Astronomy Australia Ltd.

2012/13 Annual Report

Astronomy Australia Limited

Vision

Astronomers in Australia will have access to the best astronomical research infrastructure.

Mission

AAL will achieve its vision by:

1. Engaging with Australian astronomers to advance the national research infrastructure priorities of the Australian astronomy decadal plan.
2. Advising the Australian Government on future investments in national astronomical research infrastructure.
3. Managing investments in national astronomical research infrastructure as required.

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 Australian participation in international facilities.
3. The AAO and CSIRO are empowered by the Australian Government to provide a component of the national astronomical research infrastructure and there is no need for AAL to directly manage investments to upgrade or operate the AAT and ATNF.

About AAL

Astronomy Australia Limited (AAL) is a not-for-profit company whose members are all the Australian universities and research organisations with a significant astronomical research capability. AAL works with Australia's National Observatories, astronomers and the Australian Government to advance the infrastructure goals in the *2006-2015 Decadal Plan for Australian Astronomy*.

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), the Education Investment Fund (EIF) and the Collaborative Research Infrastructure Scheme (CRIS).

Background image

5x2-minute snapshot of the Galactic centre taken using 121 tiles of the Murchison Widefield Array at 150MHz, mosaicked together in the image domain. Image credit: Natasha Hurley-Walker, Curtin University.

Front cover image

Final image from the 2013 Australian Gemini School Astronomy Contest, showing the galaxy field surrounding the face-on spiral galaxy IC 5332. Image credit: Isobelle Teljega (St. Margaret's Anglican Girls School), Travis Rector (U. Alaska Anchorage) and the Australian Gemini Office.

AAL Membership as of 30th June 2013

Contents

A message from the Chair

It has been a pleasure to fill the role of Astronomy Australia Ltd (AAL) Board Chair during 2013, having taken over from Professor Warrick Couch in March following his appointment as AAO Director. On behalf of AAL I would like to thank Warrick for having led the Board with distinction during his time as Chair, including the very successful expansion of AAL activity and staffing during 2011/12.

It has been an eventful year for AAL, with the commencement of the $3.474M Astronomy National Research Infrastructure Project under the government's Collaborative Research Infrastructure Scheme (CRIS) and the announcement of the continuation of the National Collaborative Research Infrastructure Strategy (NCRIS-2013) to provide operations support for critical infrastructure over the next two years. AAL's four advisory committees continue to play a significant role by advising the AAL Board about the complex issues facing the range of infrastructure projects with which AAL is engaged, including how these projects interact with the broader Australian and international astronomical landscapes. In order to represent the broader Australian astronomy community, AAL works to ensure that committee membership has an appropriate balance of skills, gender, seniority, and institution. AAL aims for at least 25% female representation on its advisory committees and Board, to reflect the female proportion in the community, and I am happy to report that this was achieved for the first time in 2012/13. The breadth and enthusiasm of the AAL advisory committees continue to be one of AAL's greatest strengths.

The past 12 months have seen important developments with respect to future Australian access to, and partnership in, 8-metre class optical/infrared telescopes. Australia has been a partner in the Gemini Observatory for more than a decade, and this facility has formed the basis of Australia's 8-metre class optical/IR capability. The current International Gemini Agreement, to which Australia is a party, expires at the end of 2015. In preparation for this there was a Gemini partnership assessment point in November 2012, specifying who would remain in the partnership beyond the end of 2015. Given the funding environment and the Australian ambition to become a member of the European Southern Observatory (ESO), the AAL membership endorsed the difficult decision that Australia inform the Gemini partners that we are not able to commit to the Gemini partnership beyond 2015 at this time.

One significant goal for AAL that has not been met is for Australia to join ESO. AAL continues to work towards this goal which represents the most important priority of the Australian astronomy community, through communicating the strategic value of ESO to Australian astronomy.

There were important successes in the optical/IR domain within current constraints, including the extension of access to the popular Magellan telescopes until the end of 2015. However, 2016 currently represents a "facility cliff" for optical/infra-red astronomy in Australia, with no guaranteed community access to 8-metre class telescopes secured beyond the end of 2015. This facility cliff poses a serious threat to fulfilling the ambitions set out in the last Decadal

Prof Stuart Wyithe, Chair, AAL Board of Directors

AAL directors Brian Boyle and Warrick Couch and AAL CEO Mark McAuley, during a meeting with a delegation from China led by the Vice-President of the Chinese Academy of Sciences, to discuss future collaboration between Australia and China. Image credit: Yanjie Xue

Plan for Australian access to 20% of an 8-metre class telescope, as well as to AAL's vision of providing Australian Astronomers with the best astronomical research infrastructure. Finding a solution for this most pressing issue remains the top priority for the AAL Board in 2013/2014.

A significant new objective during 2012/13 was to define a joint plan with Chinese partners for scientific output from investments made at Dome A in Antarctica. Several scientific collaborations were formed on the back of an MoU between Chinese astronomers and AAL. Subsequently the Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education (DIICCSRTE) formed a broader MoU regarding scientific engagement between Australian and Chinese astronomers, and AAL hosted the delegation of senior Chinese astronomers representing the Chinese Academy of Sciences during their visit to Australia to sign this document. These are welcome developments that promise to open up a large range of opportunities for Chinese-Australian collaboration in the future.

At the 2012 AGM, we farewelled Professor Mark Wainwright who stepped down from the AAL Board following the completion of his 3 year term. We thank Mark for his many and varied contributions to AAL, including his role in setting up the Astronomy eResearch Advisory Committee (AeRAC) and his expertise in eResearch, University structures, and many other areas. AAL was

very pleased to welcome a new Director, Professor Robyn Owens (DVC-R, UWA), to the Board. Robyn brings deep knowledge of issues facing astronomy in Australia as well as the wider University sector. Professor Brian Boyle was re-elected by the AAL members for another 3 year term on the Board. I have the pleasure of congratulating two members of the AAL Board on receiving 2013 Australia Day Honours, with Brian Boyle receiving a Public Service Medal for his contributions to Australian astronomy and the Australian SKA, and Brian Schmidt being named Companion of the Order of Australia, our country's highest civic honour.

I thank the membership of AAL for the opportunity to have chaired the AAL Board during 2013. I will step down as Chair following the 2013 AAL AGM, in order to concentrate on my role as Chair of the National Committee for Astronomy (NCA) and the development of the 2016-2025 Australian Astronomy Decadal Plan.

Prof. Stuart Wyithe

Chair

A message from the CEO

The 2012/13 financial year was another successful year for AAL, with new funding secured and notable project developments. I was personally delighted to have the opportunity to attend the launch of the Murchison Widefield Array (MWA) on 30th November 2012. Since 2007 AAL has worked to support the MWA project, including our recommendation to the Australian Government that Curtin University be appointed as the lead institution for the project with responsibility for receipt of the major Australian MWA-grants. I am delighted that the team at Curtin University, led by Professor Steven Tingay, have successfully managed the construction and commissioning of this first fully-operational SKA pathfinder.

Another significant project achievement during 2012/13 was the completion of the ATCA C/X receiver systems upgrade. I would like to extend my congratulations to Mark Bowen and the CSIRO team on the outstanding sensitivity attained by the upgraded system over a wide bandwidth and the awards this work has attracted (see box at right).

In January 2013, I flew to the USA to attend a GMT meeting and upon stepping off the plane I was shocked to hear the news of the devastating bushfires at Siding Spring Observatory and Mopra telescope. It is a great relief that the telescopes survived and more importantly, that no one was injured.

Henry Kanoniuk, Alex Dunning and Mark Bowen at the 2012 NSW Engineering Excellence Awards.

Technical Highlight

Accolades for the ATCA upgrade

The Australia Telescope Compact Array (ATCA) centimeter upgrade project has been recognised by receiving a Highly Commended Award in the "Research and Development Category" of the 2012 NSW Engineering Excellence Awards. AAL used EIF funds to support the C/X receiver systems upgrade phase of this project and was listed as a joint-entrant on the award. In addition the project manager for the C/X upgrade, Mark Bowen, was named as a finalist in the 2012 Australian Innovation Challenge.

See pg 30 for further details on the ATCA C/X receiver system upgrade project.

Mark McAuley at the Murchison Widefield Array launch. Image Credit: Roger Brissenden

Collaboration Highlight

MoU on Antarctic Astronomy

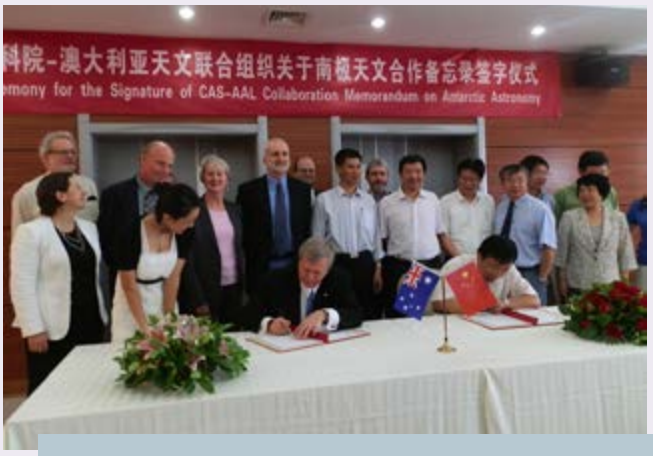
On the 25th August 2012 AAL signed a Memorandum of Understanding (MoU) with the Division of Basic Research of the Chinese Academy of Sciences regarding Antarctic Astronomy at a ceremony in Beijing, during the International Astronomical Union's XXVIII General Assembly.

The MoU addresses collaboration between Chinese and Australian astronomers in key areas of mutual scientific interest, using data from the Chinese-led Antarctic Schmidt Telescopes (AST3) project and support observations from Australian facilities. The key science areas are:

- Supernova physics;
- The discovery and characterisation of solar system objects and exo-planets and their parent stars;
- Stellar structure and evolution;
- The physics of the dynamic extragalactic Universe.

AST3 is situated at the Kunlun Station, Dome A, at the highest point of the Antarctic Plateau. Conditions on the Antarctic Plateau are ideal for astronomical observation, with extremely cold, dry and stable atmospheric conditions along with very dark skies for long, continuous periods through the year.

Australian astronomers have been involved in activities at Dome A through the University of New South Wales' PLATeau Observatory (PLATO-A) (see, which will be the primary support platform for AST3, and through equipment to characterise the infrared background and cloud cover at Dome A (see pg 36). AAL has funded these activities through the Australian Government NCRIS and EIF grants.



Brian Schmidt (Director, AAL) and Minghua Liu (Director for Basic Research, Chinese Academy of Sciences) sign the MoU, Beijing, 25 August 2012. Photo Credit: Michael Burton

AAL's engagement with international partners witnessed positive developments during the year. In June 2013, AAL agreed with the Carnegie Institution of Science to purchase an additional twenty-three nights on the Magellan telescopes, extending Australian access to these important facilities until the end of 2015.

2012/13 has also seen AAL involved in a number of activities to support the strengthening relationships between astronomers in Australia and China. In recent years, China has been rapidly building its capabilities in astronomy, and in particular has been playing an active role in exploratory astronomical science from Antarctica. The Australian Government, as well as Australian astronomers, recognise the complementary world-leading expertise and resources in astronomy existing between Australia and China.

In the past year AAL has run two workshops with Australian and Chinese astronomers, signed a Memorandum of Understanding (MoU) regarding Antarctic astronomy with the Division for Basic Research of the Chinese Academy of Sciences (see box above) and partaken in the first oversight committee meeting for this collaboration in China.

In June 2013, AAL also received a grant from DIICCSRTE to enable Australian astronomers to travel to China under the Australia China Astronomy Collaboration Award scheme during the 2013/14 year. This activity comes under DIICCSRTE's MoU regarding astronomy with the Chinese Academy of Sciences.

Snapshot of Projects & Facilities

AAL-supported projects that achieved practical completion in 2012/13 were: the Murchison Widefield Array; the gSTAR GPU-powered supercomputer; the Australia Telescope Compact Array C/X receiver upgrade; and the Pierre Auger Observatory cloud camera upgrade. On track for completion in 2013/14 are the All-Sky Virtual Observatory and the Anglo-Australian Telescope instrumentation projects (HERMES and AAOmega spectrographs).

AAL's projects in 2012/13 were primarily funded by the Education Investment Fund (EIF), which had 64 milestones due in 2012/13. Of these, 86% were completed, 6% were almost complete, and most of the remaining milestones were well progressed as at 30th June 2013. Since the project began, 91% of the 119 EIF milestones have been completed.

Australian access to AAL-supported facilities resulted in a total of 98 refereed publications in 2012/13 involving 215 Australian co-authors, 46 student co-authors and hundreds of international co-authors. These publications span a wide range of astronomical fields, including radio, optical, theoretical, and high-energy astrophysics (see Publications, pg 39).

Michael Bourne machining the 4 -12GHz Ortho Mode Transducer one of the components central to the success of the C/X receiver upgrade. Image credit: Tim Wheeler

Such project successes and access to overseas facilities require significant funding. I was therefore delighted that AAL secured over $4M in new grants during 2012/13, which was an excellent result in a tight fiscal environment. As with previous investments, AAL continued to be guided by the 2006-2015 Decadal Plan for Australian Astronomy and its Mid-Term Review in advising on the allocation of those grants. AAL-investment decisions in 2012/13 targeted the highest priorities in the Mid-Term Review, including early science operations of Australia's SKA pathfinders and Australian access to large overseas telescopes. Modest levels of funding were also allocated to support PLATO and gSTAR operations.

The Australian Government's May 2013 budget decision to provide an additional $185.9M for the National Collaborative Research Infrastructure Strategy (NCRIS) was an important announcement that AAL strongly supports. It is especially reassuring that the original NCRIS programme, which was launched by the Australian Government in 2006, was again recognised as the most effective method to support the development and operation of major research infrastructure. With the support of this new NCRIS funding, 2013/14 promises to be yet another eventful year.

Mr Mark McAuley
Chief Executive Officer

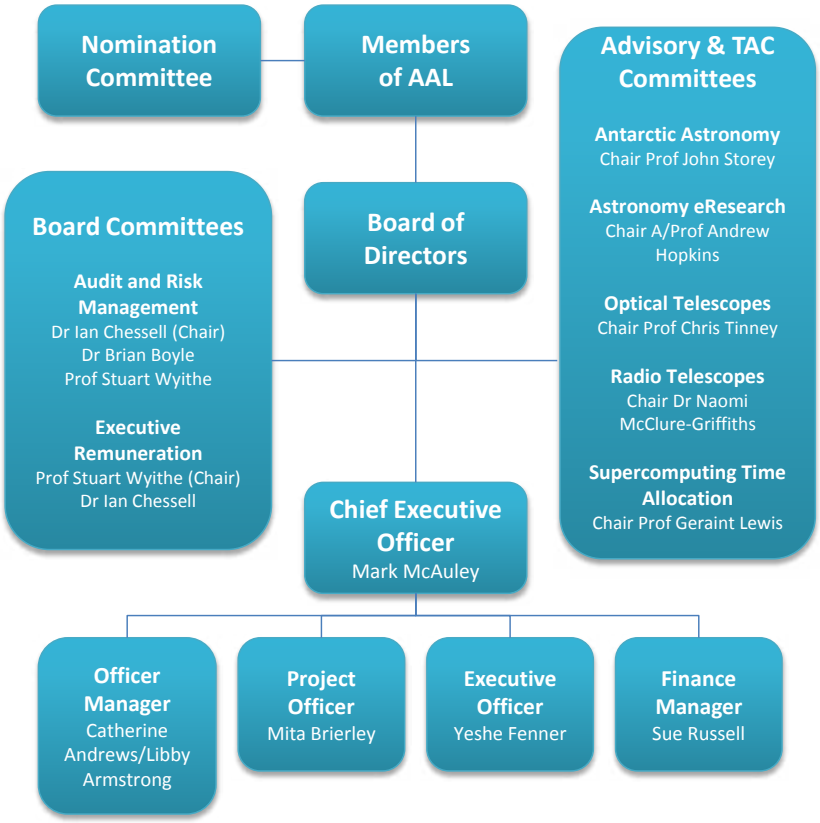
AAL in 2012/13

Murchison Widefield Array image of the galactic anti-centre; imaged using Fast-Holographic-Deconvolution. Image credit: Ian Sullivan, University of Washington.

Organisational Structure

AAL's membership includes all institutions with an astronomy research capability in Australia. AAL's four advisory committees are broadly representative of the astronomical community and are well placed to understand and reflect the views of the wider astronomy community. AAL relies on its committees to monitor and assess the progress of all projects and subprojects, evaluate key performance indicators, and advise on opportunities for collaboration and improving project outcomes. The AAL Board makes key decisions about projects based on the committees' recommendations as well as the Board's own considerable and diverse expertise.

Organisational chart as of 30th June 2013



Board of Directors as of 30th June 2013

Prof Stuart Wyithe (Chair)	Appointed Chair 14th March 2013 until 2013 AGM
	Appointed Director 11th November 2011 until 2014 AGM
Prof Brian Boyle	Appointed 5th November 2009 until 2015 AGM
Dr Ian Chessell	Appointed 5th November 2010 until 2013 AGM
Prof Warrick Couch	Appointed 18th April 2007 until 2013 AGM
Prof Anne Green	Appointed 5th November 2010 until 2013 AGM
Prof Robyn Owens	Appointed 2nd November 2012 until 2015 AGM
Prof Brian Schmidt	Appointed 18th April 2007 until 2014 AGM

Major Meetings & Events

Member updates

	Date	AAL attendees
AAO	4 Apr 2013	Brian Boyle
CSIRO	10 Apr 2013	Brian Boyle
Swinburne University	3 Jun 2013	Mark McAuley
Australian National University	16 Nov 2012	Brian Schmidt
University of Melbourne	7 May 2013	Board & staff
University of New South Wales	1 Nov 2012	Board & staff
University of Queensland	6 Aug 2012	Board & staff
University of Sydney	28 Sep 2012	Anne Green
University of Tasmania	25 Mar 2013	Mark McAuley

AAL-organised Workshops

Wide-field Optical Astronomy from Antarctica: a Chinese-Australian Workshop

13 Aug 2012, Sydney.
(Organised by AAL, UNSW and CAASTRO)

All-Sky Virtual Observatory user workshop

27 Feb 2013, Canberra

1st Antarctic Survey Telescopes Science Planning and Collaboration Workshop

19 – 20 Feb 2013, Melbourne

International engagement and overseas telescope governance meetings

Gemini	Date	AAL attendees
Gemini Science Meeting	16-20 Jul 2012	Karl Glazebrook
Gemini Board Retreat	27-29 Sep 2012	Stuart Wyithe, Peter Quinn
Gemini STAC Meeting	29-30 Oct 2012	Karl Glazebrook
Gemini Finance Committee Meeting	13 Nov 2012	Stuart Wyithe
Gemini Board	14-16 Nov 2012	Stuart Wyithe
Gemini STAC Meeting	22-23 Apr 2013	Karl Glazebrook
Gemini Finance Committee Meeting	14 May 2013	Stuart Wyithe
Gemini Board	15-17 May 2013	Stuart Wyithe
GMT		
GMT retreat	11-14 Oct 2012	Warrick Couch
GMT Finance Committee (Mark) and Board	12-16 Oct 2012	Mark McAuley, Warrick Couch
GMT Science Advisory Committee	24-26 Oct 2012	Chris Tinney
GMT Board	13-15 Jan 2013	Mark McAuley
GMT Finance Committee and Board	16-18 Apr 2013	Mark McAuley
GMT Science Advisory Committee	11-13 Mar 2013	Chris Tinney
Other		
Working Group of the Australia-China Antarctic Astronomy MoU, Tengchong, China	24-30 May 2013	Mark McAuley, Brian Boyle, John Storey

Departmental briefings and meetings

Research Data Infrastructure Committee meetings at DIICCSRTE, Canberra

31 Aug 2012	5 Dec 2012 22 Feb 2013	29 Apr 2013
5 Oct 2012		
9 Nov 2012	22 Mar 2013	

Departmental briefings by AAL to DIICCSRTE

Date	AAL attendees
23 Jul 2012	Mark McAuley, Yeshe Fenner
24 Sep 2012	Mark McAuley, Stuart Wyithe
4 Dec 2012	Mita Brierley, Yeshe Fenner
19 Mar 2013	Brian Boyle, Warrick Couch, Mark McAuley
25 Mar 2013 (Antarctic Division, Hobart)	Brian Boyle, Mark McAuley
2 Apr 2013	Brian Schmidt, Stuart Wyithe, Mark McAuley

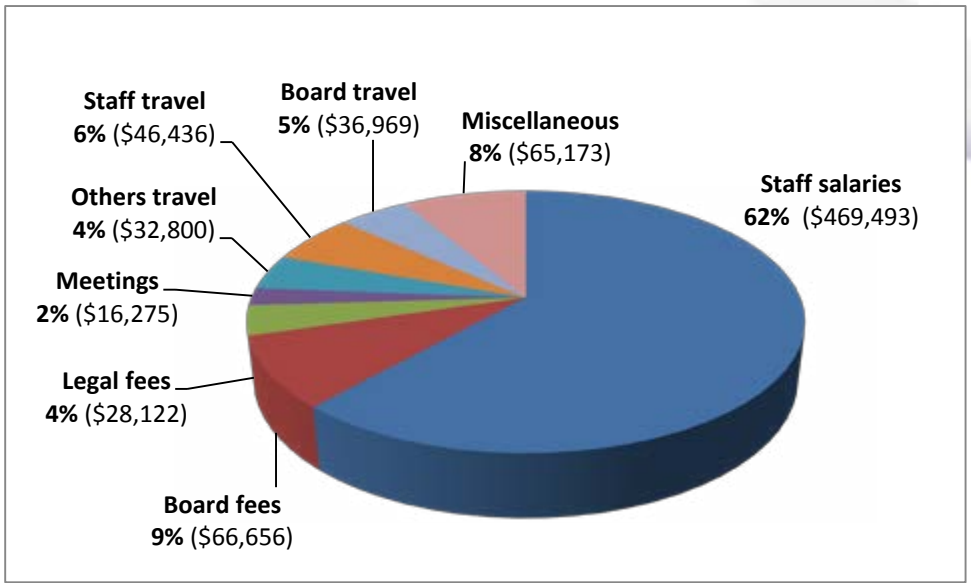
DIICCSRTE Research Infrastructure Planning

Date	AAL attendees	Activity
14 Jun 2013	Mark McAuley	NCRIS Capabilities Day
18 Jul 2012	Mark McAuley	Workshop: National Research Investment Plan
20 Sep 2012	Mark McAuley, Stuart Wyithe	NSF Astronomy Portfolio Review

Financial
Summary

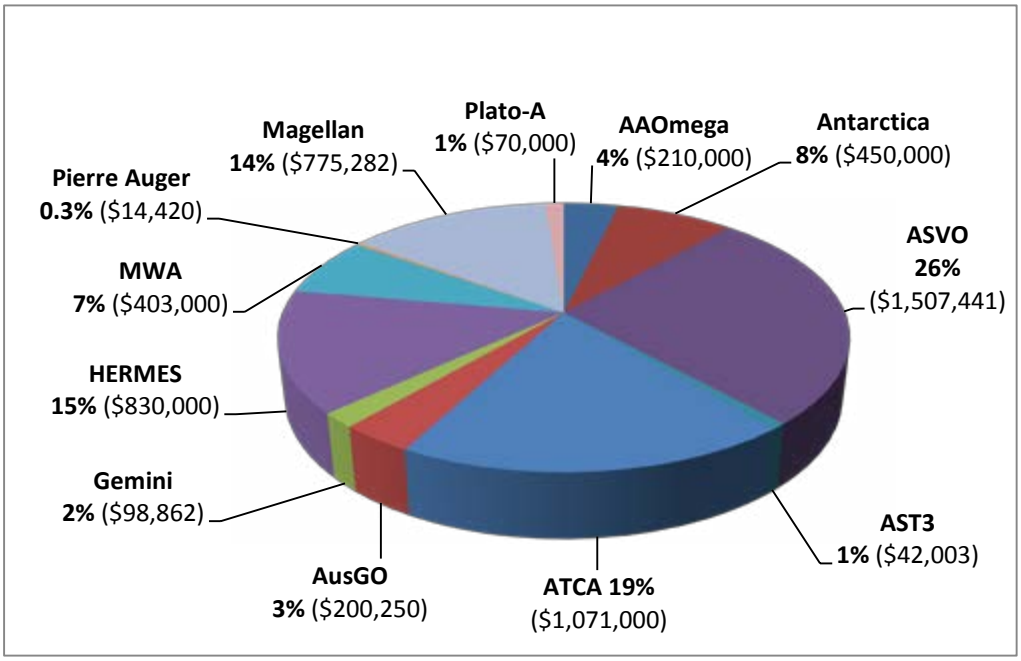
AAL Operating Expenses

Actual operating expenses for 2012/13 were $761,924. The breakdown of costs is similar to last financial year taking into account the functions of accounting, company secretarial and external consultants were brought in-house in 2012/13.



Grants Paid to Projects during 2012/13

Total grants paid for 2012/13 were $5,672,258 which includes Magellan telescope payments of $775,282 from the Overseas Optical Reserve deferred grant.



Grants Received and Balance of Grants held as at 30 June 2013

Grant	Grants Received	Closing Balance
NCRIS Grant	-	$110,887
DIICCSRTE AST3 – ALMA Grant	$30,000	$17,997
DIICCSRTE MWA Grant	-	$200,000
AAO Grant	$933,000	$1,699,750
EIF Grant	$2,500,000	$290,000
NeCTAR Grant	$1,412,201	$160,040
CRIS Grant	$1,153,000	$1,153,000
DIICCSRTE – Aust China scholarships Grant	$60,000	$60,000
	$6,088,201	**$3,691,674**

Reserves

AAL currently maintains three reserves with net interest earned used for projects associated with the relevant activity. During 2012/13 there were the following transfers to and from Reserves:

Reserve	Net Interest	Transfer from Reserve	Purpose of Funds	Closing Balance
NCRIS Reserve	$61,925	$140,715 $28,624	ASVO AAL Management Fee	$316,256[#]
Overseas Optical Reserve[*]	$118,968	$50,300 $582	AAL Management Fee Shortfall in Gemini payment	$2,583,105
EIF Reserve	$32,625	$92,565	ASVO	$26,210

[#] $255,470 is committed for ASVO in 2013/14.

[*] The Overseas Optical Reserve is primarily used to cover shortfalls in payments to overseas optical telescope facilities. During 2010/11 $1,550,562 was contractually committed to continue Australian access to fifteen nights per year on the Magellan telescopes from semester 2011B until semester 2013A inclusive. The final payments ($775,282) were made in 2012/13.

AAL
Committees

Committee membership as of 30th June 2013

Antarctic Astronomy Advisory Committee (AAAC)

Prof John Storey (Chair), University of New South Wales, until 31 December 2014

Prof Brian Boyle, Astronomy Australia Ltd (ex-officio)

Prof Michael Burton, University of New South Wales, until 31 December 2014

Dr Gary Hill, University of Adelaide, until 31 December 2013

Dr Mike Ireland, Macquarie University, until 31 December 2013

Prof Jon Lawrence, Australian Astronomical Observatory, until 31 December 2013

A/Prof Sarah Maddison, Swinburne University of Technology, until 31 December 2014

Dr Jill Rathborne, CSIRO, until 31 December 2014

Dr Nick Tothill, University of Western Sydney, until 31 December 2013

Astronomy eResearch Advisory Committee (AeRAC)

A/Prof Andrew Hopkins (Chair), Australian Astronomical Observatory, until 31 December 2013

Prof Lindsay Botten, NCI Director (ex-officio)

Dr Jessica Chapman, CSIRO, until 31 December 2014

Dr Christopher Fluke, Swinburne University of Technology, until 31 December 2013

Dr Ian Gibson, Intersect Australia Ltd CEO (ex-officio)

Dr Jenni Harrison, iVEC eResearch Program Leader (ex-officio)

A/Prof Jarrod Hurley, Swinburne University of Technology Supercomputer Manager (ex-officio)

Prof Robyn Owens, Astronomy Australia Ltd (ex-officio)

Dr Raquel Salmeron, the Australian National University, until 31 December 2014

Prof Andreas Wicenec, University of Western Australia, until 31 December 2013

Dr Ross Wilkinson, Australian National Data Service, until 31 December 2014

Astronomy Supercomputer Time Allocation Committee (ASTAC)

Prof Geraint Lewis (Chair), University of Sydney, until 31 December 2013

Dr George Beckett, iVEC Representative (ex-officio)

Prof Geoff Bicknell, Australian National University, until 31 December 2014

Dr Ben Evans, NCI Representative (ex-officio)

A/Prof Jarrod Hurley, Swinburne Supercomputer Manager (ex-officio)

Prof John Lattanzio, Monash University, until 31 December 2013

Dr Katherine Mack, University of Melbourne, until 31 December 2014

Dr Steve Ord, Curtin University, until 31 December 2014

Optical Telescopes Advisory Committee (OTAC)

Prof Chris Tinney (Chair), University of New South Wales, until 31 December 2014

Dr Sarah Brough, Australian Astronomical Observatory, until 31 December 2013

Prof Warrick Couch, Australian Astronomical Observatory Director (ex-officio)

Prof Michael Drinkwater, University of Queensland, until 31 December 2014

Prof Karl Glazebrook, AAL's Gemini STAC Representative (ex-officio)

Prof Lisa Kewley, the Australian National University, until 31 December 2014

A/Prof Michael Murphy, Swinburne University of Technology, until 31 December 2013

Prof Quentin Parker, Macquarie University, until 31 December 2013

Prof Stuart Wyithe, Astronomy Australia Ltd (ex-officio)

Prof Stuart Wyithe, Gemini Board Member (ex-officio)

Radio Telescopes Advisory Committee (RTAC)

Dr Naomi McClure-Griffiths (Chair), CSIRO, until 31 December 2013

Dr Lewis Ball CASS Director, CSIRO (ex-officio)

Prof John Dickey, University of Tasmania, until 31 December 2013

Prof Bryan Gaensler, University of Sydney, until 31 December 2014

Prof Anne Green, Astronomy Australia Ltd (ex-officio)

Prof Minh Huynh, University of Western Australia, until 31 December 2013

Dr Jean-Pierre Macquart, Curtin University, until 31 December 2014

Prof Lister Staveley-Smith, University of Western Australia, until 31 December 2014

Prof Rachel Webster, University of Melbourne, until 31 December 2014

Committee Meetings

A total of 16 Advisory Committee meetings were held in 2012/13; one meeting per quarter, for each of the four Advisory Committees.

ASTAC held three meetings in 2012/13.

The HERMES spectrograph fibre cable installed on 2dF and AAT. Image credit: Vladimir Churilov

Nominations to Overseas Committees

Giant Magellan Telescope

Board

- Prof Warrick Couch,
  Australian Astronomical Observatory
- Mr Mark McAuley,
  Astronomy Australia Ltd

Finance Committee

- Mr Mark McAuley (Chair),
  Astronomy Australia Ltd

Science Advisory Committee

- Prof Chris Tinney,
  University of New South Wales

Gemini

Board

- Prof Stuart Wyithe,
  Astronomy Australia Ltd

Finance Committee

- Prof Stuart Wyithe,
  Astronomy Australia Ltd

Science and Technology Advisory Committee

- Prof Karl Glazebrook (Deputy Chair),
  Swinburne University of Technology

AURA Oversight Council for Gemini

- Mr Mark McAuley,
  Astronomy Australia Ltd

Nomination Committee (For the 2012 AGM election)

Prof Mark Wainwright (Chair)	Astronomy Australia Ltd
Dr Kate Brooks	Astronomical Society of Australia
Prof John Lattanzio	Monash University
Dr Gavin Rowell	University of Adelaide
Prof Rachel Webster	University of Melbourne

Members and their representatives as of 30th June 2013

Australian Astronomical Observatory	A/Prof Andrew Hopkins
Australian National University	Prof Matthew Colless
Commonwealth Scientific and Industrial Research Organisation	Dr Simon Johnston
Curtin University	Prof Steven Tingay
Macquarie University	Prof Quentin Parker
Monash University	Prof Alexander Heger
Swinburne University of Technology	Prof Karl Glazebrook
University of Adelaide	Dr Gavin Rowell
University of Melbourne	Prof Rachel Webster
University of New South Wales	Prof John Storey
University of Queensland	Prof Halina Rubinsztein-Dunlop
University of Sydney	Prof Peter Tuthill
University of Tasmania	Prof John Dickey
University of Western Australia	Prof Peter Quinn

Facilities

AAL supports Australian access to a range of world-class national and international astronomical facilities. Those outlined in the following pages are operational facilities to which AAL assigned funding in 2012/13 to enable national access.

The Murchison Widefield Array core region as viewed from the air. The core contains 42 of the 128 tiles that make up the MWA.

Final image from the 2012 Australian Gemini School Astronomy Contest, showing the 3 different spiral galaxies (left to right) NGC 7232B, NGC 7233, and NGC 7232. Image credit: Ryan Soares (Trinity College), Travis Rector (U. Alaska Anchorage), and the Australian Gemini Office.

Gemini & Magellan

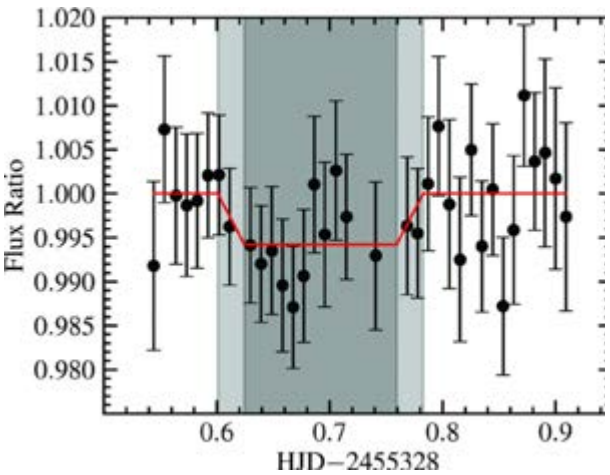
Access to the world's largest-aperture (8-metre class) telescopes remains one of the highest priorities of the Australian astronomical community. In 2012/13 AAL secured a total of $1.34M of Commonwealth-funding to extend Australian access to the Magellan telescopes through to the end of 2015 and continue supporting AusGO in 2013/14. Australia's 2012 contribution to the Gemini telescope instrumentation was funded from AAL's EIF grant.

Gemini

AAL is contracted by the Australian Research Council to be the managing entity for funds to enable Australian membership of the International Gemini Partnership. This membership allows Australian astronomers access to 6.19% of the available telescope time on the two 8-metre Gemini telescopes located in Chile and Hawaii. The International Gemini Partnership Agreement has effect until 31 December 2015.

In 2012/13 a total of 87 astronomers (including 18 students) from 13 Australian institutions were involved in proposals submitted for the Australian time on Gemini, with a subscription factor of 1.9.

Through continued engagement in the Gemini partnership, Australia has been well positioned to win contracts to build cutting-edge instrumentation for 8-metre telescopes (see box pg 18 for examples of Australian-built instrumentation for Gemini).



Measured light curve for flux in the sodium D line in WASP-17b. The red line plots the 0.58 ± 0.13 per cent transit depth fit. The darker shade marks the in-transit portion of the light curve, whilst the lighter shade marks ingress and egress. Figure taken from Zhou & Bayliss (2012).

Magellan

AAL is a direct signatory to the Carnegie Institution for Science which operates the 6.5-metre Baade and Clay telescopes, comprising the Magellan Telescopes, at its Las Campanas Observatory in Chile.

Australian-based astronomers currently have access to 15 nights per year on these telescopes, and funding has been secured to maintain this level of access through to the end of 2015.

In 2012/13 a total of 54 astronomers (including 11 students) from 13 Australian institutions were involved in submitting proposals for observing time on Magellan. This is an increase of 20 - 30% from 2011/12. Time on Magellan is highly competitive - the subscription factor is 3.5 - and successful proposals are generating high-impact science (see example below).

Science Highlight

Detecting individual elements in the atmospheres of exoplanets

An Australian team used the Magellan telescope to obtain one of the first-ever detections of sodium in the atmosphere of an exoplanet, using a ground-based telescope. This exciting result highlights the potential for more such detections as new transiting exoplanets are discovered by the HAT-South network which includes ANU cameras at Siding Spring Observatory.

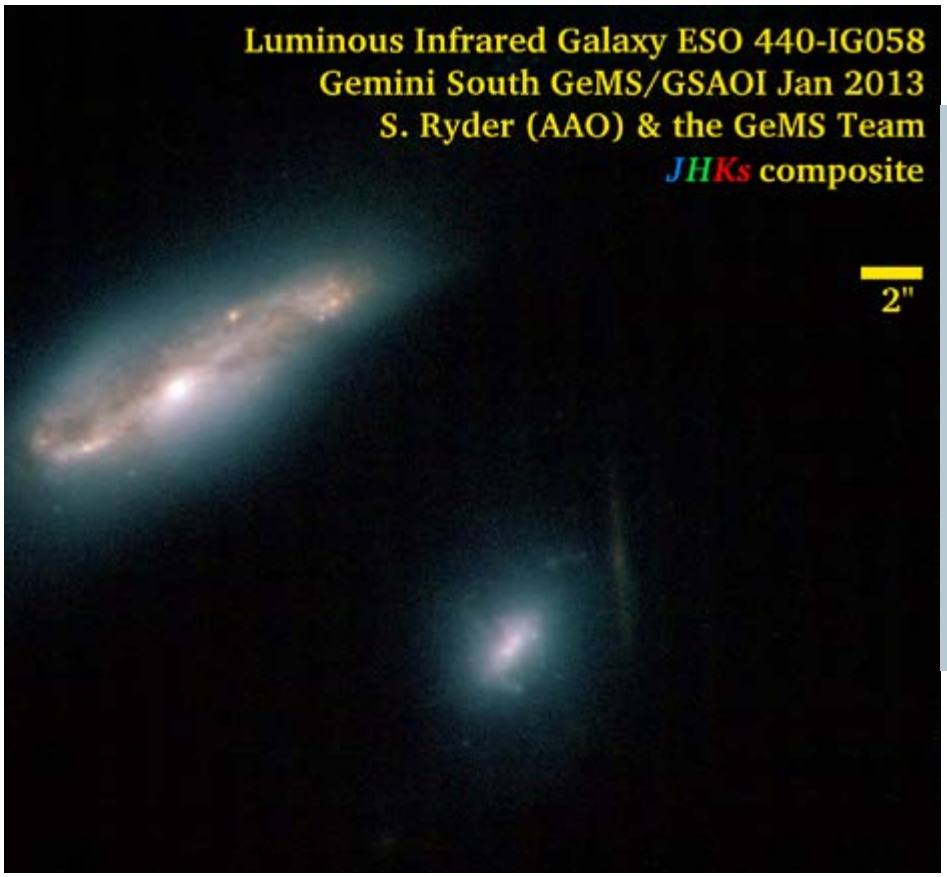
The ANU team used Magellan's MIKE high-resolution optical spectrograph to compare spectra of the "hot Jupiter" exoplanet WASP-17b when in transit in front of its parent star, with those out of transit (Zhou & Bayliss, 2012, MNRAS, 426, 2483). The excess absorption in the sodium D lines during transit of 0.6% was attributed to the presence of sodium in the planet's highly inflated atmosphere.

Technical Highlight

Australians developing instrumentation for the Gemini telescopes

Australia plays a key role in providing state-of-the-art instrumentation for the Gemini telescopes. The Gemini South Adaptive Optics Imager (GSAOI), designed and built by ANU, is a near-infrared camera designed to work in conjunction with the Gemini Multi-Conjugate Adaptive Optics System (GeMS). The system uses a laser and an optical bench to produce a "constellation" of five laser guide stars instead of just one. GeMS+GSAOI is the only facility in the world that can fully correct for atmospheric turbulence over such a large (85") field of view. In 2012/13 GeMS+GSAOI moved swiftly through commissioning and verification and was offered to the Gemini user community in Semester 2013A. One third of the available GSAOI time allocated in Semester 2013A went to Australian-led proposals, emphasising the high level of interest within the Australian community in exploiting this unparalleled new capability.

A team involving AAO, Macquarie University, ANU and KiwiStar Optics (New Zealand), was selected from among three competing bids to construct the Gemini High-resolution Optical Spectrograph (GHOS). Due to be delivered to Gemini in 2016, GHOS builds on AAO's previous experience including, HERMES and the multi-object fibre positioner MANIFEST for GMT.



Near-infrared colour composite image of the Luminous Infrared Galaxy ESO 440-IG058, obtained using Gemini's GeMS+GSAOI. The previously unsuspected faint edge-on disk galaxy visible just right of centre may be partly responsible for triggering the unusually high rate of star formation in this system. Image credit: Stuart Ryder (AAO)

Participants at the 2012 Australian Gemini and Magellan Science Symposium. Image credit: Stuart Ryder (AAO).

Australian Gemini Office

Highly valued by the Australian optical astronomy community, the AAO-operated Australian Gemini Office (AusGO) provides support and training to Australian-based astronomers to maximise access to, and science output from, large-aperture overseas optical telescopes, including Gemini and Magellan.

AAL continues to fund operations of AusGO, to enable it to coordinate Australia's usage of 8-metre class offshore telescopes by: issuing calls for proposals; acting as first point of contact for prospective Australian applicants; technically assessing proposals on behalf of the Australian Time Assignment Committee; assisting successful Australian Principal Investigators with preparing their programs; providing guidance on data reduction and analysis; and helping to promote Australian science from Gemini and Magellan to the media and general public.

AusGO also coordinates the Australian Gemini Undergraduate Summer Studentship program. This scheme allows two Australian undergraduate students to work at the Gemini South headquarters in Chile on a research project supervised by Gemini staff. AusGO runs an annual contest for Australian high school students to win one hour of time on the Gemini South telescope to observe a scientifically and aesthetically interesting object.

The inaugural Australian Gemini and Magellan Science Symposium was organised by AusGO and held at Swinburne University of Technology on 22–23 October 2012. There were about 40 participants (including 13 students and 8 postdocs), with 27 speakers presenting scientific highlights as well as a forum on the future of 8-metre access.

Murchison Widefield Array

The Murchison Widefield Array (MWA) is the first of the Square Kilometre Array (SKA) precursor facilities to become fully operational, and contributes to the highest priority in the Mid-Term Review of the Australian Astronomy Decadal Plan by helping to ensure that Australia is well positioned to participate in and host the international SKA.

AAL has supported MWA by providing the majority of the Australian funding for construction of the facility, via $7.7M of AAL-administered NCRIS and EIF funds. AAL continues to support MWA through the allocation of $890,000 of DIICCSRTE funds to support operations in CY2013 and C2014, in order to address MWA's high priority science goals. AAL has also requested Commonwealth approval to allocate $630,000 of the new Astronomy-NCRIS-2013 funds to MWA to double its duty cycle and extend operations until June 2015.

The telescope

MWA has great strategic importance as the low-frequency SKA precursor telescope, as well as enormous scientific potential, providing a unique window on the Universe in the 80-300MHz band at the world's best site in this frequency range. MWA's 128 aperture arrays are distributed over a 3km-wide area and allow large surveys of the entire Southern sky to be undertaken, as well as deep observations on targeted regions. MWA will enable astronomers to pursue four key science objectives. The primary endeavour is the hunt for intergalactic hydrogen gas that surrounded early galaxies during the cosmological epoch of reionization. The MWA will also provide new insights into our Milky Way galaxy and its magnetic field, pulsing and exploding stellar objects, and the science of space weather that connects our Sun to the environment here on Earth.

Progress and current status

2012/13 saw intensive efforts to complete construction, followed by engineering and science commissioning. The engineering commissioning program culminated with a declaration of practical completion and the formal launch of the MWA on 30 November 2012 at an opening ceremony attended by 50 VIPs and key stakeholders.

The second half of 2012/13 saw the final push toward a fully operational MWA, with the MWA Engineering and Science Commissioning Teams setting about the task of knitting together the independently commissioned 32-tile sub-arrays to constitute the full 128-tile MWA. This was completed in March 2013, with fringes identified across the array, indicating the successful correlation of products from all 128 tiles.

In the lead up to full operations beginning mid-2013, MWA conducted an inaugural Call for Proposals for observing with MWA. The response was strong and the first observing semester in 2013B was oversubscribed. The MWA Time Allocation Committee allocated

Using 105 of MWA's 128 tiles, this 35 degree-wide image encompasses Hydra A, the Vela supernova remnant (Gum nebula), and Puppis A. The "cloudy" emission seen across the image is from our own galaxy, the Milky Way, in the foreground to extragalactic point sources, which are galaxies millions to billions of light years distant. Image credit: Andre Offringa and the MWA Science Commissioning Team.

~600 hours to ten proposals in June 2013, and successful proposers began working closely with the MWA Team to schedule the 2013B observing program.

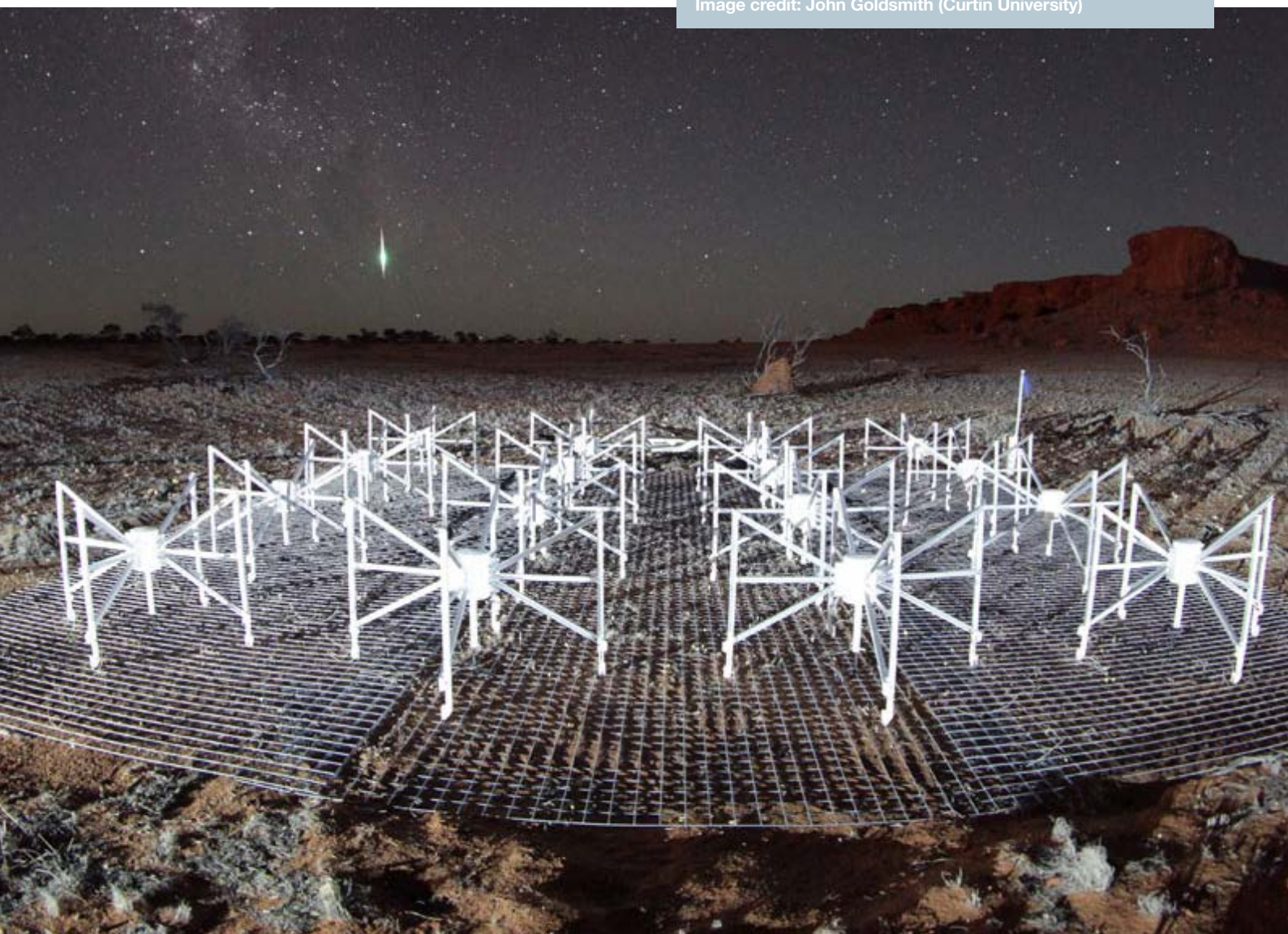
Although this facility was not yet operational in 2012/13, MWA partners published 10 referred articles during the past year, which involved >37 Australian authors from 7 institutions, and >40 international authors from 14 institutions. These papers had collectively received over 80 citations.

MWA public outreach activities during 2012/13 included at least 17 events (including school tours and talks, radio and television interviews, and other public talks) and at least 20 online and/or print articles.

Industry Highlight

Local high-tech enterprise helps astronomers explore the Universe

MWA partnered with Western Australia's Poseidon Scientific Instruments (PSI) to manufacture key components of MWA's receiver sub-system (see "Case Study - Collaboration Between Research Institutes and Industry: Lessons learned from the MWA and applicability to the Square Kilometre Array" (http://astronomy.curtin.edu.au/local/docs/MWA.pdf). This is an example of a productive and effective academic-industry collaboration that not only contributed to the success of MWA, but has also positioned Australian industry to participate in future radio astronomy opportunities, such as the SKA.



The Murchison Widefield Array in outback Western Australia. Image credit: John Goldsmith (Curtin University)

Astronomy-dedicated
High Performance Computing

As Australian astronomers face rapidly growing datasets and demand for more complex and higher resolution simulations, access to High Performance Computational (HPC) facilities becomes increasingly necessary. One of the highest priorities identified in the Mid-Term Review of the Australian Astronomy Decadal Plan was investment at a national level in eResearch-related hardware, software and technical support, in order to fully exploit Big Data from next-generation telescopes and instruments.

AAL has facilitated national access to HPC facilities through continued management of the Astronomy Supercomputer Time Allocation Committee (ASTAC) and by funding the construction and operations of the GPU Supercomputer for Theoretical Astrophysics Research (gSTAR) at the Swinburne University of Technology (SUT). gSTAR is a next-generation Graphics Processing Unit (GPU)-based supercomputer built by SUT and partially funded through AAL's EIF grant. Arrangements are in place for 40% of both gSTAR and the Swinburne Supercomputer for Theoretical Academic Research (swinSTAR) machine, to be dedicated to national astronomy use. In 2012/13, AAL committed $113K of its CRIS funding towards the employment of personnel to provide technical support to gSTAR users, assist with the merit-based time allocation process, and engage with the community to increase awareness and uptake of this facility.

The new NCI peak facility Raijin (a Fujitsu Primergy cluster) entered production in June 2013. The NCI have allocated time on this machine for use by the Australian astronomical community. Image credit: Paul Kuske, NCI

Astronomy Supercomputer Time Allocation Committee

AAL established ASTAC in 2011 to allocate dedicated computing resources for astronomy on the National Computational Infrastructure (NCI) peak system and the SUT machine. iVEC has also requested that ASTAC allocate time made available for national astronomy use on their Epic and Fornax supercomputers located in Western Australia.

ASTAC awarded time to 19 astronomy projects on these four supercomputing systems for 2012/13. A total of 37 astronomers, from 8 Australian institutions, were represented on ASTAC applications.

Facilities with dedicated time for national astronomy use, allocated by ASTAC in 2012/13:

Facility	Notes
Peak System, NCI National Facility	1 million core-hours available per-calendar year on Sun constellation cluster. This will be increased to 2 million core-hours per-year on the new Raijin Fujitsu Primergy system.
GreenII: Swinburne Supercomputer, SUT	40% of GreenII (the gSTAR/ swinSTAR system) time available, with GPU-based proposals prioritised.
Epic and Fornax, iVEC	Epic and Fornax are part of the Pawsey Centre project. Astronomy time on these machines are prioritised to meet ASKAP and MWA operational requirements, with the remainder released for national astronomy usage.

gSTAR

The GPU Supercomputer for Theoretical Astrophysics Research (gSTAR) was built to provide the Australian astronomy community with a next-generation computing cluster based on GPU technology. Astronomers have a growing reliance on HPC to help solve some of the most complex and demanding problems, ranging from theoretical simulations to large-volume data processing. Within the HPC landscape, the emerging GPU technology offers an affordable path to a massive boost in processing power. Thus the objectives of gSTAR included:

i) providing national access to a large-scale GPU-based supercomputer;

ii) keeping Australian astronomers at the cutting-edge of theoretical research;

iii) enhancing the capacity of the national astronomy community to undertake world-leading research and provide scientific innovation; and

iv) facilitating training of graduate students in this important new area of computation.

$1.04M from the Education Investment Fund was secured through AAL to build gSTAR at Swinburne University of Technology (SUT), with SUT agreeing to cover the running costs and provide ongoing support and maintenance of the hardware. The gSTAR hardware was delivered to SUT, and accepted, in 2011 and normal operations commenced in March 2012.

Progress and current status

A second phase of hardware, purchased primarily from SUT funds, was added to the system in July 2012 with acceptance testing completed in September 2012. This part of the system is referred to as swinSTAR. The final makeup of the compute nodes is:

gSTAR nodes	50 nodes each with 2 x C2070 NVIDIA GPUs, 2 x 6-core Intel X5650 CPUs 3 nodes each with 7 x M2090 NVIDIA GPUs, 2 x 6-core Intel X5650 CPUs (each node contains 48GB RAM)
swinSTAR nodes	86 nodes each 2 x 8-core Intel E5-2660 CPUs, 64GB RAM (64 nodes each contain 1 x K10 NVIDIA GPU) 4 nodes each with 4 x 8-core E78837 CPUs, 512GB RAM

In total there are 2140 CPU-cores and 165 GPUs. National astronomy personnel have access to a minimum of 40% of the compute capability. Access is through both a general access job queue and proposals to the merit-based allocation scheme overseen by ASTAC. The value of the entire system is almost $3M.

Education and training to aid the usage of gSTAR resources has included tutorials as part of the Astroinformatics School (University of Queensland, Brisbane, February 2013) and two GPU workshops held at SUT (given with assistance from NVIDIA). A 0.5FTE position to provide software support to astronomers also

Theoretical astrophysicists Anna Sippel and Dr Marie Martig in front of gSTAR at the Swinburne University of Technology.

enhances usage. Publicity of the time available to astronomers has included presentations at the Astronomical Society of Australia (ASA) annual meeting (July 2012) and the Australian National Institute for Theoretical Astrophysics (ANITA) annual workshop (February 2013).

Since becoming operational, the number of gSTAR users has risen to ≥100 (including ~50 students), and in 2012/13, 57 Australian-based astronomers (including 26 students) were co-authors on referred articles that made use of gSTAR. On average 75% of the compute nodes were in use, which is pleasing given that gSTAR was still in the first full year of operations and the aim was to create capacity to cope with demand for four years (where demand generally peaks after 2-3 years).

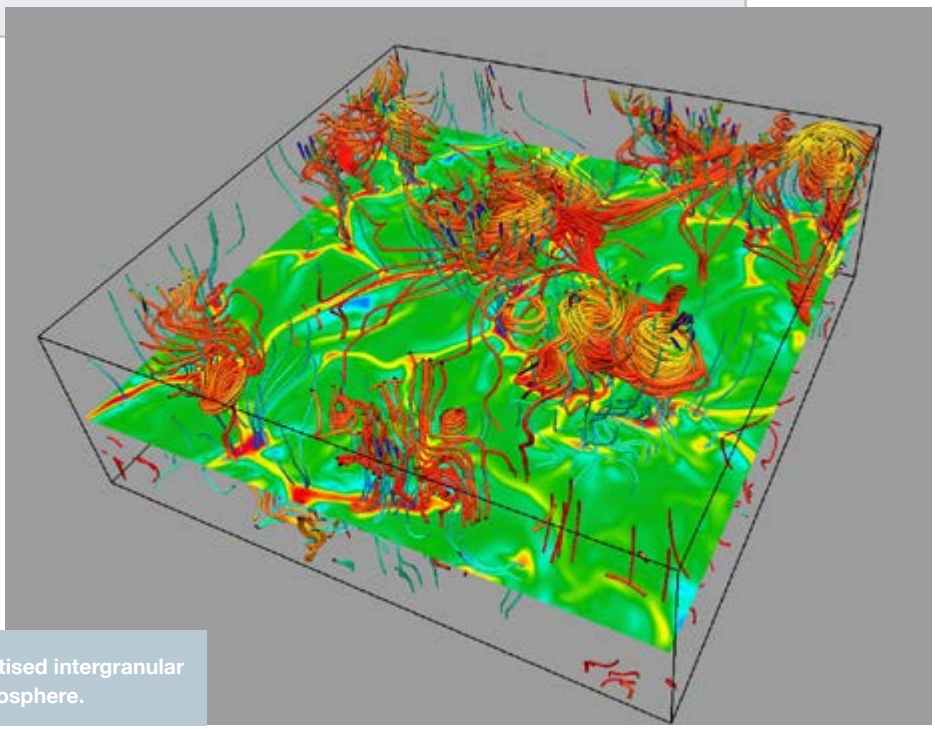
Research involving gSTAR in 2012/13 included data processing to facilitate the discovery of millisecond pulsars through high-precision pulsar timing, three-dimensional magneto-hydrodynamical simulations of helioseismic waves, the creation of mock galaxy catalogues to facilitate new analyses of the WiggleZ galaxy survey, and high-resolution simulations of cosmological microlensing.

Science Highlight

Using gSTAR to understand the structure of the Sun

Using high-precision simulations of solar magneto-convection, a Monash- led group has modelled a transparent upper boundary, located in the middle solar chromosphere, which has proven to be stable for a non-magnetic solar atmosphere. This work will ultimately lead to a better understanding of solar activity and solar structure.

Importantly, the simulations have already shown that the efficiency of vorticity generation, as described previously (Shelyag et al. A&A, 2011, 526, 5), does not depend on the upper boundary type. This is demonstrated in the figure below. Further work will determine if additional stresses and perturbations introduced by strong magnetic fields will affect the long-term stability of the upper boundary.



Vortices in the magnetised intergranular lanes in the solar atmosphere.

Development Projects

AAL supports projects to build infrastructure that aligns with the national research infrastructure priorities of the Australian Astronomy Decadal Plan. The following pages outline development and construction projects for which AAL committed funding in 2012/13.

Australia Telescope Compact Array C-X Upgrade Project: Internal view of the production 4 – 12GHz receiver. Image credit: Alex Dunning.

Giant Magellan Telescope
Design & Development

The Giant Magellan Telescope (GMT) is a next generation optical/infra-red telescope to be located at the Las Campanas Observatory site in Chile. It will combine seven 8.4-metre mirror segments to give the resolving power of a 24.5-metre primary mirror. To advance the Decadal Plan strategy for Australian participation in Extremely Large Telescopes (ELTs), AAL invested in the GMT Organisation at a level designed to secure a 5% share in the project at the end of its Design and Development Phase. AAL represents Australia's interests in GMT through roles on the GMT Board, Finance Committee, and Science Advisory Committee. The ANU also aspires to be a 5% partner, and Australian participation in GMT is fully funded until the end of construction.

Current status

The GMT program moves towards a formal construction decision in the first half of 2014. Full science operations are scheduled to begin in 2020, while early science may begin as soon as 2018, using four of the seven mirrors.

Work that has commenced to date includes: geotechnical surveys and site leveling of the Las Campanas site in Chile; successful completion of mirror GMT-1; successful casting of mirror GMT-2; commencement of GMT-3 casting and the purchase of glass stock for GMT-4. Preliminary design reviews for telescope subsystems were underway in 2013.

Australian GMT instrumentation activities

GMT Integral Field Spectrograph (GMTIFS), designed by ANU, was selected as a first generation GMT instrument. GMTIFS will peer back to the early universe, collecting very faint infrared light to help solve the mysteries of how galaxies and black holes form and evolve. It will use Adaptive Optics to make astronomical observations at very high spatial resolution. It includes both an integral-field spectrograph and a camera for direct imaging. The GMT Board has approved funding to ANU for the GMTIFS Preliminary Design Study in Stage 1 of the telescope development.

Laser Tomography Adaptive Optics (LTAO), also designed by ANU, will use laser guide stars to correct for atmospheric turbulence and allow the telescope to capitalise on its high resolution potential, opening a new era in high angular resolution astronomy. LTAO is scheduled for commissioning by 2023.

MANIFEST: AAO aspires to build a general-purpose fibre-positioning system called MANIFEST (MANy-Instrument FibrE SysTem), to feed the GMT instruments, and has successful completed the feasibility study.

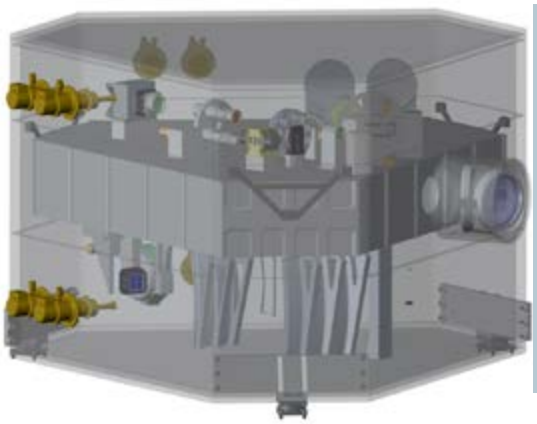


Illustration of the proposed GMT Integral Field Spectrograph cryostat on the GMT instrument platform assembly. Image credit: GMTO

Industry Highlight

Detecting space junk

With the dramatic increase of space "junk" during the last five years, it has become of paramount importance for the international space industry to accurately locate space debris. Drawing on their expertise in Adaptive Optics, which has strengthened through involvement in GMT, ANU have partnered with Electro Optic Systems Pty Ltd (EOS) to improve EOS' space debris and satellite tracking facility with the integration of a Laser Guide Star Adaptive Optics System. This will allow detection of smaller and/or more distant objects. The system has been verified in the laboratory and will undergo "on-sky" testing in 2014. The next (currently unfunded) phase of the project will test whether a high-power laser is capable of nudging debris out its orbit when a collision risk with a useful object is assessed. If the tests are successful, Australia could become the first country to develop a commercially viable system for space debris orbit deflection.

Australian SKA Pathfinder
Construction

The Australian Square Kilometer Array Pathfinder (ASKAP), located at the Murchison Radioastronomy Observatory (MRO) in Western Australia, is designed to be the world's fastest, and one of the most powerful, radio telescopes, with a large field-of-view and novel phased-array feed (PAFs) systems. Continued development and operations of ASKAP was a top priority in the Mid-Term Review of the Decadal Plan for Australian Astronomy 2006-2015. To advance this priority, AAL previously provided $14.6M of NCRIS funding to CSIRO to build ASKAP's Digital Systems (project completed successfully), and has also secured CRIS and NCRIS-2013 funds to support early ASKAP operations.

In 2012/13, CSIRO continued to construct and commission ASKAP (using non-AAL funds), which will eventually be incorporated into SKA Phase 1. Highlights from 2012/13 included: producing the world's first ever multi-beam image using a multiple-PAF interferometer; enabling remote operation of the facility; advancing the ASKAP Design Enhancement program to improve efficiency and performance of the receivers; final site acceptance of all 36 of the ASKAP antennas; and commencing planning of the early science program.

Minister John Day, WA Minister for Science and Innovation (left), Minister Chris Evans, Australian Minister for Tertiary Education, Skills, Science and Research (centre) and CSIRO's Chief Executive, Dr Megan Clark (right) at the Murchison Radio-astronomy Observatory, Western Australia for official opening of the Australian SKA Pathfinder. Image credit: CSIRO

Official opening

AAL was very pleased to attend the official launch of ASKAP in October 2012, where the Minister for Tertiary Education, Skills, Science and Research, officially opened CSIRO's newest radio telescope. The opening celebrated the construction of ASKAP and the establishment of the MRO.

Guests on the day included Board members of the SKA Organisation, senior government representatives, ambassadors of SKA countries, neighbouring pastoralists and traditional owners of the MRO, the Wajarri Yamatji.

Highlights included a 'Welcome to Country', traditional dancing by members of the Wajarri Yamatji, and a traditional naming of the ASKAP antennas with Wajarri names. Proceedings concluded as antennas pointed to Virgo A and test data began to stream in.

AAT
Instrumentation

Amongst the priorities of the Mid-Term Review of the Decadal Plan for Australian Astronomy 2006-2015 is ongoing maintenance and continued development of innovative instrumentation for Anglo-Australian Telescope (AAT). The AAT is the premier optical national facility operated by the Australian Astronomical Observatory (AAO). Continued AAL support for AAT instrumentation and upgrades has contributed to this telescope retaining its position at the leading-edge of technology. AAL currently provides EIF funds for two AAT instrumentation projects: development of the HERMES spectrograph and an upgrade to the AAOmega spectrograph.

HERMES

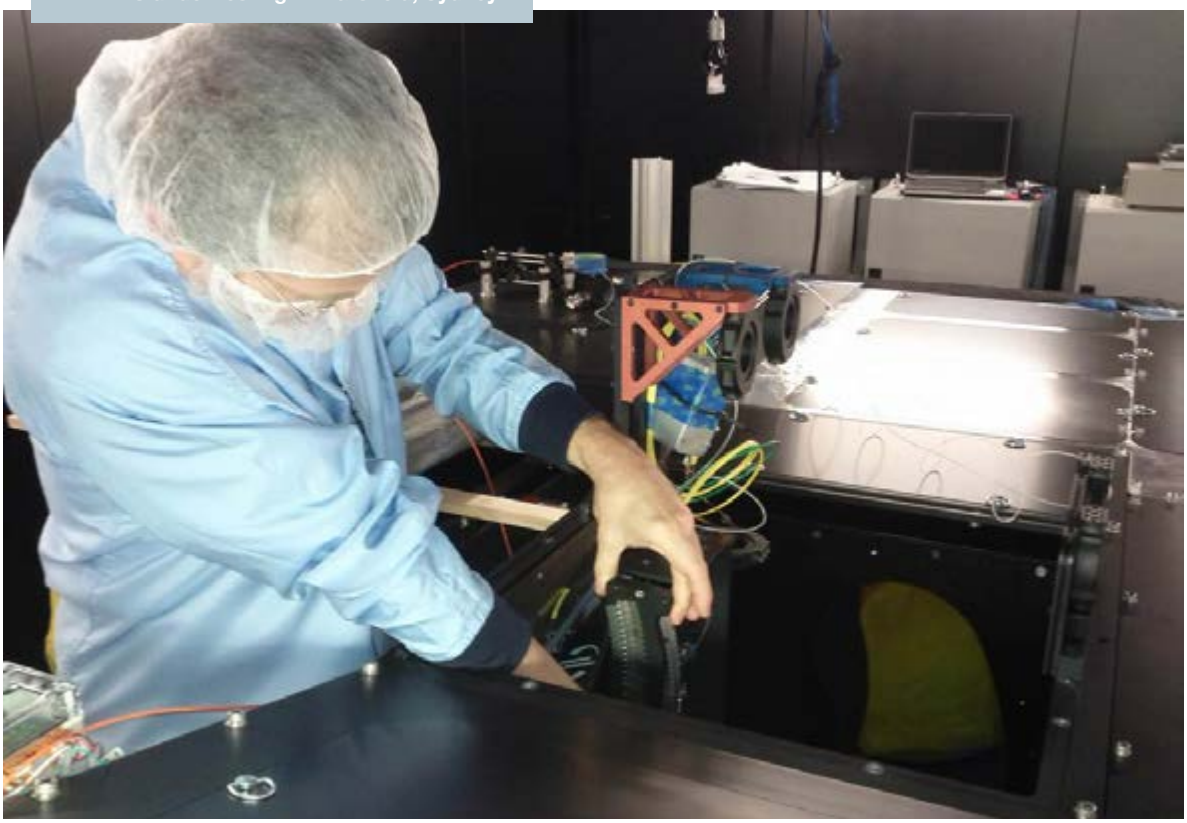
The HERMES (High Efficiency and Resolution Multi-Element Spectrograph) is a world-class instrument currently under development at the AAO. HERMES will allow the simultaneous spectroscopic observation of up to 400 targets at a spectral resolving power of about 30,000 with 4 separate simultaneous wavelength regions. The primary science objective of HERMES is to unravel the Milky Way's formation history through the "Galactic Archaeology survey with HERMES" (GALAH), which will measure the chemical composition, position and velocity of up to a million stars.

Progress and current status

2012/13 was a busy and generally successful year for the HERMES team, in which important milestones (integration, testing and transport to the telescope) were achieved. A particular highlight was first light with the HERMES blue channel on 31 August 2012.

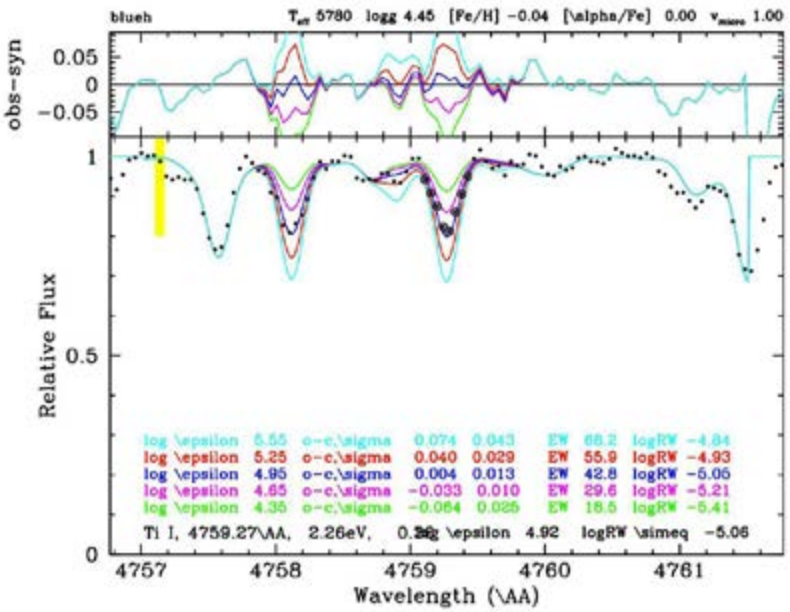
A number of technical issues were encountered through the year, due to the unique nature of, and the precision required from, many of the instrument components. This includes the slight deformation of the three VPH gratings, requiring repolishing (two of the three have now been completed, with the third IR grating scheduled for July-August

HERMES under testing in Marsfield, Sydney .



2013). Delayed delivery of components, and issues with quality from some suppliers, also impacted on the HERMES timeline.

By December 2012, all major optical components (collimator and cameras) had been delivered and instrument assembly was completed in Feb 2013. The full system test was performed in Sydney by the end of March 2013. The findings show that the instrument is functioning very well and produces correct spectra (see box and figure below).



AAOmega upgrade

AAOmega is an existing spectrograph on the AAT. The spectrograph is a dual beam system, with a blue arm and a red arm. The dual beam system covers the wavelength range 370–850nm at low resolution, and is tuneable over this entire range at higher resolutions. AAOmega can be fed either by the 2dF robotic positioner in Multi-Object Spectroscopy mode, or it can be fed by the SPIRAL Integral Field Unit. In the future it will also be fed via KOALA (replacement for SPIRAL) and the SAMI hexabundle instrument. The primary objective of this project is to improve the efficiency at blue and red wavelengths.

The disassembly at Marsfield and the re-integration of the instrument at the AAT began in June 2013. Five truck loads and many minibuses completed the delivery of all equipment to install HERMES at the AAT, where HERMES will produce spectra for millions of stars.

Technical Highlight

HERMES gets ready to reconstruct Milky Way's history

A pilot survey with HERMES is scheduled for late 2013, which will be the first scientific use of the instrument. A highlight for HERMES in 2012/13 was the collection of solar spectra using three of the four channels. The spectra were passed through the GALactic Archaeology with HERMES (GALAH) data pipeline to obtain accurate chemical abundances, thus providing important verification that the instrument and data analysis software are functioning to specification.

The figure at left shows the spectral synthesis of the Ti I line at 4759 angstroms with the data pipeline for the nominal resolution spectra HERMES Blue channel. Black points show HERMES data and coloured lines are different synthetic fits produced by the data pipeline. The spectral region used for setting the continuum level is marked in yellow. The derived abundances are within the required accuracy of 0.05 dex.

Progress and current status

The test setup for the test cryostat has been prepared and procurement has been completed, including the Blue and Red CCDs, which have been received. Testing of the CCDs is planned in late 2013.

This project has suffered delays due to late delivery of the red CCD and competing with the HERMES project for resources (particularly in electronics area and CCD testing). The AAO is making every effort to now expedite this project, with expected completion date by end of April 2014.

ATCA
C/X Receiver Upgrade

The Australia Telescope Compact Array (ATCA), located near Narrabri, New South Wales, is a six-antenna array radio telescope and forms part of the Australia Telescope National Facility. The ATCA is operated by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) Astronomy and Space Science (CASS) division. AAL has supported this national facility through EIF funding to upgrade the ATCA's C/X receiver systems. The upgrades help maintain the ATCA's competitive status in a new era of high sensitivity telescopes such as EVLA, ASKAP and MeerKAT.

Alex Dunning modeling the 4 -12GHz Ortho Mode Transducer one of the components central to the success of the C/X receiver upgrade. Image credit: Tim Wheeler

The upgrade

The C/X upgrade project is the final phase of the ATCA centimetre receiver upgrade. The project has merged the 6cm and 3cm bands from the original (4.4 – 6.9GHz & 8.0 – 9.2GHz) bands to provide continuous coverage of approximately 4 – 10.8GHz. The project complements the low frequency ATCA upgrade, completed in early 2011, which increased the frequency coverage of 1.25 – 1.8GHz & 2.2 – 2.5GHz bands to approximately 1.1 – 3GHz. Together, the ATCA upgrades have given this facility unprecedented access to the centimetre radio spectrum from 1.1 GHz to 10.8 GHz at twice the previous sensitivity and with a survey speed more than four times faster. This high performance capability will enable fundamentally new scientific programs in many areas. These include the identification and understanding of transients detected by CASS's new ASKAP antennas in Western Australia and an improved understanding of magnetic field origins in galaxy disks and Active Galactic Nuclei.

Progress and current status

The project is practically complete with production receiver systems now fitted to all six ATCA antennas. The ATCA C/X upgrade has delivered a greater than 40% improvement in the system noise performance and a 25% increase in the operating bandwidth when compared to the original C/X receiver systems. The measured system performances are better than that of the equivalent NRAO eVLA receiver systems that have been traditionally used as a benchmark. The upgraded receivers are now used for routine scientific observations as part of Australia Telescope National Facility operations.

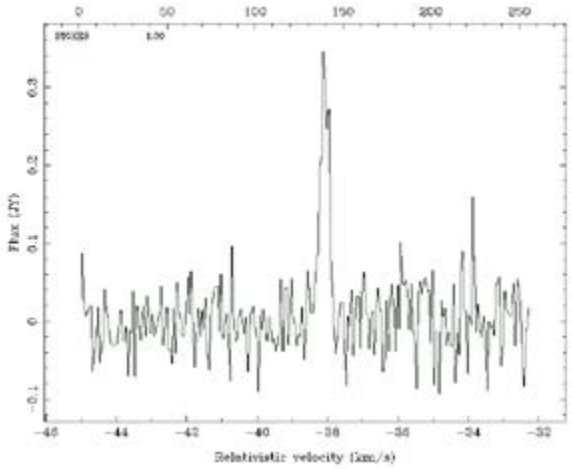
Production receiver systems were rolled out over the course of the past year, with the final two production receivers being installed on the

ATCA in February 2013. The original prototype receiver has been fitted out to be used as the operational spare. A small amount of work remains to install signal level monitoring in the Compact Array Broadband Backend interface modules and to complete the final revision of the documentation. These tasks will be completed during the latter half of 2013.

The exceptional wideband performance of the new 4 – 12GHz orthomode transducer (OMT), a device that separates the two polarisations of the incoming radiation, opened up the possibility of extending the operating frequency range of the ATCA to 12.2GHz where there is an astronomically significant spectral line (Methanol, CH3OH). As a consequence CASS and BAE Systems Australia embarked on a joint design study, in parallel with receiver production, which showed that it was possible to develop a new feed horn operating up to 12.25GHz that made full use of the performance of the upgraded receiver systems.

Two prototype 4 – 12.25GHz feed horns were installed on the ATCA in late 2012 and evaluation of their performance is currently underway. Preliminary holography measurements using an astronomical source indicate that at 11.056 GHz the beam produced by the BAE Systems horn is a significantly better than that produced by the existing C/X feed horn. At this stage there is insufficient impetus for the full frequency extension to 12.25GHz to proceed. However the BAE Systems feed horns will be characterised fully so that if future scientific interest warrants the frequency extension a decision about whether to proceed can be made with full understanding of their performance.

A number of papers are currently in preparation, and a provisional patent application has been registered covering several novel aspects of the 4 – 12GHz OMT design.



Science Highlight

ATCA used to investigate high mass star formation

The reduced system temperature and increased bandwidth of the upgraded ATCA C/X receiver systems has already had a significant impact upon some astronomy observations. An example, is the use of the ATCA to investigate intrinsically low luminosity methanol maser sources believed to be associated with very young, high-mass star formation regions, which are of particular importance for star formation studies.

The upgraded system is used to conduct deeper observations of some regions covered by the Parkes Methanol Multibeam Survey (a systematic survey for 6.7 GHz methanol masers in the Galactic plane). Observations by Simon Ellingsen and Shari Breen have detected ~80 weak 6.7 GHz methanol masers.

The low luminosity sources are potentially some of the most interesting detected in the survey, however it is not possible to do any science with them until their precise positions are determined: a task that would have required over 40 days observing with the old ATCA systems. With the new 4 – 12GHz receiver systems observations of all of the sources were completed in 5 days. The figure above is a spectrum of the Methanol Maser G306.125+0.133 and is fairly typical of the sources detected.

All Sky
Virtual Observatory

The All-Sky Virtual Observatory (ASVO) is the first step towards AAL's larger vision of a Federation of National Astronomy Datasets, and is closely aligned with a recommendation in the Mid-Term Review of the Decadal Plan; to build an astronomical data fabric to link high-performance data infrastructure and create new opportunities to access and exploit data flowing from telescopes like SkyMapper, ASKAP and the MWA. ASVO is a partnership between AAL, Swinburne University of Technology (SUT), the Australian National University (ANU), the National Computational Infrastructure (NCI), and Intersect Australia Ltd. ASVO is funded through National eResearch Collaboration Tools and Resources (NeCTAR) and AAL-managed NCRIS and EIF funds.

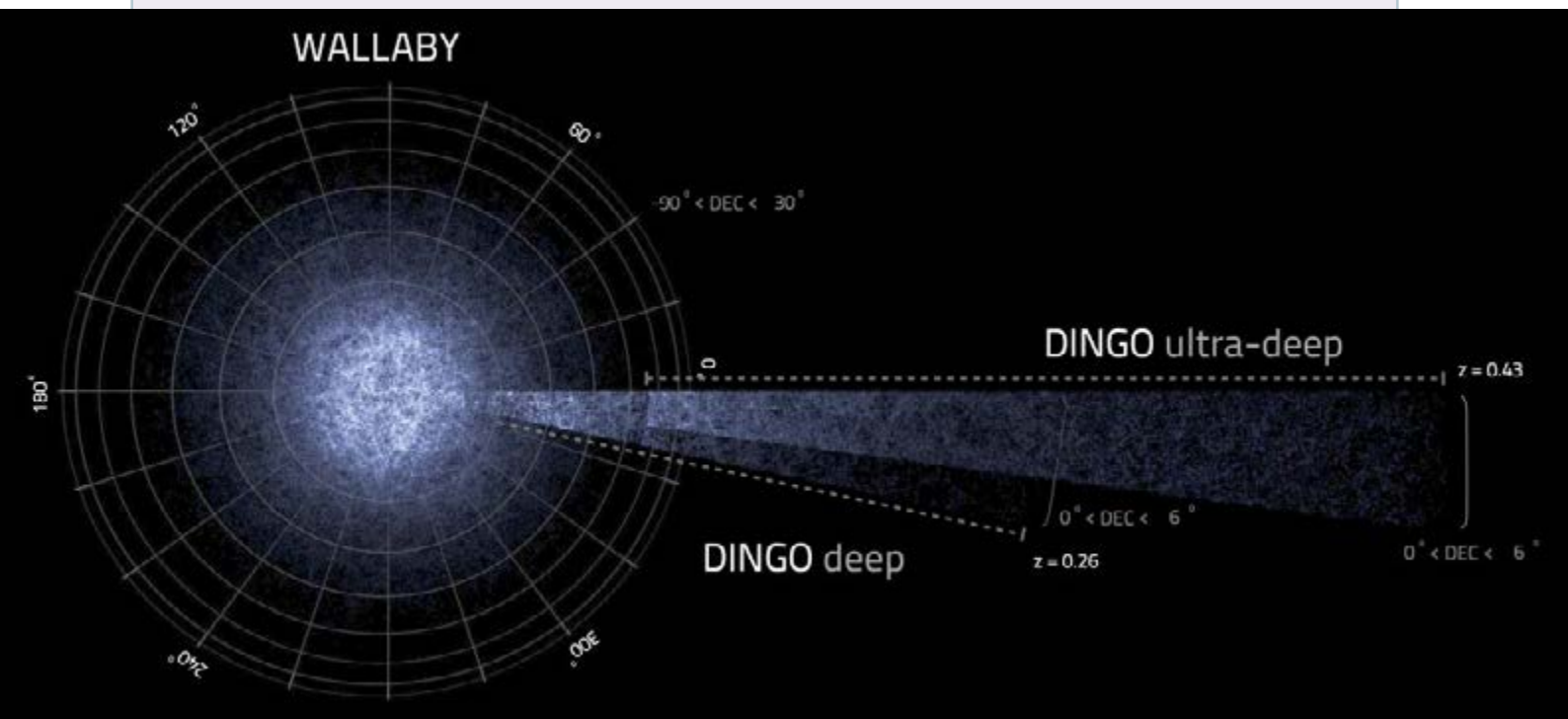
ASVO comprises two "Nodes":

- The SkyMapper Node (developed by NCI and Intersect) will enable users to access, analyse, and explore data from ANU's SkyMapper Southern Sky Survey, which will produce the most detailed digitized map of the southern sky at optical wavelengths.
- The Theoretical Astrophysical Observatory (TAO) Node (developed by SUT and Intersect) will provide access to a range of cosmological simulations and galaxy formation models, with value-add tools including custom telescope simulators, beginning with SkyMapper.

Science Highlight

Building virtual universes with TAO

The Theoretical Astrophysical Observatory (TAO) is already making it easy for the scientific community to construct virtual Universes. By using an early prototype of TAO, a group of astronomers from across Australia have been able to construct a representation of the deep night sky that will be seen by the Australian Square Kilometer Array (ASKAP) telescope. The visualisation shown below depicts the light cone of about 700,000 simulated galaxies produced by TAO. Two surveys were constructed from the simulated data. The first replicates the shallower and wider WALLABY galaxy survey and is expected to find approximately 600,000 galaxies. The second is the deeper and narrower DINGO galaxy survey, which will find approximately 100,000 galaxies according to TAO. The work was published in the Monthly Notices of the Royal Astronomical Society (http://arxiv.org/abs/1208.5592) and visualisations of the light cone can be found at: http://vimeo.com/53066502.



The SkyMapper Telescope imaged under the Milky Way Galaxy. Image credit: James Gilbert (AAO).

The ASVO project began in mid-2012 and the production version of ASVO is scheduled for release in late 2013. Significant progress was made in 2012/13, including the following highlights.

The pilot version of the TAO Node was deployed in June 2013, which included three out of four science modules. A group of researchers have been testing the system, providing very valuable and extensive feedback that has led to many improvements to TAO's features, functionality, and usability. TAO is already well ahead of any comparable astronomical service. We are receiving positive feedback and requests from researchers around the world who are eager to use TAO to generate results that would otherwise require weeks or months of effort.

The pilot version of the SkyMapper Node was deployed in June 2013, comprising a set of services for accessing and querying catalogue and image data. These services are compliant with standards developed by the International Virtual Observatory Alliance, which means that the data can be accessed by existing sophisticated VO-services as part of an international virtual network of VO-compliant datasets.

The ASVO team decided to add a second observational dataset to ASVO. This was partly motivated by delays with the external SkyMapper telescope project, that mean that SkyMapper survey data will not be available on the timescale of the ASVO project. Therefore, pilot VO-services were developed and deployed for the new Australian dataset, WiggleZ, comprising optical spectroscopy and redshifts for almost 250,000 galaxies. WiggleZ will be useful to compare with TAO's theoretical models and will complement the SkyMapper data when it comes online.

The first ASVO user workshop was held in February 2013, attended by over 40 people, including astronomers from NSW, VIC, ACT, WA, and QLD, and representatives from NeCTAR and the Commonwealth.

Antarctic Astronomy

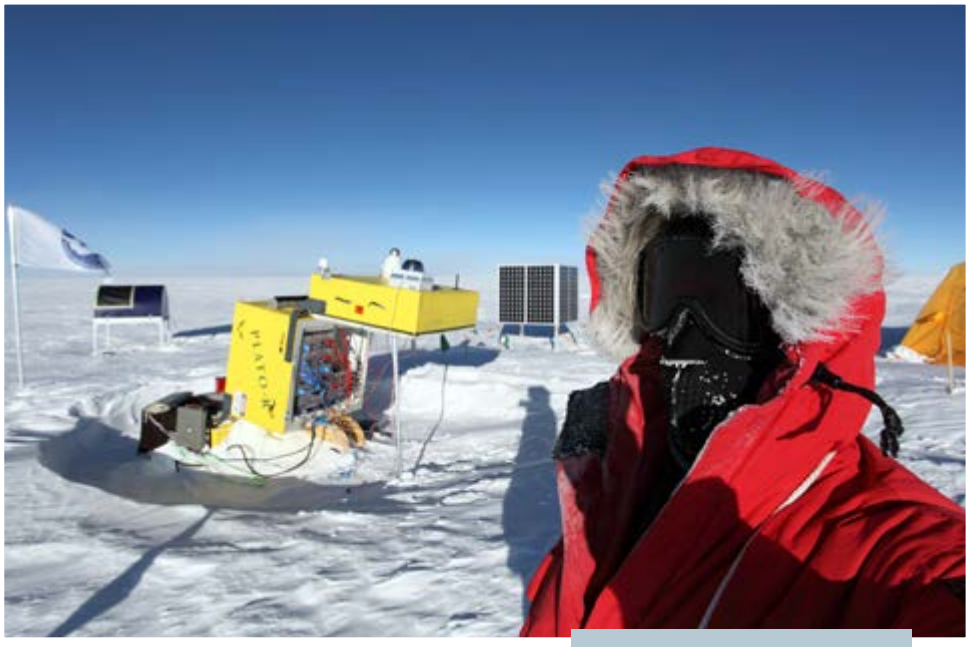
Antarctic astronomy, and the unique observing advantages afforded by the high Antarctic plateau, were identified in the Decadal Plan as being important opportunities to pursue. AAL has maintained Australia's strategic position in Antarctic astronomy by investing in robotic observatories called PLATOs ("PLATeau Observatory") and in instrumentation to support Antarctic telescopes. PLATOs have been pioneered and constructed by the University of New South Wales (UNSW), and currently support Chinese, Japanese and US instruments. AAL recognises the strategic importance of investing in these international programmes, which give Australian astronomers access to unique instruments and data, while positioning Australia to contribute to future world-class facilities to be built in Antarctica. AAL has identified Chinese efforts at Kunlun Station, including the Antarctic Schmidt Telescopes (AST3) project, as being the most in line with Australia's priorities in optical/near-infrared astronomy.

To advance Australia-China collaborations on Antarctic astronomy, AAL received a $40K grant from the DIICCSRTE to engage with the Chinese on the AST3 project. Under this grant, AAL organised a number of collaborative activities in 2012/13 (see pg 37). In the past year, AAL also provided EIF and NCRIS reserve funds to support: a) construction of PLATO-R (supporting the US-led High Elevation Antarctic Terahertz (HEAT) telescope); b) construction of instrumentation for AST3; and c) maintenance of PLATO and PLATO-A (supporting Chinese Antarctic instruments). AAL also assigned CRIS funding for servicing and operation of PLATO-A.

PLATO-R/HEAT

The PLATO-R/HEAT project has established a 0.6-metre aperture terahertz telescope at Ridge A, a remote location in Antarctica. Ridge A was chosen since satellite observations indicated that it was likely to be the best place on Earth for conducting terahertz observations.

These observations can otherwise only be performed from a high-altitude balloon or from space. The main science driver is to map the Milky Way Galaxy at terahertz frequencies (THz), which gives unique insight into how stars form. In particular, PLATO-R/HEAT can see emission from carbon atoms that is invisible to other telescopes.



UNSW's Geoff Sims with PLATO-R (open yellow box) at Ridge-A, Antarctica during the January 2013 servicing and upgrade mission. Image credit: Geoff Sims.

Progress and current status

PLATO-R was successfully serviced and upgraded during January 2013 by a team of four people from UNSW. It was a dramatic moment when the Twin Otter aircraft landed after the 950km flight from the South Pole and the team saw PLATO-R working perfectly under solar power, after having last been visited 12 months previously.

The HEAT telescope was upgraded in January with a new cryostat and detectors that can simultaneously observe three emission lines from atomic carbon and carbon monoxide.

PLATO-R and HEAT are now fully operational and working well. Astronomical data of excellent quality are being returned via the Iridium satellite network. An initial public release of data from the experiment has been made available on-line at http://soral.as.arizona.edu/heat/.

Industry Highlight

Technology developed for Antarctic astronomy used by renewable energy projects

Atmospheric turbulence is one of the crucial parameters that characterises an astronomical observatory site. To measure this turbulence under the unusual conditions in Antarctica required the development of a new instrument, Snodar, which uses an acoustic radar technique. The instrument was designed and built at UNSW by PhD student Colin Bonner and his supervisor Prof Michael Ashley.

Colin built on the technology developed as part of this Antarctic research to start Fulcrum3D, which has grown into a technology development company based in Sydney with 10 staff.

Twenty sonic radars built by Fulcrum3D are now deployed in the field and are assisting with renewable energy projects. Fulcrum3D in collaboration with UNSW has contracts to supply a Snodar to the Japanese Subaru telescope at Mauna Kea Observatory, and two Snodars to China for site-testing in Tibet.

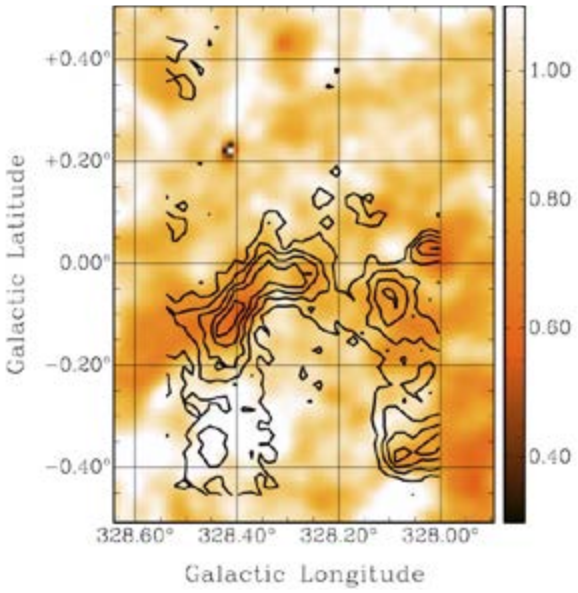
Fulcrum3D was awarded a Commercialisation Australia Grant for $800K this year, and has developed three new products (a fast digital data logger, CloudTracker, and CloudCAM), the genesis of which have been influenced by the early connection with Antarctic astronomy.

Science Highlight

Probing the earliest stages of star formation with PLATO-R/HEAT

THz observations from Antarctica show, for the first time, what could be the signature of a newly forming molecular cloud - the first stage of star formation. Data from the PLATO-R/HEAT project shows that atomic carbon ([CI]) emission is much more widespread than expected in the Galaxy: suggesting 50% more star-forming gas than had been extrapolated from millimetre wave carbon monoxide (CO) emission studies. For the first time astronomers are able to probe regions in molecular clouds where carbon is predominately in the atomic form, and where CO has not yet had time to form. Indications are that molecular clouds are more fractal and filamentary in nature that previously suspected, thereby allowing UV to penetrate into a larger volume of the clouds, preventing CO from forming. A paper describing these results is in preparation.

Atomic carbon 809 GHz emission contours from PLATO-R/HEAT with 21-cm atomic hydrogen absorption of background continuum radiation (colour) at the same radial velocity.



AST3

The telescope

The AST3 project is an optical telescope facility being established by the Chinese Centre for Antarctic Astronomy at Kunlun Station. The aim of AST3 is to survey the sky at high-precision using wide-field optical telescopes. The data will be used for a variety of scientific programs, notably searching for planets around other stars, rapidly detecting supernova explosions, astroseismology, and studying variable stars.

The first of three planned AST3 telescopes was deployed to Kunlun Station in the summer of 2011/2012. Data taken during the 2012 Antarctic winter was returned to Australia by a Chinese traverse team in March 2013 and demonstrates excellent photometric performance.

An issue with a power supply in the CCD camera means AST3 will not obtain images during 2013, but the telescope will continue to undergo performance tests. An Australian experiment, the all-sky three-colour optical camera HRCAM, is taking data this year at Dome A.

Progress and current status (AAL-funded projects)

Australia is primarily involved in Dome A infrastructure through UNSW's PLATO-A observatory. PLATO-A is the primary support platform for the AST3 project and provides power, data-handling and communications to the telescope. Establishing a completely robotic 1kW power and communication system at the highest point of the Antarctic plateau is a significant technical achievement that has not been duplicated. PLATO-A was serviced in January 2013, and has been operating flawlessly since that date.

UNSW and the University of Sydney are also constructing support instruments to characterise the site's infrared background and all-sky cloud cover. Results from these experiments will help in planning future large telescopes at Dome A.

Two instruments are currently in the final stages of construction: one will measure the sky background emission at 2.35 microns, and the other will make detailed spectroscopic measurements of the sky from 0.9 to 1.7 microns.

Australian work with AST3 has resulted in an invitation from China to submit a Letter of Interest to design and build a gigapixel CCD camera for the proposed Chinese KDUST telescope at Dome A. AAO, ANU and UNSW formed a consortium to submit the Letter of Interest. If successful, a final contract of up to $20M has been anticipated.

The AST3-1 telescope, installed at Dome A, with the UNSW PLATO-A Observatory (yellow box). The telescope itself is wrapped in fabric to prevent the ingress of wind-blown snow. The hemispherical structure at the top can open up to expose the telescope to the sky. Image credit: Nanjing Institute of Astronomical Optics and Technology.

AST3 Collaborative Activities

Workshop: August 2012

AAL, UNSW and CAASTRO held a 1-day workshop in Sydney for Australian astronomers to engage with Chinese astronomers involved in the AST3 project at Dome A. The objective was to define a plan for Australian contribution to the commencement of significant scientific output from this project. Around fifty Australian astronomers attended and engaged with invited Chinese astronomers from Purple Mountain Observatory Nanjing University. The participants identified four key science areas for collaboration between Chinese and Australian astronomers using AST3 data and potential complementary instruments and resources in Australia:

- Supernova physics, including the detection of prompt emission and the spectroscopic and/or photometric follow-up using Australian telescopes;
- The discovery and characterisation of solar system objects, and exoplanets and their parent stars including detection through transit and lensing observations, and spectroscopic and/or photometric follow-up using Australian telescopes;
- Stellar structure and evolution, including high precision photometry of variable stars and further spectroscopic and/or photometric follow-up using Australian telescopes;
- The physics of the dynamic extragalactic Universe, including coordinated synoptic surveys between AST3/CSTAR and appropriate complementary Australian facilities.

These science areas were then used as the four key areas for collaboration in the Memorandum of Understanding (MoU) on Antarctic astronomy between the Chinese Academy of Sciences and AAL signed in late August 2012 (see pg 5 for details on the MoU).

The Implementation Plan for the MoU established a Working Group to facilitate the proposed collaborative activities, with the aim that the science collaborations would become self-sustaining by December 2013. The Implementation Plan also identified science leaders in both Australia and China, to act as the points of contact in each country for each of the four priority science areas.

Workshop: February 2013

AAL held a workshop, hosted by Swinburne University of Technology in Melbourne, with an aim to determine how the four science programmes could best be coordinated in the AST3 schedule and the access to Australian facilities that would be required to support the AST3 observations. The workshop was attended by sixteen Australian astronomers and four Chinese astronomers, with representation in each of the four key science areas.

The key result from this meeting was the production of a science plan outlining the key telescope (Antarctic and Australian) requirements for each of the science programmes.

Working Group Meeting: May 2013

The first meeting of the Antarctic astronomy Working Group under the AAL-DBRCAS MoU was held in Tengchong, China on the 27th May 2013. This meeting was held to coincide with the 2nd Collaboration Meeting on Antarctic Survey Telescopes in Tengchong, which was attended by a number of Australian astronomers, including representatives from the MoU science teams. The Working Group noted that the workshops held over the previous year had resulted in active collaborations in the areas of supernovae and exo-planets.

Attendees of the 2013 International Collaboration Meeting on Antarctic Survey Telescopes, Tengchong, China 26 - 29 May 2013. Australian attendees included AAL representatives Brian Boyle (Director), Mark McAuley (CEO) and John Storey (Chair, Antarctic Astronomy Advisory Committee). Image credit: Michael Ashley.

Pierre Auger Observatory
Cloud Cameras

Australian astronomers and engineers realise the importance of participation in international collaborative projects, particularly where Australia can make unique and valued contributions. One such project is the Pierre Auger Observatory in Argentina, studying ultra-high energy cosmic rays. Through the University of Adelaide, Australian scientists have played a central role in the Observatory based on their experience in high energy astrophysics, and particularly in the atmospheric fluorescence techniques employed by the detectors at the Observatory. AAL has supported the project by providing EIF funding to the University of Adelaide to build four new cloud monitoring systems for the Observatory.

The observatory

The $150M Pierre Auger Observatory is the premier observatory for the study of the highest energy particles in Nature. It studies mainly cosmic ray particles in the energy range above 1 EeV. The flux of these particles is of the order of one particle per square kilometre per hour, and the flux at the very interesting range substantially above 10 EeV is measured in particles per square kilometre per century. The requirement is thus for a large collecting area, and the Pierre Auger Observatory has 3,000 square kilometres of collecting area in the foothills of the Argentinean Andes mountains.

The observatory employs two detection techniques. It has 1660 large water Cherenkov radiation detectors which operate continuously. It also has 27, 4 m diameter, UV telescopes which study the overall development of the cosmic ray cascades on clear moonless nights. The understanding of data from these telescopes requires detailed knowledge of the cloud conditions over the whole 3000 square kilometre observatory. This is studied using an array of lasers, continuous star monitoring, and the Adelaide cloud cameras. The fluorescence cameras provide calorimetric energy information and detailed information on a five minute interval from the cloud cameras is a vital component of the analysis chain.

Progress and current status

Three cameras have been installed in Argentina over the past year and the final camera is scheduled for installation in July 2013. Image analysis software is being developed but real-time fully-sky images are now routinely available for on-site observers. The final product is an estimate of the cloud coverage for each camera pixel for each telescope on a five minute spacing on every clear moonless night (~13% of the total observing time).

The project is now essentially complete.

Cloud camera installed at the Los Leones fluorescence site of the Pierre Auger Observatory.

Publications

Swinburne University of Technology astronomer Prof Karl Glazebrook captured the "diamond ring" effect at the end of the 14th November 2012 Total Solar Eclipse from Palm Cove in Northern Australia. Image credit: Karl Glazebrook.

Publications in refereed journals in the 2012/13 year, with at least one Australian co-author, based on data from the various facilities in which AAL was involved. Bold face indicates Australian authors unless stated otherwise.

Gemini

1. **Spitler, L.**, Romanowsky, A., Diemand, J., Strader, J., **Forbes, D.**, Moore, B., Brodie J. (2012). ``Evidence for inhomogeneous reionization in the local Universe from metal-poor globular cluster systems", Monthly Notices of the Royal Astronomical Society, 423, p. 2177-2189.
2. Romero-Canizales, C., Perez-Torres, M., Alberdi, A., Argo, M., Beswick, R., Kankare, E., Batejat, F., Efstathiou, A., Mattila, S., Conway, J., Garrington, S., Muxlow, T., **Ryder, S.**, Vaisanen, P. (2012). ``e-MERLIN and VLBI observations of the luminous infrared galaxy IC 883: a nuclear starburst and an AGN candidate revealed", Astronomy & Astrophysics, 543, A72.
3. Grutzbauch, R., **Bauer, A.**, Jorgensen, I., Varela, J. (2012). ``Suppression of star formation in the central 200 kpc of a z= 1.4 galaxy cluster", Monthly Notices of the Royal Astronomical Society, 423, p. 3652-3662.
4. Melis, C., Zuckerman, B., Rhee, J., Song, I., **Murphy, S., Bessell, M.** (2012). ``Rapid disappearance of a warm, dusty circumstellar disk", Nature, 487, p. 74-76.
5. **Wittenmyer, R., Horner, J.**, Tuomi, M., **Salter, G., Tinney, C.**, Butler, P., Jones, H., **O'Toole, S., Bailey, J., Carter, B.**, Jenkins, J., Zhang, Z., Vogt, S., Rivera, E. (2012). ``The Anglo-Australian Planet Search. XXII. Two New Multi-planet Systems", Astrophysical Journal, 753:169.
6. **Rapoport, S., Onken, C., Schmidt, B., Wyithe, S., Tucker, B.**, Levan, A. (2012). ``Testing Gravitational Lensing as the Source of Enhanced Strong Mg II Absorption toward Gamma-Ray Bursts", Astrophysical Journal, 754:139.
7. Perrett, K., Sullivan, M., Conley, A., Gonzalez-Gaitan, S., Carlberg, R., Fouchez, D., Ripoche, P., Neill, J., Astier, P., Balam, D., Balland, C., Basa, S., Guy, J., Hardin, D., Hook, I., Howell, D., Pain, R., Palanque-Delabrouille, N., Pritchet, C., Regnault, N., Rich, J., Ruhlmann-Kleider, V., Baumont, S., **Lidman, C.**, Perlmutter, S., Walker, E. (2012). ``Evolution in the Volumetric Type Ia Supernova Rate from the Supernova Legacy Survey", Astronomical Journal, 144:59.
8. Storchi-Bergmann, T., Riffel, R., Riffel, R., Diniz, M., Borges Vale, T., **McGregor, P.** (2012). ``Two-dimensional Mapping of Young Stars in the Inner 180 pc of NGC 1068: Correlation with Molecular Gas Ring and Stellar Kinematics", Astrophysical Journal, 755:87.
9. **Barone-Nugent, R., Lidman, C., Wyithe, S., Mould, J.**, Howell, D., Hook, I., Sullivan, M., Nugent, P., Arcavi, I., Cenko, S., **Cooke, J.**, Gal-Yam, A., Hsiao, E., Kasliwal, M., Maguire, K., Ofek, E., Poznanski, D., Xu, D. (2012). ``Near-infrared observations of Type Ia supernovae: the best known standard candle for cosmology", Monthly Notices of the Royal Astronomical Society, 425, p. 1007-1012.
10. **Francis, K., Drinkwater, M.**, Chilingarian, I., **Bolt, A., Firth, P.** (2012). ``The chemical composition of ultracompact dwarf galaxies in the Virgo and Fornax clusters", Monthly Notices of the Royal Astronomical Society, 425, p. 325-337.
11. Long, K., Blair, W., **Godfrey, L.**, Kuntz, K., Plucinsky, P., **Soria, R.,** Stockdale, C., Whitmore, B., Winkler, F. (2012). ``Recovery of the Historical SN1957D in X-Rays with Chandra", Astrophysical Journal, 756:18.
12. Mattila, S., Dahlen, T., Efstathiou, A., Kankare, E., Melinder, J., Alonso-Herrero, A., Perez-Torres, M., **Ryder, S.**, Vaisanen, P., Ostlin, G. (2012). ``Core-collapse Supernovae Missed by Optical Surveys", Astrophysical Journal, 756:111.
13. **Usher, C., Forbes, D.**, Brodie, J., Foster, C., **Spitler, L.**, Arnold, J., Romanowsky, A., Strader, J., Pota, V. (2012). ``The SLUGGS survey: calcium triplet-based spectroscopic metallicities for over 900 globular clusters", Monthly Notices of the Royal Astronomical Society, 426, p. 1475-1495.
14. Davis, T., Krajnovic, D., McDermid, R., Bureau, M., Sarzi, M., Nyland, K., Alatalo, K., Bayet, E., Blitz, L., Bois, M., Bournaud, F., Cappellari, M., Crocker, A., Davies, R., de Zeeuw, P., Duc, P.-A., Emsellem, E., Khochfar, S., Kuntschner, H., Lablanche, P.-Y., Morganti, R., Naab, T., Oosterloo, T., **Scott, N.**, Serra, P., Weijmans, A.-M., Young, L. (2012). ``Gemini GMOS and WHT SAURON integral-field spectrograph observations of the AGN-driven outflow in NGC 1266", Monthly Notices of the Royal Astronomical Society, 426, p. 1574-1590.
15. Li, D., Telesco, C., **Wright, C.** (2012). ``The Mineralogy and Structure of the Inner Debris Disk of Beta Pictoris", Astrophysical Journal, 759:81.
16. **Keller, S., Mackey, D., Da Costa, G.** (2012). ``Extended Star Formation in the Intermediate-age Large Magellanic Cloud Star Cluster NGC 2209", Astrophysical Journal Letters, 761:L5.
17. **Norris, J., Bessell, M., Yong, D.**, Christlieb, N., Barklem, P., **Asplund, M., Murphy, S.**, Beers, T., Frebel, A., Ryan, S. (2013). ``The Most Metal-poor Stars. I. Discovery, Data, and Atmospheric Parameters", Astrophysical Journal, 762:25.
18. **Yong, D., Norris, J., Bessell, M.**, Christlieb, N., **Asplund, M.**, Beers, T., Barklem, P., Frebel, A., Ryan, S. (2013). ``The Most Metal-poor Stars. II. Chemical Abundances of 190 Metal-poor Stars Including 10 New Stars with [Fe/H] <= -3.5", Astrophysical Journal, 762:26.
19. **Yong, D., Norris, J., Bessell, M.**, Christlieb, N., **Asplund, M.**, Beers, T., Barklem, P., Frebel, A., Ryan, S. (2013). ``The Most Metal-poor

Stars. III. The Metallicity Distribution Function and Carbon-enhanced Metal-poor Fraction", Astrophysical Journal, 762:27.

20. **Norris, J., Yong, D., Bessell, M.**, Christlieb, N., **Asplund, M.**, Gilmore, G., Wyse, R., Beers, T., Barklem, P., Frebel, A., Ryan, S. (2013). ``The Most Metal-poor Stars. IV. The Two Populations with [Fe/H] <~ -3.0", Astrophysical Journal, 762:28.

21. **Francis, P., Dopita, M.**, Colbert, J., Palunas, P., Scarlata, C., Teplitz, H., Williger, G., Woodgate, B. (2013). ``Hot gas, cold gas and sub-haloes in a Lyman-alpha blob at redshift 2.38", Monthly Notices of the Royal Astronomical Society, 428, p. 28-39.

22. Pota, V., **Forbes, D.,** Romanowsky, A., Brodie, J., **Spitler, L.**, Strader, J., Foster, C., Arnold, J., Benson, A., **Blom, C.**, Hargis, J., Rhode, K., Usher, C. (2013). ``The SLUGGS Survey: kinematics for over 2500 globular clusters in 12 early-type galaxies", Monthly Notices of the Royal Astronomical Society, 428, p. 389-420.

23. **Mackey, D.**, Huxor, A., Ferguson, A., Irwin, M., Veljanoski, J., McConnachie, A., Ibata, R., **Lewis, G.**, Tanvir, N. (2013). ``Young accreted globular clusters in the outer halo of M31", Monthly Notices of the Royal Astronomical Society, 429, p. 281-293.

24. Barclay, T., Rowe, J., Lissauer, J., Huber, D., Fressin, F., Howell, S., Bryson, S., Chaplin, W., Desert, J.-M., Lopez, E., Marcy, G., Mullally, F., Ragozzine, D., Torres, G., Adams, E., Agol, E., Barrado, D., Basu, S., **Bedding, T.**, Buchhave, L., Charbonneau, D., Christiansen, J., Christensen-Dalsgaard, J., Ciardi, D., Cochran, W., Dupree, A., Elsworth, Y., Everett, M., Fischer, D., Ford, E., Fortney, J., Geary, J., Haas, M., Handberg, R., Hekker, S., Henze, C., Horch, E., Howard, A., Hunter, R., Isaacson, H., Jenkins, J., Karoff, C., Kawaler, S., Kjeldsen, H., Klaus, T., Latham, D., Li, J., Lillo-Box, J., Lund, M., Lundkvist, M., Metcalfe, T., Miglio, A., Morris, R., Quintana, E., **Stello, D.**, Smith, J., Still, M., Thompson, S. (2013). ``A sub-Mercury-sized exoplanet", Nature, 494, p. 452-454.

25. **Scharwachter, J., McGregor, P., Dopita, M.**, Beck, T. (2013). ``Kinematics and excitation of the molecular hydrogen accretion disc in NGC 1275", Monthly Notices of the Royal Astronomical Society, 429, p. 2315-2332.

26. Hachinger, S., Mazzali, P., Sullivan, M., Ellis, R., Maguire, K., Gal-Yam, A., Howell, D., Nugent, P., Baron, E., **Cooke, J.**, Arcavi, I., Bersier, D., Dilday, B., James, P., Kasliwal, M., Kulkarni, S., Ofek, E., Laher, R., Parrent, J., Surace, J., Yaron, O., Walker, E. (2013). ``The UV/optical spectra of the Type Ia supernova SN 2010jn: a bright supernova with outer layers rich in iron-group elements", Monthly Notices of the Royal Astronomical Society, 429, p. 2228-2248.

27. **Rapoport, S., Onken, C., Wyithe, S., Schmidt, B.**, Thygesen, A. (2013). ``On the Significance of the Excess Number of Strong Mg II Absorbers Observed toward Gamma-Ray Bursts", Astrophysical Journal, 766:23.

28. Mazzalay, X., Rodriguez-Ardila, A., Komossa, S., **McGregor, P.** (2013). ``Resolving the coronal line region of NGC 1068 with near-infrared integral field spectroscopy", Monthly Notices of the Royal Astronomical Society, 430, p. 2411-2426.

29. Pan, H.-A., Lim, J., Matsushita, S., Wong, T., Ryder, S. (2013). ``Formation of Dense Molecular Gas and Stars at the Circumnuclear Starburst Ring in the Barred Galaxy NGC 7552", Astrophysical Journal, 768:57.

30. Kraus, S., **Ireland, M.**, Sitko, M., Monnier, J., Calvet, N., Espaillat, C., Grady, C., Harries, T., Honig, S., Russell, R., Swearingen, J., Werren, C., Wilner, D. (2013). ``Resolving the Gap and AU-scale Asymmetries in the Pre-transitional Disk of V1247 Orionis", Astrophysical Journal, 768:80.

31. Randriamanakoto, Z., Vaisanen, P., **Ryder, S.**, Kankare, E., Kotilainen, J., Mattila, S. (2013). ``The K-band luminosity functions of super star clusters in luminous infrared galaxies, their slopes and the effects of blending", Monthly Notices of the Royal Astronomical Society, 431, p. 554-569.

32. **Da Costa, G., Norris, J., Yong, D.** (2013). ``Magnesium Isotope Ratios in Omega Centauri Red Giants", Astrophysical Journal, 769:8.

33. **Landt, H.**, Ward, M., Peterson, B., Bentz, M., Elvis, M., Korista, K., Karovska, M. (2013). ``A near-infrared relationship for estimating black hole masses in active galactic nuclei", Monthly Notices of the Royal Astronomical Society, 432, p. 113-126.

34. Hinkle, K., Fekel, F., Joyce, R., **Wood, P.** (2013). ``Infrared Spectroscopy of Symbiotic Stars. IX. D-type Symbiotic Novae", Astrophysical Journal, 770:28.

35. **Childress, M.**, Aldering, G., Antilogus, P., Aragon, C., Bailey, S., Baltay, C., Bongard, S., Buton, C., Canto, A., Cellier-Holzem, F., Chotard, N., Copin, Y., Fakhouri, H., Gangler, E., Guy, J., Hsiao, E., Kerschhaggl, M., Kim, A., Kowalski, M., Loken, S., Nugent, P., Paech, K., Pain, R., Pecontal, E., Pereira, R., Perlmutter, S., Rabinowitz, D., Rigault, M., Runge, K., **Scalzo, R.**, Smadja, G., Tao, C., Thomas, R., Weaver, B., Wu, C. (2013). ``Host Galaxy Properties and Hubble Residuals of Type Ia Supernovae from the Nearby Supernova Factory", Astrophysical Journal, 770:108.

36. **Childress, M.**, Aldering, G., Antilogus, P., Aragon, C., Bailey, S., Baltay, C., Bongard, S., Buton, C., Canto, A., Cellier-Holzem, F., Chotard, N., Copin, Y., Fakhouri, H., Gangler, E., Guy, J., Hsiao, E., Kerschhaggl, M., Kim, A., Kowalski, M., Loken, S., Nugent, P., Paech, K., Pain, R., Pecontal, E., Pereira, R., Perlmutter, S., Rabinowitz, D., Rigault, M., Runge, K., **Scalzo, R.**, Smadja, G., Tao, C., Thomas, R., Weaver, B., Wu, C. (2013). ``Host Galaxies of Type Ia Supernovae from the Nearby Supernova Factory", Astrophysical Journal, 770:107.

37. **Madrid, J.**, Donzelli, C. (2013). ``Gemini Spectroscopy of Ultracompact Dwarfs in the Fossil Group NGC 1132", Astrophysical Journal, 770:158.

38. Placco, V., Frebel, A., Beers, T., **Karakas, A., Kennedy, C.**, Rossi, S., Christlieb, N., Stancliffe, R. (2013). ``Metal-poor Stars Observed with the Magellan Telescope. I. Constraints on Progenitor Mass and Metallicity of AGB Stars Undergoing s-process Nucleosynthesis", Astrophysical Journal, 770:104.

Magellan

1. Melendez, J., Bergemann, M., Cohen, J., Endl, M., **Karakas, A.**, Ramirez, I., Cochran, W., **Yong, D.**, MacQueen, **P., Kobayashi, C., Asplund, M.** (2012). ``The remarkable solar twin HIP 56948: a prime target in the quest for other Earths", Astronomy & Astrophysics, 543:A29.

2. Kirkpatrick, D., Gelino, C., Cushing, M., Mace, G., Griffith, R., Skrutskie, M., Marsh, K., Wright, E., Eisenhardt, P., McLean, I., Mainzer, A., Burgasser, A., **Tinney, C., Parker, S.**, Salter, G. (2012). ``Further Defining Spectral Type Y and Exploring the Low-mass End of the Field Brown Dwarf Mass Function", Astrophysical Journal, 753:156.

3. Frye, B., Hurley, M., Bowen, D., **Meurer, G.**, Sharon, K., Straughn, A., Coe, D., Broadhurst, T., Guhathakurta, P. (2012). ``Spatially Resolved HST Grism Spectroscopy of a Lensed Emission Line Galaxy at z~1", Astrophysical Journal, 754:17.

4. **Dobbie, P.,** Day-Jones, A., Williams, K., Casewell, S., Burleigh, M., Lodieu, N., **Parker, Q., Baxter, R.** (2012). ``Further investigation of white dwarfs in the open clusters NGC 2287 and NGC 3532", Monthly Notices of the Royal Astronomical Society, 423, p. 2815-2828.

5. Lee, J., Ly, C., **Spitler, L.**, Labbe, I., Salim, S., Persson, E., Ouchi, M., Dale, D., Monson, A., Murphy, D. (2012). ``A Dual-Narrowband Survey for H-alpha Emitters at Redshift of 2.2: Demonstration of the Technique and Constraints on the H-alpha Luminosity Function", Publications of the Astronomical Society of the Pacific, 124, p. 782-797.

6. Long, K., Blair, W., **Godfrey, L.**, Kuntz, K., Plucinsky, P., **Soria, R.**, Stockdale, C., Whitmore, B., Winkler, F. (2012). ``Recovery of the Historical SN1957D in X-Rays with Chandra", Astrophysical Journal, 756:18.

7. Greene, C., Gilbank, D., Balogh, M., **Glazebrook, K**., Bower, R., Baldry, I., Hau, G., **Li, I.**, McCarthy, P. (2012). ``The slowly evolving role of environment in a spectroscopic survey of star formation in M* > 5 × 10^8 M_sun galaxies since z~1", Monthly Notices of the Royal Astronomical Society, 425, p. 1738-1752.

8. **Tinney, C.**, Faherty, J., Kirkpatrick, D., Wright, E., Gelino, C., Cushing, M., Griffith, R., **Salter, G.** (2012). ``WISE J163940.83-684738.6: A Y Dwarf Identified by Methane Imaging", Astrophysical Journal, 759:60.

9. **Zhou, G., Bayliss, D.** (2012). ``Detection of sodium absorption in WASP-17b with Magellan", Monthly Notices of the Royal Astronomical Society, 426, p. 2483-2488.

10. Nobuta, K., Akiyama, M., Ueda, Y., Watson, M., Silverman, J., Hiroi, K., Ohta, K., Iwamuro, F., Yabe, K., Tamura, N., Moritani, Y., Sumiyoshi, M., Takato, N., Kimura, M., Maihara, T., Dalton, G., Lewis, I., Bonfield, D., Lee, H., Curtis-Lake, E., Macaulay, E., Clarke, F., Sekiguchi, K., Simpson, C., **Croom, S.**, Ouchi, M., Hanami, H., Yamada, T. (2012). ``Black Hole Mass and Eddington Ratio Distribution Functions of X-Ray-selected Broad-line AGNs at z~1.4 in the Subaru XMM-Newton Deep Field", Astrophysical Journal, 761:143.

11. **Fogarty, L., Bland-Hawthorn, J., Croom, S., Green, A., Bryant, J., Lawrence, J., Richards, S., Allen, J., Bauer, A., Birchall, M., Brough, S., Colless, M., Ellis, S., Farrell, T., Goodwin, M., Heald, R., Hopkins, A., Horton, A., Jones, H., Lee, S., Lewis, G., Lopez-Sanchez, A., Miziarski, S., Trowland, H., Leon-Saval, S., Min, S.-S., Trinh, C.**, Cecil, G., Veilleux, S., Kreimeyer, K. (2012). ``First Science with SAMI: A Serendipitously Discovered Galactic Wind in ESO 185-G031", Astrophysical Journal, 761:169.

12. **Norris, J., Bessell, M., Yong, D.**, Christlieb, N., Barklem, P., **Asplund, M.**, Murphy, S., Beers, T., Frebel, A., Ryan, S. (2013). ``The Most Metal-poor Stars. I. Discovery, Data, and Atmospheric Parameters", Astrophysical Journal, 762:25.

13. **Yong, D., Norris, J., Bessell, M.**, Christlieb, N., **Asplund, M.**, Beers, T., Barklem, P., Frebel, A., Ryan, S. (2013). ``The Most Metal-poor Stars. II. Chemical Abundances of 190 Metal-poor Stars Including 10 New Stars with [Fe/H] <= -3.5", Astrophysical Journal, 762:26.

14. **Yong, D., Norris, J., Bessell, M.**, Christlieb, N., **Asplund, M.**, Beers, T., Barklem, P., Frebel, A., Ryan, S. (2013). ``The Most Metal-poor Stars. III. The Metallicity Distribution Function and Carbon-enhanced Metal-poor Fraction", Astrophysical Journal, 762:27.

15. **Norris, J., Yong, D., Bessell, M.**, Christlieb, N., **Asplund, M.**, Gilmore, G., Wyse, R., Beers, T., Barklem, P., Frebel, A., Ryan, S. (2013). ``The Most Metal-poor Stars. IV. The Two Populations with [Fe/H] <~ -3.0", Astrophysical Journal, 762:28.

16. Bensby, T., Yee, J., Feltzing, S., Johnson, J., Gould, A., Cohen, J., **Asplund, M.,** Melendez, J., Lucatello, S., Han, C., Thompson, I., Gal-Yam, A., Udalski, A., Bennett, D., Bond, I., Kohei, W., Sumi, T., Suzuki, D., Suzuki, K., Takino, S., Tristram, P., Yamai, N., Yonehara, A. (2013). ``Chemical evolution of the Galactic bulge as traced by microlensed dwarf and subgiant stars. V. Evidence for a wide age distribution and a complex MDF", Astronomy & Astrophysics, 549:147.

17. **Parker, S., Tinney, C.** (2013). ``Searching for T dwarfs in IC 2391 using methane imaging", Monthly Notices of the Royal Astronomical Society, 430, p. 1208-1218.

18. Tilvi, V., Papovich, C., Tran, K.-V., Labbe, I., **Spitler, L.**, Straatman, C., Persson, S., Monson, A., **Glazebrook, K.**, Quadri, R., van Dokkum, P., Ashby, M., Faber, S., Fazio, G., Finkelstein, S., Ferguson, H., Grogin, N., **Kacprzak, G.**, Kelson, D., Koekemoer, A., Murphy, D., McCarthy, P., Newman, J., Salmon, B., Willner, S. (2013). ``Discovery of Lyman Break Galaxies at z~7 from the zFourGE Survey", Astrophysical Journal, 768:56.

19. Placco, V., Frebel, A., Beers, T., **Karakas, A., Kennedy, C.**, Rossi, S., Christlieb, N., Stancliffe, R. (2013). ``Metal-poor Stars Observed with the Magellan Telescope. I. Constraints on Progenitor Mass and Metallicity of AGB Stars Undergoing s-process Nucleosynthesis", Astrophysical Journal, 770:104.

gSTAR

1. **Barsdell B.R., Bailes M., Barnes D.G., Fluke C.J.**, Accelerating incoherent dedispersion, 2012, Monthly Notices of the Royal Astronomical Society, 422, 379

2. Bates S.D., et al. (21 co-authors), The High Time Resolution Universe Pulsar Survey - VI. An artificial neural network and timing of 75 pulsars, 2012, Monthly Notices of the Royal Astronomical Society, 427, 1052

3. **Bekki K.**, Coevolution of dust, gas and stars in galaxies - I. Spatial distributions and scaling-relations of dust and molecular hydrogen, 2013, Monthly Notices of the Royal Astronomical Society, 432, 2298

4. **Bhat N.D.R.**, et al. (9 co-authors), Detection of Fast Transients with Radio Interferometric Arrays, 2013, The Astrophysical Journal Supplement Series, 206, 2

5. Bouwens R.J., et al. (12 co-authors), Photometric Constraints on the Redshift of z ~ 10 Candidate UDFj-39546284 from Deeper WFC3/IR+ACS+IRAC Observations over the HUDF, 2013, The Astrophysical Journal Letters, 765, L16

6. Burgay M., et al. (20 co-authors), The High Time Resolution Universe Pulsar Survey - VII. Discovery of five millisecond pulsars and the different luminosity properties of binary and isolated recycled pulsars, 2013, Monthly Notices of the Royal Astronomical Society, 433, 259

7. **Hassan A.H., Fluke C.J., Barnes D.G., Kilborn V.A.**, Tera-scale astronomical data analysis and visualization, 2013, Monthly Notices of the Royal Astronomical Society, 429, 2442

8. **Hassan A.H., Fluke C.J., Barnes D.G.**, A Distributed GPU-Based Framework for Real-Time 3D Volume Rendering of Large Astronomical Data Cubes, 2013, Publications of the Astronomical Society of Australia,, 29, 340

9. **Hobbs G.**, et al. (23 co-authors), Development of a pulsar-based time-scale, 2012, Monthly Notices of the Royal Astronomical Society, 427, 2780

10. **Keith M.J.**, et al. (18 co-authors), Measurement and correction of variations in interstellar dispersion in high-precision pulsar timing, 2013, Monthly Notices of the Royal Astronomical Society, 429, 2161

11. **Madrid J.P., Hurley J.R., Sippel A.C.**, The size scale of star clusters, 2012, The Astrophysical Journal, 756, 167

12. **Manchester R.N.**, et al. (31 co-authors), The Parkes Pulsar Timing Array Project, 2013, Publications of the Astronomical Society of Australia, 30, 17

13. **Mutch S.J., Poole G.B., Croton D.J.**, Constraining the last 7 billion years of galaxy evolution in semi-analytic models, 2013, Monthly Notices of the Royal Astronomical Society, 428, 2001

14. **Oslowski S.**, van Straten W., Demorest P., Bailes M., Improving the precision of pulsar timing through polarization statistics, 2013, Monthly Notices of the Royal Astronomical Society, 430, 416

15. **Poole G.B.**, et al. (26 co-authors), The WiggleZ Dark Energy Survey: probing the epoch of radiation domination using large-scale structure, 2013, Monthly Notices of the Royal Astronomical Society, 429, 1902

16. **Sippel A.C., Hurley J.R., Madrid J.P.**, Harris W.E., N-body models of globular clusters: metallicities, half-light radii and mass-to-light ratios, 2012, Monthly Notices of the Royal Astronomical Society, 427, 167

17. **Shattow G.M., Croton D.J.**, Skibba R.A., Muldrew S.I., Pearce F.R., Abbas U., Measures of galaxy environment - III. Difficulties in identifying protoclusters at z ~ 2, 2013, Monthly Notices of the Royal Astronomical Society, 1649 (in press)

18. **Vernardos G., Fluke C.J.**, A new parameter space study of cosmological microlensing, Monthly Notices of the Royal Astronomical Society, 2013, accepted (June 2013) [arXiv:1306.3722]

PLATOs

1. **Ashley, M. C. B.**, 2013, The care and feeding of an Antarctic telescope, Physics Today, 66, 60-61.

2. Okita, H., Ichikawa, T., **Ashley, M. C. B.**, Takato, N., Motoyama, H., 2013, Excellent daytime seeing at Dome Fuji on the Antarctic plateau, Astronomy and Astrophysics, 554, L5.

MWA

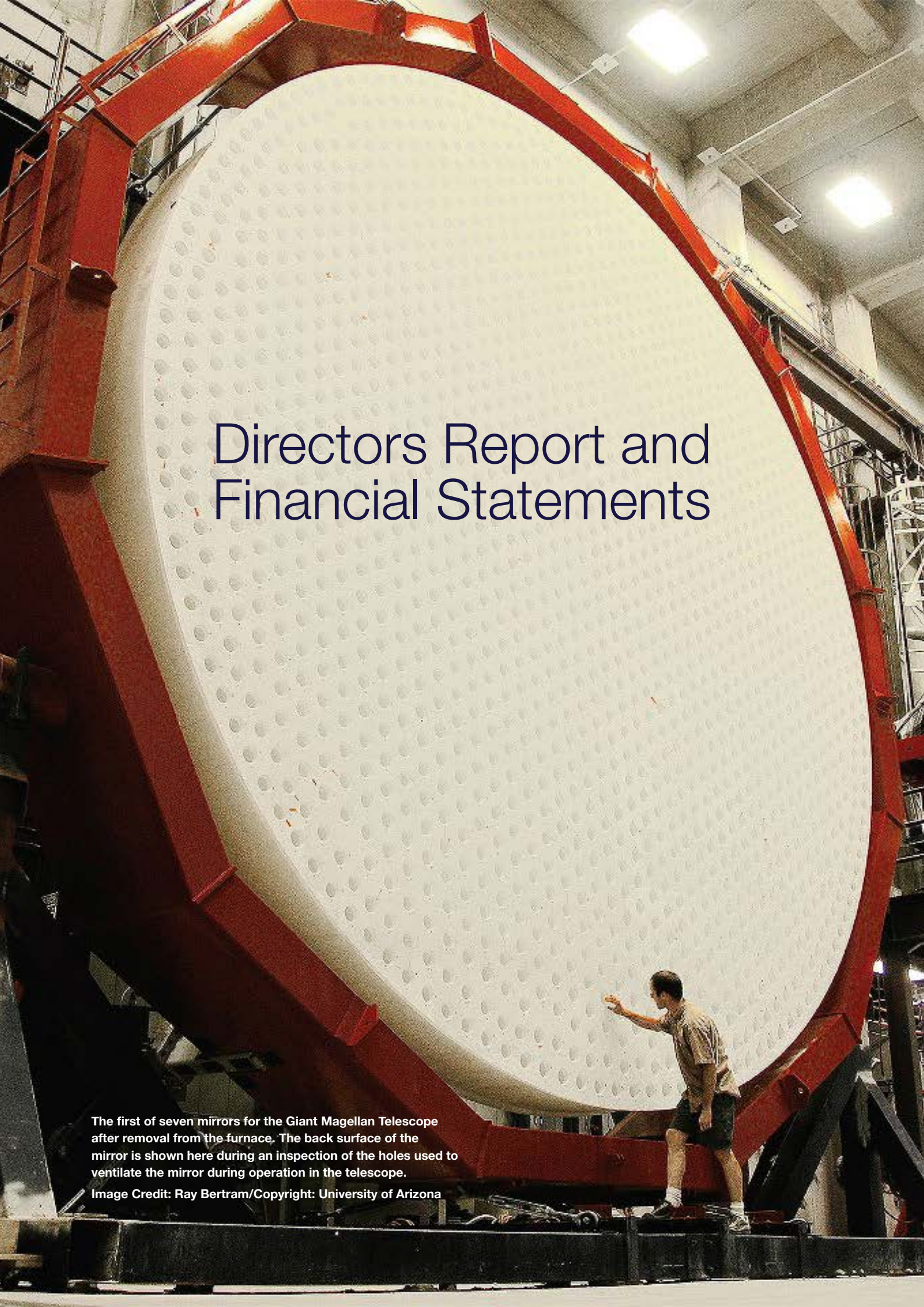
1. Bernardi, G., et al. (53 co-authors), A 189 MHz, 2400 deg2 Polarization Survey with the Murchison Widefield Array 32-element Prototype, The Astrophysical Journal, Volume 771, Issue 2, article id. 105, 16 pp. (2013)
2. Bowman, Judd D., et al. (60 co-authors), Science with the Murchison Widefield Array, Publications of the Astronomical Society of Australia, Volume 30, id.e031 28 pp. (2013)
3. **Tingay, S. J.**, et al (53 co-authors), The Murchison Widefield Array: solar science with the low frequency SKA Precursor, Journal of Physics: Conference Series, Volume 440, Issue 1, article id. 012033 (2013)
4. **Tingay, S. J.**, et al. (60 co-authors), The Murchison Widefield Array: The Square Kilometre Array Precursor at Low Radio Frequencies, Publications of the Astronomical Society of Australia, Volume 30, id.e007 21 pp. (2013)
5. **Tingay, S.**, et al. (58 co-authors), Realisation of a low frequency SKA Percursor: The Murchison Widefield Array, Proceedings of the meeting "Resolving The Sky—Radio Interferometry: Past, Present and Future". April 17-20,2012. Manchester, UK. Published online at http://pos.sissa.it/cgi-bin/reader/conf.cgi?confid=163, id.36 (2012)
6. **McKinley, B.**, et al. (51 co-authors), Low Frequency Observations of the Moon with the Murchison Widefield Array, The Astronomical Journal, Volume 145, Issue 1, article id. 23, 9 pp. (2013)
7. Beardsley, A. P., et al. (50 co-authors), The EoR Sensitivity of the 128 Antenna Murchison Widefield Array, Monthly Notices of the Royal Astronomical Society: Letters, Volume 429, Issue 1, p.L5-L9 (2013)
8. Sullivan, I. S., et al (50 co-authors), Fast Holographic Deconvolution: A New Technique For Precision Radio Interferometry, The Astrophysical Journal, Volume 759, Issue 1, article id. 17, 6 pp. (2012)
9. Williams, Christopher L., et al. (54 co-authors), Low Frequency Imaging of Fields at High Galactic Latitude with the Murchison Widefield Array 32-Element Prototype, The Astrophysical Journal, Volume 755, Issue 1, article id. 47, 19 pp. (2012)
10. Beardsley, A. P., et al. (49 co-authors), A new layout optimization technique for interferometric arrays, applied to the MWA, Monthly Notices of the Royal Astronomical Society, Volume 425, Issue 3, pp. 1781-1788 (2012)

Pierre Auger

Journal publications by the Pierre Auger Collaboration.

1. Techniques for Measuring Aerosols using the Central Laser Facility at the Pierre Auger Observatory, JINST, in press (2013)
2. Bounds on the density of sources of ultra-high energy cosmic rays from the Pierre Auger Observatory, JCAP, in press (2013)
3. Ultra-High Energy Neutrinos at the Pierre Auger Observatory , Advances in High Energy Physics, 2013 (2013) 708680
4. The Interpretation of the Depths of Shower Maximum of Extensive Air Showers Measured by the Pierre Auger Observatory, JCAP 02 (2013) 026
5. Constraints on the origin of cosmic rays above 10^18 eV from large scale anisotropy searches in data of the Pierre Auger observatory, ApJL, 762 (2013) L13
6. Large scale distribution of arrival directions of cosmic rays detected above 10^18 eV at the Pierre Auger observatory, Astrophysical Journal Supplement, 203 (2012) 34
7. A Search for Point Sources of EeV Neutrons, ApJ, 760 (2012) 148
8. Results of a self-triggered prototype system at the Pierre Auger Observatory for radio-detection of air showers induced by cosmic rays, JINST, 7 (2012) P11023
9. Antennas for the Detection of Radio Emission Pulses from Cosmic-Ray induced Air Showers at the Pierre Auger Obervatory, JINST 7 P10011 (2012)
10. The Rapid Atmospheric Monitoring System of the Pierre Auger Observatory, JINST 7 (2012) P09001
11. Measurement of the cosmic ray energy spectrum using hybrid events of the Pierre Auger Observatory, Eur. Phys. J. Plus 127 (2012) 87 (M. Settimo for the Pierre Auger Collaboration)

Directors Report and Financial Statements



The first of seven mirrors for the Giant Magellan Telescope after removal from the furnace. The back surface of the mirror is shown here during an inspection of the holes used to ventilate the mirror during operation in the telescope.

Image Credit: Ray Bertram/Copyright: University of Arizona

Financial Report for the year ended
30 June 2013

Astronomy Australia Limited

A.B.N 19 124 973 584

Contents

General Information

The financial report covers Astronomy Australia Limited as an individual entity. The financial report is presented in Australian Dollars, which is Astronomy Australia Limited's functional and presentation currency.

The financial report consists of the financial statements, notes to the financial statements and directors' declaration.

Astronomy Australia Limited is a not-for-profit unlisted public company limited by guarantee, incorporated and domiciled in Australia. Its registered office and principal place of business are:

Registered Office

Swinburne University of Technology
Centre for Astrophysics and Supercomputing
Room AR 201
1 John Street
Hawthorn Vic 3122

Principal Place of Business

Swinburne University of Technology
Centre for Astrophysics and Supercomputing
Room AR 201
1 John Street
Hawthorn Vic 3122

A description of the nature of the company's operation and its principal activities are included in the directors' report, which is not part of the financial report.

The financial report was authorised for issue, in accordance with a resolution of directors, on 15 August 2013. The directors have the power to amend and reissue the financial report.

Astronomy Australia Limited A.B.N 19 124 973 584

Directors' Report

Your directors present their report together with the financial statements on the company for the financial year ended 30 June 2013. Astronomy Australia Limited is a company limited by guarantee and is an income tax exempt charitable institution.

Directors

The names of the non-executive directors in office at any time during, or since the end of, the year are:

Prof. Warrick J. Couch (appointed 18 April 2007, reappointed 5 November 2010)
Prof. Anne Green (appointed 5 November 2010)
Prof. Brian P. Schmidt AC (appointed 18 April 2007 reappointed, 11 November 2011)
Emeritus Prof. Mark S. Wainwright AM (appointed 5 November 2009, retired 2 November 2012)
Prof. Brian J. Boyle (appointed 5 November 2009, reappointed 2 November 2012)
Dr. Ian Chessell (appointed 5 November 2010)
Prof. Stuart Wyithe (appointed 11 November 2011)
Prof. Robyn Owens (appointed 2 November 2012)

Information on Directors

Prof. Stuart Wyithe
BSc(Hons), PhD, FAICD

Special responsibilities - Board Chair from 14 March 2013. He is a member of the Executive Remuneration Committee, Audit and Risk Management Committee, Optical Telescopes Advisory Committee and Gemini Board and Finance Committee.

Prof. Stuart Wyithe is an ARC Australian Laureate Fellow and a Professor at The University of Melbourne. Previously, he was University Associate Dean in the Melbourne School of Graduate research (2009-2011). A cosmologist and author of over 100 scientific publications, he has a history of collaboration at the national and international level, encompassing both theory and observation. He has received many awards, including the Pawsey Medal from the Australian Academy of Science and the Malcome McIntosh prize. He served as MWA Science Council Chair (2010-2011), during which he developed and implemented project policies. He has contributed to the running of a range of national bodies and is the current Chair of the Australian Academy of Science's National Committee for Astronomy.

Prof. Brian Boyle
BSc(Hons), PhD, FAA, FAICD

Special responsibilities - a member of the Audit and Risk Management Committee and Antarctic Astronomy Advisory Committee.

Prof. Brian Boyle is the Acting SKA Director for the Department of Industry, Innovation, Science, Research, and Tertiary Education, following his role as CSIRO SKA Director. Previously, he was the Director of the CSIRO Australia Telescope National Facility (2003-2009) where he initiated the construction of ASKAP, and Director of the Anglo-Australian Observatory (1996-2003). His main research interests are cosmology, active galactic nuclei and quasars. During his career he has overseen the successful commissioning of world-class instruments and has led many international scientific collaborations. He has been a Fellow of the Australian Institute of Company Directors since 2005. As Chairman of the National Committee for Astronomy, he led the development of the Decadal Plan for Australian Astronomy 2006-15. He was also the facilitator for the NCRIS investment plan for optical and radio astronomy.

Astronomy Australia Limited A.B.N 19 124 973 584

Directors' Report

Dr Ian Chessell
BSc(Hons), PhD (Physics), FTSE

Special responsibilities - member of the Executive Remuneration Committee and Audit and Risk Management Committee.

Dr Ian Chessell followed a career in the Defence Science and Technology Organisation, retiring as Australia's Chief Defence Scientist in 2003. Dr Chessell served as a member of the Prime Minister's Science, Engineering and Innovation Council (2001-2003) and in 2003 he was awarded the Centenary Medal for services to defence science. He was elected a Fellow of the Australian Academy of Technological Sciences and Engineering in 2003. He was Chief Scientist of South Australia from 2008-2010. He is a member of the Defence South Australia Advisory Board, the Board of QinetiQ Pty Ltd and is Chair of the Goyder Institute for Water Research. He has chaired a number of science reviews including Commonwealth reviews of National ICT Australia in 2005, the Anglo-Australian Telescope in 2006, and CSIRO's Climate Adaptation Flagship in 2011

Prof. Warrick Couch
BSc(Hons), MSc, PhD (Astronomy), DSc, FAA, FASA, FAIP

Special responsibilities- Board Chair until 13 March 2013.

Prof. Warrick Couch has recently taken up the position of Director of the Australian Astronomical Observatory. Previously he was the Director of the Centre for Astrophysics and Supercomputing at Swinburne University of Technology. He has a research career spanning 30 years in optical astronomy, with an extensive and distinguished track record in terms of (i) use of university, national and international telescope facilities, (ii) research publications and citation impact (Australian citation laureate and "Highly Cited" researcher), and (iii) securing external research grant funding. He is or has been an active member of key national astronomy committees and bodies that are responsible for dealing with research policy and priorities, which have given him considerable experience in developing short- and long-term strategies and priorities for our national astronomy infrastructure, and implementing related funding programs.

Prof. Anne Green
BSc(Hons), PhD, Grad Dip AICD, FASA, FAIP

Special responsibilities - Deputy Chair and a member of the Radio Telescopes Advisory Committee.

Prof. Anne Green is a Professor at the University of Sydney, and is Director of the Square Kilometre Array Molonglo Project, a pathfinder instrument that will help advance science and technology for the next generation of radio telescopes. Previously she was the Head of the School of Physics, the Director of the Science Foundation for Physics, and the Director of the Molonglo Observatory, all associated with the University of Sydney. Her research career spans more than 20 years in radio astronomy, with a focus on the structure and ecology of the Milky Way Galaxy. She has also been an active member of several national and international astronomy committees with responsibility for setting strategy and managing competing priorities. Since 2007, she has been a Graduate Member of the Australian Institute of Company Directors.

Astronomy Australia Limited A.B.N 19 124 973 584

Directors' Report

Prof. Robyn Owens
BSc(Hons), MSc (Mathematics), PhD (Mathematics)

Special responsibilities – a member of Astronomy eReseach Advisory Committee.

Prof. Robyn Owens is Deputy Vice-Chancellor (Research) at the University of Western Australia (UWA) and has responsibility for research policy development and leadership of the University's research activities, postgraduate education, industry liaison, intellectual property and commercialisation. Previously she was the Head of the School of Computer Science & Software Engineering at UWA and has also lectured in Australia and internationally in mathematics and computer science. She has an extensive background in mathematical analysis and research with a focus on computer vision, including feature detection in images, 3D shape measurement, image understanding, and representation.

Prof. Brian Schmidt AC
BSc (Physics & Astronomy), A.M. in Astronomy, PhD (Astronomy), FAA, NAS, FRS

Prof Brian Schmidt is an ARC Australian Laureate Fellow at the Australian National University. He is the Project scientist for the new SkyMapper Telescope which will undertake a comprehensive optical survey of the southern sky. His research has focused on the physics of distant exploding stars to trace the expansion of the Universe. He has received a variety of awards over his career culminating in his sharing the 2011 Nobel Prize for Physics. He has been an active member of several national astronomy and science bodies including the Major National Research Facilities selection panel, Australian Square Kilometre Array Steering Committee, Australian Decadal Working group on International Facilities and Mid-Term Review of the Australian Astronomy Decadal Plan.

Emeritus Prof. Mark S. Wainwright AM
BAppSc (Hons), MAppSc (Chemical Engineering), PhD (Chemical Engineering), DSc (honoris causa), FTSE, FIEAust, FIChemE, FRACI

Emeritus Professor Mark Wainwright is currently Executive Director, International Engagement, at the University of New South Wales following his retirement from the position of Vice-Chancellor and President of the University of New South Wales. Previously, he was Acting Vice-Chancellor and Vice-Chancellor (R&I) at the University. He is Chair of Intersect, Chair of The New Horizons Project at Monash University, Chair of the National Institute for the Promotion of ICT in Health, Chair of the UNSW Faculty of Science Advisory Committee, and member of the board of Engineering Aid Australia. In 2000 he was awarded the Centenary Medal for service to Australian society in research policy and management and engineering education. In 2004, Professor Wainwright was made a Member of the Order of Australia (AM) for his service to chemical engineering as a researcher and academic, and to tertiary education.

Directors' Report

Meetings of Directors

The number of meetings of the company's Board of Directors and of each board committee held during the year ended 30 June 2013, and the number of meetings attended by each director were:

	Directors Meetings		Board Committee Meetings	
Name	No. Eligible to Attend	No. Attended	No. Eligible to Attend	No. Attended
Prof. Warrick J. Couch	4	4	1	0
Prof. Brian P. Schmidt	4	4	-	-
Prof. Robyn Owens	2	2	-	-
Prof. Brian J. Boyle	4	3	1	1
Emeritus Prof. Mark S. Wainwright	2	2	1	1
Dr. Ian Chessell	4	2	2	2
Prof. Anne Green	4	3	-	-
Prof. Stuart Wyithe	4	4	1	1

Company Secretary

Ms. Sue Russell (BSC, MSc, Grad DipBus(Acc), CPA) was appointed to the position of Company Secretary on 1 July 2012.

Objectives

The Australian Government has defined the science of astronomy as one of only a few Super Sciences (Super Science Initiative, available online: http://www.innovation.gov.au/Science/ResearchInfrastructure/Pages/SuperScience.aspx). To support this definition, Astronomy Australia Limited's core objective is to ensure that astronomers in Australia have access to the best astronomical research infrastructure, including Australian participation in international facilities.

Strategy for achieving the objectives

During the financial year the company worked to achieve its core objective by:

1. Engaging with Australian astronomers to advance the national research infrastructure priorities of the Australian astronomy decadal plan.
2. Advising the Australian Government on future investments in national astronomical research infrastructure.
3. Managing investments in national astronomical research infrastructure as required.

Astronomy Australia Limited A.B.N 19 124 973 584

Directors' Report

Principal activities

During the financial year the company's principal activities were:

1. Communicating directly with every Australian institution with a significant astronomy research capability, regardless of whether they were a member of the company.
2. Managing several major grants from the Australian Government for astronomical research infrastructure.
3. Founder in Giant Magellan Telescope Organisation.

Performance measures

The company measures its performance in two different ways. For facilities that are currently operational the company measures the cost of access to the facility and its scientific return (through number of refereed journal articles). For facilities still under construction, a range of technical and construction milestones exist by which the performance of the project is measured. Both sets of measures are included in the company's annual report to Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education (DIICCSRTE).

Operating and Financial Review

The company recorded a deficit of $61,523 for the financial year ended 30 June 2013 (2012: profit of $126,021).

Contribution on winding up

In the event of the company being wound up, ordinary members are required to contribute a maximum $10 each. The total amount that members of the company are liable to contribute if the company is wound up is $140, based on 14 current members.

Auditor's Independence Declaration

A copy of the auditor's independence declaration as required under section 307C of the Corporations Act 2001 is set out on pg 52.

Signed in accordance with a resolution of the Board of Directors:

On behalf of the Directors

Director:

Prof. Stuart Wyithe

Director:

Dr. Ian Chessell

Dated this 15th day of August 2013

Astronomy Australia Limited A.B.N 19 124 973 584

Auditor's Independence Declaration under section 307C of the Corporation Act 2001 to the Directors of Astronomy Australia Limited

I hereby declare, that to the best of my knowledge and belief, during the financial year ended 30 June 2013 there have been no:

(i) contraventions of the auditor independence requirements as set out in the Corporations Act 2001 in relation to the audit; and

(ii) contraventions of any applicable code of professional conduct in relation to the audit.

Name of Firm: E. Townsend & Co.
Chartered Accountant

Name of Partner:

Eric Townsend

Address: 15 Taylor Street, Ashburton. Vic. 3147.

Dated this 15th day of August 2013

Statement of profit and loss and other comprehensive income for the year ended 30 June 2013

	Note	2013 $	2012 $
Revenue including Government Grants	3	5,597,621	12,293,915
Expenses			
Depreciation	9	(3,909)	(1,881)
Grants paid		(4,854,973)	(11,543,946)
Direct grant project expenses		(42,247)	-
Employee benefits expenses		(536,149)	(364,830)
Other expenses	4	(221,866)	(257,237)
Surplus (Deficit) before income tax attributable to members of the entity	5	**(61,523)**	**126,021**
Income tax		-	-
Surplus (Deficit) after income tax attributable to members of Astronomy Australia Ltd		**(61,523)**	**126,021**
Other comprehensive income		-	-
Total comprehensive income for the year attributable to members of Astronomy Australia Ltd		**(61,523)**	**126,021**

The Company is an income tax exempt charitable institution.

Statement of Financial Position as at 30 June 2013

	Note	2013 $	2012 $
Current Assets			
Cash and cash equivalents	7	6,903,577	6,700,645
Trade and other receivables	8	98,818	69,837
Total Current Assets		7,002,395	6,770,482
Non-Current Assets			
Property, plant and equipment	9	5,000	8,501
Total Non-Current Assets		5,000	8,501
Total Assets		7,007,395	6,778,983
Current Liabilities			
Trade and other payables	10	3,932,462	3,664,160
Employee benefits	11	53,330	31,697
Total Current Liabilities		3,985,792	3,695,857
Total Liabilities		3,985,792	3,695,857
Net Assets		3,021,603	3,083,126
Equity			
Reserves		2,925,571	3,024,839
Retained surpluses	12	96,032	58,287
Total Equity		3,021,603	3,083,126

Statement of changes in equity for the year ended 30 June 2013

	Retained Surpluses	NCRIS Reserve Account	Overseas Optical Reserve Account	EIF Reserve Account	Total Equity
	$	$	$	$	$
Balance at 30 June 2011	**64,504**	**461,132**	**2,431,469**	**-**	**2,957,105**
Surplus attributable to equity members	126,021	-	-	-	126,021
Allocated to Reserves	(281,856)	39,788	155,918	86,150	-
Transfers from Reserves	149,618	(77,250)	(72,368)	-	-
Balance at 30 June 2012	**58,287**	**423,670**	**2,515,019**	**86,150**	**3,083,126**
Surplus attributable to equity members	(61,523)	-	-	-	(61,523)
Allocated to Reserves	(213,518)	61,925	118,968	32,625	-
Transfers from Reserves	312,786	(169,339)	(50,882)	(92,565)	-
Balance at 30 June 2013	**96,032**	**316,256**	**2,583,105**	**26,210**	**3,021,603**

Statement of cash flows for the year ended 30 June 2013

	Note	2013 $	2012 $
Cash Flows from Operating Activities:			
Receipts from grants/members (inclusive of GST)		6,010,997	10,029,699
Interest received		266,319	220,802
Payments to suppliers & employees (inclusive of GST)		(733,556)	(334,118)
Payments of grants		(5,340,420)	(13,179,588)
Net Cash generated by (Used in) Operating Activities	13	203,340	(3,263,205)
Cash Flows from Investing Activities:			
Proceeds from sale of property, plant & equipment		-	-
Payment for property, plant & equipment	9	(408)	(6,453)
Net Cash generated by (Used in) Investing Activities		(408)	(6,453)
Net increase (decrease) in cash and cash equivalents		202,932	(3,269,658)
Cash at beginning of the financial year		6,700,645	9,970,303
Cash at 30 June 2013	7	6,903,577	6,700,645

Notes to the Financial Statements for the year ended 30 June 2013

Astronomy Australia Limited is a company limited by guarantee incorporated and domiciled in Australia. The company is a not-for-profit income tax exempt charitable institution.

1 Summary of Significant Accounting Policies

The principal accounting policies adopted in the preparation of the financial statement are set out below. These policies have been consistently applied to all the years presented, unless otherwise stated.

New, revised or amending Accounting Standards and Interpretations adopted

The company has adopted all new, revised or amending Accounting Standards and Interpretations issued by the Australian Accounting Standards Board ('AASB') that are mandatory for the current reporting period.

Any new, revised or amending Accounting Standards or Interpretations that are not yet mandatory have not been early adopted.

Any significant impact on the accounting policies of the company from the adoption of these Accounting Standards and Interpretations are disclosed below. The adoption of these Accounting Standards and Interpretations did not have any significant impact on the financial performance or position of the company.

The following Accounting Standards and Interpretations are most relevant to the company:

AASB 2011-9 Amendments to Australian Accounting Standards – Presentation of Items of Other Comprehensive Income.

The company has applied AASB 2011-9 amendments from 1 July 2012. The amendments requires grouping together of items within other comprehensive income on the basis of whether they will eventually be 'recycled' to the profit or loss (Reclassification adjustments). The change provides clarity about the nature of items presented as other comprehensive income and the related tax presentation. The amendments also introduced the term 'Statement of profit or loss and other comprehensive income' clarifying that there are two discrete sections, the profit or loss section (or separate statement of profit or loss) and other comprehensive income section.

Basis of preparation

These general purpose financial statements have been prepared in accordance with Australian Accounting Standards and the Corporations Act 2001, as appropriate for not-for-profit oriented entities. These financial statements also comply with International Financial Reporting Standards as issued by the International Accounting Standards Board ('IASB').

Historical cost convention

The financial statements have been prepared under the historical cost convention.

Critical accounting estimates

The preparation of the financial statements requires the use of certain critical accounting estimates. It also requires management to exercise its judgement in the process of applying the company's accounting policies. The areas involving a higher degree of judgement or complexity, or areas where assumptions and estimates are significant to the financial statements, are disclosed in note 2.

Revenue recognition

Interest revenue is recognised on a proportional basis taking into account the interest rates applicable to the financial assets.

Revenue from the rendering of a service is recognised upon the delivery of the service to the customers.

Grants are recognised at fair value where there is reasonable assurance that the grant

will be received and all grant conditions will be met. Grants relating to expense items are recognised as income over the periods necessary to match the grant to the costs they are compensating. Grants relating to assets are credited to deferred income at fair value and are credited to income over the expected useful life of the asset on a straight-line basis.

All revenue is stated net of the amount of Goods and Services Tax (GST).

Comparative Figures

When required by Accounting Standards, comparative figures have been adjusted to conform to changes in presentation for the current financial year.

Income Taxation

The company is a charitable institution endorsed by the Australian Charities and Not-for-profits Commission as a charity and is exempt from paying income taxation.

Property, Plant and Equipment

Office Furniture and Equipment

Office Furniture and Equipment are carried at cost or fair value less, where applicable, any accumulated depreciation and impairment losses.

Depreciation

The depreciable amount of Office Furniture and Equipment is on a written down value (WDV) over their useful lives to the company commencing from the time the asset is held ready for use. Leasehold improvements are depreciated over the shorter of either the unexpired period of the lease or the estimated useful lives of the improvements.

The depreciation rates used for each class of depreciable assets are:

Class of Fixed Assets	Depreciation Rate	Method
Office Furniture & Equipment	15% to 50%	Written down value

The assets' residual values and useful lives and depreciation methods are reviewed, and adjusted if appropriate, at each balance sheet date.

An item of property, plant and equipment is derecognised upon disposal or when there is no future economic benefit to the company.

Gains and losses on disposals are determined by comparing proceeds with the carrying amount. These gains or losses are included in the income statement. When revalued assets are sold, amounts included in the revaluation reserve relating to that asset are transferred to retained earnings.

Impairment of non-financial assets

Non-financial assets are reviewed for impairment whenever the events or changes in circumstances indicate that the carrying amount may not be recoverable. An impairment loss is recognised for the amount by which the asset's carrying amount exceeds its recoverable amount.

Recoverable amount is the higher of an asset's fair value less costs to sell and value-in-use. The value-in-use is the present value of the estimated future cash flows relating to the asset using a pre-tax discount rate specific to the asset or cash-generating unit to which the asset belongs. Assets that do not have independent cash flows are grouped together to form a cash-generating unit.

Trade and other payables

These amounts represent liabilities for goods and services provided to the company prior to the end of the financial year and which are unpaid. Due to their short-term nature they are measured at amortised cost and are not discounted. The amounts are unsecured and are usually paid within 30 days of recognition.

Employee Benefits

Wages and salaries and annual leave

Liabilities for wages and salaries, including non-monetary benefits, and annual leave expected to be settled within 12 months of the reporting date are recognised in current

liabilities in respect of employees' services up to the reporting date and are measured at the amounts expected to be paid when the liabilities are settled.

Long service leave

The liability for long service leave is recognised in current and non-current liabilities, depending on the unconditional right to defer settlement of the liability for at least 12 months after the reporting date. The liability is measured as the present value of expected future payments to be made in respect of services provided by employees up to the reporting date using the projected unit credit method. Consideration is given to expected future wage and salary levels, experience of employee departures and periods of service. Expected future payments are discounted using market yields at the reporting date on national government bonds with terms to maturity and currency that match, as closely as possible, the estimated future cash outflows.

Cash and Cash Equivalents

Cash and cash equivalents include cash on hand, deposits held at call with banks, other short- term highly liquid investments with original maturities of three months or less, and bank overdrafts. Bank overdrafts are shown within short-term borrowings in current liabilities on the balance sheet.

Goods and Services Tax ('GST') and other similar taxes

Revenues, expenses and assets are recognised net of the amount of associated GST, unless the GST incurred is not recoverable from the tax authority. In this case it is recognised as part of the cost of acquisition of the asset or as part of the expense.

Receivables and payables are stated inclusive of the amount of GST receivable or payable. The net amount of GST recoverable from, or payable to the tax authority is included in other receivables or other payables in the statement of financial position.

Cash flows are presented on a gross basis. The GST components of cash flows arising from investing and financing activities which are recoverable from, or payable to the tax authority are presented as operating cash flows.

Commitments and contingencies are disclosed net to the amount of GST recoverable from, or payable to, the tax authority.

Unspent Grant Funds

Unspent Grant Funds available as revenue or liable to be returned to the grant provider in the following year are recognised as deferred grants, a current liability, in the balance sheet. They are not treated as an operating surplus or profit.

Overseas Optical Reserve

As part of the Australian Research Council's financial arrangements with Sydney University for paying for the Australian share of Gemini, a substantial reserve was established. When the ARC LIEF grant for Gemini was transferred from Sydney University to AAL, this "Gemini Reserve" was also transferred to AAL. AAL and the ARC have agreed that the primary use of this reserve would be to cover shortfalls in payments to overseas optical telescope facilities due to currency fluctuations. AAL therefore renamed this reserve the "Overseas Optical Reserve".

A 2% (2012 – 2%) administration fee totalling $50,300 (2012 - $48,630) has been transferred from the Reserve. Grant payments totalling $582 (2012 - $23,738) have been transferred from the Reserve.

New Accounting Standards and Interpretations not yet mandatory or early adopted

Australian Accounting Standards and Interpretations that have recently been issued or amended but are not yet mandatory, have not been early adopted by the company for the annual reporting period ended 30 June 2013. The company's

assessment of the impact of these new or amended Australian Accounting Standards and Interpretations, most relevant to the company, are set out below.

2 Critical accounting judgements, estimates and assumptions

The preparation of the financial statements requires management to make judgements, estimates and assumptions that affect the reported amounts in the financial statements. Management continually evaluates its judgements and estimates in relation to assets, liabilities, contingent liabilities, revenue and expenses. Management bases its judgements, estimates and assumptions on historical experience and on other various factors, including expectations of future events, management believes to be reasonable under the circumstances. The resulting accounting judgements and estimates will seldom equal the related actual results. The judgements, estimates and assumptions that have a significant risk of causing a material adjustment to the carrying amounts of assets and liabilities (refer to the respective notes) within the next financial year are discussed below.

Estimation of useful lives of assets

The company determines the estimated useful lives and related depreciation and amortisation charges for its property, plant and equipment and finite life intangible assets. The useful lives could change significantly as a result of technical innovations or some other event. The depreciation and amortization charge will increase where the useful lives are less than previously estimated lives, or technically obsolete or non-strategic assets that have been abandoned or sold will be written off or written down.

Impairment of non-financial assets other than goodwill and other indefinite life intangible assets

The company assesses impairment of non-financial assets other than goodwill and other indefinite life intangible assets at each reporting date by evaluating conditions specific to the company and to the particular asset that may lead to impairment. If an impairment trigger exists, the recoverable amount of the asset is determined. This involves fair value less costs to sell or value-in-use calculations, which incorporate a number of key estimates and assumptions.

Long service leave provision

As discussed in note 1, the liability for long service leave is recognised and measured at the present value of the estimated future cash flows to be made in respect of all employees at the reporting date. In determining the present value of the liability, estimates of attrition rates and pay increases through promotion and inflation have been taken into account.

3 Revenue including Government Grants

	2013	2012
	$	$
Grants	4,755,114	11,520,208
Administration grant	395,583	262,160
Members subscriptions	217,624	220,908
Interest received – General Account	15,537	8,683
Interest received – Grants Account	62,018	39,889
Interest received – Overseas Optical Reserve Account	119,069	155,917
Interest received – EIF Account	32,676	86,150
Total Revenue	5,597,621	12,293,915

4 Other Expense Items

	2013	2012
	$	$
Accounting & company secretarial	13,650	33,330
Consultant fees	-	12,273
Insurance	10,936	10,485
Legal costs	29,134	46,271
Meeting expenses	16,275	46,839
Printing & stationery	6,115	12,452
Travel expenses	116,205	61,934
Miscellaneous expenses	29,551	33,653
	221,866	257,237

5 Segmented Granting and Operating Revenue and Expenses

	Grants	Administration	Total
	$	$	$
Revenue			
Grant received	4,755,114	395,583	5,150,697
Interest	213,763	15,537	229,300
Membership	-	217,624	217,624
Total Revenue	4,968,877	628,744	5,597,621
Expenses			
Grants paid	(4,854,973)	-	(4,854,973)
Direct project expenses	(42,003)	(208,000)	(250,003)
Operating costs	(244)	(553,924)	(554,168)
Total Expenses	(4,897,220)	(761,924)	(5,659,144)
Surplus / (deficit)	71,657	(133,180)	(61,523)
Transfer to Reserves	(213,519)	-	(213,519)
Transfer from Reserves	141,862	170,924	312,786
	0	37,744	37,744

	2013	2012
	$	$

6 Remuneration of Auditors

During the financial year the following fees were paid or payable for services provided by E Townsend & Co, the auditor of the company.

Audit services - E Townsend & Co	6,000	5,000
Other services	1,000	-
	7,000	5,000

7 Current Assets - Cash and Cash Equivalents

Cash on hand	22	65
Cash at bank – General account	116	3,960
Cash at bank – General Maximiser account	706,983	113,295
Cash at bank – Grant account	89	440,089
Cash at bank – Grant Maximiser account	1,358,303	2,916,851
Term Deposit – Grant account	3,000,000	2,364,327
Term Deposit – Grant account USD	1,838,064	862,058
	6,903,577	6,700,645

8 Current Assets - Trade and Other Receivables

Trade debtors	66,000	-
Other receivables	32,818	69,837
	98,818	69,837

9 Non-current Assets - Property, Plant and Equipment

Office Furniture and Equipment

At cost	20,858	20,450
Less accumulated depreciation	(15,858)	(11,949)
Total Office Furniture and Equipment	5,000	8,501

Reconciliations

Reconciliations of the written down values at the beginning and end of the current and previous financial year are set out below:

	Office Furniture & Equipment	Total
Balance at 1 July 2012	3,859	3,859
Additions	6,453	6,453
Disposals	-	-
Depreciation expense	(1,811)	(1,811)
Balance at 30 June 2012	**8,501**	**8,501**
Additions	408	408
Disposals	-	-
Depreciation expense	(3,909)	(3,909)
Balance at 30 June 2013	**5,000**	**5,000**

10 Current Liabilities - Trade and Other Payables

	2013 $	2012 $
Trade creditors	5,240	-
Other payables	44,951	44,677
GST Payable	190,597	90,031
NCRIS Grant deferred	110,887	390,470
OOR Grant deferred	0	775,282
DIICCSRTE AST3 – ALMA Grant deferred	17,997	30,000
DIICCSRTE MWA Grant deferred	200,000	400,000
AAO Grant deferred	1,699,750	967,000
EIF Grant deferred	290,000	966,700
NeCTAR Grant deferred	160,040	-
CRIS Grant deferred	1,153,000	-
DIICCSRTE – Aust China scholarships Grant deferred	60,000	-
	3,932,462	3,664,160

Movement in Deferred Grants during the Financial Year

	EIF Grant	NCRIS Grant	OOR Grant	DIICCSRTE AST3 - ALMA
	$	$	$	$
2012				
Opening Balance 1 July 2012	-	1,679,538	1,550,562	-
Grants Received	966,700	-	-	30,000
Grants Paid	-	(1,289,068)	(775,280)	-
Closing Balance 30 June 2012	966,700	390,470	775,282	30,000
2013				
Opening Balance 1 July 2012	966,700	390,470	775,282	30,000
Grants received	2,500,000	-	-	30,000
Grants paid	(3,176,700)	(279,583)	(775,282)	(42,003)
Closing Balance 30 June 2013	290,000	110,887	-	17,997

	AAO Grant	DIICCSRTE MWA Grant	NeCTAR Grant	CRIS Grant	DIICCSRTE Aust China scholarship
	$	$	$	$	$
2012					
Opening Balance 1 July 2011	-	-		-	-
Grants Received	967,000	400,000	31,250	-	-
Grants Paid	-	-	(31,250)	-	-
Closing Balance 30 June 2012	967,000	400,000	-	-	-
2013					
Opening Balance 1 July 2012	967,000	400,000	-	-	-
Grants received	933,000	-	1,412,201	1,153,000	60,000
Grants paid	(200,250)	(200,000)	(1,252,161)	-	-
Closing Balance 30 June 2013	1,699,750	200,000	160,040	1,153,000	60,000

11 Current Liabilities – Employee Benefits

	2013	2012
	$	$
Provision for Long Service Leave	21,388	11,906
Provision for Annual Leave	31,942	19,791
	53,330	31,697

	2013	2012
	$	$

12 Equity – Retained Surpluses

Retained surpluses at the beginning of the financial year	58,287	64,504
Surplus (deficit) after income tax expense for the year	(61,523)	126,021
Allocation to Reserves	(213,518)	(281,856)
Transfers to Reserves	312,786	149,618
Retained surpluses at the end of the financial year	96,032	58,287

13 Reconciliation of Surplus after Income Tax to Net Cash from Operating Activities

Surplus/(deficit) from ordinary activities after income tax	(61,523)	126,021
Adjustments for:		
Depreciation	3,909	1,811
Changes in operating assets and liabilities:		
(Increase)/decrease in trade and other receivables	(28,981)	374,549
Increase/(decrease) in trade and other payables	268,302	(3,787,492)
Increase/(decrease) in current provisions	21,633	21,906
Net cash from operating activities	203,340	(3,263,205)

14 Financial Instruments

Financial risk management objectives

The company's activities do not expose it to many financial risks, with only liquidity risk and foreign exchange risk being needed to be actively managed.

Market risk

Foreign currency risk

The company manages its foreign currency risk by pre-purchasing its US dollar commitments.

Price risk

The company is not exposed to any significant price risk.

Interest rate risk

The company is not exposed to any significant interest rate risk.

Credit risk

The company is not exposed to any significant credit risk.

Liquidity risk

Vigilant liquidity risk management requires the company to maintain sufficient liquid assets (mainly cash and cash equivalents) to be able to pay debts as and when they become due and payable.

The company manages liquidity risk by maintaining adequate cash reserves by continuously monitoring actual and forecast cash flows and matching the maturity profiles of financial assets and liabilities.

Remaining contractual maturities

The following tables detail the company's remaining contractual maturity for its financial instrument liabilities. The tables have been drawn up based on the undiscounted cash flows of financial liabilities based on the earliest date on which the financial liabilities are required to be paid. The tables include both interest and principal cash flows disclosed as remaining contractual maturities and therefore these totals may differ from their carrying amount in the statement of financial position.

	Weighted average interest rate	1 year and or less	Between 1 and 2 years	Between 2 and 5 years	Over 5 years	Remaining contractual maturities
2013	%	$	$	$	$	$
Non-derivatives						
Non-interest bearing Trade payables	-	240,788	-	-	-	240,788
Other payables/ Grants deferred	-	3,691,674	-	-	-	3,691,674
Total non-derivatives		3,932,462	-	-	-	3,932,462

	Weighted average interest rate	1 year and or less	Between 1 and 2 years	Between 2 and 5 years	Over 5 years	Remaining contractual maturities
2012	%	$	$	$	$	$
Non-derivatives						
Non-interest bearing Trade payables	-	134,708	-	-	-	134,708
Other payables/ Grants deferred	-	3,529,452	-	-	-	3,529,452
Total non-derivatives		3,664,160	-	-	-	3,664,160

Fair value of financial instruments

Unless otherwise stated, the carrying amounts of financial instruments reflect their fair value. The carrying amounts of trade receivables and trade payables are assumed to approximate their fair values due to their short-term nature. The fair value of financial liabilities is estimated by discounting the remaining contractual maturities at the current market interest rate that is available for similar financial instruments.

Foreign Exchange Risk

Exposure to foreign exchange risk may result in the fair value or future cash flows of a financial instrument fluctuating due to movement in the foreign exchange rates of currencies in which the entity holds financial instruments other than the Australian Dollar (AUD) functional currency of the entity.

The following table shows the foreign currency risk of the entity:

Net Financial Assets (liabilities) in AUD	**2013**	**2012**
	$	**$**
Term deposit – Grant Account USD	1,838,064	862,058

Forward US Dollar Contracts

There were no such contracts held at 30 June 2013

15 Key Management Personnel Disclosures

The number of directors and other members of key management personnel who received:

	2013	**2012**
Less than $4,999	2	2
$5,000 to $9,999	3	4
$10,000 to $19,999	3	2
$130,000 to $139,999	1	1
Total	**9**	**9**

The aggregate compensation made to directors and other members of key management personnel of the company is set out below.

	2013	**2012**
	$	**$**
Short-term employee benefits	213,854	196,794

16 Contingent Liabilities

The company has a contingent liability for severance pay for existing employees should the company's funding not be continued beyond 31 December 2014.

17 Commitments

The company had no commitments for capital expenditure as at 30 June 2013 and 30 June 2012.

The company has the following commitments for expenditure:

NCRIS & EIF Reserves to be allocated for future commitments as at 30 June 2013 is $255,470 (2012 commitments $418,750).

	NCRIS Reserve Account	Overseas Optical Reserve Account	EIF Reserve Account
	$	$	$
Balance 30 June 2013	316,256	2,583,105	26,210
Less committed to All-Sky Virtual Observatory project	(255,470)	-	-
Uncommitted balance 30 June 2013	**60,786**	**2,583,105**	**26,210**

18 Segment Reporting

The company operates predominantly in one business and geographical segment being liaison with the astronomy community and managing capital grant funds to astronomy projects throughout Australia.

19 Economic Dependency

The company receives the majority of its grant funds from the Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education (DIICCSRTE). This funding source establishes certain procedures for grant expenditure and acquittal. If grants are not expended and acquitted in accordance with grantor's procedures, the Grantor can refuse to make further grants and request repayments of grants made.

20 Related Party Transactions

Transactions between related parties are on normal commercial terms and conditions no more favourable than those available to the other parties unless otherwise stated.

21 Events After the Reporting Period

No material or circumstance has arisen since 30 June 2013 that has significantly affected, or may significantly affect the company's operations, the results of those operations, or the company's state of affairs in the future financial years.

22 Member's Guarantee

Astronomy Australia Limited is a company limited by guarantee. Every member of the company undertakes to contribute to the assets of the company in the event of it being wound up while he/she is a member or within one year after he or she ceases to be a member for the payment of the debts and liabilities of the company contracted before he/she ceases to be a member and the costs, charges and expenses of winding up and for the adjustment of the rights of the contributories among themselves such amount as may be required not exceeding 10 dollars.

Astronomy Australia Limited A.B.N 19 124 973 584

Directors' Declaration

For the year ended 30 June 2013

In the directors' opinion:

the attached financial statements and notes thereto comply with the Corporations Act 2001, the Accounting Standards, the Corporations Regulations 2001 and other mandatory professional reporting requirements;

the attached financial statements and notes thereto comply with International Financial Reporting Standards as issued by the International Accounting Standards Board as described in note 1 to the financial statements;

the attached financial statements and notes thereto give a true and fair view of the company's financial position as at 30 June 2013 and of its performance for the financial year ended on that date; and

there are reasonable grounds to believe that the company will be able to pay its debts as and when they become due and payable.

This declaration is made in accordance with a resolution of directors made pursuant to section 295(5)(a) of the Corporations Act 2001.

On behalf of the directors

Director:

Professor Stuart Wyithe

Director:

Professor Ian Chessell

Dated this 15th day of August 2013

Astronomy Australia Limited A.B.N 19 124 973 584

Independent Auditors' Report to the Members of Astronomy Australia Limited

Report on the Financial Report

I have audited the accompanying financial statements of Astronomy Australia Limited, which comprises the statement of financial position as at 30 June 2013, and the statement of comprehensive income, statement of changes in equity and statement of cash flows for the year then ended, notes comprising a summary of significant accounting policies and other explanatory information and the director's declaration.

Director's Responsibility for the Financial Statements

The directors of the company are responsible for the preparation and fair presentation of the financial statements that gives a true and fair view in accordance with Australian Accounting Standards (including the Australian Accounting Interpretations) and the Corporations Act 2001 and for such internal control as the directors determine is necessary to enable the preparation of the financial statements that are free from material misstatement, whether due to fraud or error.

Auditors' Responsibility

My responsibility is to express an opinion on the financial statements based on my audit. I conducted my audit in accordance with Australian Auditing Standards. These Auditing Standards require that I comply with relevant ethical requirements relating to audit engagements and plan and perform the audit to obtain reasonable assurance whether the financial statements are free from material misstatement.

An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the financial statements. The procedures selected depend on the auditors' judgment, including the assessment of the risks of material misstatement of the financial statements, whether due to fraud or error. In making those risk assessments, the auditors consider internal control relevant to the entity's preparation of the financial statements that gives a true and fair view in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the entity's internal control. An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of accounting estimates made by the director, as well as evaluating the overall presentation of the financial statements.

I believe that the audit evidence I have obtained is sufficient and appropriate to provide a basis for my audit opinion.

Independence

In conducting my audit, I have complied with the independence requirements of the Corporations Act 2001. I confirm that the independence declaration required by the Corporations Act 2001, provided to your directors and included in the financial statements, would be in the same terms if provided to the directors as at the date of this auditors' report.

Astronomy Australia Limited A.B.N 19 124 973 584

Independent Auditors' Report to the members of Astronomy Australia Limited2013

Auditors' Opinion

In my opinion the financial statements of Astronomy Australia Ltd. is in accordance with the Corporations Act 2001, including:

(i) Giving a true and fair view of the company's financial position as at 30 June 2013 and of its performance for the year ended on that date; and

(ii) Complying with Australian Accounting Standards and the Corporations Regulations 2001

Name of firm: E Townsend & Co

Name of Auditor: Eric Townsend, Chartered Accountant
Address: 15 Taylor Street, Ashburton. Vic. 3147.

Dated this 15th day of August 2013

Acronyms used in this report

AAAC	Antarctic Astronomy Advisory Committee
AAL	Astronomy Australia Limited
AAO	Australian Astronomical Observatory
AAT	Anglo-Australian Telescope
AeRAC	Astronomy eResearch Advisory Committee
ALMA	Atacama Large Millimeter/ submillimeter Array
ANU	The Australian National University
ARC	Australian Research Council
ASA	The Astronomical Society of Australia
ASKAP	Australian Square Kilometre Array Pathfinder
ASTAC	Astronomy Supercomputer Time Allocation Committee
AST3	Antarctic Schmidt Telescopes
ASVO	All-Sky Virtual Observatory
ATCA	Australia Telescope Compact Array
ATNF	Australia Telescope National Facility
AURA	Association of Universities for Research in Astronomy
AusGO	Australian Gemini Office
CASS	CSIRO Astronomy and Space Science
CCD	Charge-coupled device
CPU	Central Processing Unit
CRIS	Collaborative Research Infrastructure Strategy
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DBRCAS	Division for Basic Research, Chinese Academy of Sciences
DIICCSRTE	Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education
DVC-R	Deputy Vice-Chancellor, Research
EIF	Education Investment Fund
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.
FAIP	Fellow of the Australian Institute of Physics
FASA	Fellow of the Astronomical Society of Australia
FIEAust	Fellow of the Institution of Engineers Australia
FIEChemE	Fellow of the Institution of Chemical Engineers
FRACI	Fellow of the Royal Australian Chemical Institute
FRAS	Fellow of the Royal Astronomical Society
FTE	Full time equivalent
FTSE	Fellow of the Australian Academy of Technological and Engineering Sciences
GeMS	Gemini Multi-Conjugate Adaptive Optics System
GMT	Giant Magellan Telescope
GPU	Graphics Processing Unit
GSAOI	Gemini South Adaptive Optics Imager
GST	Goods and Services Tax
gSTAR	GPU Supercomputer for Theoretical Astrophysics Research
HEAT	High Elevation Antarctic Terahertz (telescope)
HERMES	High Efficiency and Resolution Multi-Element Spectrograph
HPC	High Performance Computing
MoU	Memorandum of Understanding
MRO	Murchison Radio-astronomy Observatory
MWA	Murchison Widefield Array
NAS	National Academy of Sciences
NCA	National Committee for Astronomy
NCI	National Computational Infrastructure
NCRIS	National Collaborative Research Infrastructure Strategy
NeCTAR	National eResearch Collaboration Tools and Resources
OMT	Ortho Mode Transducer
OOR	Overseas Optical Reserve
OTAC	Optical Telescopes Advisory Committee
PLATO	Plateau Observatory
RTAC	Radio Telescopes Advisory Committee
SKA	Square Kilometre Array
STAC	Science and Technology Advisory Committee
SUT	Swinburne University of Technology
swinSTAR	Swinburne Supercomputer for Theoretical Academic Research
TAO	Theoretical Astrophysical Observatory
TB	Terabytes
UNSW	University of New South Wales
UWA	University of Western Australia

Astronomy Australia Ltd

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