Multi-Object IFU comes to the AAT
We are currently in the process of developing the AAO Forward Look, a strategic plan that will define the AAO’s goals for 2011–2015 and beyond. It is based on the goals and priorities set out in the Australian Astronomy (Decadal Plan 2006–2010) and the recent Mid-Term Review of the Decadal Plan (see http://www.science. au.org.au/home/nc-astronomy/decadplan.html). The AAO Advisory Committee endorsed the Forward Look process at its inaugural meeting in March, and initial consultations have already been held with the Advisory Committee, the AAO Board, AAO’s Optical Telescopes Advisory Committee, the AAO Users’ Committee, the Australian Time Assignment Committee and AAO staff.

There are many challenges and opportunities for the AAO in the next few years, but the eight framing goals for the Forward Look are:

1. Maximising the research productivity and impact of both the AAO itself and the users of its facilities. This is the fundamental goal of the AAO, and sets the context in which all other issues are addressed. The AAO aims to be a world-class astronomical institution, providing excellent optical and infrared observing facilities and innovative telescope instrumentation that enable Australian astronomers to do outstanding science (as evidenced by the articles on pages 4, 10, 11 and 15 of this issue).

2. Determining the effective scientific lifetimes of the AAT and UKST, and developing appropriate and cost-effective operations models. World-class research requires an appropriate mix of facilities on all scales. In the next 5 years the Decadal Plan and Mid-Term Review recommend that Australia increase its access to large optical facilities to at least the equivalent of a 20% share in an 8-metre telescope. On a ten-year timescale, Australian astronomers aim for a 10% share in an Extragalactic Large Telescope, an ambition currently realised by Australia’s participation in the 25-metre Giant Magellan Telescope project. The effective lifetimes of the AAT and UKST depend on their scientific competitiveness with respect to such facilities, which in turn depends on telescope capabilities, instrumentation suites, levels of access, scientific agendas, and the operational funding available to support Australia’s portfolio of optical telescopes.

With the ongoing refurbishment program, new instruments such as HERMES, and upgrades to the existing instrument suite, the AAT will remain scientifically competitive for another decade while also remaining a valuable testbed for new instruments and technologies. Over this period however, the AAO, which already supports Australian access to Gemini and Magellan, will shift its operational emphasis towards these larger telescopes and GMT. In the meantime, the UKST can continue operating in user-pays mode, particularly if refurbishment of the telescope and an upgrade to EdF allow more ambitious programs, such as the proposed TAPPII galaxy survey.

3. Managing the AAO’s evolving role at Siding Spring Observatory in light of foreseen changes in ANU’s role and support. Over the next five to ten years the ANU is likely to be scaling back its level of support for operations at Siding Spring Observatory (SSO). Appropriate evolution of the operations model for SSO therefore needs to be considered, including the possibility that the AAO might assume responsibility for SSO operations. In that case the ANU would continue to own the site, but become one of several organisations with facilities at SSO that are supported by the AAO.

4. Improving the AAO’s support model for offshore telescopes where Australia is a partner in an international consortium. At present the AAO’s focus is on operating its offshore telescopes (AAT & UKST), but it also supports Australian users of offshore telescopes (Gemini & Magellan). As the focus and investments shift to larger offshore telescopes, the AAO must develop a plan for maximising outcomes from such facilities. This will involve some appropriate mix of operational support (for time allocation committees, user committees and so on), user support (for preparation of proposals, remote observing capabilities, expert assistance in data reduction and the like) and instrumentation development (existing scientific agendas and reserved guaranteed time for the community). Together these services must provide evident added value to Australian users of these facilities.

5. Planning the AAO’s next generation of instruments for offshore telescopes and leveraging the best scientific opportunities for Australian astronomers in these telescopes and the instrumentation program. The AAO has one of the world’s best astronomical instrumentation programs and is a leader in web-based multi-object spectrographs and robotic fibre positioners. The AAO also has a unique and innovative instrument science group developing new technologies such as DH-suppression fibres, hexabundles, starbug robots and integrated photonic spectrographs (see the articles on pages 7 and 13 of this issue). Those capabilities are already exploited to keep the AAT competitive. The AAO is considering how to leverage additional access to front rank facilities by providing instruments. This latter approach will become increasingly important for the AAO and Australian astronomers as the importance of Australian offshore facilities declines relative to international offshore facilities. The next generation of AAO instruments needs to be matched to the scientific lifetimes and operational models of the AAT and UKST, and balanced with the opportunities to gain additional access to international facilities in which Australian astronomers have an interest.

6. Exploiting the improved facilities of the AAO’s new Sydney headquarters to energise and advertise the organisation. The move of the AAO headquarters to new premises in North Ryde, slated for the middle of next year, represents a significant investment in the organisation by the Australian government. The new building will provide improved office areas and better facilities for the instrumentation program, allowing the AAO to efficiently assemble, integrate and test larger instruments for larger telescopes. Together with the solid funding outlook for the Observatory, the new headquarters will provide the AAO with the confidence and capacity to make the changes needed to respond to the changing astronomical environment and to undertake more ambitious instrument projects. This in turn will energise AAO staff and advertise to the world that the AAO continues to be a force in international astronomy.

7. Recruiting and nurturing world-class staff. A research institution’s staff is its most important resource, so it is key to the AAO’s future that it continues to recruit and nurture world-class astronomers, instrument scientists and engineers. This will be possible if the AAO is recognised internationally as a powerhouse of astronomical research and technology development, and if it provides facilities and opportunities that excite and challenge the best young people in Australia and from overseas.

8. Maintaining good relations with the astronomical community by being responsive to changing needs and effective in delivering services. The AAO’s success and strong support in the Australian astronomical community is founded upon its track record of responsiveness to community needs and effectiveness in providing competitive facilities and services for researchers. Close consultation with the community is essential to maintain this situation in future, and the AAO Forward Look must therefore be consulted with, and owned by, the community if it is to achieve its goals.

We plan to make a consultation draft of the Forward Look available to the Australian astronomical community in early November, with the final version to be completed and made public by the end of the year. In order to ensure that the community has every opportunity to discuss the draft and provide feedback, I will be visiting major centres to hold town-hall meetings discussing the Forward Look during November and early December. The AAO’s Forward look will be critical to the successful evolution of the AAO as Australia’s national optical observatory over the next five to ten years, so I look forward to these discussions!
Hexabundles are a recently developed technology (Bryant et al., 2011) that offer the potential for integral-field spatially-resolved spectroscopy without the complexities inherent with existing bulk-optic lenslet array, microlens array, or image-slicing mirror techniques. The hexabundle consists of a series of multimode fibre cores (so far 7, 19, and 61 core devices have been demonstrated) that are lightly fused together over a small (1–20 mm) interaction length. Interstitial holes are filled with soft, low refractive index glass. This geometry acts as a compact relatively high fill-factor integral-field unit (IFU)/image-slicer, giving significant advantages for multi-object IFU systems that bridge the gap between large monolithic IFUs and single-aperture multi-object systems.

**The Hexabundle Advantage**

The key benefits of integral-field spectroscopy for extra-galactic science are that gas and stellar kinematics over an entire galaxy can be measured enabling the separation of dynamical components, the measurement of dynamical mass, the examination of the impact of winds and outflows, and the discovery of merging systems via dynamical disturbance. This information is obtained in addition to parameters that can be readily measured with single-aperture spectroscopic instruments (e.g., star formation rates, gas phase metallicities, stellar ages, stellar metallicities, and black hole accretion and extinction due to dust).

Integral field spectroscopy has so far almost exclusively been limited to single-object instruments, meaning that it is time consuming to build large galaxy samples. The key innovation of the hexabundle-based approach is that it becomes possible to build systems that are capable of positioning a significant number (i.e., tens to hundreds) of IFUs simultaneously. If fed at a low enough focal ratio, optics are not required in the fibre bundle, significantly simplifying alignment and assembly. Additionally, each hexabundle IFU can be made much smaller than its bulk- or micro-optics counterpart – simplifying the positioner system design and allowing close packing of objects.

**The SAMI Instrument**

With a view to providing the first on-telescope demonstration of hexabundle technology, the AAO and the University of Sydney have collaborated on the development of the SAMI instrument for the AAT. SAMI uses 13 x 61 core unfused hexabundles that are mounted on a plug-plate at the 1 degree field-of-view triplet corrector top-end focus (Figure 1) on the Prime Focus Camera. At f/3.4 with 105 μm core diameter fibres, each hexabundle samples a 14’ field at 1.6’ per fibre. At the output end, a total of 13 V-groove slit blocks are mounted at the AAOmega slit. Each slit block includes 63 fibres (all the fibres from 1 hexabundle and 2 fibres for sky subtraction). A ribbonised fibre cable of length ~40m joins the two instrument ends. Fibres from this cable are glued into the V-grooves at the spectrograph slit. At the top end, the hexabundle fibres are each fusion spliced to the ribbon fibres inside a protective “splice box”, mounted on the internal wall of the top-end barrel.

Each hexabundle is mounted in a standard (SAM) screw-thread fibre connector. The plug plates have a mating connector at each object position. Two galaxy fields (i.e., 24 objects) are pre-drilled per plate along with a set of 26 blank sky locations common to both galaxy fields. For the proposed integration time of 2 hours per field this means that 3 plates (or 2 plate exchanges) are required each observing night. The down time between fields is less than 30 minutes.

For acquisition and guiding we use a CCD camera mounted on a gantry above the plug plate that views the central few arcminutes of the field through a hole in the plate.

**SAMI Commissioning**

The first commissioning run for the SAMI multi-object IFU instrument occurred from 1st-4th July 2011. After installing the instrument, the initial step was to align the plug plate to the telescope optical axis. It was unsuitable prior to commissioning whether the Prime Focus Camera that was originally built for commissioning of the AAT in the early 1970s and last used over a decade ago, would be well aligned to the telescope optical axis. This provided the opportunity/necessity for an observer to ride in the top end (Figure 2 and front page), something also not seen at the AAT for some years.

Initial coarse alignment of the plug plate assembly was done by eye – using holes positioned around several bright (m~6) stars in the field. Fine adjustment was accomplished using fainter (m~14) stars coupled through the hexabundles and the AAOmega spectrograph. A near real-time data pipeline extracted the partially-reduced spectra from the detector images and incorporated a schematic display of reconstructed hexabundle fields based on total integrated counts per hexabundle core (Figure 3). Measured centroids were used to derive precise offsets for each bundle – allowing field rotation and telescope pointing corrections. These data were also used to derive corrections to the field distortion coefficients that will be used for the next commissioning run.

Early in the morning on the first commissioning night, after alignment and system checks using stellar field plates were completed, a galaxy field plate was installed, and a 20 minute galaxy observation was made (Figure 4). Stacked images from subsequent nights observing were used to construct velocity fields for each of the target galaxies, see for example Figure 5.

**Conclusions**

The first commissioning run of the SAMI instrument was extremely successful. This on-telescope experiment has demonstrated the potential of hexabundle technology for multi-object IFU science. While some modifications to the instrument are required, it appears feasible to conduct dedicated science surveys with SAMI in the near future.

**Acknowledgements**

We warmly thank all staff at the AAO for their support in developing and commissioning the SAMI instrument and the AAOmega spectrograph.

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**Figure 1.** The SAMI plug plate assembly, unit mounted onto the Prime Focus Camera. The white “splice box” connects the blue hexabundles and orange sky fibres from the brass plug-plate to the fibre bundle.

**Figure 2.** Team member Sam Richards prepares for a long cold night in the triplet top end.

**Figure 3.** Schematic display of reconstructed hexabundle images based on total integrated counts per hexabundle core for a field with 13 galaxies. Note that hexabundles #5 and #2 were not functional during this observation. Galaxy positions were all centred within ~2 arcsec.

**Figure 4.** SAMI commissioning team galaxy-field celebrations.

**Figure 5.** Velocity map produced from the first galaxy-field commissioning plate. The box is ~13 arcmin square.
From 2001 to 2006, the UK Schmidt Telescope undertook an all-southern sky spectroscopic survey, known as the 6-degree Field galaxy survey (6dF). The final data release of 6dF redshifts took place in 2009 (Jones et al., 2009), though we continue to make use of the survey’s spectra for extragalactic and cosmological studies.

The peculiar velocity subsample of 6dF 6dFsg includes approximately 10,000 early-type galaxies. With the goal of ultimately deriving the distances and peculiar velocities of each of these galaxies, we make use of an important correlation for early-type galaxies, the Fundamental Plane (FP). The FP is a three-dimensional relation in the logarithmic space of galaxy size, velocity dispersion and surface brightness (Jörgensen & Davis 1987, Dressler et al., 1987). A redshift-independent distance to an early-type galaxy can be derived by measuring its offset from the FP relation. However, such an analysis requires us to carefully consider how we fit the FP, and how we account for selection effects. In this article, we describe how we fit the FP for this sample, and how we account for the trends of other parameters within ‘FP space’. This process also allows us to gain new insights about galaxy formation and evolution.

Sample Selection and Fundamental Plane Fitting
6dFsg comprises 10,000 of the brightest galaxies with redshift z < 0.055 from the main redshift survey of 6dF. The near-infrared target selection of 6dFsg favours older, bulge-dominated galaxies, as these wavelengths are less sensitive to dust extinction than are optical wavelengths. The 6dFsg sample combines 6dFsg velocity dispersion measurements with stellar population parameters in the J, H and K near-infrared passbands from the Two Micron All Sky Survey Second Data Release (Skrutskie et al., 2006). Since the original formulation of the Fundamental Plane relation, the size and quality of galaxy samples has steadily increased (Bernardi et al., 2003, La Barbera et al., 2010, Graves et al., 2009a), yet the statistical models and fitting techniques used to derive the plane have not evolved with the same level of detail. Many previous studies used simplistic linear regression fitting techniques and model the distribution of galaxies in FP space as a 2D plane with scatter. However, these fitting methods fail to account for the censoring present in an observed FP sample and the measurement errors (and their correlations) in each of the FP parameters and so are susceptible to bias, limiting any interpretations drawn from their best-fit plane. Instead, we adopt a three-dimensional Gaussian model for the FP distribution, whose best-fit parameters are determined using a maximum likelihood method (in a similar manner to Saglia et al., 2001).

Our fitting method properly accounts for selection effects in the sample due to cuts in velocity dispersion and apparent magnitude and observational error (and their correlations) in the FP parameters (Magoulas et al., in prep.). In the J-band, our tightest sample, the best-fit Fundamental Plane has a slope and scatter that is consistent with other early-type galaxies and spiral bulges in our sample are more biased towards finding planets with higher masses in mass orbits. For studying planets that are further out there is strong interest in so-called “direct detection” techniques, such as spectrography or optical stellar interferometry. This light is isolated, negating the need for continuous monitoring over one or more orbital periods (>20 years).

With the aim of developing an instrument that allows for high dynamic range imaging for use in exoplanetary science, the Dragonfly instrument was conceived. Dragonfly is an optical stellar interferometer but unlike interferometers before it, it takes a revolutionary new approach to the design of such instrumentation; it is based on integrated photonic circuits (micro-optic chips), micro-mechanical mirrors and an on-chip optical detector (see Fig. 1). With this unique photonic-based instrument offers many benefits including:

- **Spatial filtering** - the light propagating within the single-mode waveguides has a simple planar wavefront. As a result, all residual phase aberrations across each sub-aperture is rejected, resulting in a mode-cleaned interferogram.

- **Simple, high precision optical path length matching** - Routing of waveguides on a single chip can be achieved with sub-micron precision allowing for extremely precise matching of optical path lengths.

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Compact and robust – An entire photonic chip encoding advanced processing capability will only measure several centimetres in size, and is thus a compact, robust device highly resilient to errors induced by thermal or mechanical anisotropies.

Non-redundant beam combination – The input pupil geometry can be arbitrarily remapped into any output configuration. Therefore beam recombination schemes can be configured to eliminate any redundancy noise.

Full utilization of the available telescope pupil – In contrast to aperture masking interferometry where very few holes are used in a plate to achieve non-redundancy, the remapping capability inherent to optical waveguides makes it possible to fill the entire pupil plane with waveguides, allowing a significant increase in sensitivity.

Cross-dispersed integral field unit – Pupil remapping into a linear pattern permits the orthogonal ordinate of a 2-D array detector to be utilized to record spectral data.

Waveguide coupling optimization – By positioning the segmented mirror and the injection micro-lens array at the pupil plane of the telescope, it is possible to use the tip/tilt feature of the segmented mirror to carefully optimise the coupling into the 10 μm optical waveguides. The principle of the interferometer is that the output of each waveguide acts like a slit. By choosing which waveguides slits have light injected into them, it is possible to choose the separation between slits and hence frequency of fringes that are generated on the detector as shown in Figure 2. It is not only possible to select a single set of fringes corresponding to a single baseline of the instrument as depicted in Figure 2(a) and (b), but it is also possible to turn on a combination of waveguides such that multiple sets of fringes with various fringe frequencies are superimposed on the detector simultaneously, as depicted in Figure 2(c). By measuring the phase associated with multiple fringe frequencies/baselines/spatial frequencies, it is possible to calculate a “closure phase”, which is a measurable used to eventually reconstruct an image of the stellar target.

Within 30 minutes after first injecting light from the scope, we had star light on the detector. This in itself is an accomplishment as the AAT does not have adaptive optics, making coupling into single-mode waveguides very difficult. Further, in order to avoid blurring of the fringes as a result of atmospheric fluctuations, we had to integrate at times commensurate with the atmospheric coherence time (~10 ms) which meant we had very low signals on a high read-noise laboratory grade detector.

On the second night, we pointed the telescope at Antares as it is one of the brightest objects in the sky in the H-band (-3.5mag) and after stacking frames for several hours we managed to demonstrate that we could detect all 6 baselines of the interferometer. Figure 4 shows the spatial frequency/baseline separation plot as a function of wavelength.

This was a fantastic proof-of-concept demonstration and over the next 6 months we will be refining Dragonfly ready to go to a larger scope with an adaptive optics system, where we hope to begin doing science with it. One day, Dragonfly may help astronomers hunt for and study faint exoplanets which will give us a better understanding of planetary and solar system evolution, but for now it’s just a lot of fun.

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**Figure 1:** Schematic diagram of the Dragonfly instrument. Orange circles indicate the segments used on each optical component. Red arrows depict the direction of propagation of the stellar signal through the instrument, arriving from the telescope at the left.

**Figure 2:** (a) and (b) depict the power spectra and fringe patterns (insets) associated with 2 pairs of waveguides with different separations. (c) Shows the power spectrum and the corresponding fringe pattern when light was injected into a combination of 6 waveguides. The dots represent the waveguides. Yellow – light injected, blue – light decoupled. The various baselines achieved with each combination of waveguides is displayed below each set of dots.

**Figure 3:** Nem aligning Dragonfly in the Coude room.

**Figure 4:** Power spectrum of the fringes detected by the system. Vertical axis is the wavelength decreasing from ~1.75 to 1 μm as you move up the axis. Horizontal axis shows the spatial frequency components of the interferogram. The lower band of dots is in the H-band and 6 can clearly be seen. The white lines show the predicted position of the spatial frequency/baselines for the system.

**Figure 5:** The Dragonfly team celebrating their fringe victory.
The variability of quasars has provided many clues about the nature of active galactic nuclei (AGN), but recent developments also reveal the evolution in quantitatively analyzing variability. Variability time scales led to some of the first crude ideas on the near-infrared AGN at all wavelengths. However, since few quasars were well monitored, studies focused on the statistical variability of large numbers of sparsely monitored quasars as a function of time scale. The largest analyses used tens of thousands of SOSS quasars, finding that quasar variability increases towards shorter optical wavelengths, lower luminosities and, probably, lower black hole masses (e.g., Van der Bert et al. 2004, de Vries et al. 2005). Detailed studies of individual quasars showed that they get bluer as they become brighter, consistent with thermal emission from a disc (e.g., Worse et al. 1999). The most important application of these detailed studies, however, has been the development of “reverberation mapping” where the lag between continuum and line variations is used to measure the physical radius of the line emitting regions and then to calibrate relations between emission line widths and black hole masses (e.g., Peterson 1993).

But what about the light curves of individual quasars? How do you turn an apparently random wandering in brightness into numbers that you can analyze and use as astrophysical tools? A solution was proposed by Kelly et al. (2009) who showed that individual light curves could be well modeled as a particular stochastic process, the damped random walk (DRW). This reduces the random wanderings of the light curve into two numbers, an amplitude and a time scale, and Kelly et al. (2009) showed using a very small sample of about 100 AGN that these parameters appeared to be correlated with the physical properties of the AGN. In MacLeod et al. (2010), we expanded these studies to the largest available sample of quasars with light curves, the roughly 9000 quasars in the SDSS Stripe 82, finding that the time scales and amplitudes are correlated with rest-wavelength, luminosity and black hole mass. Unfortunately, while the SDSS Stripe 82 quasar sample was the largest and best available, the light curves are not very long enough to allow an effective duration too short to well-constrain the variability parameters of individual quasars. There are, however, quasars with extremely well-sampled light curves -- any quasars lying in the fields monitored by the microlensing surveys of the Magellanic Clouds and the Galactic bulge. The OGLE survey, for example, currently contains 15-year-long continuously growing light curves with ~1000 epochs for about 50 million sources in the Magellanic Clouds. For a serious study of variability, you need relatively large numbers of quasars since there are a minimum of three relevant physical variables: rest wavelength, luminosity and black hole mass (estimated from line widths). The necessary numbers of quasars are present in the microlensing fields with one little problem -- there are only about a dozen quasars for every million LMC/SMC stars in these fields.

Standard optical color selection methods do not work for the Clouds, but there are two alternative methods. First, objects with red mid-IR colors (3.6 versus 8.0 microns) are either AGN or the relatively rarer stars with warm dust -- normal stars and galaxies are blue sources in these bands. The primary contaminants are AGB stars, young stellar objects (YSOs) and planetary nebulae (PNe), but these can be controlled with a few ancillary cuts, as we explored in Kozlowski & Kochanek (2009). Second, we can use the variability parameters for the SDSS quasars to identify sources varying like quasars. Here the contamination comes from irregularly varying massive stars, but most of the quasar parameter range differs from that of the stars, as we showed in Kozlowski et al. (2010). In both cases, you can define selection criteria that produce high purities at the price of reduced completeness.

When you go to plan your AAOmega observation, however, you realize you should simply forget about purity and aim for completeness because the density of available fibres is comparable to the density of all vaguely plausible quasar candidates. Tossing in all the reasonable mid-IR and variability-selected candidates and then adding possible OGLE matches for any quasar candidates to the SDSS sample would provide a very interesting list of AGN candidates.
to X-ray sources in the fields only comes to about 80 sources per square degree compared to an expectation of roughly 25 quasars per square degree with I<21 mag. Since there is no point in leaving a fibre empty, you should just do everything, including objects starting to be a little faint for the planned observation times. In this “no fibre left behind” approach, contamination is a feature, not a bug, and it will identify many peculiar LMC sources as a by-product.

So far we have observed 4 AAOmega fields in the LMC and 1 in the SMC in 17 planned, mostly while fighting cyclone Yasi and with only one field completed to the planned depth. In 5 hours on sky, we observed 1100 candidates, finding 174 new quasars, quadrupling [doubling] the number known behind the LMC (SMC). The quasar samples are roughly 80% complete for I<19.2 mag, and the completeness then drops. There are a comparable number of contaminating stellar sources, mostly previously unidentified B[e] stars, V505s and PNe. The contamination and failure rates are high, but this was expected. We estimate that completing the current OGLE-III LMC and SMC fields would yield a total of ~700 quasars, and that an additional 3400 quasars can be identified in the OGLE-IV fields, ignoring any potential gains from obtaining the longer, planned integrations. While the sample would still be smaller than the ~9000 SDSS quasars we considered in MacLeod et al. (2010), the longer and more densely sampled OGLE light curves should let us examine the physical correlations of the variability parameters with a higher accuracy, making it easier to determine the intrinsic parameter distributions and their correlations with the physical properties of the quasars. These quasars have additional uses beyond studies of quasar variability.

Pressing in for more time will improve the quality of the data, but at an increasing cost. As the redshift of a quasar increases, the amount of flux obtained drops in proportion to 

\[ \frac{1}{(1+z)^4} \]

This equation reflects the decrease in received flux due to the cosmological expansion. The time required to detect a quasar at a given redshift increases as 

\[ \frac{1}{(1+z)^4} \]

For example, to detect a quasar at a redshift of 3, which is about the range of redshift of LMC quasars, a detection in the OGLE-IV field would require 

\[ \frac{1}{(1+3)^4} = \frac{1}{167} \]

times longer than a similar observation in the OGLE-III field. This is a significant challenge, especially given the increasing failure rate as we go to higher redshifts. However, the benefits of improved data quality can be significant, as higher redshift quasars can provide insights into the nature of dark matter and the evolution of the universe. This highlights the importance of continued support for such programs, as well as the need for innovative solutions to address the increasing cost and time required for high-redshift observations.

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On the 19th of May, we interfaced a new APS prototype with the AAT using an IFU which fed a multimode fibre (a fibre with a 50 micron core) and in turn a photonic lantern. This is the same interface as used by the GNOSIS OH-suppression instrument. The photonic lantern acts as a multimode-to-single mode converter, allowing our diffraction-limited APS (hitherto single-mode) to collect the light propagating down the fibres. Furthermore, we modified the APS to simultaneously input twelve single-mode fibres, thus increasing our observational efficiency by an order of magnitude. The APS chips have a throughput of ∼80% and a typical resolving power of R=7000. The output face of the chips was imaged onto the IRIS2 detector, which we used in spectroscopic mode as a cross disperser for the astronomical H-band (1.48–1.62μm), in which we were observing.

The first spectrum of the night was of Antares (ε Scorpis) as it was the brightest sky up at the time, and served as a calibration source for final alignment adjustments (Figure 2a). With a world-first under our belts, we continued to observe a Bl star (α Ara) (Figure 3a) and Ψ Pi 01 Gru, a cold red giant (Figure 3b), as they would hopefully contain more interesting spectral features in the H-band.

This demonstration is, to our knowledge, the first time a photonic spectrograph has successfully taken spectra of a source beyond the Earth, and the first time such a device was interfaced to a telescope. With the success of the new prototype, we have shown the practicality of such a device for astronomy. Further work on the APS continues with potential interfacing with adaptive optics aided telescopes, and a large redesign and fabrication of new APS chips more ideally suited for astronomy. While still a long way from becoming a fully-fledged instrument, the recent successes make our ambition of having a spectrograph for astronomy that you can fit in your hand, seem very bright indeed.

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SCIENCE HIGHLIGHTS

AUGUST 2011

Using AAOMeGa to measure the age of the young open cluster IC2602
Paul Dobbie (AAO), Nicolas Lodieu (IAC) and Rob Sharp (ANU)

Open clusters consist of co-eval populations of stars residing at similar heliocentric distances, that have formed from a single gas cloud with near uniform chemical compositions. The common properties of their members render them excellent targets for addressing fundamental questions in stellar astrophysics. For example, they are frequently utilised to investigate the forms of the stellar/substellar initial mass function (e.g. Moraux et al. 2005; Lodieu et al. 2009) and the stellar initial mass-final mass relation (e.g. Williams et al. 2004; Kajari et al. 2005; Dobie et al. 2009). Open cluster members are also frequently used to probe stellar magnetism (e.g. Marsden et al. 2005), the evolution of stellar angular momentum (e.g. Irwin et al. 2009) and the mixing processes which occur within stars (e.g. Pinsonneault 1997).

Critical to the success of many of these types of investigation is the availability of a reliable age determination for the population under scrutiny. This allows meaningful comparisons to be drawn between the measured properties of the members of different clusters and aids in the judicious interpretation of the observed trends in the theoretical context (e.g. the variation of Li abundance in stars of different effective temperatures as a function of age; Randich et al. 2001). In general, age estimates for open clusters are obtained using the main sequence turn-off technique (MSOT), where the observed location in the luminosity-temperature plane of stars at the end of their main sequence life is compared to the predictions of stellar evolutionary models (Yェnet, Mermillod & Mader 1993). However, for all but the oldest populations these age estimates are muddied by uncertainties associated with the extra convective mixing which is believed to occur at the boundary between the cores of stars and the overlying layers (MS & Demarque 2001). The degree of convective core overshooting adopted in stellar evolutionary models impacts both the predicted main sequence lifetimes and the luminosities of stars, with greater overshoot leading to larger cluster age estimates. Thus a method of determining ages which is independent of assumptions about the physics of the stellar core boundary is to be preferred.

We are fortunate that such a technique has been successfully demonstrated (Baum et al. 1996). It relies on locating the boundary, in terms of mass, at which the element Li re-appears in the spectral energy distributions of the completely convective very-low-mass stellar and substellar members of a population (Rebolledo et al. 1992). As a population matures, up to 38 Myr, the location of this Li depletion boundary (LDB) migrates to lower mass (corresponding to later spectral type), providing a potential excellent handle on the age (D’Antona & Mazzitelli 1994). However, the draw back of this approach is that it is reliant on the availability of moderate signal-to-noise, medium resolution optical spectroscopy of intrinsically faint red objects. Hence, prior to this work there were only five young open clusters with LDB based age determinations.

With the commencement of the operation of near-IR survey instruments such as VISTA, which are capable of probing the sequences of young, nearby stellar populations down to planetary masses, it is desirable to expand the set of southern open clusters for which LDB ages are available so that these data sets can be fully exploited. The nearby (d=150–170pc e.g. Brass 1961; van Leeuwen 2007) pro-main-sequence population, IC2602 is potentially one of the most astrophysically interesting of these targets. Currently, it’s age, which is estimated to lie in the range 10–30–70 Myr (e.g. Karchheno et al. 2005), is rather poorly determined. As this cluster is located close to the Galactic plane (b=–4.9°) and spread over several square degrees of sky, it is rather difficult to distinguish members from reddened background field stars via photometric surveys. Therefore, assembling a reasonably clean list of faint candidate members for the traditional long-slit spectroscopic follow-up program, which is necessary to determine the location of the LDB, is extremely challenging. Indeed, despite the youth and proximity of IC2602, the low mass stellar or substellar members have been reported prior to this study.

Fortunately, the difficulties above can be mitigated to a large extent by undertaking the follow-up observations with a high gain, multi-object spectrograph which has a wide field-of-view i.e. AAOMeGa. Here we briefly describe our recent work on IC2602 aimed at securing a LDB age for this population.

The initial identification of candidate low mass cluster members

We retrieved i-band imaging for ∼1.4 square degrees towards IC2602 from the European Southern Observatory’s (ESO) data archive. This had been obtained with the 2.2m telescope and the Wide Field Imager (WFI, Baade et al. 1999) during February 2001. These datasets were processed and calibrated using the Cambridge Astronomical Survey Unit’s CCD reduction toolkit (Irwin & Lewis 2001). The optical detections were cross-correlated with the Two Micron All-Sky Survey (2MASS, Skrutskie et al. 2006) point source catalogue to obtain corresponding J and K band magnitudes for the brighter sources. Subsequently, these data were used to construct an I–J colour-magnitude for objects classified as stellar, towards the cluster. As our guide to the likely location of the cluster sequence we used a selection of low mass cluster stars from the Ploegoids for which I and J photometry are available in the literature (Stauffer et al. 1994, 1998). The photometry of these Ploegoids objects was shifted from an assumed d=135pc; Pan et al. 2004) to the new Hipparcos distance of IC2602 and adjusted by 0.45 magnitudes to larger luminosities (based on the predictions of evolutionary models for low mass stars) to account for the expected lower age of this cluster i.e. ∼50Myr. Based on the minimum and maximum nuclear age estimates for IC2602 in the literature, we estimated the probable location.

Using AAOMeGa to measure the age of the young open cluster IC2602
Paul Dobbie (AAO), Nicolas Lodieu (IAC) and Rob Sharp (ANU)
We used the AAOmega + 2dF facility (Sharp et al. 2006, Lewis et al. 2002) at the Anglo-Australian Telescope for a mere 2 hours during February 2010 to obtain medium resolution spectroscopy of 219 of our 249 candidate members of IC2602. These observations were performed using the 1000R grating on the red arm to cover the wavelength range 6200–7300 Å, within which the resonance line of Li is located. Our science observations were bracketed by fiber-flat and arc calibration frames. Simultaneous 2MASS photometry was performed with the 580R grating on the blue arm but these are not relevant to this study. The red arm data were processed using a slightly modified procedure to the standard reduction implemented by 2DPR. Due to the presence of weak but slowly variable Ha emission across our AAOmega field-of-view we used a median of the background counts from the closest ~8 sky fibres to each science fiber to obtain an estimate of the night sky spectrum. The residuals in each of the sky fibre spectra showed a noticeable improvement to the background subtraction accuracy using this approach.

Out of the total of 219 objects observed spectroscopically we found only 22 had energy distributions that resembled mid-M spectral types. As young very-low-mass stars typically display strong [EW < few Å] iron lines, and HA residuals of the available data were weak, we examined the spectra of these 22 sources. The vast majority of the spectroscopically observed objects that we rejected appeared to be very-early M spectral types and were presumed to be reddened background stars, which are known to be a major problem for low mass photometric studies of this cluster (e.g. Foster et al. 1997). To assess more quantitatively the spectral types of the 17 remaining candidates we computed spectral indices based on the strengths of the TiO and CaH bands (Tigges et al. 2009; Cruz & Reid 1995; Reid et al. 1995; Cruz & Reid 2002) which are present in the wavelength range covered by our AAOmega observations. As an additional check we also compared all the spectral indices of the young M3–M6 dwarfs members of the Chamaeleon region (Luhman & Steeghs 2004; Cruz & Reid 2002) which are present in the wavelength range covered by our AAOmega observations. We estimated the uncertainties in our position and flux measurements to be ±7% based on the dispersion seen in the radial velocities determined from each of the four unstacked spectra of a subsample of the candidates. We verified their internal accuracy by using the IRAF FXCOR routine to estimate the radial velocities of each targets with respect to 2MASS J10430236−6402132, the brightest object in our sample. We found a broad peak in the distribution of radial velocity measurements centered around 15 km s⁻¹. This likely corresponds to the cluster population. We chose to select as radial velocity members those objects which lie within 2σ of the mean radial velocity. Since our spectroscopic investigation unearthed a total of 14 M4/M5 dwarfs, we found that 12 objects to the field population remaining sample contained a significant excess (10) of these strong Ha emitting objects. Many of these objects were found to lie on a relatively tight sequence in the I−J, colour−magnitude diagram, bracketed by 2MASS J10420832−6356228 which has J=14.30 ± 0.03 mag (KS=13.17 ± 0.04 mag). The bright Li rich star with a possible, but not confirmed, membership in our cluster which was found to be consistent with the single star sequence defined by the other members is 2MASS J10432826−6402132 which has J=14.25±0.05 mag (KS=13.30±0.04 mag). Following Manzi et al. (2008), we selected on the basis of the photometry of these two objects we concluded that the LDB of IC2602 lies within the range J=14.01–14.30 mag (KR=13.13–13.34 mag), allowing for the uncertainties in the 2MASS photometry. Spectroscopy around the 6708 Å line for the four objects closest to either side of the LDB is shown in Figure 3.

We used the derived M and Mg, magnitudes of the LDB and the LDB and the theoretical near-IR photometry of Baraffe et al. (1998) to estimate the age of the cluster. We adopted absolute magnitudes we adopted a distance modulus of (m−M) = 5.86±0.1, which is based on the most recent Hipparcos parallaxes and is consistent with the majority of other distance estimates in the literature (Whitehurst 1941, Braes 1961; Righeroni et al. 1999, van Leeuwen 2009). We assumed reddening of A(J)=0.03 and A(K)=0.01 based on E(B−V)=0.035 (Hill & Perry 1949) and A(J)/E(B−V)=0.84 and A(K)/E(B−V)=0.36 ( Fitzpatrick 1999). We also considered the finite depth of the cluster since it is effectively a further uncertainty on the distance to each individual member. We estimated that most low mass stars should lie within 4 pc of the cluster centre which corresponds to ±0.06 on the distance modulus of individual members. Adding the uncertainties in quadrature we found that the LDB of IC2602 occurs within the range M7±0.83–0.69 mag and M7±0.77–7.56 mag. These were compared to the theoretical predictions for the Lyon group (Chabrier & Baraffe 1997, Chabrier et al. 1998) for M and K, as a function of age, at which 99% of stars primordial Li has been burned (Figure 4). Based on these
In contrast, Kharchenko et al. (2005) overshoot (Maeder & Mermilliod 1981). The MSTO age of IC2602 is greater by a factor 1.3 than the MSTO age obtained by comparing the position in photometric bands we determined the age of IC2602 to be 46(±6)/-5 Myr. This is consistent with adopting the primary mirror diameter (D) to powers greater than unity (iso-called D’ science). However, it can dominate wide field and survey astronomy (so-called AD science), because the other ELTs are not making use of the full field of view delivered by the telescope. 

Enhanced functionality: MANIFEST offers GMT spectrographs a wide range of enhanced functionality: (1) increased fields of view; (2) multiple deployable IFUs; (3) increased resolution via image-slicing; (4) efficient detector packing, both spectrally and spatially; (5) efficiency gains from working at VPH super-blaze angles; (6) simultaneous observations of multiple fibre feeds; (7) gravity-invariant spectrograph mounting; and (8) OH suppression in the NIR. Enhanced functionality dominates wide field and simultaneous observations of multiple fibre feed IFUs. 

Versatility: The MANIFEST concept increases the versatility of GMT by embodying three prime principles: (1) selectability: instruments can work either in their native mode or with fibre feeds that reformat the focal plane in a variety of native mode or with fibre feeds that in the NIR. Capabilities such as the instrument suite. 

The AAO is proposing a concept for the Giant Magellan Telescope’s Facility Multi-Object Fibre System called MANIFEST. It is a fibre-fed system for GMT that offers access to larger fields of view, higher multiplex gain, versatile reconfigurable field coverage, efficient detector packing, both spectrally and spatially, and increased resolution enable entirely new science with GMT: other functionality offers efficiency gains ranging from incremental (e.g. efficient detector packing and working at the super-blaze angle), to substantial (increased fields of view and simultaneous observations), to transformative (multi-IFUs and OH suppression).

World-leading capabilities: MANIFEST is not only a major force multiplier for GMT instruments and science; it also provides GMT with world-leading capabilities compared to the other ELTs. Although GMT is the ELT with the smallest aperture (A), it has the equal-largest field of view (Ω). It cannot beat the other ELTs at science where the figures of merit are the primary mirror diameter (D) to powers greater than unity (iso-called D’ science). However, it can dominate wide field and survey astronomy (so-called AD science), because the other ELTs are not making use of the full field of view delivered by the telescope.

The AAO has now completed the MANIFEST Feasibility Study for GMT and is currently carrying out a targeted R&D program while awaiting the outcome of the selection process for the GMT first-light instrument, a decision which is expected early in 2012.
A Voyage Through FOG
Kevin A. Pimbblet (Monash University)

Filaments of Galaxies (FOGs) have long been known about in the literature and discussed with a variety of mixed nomenclature (e.g., Walls, Filaments), a famous early example being the Cia Great Wall (Geller & Huchra 1989) and more recently the Sloan Great Wall (Gott et al. 2005; Pimbblet et al. 2011). Over recent years, there has been increased interest in FOGs from the ready availability of large-volume redshift surveys N-body simulations (see Pimbblet 2005 for a general discussion).

My own interest in FOGs began during my PhD when I was undertaking observations of rich galaxy clusters using a new spectrograph that was called 2dF (e.g., Pimbblet et al. 2001). Fig. 1 displays a plot of one of these clusters (Abell 22). Pimbblet et al. 2000) where in front of the cluster (z~0.14), there appears to be coherent ‘wall’ of galaxies in RA at lower redshift (z~0.11). This is clearly not the same mass regime or physical dimensions as the classic Great Wall from Cia. However, we find that it appears to connect up a set of distant galaxy cluster pairs together in non-trivial manner (Pimbblet et al. 2005). This opened up a large number of questions that included (but were not limited to): what role filaments have in the growth of clusters that they inter-connect? What effect do FOGs have on the evolution of galaxies contained therein? Can they be used as a cosmological probe to test theories of structure formation?

Using the final data release of the 2dF Galaxy Redshift Survey (Colless et al. 2001) coupled with a knowledge to the location of the galaxy clusters contained therein (De Propris et al. 2002), we undertook a systematic search for inter-cluster filaments (Pimbblet et al. 2004; PDH). PDH extracted all possible combinations of pairs of clusters within 10 degrees and Δz<1000 km/s of each other. This generated a sample of 805 unique inter-cluster areas which were visually inspected for the presence of FOGs. Each filament that was confirmed in this manner was also given a morphological classification (straight, curved, wall or sheet-like, complex) and a length (explicitly, the inter-cluster axis regardless of morphology) was computed.

The relative fractions of morphological types are found to be entirely consistent with predictions from models (Colberg et al. 2005). However, the length of the filaments can stretch from 10 kms, to sometimes hundreds of Mpc which could pose a problem for models (cf. Yarurys et al. 2011).

If galaxies spend a lot of their lifespan inside FOGs, flowing toward clusters (see Pimbblet 2005), then presumably there could be some evolutionary pre-processing occurring inside FOGs before they ever encounter the hostile high-density cluster core regions. We know from Lewis et al. (2002) and Gomez et al. (2003) star formation suppression starts to occur on a mass scale of galaxy groups. However those studies considered a radially averaged (or density averaged) star formation rate. Hence the detail of what happens to galaxies inside filaments is lost in the averaging process. If we consider the star-formation rate as a function of distance away from a galaxy cluster, but only along a FOG vector, we find a result that was not seen in the previous analyses: a small blip (star burst) in star formation rate at a few Mpc away from cluster centres (Porter et al. 2006). We hypothesize that this starburst is caused by first time harassment.

FOGs should also contain most of the mass of the Universe (Gao & Ostriker 1999; Aragon-Calvo et al. 2010). Using archival data and a knowledge of where FOGs reside (i.e. PDH), we searched for X-ray emission from filaments and through a stacking process (carefully avoiding known contaminants such as other galaxy clusters) we determined an estimate for the electron density inside FOGs at z~0.1. n_e = (4.7 ± 0.2) x 10^18 cm^-3[1] (Fraser-McKelvie et al. 2011). This is, perhaps, a higher than expected density and may reflect the stacking & background subtraction process and/or the modelling of the X-ray count rate. Future work with new satellites such as Suzaku should clarify this preliminary estimate.

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Are You Biased?
Sarah Brough (AAO), Tanya Hill (Melbourne Planetarium), Amanda E. Bauer (AAO), Andrew Hopkins (AAO), Sarah Maddison (Swinburne University)

Are you biased? We ask you to choose one of the doors - one full of blokes who are full of wine, and the other full of ladies who are full of wine.

![Figure 1: Wedge plots of right ascension and declination versus redshift in the direction of Abell 22. The X-ray centre of the cluster is located at α = 6° 0. Note the ensemble of galaxies in the foreground of the cluster. Although one may expect this plot to exhibit a `finger of god’ effect for the cluster, arising from the distorting effects in redshift space, this is not seen, as the elongation in redshift space of the cluster is small in comparison to the depth of redshift space covered.](image1.png)

If you feel ostracised by these comments — well that’s the point isn’t it? It’s a basic human desire to feel like we belong. But can you recognise your unconscious bias? Do you know how this affects your interactions with people, especially in the workplace?

This article follows from a recent ‘Women in Astronomy’ workshop organised by the Women in Astronomy Chapter of the Astronomical Society of Australia (ASA) and sponsored by the AAO, as well as the Centre for All-sky Astrophysics (CASS) and CSIRO Space Science and Engineering (CSS). The aim of the workshop was to investigate why many women leave astronomy at the mid-career level but the condition does not cease to exist.

Science HIGHLIGHTS

1 This article is based on the Women in Astronomy Workshop 2011 Report, available at http://asawomeninastronomy.org/meetings/wia2011/
We all find it easier to work with people with whom we have something in common. On this basic level, a male manager (and he’s in the majority) might choose to give a big job to a younger male colleague because he remembers the conversation they had after a meeting about a shared interest in footy, for example. Recognising that you might have a tendency do this is a good start. Then try giving 50% of the time to go outside your comfort sphere and offer the job to someone else, who might be just as deserving but not having an obvious common interest, will impact positively not only on the diversity of people working in astronomy, but the happiness of those people. Everyone wants to be valued.

It is not clear whether the lack of women in committees, in invited talks, and appointment panels is forgetfulness or unconscious bias, but it certainly does not help address the problem of diversity. Not only do these people make decisions, but it certainly does not help address the problem of diversity.

We need to think carefully about ensuring the availability of childcare close to work and at professional meetings, especially national meetings. The closer/easier the childcare, the more researchers will return to work quicker and happier. Childcare at professional meetings means that more primary caregivers can participate in those meetings; they may not have been able to attend otherwise.

As we continue to peer-review each other’s grant, award or job applications, we need to actively take into account career breaks (of all varieties), and non-100% research roles, when taking responsibility for such judgments. Also, in assessing candidates for job/grant applications, we should be asking for recent years of publications, rather than previous N years, to account for those career breaks.

Amazing researchers even in recent times have had to ‘hide’ the fact that they have kids, have taken time off, or that they work part-time, all to compete. For researchers of this generation, our challenge is to make all these normal and open to acceptance. Not hidden away.

Imposter syndrome

Despite external evidence of their competence, individuals with imposter syndrome remain convinced that they are frauds and do not deserve the success they have achieved. Proof of personal success is dismissed as luck, timing, or as a result of deceiving others into thinking they are more intelligent and competent than they believe themselves to be. Impostor syndrome affects everyone. As individuals we need to face this, stand up to it and then be empowered by overcoming it! Managers need to be aware that their staff may suffer from this and that they can help! For whatever reason, some people need a champion to help them apply for jobs, promotions, or to ask a question in a meeting. A good manager can do this but additional mentoring is crucial. Having a senior member of the community (male or female) providing advice and encouragement is vital no matter what career stage you are at. Whilst we enjoy our varied careers, we need to accept the differences our colleagues bring to the table and use our understanding of the positive benefits of such diversity to help us work together. Which is really what this article is all about - creating environments where we all feel we belong, can contribute and will be respected.

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Proposal Statistics
For Semester 2011B ATAC received a total of 34 Gemini proposals, of which 21 were for time on Gemini North, 4 were for exchange time on Keck or Subaru, and 9 were for time on Gemini South. The overall oversubscription (1.81) was up on 2010A, although Gemini South was barely oversubscribed. At the ITAC meeting Australia was able to schedule 24 programs into Bands 1–3 (half of which involved joint allocations with other Gemini partners), and one more in the expanded Poor Weather Queue. For Magellan we received 12 proposals, resulting in the highest Magellan oversubscription ever of 4.86, due in part to the availability of the new wide-field near-IR camera FourStar.

In 2010B, all but one of the seven Band 1 programs were completed or had insufficient Target of Opportunity (ToO) triggers; 4 of 6 Band 2 programs got 90% or more of their data or did not trigger ToOs; while no Band 3 programs were even started. While Australia used barely half its allocated time in 2010B, nearly 80% of that time went to programs that were completed.

Magellan and Gemini travel fund
The ANSTO-administered Access to Major Research Facilities Program (AMRFP), which has supported travel to overseas observatories for a number of years finished in June 2011. AusGO and AAL approached DISA with a request to use some uncommitted travel funds from the National Collaborative Research Infrastructure Strategy (NCRIS) to cover Magellan observer travel in Semester 2011B, which DISA approved as a one-off gesture and not a precedent. However with NCRIS itself also finishing in 2011, the AAO and AAL are actively exploring options to ensure that users who are fortunate to be awarded a significant block of time on Magellan, Gemini, or Gemini exchange time on Subaru or Keck are actually able to take up that opportunity.

GeMS First Light
The Gemini Multi-Conjugate Adaptive Optics System (GeMS) consisting of the Canopus optical bench; a 50 W laser to produce a “constellation” of 5 laser guide stars over an 85” field; and the RASA-built Gemini South Adaptive Optics Imager (GSAOI) has been undergoing commissioning in 5 night blocks each month throughout Semester 2011A.

While initial results are promising, much work remains to be done to tune the full system and the many control loops which must operate to correct for atmospheric turbulence across the full field of view (unlike ALTAIR on Gemini North, for which the correction deteriorates going radially outward from the natural or laser guide star). The image shown here is an “engineering first light” image from GeMS taken on 19 April 2011 and demonstrates that already the system can deliver remarkably uniform images across most of the GSAOI field. A call for System Verification observations with GeMS is likely to be issued during Semester 2012B.

GeMS first light image

Figure 1: “First light” image obtained with GeMS and GSAOI on Gemini South at a wavelength of 2.12 microns. Strehl ratio and full-width at half-maximum values for all stars are shown in the insets. The poorer image quality on the left edge is expected, as these stars are outside the constellation defined by the three bright stars in the right half used to provide the tip-tilt correction.

Gemini High-resolution Optical Spectrograph
On 6 May 2011, the Gemini Observatory issued a Request for Proposals for Conceptual Design Studies for a Gemini High-resolution Optical Spectrograph (GHOS). A team led by Dr Michael Ireland from AAO/Macquarie University with involvement from AAO and RASA, as well as KeiStar Optics in New Zealand has submitted a bid for a concept design study, building upon the AAO’s experience with the CYCLOPS image slicer and fibre-feed for UCLES, as well as HERMES and the multi-object fibre positioner MANIFEST for GMT.

NIRI Replacement
With the commencement of the GHOS procurement, the Gemini Science Committee (GSC) is now turning its attention to the next Gemini instrument. With concern growing about the reliability of NIRI, the GSC asked all National Gemini Offices to poll their user communities on their future needs and desired capabilities for near-infrared imaging on Gemini North. AusGO ran a survey for the Australian community, with results forwarded to the GSC on 8 June. Our findings were that: (a) only 20% support an L’ & M band capability for a replacement instrument; (b) two-thirds see no need for a spectroscopic or other additional modes in any replacement; (c) about half plan to use NIRI in “wide-field” (2’) or Adaptive Optics mode in coming years; (d) 87% are fully or mostly satisfied with current NIRI performance; and (e) about half feel that NICI could substitute for NIRI if needed be.

Gemini Town Hall meeting
As part of the Gemini Observatory’s effort to engage with their user community on a regular basis, Associate Director for Operations Dr Andy Adamson followed up his visit to Australia last September with a Gemini “Town Hall” meeting held in conjunction with the ASA ASM in Adelaide. He provided an update on the status of the Gemini Observatory, including recent changes in management and a review of developments in the “transition plan” for the observatory as they move into the final year of UK membership. The instrument development program was also reviewed, followed by a Q&A session afterwards.

Observational Techniques workshop
From 30 Aug-2 Sep 2011 the AusGO and AAT Science Workgroups will run an optical/IR observational techniques workshop in Sydney. This is the first time such a workshop has been run by the AAO for a decade; the early level of interest in attendance by students and even postdocs highlights that such a workshop is long overdue. Presentations on all aspects of imaging, photometry, and spectroscopy available on the wide variety of instrumentation offered on the AAT, Gemini, and Magellan will be given primarily by AAO and Gemini Observatory staff, together with data reduction tutorials. Details of the workshop are available at [http://www.aao.gov.au/AAO/ AusGO: AAO Workshop/].

Gemini e-newscast
To help stay in touch with recent developments, announcements, and news releases, why not subscribe to Gemini’s e-newscast service? To subscribe to the list, send a message to listserver@gemini.edu with a subject of “subscribe Gemini-eNewscast” (without the quotation marks). Previous issues can be accessed at [http://www.gemini. edu/enewscast/].
Supernovae and their Host Galaxies

Sydney, Australia, 20-24 June 2011

Chris Lidman (AAO)

During a marvellously sunny week at the end of June (as can be verified by the group photo), 150 astronomers from all parts of the world came to Sydney to talk about supernovae and their host galaxies. The week long conference was held at the Australian National Maritime Museum in Darling Harbour, and was the fourth conference in the Southern Cross Astrophysics Conference Series, which is jointly sponsored and organised by the AAO and CASS.

The conference started with a public talk given by Prof. Robert Kirshner at the Powerhouse Museum. Prof. Kirshner captivated the audience with his description how astronomers uncovered what is now considered one of the biggest unsolved mysteries of physics - the reason why the expansion of the Universe is accelerating. His talk also reminded some of us that doing science is fun.

A wide range of topics were covered at the conference: from the progenitors of core-collapse and thermonuclear supernovae to the influence that supernovae have on the properties of their hosts and via versa. Of special interest to the author of these lines are the new types of supernovae being discovered by the current wide-field transient surveys. We also heard about future new surveys for transients, including surveys for transients at radio wavelengths. There was also a special session on SN 2011dh, a supernova that was discovered in the Whirlpool Galaxy (M51) just a couple of weeks before the start of the conference.

Even though the scientific program was very active, there was time for social activities. Brian Schmidt hosted a wine tasting event at the Museum, where we were able to sample a range of wines, including one of his own, from Australia and New Zealand, we got to see Saturn through telescopes at the Sydney Observatory that were probably older than any of the participants, and we enjoyed some nice views and nice food at the conference dinner at Doltone House.

The conference would not have been possible without the dedicated work of the local and scientific organising committees, the members of which are listed below, and to the many people who helped at the conference: Robert Barone-Nugent, Erica Rosenblum, Philippa Morley, Janine Myszka, Stacey-Jo Dyas, Billy Robbins, Kitty Lo, Jason Spyromilio, and Amanda Bauer. On behalf of the participants, I thank all of you. A very special word of thanks goes out to Brian Schmidt for the great work that they did before, during and after the conference.

The Scientist Meets Parliament

Sarah Brough (AAO)

I was invited to attend the 2011 Science Meets Parliament in Canberra in June this year as the representative of the Astronomical Society of Australia (ASA), along with several other astronomers from around Australia. The event is organised by Science & Technology Australia (formerly the Federation of Australian Scientific and Technological Societies; FASTS) to give scientists the opportunity to meet Federal politicians and discuss science issues with them. In preparation for that meeting we had also a day of training in communicating science to the media, general public and politicians.

The event started with the launch of the Respect the Science campaign to explain to the general public how the scientific and peer review processes weight information from scientists, and to make sure that these words have not gone through those processes. Followed by a presentation on the current political climate, informing us that it is very, very local, and very hard to get a mention in between the current ‘BIG’ issues.

We had a ‘Meet the Press’ session with political reporters from the parliamentary press gallery helping us understand how to get our science into the general media. Some of the messages I took away were, if you do have an interesting press release, send it out before the release day to a targeted journalist so that they have the hint of exclusivity as that will help you get coverage. Also that pictures are appreciated, as well as, if possible, case studies to humanise the story (although I’m not sure this is applicable to astronomy).

After lunch each person prepared and presented a 45s piece on our research (in less than the time it takes a sparkler to burn). This turned out to be a very valuable exercise prior to our meeting the politician on the second day.

In the afternoon we had presentations on how to convey our message to politicians. We were informed to leave plenty of time for small talk, to be able to think up good stories with our science, and come up with verbal pictures to connect large numbers to reality, to go in have a conversation in their language (emphasising what is important to them) and form a relationship.

We were advised not to lecture, information dump, whinge about funding, offer mixed messages or have nothing to say. Also that we should be careful about how uncertainty is communicated, as ‘almost certain’ is not really understood. It was emphasised that preparation on our part is key - to research our assigned minister and their interests - and that ‘what excites a teenager will excite a parliamentarian’.

The end of Day 1 was the dinner in Parliament House. Sadly several politicians were unable to attend so there was no parliamentarian at our table. Over dinner Former Victorian Premier John Brumby, gave an overview of science funding during his years in the Victorian Labor government. Followed by FASTS President Cathy Foley introducing the Respect the Science video and the new name for FASTS: Science & Technology, Australia.

The second day started early with a breakfast briefing on the Excellence in Research for Australia (ERA) process from Professor Margaret Sheil, CEO of the Australian Research Council. It was interesting to hear the reasoning for having the ERA process, the acknowledgement that the choice of assessment metric (process behaviour) has to be thought through, as well as some of the outcomes and the improvements that are being implemented for the next round in 2012.

Following the breakfast briefing the imminent closure of Canberra airport due to the Chilean volcanic ash cloud caused a brief hiatus as everyone tried to make new arrangements for travel and accommodation.

Our second presentation of the day was from Senator Kim Carr, the Minister for Innovation, Industry, Science and Research. He gave a very good, impassioned speech about the value of science - evidence based policy and the new ‘Respect the Science’ campaign.

We were fortunate to be able to attend new Chief Scientist Professor Ian Chubb’s first National Press Club Address. This was fascinating, as well as being the best meal of the two days. Professor Chubb reiterated the Respect the Science campaign and peer review process message that underpinned this meeting. He also showed his experience in expertly handling questions from journalists. It is clear that he will take the science agenda to parliament.

From the Press Club we sat in the Public Gallery of the National House of Representatives to watch Question Time. This was also fascinating with The Speaker of the House introducing the Science Meets Parliament delegates to the House, resulting in a wave from Prime Minister Julia Gillard (we all waved back).

My meeting with Senator Chris Evans, Minister for Tertiary Education, Skills, Jobs and Workplace Relations, was scheduled shortly after the formal end of the day. John O’Byrne (University of Sydney), two other scientists and I went to meet the Senator. As he was still speaking in the Senate we ended up meeting with one of his advisors, Andrew Dempster. Luckily I was well-prepared by the previous day’s presentations and I spoke quickly on the value of Square Kilometre Array (SKA) to enhance such issues in science, jobs and technological skills with processing of such huge quantities of data. I was impressed by Mr Dempster’s awareness of the SKA.

I greatly enjoyed myself at Science Meets Parliament and found meeting so many other scientists very valuable. I would like to thank the ASA for sponsoring me to attend and Science & Technology Australia for organising the event. I would definitely recommend it to anyone interested in science communication or the parliamentary process.
Two members of AAO staff have won annual prizes announced by the Astronomical Society of Australia (ASA) in recognition of outstanding research. Gayandhi De Silva has won the Louise Webster prize. This prize is awarded for outstanding research by a scientist early in their career. Gayandhi’s award was based on the research she published establishing the viability of the chemical tagging technique and setting the stage for the field of Galactic Archaeology. Detailed chemical abundance patterns of stars offer the possibility to reconstruct some components of the protogalactic disk and so improve our understanding of the Galactic disk formation process. Star-forming aggregates can preserve unique chemical signatures within their members, with our use this signature to tag dispersed individual stars to a common formation site. This is the concept of chemical tagging.

De Silva et al. 2007 (AJ, 133, 494) was the first to demonstrate the viability of the chemical tagging technique. Using MOCRE/AAT data they derived abundances for elements of various nuclessynthesis origins for stars in the HR 164 moving group. They covered these dispersed stars were metal rich with [Fe/H] 0.25 dex; and that the star-to-star abundance dispersion was less than 0.03 dex across all elements. This was the first time that stars which are physically associated were not located all over the sky, we found to have near identical abundances and kinematics. Hence this was the first demonstration of an ancient relic star forming event in the disk and paved the way for large scale applications of the chemical tagging technique.

Max Spolaor has won the Charlene Whittard prize. This prize is awarded for the most outstanding PhD thesis in astronomy by a closely related field, and accepted by an Australian university. The thesis research must show outstanding excellence and originality. Max’s thesis produced important results relating the metallicity gradient and host galaxy mass for early-type galaxies. At least 5 first-author refereed publications resulted directly from his thesis, which was also awarded an internal prize for best PhD thesis at Swinburne University. We congratulate them both!

Sarah Brough (AAO)

AUGUST 2011

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Sarah Brough (AAO)
It was to amateur astronomy that Tom really devoted himself. His loves were close to home - the Sun in particular and the planets, and variable stars. None of this cosmology rubbish (science fiction he called it) - you had to understand the stars before you could understand galaxies and the rest of the universe.

Tom was one of the growing band of amateur scientists, making contributions to astronomy through his own personal observations. From 1944 - at the age of about 17 to put it in perspective - he started making drawings of the Sun. He carried on his daily solar drawings for most of the rest of his life - including taking his telescope on holidays so that he didn’t miss out. Hundreds of drawings in all. I remember him occasionally photocopying drawings to mail back to the observers at Mt Wilson when they had extended cloudy periods - “just so they knew what was happening on the Sun.”

At the same time he started his regular solar observations, he started making variable star observations. Long before the days of computer controlled telescopes a very detailed knowledge of the sky was required to locate the star to be observed. The comparison was then done by eye, judging the difference in brightness between the variable and reference field stars. Good observers, like Tom, could do this with almost photometric precision. Exacting work. You then went to the next star in your list. Tom could do perhaps 20 an hour on a good night, although sometimes the going was much slower. He did this for several hours every clear night. For many nights a year. For many years. He amassed well over 160,000 variable star observations in his life.

Earlier last year, Doug Gray made a wager with another staff member, (who wants to remain anonymous) that if the unnamed staff member could go without a cigarette for 12 months, then Doug would have to cycle up the mountain. Doug did manage to cycle up the mountain earlier this year and then collapsing in a heap on the ground floor after his accomplishment.

For his dedication he was given many awards and accolades by his peers, but perhaps the most long-lived recognition was that a celestial body was named after him. On his retirement from the AAT, Rob McNaught named asteroid number 5068 (originally designated as 1990TC) as Dragg.

You might think from this that Tom was only interested in astronomy. Far from it. Amongst his other interests were music, war history and playing war games when he could, plus chess and bridge. He was a founding member of the local astronomical society, as well as a regular player the bridge club and chess clubs in Coonabarabran (when there was one) and in Gunnedah. He played flute with the town orchestra, as well as occasionally accompanying Mary who plays harp.

Tom’s funeral at the Coonabarabran Native Grove Cemetery was held on a pleasant sunny day in May and was attended by wide variety of people, many of whom had met him since his retirement and were surprised to learn of his interest in astronomy.

I shared an office with Tom for most of the 14 years he was at the AAT. We shared an interest in astronomy, and I was always fascinated when he would tell stories of the astronomers he’d worked with, the telescopes he’d used and things he’d seen. He was a gentleman, always polite and thinking of others, very generous with both his time and toys (letting me come and use his telescope when he was away) and wonderfully keen and dedicated to astronomy. Astronomy has lost a great observer and recorder of the sky with his passing. <br/><br/>---

**Letter from Coona**

Katrina Harley (AAO)

Well it has been a very busy couple of months at site, with many attending training courses for First Aid and Heights Rescue. In early May the fire team on the mountain conducted burn-offs around the mountain top. Members of the fire team thought it was great experience for the team, and they were very happy with the outcome of the burn.

In February, Tim Connors left sunny Coonabarabran for Melbourne. Tim is now working for the Bureau of Meteorology. Imogen Cosier joined us in April from Canberra. Imogen is the new IT Support Officer at site, and has settled in well and enjoying Coona life.

In June, the RAVE Workshop was held over two days in Coonabarabran, with reports from many stating it was a very successful and enjoyable meeting. The Acacia Motor Lodge did an excellent job accommodating all of the RAVErs. Many attendees of the workshop travelled back to Vaucluse, to attend a cocktail reception at the residence of the German Consul General.

Ending on a high, during the refurbishment of the lifts at the AAT, the OTIS Contractors found a small Black-Headed Python, along with bones of other little critters, in the visitor’s lift well. Once the python was rescued from the lift well, it was released back in the bush - one very lucky python. <br/>
ABOVE: Dragonfly is an optical stellar interferometer taking a revolutionary approach to the design of such instrumentation. This is the power spectrum of the fringes detected from Antares during the Dragonfly commissioning run. Dragonfly is described further on page 7.