AAO

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Minister Macfarlane Launches HERMES

GALAH Takes Flight | Successful on-sky Starbugs test | Around the horizon imaging

Director's message

Warrick Couch

One of my immediate tasks after writing this column will be to travel to Parkes in central-west New South Wales to deliver the John Bolton Lecture to the very active astronomical society in this town at its annual AstroFest event. As well as it being a good opportunity to connect with the amateur astronomers and members of the public in Parkes, preparation of the lecture - entitled "The AAO at 40 years" – has served as a valuable reminder of the early history of the AAO, and the AAT being no exception in terms of the enormous lead time that is required to take a new telescope facility from an idea to one which has government backing, is funded, and then constructed. For the AAT, this gestation period spanned almost 20 years, starting with Australian and British astronomers in the 1950's looking to the already built 5m Hale Telescope and fancying a telescope of this class in the southern hemisphere. But as is often the case, it requires astronomers with great vision and political influence to make things happen. Here the credit goes to Richard Woolley and Bart Bok, who as Directors of Mt Stromlo Observatory in Canberra and the Royal Greenwich Observatory in the UK, were instrumental in convincing the Australian and UK governments to fund the construction of the AAT. This important break-through occurred in 1967, and it was then another 7 years before construction of the AAT was completed.

This very early history is just a small part of the AAT's life story, and more will be said on this in the next issue. Indeed this year is a notable one for significant birthdays: the 40th for the AAT and the 50th for Siding Spring Observatory (SSO) itself and the opening of the first telescope there – the ANU's 40-inch. What actually constitutes the AAT's exact birthday is open to debate, since its first light occurred on 27 April 1974, and its official inauguration (conducted by HRH Prince Charles) occurred on 16 October 1974. But in the true AAO tradition, this will be used as an excuse to celebrate all year, and indeed 40 years since first light has been appropriately observed at both North Ryde and at site. We now

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Front cover photo Credit: David Malin
Caption: The Milky Way Galaxy rising vertically out of a yellow glow on the horizon. The glow is from the lights of Sydney, 355 km in the distance. The dark shape in the upper centre of the image is the Coal Sack Nebula, with the Pointer stars, alpha and beta Centaurus below it. The bright object at the left of the frame is Omega Centauri. The image was made with a Canon Mk5 III digital camera, fitted with a Samyang F/1.4 35 mm lens working at F/2.8. The exposures were 30 seconds and taken on Jan 28-29, 2014.

look forward to the annual Open Day event at SSO where the 40 and 50 year milestones will be further celebrated.

In the last issue, much was made of the successful commissioning of our new multi-object high-resolution spectrograph on the AAT – HERMES. This is too significant and innovative an instrument to not have its completion more formally recognised, and so we were delighted that HERMES was officially launched by the Minister for Industry, the Hon Ian Macfarlane, on 16 April (see article on page 20). The ceremony rightly took place on the dome floor at the foot of the AAT, and was attended by more than 100 people. What was particularly gratifying were the many people from the Minister's Office and the Department of Industry who attended, with the latter including its Secretary, Ms Glenys Beauchamp, and Deputy Secretary, Dr Subho Banerjee. This was a great opportunity to show them and the Minister what a great research facility the AAT is, and how well it delivers on one of the Department's key outcomes: to facilitate science, research, and innovation.

HERMES of course has been operating as a full facility instrument since the beginning of this year, and has already seen the GALAH survey collect spectra for some 33,000 stars (see report on page page 4). It is very pleasing that GALAH has made such a good start, that scientifically is very much a journey into the unknown, in that no one can predict the number and nature of the chemically related groups of stars in our Milky Way that will be encountered. Furthermore, the GALAH program also has an important role in determining the detailed performance of HERMES and its data reduction pipelines. While the overall performance of HERMES is good and to spec, there nonetheless are some issues that need to be addressed. These include radioactivity in the corrector lens (which produce bright streaks in the CCD images), the vacuum not holding as well as it should in the green, red, and near-infrared cameras, and the occasional loss of focus in the red camera. All of these will be addressed in the near future.

While on the topic of AAT instrument upgrades, readers should take note that the CCDs in the AAT's AAOmega spectrograph are being replaced with new, more sensitive and cosmetically superior devices this year, thanks to an EIF grant received from Astronomy Australia Limited. The CCD in the blue camera has already been replaced, and the CCD in the red camera will be replaced in August-September. As mentioned in Sarah Brough's article on page 15, some unanticipated problems were encountered with the blue camera upgrade, causing disruption to some observing programs. Having learned from this experience, we are hopeful this will not be repeated with the red camera upgrade. There are always risks with such CCD upgrades, but as I hope all AAOmega users will come to appreciate, in this case these are very much worth taking, given the great improvement in sensitivity and cosmetic quality that will be realised by the new AAOmega CCDs.

Moving from 4m to 8m telescopes, there has been another cause to celebrate over the last few months. At the end of March, the AAO received formal approval to proceed with the Gemini High resolution Optical Spectrograph (GHOS) project. This will build on its heritage of constructing major bench-mounted spectrographs for the AAT (AAOmega and HERMES), and involve partnering with NRC-Herzberg in Victoria, Canada, in sharing the work. After many delays in getting to this point, we are delighted to have now commenced this project, and see it get off to such a good start with a very productive kick-off meeting here at the AAO in early May.

Finally, this contribution would be incomplete without mention of two further developments reported in this issue. The first is the successful on-sky demonstration of the AAO's "Starbug" technology on the UK Schmidt Telescope (see Kyler Keuhn & Sam Richard's article on page 6). The starbug concept has been one of the AAO's flagship technology developments over the last decade and one which will be a critical part of the next generation of multi-object fibre positioners for spectrographs on new and existing telescopes. The successful deployment of starbug positioners on the UKST is an important first step to both revitalising this telescope (in equipping it to undertake the TAIPAN and FunnelWeb Surveys; see page 8), as well as prototyping this technology for the MANIFEST positioner on the 25m Giant Magellan Telescope. The second is the new around-the-horizon imaging undertaken at SSO by David Malin and Steve Lee (see page 18). Not only does it dramatically capture the number and brightness of light-polluting sources that impact on SSO, but the comparison that can now be made with almost identical images taken 28 years ago serves as an important reminder of the constant and growing threat to the dark sky environment at SSO. This is something we must remain vigilant about and, through working with the relevant stakeholders, continue to protect.

GALAH Takes Flight

Sarah Martell (University of New South Wales) and Gayandhi de Silva (Australian Astronomical Observatory).

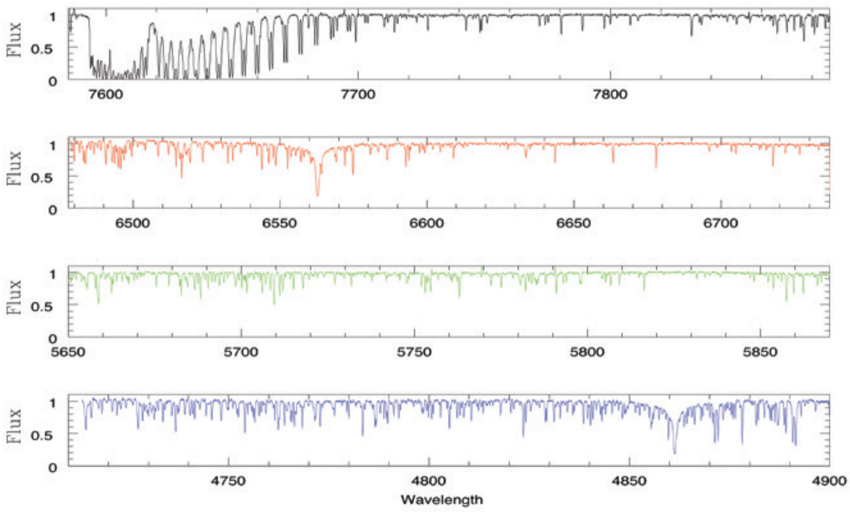


Figure 1 The Sun as seen by HERMES

The Galactic Archaeology with HERMES (GALAH) survey is an ambitious observational project aimed at unravelling the star formation, chemical evolution, merger, and migration history of the Galactic disk. By measuring detailed elemental abundance information, GALAH will provide the opportunity to identify the original stellar building blocks of the Milky Way, that have long since dispersed into the Galaxy background.

The idea of "Galactic archaeology", the driving concept of GALAH, was first hatched in 2002, when project PIs Ken Freeman and Joss Bland-Hawthorn wrote a review paper entitled "The New Galaxy: Signatures of Its Formation" (ARA&A, vol. 40, p. 487). They proposed the use of stellar chemical abundances as a marker to identify common star-formation events, and referred to this concept as “chemical tagging”. The concept of chemical tagging had several requirements to be successful, from which the two most fundamental was that (i) stars formed together in clusters had to be chemically uniform, and (ii) chemical abundance space had to be multi-dimensional, without all elements following similar patterns.

Subsequent studies using high-resolution observations demonstrated that present-day Galactic star clusters are indeed chemically homogeneous within observational accuracy (De Silva et al., 2007, AJ, vol. 133, p.1161). This is the case even for very old star clusters, giving observational support to the idea that chemical properties of stars reflect the preserved conditions of the proto-cluster gas cloud. Ting et al. (2012, MNRAS, vol. 421, p. 1231) carried out a principal component analysis of the chemical space and found 8-9 independent dimensions with various nucleosynthetic processes as their source. Further, Mitschang et al. (2014, MNRAS, vol. 438, p.2753) used a chemical metric to identify substructure within the local solar neighbourhood for stars with no prior identity, and demonstrated that stellar ages could be derived via chemical tagging (see Fig. 2).

These on-going developments within Galactic Archaeology show the real possibility and the need to carry out large scale chemical tagging to develop a physical sequence of events that led to the present day Milky Way. These include the rate of star formation as a function of time, the distribution in mass of the groups of stars that formed together, the progress of chemical enrichment from various nucleosynthetic processes, the rate of accretion or merger events and the efficiency of a theoretically predicted stellar migration process called "radial mixing". These processes are key to understanding every disk galaxy, but the Milky Way is the only galaxy for which we can collect detailed enough information about individual stars to study the abundance patterns in detail.

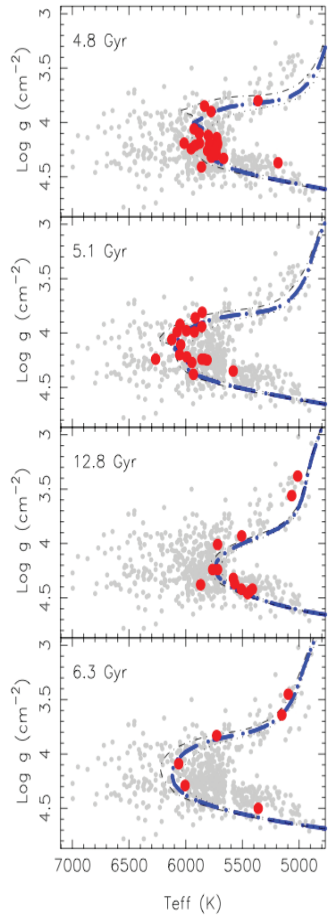


Figure 2 Chemical substructure from the solar neighbourhood with no other identity. The blue lines are “isochrones” that show where a single age population of stars would lie. The red dots are the chemically tagged stars from the solar neighbourhood. Clearly the chemical method is grouping similar aged stars.

Based on models of the Galactic star formation rate, the mass distribution of newly formed star clusters, and processes like radial mixing that distribute stars through the Galaxy, the GALAH survey team calculate that the abundance patterns for 1 million stars will be needed in order to adequately sample the relic star forming groups. A smaller survey

The GALAH survey team

The GALAH survey team has 72 members from 19 institutions in 7 countries. All Australian astronomers are welcome to join the team; send an email describing your interest to the survey Executive Team *(galah-ext@aao.gov.au)*.

will mean fewer stars per group from the same number of groups, which is inherent to any volume of the Galaxy.

Such a million-star chemical tagging project was the main science driver for the design and construction of the AAO's new HERMES spectrograph, which works with the 2dF fibre positioner to acquire high-resolution spectra of up to 392 stars simultaneously (See HERMES Launch Story in this issue). Spending one hour of observing time per field, and observing typically 360 stars at the same time, it will take the GALAH team roughly 500 observing nights to collect the million-star data set to complete the project.

The GALAH survey began with a 6-month "pilot survey" aimed at answering five specific science questions while testing out instrument capabilities. The survey team were so keen to get started that the pilot survey started during HERMES commissioning, in November 2013. Observing with such a new instrument always brings extra challenges, but the team have worked closely with the AAO Instrumentation and Software groups to tune up the instrument configuration, observing control software and data reduction software. These continue to be improved based on GALAH data and analysis, and this process will result in a more reliable instrument and better data for all HERMES observers.

The main GALAH survey began in February 2014. In the first four observing runs there were 37 nights on sky, and in that time there were nearly 33,000 survey targets observed, plus over 3000 stars in observations meant to test HERMES performance. Targets are chosen from the GALAH input catalogue, which contains over 2 million stars divided into 6546 fields matched to the 2dF field of view (see Fig. 3). The selection rules for the GALAH input catalogue are very simple: a star must have V magnitude between 12 and 14, declination between +10 and -80, Galactic latitude more than 10 degrees off the plane, and it must be in a dense enough field that the 2dF fibres can all be placed on targets. Experienced 2dF observers within the GALAH survey team have been providing all of the observing support for the project and training other members of the team as HERMES observers, something that has become standard during other large AAT survey programs like GAMA and SAMI.

Transforming the spectra into a list of elemental abundances for each star happens in two stages: first, raw HERMES frames are reduced and the spectrum of each star is extracted (see Fig. 1). The GAP (GALAH Analysis Pipeline) runs the reduction, tracks data quality, and stores all the observational metadata (such as date of observation and exposure time) along with 5-band photometry, radial velocity and extracted spectra in a database. This process is carried out with care in order to ensure that the resulting data produce accurate abundances. While data reduction is sometimes seen as the bane of observational astronomy, the GALAH survey team recognises its impact and has invested much time to (on-going) testing of the reduction pipeline.

Following accurate data reduction, the Theremin pipeline takes the extracted spectra and determines the atmospheric parameters of the stars: effective temperature, surface gravity, atmospheric turbulence and overall metallicity. This is done by a standard process based on the strengths of absorption lines caused by iron and titanium. However, while that standard process usually required the attention of an experienced spectroscopist, Theremin has been designed to run without supervision because of the extremely large number of spectra it will be processing. Once the atmospheric parameters have been found to a high enough level of precision, Theremin moves on to calculating the abundances of individual elements by spectral synthesis: generating several model spectra with the correct atmospheric parameters and a range of possible abundances, to find the one that best matches the data.

The GALAH survey team is currently busy with the operational part of the project, taking the data, processing through pipelines and building the database of stellar abundances. As the data set grows, the team will move into the unexplored space of searching for groups of chemically related stars and using them to unfold the history of the Milky Way. Since a project of this type and scale has never been carried out before, it is impossible to predict exactly what it will find. The resulting dataset is of enormous legacy value to many fields of astronomy and will be revisited by many in the years to come. However, the survey team is excited to be in such a unique position, and is looking forward to exploring the history of star formation and chemical enrichment in the Galaxy.

To learn more about the GALAH survey, please visit our web site at www.mso.anu.edu.au/galah/home.html or follow @galahsurvey on Twitter.

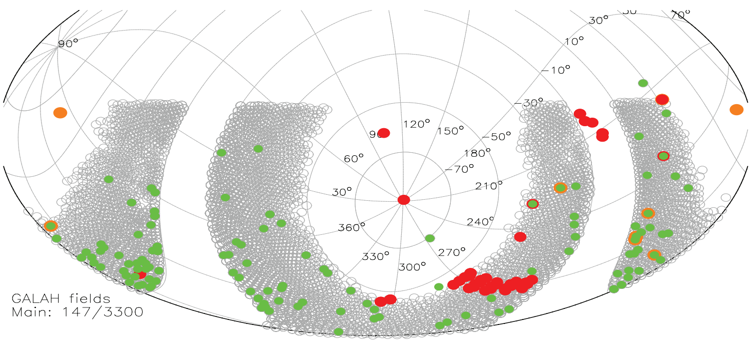


Figure 3 GALAH observational progress map from March 2014. All 6546 possible fields are shown as circles, with fields observed for the pilot survey in red, fields from the main survey in green, and fields taken for instrument and software testing in orange.
Credit: A. Mitschang, Macquarie University

GALAH pilot survey projects

- Contrast the abundance patterns of stars in the Galactic thin and thick disks
- Use stars in globular clusters to test the reliability of the Theremin spectral analysis software developed for GALAH
- Observe open cluster stars and field stars at the same time to test methods for finding chemically similar groups within an homogeneous data set
- Explore GALAH synergy with asteroseismology for stars observed by the CoRoT asteroseismic satellite
- Determine stellar parameters of planet host stars discovered by the WASP transit survey

First Light for AAO's Starbugs!

Kyler Kuehn (AAO), Samuel Richards (University of Sydney/AAO)

In the instrument science lab at the AAO, an incessant buzzing sound is a welcome noise to the ears of the Instrument Science team. It means that the Starbugs, the groundbreaking fibre positioner technology developed by the AAO, are working just as they should. Each Starbug consists of concentric piezoceramic tubes that allow the movement and positioning of a small payload (in this case, an optical fibre) with a precision of a few microns (see Figure 1). It is the high-speed (up to a few hundred Hz) motion of the tubes that is heard as a buzz, and that gives the Starbugs their name.

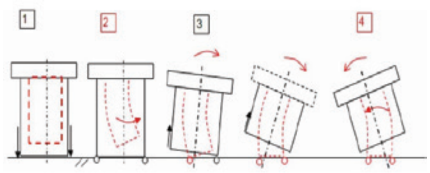


Figure 1 A Starbug Walking

The Need for a New Fibre-Positioning Technology

The current generation of multi-object spectrographic instruments (e.g., SAMI[1], 2dF[2]) uses plug plates or pick-and-place robots that require tens of minutes at best to prepare a set of fibres for observation. Because Starbugs are each controlled independently, they can position fibres in parallel rather than in series, potentially cutting the reconfiguration time for an entire field down to just a few minutes. Adhering to a glass plate positioned at the focal surface of a telescope, the Starbugs are positioned to observe stars and galaxies spread throughout a telescope's field of view[3]. Figure 2 shows the 6 degree field of view of TAIPAN, along with 150 Starbugs (open circles) and their routes to the selected target objects.

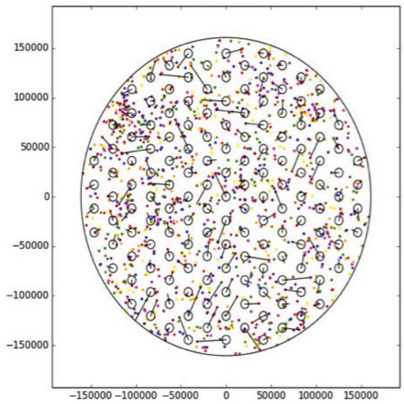


Figure 2 Starbugs (open circles) and Potential Targets (small filled circles), with lines showing the Starbug path to the selected target.

Starbugs have been at least mentioned in nearly every one of the AAO Observer issues in recent years, and the technology even featured prominently in the February 2012 issue. At that time, the hardware and software to enable the walking motion had been developed, but payloads had not yet been integrated into the Starbugs. Hard work by many scientists and engineers since then has led to a vastly improved Starbug design that is capable of carrying a variety of payloads[4]. The recent design effort culminated in the first on-sky tests of Starbugs in May 2014, on the UK Schmidt Telescope (UKST) at Siding Spring Observatory.

TAIPAN: A Cutting-Edge Instrument for a Classic Telescope

Starbugs will bring new life to the UKST, since that telescope will undergo significant refurbishment and upgrades in order to host the TAIPAN instrument, starting in late 2015 (see Figure 3). Utilising 150 Starbugs initially, and aiming to install 300 eventually, the TAIPAN instrument will perform the TAIPAN galaxy survey, enabling major new projects in galaxy evolution and cosmology[5]. A complementary stellar survey, FunnelWeb, will occur in parallel with the galaxy survey. In addition to a wealth of new scientific opportunities with TAIPAN and FunnelWeb, the Starbugs that are used for observing on the UKST will serve another vital role as a prototype design study for the Many-Fibre Positioner System (MANIFEST)[6], a facility to be installed on the Giant Magellan Telescope (GMT, see Figure 4) in the mid-2020's. While GMT will not be the largest of the planned 30m-class telescopes, it will have the largest field of view and will be ideal for survey science. MANIFEST will greatly expand these capabilities by allowing it to maximize the use of its wide field of view (see Table 1), and will even be capable of feeding fibres to multiple other instruments simultaneously.

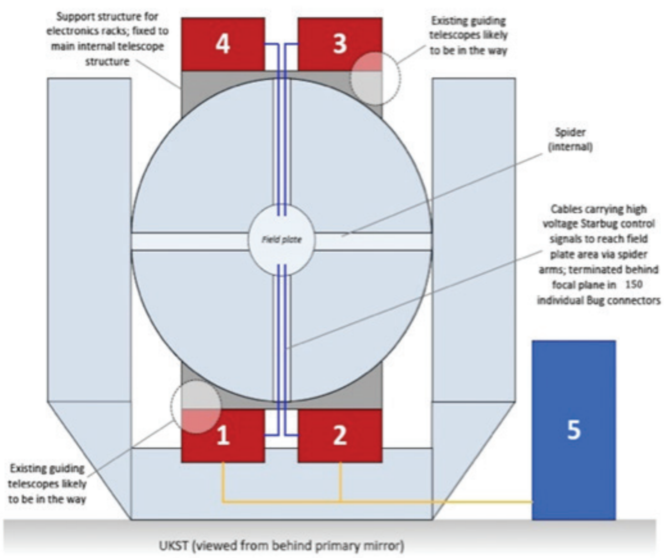


Figure 3 Starbug technology will first be utilized for the TAIPAN survey on the UK Schmidt Telescope. TAIPAN will also serve as a prototype design study for the GMT's MANIFEST fibre-positioner facility.

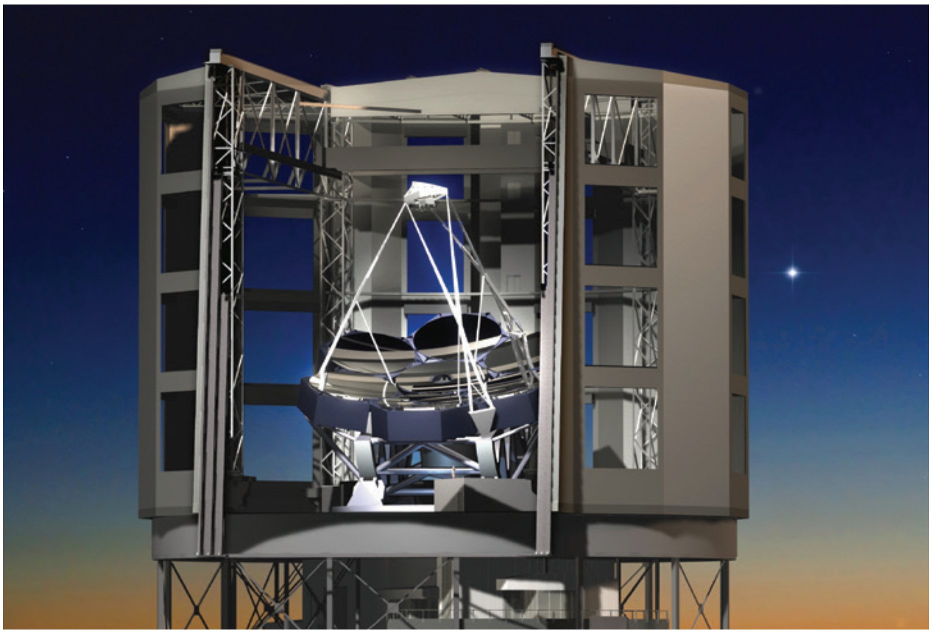


Figure 4 The longer-term goal for Starbugs is to use them within the MANIFEST fibre positioner to enhance several other instruments on the Giant Magellan Telescope. An artist's rendering of GMT is pictured here.

Starbugs Achieve First Light

The first successful on-sky tests with Starbugs were performed in late May, when prototypes of the TAIPAN vacuum, metrology, and command and control software and hardware were installed on the UKST (see Figure 5). These tests, dubbed Proto-TAIPAN, witnessed the integrated prototype Starbug system performing admirably, and saw the repeated detection of starlight with a 1.5mm imaging fibre bundle (see Figure 6).

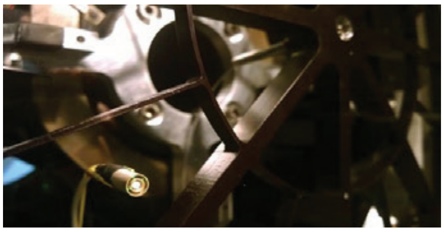


Figure 5 A Proto-TAIPAN Starbug installed on a transparent plastic field plate, with the rigid supporting frame and ancillary hardware also shown.

The final TAIPAN instrument will use a suite of smaller fibres to feed a custom-built spectrograph, and work is ongoing to build the full complement of Starbugs. In parallel, research and development efforts are underway to incorporate IFUs (important for MANIFEST) and other large payloads into the Starbug technology. For more information about Starbugs and the TAIPAN instrument, including time-lapse videos of the Proto-TAIPAN installation procedure, the detection of first light with the Starbugs, and even a view of the moving Starbugs from inside the telescope, please visit the AAO Instrument Science webpage: *http://www.aao.gov.au/instsci/*

Telescope + Instrument	Diam. (D)	Tel. Field (Φ_T)	Inst. Field (Ω_I)	D^2	D^4	$A\Phi_T$	$A\Omega_I$
GMT + MANIFEST	25.4 m	20′	314′	≡1	≡1	≡1	≡1
TMT + WFOS	30m	20′	100-200′	1.4	1.9	1.40	0.35-0.70
E-ELT + DIORAMAS	42m	10′	46′	2.7	7.5	0.68	0.40

Table 1 GMT + MANIFEST is the best telescope + instrument combination for survey science with a 30m-class telescope.

References

[1] Croom, S. M., Lawrence, J. S., Bland-Hawthorn, J., et al., ``The Sydney-AAO Multi-object Integral _eld spectrograph'', MNRAS 421, 872 (2012).

[2] Lewis, I. J., Cannon, R. D., Taylor, K., et al., ``The Anglo-Australian Observatory 2dF facility'', MNRAS 333, 279-299 (2002).

[3] Goodwin, M., Lorente, N. P. F., Hong, S. E., et al., ``Field target allocation and routing algorithms for starbugs", Proc. SPIE 9152, Software and Cyberinfrastructure for Astronomy III, in press (2014) 9152-26.

[4] Brown, D. M., Case, S., Gilbert, J., et al., ``Starbug Fibre positioning robots: performance and reliability enhancements'', Proc. SPIE 9151, Advances in Optical and Mechanical Technologies for Telescopes and Instrumentation, in press (2014) 9151-45.

[5] Kuehn, K., Lawrence, J., Brown, D., et al., ``TAIPAN: Optical Spectroscopy with Starbugs'', Proc. SPIE 9147, Ground-based and Airborne Instrumentation for Astronomy V, in press (2014) 9147-35.

[6] Lawrence, J., Brown, D., Brzeski, J., et al., ``The MANIFEST Fibre positioning system for the Giant Magellan Telescope'', Proc. SPIE 9147, Ground-based and Airborne Instrumentation for Astronomy V, in press (2014) 9147-341.

Figure 6 A screen capture of the Proto-TAIPAN control console, showing telemetry and guiding information (right), a series of imaging fibre bundles (centre), and a zoomed-in image of the central fibre bundle observing a star (left).

The Taipan galaxy survey

Andrew Hopkins (AAO), Matthew Colless (ANU), Chris Blake (Swinburne), Jeremy Mould (Swinburne), Michael Brown (Monash), Scott Croom (Sydney), Lee Spitler (AAO/Macquarie), Chris Tinney (UNSW)

Introduction

Taipan is a new survey planned with a refurbished and upgraded UK Schmidt Telescope, using the innovative 'starbugs' optical-fibre positioner and a purpose-built spectrograph. The Taipan survey will measure spectra for 500,000 galaxies, including peculiar velocities for a subset of 50,000 early-type galaxies, over the whole southern sky. Taipan will make the best direct measurement of the present-day expansion rate of the Universe, the largest maps of the density and velocity fields of local structures, and unique new tests of large-scale gravitational physics using galaxy motions, including tests of modified theories of gravity. Taipan will also provide the largest sample of galaxy groups, complementing those from the GAMA survey, to allow a unique investigation of the process of galaxy transition from blue, active disks to passive, red spheroids. Together this data will serve as a legacy database for studies of galaxy evolution, in particular complementing observations with the ANU SkyMapper telescope and the Australian SKA Pathfinder.

The TAIPAN facility will enable both the Taipan galaxy survey and the Funnelweb stellar survey. Jointly these programs will allow us to make significant progress in our understanding of cosmology, galaxy evolution, stellar evolution and Galactic structure. This article outlines the goals for the Taipan galaxy survey.

Survey team

The Taipan galaxy survey collaboration currently consists of over 50 members. Twelve Australian research institutions and the ARC are contributing funding support for the TAIPAN facility. We clarify the nomenclature used here, with 'TAIPAN' being used to refer to the instrumentation on the UKST, and 'Taipan' or the 'Taipan survey' referring to the galaxy survey using the facility. The Taipan survey has an executive group to manage the survey preparations and the interface with the instrumentation group as the positioner and spectrograph are being developed and the telescope refurbished. The executive will also manage the survey itself once underway. The executive consists of: Andrew Hopkins (PI), Michael Brown, Matthew Colless, Scott Croom, Lee Spitler (Science Coordinator), and Chris Tinney (Funnelweb executive, ex-officio). All three elements of the TAIPAN facility, the positioner, the spectrograph, and the telescope refurbishment, are funded. Work on all three has begun at the AAO, and we anticipate that the facility will be commissioned in the second half of 2015, allowing the survey to start in early 2016.

Measuring H_0 to a 1% precision

Measurements of the Cosmic Microwave Background (CMB) have allowed an accurate prediction of Hubble's constant at redshift z=0, assuming the standard ΛCDM model. The recent Planck collaboration (2013) results give H_0 = 67.4 ± 1.4 km s^{-1} Mpc^{-1}. The key question is does this prediction accord with direct measurements of H_0? In the local Universe H_0 may be measured using standard candles and standard rulers, such as supernovae, Cepheid variable stars, and water masers. Combining the best current datasets, Riess et al. (2011) obtained a measurement of H_0 = 73.8 ± 2.4 km s^{-1} Mpc^{-1}. Figure 1 shows that there are systematic discrepancies at the 2.5σ level between current H_0 measurements from local standard candles and the value predicted from the CMB under the ΛCDM model. These offsets have three possible causes: (1) ΛCDM is not the correct cosmological model, causing an error in the prediction from the CMB; (2) there are systematic errors in the measurement of local standard candles; or (3) the standard assumption that the Universe is homogeneous and isotropic, used to predict a global expansion rate, fails to describe the local expansion of the real, clumpy Universe. The Taipan galaxy survey will resolve this conflict by obtaining a more precise, and direct, local determination of H_0 based on independent and robust techniques.

The Taipan survey will use the baryon acoustic oscillation (BAO) method, supplemented by density-field reconstruction (Eisenstein et al. 2007), to measure H_0. The limitation with the BAO method is that the motion of galaxies blurs the signal. As they fall toward nearby clusters and superclusters, the large-scale galaxy pairs that encode the pristine baryon acoustic scale are shifted to smaller or larger separations. The solution is to estimate these motions and approximately reconstruct the original positions of the galaxies in the linear density field, sharpening the baryon acoustic peak and so improving the distance measurements. This method has already been successfully applied to datasets such as BOSS (Anderson et al. 2013) and WiggleZ (Kazin et al. 2014). Our detailed simulations of the Taipan survey (Beutler et al. 2011, Koda et al. 2014) show that a 1% H_0 measurement may be obtained by mapping the redshifts of about 500,000 galaxies brighter than r=17.6 mag.

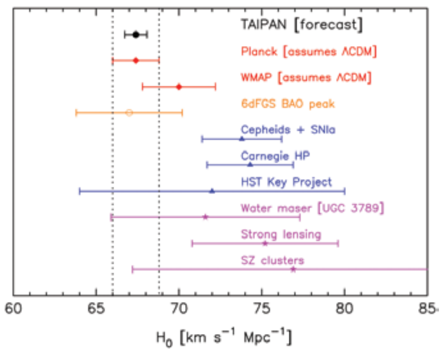


Figure 1 Comparison of predictions and measurements of H_0 from different methods and datasets. The predictions from CMB measurements are from WMAP (Komatsu et al. 2011) and Planck (Planck collaboration 2013), assuming the ΛCDM model. Other measurements are based on local standard candles (Cepheid stars and supernovae) by Riess et al. (2011) and Freedman et al. (2001, 2012) and geometrical methods: local water masers (Reid etal. 2013), strong lensing (Suyu etal. 2013) and galaxy clusters (Bonamente et al. 2006). Also shown are the baryon acoustic oscillation (BAO) peak measurement from 6dFGS (Beutler et al. 2011) and that forecast for the Taipan survey. The latter will be precise enough to resolve the current debate over whether the local expansion-rate is consistent with the predictions from CMB measurements that have to assume ΛCDM.

Mapping galaxy motions with Taipan

The Taipan survey will provide a comprehensive description of the density and velocity fields in the local Universe, both in terms of cosmography (mapping the large-scale distribution of matter and its motions) and statistics (characterizing the properties of the fields through power spectra and other measures). The Taipan survey will exploit and improve on the techniques developed for the 6dF Galaxy Survey (6dFGS) to measure galaxy peculiar velocities. The 6dFGS used the well-known Fundamental Plane method for early-type galaxies, which compares their internal velocity dispersions to their sizes and surface brightnesses to obtain relative distances, and hence peculiar velocities (Magoulas et al. 2012). We will both extend the set of galaxies to which the method can be applied and enhance the precision with which velocities can be measured.

Specific cosmographic goals include understanding the origin of the observed dipole motion of the Local Group of galaxies with respect to the CMB. This motion is the sum of the attraction of the Local Group to all the surrounding mass concentrations, but at present the main contributions are not convincingly established and the scale at which these contributions converge to the CMB dipole remains a matter of controversy (Lavaux et al. 2010, Bilicki et al. 2011, Magoulas et al. 2012). The Taipan survey will measure both the density and velocity fields over a larger volume, by a factor of four, than any previous survey, with denser sampling and improved velocity precision. This map will identify the major supercluster and void structures contributing to the Local Group's motion, including the specific contributions from the nearby structures referred to as the Great Attractor as well as those from the most massive structure in the nearby Universe, the Shapley Supercluster. The Taipan survey will reach out far enough into the local Universe that the effects from all these structures within the survey volume will have converged closely to the CMB dipole. This makes the Taipan survey unique in its ability to identify the key mass concentrations influencing the Local Group motion, and so resolve the current controversy.

Testing how gravity works on the largest scales

A broad set of cosmological observations suggests that some form of 'dark energy' currently dominates the dynamics of the Universe. The physical nature of dark energy is not yet understood, and a widely considered possibility is that the nature of gravitation differs on large cosmological scales from the predictions of General Relativity (GR). GR has survived almost a century of experimental scrutiny, but these tests are essentially restricted to inter-planetary scales, fourteen orders of magnitude smaller than the distances probed by galaxy surveys. A key task for current cosmological surveys is to perform observational tests for departures from the predictions of GR. A number of physically motivated alternatives to GR have been proposed, such as generalizing the Einstein-Hilbert action (as in f(R) gravity models; Song et al. 2007), embedding 3+1 dimensional spacetime in a higher-dimensional manifold such as 'Cascading gravity' (de Rham et al. 2008) or 'Galileon gravity' (Chow & Khoury 2009).

The gravitational physics of the Universe produces a rich variety of observable signatures that can be used for this purpose. The most important of these involve the way in which the low-contrast density fluctuations observed in the CMB grow by gravitational amplification to form today's high-contrast cosmic structures. This growth of structure can be precisely observed by tracking the 'peculiar motions' of galaxies as they fall under gravity toward nearby over-dense regions. These motions cause small Doppler shifts in the observed redshifts of the galaxies, from which the average amplitude of the velocities can be statistically determined, delineating the growth rate of cosmic structure. A key prediction of the standard cosmological model, including GR, is that the growth rate should be independent of the separation of galaxies and have the specific value $\Omega_m^{0.55}$ in today's Universe, where Ω_m represents the average density of matter. An observed violation of this straightforward prediction would constitute strong evidence that gravitational physics was not well described by GR on cosmological scales, and would have revolutionary implications for fundamental physics.

The Taipan survey will measure the cosmic growth rate using two complementary techniques, the peculiar velocities of galaxies, and the redshift-space distortion (Kaiser 1987). The precision of this measurement anticipated from Taipan is illustrated in Figure 2.

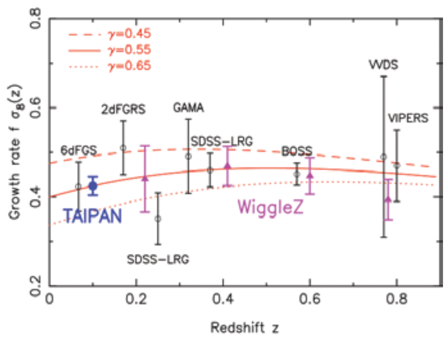


Figure 2 Comparison of predictions of the growth rate of structure and measurements using various datasets. The predictions use a standard model where the growth rate evolves as Ω_m^{γ} (for GR, γ = 0.55). In this model, low-redshift observations are the strongest discriminant of γ and give the most stringent test of GR. Growth rate measurements are shown for various surveys: 6dFGS (Beutler et al. 2012), 2dFGRS (Hawkins et al. 2003), SDSS luminous red galaxies (Samushia et al. 2012), GAMA (Blake et al. 2013), WiggleZ (Blake et al. 2011), the Baryon Oscillation Spectroscopic Survey (BOSS, Reid et al. 2012), VVDS (Guzzo et al. 2008) and the VIPERS survey (de la Torre et al. 2013). The Taipan survey offers the most powerful discrimination between these models and the strictest test of GR.

How do galaxies die?

The Taipan survey will address the puzzle of galaxy transformation, as galaxies evolve from blue, star forming and predominantly disk-shaped systems, to red, passive and predominantly elliptical systems. Understanding this transition phase requires a large and highly complete survey in order to adequately sample the rare transition, or post-starburst, galaxies over a broad range in galaxy mass and environment. Accurately quantifying the environment of galaxies will be facilitated through Taipan's highly complete survey strategy. Taipan will measure the largest sample of galaxy groups yet available, and combine this with robust measurements of galaxy age, mass and star formation rate, to provide the broad demographics describing the galaxy population as a function of mass and environment. Identifying the distribution of the post-starburst population within this broader context, and as a function of mass and environment, together with other factors such as galaxy interactions and the presence or not of supermassive black holes in an active state, will establish the dominant mechanisms at work in driving the cessation of star formation in galaxies.

This transformation is also intimately related to the reservoir of neutral hydrogen gas available to galaxies for fuelling their star formation. This leads into the numerous complementary projects supported by Taipan, notably the major survey projects planned with the ASKAP radio telescope, called EMU and WALLABY. These surveys, measuring the radio continuum and neutral hydrogen gas content of galaxies respectively, will add to the scope of analyses possible with the Taipan measurements, as well as benefiting in turn from the independent distances provided by Taipan and the astrophysical properties of the galaxies revealed by their spectra. To ensure the maximum scientific return from the survey, Taipan (like 6dFGS) will also target a range of ancillary samples that can make use of 'spare' fibres that cannot be allocated to the primary survey targets.

Legacy

The Taipan survey will be a major legacy resource for years to come, supporting studies not yet envisaged through the public database, which will be made available through periodic data releases of the survey observations as they progress. The importance of observing the entire hemisphere cannot be overstated, being vital not only for the cosmology goals but also for the identification of statistically significant populations of extremely rare classes of galaxy in the nearby Universe. In addition, the Taipan survey will provide instant access to the redshift and spectral properties for the host galaxies of nearby supernovae and other transients, such as those identified in the VAST survey with ASKAP. The measurements of environment, mass, star formation rate and other key properties add significant further value. The Taipan survey will have long-term value. In order to ensure that the synergy and legacy opportunities are maximized, the Taipan survey team has been constructed to include the team leaders from all of the major surveys that will benefit from Taipan; this includes in particular the leaders of the VISTA VHS, WISE, EMU, WALLABY, SkyMapper, VAST, POSSUM, and FLASH survey projects.

REFERENCES

Anderson L., et al., 2013, submitted (http://arxiv.org/pdf/1312.4877v1.pdf)
Beutler F., et al., 2011, MNRAS, 416, 3017
Beutler F., et al., 2012, MNRAS, 423, 3430
Bilicki M., et al., 2011, ApJ, 741, 31
Blake C., et al., 2011, MNRAS, 415, 2876
Blake C., et al., 2013, MNRAS, 436, 3089
Bonamente M., et al., 2006, ApJ, 647, 25
Chow N., Khoury J., 2009, PhRvD, 80, 24037
de Rham C., et al., 2008, PhRvL, 100, 1603
Eisenstein D., et al., 2007, ApJ, 664, 675
Freedman W., et al., 2001, ApJ, 553, 47
Freedman W., et al., 2012, ApJ, 758, 24
Guzzo L., et al., 2008, Nature, 451, 541
Hawkins E., et al. 2003, MNRAS, 346, 78
Kaiser N., 1987, MNRAS, 227, 1
Kazin E., et al., 2014, MNRAS, submitted (http://arxiv.org/pdf/1401.0358.pdf)
Komatsu E., et al., 2011, ApJS, 192, 18
Koda J., et al., 2014, MNRAS, submitted (http://arxiv.org/pdf/1312.1022.pdf)
Lavaux G., et al., 2010, ApJ, 709, 483
Magoulas C., et al., 2012, MNRAS, 427, 245
Planck collaboration, 2013, A&A, submitted (http://arxiv.org/pdf/1303.5076v2.pdf)
Reid B., et al., 2012, MNRAS, 426, 2719
Reid M., et al., 2013, ApJ, 767, 154
Riess A., et al., 2011, ApJ, 730, 119
Samushia L., et al., 2012, MNRAS, 420, 2102
Song Y-S., et al., 2007, PhRvD, 75, 4004
Suyu S., et al., 2013, ApJ, 766, 70

SAMI finds a Burst of Star Formation inside a GAMA Dwarf Galaxy

Adam Schaefer (Sydney University, CAASTRO), Sam Richards (AAO/Sydney University, CAASTRO

Massive galaxies like the Milky Way are thought to have built up their mass by continually absorbing smaller entities, called Dwarf Galaxies. The diminutive size of dwarf galaxies indicates that these objects have experienced limited evolution since their formation. As such, these galaxies can be representative of the conditions present in the early Universe, which is very exciting.

Another indication that dwarf galaxies have undergone less change since they formed early in the history of the Universe is that they are typically observed to have a lower proportion of heavy elements. We refer to these galaxies as having "low metallicity" which indicates that only minimal chemical enrichment of their interstellar medium has occurred. Star formation in these environments is therefore occurring in much more pristine gas than can be seen in our own Galaxy.

Dwarf galaxies have fewer stars than Milky Way-like galaxies and are therefore not as bright in optical light. As such, these low luminosity objects have only been studied in detail relatively nearby, within about 10 Mpc of our Galaxy. This has severely limited the range of environments that we can observe dwarfs in.

Star formation in dwarf galaxies can be the result of a number of different triggering mechanisms and is therefore complicated. The onset of a burst of star formation is often the result of an interaction with a companion galaxy that has compressed the interstellar gas clouds enough to initiate new star formation. Interaction induced starbursts in dwarf galaxies have been observed extensively (Koribalski & López- Sanchez 2009, López-Sanchez 2010). Such galaxies, which contain luminous HII regions where new stars form, often show evidence for disturbances in their gas kinematics.

The triggering of star formation can also occur without the presence of any external forces. This can occur in galaxies with spiral arms, for example, due to the propagation of density waves through a clumpy distribution of neutral gas.

Differentiation between the triggering mechanisms for star formation in Dwarf galaxies is extremely difficult from broadband optical images alone. The irregular nature of their optical morphologies does not always imply that mergers and interactions with other galaxies have played an important role in their history. Instead, evidence for such activity is much more prominent when such galaxies are observed with integral field spectroscopy. These observations of galaxies allow us to trace how stars and gas move around the centre of a galaxy. Any disruptions from smooth motions can be the result of a recent merger or interaction with another galaxy.

Integral field spectroscopy of dwarf galaxies will therefore be highly advantageous in identifying interaction driven starbursts in dwarfs.

This will be where the SAMI Galaxy Survey will come into its own. Using the loose definition of a dwarf to be a system with stellar mass less than 10^9 solar masses, SAMI will observe approximately 400 dwarf galaxies by its completion. Have already been observed.

A standout among the current SAMI sample is one also observed by the Galaxy and Mass Assembly (GAMA) Survey, called GAMA 567676. This is a dwarf galaxy with a redshift of 0.026, which places it at a distance of 100 Mpc. An optical image of this galaxy can be seen in Figure 1 a. With SAMI we are able to trace the distribution of star formation across the entire galaxy using the Hydrogen-alpha (Hα) emission line.

GAMA 567676 is noteworthy because a bright, unresolved source of Hα emission is present in the galaxy's outskirts. Integrating the Hα flux over the unresolved blob yields an integrated luminosity in hydrogen emission of 1.6×10^{40} erg/s, placing it at the top end of the HII region luminosity function. A luminosity this high is very unusual for a compact region of Hα emission and in the Local Group of galaxies it is equalled in magnitude only by the enormous 30 Doradus complex in the Large Magellanic Cloud. This level of Hα emission corresponds to a star formation

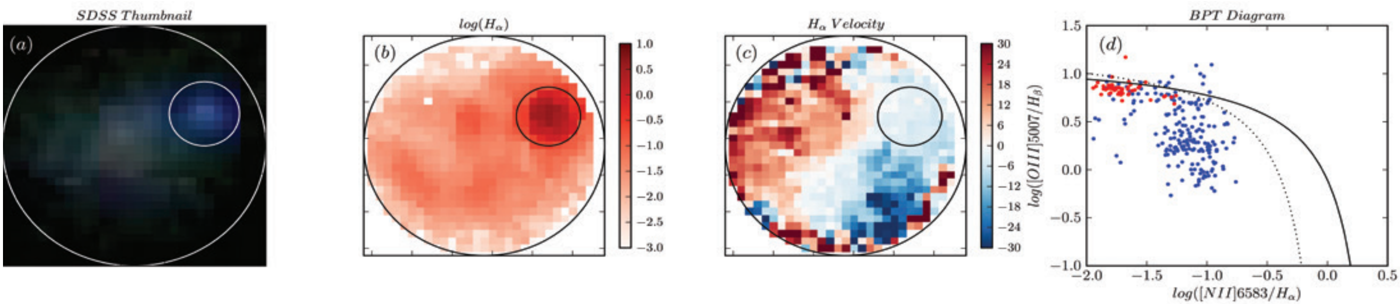


Figure 1 Diagnostic plots for GAMA J141103.98-003242.3. (a) is the SDSS 3-colour thumbnail. (b) is the log(Hα) map (in units of 10^{-16} ergs/s/cm^2). (c) is the Hα velocity field in km/s. (d) is the BPT diagram where the spaxels are colour-coded such that the red points are the spaxels within the H II complex, and the blue spaxels are the rest of the galaxy. The black solid and dotted lines represent the star formation limits as prescribed by Kewley et al. (2001) and Kauffmann et al. (2003) respectively. In all images, the box is 15 ×15 arcsec (0.5-arcsec per pixel), the large black circle enclosing the galaxy has a diameter enclosing the galaxy represents the SAMI integral field unit aperture and has a diameter of 15 arcsec, and the small black circle (centred about the H II complex) has a diameter of 4 arcsec. In all images, north is up and east is left.

rate of 0.12 ± 0.03 $M_\odot$/yr and represents approximately 75% of the star formation occurring in the galaxy! Figure 1 b shows the Hα map in which this dominant region can be seen in the upper right.

The physical scale of this localised burst of star formation is constrained by the SDSS broadband images, which also fail to resolve it with 1 arcsecond angular resolution, to be less than 600 pc in diameter. As an upper limit on its size, it is likely the source dominated by a large HII region, but also grouped with a set of smaller discrete star forming regions concentrated within this to this small region of the galaxy. Nevertheless, it is surprising that such a high fraction of the galaxy's total star formation should be occurring in such a small region in its outskirts.

The spectrum of GAMA 567676 displays emission lines across the entire SAMI field of view. This is incredibly useful as it allows us to determine the line-of-sight motion of the gas in the galaxy disc from the relative shifts in wavelength of the spectral lines. In this galaxy, the emission line velocities reveal the gas to be a smoothly rotating system with no hint of disruptions. The line-of-sight velocity of the HII complex, shown in Figure 1 c, indicates that it is moving in unison with the rest of the galaxy.

The excellent spectral coverage and resolution of the SAMI survey allows us to make accurate measurements of other properties of the interstellar medium in this unusual dwarf galaxy. Moreover, the high signal to noise ratio in the spectrum extracted from the HII complex has allowed us to detect an abundance of spectral lines, which are often difficult to measure. These include He I, [O I], [S II], [S III], [Ne III], [Ar III] and [Ar IV], as well as the auroral [O III] λ 4363 line and many H I Balmer lines. The spectrum of the HII complex is displayed in Figure (2).

With these data we have measured the oxygen abundance, a measure of how rich in heavier elements the gas is, in both the HII complex and in the rest of the galaxy using a variety of different metrics. Curiously, there exists a gradient in the oxygen abundance between the galaxy and the HII complex, with the starburst region having approximately only half of the oxygen abundance of the rest of the galaxy! The Baldwin-Phillips-Terlevich diagram in Figure 1 d is suggestive of this trend. This observation is surprising, as we would expect the metallicity of the gas to vary smoothly across the disc. Could this imply that the gas feeding this star formation burst has its origin outside the galaxy where the gas cannot have been chemically enriched by previous episodes of star formation?

Interestingly, this galaxy has also been detected in the HI Parkes All Sky Survey (HIPASS), a radio survey made by the Parkes radio dish looking to detect neutral hydrogen in nearby galaxies. From the radio data this galaxy is estimated to contain roughly $10^{9.5}$ $M_\odot$ of neutral gas, 10 times the mass of the stars in the galaxy! This is an enormous reservoir of neutral gas and its presence lends credibility to the scenario of an infalling gas cloud sparking a burst of star formation.

All of these observations raise some questions: What has kicked off the star formation in this galaxy: interaction with an unknown companion or the infall of neutral gas? Furthermore, what processes dominate in triggering star formation in dwarf galaxies, and what role does the local environment and the presence of a neutral gas reservoir play in this triggering?

With approximately 400 dwarf galaxies to be observed in a wide range of environments, SAMI has the capacity to answer some of these questions. If augmented with data from a deep HI radio survey we have a chance to resolve these problems completely.

References:

Koribalski B. S., López-Sánchez Á. R., 2009, MNRAS, 400, 1749

López-Sánchez, Á. R., 2010, A&A, 521, A63

Kauffmann, G., et al., 2003, MNRAS, 341, 33

Kewley L. J., Dopita M. A., Sutherland R. S., Heisler C. A., Trevena J., 2001, ApJ, 556, 121

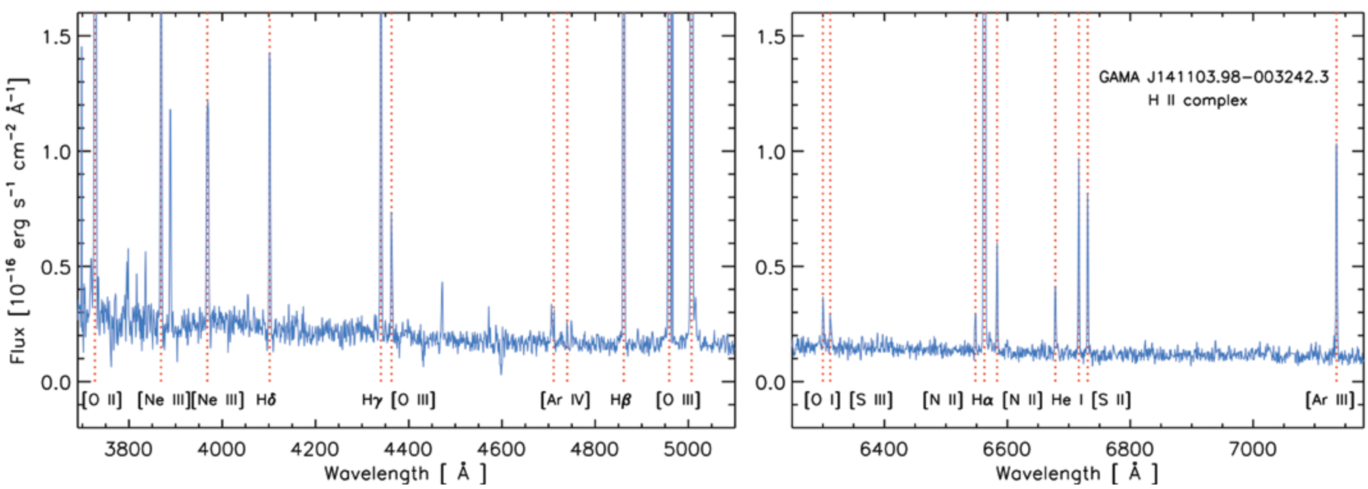


Figure 2 Optical spectrum of the luminous H II complex discovered in the dwarf galaxy GAMA J141103.98-003242.3 using SAMI data. The main emission lines are identified by red dotted lines. The wavelength scale is expressed in the rest frame of the galaxy. The red spectrum only shows the λλ 6500–6770 range. Note that the flux scales in both the blue and red spectra have been truncated in order to accentuate the weaker emission lines.

Nuclear Storm launches gas outward detected by the SAMI Galaxy Survey

I-Ting Ho (Institute for Astronomy, University of Hawaii, USA)

Major galactic outflows are long known to play a critical role in galaxy formation and evolution. `Feedback' from star formation or active galactic nuclei (supermassive black holes at centres of galaxies) inject huge amounts of thermal energy and momentum into the interstellar medium, which subsequently lift (or eject) gas out of the galaxies. As gas is the fuel for star formation, galaxies can no longer form stars (or form stars at much smaller rates) if substantial amounts of gas are removed. Understanding the prevalence and degree of galactic outflows is therefore the foundation of building a self-consistent picture of how galaxies evolve over cosmic time.

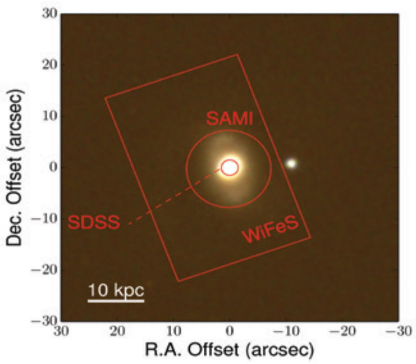


Figure 1 SDSS g, r, i colour composite image of 209807 overplotted with footprints of SDSS, SAMI and WiFeS. The SDSS fiber has a diameter of 3''. The SAMI hexabundle has a circular field of view (FOV) of 15'' in diameter, and the WiFeS image-slicing Integral Field Unit has a FOV of 25'' x 38''.

Unfortunately, observing galactic outflows has been a very difficult task and astronomers have little understanding of these spectacular events, except in a handful of galaxies just in the backyard of our Milky Way and in rare systems that are extreme in their physical properties (e.g., galaxy merger, luminous infrared galaxy, etc.). In particular, we do not know, even for normal galaxies, how many of them launch outflows at each epoch.

The critical characteristics determining whether a galaxy can or cannot drive outflows remain largely uncertain.

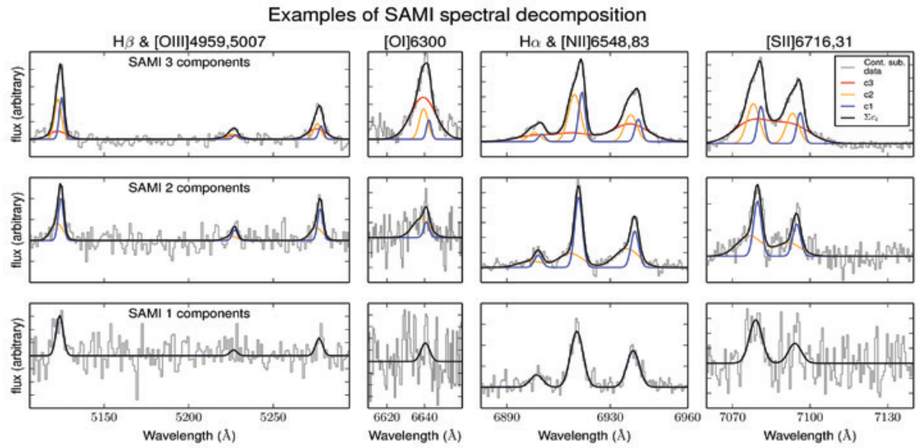


Figure 2 Examples of our spectral decomposition. First, second and third rows are examples of selected spaxels requiring 3-component, 2-component and 1-component fits to describe the spectral profiles, respectively. Each panel is a zoom-in of the spectral ranges comprising key diagnostic emission lines. Continuum subtracted spectra are shown in grey. Best-fit c3, c2, and c1 component are shown in red, orange, and blue, respectively. The best-fit emission line models (sum of all components) are shown in black.

From the observational side, the difficulties lie in the fact that current large galaxy surveys only deliver a single spectrum per galaxy. Such limited information confuses the situation because outflows generally spread over different parts of a galaxy which can easily be missed by traditional long slit or single fibre spectroscopic data.

The SAMI Galaxy Survey is on the cusp of a major breakthrough in this area, thanks to the efficient and high resolution integral field spectroscopy on AAT. Being the largest integral field survey so far, the SAMI Galaxy Survey will have enough statistics to answer the question: What fraction of galaxies at redshift 0.05 are launching gas outflows? In a recent paper we submitted to the Monthly Notices of the Royal Astronomical Society, we demonstrate the feasibility and potential of using the SAMI Galaxy Survey to hunt for large numbers of galaxies launching outflows.

In this work, we perform detailed spectral analysis on a SAMI galaxy (GAMA ID: 209807; Figure 1) and show convincing evidence that we have the right tools and right dataset for finding outflows. The core of our analysis contains (1) a novel approach of spectral decomposition that takes full advantage of the high spectral resolution of the SAMI instrument, and (2) state-of-the-art theoretical modeling of shock excitation and photoionisation. Figure 2 shows that the high spectral resolution of SAMI resolves the complex emission line profiles that change as a function of positions in the galaxy, and we model the line profiles with overlapping Gaussians to separate different (gas) kinematic components in the galaxy. Being able to spectrally decompose different kinematic components opens up an opportunity to study their physical origins using our theoretical modeling code MAPPINGS IV.

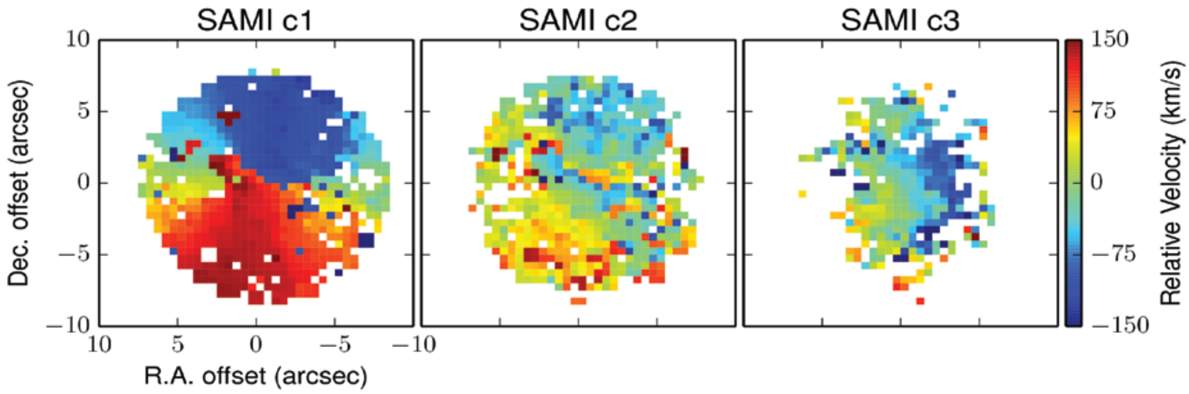


Figure 3 SAMI observations of the image shown in Figure 1. Shown are the velocity fields of the different kinematic components. The c1 component shows clear rotation: blue shows gas coming toward us and red is rotating away. . The c3 component shows a prominent velocity gradient almost perpendicular to the velocity gradient of the c1 component. The c3 component traces the bipolar outflows in 209807, while the c1 component traces star-forming regions rotating with the galactic disk.

In the paper, we show that although 209807 appears to be quiescent (from its optical appearance), it is in fact launching large-scale galactic outflows driven by a nucleus starburst. The first evidence comes from the distinctly different kinematics of the different components (see Figure 2). The c1 kinematic component traces the regular rotation of the galactic disk, but the c3 kinematic component shows a velocity gradient along the minor axis of the galaxy, a common signature of bipolar outflows. The second evidence comes from the distinctly different line ratios of the different components, as shown in Figure 3 and Figure 4. The different gas kinematic components are excited by different mechanisms. Our models show that the c3 (outflow) component is excited by radiative shocks embedded in the outflows, traveling at 200 – 300 km/s; the c1 (rotation) component is excited by photoionisation from star-forming regions on the disk. An intermediate component c2 also exists, which is excited by a combination of shock excitation and photoionisation. Our work on 209807 is the first time such a clean and elegant analysis has been accomplished with integral field data. Using integral field spectroscopy to dissect the 3 dimensional structures of 209807 allows us to gain insight into the nature of outflows in 209807. As we have just finished observing the 1000th galaxy of the SAMI Galaxy Survey (on the way to 4500 total!), it is promising that by applying similar analysis to the entire sample, we will soon learn a lot more about the prevalence and cause of galactic outflows in the local Universe! in the local Universe!

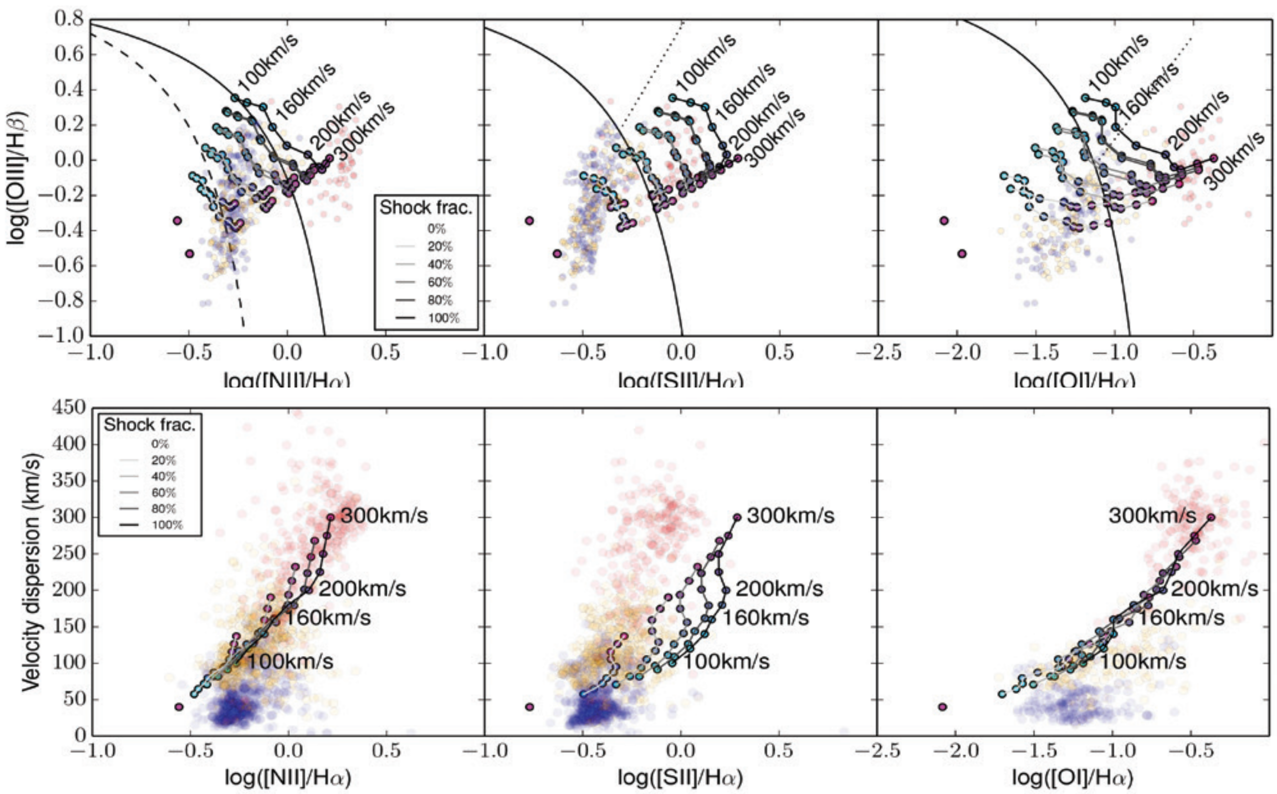


Figure 4 Line ratio diagrams (upper panels) and line ratio versus velocity dispersion diagrams (lower panels). Transparent color points are SAMI measurements with red, orange and blue indicating the c3, c2, and c1 component, respectively. The different components are well separated in these parameter spaces. Filled color points connected by solid lines are predictions from our shock and photoionisation MAPPING IV models. The c3 component is consistent with being excited by 200 – 300 km/s shocks, and the c1 component is consistent with virtually pure photoionisation. The c2 component is excited by both shock excitation and photoionisation.

AAOmega Spectrograph News

Sarah Brough (AAO), Andy Green (AAO), Julia Bryant (AAO and University of Sydney)

The AAOmega dual-beam spectrograph has had an exciting 6 months since the last edition of the AAO Observer came out in February 2014.

As part of the ongoing Education Investment Fund upgrades to the spectrograph, the blue and red CCDs are being replaced. Figure 1 shows the measured quantum efficiency (QE) of the old and new, blue and red CCDs. This highlights the significant QE improvement we will get in the red arm of the spectrograph, enabling work to higher wavelengths. There is a small improvement of the QE in the blue arm (~5% at wavelengths >400nm). More importantly in the blue arm, the new science grade 0 chip will bring significant improvements in cosmetic image quality over the old chip.

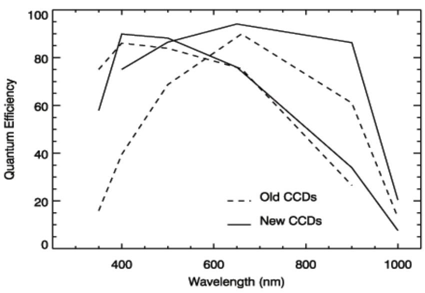


Figure 1 Measured quantum efficiencies for the old (dashed) and new (solid line), blue (lower wavelengths) and red (higher wavelengths) AAOmega CCDs.

The new CCDs arrived at the end of last year, just in time for AAO staff availability following the completion of the HERMES spectrograph. Mid-February 2014 was identified as the best window to undertake the blue CCD replacement.

Replacing the CCD requires the blue camera (shown in Figure 2) to be opened and many delicate optical elements to be removed. This has not happened since AAOmega commissioning in 2006 so the opportunity was also taken to clean these elements.

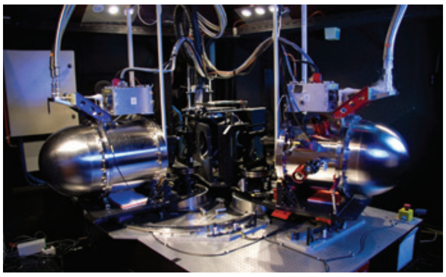


Figure 2: The AAOmega spectrograph. The blue camera is the bullet-shaped canister on the left-hand side.

In testing the system after the CCD was replaced it was quickly apparent that the new CCD would not maintain the stable temperature required for science observations. Unfortunately, this meant that we had to reschedule several programs on short notice. We thank everyone involved for their flexibility. Over a few long weeks AAO engineers worked hard to determine the source of the problem and solve it. This included very carefully transporting the camera back to our North Ryde offices for closer analysis. Once the temperature problem was solved the camera was returned to the telescope. When the detector was cooled down to its operating temperature, fogging due to tiny quantities of water in the camera was observed. After several cycles of warming up the detector, pumping out the air and cooling it down again later, the data were found to have no significant issues from the fogging. AAOmega observations resumed in early April and the detector is now free from fogging.

In the months since then we have been able to prove that data quality has improved significantly. The bad pixel masks have been updated for the old blue CCD (these now mask significantly fewer pixels: 0.4% down from 0.8%). The new blue CCD improves those numbers further with only 0.04% of pixels marked as bad (Figure 3). This returns ~29,000 pixels to science usage. The new bad pixel masks will be released with the next public version of the 2dfdr data reduction package.

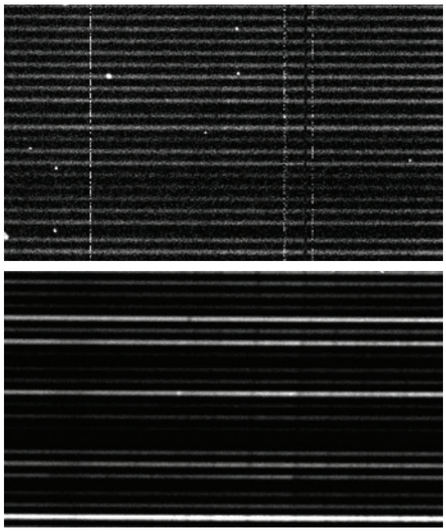


Figure 3 The old blue CCD (a; upper panel) compared to the same region in the new blue CCD (b; lower panel). The columns of bad pixels in the old CCD are not present in the new CCD.

Throughput measurements (which include the effects of the mirror, detector and gratings as well as the QE of the CCD) from AAOmega fed by the SAMI instrument (Figure 4) indicate that there has also been an overall throughput improvement of ~5% in the blue arm.

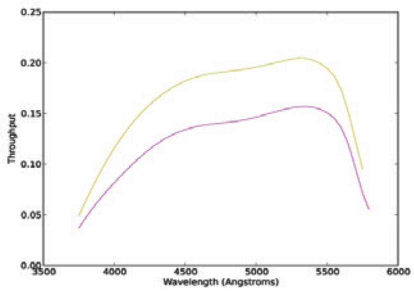


Figure 4 Throughput of the SAMI instrument before (purple line) and after (yellow line) the blue CCD was replaced.

Replacing the blue CCD of AAOmega has brought clear improvements in throughput and image quality.

The red CCD has been scheduled for replacement in August-September 2014 and we look forward to a smoother replacement process and the significantly increased throughput it promises.

KOALA commissioning results

Simon Ellis (AAO) on behalf of the KOALA team

KOALA is a new integral field unit which feeds the AAOmega spectrograph on the AAT. It has 1000 elements which are hexagonally packed in a 40 × 25 rectangular array. The spatial sampling can be set to either 0.7 arcsec per microlens or 1.25 arcsec per microlens providing a field of view of 15.3 × 28.3 arcsec or 27.4 × 50.6 arcsec respectively.

In the previous issue of the AAO Observer we provided details on the instrument and early results from commissioning. More details on the assembly and commissioning can be found in Zhelem et al. (2014). Here we provide a brief update on the commissioning results.

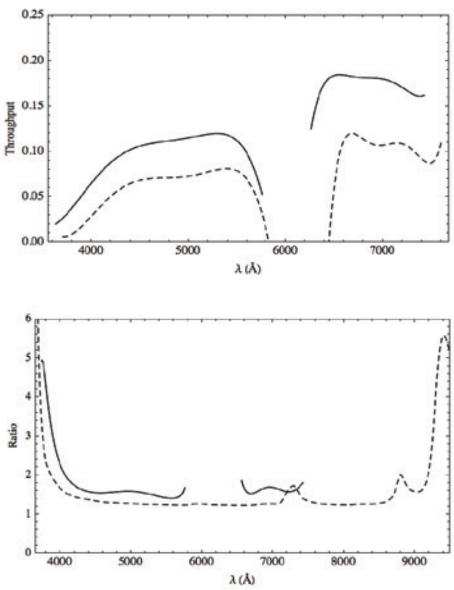


Figure 1 Top panel. The combined throughput of KOALA, the telescope and AAOmega using the 580V and 1000R gratings (black), compared to the combined throughput of SPIRAL, the telescope and AAOmega using the same gratings. Bottom Panel. The ratio of the throughput of KOALA to the throughput of SPIRAL (black), compared to predictions.

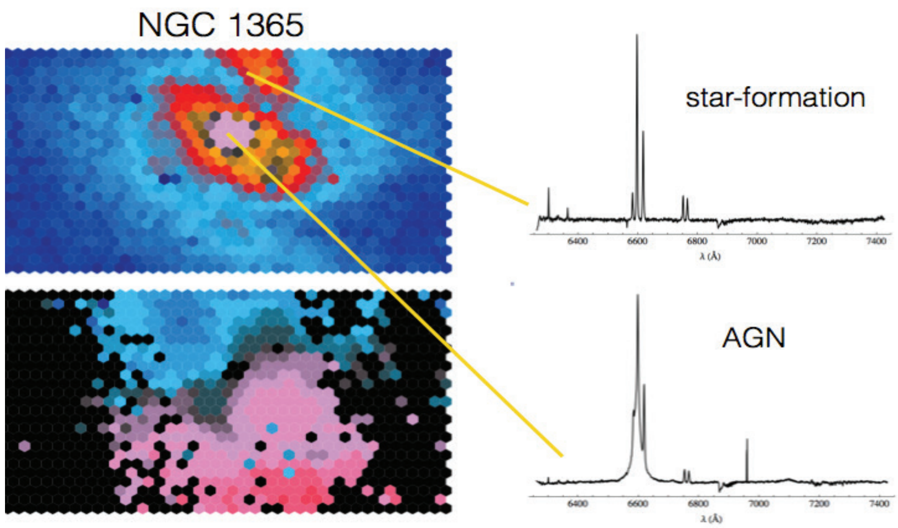


Figure 2 Example data from a 15 minute exposure of the core of NGC 1365, obtained during commissioning.

The combined throughput of KOALA, AAOmega and the AAT was measured from observations of spectrophotometric standard stars. These are shown in Figure 1, compared to throughput measurements of SPIRAL obtained in the same way. The lower panel shows the relative improvements compared to predictions. The throughput of KOALA is more than ≈ 1.6 times that of SPIRAL throughout, and significantly more so at < 4200 Å, and exceeds specifications. The AAOmega CCD upgrade will have improved the blue throughput further still; see the report by Sarah Brough in this issue.

Figure 2 shows a summary of a 15 minute exposure of the core of NGC 1365, using the 1000R grating. Shown is a map at the wavelength of Hα, a velocity map obtained from Hα, and example spectra from two elements, one of which is in the nucleus of the galaxy and shows the typical broad emission lines, and one of which is in a star-forming region.

KOALA had its first successful science run in June this year, when it was being employed to measure precise kinematics of the outskirts of nearby disc galaxies from the Ca II infrared triplet by Ken Freeman and collaborators.

References

Zhelem, R. et al., 2014, KOALA, a wide-field 1000 element integral-field unit for the Anglo- Australian Telescope: assembly and commissioning, Proc. SPIE, 9147

Astronomers Perfecting Their Trade at the 2014 AusGO/AAO Observational Techniques Workshop

Caroline Foster (AAO)

Figure 1 Group photo of the participants and presenters. Image credit: Jenny Ghabache

The Australian Gemini Office (AusGO) and the Australian Astronomical Observatory hosted and organised the 2014 AusGO/AAO Observational Techniques Workshop on 1-4 April. The primary aim of the workshop was to provide observing training to Australian-based Honours and PhD students as well as early career researchers.

Attendees got to learn about a broad range of topics including available optical/infrared facilities, tips on writing successful proposals, data reduction methods with hands-on tutorials, data analysis tools, publicising their results, etc. As one attendee put it: "early talks gave an introduction to the topic, while subsequent presenters expanded on the topic."

A total of 45 attendees participated, and thanks to the enthusiasm of the 16 speakers, our sponsors and organisers, the event was a fantastic success. Feedback from at least one attendee affirms that "the workshop fitted [his/her] needs perfectly and was the best [she/he has] encountered since commencing [her/his] studies".

As mentioned by guest speaker and software engineer Keith Shortridge, astronomers often write their own software to reduce data in the very specific way required for their individual science. Hence, in depth knowledge of data, reduction techniques and solutions to known problems are essential for observers. That said, observatories, instrument scientists and software engineers often provide data reduction and analysis packages. A clear highlight of the workshop was the use and distribution of the Ureka package *(http://ssb.stsci.edu/ureka/)* maintained by STScI and the Gemini Observatory, which makes installation and use of a slew of software frequently used by astronomers a breeze to install on either Mac or Linux. Amongst others, Ureka includes IRAF, python, topcat, and more and is quickly gaining popularity.

Figure 2 Winning images of the imaging data reduction challenge. The "true to science" (left) category image was reduced and combined by Vincent Dumont. The winning image in the "psychedelic" (right) category was prepared by Ly Duong and Daniela Opitz.

There was significant time allocated to hands-on tutorials and so-called "data challenges" during the workshop. The latter afforded participants the opportunity to test their newly acquired data reduction skills against other participants in a friendly competition. Everyone was given a set of raw data that they needed to reduce and combine into either a "true to science" or "psychedelic" version of the image (see Figure 2). Winners were selected by the workshop organising committee. The prize: a mention in the AAO Observer and a box of chocolates! Hence, we congratulate Vincent Dumont, Ly Duong and Daniela Opitz for winning the data challenge.

For those who were unable to attend in person and would like access to the material, talks and other information can be found at http://www.aao.gov.au/conferences/OTW2014.

In closing, we thank Astronomy Australia Limited (AAL), the Gemini Observatory (especially Dr Emma Hogan) and the Australian Astronomical Observatory (AAO) for their generous sponsorship of the event.

Keeping astronomers in the dark

Fred Watson and David Malin (AAO)

Figure 1 DSLR panoramas of the northern (upper) and southern (lower) horizons from Siding Spring in January 2014. The 30 second exposures were sufficient to reveal the green auroral skyglow, as well as the near-vertical band of the Milky Way.

When Siding Spring Observatory was opened in 1964, its dark skies seemed assured simply by its remoteness from major centres of population. Chosen as Mount Stromlo's new observatory site to escape the growing light-pollution of Canberra, Siding Spring had faced stiff competition from Mount Bingar in the Riverina, but had won on the grounds of ready access to local infrastructure in the shape of the rural community of Coonabarabran.

During Siding Spring's first flush of youth, that remoteness was, indeed, all that was required to keep the skies dark. With an average zenith night sky brightness in V of 22.7 magnitudes/arcsec^2 (e.g. Payne 1985), the site earned its reputation as one of the darkest in the world. It was with a view to keeping it that way that one of us (DFM) undertook in 1986 to make a photographic V+R band image of the Siding Spring horizon to provide a benchmark in potential sources of artificial sky-glow. One-hour exposures on hypersensitised astronomical plates were used to create the panoramic view.

Laying down the law

Soon after this, John Dawe, then the ANU's Observatory Manager, began working towards a legislative framework to protect the dark skies of Siding Spring by specifying limits on outdoor lighting within 100 km of the Observatory. This eventually materialised as the Orana Regional Environmental Plan No. 1 – Siding Spring (REP), which was gazetted on 31 August 1990. Within a decade, however, it had become clear that the REP had a number of drawbacks – most notably, that it was difficult to understand and apply, and that it failed to take account of changing trends in the lighting industry. For that reason, in 2000, the then-Director of Mount Stromlo, Jeremy Mould, set up a Revision Working Group with FGW as chair, and with representatives from both local government and the NSW Planning Department. Significantly, the group also included a leading industry authority on night-sky-friendly lighting, Reg Wilson of Lighting Analysis and Design.

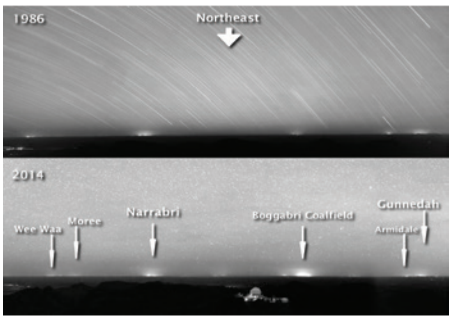


Figure 2 Northeast sector of the 1986 and 2014 images compared.

This group continues its work today as the Siding Spring Dark Skies Committee, but embraces a wider and more vigorous approach to dark skies than before. While it still focuses on the regulatory framework, it also has an important role in industry monitoring, education and advocacy in good lighting. In fact, its efforts in updating legislation have been more successful at the local government level than the state level, mainly because state planning legislation has changed considerably over the past decade, and is still in a state of flux. In particular, although the Orana REP is still in force, it is now outdated legislation, and will eventually be repealed. It is the job of the Dark Skies Committee to ensure that it is replaced by planning policies that provide an even greater level of protection.

Equally important, however, is the committee's job of winning hearts and minds in the broader community's view of outdoor lighting. This ranges from straightforward media outreach to special projects like engagement with state politicians, industry representatives (in both the lighting and resources industries) and Standards Australia, and a forthcoming bid to have the Warrumbungle National Park recognised by the International Dark Sky Association as a Dark Sky Park.

New horizon imagery

Against this background, a new horizon panorama has been generated by DFM using digital imagery made in January 2014. The choice of camera and lens enabled a similar level of sensitivity to the 1986 images to be obtained with 30 second exposures, resulting in minimal star trail. Figure 1 shows colour imagery of the northern and southern horizons, with the principal light-sources labelled. Some observatory buildings are visible in the northern half, including the starlit dome of the UK Schmidt Telescope, while to the south, the Warrumbungle range is silhouetted by the skyglow of several large centres of population.

By restricting the DSLR images to just the V and R passbands, it is possible to make a direct comparison with the 1986 photographic images, and Figures 2-4 show three sectors of the horizon with the pairs juxtaposed. While the matching of light sources is not perfect (mainly because of differing camera locations on the mountain top), the change in illumination is clearly seen. In Figure 2, the brightening due to the development of the Boggabri coalfield is noticeable. It is within this area that several new mining projects that are currently occupying the Dark Skies Committee will be located.

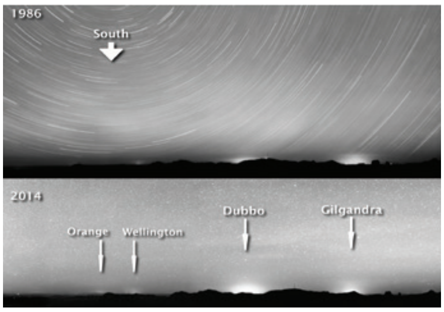


Figure 3 Southern sector of the 1986 and 2014 images.

Figure 3 shows the southerly outlook from Siding Spring, where the most notable change is due to the brightening of Dubbo (100 km). The city has undergone significant development in the 28 years separating the two images. While there have been some notable successes in negotiating the use of sky-friendly lighting for sports ground illumination, general expansion has taken its toll on the darkness of Dubbo's night sky. In Figure 4, the view to the southeast is now dominated by the Sydney metropolitan area and the combined glow of the city of Newcastle and the nearer Hunter Valley coalfield. The latter is probably the dominant component of this, and it is hardly seen on the 1986 images. The Ulan coalmine (at 100 km distant) is also visible.

One very encouraging aspect not seen in these images is that there has been no appreciable increase in the zenith night-sky brightness itself. Another is the absence of any increase in sky glow from Coonabarabran, which is a testament to the goodwill of the town as well as the effectiveness of the local Development Control Plan. In that regard, the original decision to site the observatory close to the town has proved to be a wise one.

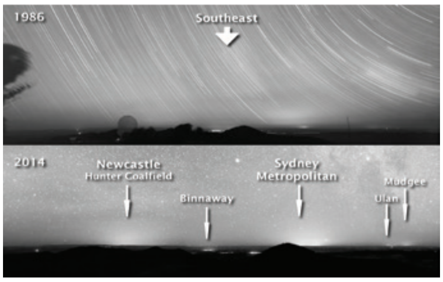


Figure 4 Southeast sector of the 1986 and 2014 images.

The view from above

As an adjunct to the horizon imagery, DFM has requested dark-of-Moon astronaut photography of New South Wales from the International Space Station. This will provide an up-to-date evaluation of the sky-glow emissions. In earlier work on a rather larger scale, Pierantonio Cinzano (University of Padua) mapped the world's light pollution using night-time images from space combined with the known propagation characteristics of the atmosphere by molecular and aerosol scattering (Cinzano, Falchi & Elvidge 2001). Their process was highly refined, taking into account the curvature of the Earth, and showed that two-thirds of the world's population lives in light-polluted conditions. More dramatically, about one-fifth of the population can no longer see the Milky Way.

We are optimistic, however, that with educational and advocacy efforts such as those mentioned above, we will start to see a reduction in the growth of damaging light pollution. The widespread uptake of LEDs for outdoor lighting, for example, offers scope for better stray-light control, while the recognition that wasted energy associated with upward light-spill has a significant greenhouse footprint assists in getting the message across. And, at the end of the day, it is the fact that bad lighting costs more to run than good lighting that might be the astronomer's greatest ally.

Acknowledgement

We thank past and present members of the Siding Spring Dark Skies Committee for their tireless support in the quest to keep Siding Spring dark. DFM thanks Steve Lee and the AAO for support and assistance.

References

Cinzano, P., Falchi, F. and Elvidge, C.D. 2001. Mon. Not. Roy. Astr. Soc. 328, 689.

Payne, Paul, 1985. Proc ASA, 6 (2), 182.

Official HERMES Launch by Minister Ian Macfarlane

Amanda Bauer (AAO)

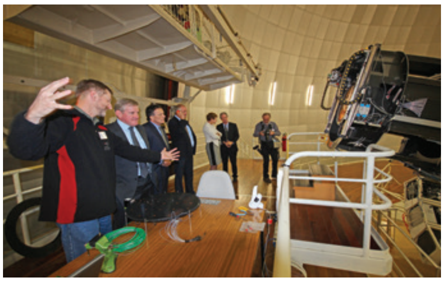


Figure 1 Rob Patterson (left) describes the operations of the 2dF robot on the AAT to Minister Ian Macfarlane (second from left). (Credit: Ángel R. López-Sánchez, AAO/ Macquarie University)

The $13 million HERMES instrument was launched with style by Department of Industry Minister Ian Macfarlane on 16 April 2014. Minister Macfarlane arrived in Coonabarabran from Canberra with a delegation of advisors and assorted members of the Department of Industry, eager to see the array of cutting-edge technology the AAO develops at Siding Spring Observatory.

Figure 2 Industry Minister Ian Macfarlane delivers his HERMES Launch speech on the dome floor of the AAT telescope. (Credit: Ángel R. López-Sánchez, AAO/Macquarie University)

Figure 4 Minister Ian Macfarlane with AAO electronics technician Rob Brookfield. (Credit: Phil Fitzgerald, Dept of Industry)

Upon arrival, the Minister was escorted to AAT dome floor, and up to the platform to view the 2dF Robot in action positioning fibres. He seemed genuinely impressed as robot whisperer Rob Patterson described the long list of scientific achievements astronomers have discovered with this instrument over the last 20 years.

AAO Director Professor Warrick Couch reflected on the intensive process required to develop and complete the novel HERMES technology, and introduced speeches from former AAO Director Professor Matthew Colless and HERMES project Astronomer Professor Ken Freeman.

Minister Macfarlane showed genuine pride when learning that so much of the technology for HERMES was design and built in house by AAO engineers. In his speech, he stated that "Australia is a world leader in astronomy. This new instrument will allow some of our greatest scientists to make new breakthroughs in this important field.

"The AAO's Anglo-Australian Telescope is world-renowned for its record of discovery and this new instrument, HERMES, will ensure it continues to lead the way.

"Using HERMES, astronomers will be able to analyse light from more than a million stars in our galaxy, helping them map the age and movements of the stars and unravel how the Milky Way formed.

"HERMES has been developed over five years by scientists and engineers at the AAO, and will be used by scientists from all over the world."

The AAO team at site prepared everything perfectly, from the dramatic red lights illuminating HERMES, to the guided tours of the control room, 2dF, and the catwalk, to the catered lunches which were given to the Minister and his staff in takeaway boxes as they had to rush off to catch their return flight.

An update on how data collection and the performance of the HERMES instrument can be found in this issue of the AAO Observer on Page 4.

Figure 6 AAO Head of Instrumentation, A/Prof Andy Sheinis, shows a state of the art VPH grating to Department Secretary Glenys Beauchamp, while former AAO Director, Prof Matthew Colless looks on. (Credit: Phil Fitzgerald, Dept of Industry)

Introducing AAO's "Surprise! Stargazing" Events: A Partial Solar Eclipse over Sydney Harbour

Ángel R. López-Sánchez (AAO/Macquarie University)

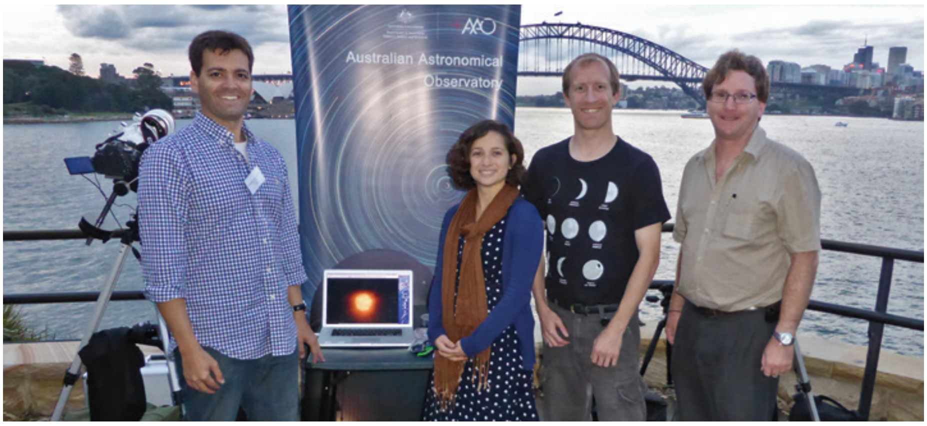


Figure 1 AAO staff at the first "Surprise! Stargazing" event. From right to left, Stuart Ryder (AAO/AusGO), Kyler Kuehn (AAO), Paola Oliva-Altamiro (Swinburne/AAO) and Ángel R. López-Sánchez (AAO/MQ). The laptop shows the only good image we could get of the eclipse using my telescope. Mrs Macquarie Chair, Sydney Botanic Gardens / Domain, 29 Apr 2014. Photo Credit: Stuart Ryder (AAO/AusGO).

On Tuesday 29th April 2014 the Earth, the Moon, and the Sun aligned to produce one of the most spectacular astronomical phenomena we can see with our eyes: a solar eclipse. This solar eclipse was not a total eclipse, where the disk of the Moon covers the entire bright disk of the Sun, it was an Annular eclipse, where a "ring of fire" is still seen around the dark disk of the moon for a few minutes at the peak of the eclipse. The full annular phase could only be seen from Antarctica, but the partial solar eclipse, which lasts for several hours, was seen throughout Australia in the late afternoon.

As the Sun would be eclipsed by the Moon during the sunset, it was a perfect opportunity to capture some nice photos of the eclipsed Sun with famous Sydney structures such as the Opera House or Harbour Bridge. With this excuse, and also with the idea of showing the wonders of nature to the public, a group of astrophysicists working at Australian Astronomical Observatory (AAO) decided to use this solar eclipse to organise our first "Surprise! Stargazing" event. The aim of these events is to set up telescopes in public areas, and let anyone around look through, while talking to them about astronomy, what astronomers do, and what the Australian Astronomical Observatory is. We plan to run many more of these events in the future, but this was our first chance to test our setup.

Figure 2 Visitors, but clouds please go away! First AAO "Surprise! Stargazing" Event: partial solar eclipse on 29 April 2014 over Sydney Harbour. Mrs Macquarie Chair, Sydney Botanic Gardens / Domain. Photo Credit: Paola Oliva-Altamiro (Swinburne/AAO).

We chose to hold our first "Surprise! Stargazing" event was Mrs Macquarie Chair point, in the Domain, Sydney Botanic Gardens, which shows off a dramatic view of the Sydney Opera House and the Sydney Harbour Bridge, with the eclipsed sun setting behind them. Event organizers from the Domain were very supportive of "Surprise! Stargazing" being held in this space. They offered us free nearby parking and even came along to see the eclipse through the telescopes (which had solar filters!).

It was four of us, Stuart Ryder (AAO/AusGO), Kyler Kuehn (AAO), Paola Oliva-Altamiro (Swinburne/AAO) and myself, who participated in this first "Surprise! Stargazing" event. To have everything ready on time, we started setting up telescopes, AAO banner and laptop an hour before the beginning of the eclipse. The weather seemed very clear in the morning, but in the afternoon, as we feared, some clouds started to arrive from the west. We already knew this could be a killer... but we had to try!

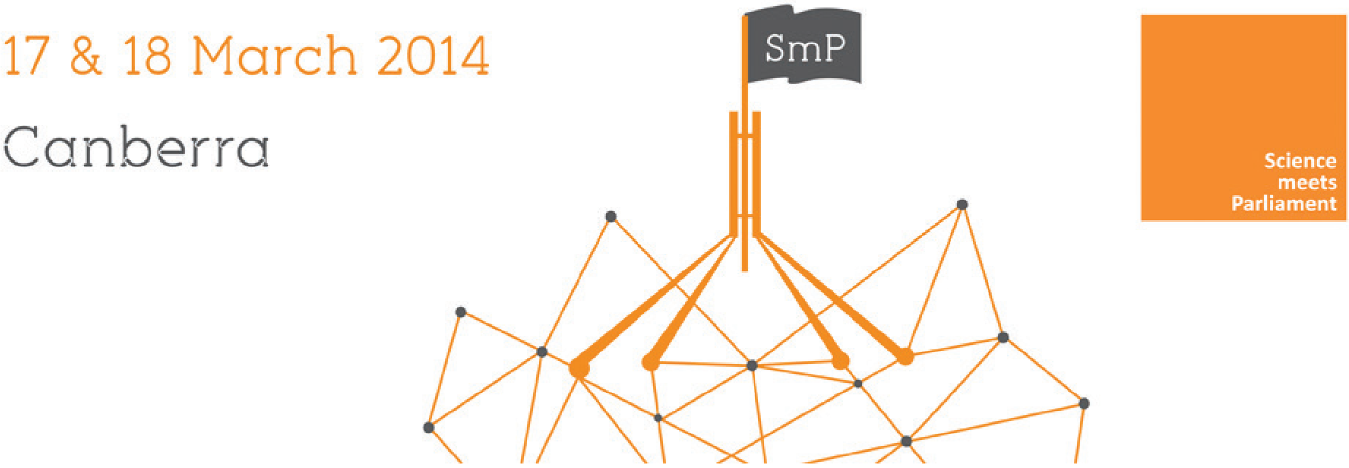
With the clouds moving in, we were lucky at the beginning of the eclipse, and managed to see the Sun through thin clouds for the first 10 minutes of the eclipse. I could even get a nice image through my telescope (I had my camera attached to the telescope, and hence the vision of the Sun appeared in the laptop). Once the Sun was completely covered by thick clouds we just waited and hoped for a little gap, but unfortunately this never happened and we didn't see the Sun again that day. It would have been really nice to see the eclipsed sun setting over the Sydney Harbour Bridge and sinking close to the Sydney Opera House. I'm sure the images and time-lapse video would have been quite spectacular. In any case, all four AAO participants were very happy about how the event turned out and the enthusiasm and interest of the people who talked to us. We are looking forward to hosting future "Surprise! Stargazing" events around Sydney and beyond!

Stay tuned for future Surprise! Stargazing events. Follow us on twitter @AAOastro or facebook for announcements!

Figure 3 Partial Solar Eclipse from Sydney on 29 Apr 2014. Telescope Skywatcher Black Diamond D = 80 mm, f = 600 mm + CANON EOS 600D at primary focus + Solar filter. Just 1 frame at ISO 400, 1/8 s, colour processing using Photoshop. 29 April 2014 @ 16:20 AEST (06:20 UT). First AAO "Surprise! Stargazing" Event: partial solar eclipse on 29 April 2014 over Sydney Harbour. Mrs Macquarie Chair, Sydney Botanic Gardens / Domain. Photo Credit: Ángel R. López-Sánchez (AAO/MQ).

Science Meets Parliament

Chris Lidman and Caroline Foster



Scientists clearly understand that many of the things we take for granted in the modern world (uncontaminated food and water, vaccines, and rapid, cheep and accessible communication) would not be available if it were not for the fundamental research that was done by countless scientists over many generations. What scientists fail to understand is that this fact is not appreciated by the general public.

As scientists, we owe it to ourselves and to the broader public to be more outspoken about the benefits of scientific research. Many of us do engage with the public, through public talks, online forums, open days and press releases. We should also engage with our elected representatives.

During two days in the middle of March, two astronomers from the AAO, Caroline Foster and Chris Lidman, travelled to Canberra to take part in the 14th annual Science meets Parliament (SmP) event. Organised by Science and Technology Australia, and sponsored by a broad range of scientific organisations, SmP brought together 200 Australia scientists from all over Australia to meet with policy makers and politicians in Canberra.

Apart from using the occasion to dust off and wear our lounge and dinner suits, we were treated to a wide range of activities. On the first day, we listened to a number of speakers talk about the role of science in developing our nation and the often competing forces at play in the development of government policy. During the evening, we listened to a number of very interesting speeches as we dinned in the Great Hall. It is clear that science has friends in parliament. We should not let these friendships lapse. The second day was spent with face to face meetings with politicians. It gave us an opportunity to see a different side of politics, a side where reason, logic and civil debate are still valued. We also had the opportunity to attend question time.

SmP was a great event. It broadened our perspectives, it enabled us to establish links with decision makers in Canberra, and it made us aware that to be a better, more effective scientist, you need to be a little bit of a politician too.

Figure 2 The Hon Ian McFarlane, Minister of Industry, talking at the Gala Dinner in the Great Hall in front of over 200 scientists from all over Australia. Photo credit: Lorna Sim.

AusGo Corner

Stuart Ryder (Australian Gemini Office, AAO)

The future for Australian 8-metre telescope access and AusGO

The Australian Gemini Office (AusGO) has been hosted by the AAO since 2008, and has been largely funded by the National Collaborative Research Infrastructure Strategy (NCRIS) and successor scheme funds administered by Astronomy Australia Ltd (AAL). AusGO's primary roles are to provide pre- and post-observing support for Australian Gemini users; to train the next generation of 8m telescope users via regular observational techniques workshops, and the Australian Gemini Undergraduate Summer Studentships; and engage in public outreach through annual school and amateur astronomer contests, as well as media releases.

Since 2007 AusGO has also managed Australian access to the twin Magellan 6.5m telescopes, via the provision of Chilean-based Magellan Fellows (up until 2011), soliciting and assessing proposals on behalf of the Australian Time Allocation Committee (ATAC), and through reimbursing observer travel costs. With Australian membership in Gemini due to end with the expiration of the current partnership agreement on 31 Dec 2015, the make-up of Australia's access to 8m-class facilities has until quite recently been somewhat uncertain. Thanks to access agreements negotiated by AAL, using funding provided by the federal government, we can now announce that with effect from 1 Jan 2016 Australian astronomers will have access via ATAC to the following:

- 15 nights per year on the Magellan telescopes in 2016 and 2017, with travel support;
- 10 nights per year on the Keck telescopes in 2016 and 2017, with travel support; and
- potentially some Gemini classical time (~7 nights) in 2016 that will allow a smoother ramp down of programs that require Gemini access beyond 2015, as well as extend access to Australian contributions to Gemini including a LIEF-funded upgrade to the GeMS wavefront sensors.

In recognition of the changing make-up of Australia's 8m access, the Australian Gemini Office will become known internally as the International Telescopes Support Office (ITSO). The current staff (Stuart Ryder, Caroline Foster, and Richard McDermid) will continue to focus on supporting Gemini and Magellan users throughout 2015, but are also formulating a strategic plan for how best to "add value" to the Magellan and Keck user experience from 2016. As part of this process input will be sought from the Australian community (including those at Swinburne and ANU who already enjoy access to Keck) on where they would most like to see our efforts directed. If you have any thoughts you would like to contribute then please contact us at *ausgo@aao.gov.au.*

Changes to Phase 2 support

With effect from Semester 2014B there will be some major changes to the way that Gemini and its National Gemini Offices (NGOs) such as AusGO provide Phase 2 support to successful Gemini applicants. Most significantly, Phase 2 support for US-led programs will now be provided directly by Gemini Observatory staff. In exchange the US NGO at NOAO will take on more responsibility for post-observing support on behalf of the Observatory and all partners. Meanwhile the other NGOs including AusGO are looking to better utilize their respective expertise in particular instruments, e.g. AusGO has specialist in-house knowledge of GSAOI and NIFS. As a result the primary contact for each queue and classical program may not necessarily be from the PI's NGO, but could be someone from another NGO who is best suited to provide Phase 2 advice and checking of that program. Each program will still have a contact scientist at Gemini to carry out the final approval of the program before entering into the queue. To ensure that each NGO still has engagement with all their PIs, the role of the secondary contact scientist at Gemini has been replaced by an NGO contact scientist who will monitor progress with the program throughout the semester and ensure that everything that can be done to get the program executed to completion is done.

Proposal Statistics

For Semester 2014B ATAC received a total of 23 Gemini proposals, the same number as in 2014A. There was a surge in interest in the exchange time on Subaru with 6 proposals received; there were 6 proposals for Gemini North; 7 for Gemini South; and 4 for both Gemini North and South. Including exchange time requests the oversubscription for Gemini North was 1.8, while demand for Gemini South was just 1.3, despite GPI and the new Hamamatsu CCDs on GMOS-S being offered for the first time. The oversubscription factors would no doubt have been higher if the Large and Long Programs with Australian involvement (see below) had been submitted as regular joint programs in 2014B.

Magellan demand in 2014B was also down on 2014A, with only 8 proposals received and oversubscription dropping from 2.4 to 2.1. For the first time MagE proved the most popular offering, while most other instruments received one proposal each.

In 2013B, just 4 of the 9 Band 1 programs were completed or had insufficient Target of Opportunity triggers, though 4 of the remainder have rollover into 2014B; 5 of the 7 Band 2 programs were completed; and just 2 of the 6 Band 3 programs were completed. The primary causes of the poorer than usual completion rates in 2013B were the dome shutter failure at Gemini North which cost the last 5 weeks of the semester, as well as poor weather and technical issues with GeMS earlier in the semester.

AGUSS

The Australian Gemini Undergraduate Summer Studentship (AGUSS) program offers talented undergraduate students the opportunity to spend 10 weeks over summer working at the Gemini South observatory in La Serena, Chile, on a research project with Gemini staff. They also assist with queue observations at Gemini South itself, and visit the Magellan telescopes at Las Campanas Observatory. Applications are open to undergraduate students who are Australian citizens or permanent residents currently enrolled at an Australian university who have completed at least two years of an undergraduate degree in Physics, Maths, Astronomy or Engineering. AGUSS students will be temporarily appointed to the Australian Public Service and travel on an Official Passport, and must receive a security clearance. The application deadline for the 2014/15 AGUSS program is Friday 29 August 2014 – please direct any interested Australian undergraduate students to *http://ausgo.aao.gov.au/aguss.html.*

Instrumentation Update

- **GPI:** Following first light on-sky in Nov 2013, the Gemini Planet Imager (GPI) has proceeded rapidly through commissioning, allowing Early Science programs to be executed in April 2014. Of the 10 proposals selected for Band 1, three had Australian PIs, highlighting the strong demand from within the Australian community for early access to this revolutionary instrument. Early Science observations were carried out in queue mode in mid-April. University of Sydney PhD student Anthony Cheetham participated in the commissioning of the Non-Redundant Mask mode of GPI in mid-March.
- **FLAMINGOS-2:** Following remediation work performed in April, the delivered image quality has greatly improved, with a fairly constant FWHM (~ 0.36") across its field of view. Spectroscopy is still an issue: chromatic aberration is affecting the spectral resolution significantly toward the edges of the spectrum. The next step is to fully commission the OIWFS to provide reliable astigmatism corrections.
- **GMOS-S:** The first focal plane array of 3 new red-sensitive Hamamatsu CCDs was installed in GMOS-South in April/May, but commissioning has been impacted by winter weather at Cerro Pachon.
- **GeMS/GSAOI:** A failure of the GeMS 50 W laser in February led to the postponement of a block of GSAOI Guaranteed Time for the RSAA team that built the instrument. The laser has now been restored to service, but at somewhat lower power than before.
- **GHOS:** Final approval of the post-conceptual-design contracts by the National Science Foundation, the Gemini Board, and the Association of Universities for Research in Astronomy for the Gemini High-resolution Optical Spectrograph (GHOS) was received in early April. Representatives from Gemini, the AAO, National Research Council of Canada-Herzberg, and ANU have now held kick-off meetings, with a goal of completion within four years.
- **GRACES:** The GRACES (Gemini Remote Access to the ESPaDOnS Spectrograph) project led by NRC Herzberg uses a 280m fibre feed from GMOS in Gemini North to the CFHT's high resolution spectrograph. First light was obtained in early May, and indications are that the system performs well though overall throughput has yet to be fully characterised.

Student visits to Gemini

Rob Bassett is a PhD student at Swinburne University of Technology, who in Semester 2014A was awarded time as PI on both GMOS-North and GMOS-South. AusGO was able to make a contribution towards the cost of Rob's visit to Gemini South in order to get first-hand experience with the instrument and Gemini's queue process. Rob writes:

"When I started my PhD two years ago at Swinburne University of Technology in Melbourne, Australia, I was provided with a project in the form of raw integral field spectroscopic data of extremely star-forming disk galaxies taken at Gemini. Any good study warrants follow up observations, and at the end of 2013 I was awarded 42 additional hours of observing time as a queue mode PI with the Gemini

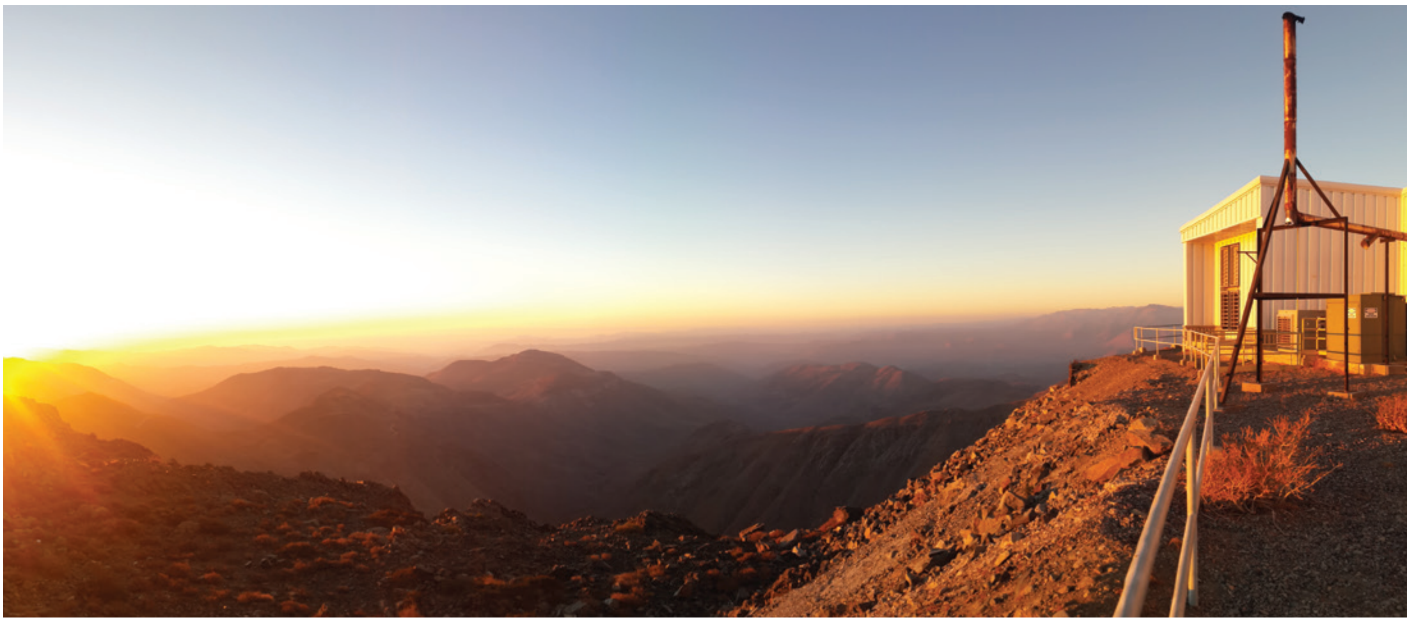


Figure 1: Sunset from Cerro Pachon (image credit: Rob Bassett).

Multi-Object Spectrograph. In addition to being a terrific result for my PhD research, this was an excellent opportunity to visit the telescope on which a majority of the data for my thesis was collected. Planning my visit from across the Pacific during the Chilean holiday was a bit of a trick, but Gemini staff in La Serena were always ready to help through the confusion.

Upon arriving in La Serena, I had a couple of nights to recover from my jet lag and was then off to Cerro Pachon for a four night visit to the summit (Fig. 1). During my visit. During my visit I was able to help collect science data on various programs, better understand the queue observing process and the various forms of interaction between queue observers and project PI's, and even got some unexpected excitement with a target of opportunity call for a gamma ray burst in the wee hours of the morning. Due to both technical and timing constraints we were not able to observe any of my targets during my stay, however this would have just been icing on the cake. This observing run was unique for me, as my limited observing responsibility made for a very relaxed four nights enjoying some of the clearest skies on Earth (this was also the perfect time to put the finishing touches on my first paper based on Gemini data!).

After returning to La Serena I spent a week working at the Gemini office. I finally got to meet the host for my stay, Pascale Hibon, who showed me around and gave me some pointers for vegetarian eating in Chile. My data reduction experience prior to starting my PhD was extremely limited and jumping straight into integral field spectroscopy had quite a learning curve! Pascale, along with the other local GMOS experts, helped me to hammer out the final issues I've been having with my GMOS IFS reduction pipeline. As my new data is collected during the current semester, I now have all the tools I need to efficiently produce high quality data products with a quick turnaround from observation to publication.

At the end of my stay I also had the opportunity to give a full colloquium on my Gemini results to date. This was a bit intimidating at first as I've never given such a long talk, however the support and encouragement I received was exceptional. In the end the talk was very well received with interest and plenty of positive feedback. Overall my visit to Gemini South was a productive and encouraging experience, and I would recommend such a visit to any queue mode observer, particularly PhD students with limited experience!"

The Gemini Observatory welcomes visits by student and more experienced users at any time, regardless of whether they have been allocated queue or classical time on Gemini. For further details, please see the article on p. 39 of GeminiFocus for June 2012 *(http://www.gemini.edu/images/pio/newsletters/pdf/gf_0612.pdf)*. In Semesters 2014B and 2015A AusGO will be offering funds from the NCRIS 2013 program to enable some student PIs allocated queue or classical time on Gemini to travel to the telescope to participate in the queue observing process, possibly including their own program.

Large and Long-Term Programs

The Gemini Observatory issued a Call for Large and long programs (hereafter "large programs" or LPs) for the Semester 2014B proposal deadline. These are Principal Investigator-defined and -driven programs that, as a guideline, either require significantly more time than a partner typically approves for a single program or extend over two to six semesters, or both. Large programs are expected to promote collaborations across the partnership's communities; to have significant scientific impact; and normally to provide a homogeneous data set, potentially for more general use. The participating partners (US, Canada, Australia, and Argentina) will make available for LPs up to 20% of their time at each Gemini telescope over each of the next 6 semesters from the start of LP execution. Australia has agreed to participate in the LP process through the end of its membership in 2015, so Australian PIs are eligible for programs that will conclude by the end of 2015.

There were 32 LP proposals submitted to start in 2014B, 4 with Australian PIs and 11 more with Australian Co-Is. This highlights a previously unmet demand from the Australian community for more ambitious programs with Gemini. A special LP TAC (which included the ATAC Chair) met in Tucson on 30 April to allocate time to programs without having regard to partner share. Ultimately just 7 LPs were selected, none with an Australian PI but 3 of which have a total of 9 Australian co-investigators.

New web pages

As many of you will have noticed the AAO web sites have undergone a major refurbishment. The AusGO web pages are also in the process of being reorganized and given a fresh look. One of many advantages of the new web content management system is the ability for users to follow news and announcements from AusGO as they appear on the AusGO home page via an RSS feed. We encourage everyone to register for this service by subscribing with your favourite RSS reader to *http://www.aao.gov.au/ausgo/rss.xml.*

News From North Ryde

Amanda Bauer (AAO)

This year marks the 40th Anniversary of AAT! The main celebrations to mark this major occasion will be held at Siding Spring Observatory during the StarFest weekend of events.

On 24 June 2014 the Australian Astronomical Observatory was awarded a special commendation for outstanding support to the NSW Rural Fire Service Volunteers Program by the Minister for Police and Emergency Services Stuart Ayres MP. AAO was one of twelve businesses to be awarded the special commendation (see photo).

Lee Spitler, Anthony Horton and Steve Lee have received a Professional And Community Involvement (PACE) Development Grant through Macquarie University's undergraduate industrial placement scheme. With the awarded funding they are purchasing equipment for an astronomical imaging system based on commercial off the shelf camera lenses, which is optimised for observations of low surface brightness objects such as dwarf galaxies and stellar streams. This will form the basis of a student project to assemble, test, observe with and analyse data from the imager.

We welcome two new members of staff to the AAO this year. Julia Bryant began as a joint AAO-CAASTRO Research Fellow on 31st March. Nick Bingham joined the AAO team on 19th May as our newest Instrument Scientist. Welcome to both Julia and Nick!

Sarah Martell has moved across town to start her ARC DECRA Fellowship at the University of New South Wales. Good Luck, Sarah! And huge congratulations to two new AAO-hosted ARC Future Fellowship recipients: Matt Owers and Sarah Brough.

In August this year staff from the AAO will be hosting several public events during National Science week. Please check for updates at our newly launched website, *www.aao.gov.au, the AAO facebook* page, *https://www.facebook.com/AustralianAstronomicalObservatory*, or follow up to the minute updates on *twitter @AAOastro, https://twitter.com/AAOastro.*

AAO staff receiving the Rural Fire Service Supportive Employer Special Commendation (Credit: Zoe Holcombe)

Letter from Coona

Zoe Holcombe

Figure 1: Siding Spring Social Club enjoying a golf outing. Credit – Zoe Holcombe / AAO

Figure 3 Sydney staff (right to left) Jenny Ghabache, Rajni Prasad, and Jessica Parr enjoy the view from Siding Spring and Zoe's newly shaved head! Credit: Zoe Holcombe / AAO

Hi everyone,

January 2014- We first celebrated Katrina Harley's 30th birthday and then a week later, her baby girl. Millie Sara McDonaugh was born on 30th January at 3060 grams and 51 cm. Katrina struck gold - her little girl slept through the night and Katrina admitted she was slightly bored, so we have given her Open Day work to keep her busy while Millie is being too good!

Figure 2 The early stages of preparing the 4-metre AAT mirror for aluminizing. Credit: Andy Green / AAO

February – The social club SSO here at Siding Spring decided to have a golf afternoon. We split up into 2 teams and played an Ambrose, 5 in each team. Tony Antaw took one group and me the other. Our poor course had not seen rain for quite a while and it was a desert on the fairways but our greens were looking amazing considering the heat and drought. We played 6 holes in 32 degree heat; the drinks carts were doing a great job. In the end, Tony's team won by 1 shot on the 9th hole, and we all retreated back to the 19th hole for drinks and dinner overlooking the course.

March – Started with me doing something CRAZY but important. I participated in the World's Greatest Shave. My target was to raise $2000 for the cause. With the help of everyone here at the AAO and SSO, and others in town, I officially raised $3271! THANKS SO MUCH FOR YOUR HELP.

The social club again was on the move, we organised a camping trip to Mendooran on a Saturday afternoon a few of us left Coona and Dubbo to go camp for the night. We had some afternoon drinks by the river and then had dinner at the Pub, the meal there was really good and I would recommend going there if you are passing by. After dinner Amanda Wherrett from ANU and Darren Stafford got their telescopes out for some viewing of the skies.

We took the AAT's primary mirror out for its first aluminising in some time. It was very interesting and I got involved in cleaning it down and putting it in the tank for re-coating. After it came out it was beautiful and ready for another year of hard work.

The Advisory Committee paid us a visit for their meeting, along with Jess, Jenny and Rajni. I got to show the girls around the AAT, both inside and out.

April – The official HERMES opening went off without a hitch, the weather was perfect, and the AAT looked sparkling. The Minister and his entourage had a good time and were very impressed with the AAT from what I have heard.

May – Warrick and Neville came to visit us so we put on SSO BBQ. We were meant to have Salmon but because the SSO Spring has dried up there were no fish. We had the regular spread of steak, sausages, salads and potato bakes instead. Maybe when it rains we can have salmon but it doesn't look like raining at all so Neville and Warrick could be waiting for a while.

June – We started the month with over 50mm of rain. Coona had the most rain in the area, which was nice to hear, as we really needed it.

I went and played golf in Moree for the week, highlight was hitting myself with my own golf ball, not only did I get a massive bruise I also got a 2 shot penalty, Moree 1 - Zoe 0. Although I didn't play well, I came about 20th out of 140 players, so that's not a bad result!

So we reach the end of another financial year and only 6 months till Christmas. Where has the year gone? Soon it will be warming up again and I won't be complaining about how cold it is and my hair will be a little bit longer.

And to end this; wishing all those that have turned a "BIG 0" over the last few months including the AAT HAPPY BIRTHDAY!!

Until next time

Zoe Holcombe

Top: Enjoying the view of the recovering Warrumbungles National Park from the walkway around the AAT are (L to R) AAO operations manager Doug Gray, Director Prof Warrick Couch, and Minister Ian Macfarlane. (Credit: Phil Fitzgerald, Dept of Industry)

Bottom: Department of Industry Minister Ian Macfarlane congratulates AAO Director Professor Warrick Couch at the official launch of the HERMES instrument on the AAT. (Credit: Phil Fitzgerald, Dept of Industry)

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