of projects; and liaising with stakeholders including advisory committees, project leaders, AAL members, government departments.

Equity and Diversity

AAL is committed to equity and diversity and endeavours to create an environment in which every individual is treated with dignity and respect. To achieve this commitment, AAL has an Equity and Diversity Management Plan, the core objectives of which are reported at the Board Meetings. AAL currently holds a Bronze Pleiades Award for its equity and diversity efforts.



Committees

Astronomy eResearch Advisory Committee (AeRAC)

Chris Power (Chair), University of Western Australia

Ben Evans, National Computational Infrastructure (NCI)*

Jenni Harrison, Pawsey Supercomputing Centre*

Alex Heger, Monash University

Jarrod Hurley, Swinburne University of Technology*

Arna Karick, Swinburne University of Technology

Mark Krumholz, Australian National University

Greg Poole, University of Melbourne

Katrina Sealey, Australian Astronomical Observatory

Chris Tinney, AAL Board representative*

Matthew Whiting, CSIRO

Andreas Wicenec, University of Western Australia

Astronomy Supercomputer Time Allocation Committee (ASTAC)

Christoph Federrath (Chair), Australian National University

Weiguang Cui, University of Western Australia

Roger Edberg, National Computational Infrastructure (NCI) representative*

Magda Guglielmo, University of Sydney

Chris Harris, Pawsey Supercomputing Centre representative*

Jarrod Hurley, Swinburne University of Technology*

Anne Hutter, Swinburne University of Technology

Daniel Mitchell, CSIRO

Simon Mutch, University of Melbourne

Multi Messenger Astronomy Advisory Committee (MMAAC)

Gavin Rowell (Chair), University of Adelaide

Matthew Bailes, AAL Board representative*

Miroslav Filipovic, Western Sydney University

Anne Green, University of Sydney

Gary Hill, University of Adelaide

Susan Scott, Australian National University, OzGrav representative*

Bram Slagmolen, Australian National University

Optical Telescopes Advisory Committee (OTAC)

Michele Trenti (Chair), University of Melbourne

Michael Ashley, University of New South Wales

Martin Asplund, Australian National University

Julia Bryant, University of Sydney

Warrick Couch, Australian Astronomical Observatory*

Karl Glazebrook, AAL Board representative*

Juan Madrid, CSIRO

Richard McDermid, Magellan SAC representative*

Stuart Ryder, Australian Astronomical Observatory*

Lee Spitler, Macquarie University

Radio Telescopes Advisory Committee (RTAC)

Nick Seymour (Chair), Curtin University

Adam Deller, Swinburne University of Technology

Simon Ellingsen, University of Tasmania

Natasha Hurley-Walker, Curtin University

Minh Huynh, University of Western Australia

Naomi McClure-Griffiths, AAL Board representative*

Attila Popping, University of Western Australia

John Reynolds, CSIRO*

* Ex-officio.

Members represented as of 30 June 2018

Member	Representative
Australian Astronomical Observatory	Prof Warrick Couch
Australian National University	Prof Matthew Colless
CSIRO	Dr Douglas Bock
Curtin University	Prof Steven Tingay
Macquarie University	Prof Mark Wardle
Monash University	Prof Alexander Heger
Swinburne University of Technology	Prof Michael Murphy
University of Adelaide	Prof Bruce Dawson
University of Melbourne	Dr Christian Reichardt
University of New South Wales	Prof Kim-Vy Tran
University of Queensland	Prof Tamara Davis
University of Southern Queensland	Prof Brad Carter
University of Sydney	Prof Joss Bland-Hawthorn
University of Tasmania	Prof John Dickey
University of Western Australia	Prof Peter Quinn
Western Sydney University	Prof Miroslav Filipovic

Telescopes Representatives

Cherenkov Telescope Array

CTAO Board: Gavin Rowell, University of Adelaide; James Murray, AAL

Giant Magellan Telescope

Board: Nigel Poole, University of New South Wales

GMTO Founder Representative: Mark McAuley, AAL

GMT SAC: Sarah Brough, University of New South Wales

Keck Telescopes

California Association for Research in Astronomy (CARA) Board: Lisa Kewley (ANU appointment)

Magellan Telescopes

Magellan Council: Mita Brierley, AAL (observer)

Magellan SAC: Richard McDermid, Macquarie University (observer)

Murchison Widefield Array

MWA Board: Andrew Hopkins, Australian Astronomical Observatory (observer)

STATEMENT OF PROFIT OR LOSS AND OTHER COMPREHENSIVE INCOME FOR THE YEAR ENDED 30 JUNE 2018

	2018 $	2017 $
Revenue and other income	7,528,733	9,834,043
Expenses		
Depreciation	(4,705)	(3,384)
Grants program expenses	(6,425,399)	(8,855,232)
Employee benefits expenses	(947,046)	(696,455)
Other expenses	(338,262)	(237,727)
Surplus/(Deficit) for the year	**(186,679)**	**41,245**
Other comprehensive income	-	-
Total comprehensive income for the year	**(186,679)**	**41,245**

STATEMENT OF FINANCIAL POSITION AS AT 30 JUNE 2018

	2018 $	2017 $
Current Assets		
Cash and cash equivalents	14,766,560	8,756,602
Trade and other receivables	3,582,274	209,442
Other assets	57,885	-
Total Current Assets	18,406,719	8,966,044
Non-Current Assets		
Plant and equipment	5,949	5,942
Other financial assets	826	-
Total Non-Current Assets	6,775	5,942
Total Assets	**18,413,494**	**8,971,986**
Current Liabilities		
Trade and other payables	4,023,058	81,267
Employee benefits	64,767	49,609
Other liabilities	11,340,345	5,680,498
Total Current Liabilities	15,428,170	5,811,374
Non-Current Liabilities		
Employee benefits	17,061	5,670
Total Non-Current Liabilities	17,061	5,670
Total Liabilities	**15,445,231**	**5,817,044**
Net Assets	**2,968,263**	**3,154,942**
Equity		
Reserves	2,617,485	2,683,769
Retained surpluses	350,778	471,173
Total Equity	**2,968,263**	**3,154,942**

For the purpose of this financial report, extracts from the audited financial statements for the year ended 30 June 2018 are included. The financial statements were independently audited by RSM Australia Partners. The complete audited financial statements and auditor's report are available on the AAL website at http://www.astronomyaustralia.org.au.

STATEMENT OF CHANGES IN EQUITY
FOR THE YEAR ENDED 30 JUNE 2018

	Retained Surpluses	Overseas Optical Reserve	NCRIS Reserve	Total Equity
	$	$	$	$
Balance at 30 June 2016	**361,449**	**2,608,579**	**143,669**	**3,113,697**
Surplus for the year	41,245	-	-	41,245
Transfer to Reserves	(116,707)	38,963	77,744	-
Allocation from Reserves	185,186	(52,172)	(133,014)	-
Balance at 30 June 2017	**471,173**	**2,595,370**	**88,399**	**3,154,942**
Deficit for the year	(186,679)	-	-	(186,679)
Transfer to Reserves	(196,175)	37,456	158,719	-
Allocation from Reserves	262,459	(156,490)	(105,969)	-
Balance at 30 June 2018	**350,778**	**2,476,336**	**141,149**	**2,968,263**

Acronyms

2dF	Two-degree Field
AAL	Astronomy Australia Limited
AAO	Australian Astronomical Observatory
AAT	Anglo-Australian Telescope
ADACS	Astronomy Data and Computing Services
AeRAC	Astronomy eResearch Advisory Committee
AITC	Advanced Instrumentation and Technology Centre
ANDS	Australian National Data Service
ANU	Australian National University
ARC	Australian Research Council
ASA	Astronomical Society of Australia
ASKAP	Australian Square Kilometre Array Pathfinder
AST3	Antarctic Survey Telescopes × 3
ASTAC	Astronomy Supercomputing Time Allocation Committee
ASVO	All-Sky Virtual Observatory
ATSE	Australian Academy of Technology and Engineering
CAASTRO	ARC Centre of Excellence for All-Sky Astrophysics
CASPER	Collaboration for Astronomical Signal Processing and Electronics Research
CRAFT	Commensal Real-time ASKAP Fast Transients
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CTA	Cherenkov Telescope Array
CTAO	CTA Observatory
DIIS	Department of Industry, Innovation and Science
ELT	Extremely large telescope
ESO	European Southern Observatory
FAA	Fellow of the Australian Academy of Science
FAICD	Fellow of the Australian Institute of Company Directors
FASA	Fellow of the Astronomical Society of Australia
FRB	Fast Radio Burst
FTSE	Fellow of the Australian Academy of Technological and Engineering Sciences
GAICD	Graduate of the Australian Institute of Company Directors
GMT	Giant Magellan Telescope
GMTO	GMT Organisation
GPU	Graphics Processing Unit
gSTAR	GPU Supercomputer for Theoretical Astrophysics Research
HERMES	High Efficiency and Resolution Multi-Element Spectrograph
ICRAR	International Centre for Radio Astronomy Research
IR	Infrared
IRIS2	Infrared Imager and Spectrograph 2
ISI	Institute for Scientific Information
ITSO	International Telescope Support Office
KTAC	Keck Time Allocation Committee
MMAAC	Multi Messenger Astronomy Advisory Committee
MPIfR	Max Planck Institute for Radio Astronomy
MRO	Murchison Radio-astronomy Observatory
MWA	Murchison Widefield Array
NAOJ	National Astronomical Observatory of Japan
NCI	National Computational Infrastructure
NCRIS	National Collaborative Research Infrastructure Strategy
NeCTAR	National eResearch Collaboration Tools and Resources
OTAC	Optical Telscopes Advisory Committee
OzGrav	ARC Centre of Excellence for Gravitational Wave Discovery
PAF	Phased Array Feed
PLATO	PLATeau Observatory
PLATO-A	PLATO for Dome A
RSAA	Research School of Astronomy and Astrophysics (ANU)
RTAC	Radio Astronomy Advisory Committee
SAC	Science Advisory Committee
SKA	Square Kilometre Array
SUT	Swinburne University of Technology
TAC	Time Allocation Committee
UNSW	University of New South Wales
UWA	University of Western Australia
VISTA	Visible and Infrared Survey Telescope for Astronomy
VLT	Very Large Telescope

Astronomy Australia Ltd.

Australian Government | NCRIS National Research Infrastructure for Australia

Part of the NCRIS network

Astronomy Australia Ltd

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