AAO OBSERVER

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HERMES shipped

New AAO Director | Wambelong Fire: Before and After | Growth of BCGs

Director's message

Warrick Couch

Having been associated with the AAO for more than 30 years as both one of its employees and a user of its telescopes, I feel very honoured to now being making this appearance on page 3 of the newsletter, with the responsibility of providing the Director's message. Moreover, I realize I have a very hard act to follow, given the outstanding calibre of my immediate predecessor, Matthew Colless, as well as his predecessors (Brian Boyle, Russell Cannon, Don Morton, and Joe Wampler). I feel very fortunate to have worked closely with Matthew during his time as AAO Director, in my roles as Chair of the AAT Board and then Chair of the AAO Advisory Committee, and I look forward to continuing to do so in his new role as RSAA Director at ANU, where there are many areas the AAO and ANU can both benefit by working closely together (e.g. on instrumentation projects and SSO operations).

As readers will be well aware from the last issue of the *AAO Observer*, the time between this most recent change of directors was a very eventful and challenging period for the AAO. Just days after I had accepted the job, I wondered if there would be any telescopes left for me to direct, with a massive bushfire overrunning SSO on 13 January. Anyone who knows SSO and the surrounding Warrumbungle National Park area well, and has visited it since the fires, cannot help but be overawed by the massive and widespread loss of vegetation and property, including the ANU Lodge and Director's cottage adjacent to the AAT. The Warrumbungles seem to have taken on a whole new character and appearance, with rocky outcrops and other geological features that had never been seen before now rendered visible, and the ghostly appearance of hectare upon hectare of gum trees stripped bare of their leaves, but their pale bark left intact. That none of the telescopes on Siding Spring Mountain were seriously damaged would seem a miracle, and the fact that the AAT was back in full operation just a month after the fires speaks volumes for the dedication and massive recovery effort put in by all the AAO and ANU staff at SSO. Furthermore, in coming into the job 3 months later, I have been struck by what an outstanding job Andrew Hopkins did as Acting Director,

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The major galaxies of Lyon Galaxy Group #455 were captured in the winning image from the 2012 Gemini School Astronomy Contest. Ryan Soares, a Year 11 student from Perth's Trinity College, suggested obtaining a mosaic of LGG 455 in his winning contest entry. Gemini South's GMOS instrument obtained the data for the three spiral galaxies: NGC 7232 (lower right), NGC 7232B (top), and NGC 7233 (centre). The colour-composite was created from images in three filters: g (blue), r (green), and i (red).

Credit: Ryan Soares (Trinity College), Travis Rector (U. Alaska Anchorage), and the Australian Gemini Office.

both in skillfully negotiating the bushfire crisis and returning the AAO to 'business as usual' mode in a very short period.

In looking to the future in my new job, there are many challenges as well as many exciting opportunities to look forward to. At a personal level, there is a massive adjustment that I need to make in moving from the university sector into the Australian public service. This will continue to be a work in progress for sometime! In terms of the AAO, I have an excellent platform to start from by way of a well-oiled organization with excellent staff, and a clear plan in place – the *AAO Forward Look*, which sets out the AAO's key priorities through until 2015/16. Importantly, it was developed by my predecessor in consultation with the Australian astronomy community, and is aligned with its Decadal Plan. The full implementation of this *Forward Look* is therefore one of my highest priorities.

One of the biggest challenges currently facing Australian optical astronomy (and hence the AAO) on the 2015/16 time-scale is the future of its national 8m access. At the moment, the current arrangements involving membership of Gemini and the purchase of nights on the Magellan telescopes are funded only through until the end of 2015. Furthermore, in the mid-term review of its Decadal Plan, the Australian astronomy community identified membership of ESO as its highest priority for, amongst other things, providing 8m access in the longer term. Since becoming Director, it has been gratifying for me to learn that this 8m access issue is well recognized within our Department, and to have the opportunity to work with colleagues there (as well as fellow members of the AAL Board) on identifying the best pathway forward. Whatever that pathway turns out to be, there is bound to be change in the ways and means by which our community accesses and uses 8m telescopes – for example, the move to remote classical observing and eavesdropping, the use of 'visitor' instruments – and as such the AAO has to diversify and adapt in supporting this use, which is one of its primary functions. Hence my intention is to bring the AAO's 8m support activities (AusGO, Magellan, plus other 8m facilities of the future) under a single *International Telescope Support Office* that will be appropriately resourced to continue providing a very high standard of support, no matter what Australia's 8m future is.

One of the great attractions in being Director of the AAO is the organization's world-class and well-resourced instrumentation construction and R&D groups. At this point in time I see them having two key roles: to provide innovative new instruments for the AAT and UKST to keep them competitive into the next decade, and to exploit the cutting-edge capabilities they have developed (e.g. fibre positioner systems) to leverage scientific and instrument-building opportunities on current and future international telescopes. The latter is clearly an important 'playing card' in providing Australia further access options to 8m telescopes. Consistent with the great importance I place on fully implementing the *AAO Forward Look*, the highest priorities right now for the AAT are the successful commissioning of the new high-resolution HERMES spectrograph and the KOALA IFU for AAOmega by the end of this year, and for the UKST a complete upgrade of its drive and control systems, as well as construction of a completely new fibre positioner and spectrograph, in preparation for the TAIPAN Survey. On the international front, construction of the GHOS spectrograph for Gemini, continued development of the multi-fibre MANIFEST system for GMT (the 'starbug' positioner system which will be prototyped on the UKST), and participation in ESO's 4MOST and LBNL's Dark Energy Spectroscopic Instrument (DESI) projects, will be the AAO's front-line projects in the immediate term.

While the AAO is a very well-run organization, it is not immune from risks. One of these is the loss of key personnel through retirement, and here the AAO has been very fortunate to have had so many talented and dedicated staff who have been here for most of their working lifetimes. Just this week we have been reminded of this with the retirement of Helen Davies and Mick Kanonczuk. Helen, for example, has been at the AAO almost since its beginning, and indeed retires after 34 years of excellent service. Such retirements highlight the need for succession planning within the AAO, and this is something I plan to address.

The AAO also takes on significant financial risk with its various instrumentation projects, particularly given many of them are funded externally. With better long-range resource planning and forecasting processes in place so that the AAO can more quantitatively assess its capacity to take on new instrumentation opportunities as they arise, this risk can be mitigated, and this is something I also want to implement.

Finally, this message would be incomplete without mentioning the following two 'people' matters. Firstly, the AAO last week was announced winner of the Australian Human Resources Institute's "Gender Equity in the Workplace" Award. This is a great testament to the strong commitment of the AAO management to embracing and implementing gender equity policies within the organization. Secondly, as part of my plan to better resource and coordinate the AAO's outreach activities, I am very pleased to announce that Dr Amanda Bauer will be the AAO's new Outreach Coordinator. Amanda has already contributed enormously to raising the AAO's profile within the social media – her blog covering the SSO bushfire being one outstanding example – and we all look forward to her continuing to further develop such activities as well as coordinate all the other forms of outreach the AAO is involved in.

HERMES goes to the AAT: Results of the pre-shipment tests

Gayandhi de Silva, Jeroen Heijmans, Keith Shortridge and the HERMES team (AAO)

Fig 1: HERMES being wrapped up and ready to leave the Epping labs. Credit: Urs Klauser

In April 2013, after five truck loads and many car+minibus trips with sensitive equipment, the High Efficiency and Resolution Multi-Element Spectrograph (HERMES) was safely shipped from the AAO Epping labs to the AAT. Before this momentous milestone, the HERMES team put in much effort to carry out many pre-shipment tests to characterize the instrument performance. For this, almost all components of the instrument were aligned and connected, and in March 2013 the instrument's full functionality was checked...and it works!

The tests were carried out on the completed Blue, Green and Red channels. The Infrared channel, while structurally complete, was unable to be tested, as the VPH grating had not yet been received. The other channels used all the final components from collimator to detectors, and were controlled using the full control software to be deployed at the AAT. One of the limitations of these tests was that we used the test slit-body, whose specification is close to that of the final slit-body at the AAT. Further the fibre feed into HERMES consisted of 40 short fibres, in a single bundle, which was fed directly into calibration light sources or pointed at the Sun using a tripod. The actual 2df-HERMES fibre cable and final slit-body are already assembled at the telescope and await integration with the spectrograph.

The testing process ticked many boxes in all aspects from electronics performance and control software functionality to spectral resolution and solar abundance verification. The test exposures included Quartz flat field frames, ThXe arc lamp frames, and solar exposures in both the nominal and high-resolution mask mode. We summarise the findings in the sections below.

One of the major findings of these tests were astigmatism in the Green and Red VPH gratings, as they turned out to be bent, giving rise to different spectral and spatial focus values. This situation has been rectified at the time of writing this article, where repolishing of the two gratings has corrected the astigmatism and vendor tests provide positive reports of the transmitted wavefronts. We expect to receive these recoated gratings and the new IR grating shortly, in time for the first commissioning run later in 2013.

Resolution

HERMES is designed to operate in two resolution modes, where the higher resolution is achieved by placing a mask at the entrance slit. The measured resolution based on the FWHM of 14 spectral lines per fibre across the detector is shown in Figure 2 for the Blue channel for both the nominal and high-res mask modes. The measured values are close to the theoretical predicted model values and the expected average resolutions of R~28,000 and R~45000 in each mode are met.

These values were also confirmed using the obtained solar spectra by comparison against synthetic spectra. Accurate resolution values were not possible for the Green and Red channels due to the astigmatism issues faced at that time.

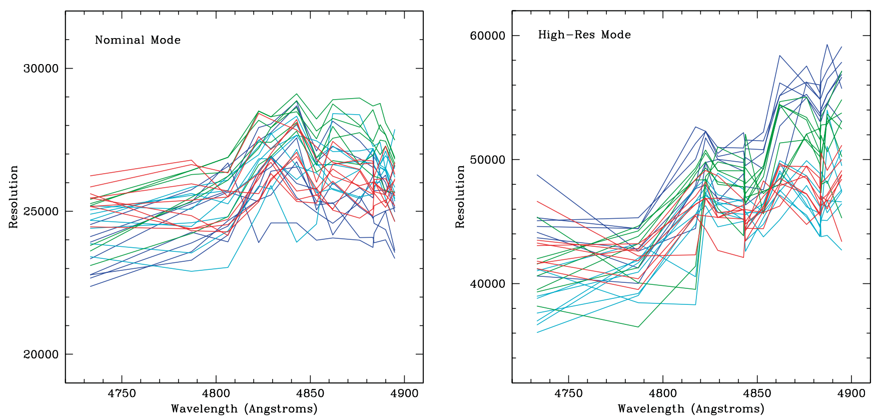

Fig 2: Measured resolution vs. wavelength for the nominal (left) and high-res mode (right). Each line represents a single fibre measurement and each colour represents a bundle of ten fibres, distributed from bottom to top of the detector.

Efficiency

The efficiencies were measured both for the spectrograph and the 2dF-HERMES fibre cable at the AAT with slit relay optics.

The measured efficiency of the fibre cable with slit relay optics is in good agreement with the expected efficiency. Figure 3 shows the relative throughput for about 50 fibres measured using a green laser at 500nm. The average throughput measured was 60-64% for the two plates with an rms of 8% across the measured fibres.

The results of the measured spectrograph efficiencies are shown in Figure 4 for the Blue, Green and Red channels. The measurements start at the slit image (after the relay optics) and go up to (but do not include) the detector. As predicted the Blue channel has the lowest efficiency.

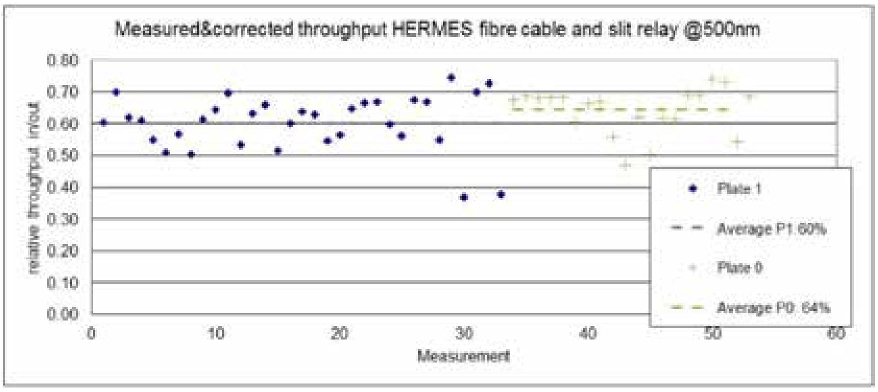

Fig 3: Measured relative throughput of the HERMES fibres including the slit relay optics.

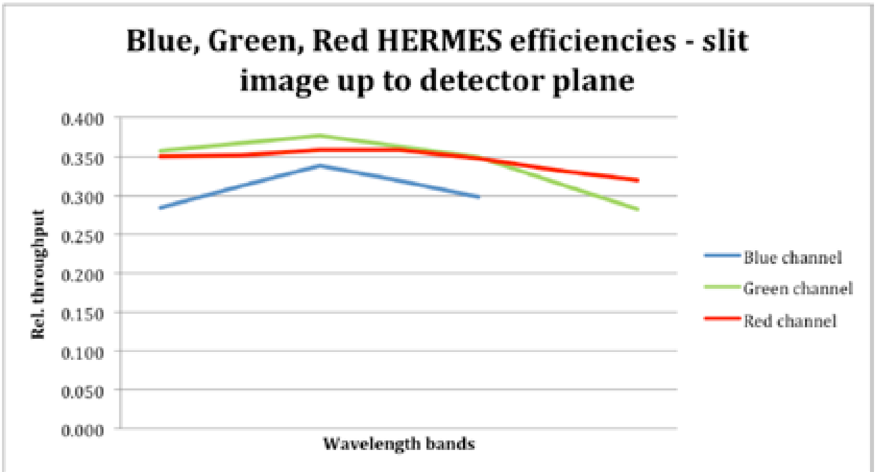

Fig 4: Measured relative throughput of the HERMES channels after relay optics up to the detectors.

Littrow ghost

The predicted Littrow ghosts were found and quantified (see Figure 5). The ghost images are small and faint due to the good anti-reflection properties of the gratings and detectors. Table 1 gives the measured relative brightness of the ghost compared to the total flux in the fibre that causes the ghost. The ghosts don't contaminate their originating spectra and fall spatially mirrored on the detector.

Table 1: Relative Brightness of the Littrow ghosts

Channel	Relative brightness
Blue	0.012%
Green	0.03%
Red	0.002%

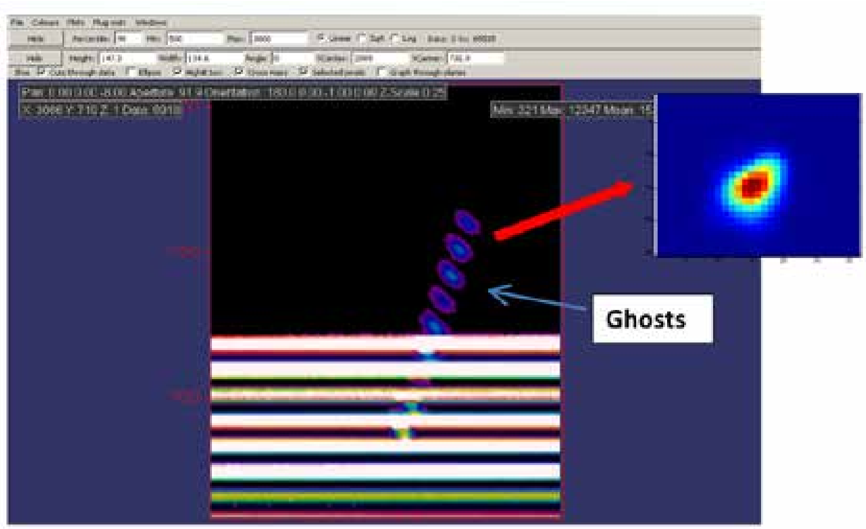

Fig 5: Test fibre Flat Field image showing the ghosts

Scattered light

During the March tests we investigated two types of scattering effects; the inter-fibre contamination where light from one fibre contaminates the neighbouring fibres (also referred as fibre crosstalk) and the background scattered light such as due to surface reflections and the light of the VPH 0^{th} and -1 order that scatters off the black walls and masks.

The measured inter-fibre scattered light is at a level, which allows us to reach a signal to noise of 100 when observing neighbouring fibres with stars of up to two magnitudes in difference with the existing optimal extraction method in the 2dfdr reduction software.

Regarding the background scattered light, the maximum measured levels were ~ 15 counts above the bias level in these 40 fibre test exposures. The Blue channel was found to have the highest background scattered light levels of the three measured channels. The most obvious scattered light effects are shown in Figure 6. Given the geometry of the instrument and the "openings" facing the Blue channel, this finding was expected. Note that at the time of these tests, the inside of the instrument was not yet painted black and therefore we expect this to be reduced even further when the painting is completed before commissioning.

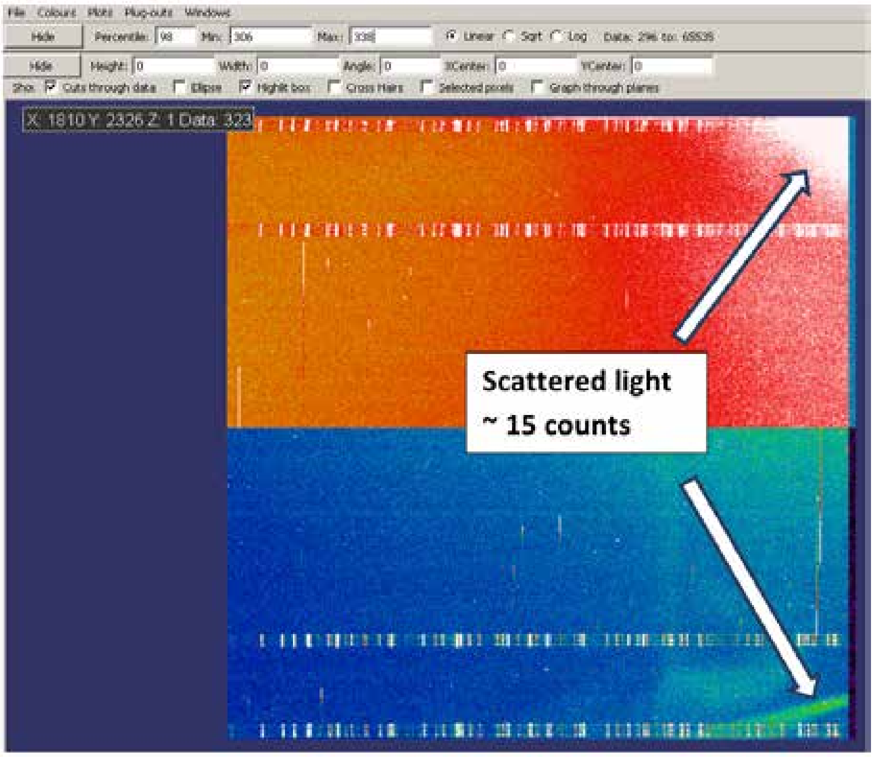

Fig 6: A test ThXe arc exposure with the Blue detector at nominal resolution using 2-amplifier read-out. The most prominent scattered light features are marked.

Analysis with the THEREMIN Pipeline

The HERMES test data were reduced using standard routines to debias, flat field, extract, wavelength calibrate and continuum normalise into 40 individual solar spectra in both nominal and high-res mode.

The reduced data were then analysed with the Theremin automated abundance analysis pipeline by Valentina D'Orazi (MQ/Monash). Figure 7 shows the derivation of the solar parameters using the Fe I, Fe II and Ti I, Ti II excitation and ionization equilibrium from the HERMES Blue channel nominal resolution spectra, with the other channels using the UVES spectra convolved to HERMES nominal resolution as input. The derived solar parameters are an effective temperature of 5780 K and log gravity of 4.45, and the derived metallicity is [Fe/H] = -0.04 and -0.01 for the nominal and high-res spectra respectively.

Figures 8 and 9 show the spectral synthesis of the Ti I line at 4759 angstroms with Theremin for the nominal and high-res spectra HERMES Blue channel data. The HERMES data are shown in black points and the various colours are different synthetic fits produced by Theremin.

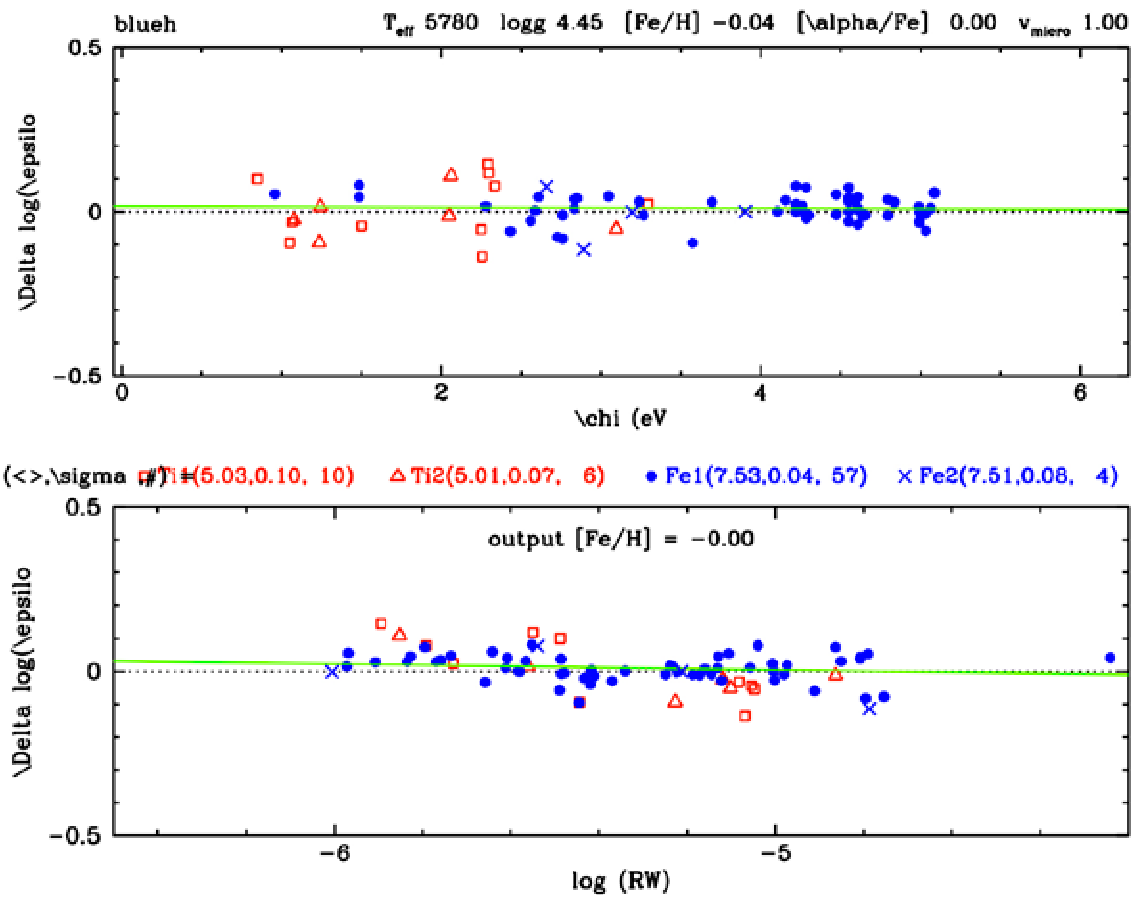

Fig 7: Deriving the stellar parameters in Theremin using the HERMES Blue channel test data and UVES spectra convolved to HERMES resolution for the other channels.

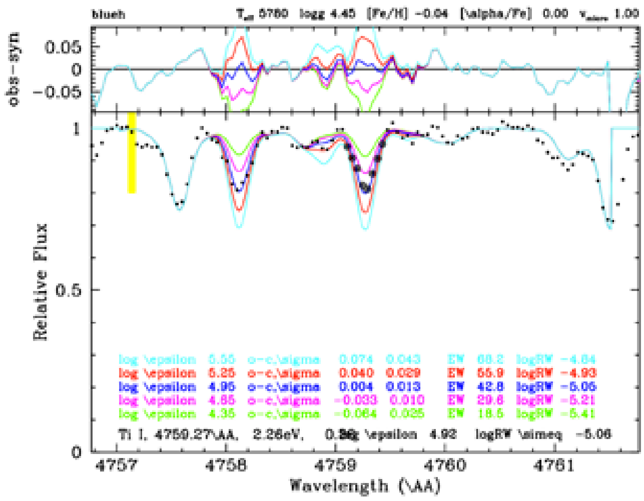

Fig 8: Theremin spectral synthesis of the Ti I line using the HERMES nominal resolution solar spectra. The observed HERMES data are shown in black dots and the various colours show different synthetic spectra. The best fit in this example is found to be a Ti abundance of 4.92 dex, which is in excellent agreement with the literature value of 4.93 dex.

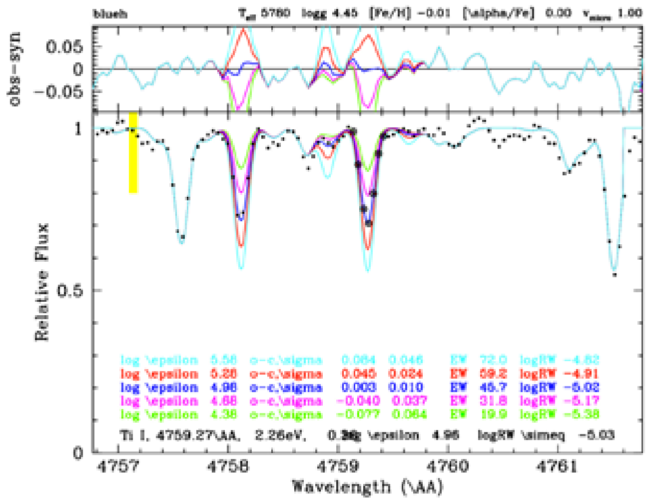

Fig 9: Same as Figure 8 but using the HERMES high-resolution solar spectra.

The spectral region used for setting the continuum level is marked in yellow. The best fitting abundances for the data are 4.92 dex and 4.96 dex for the nominal and high-res spectra respectively. The expected solar abundance of this Ti I line is 4.93 dex, hence the derived abundances are within our required accuracy of 0.05 dex.

These early results verify that the instrument and data analysis software are functioning to specification.

Next steps

All the HERMES components are currently residing in assorted boxes at the AAT, awaiting reassembly. The integration at the telescope commenced in late June, on schedule for on sky commissioning to begin in October 2013. At the time of writing the HERMES frame has been reassembled at site and will next have optics and electronics installed.

At the same time the GALAH survey team is preparing to carry out the GALAH Pilot survey, which was allocated 26 nights in Semester 13B and is scheduled to commence in November 2013. Further details of the GALAH survey can be found at the new website at: www.mso.anu.edu.au/galah/home.html.

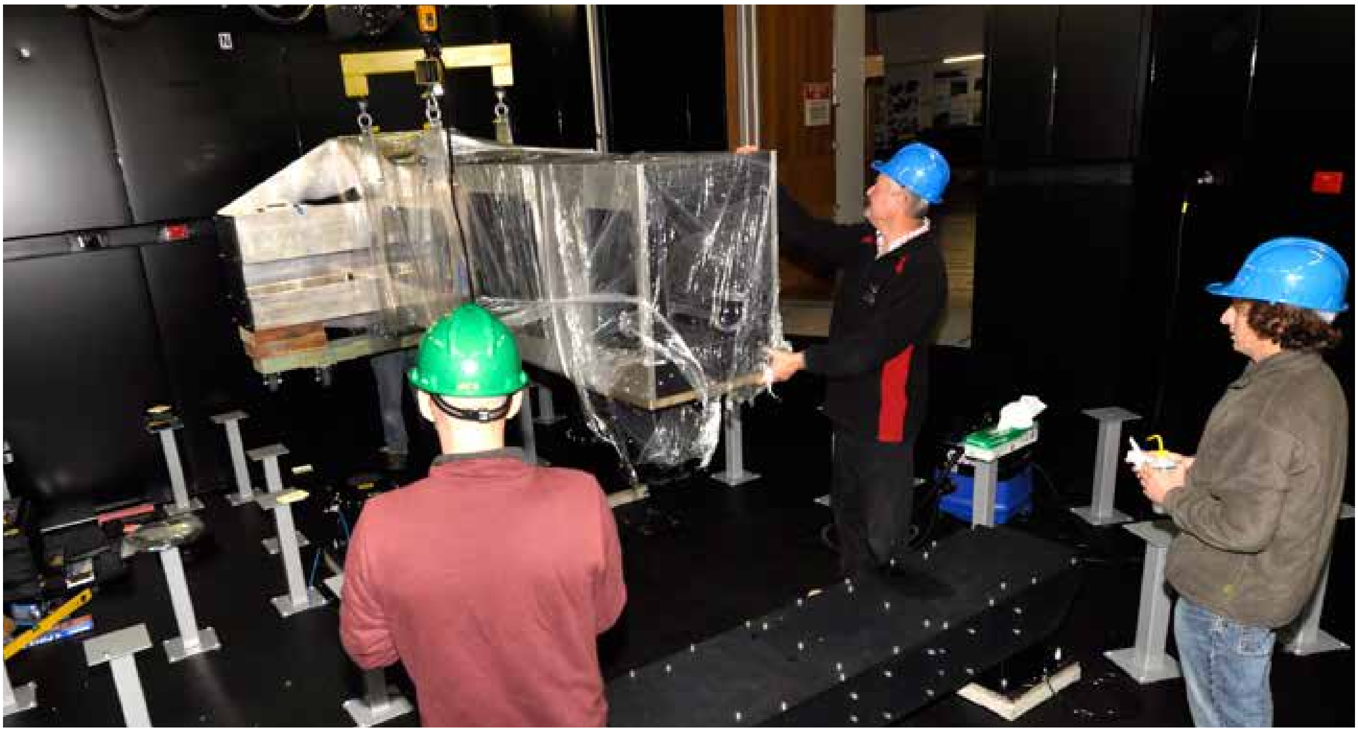

Fig 10: HERMES being received and reassembled at the AAT.

The middle age growth spurts of brightest cluster galaxies

Chris Lidman, (AAO), Gabriela Iacobuta (AAO), Amanda Bauer (AAO), Gillian Wilson (University of California Riverside, USA) and Adam Muzzin (Leiden Observatory, The Netherlands)

The brightest, most luminous and most massive galaxies in the Universe are the so-called brightest cluster galaxies (or BCGs for short). As their name suggests, BCGs are located in galaxy clusters. More often than not, they are usually located in the very centre of the cluster. See Figure 1 for an example.

Apart from their extreme masses and their special location, BCGs also appear to be special in other ways. For example, the light profiles of BCGs are much more extended than the light profiles of other large elliptical galaxies. In the not too distant past, BCGs were used as standard candles, and were therefore used to constrain the expansion history of the Universe, a role they fulfilled for several decades until it was discovered that Type Ia supernovae are much better standard candles.

In the hierarchical scenario for the formation of structure in the Universe, BCGs build up their stellar mass over time by accreting material from their surroundings. Between z~1 and today, recent numerical models [1] predict that the stellar mass increases by a factor of a two, and that most of the growth occurs through merging with other galaxies and not through converting gas into stars.

Janette Suherli, during her AAO student fellowship[1], showed that the stellar mass of BCGs does indeed increase with time. Janette found that, between z~0.9 and z~0.2, BCGs grew by a factor of 1.8 [2], in good agreement with recent numerical models.

1 The AAO student fellowship program runs twice a year. Students come from all over the world to work with astronomers and engineers at the AAO. For details on how to apply, check out the web page at http://www.aao.gov.au/AAO/students/aaosf.html.

From the strength of emission lines in the spectra of the BCGs, it was clear that the growth was not due to star formation. Instead it was suggested that most of the growth had to occur through merging, although it was not clear if this was via minor of major[2] mergers.

As part of her work as an AAO student fellow, Gabriela Iacobuta examined a larger sample of distant clusters to see if there was evidence for major mergers. This article summarises the work that she did. A more detailed description can be found in a paper that has been accepted for publication in the Monthly Notices of the Royal Astronomical Society [3].

2 A merger is classified as a major merger if the mass of the BCG is not more than four times the mass of the companion. The definition can vary between authors.

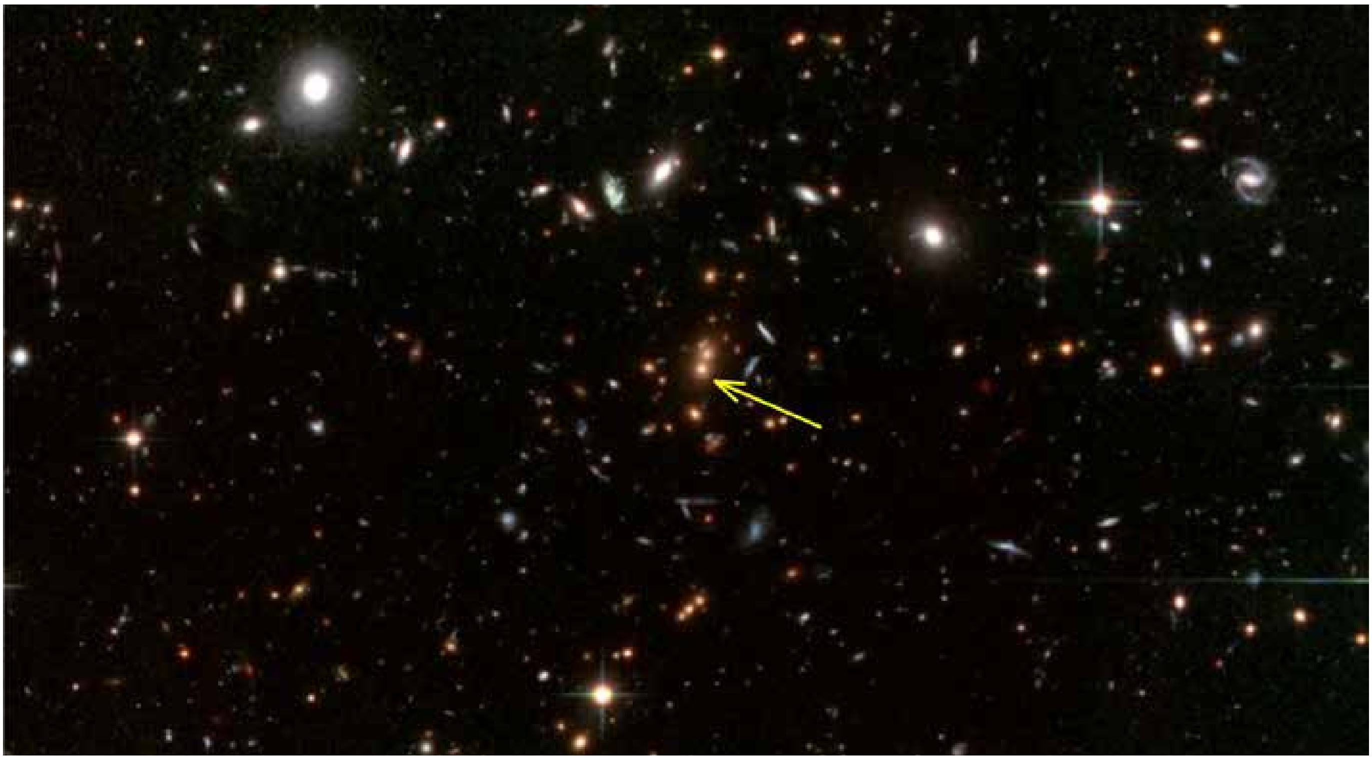

Figure 1: A colour image (courtesy of P. Rosati) of the centre of the z=1.23 galaxy cluster RDCS1252.9-2927. Note the two bright orange-coloured galaxies in the centre of the cluster. The yellow arrow marks the BCG. The colour image was made from a Ks-band image from the ISAAC instrument on the Very Large Telescope and i and z-band images from the ACS instrument on the Hubble Space Telescope.

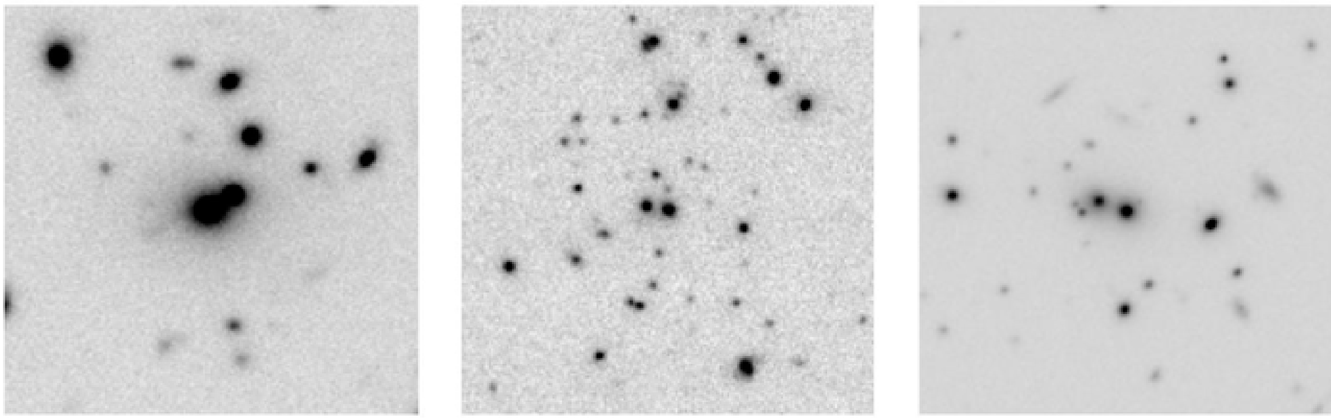

Figure 2: Images centred on the BCGs of the three clusters with bright companions. The projected separation between the galaxies in each pair is less than 30 kpc and the line-of-sight velocity difference is less than 500 km/s. The companions are amongst the brightest galaxies in their respective clusters. From left to right, the companion is the 4th, 3rd and 2nd brightest galaxy in the cluster.

The cluster sample and the frequency of bright companions

The sample consisted of 10 clusters from GCLASS[3] and 8 clusters from the HAWK-I cluster survey (HCS). The redshifts of these 18 distant clusters extends from z=0.84 to z=1.46, corresponding to look-back times ranging from 7.1 to 9.3 billion years[4]. Between the 18 clusters, there are over 600 spectroscopically confirmed cluster members. The high spectroscopic completeness enables us to clearly separate cluster galaxies from field galaxies, and to identify the BCGs.

Out of 18 BCGs, 14 of them are located close to the centres of their respective clusters. A closer inspection of these BCGs revealed that 3 of them have very luminous companions that are within 30 kpc of the BCG and with line-of-sight velocity differences that are less than 500 km/s. The three BCSs are shown in Figure 2.

Galaxies that are this close are likely to merge within 600 million years. Of course, these galaxies may simply be projections along the line of sight. We consider this unlikely for a couple of reasons. First, the companions are highly ranked in terms of their brightness. In the three examples shown in Figure 2, the companions are, from left to right, the 4th, 3rd and 2nd brightest galaxies. Second, compared to faint galaxies, there is a clear statistical excess of bright galaxies near to BCGs.

There is also the issue of how the cluster potential itself affects the time for mergers to occur, since the timescale quoted above has been computed for field galaxies. As these galaxies are located in the centre and appear to be at rest with the cluster, the mass outside their orbits can be largely ignored. This is one of the reasons for considering only the BCGs that are in the cluster centre.

Given the timescale for merging and the growth in mass that has been measured between z~0.9 and z~0.2 [2], we can calculate how many close massive companions we should have observed. Under the assumption that half of the mass of the companion is lost to the intra-cluster medium during the merger and half ends up in the BCG, we derive that we should see three close companions if the times-scale for merging is 600 million years. Interestingly, this is the number we observe.

Future Work

While the frequency of nearby neighbours is consistent with the notion that the build up of stellar mass in BCGs between z=1 and today mainly occurs through major mergers, we stress that the sample size is still small. The small sample size leads to large uncertainties. Extending this work to larger samples would help reduce the uncertainties.

It will also be interesting to see if BCGs continue to grow between z~0.4 (corresponding to a look-back time of 4.3 billion years) and today. There is a hint that the growth stalls at z~0.4 (see Figure 6 of [2]). Numerical models predict that significant growth still occurs between these two redshifts. Work, by Paola Oliva from Swinburne University, to measure the growth at lower redshifts using data from the GAMA[5] survey is underway. Stay tuned for the results of her work.

[1] Laporte, C. F. P. et al. 2013, arXiv:1303.1534

[2] Lidman, C. et al. 2012, MNRAS, 427, 550

[3] Lidman, C. et al. 2013, MNRAS in press, arXiv:1305:0882

3 Gemini Cluster Astrophysics Spectroscopic Survey http://www.faculty.ucr.edu/~gillianw/GCLASS/

4 The Universe is 13.7 billion years old.

5 Galaxy and Mass Assembly - http://www.gama-survey.org/

Compact Galaxy Groups, their Star Clusters and Dwarf Galaxies

I. S. Konstantopoulos (AAO), A. Maybhate [1], J. C. Charlton [2], K. Fedotov [4,5], P. R. Durrell [5], J. S. Mulchaey [6], J. English [7], T. D. Desjardins [3], S. C. Gallagher [3], L. M. Walker [8], K. E. Johnson [8,9], P. Tzanavaris [10,11], C. Gronwall [2].

The quest to understand the role of local environment in galaxy evolution is one of cosmic webs and filaments, voids and under-densities, clusters and groups. Most galaxies are found in groups (e. g., Small et al., 1999, Tully 1987), and among them compact groups (CGs) represent some of the densest environments in the cosmic hierarchy. As such, they define a grouping study-worthy both as a class, as well as in the context of structural variations in the universe.

To define CGs as a class, however, a joint physical trait is required. This is found in the form of their HI deficiency, studied in detail by Verdes-Montenegro et al. (2001) and Johnson et al. (2007), and expanded in our previous work (Konstantopoulos et al., 2010) to a two-pronged evolutionary diagram, shown in Figure 1. In this diagram gas richness runs from left to right, marking the three types defined by Johnson et al. (2007): I, II, and III for gas rich, intermediate, and poor. The duality of this plot was introduced to distinguish between groups where gas is contained solely within individual galaxies (Sequence A, top) and those that have begun building an intra-group medium (IGM) through interactions and other processes (such as outflows, see Konstantopoulos et al., 2010). This distinction according to the IGM is introduced to reflect different pathways for the quenching of star formation and therefore galaxy evolution; galaxies in Sequence A will consume their gas by transforming it into stars, while groups in Sequence B may heat a component of their gaseous reservoir and therefore inhibit further star formation.

Additionally, studies capitalising on large spectroscopic surveys (Mendel et al., 2011) and simulations of large-scale structure (McConnachie et al., 2009) have helped typify the surroundings of CGs in a statistical fashion, and discover an even division between isolated groups and those embedded in larger groupings. The two hierarchies therefore end at separate possible end-states for CGs: isolated groups may give rise to field ellipticals, while embedded groups might be the sites of galaxy pre-processing, where spiral galaxies deplete their gas supply and eventually become the ingredients of a dry merger.

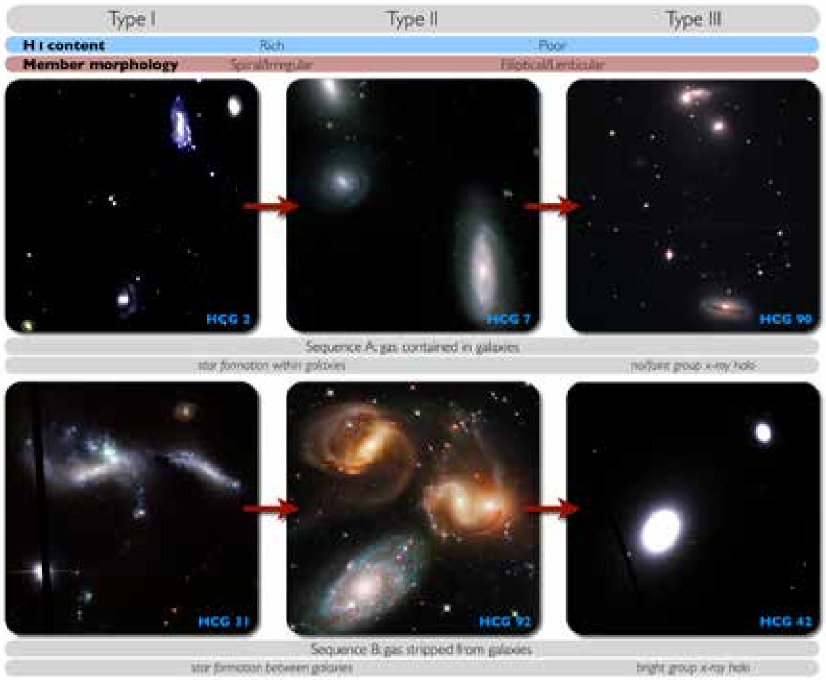

Figure 1: The evolutionary diagram proposed by Konstantopoulos et al. (2010). Gas richness runs left to right according to the Johnson et al. (2007) ratio of gas-to-dynamical mass. The dual sequences include groups where the gas is contained within the giant galaxies (Sequence A, top), while Sequence B (bottom) includes groups that feature an intra-group medium. One major difference is the appearance of an X-ray halo in Sequence B, which seems to rely on large scale collisions (recently observed by Cluver et al., 2013), rather than the gradual buildup seen in clusters.

In this article we report on the most recent instalment of multi-wavelength studies of CGs, which treats the stellar populations of three groups that form a Type I-II-III sequence along the Konstantopoulos et al. (2010) evolutionary diagram. The full study was recently published on the *Astrophysical Journal* (Konstantopoulos et al., 2013) and it treats the star cluster populations and dwarf galaxy contingents of HCGs 16, 22, and 42.

The three groups are very different in terms of the morphologies and colours of their member galaxies, reflecting the variety found among CGs in general — despite being perceived as preferentially interacting groups with a high irregular galaxy fraction. The core of HCG 16 consists of one spiral and one lenticular galaxy (A, B respectively), while the C and D galaxies (lettering follows optical

[1] Space Telescope Science Institute

[2] The Pennsylvania State University

[3] The University of Western Ontario

[4] Herzberg Institute of Astrophysics

[5] Youngstown State University

[6] Carnegie Observatories

[7] University of Manitoba

[8] University of Virginia

[9] National Radio Astronomy Observatory

[10] NASA Goddard Space Flight Center

[11] The Johns Hopkins University

brightness) are relatively small starburst galaxies, both featuring super-galactic winds (Vogt, Dopita, & Kewley, 2013). The four galaxies share an extended HI envelope that places them in Sequence B of Figure 1. The early-to-late type fraction is higher in HCG 22, two galaxies to one. The spiral galaxy here (22C) features a very large but very faint network of spiral arms and contains all the HI detected in the group (Price et al., 2000). Finally, the giant galaxy membership of HCG 42 consists only of early-types with no discernible pockets of star formation (as diagnosed from mid-infrared imaging), and the HI has been depleted, much of the gas having been converted to an X-ray emitting halo about 42A.

1 Star Clusters and Star Formation History

This work is largely based on optical imaging from the *Hubble Space Telescope*, the resolution of which allows for the detection of individual massive star clusters of all ages in the three compact groups. Star clusters are closely approximated by single stellar populations (that is, they contain populations of coeval stars with similar metallicities), and the continuity of their age and mass distributions proves a valuable tool for diagnosing past star formation events. Such methodology has been applied to time the progression of starbursts (e. g., Trancho et al., 2007b, Konstantopoulos et al., 2008, 2009) and determine the age of tidal features released by interactions (e. g., Trancho et al., 2007a, Fedotov et al., 2011). The three groups studied here display rather different star cluster populations, as shown in the colour colour diagram of Figure 1. This shows the evolution of star cluster colours, as modelled by Zackrisson et al. (2011) for the *Yggdrasil* population synthesis model suite. The model tracks in Figure 2 run from young to old in a clockwise direction, and the numbers correspond to the logarithmic age of the model. The 'knee' in the line is due to the inclusion of emission lines in young clusters — arising not from the stars, but the ionisation of residual gas from the star formation process. Models of three different metallicities are shown here, and the colour/symbol coding corresponds to the three CGs. The arrow shows an extinction vector, that is, the direction along which reddening displaces the footprint of a star cluster on this plot.

In all, HCGs 16 and 22 exhibit a normal assortment of cluster colours. They are forming stars, as diagnosed from the alignment of clusters with the young 'knee' of the model. Gas-rich HCG 16 shows a great abundance of young clusters, while the balance begins to tip toward older clusters in HCG 22. Continuing on the Type I-II-III sequence described by the three groups, HCG 42 only shows older star clusters, the population dominated by old globulars around the [(B−V),(V−I)]≈(0.7,1.0) mark. This is of great importance in interpreting the star formation history of HCG 42 as a whole: if there are no massive star clusters younger than a few billion years (most green triangles are past the Gyr mark), then the group has not formed any. This means that star formation was quenched about that time, and what gas didn't collapse into stars must have been heated before that point in time. HCG 42 lies at the end of our proposed evolutionary sequence, the analysis of its star clusters provides a very interesting insight into its history.

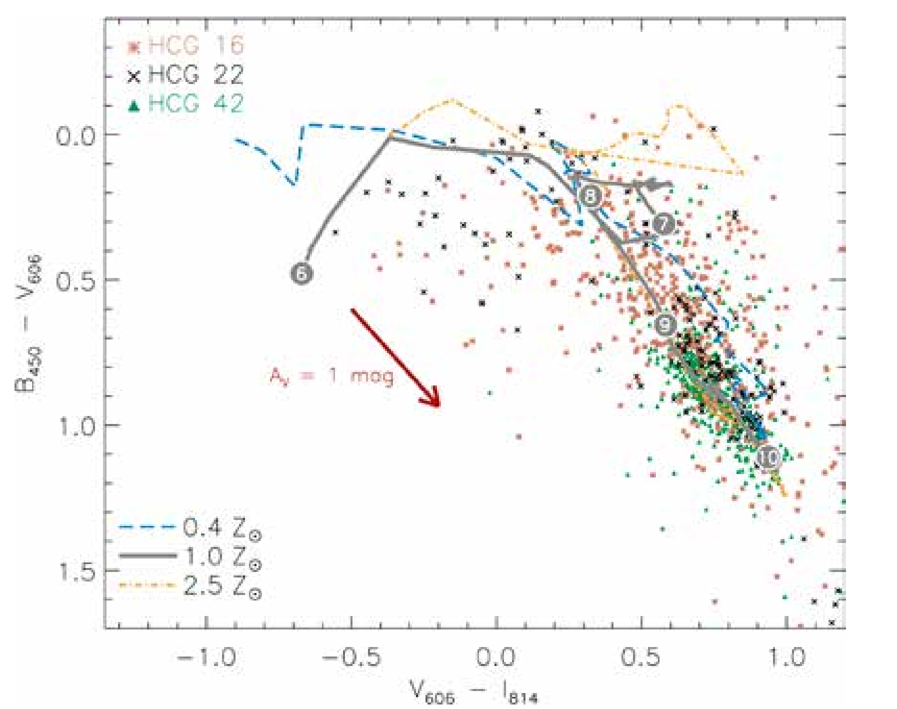

Figure 2: Star cluster candidates in HCGs 16, 22, 42. The dashed, solid, and dashed-dotted lines trace the evolution of *Yggdrasil* SSP models of Zackrisson et al. (2011). The model tracks include nebular emission transmitted in the F435W and F606W filters at ages ≲7 Myr. The extinction vector has a length of 1 magnitude (A_V). Sources aligned with vectors originating on the nebular segment have ages less than ≈7 Myr. The three groups display different star formation histories. HCG 16 features many clusters of super-solar metallicity, while it does not appear to host a distinct population of old globular clusters. This is to be expected, given the low galaxy masses and mainly late-type morphologies. Both HCG 22 and 42 show remarkable populations, dominated by clusters at intermediate and old ages (>1 Gyr), with only very few young clusters in HCG 22C. This is probably related to a group-wide era of merger-driven star formation in the past, consistent with the morphological types of the galaxies in these two groups, and the various signs of disturbance. From this we diagnose that HCGs 42, and two-thirds of HCG 22 entered a different mode of evolution (with little conversion of gas to stars) over the past ~1 Gyr.

2 Dwarf Galaxies

The small membership of CGs often casts doubt on the validity of statistical measures such as the dynamical mass. From this it follows that a full account of all galaxies associated with the group is required to derive such statistics. This is one of the viewpoints we took with the three CGs studied here. By combining literature detections, large surveys (SDSS, York et al, 2000), and our own data, we compiled a list of 60 dwarf galaxies, the majority associated with HCG 42.

Two main results follow from these lists. First, HCGs 16 and 22 appear to be isolated, while HCG 42 is embedded in a larger structure. Combining with our previous multi-wavelength studies (Konstantopoulos et al., 2010, Gallagher et al., 2010, Konstantopoulos et al., 2012) produces a tally, as diagnosed by the network of dwarf galaxies, of five

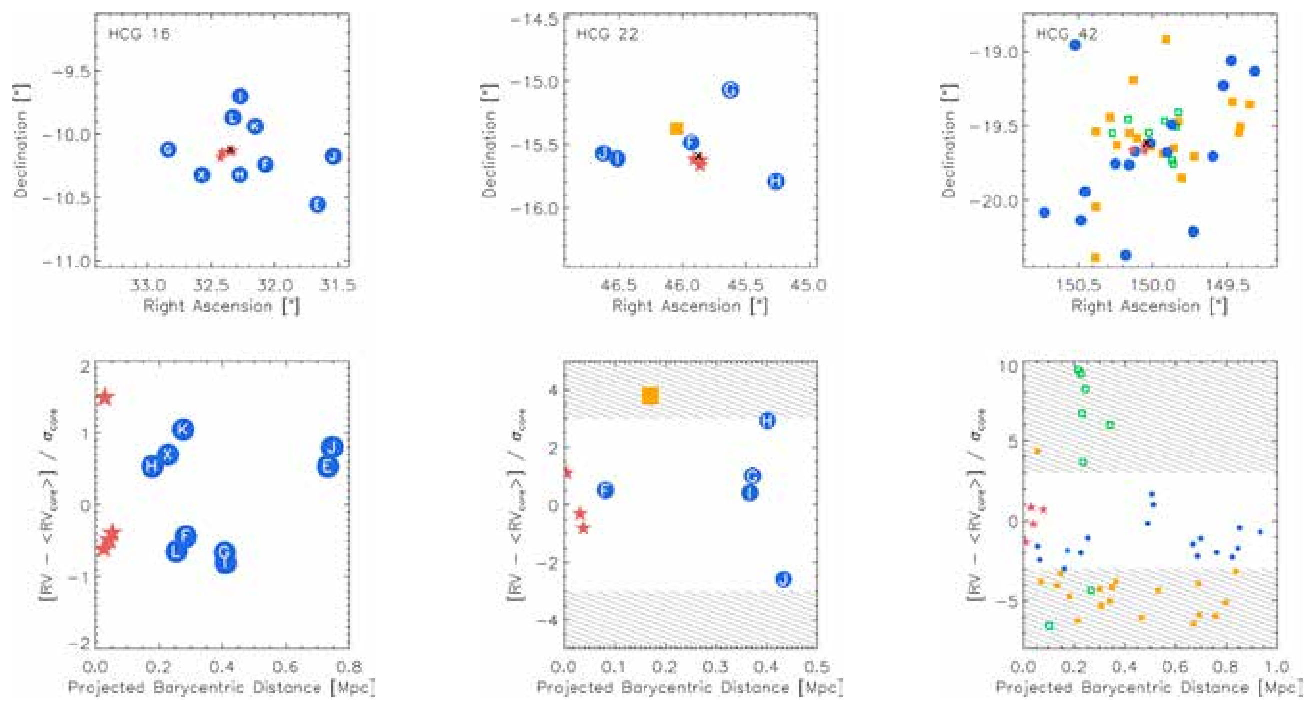

Figure 3: Diagnostic maps (**top row**) and phase-space diagrams (**bottom row**) for candidate member galaxies in HCGs 16, 22, and 42 (left, center, right). Main members are marked with stars and their barycenter as a cross. Lettered circles and yellow boxes mark galaxies that qualify as 'members' and 'associates' (see text). The hashed regions mark the 3 σ boundary that qualifies a galaxy as a group member. HCGs 16 and 22 appears to be isolated, while HCG 42 forms part of a populous group, with which it seems to share a large dwarf galaxy population. The open green boxes on the right (HCG 42) mark detections by Carrasco et al. (2006) that cover a fainter part of the luminosity function than the rest of our data (from Zabludoff & Mulchaey, 2000, de Carvalho et al, 1997).

isolated groups (HCGs 7, 16, 22, 31, and 59) to just one embedded group. While this number is small, it runs counter to the 50:50 split derived from SDSS by Mendel et al. (2011), indicating that, perhaps, the selection by Hickson (1982) and Hickson et al. (1992) runs counter to the results derived from large scale structure. This could result from the proximity of the Hickson groups, or the selection criteria themselves, as they include an isolation parameter.

The second result pertains to dynamical mass the of the three groups. In order to refine this measurement we have to decide which of the detected dwarfs are likely to be true members. To diagnose membership we relied on phase-space diagrams, shown in Figure 3. We first defined the core velocity as the median of all giant galaxies and then measured the deviation of every detected dwarf, quantified in terms of the standard deviation of the giants. We set the threshold for inclusion at 3 σ, and branded any dwarfs between 3 σ and 10 σ as 'associates' to ask the following question: if we include the velocities and spatial extent of all members and all associates, how much does the dynamical mass change? HCG 16, the least evolved group according to Figure 1, seems to be well represented by its giants alone, as the dynamical mass only increases by a factor of~4 by including its nine dwarfs. In the more evolved HCG 22, however, the mass changes by a factor of ~50 when including all associates, while in the evolved and embedded HCG 42, the change represents a staggering factor of 10^5. Interestingly, including only members (within 3 σ) changes the by a small factor of ≲10 in all three cases, indicating that this statistical measure still holds as a first-order approximation. In any case, we find the metric to be far more reliable for isolated groups.

3 What The Future Holds

The results this work produced hold many tantalising possibilities that can only be confirmed through statistical studies. Toward this end we will be using the GAMA groups catalogue of Robotham et al. (2011) to understand the nature, occurrence, environmental dependence, and role in the cosmic hierarchy of CGs, as well as refining the definition itself of what makes CGs a class in their own right.

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Ten Years of RAVE

Fred Watson (AAO) and Matthias Steinmetz (Leibniz-Institut für Astrophysik Potsdam, AIP)

Back in 2001, when the UK Schmidt Telescope's 6dF Galaxy Survey had only just got underway, the then-Director of AAO, Brian Boyle, was already thinking ahead. With the newly-commissioned 6dF multi-fibre spectroscopy system working well, the Galaxy Survey seemed likely to achieve its target completion date of late 2004. But what then for the telescope? The AAT Board had already indicated that there would be no further financial support for the UKST once the Galaxy Survey was completed. However, it was also acknowledged that the telescope still had considerable potential for all-sky spectroscopic surveys.

One possibility was for the UKST to carry out follow-up work for a space-astronomy mission, using external funding. Just a few months earlier, the German space agency (DLR) had selected its next mission in the national space programme. DIVA was to be an astrometric satellite (Bastian et al., 1996) intended to produce parallaxes, proper motions and photometry for ~4×10^7 stars brighter than $V=10^m.5$. A group of astronomers in Germany centred around the DIVA PI, Sigi Roeser (Heidelberg), and one of the authors of this article (MS—who was about to start his post as Director of the AIP in Germany) worried about not having radial velocities available, a problem that was already compromising our understanding of galactic dynamics using Hipparcos data. High-accuracy astrometry had been provided by the ESA Hipparcos satellite for ~10^5 stars, but the sixth dimension of phase-space —precision radial velocities—were known for less than a quarter of that number.

Completion of the phase-space dataset by including radial velocities was seen as a potential role for the UKST. In the spring of 2002, a group from Germany and Australia met in Potsdam, and with them experts in the field from other countries, the core of what later became the RAVE collaboration. The result of that was a white paper, developed during the summer of 2002, which proposed the measurement of the velocities of some 5×10^7 stars with the UKST, in two phases (Steinmetz, 2003).

This Radial Velocity Experiment, or RAVE (the acronym was suggested in Potsdam by Julio Navarro), would obtain intermediate dispersion spectra of stars brighter than I=12 in the far-red, centred on the Ca II triplet. It would consist of a pilot study with 6dF, measuring ~10^5 stars in gray time not used by the galaxy survey, to be followed eventually by an ambitious main survey carried out with a new instrument called Ukidna, an adaptation of the Echidna spine-based fibre positioner built for Subaru by the AAO. The proposal was presented to the AAT Board meeting in Bristol in October 2002, and, with a strong science case and support from 23 scientists in a dozen institutions (together with financial contributions), the pilot survey was given the go-ahead. In the event, DIVA itself was cancelled due to a shortfall in funding, but by then, the momentum for a southern sky radial velocity survey was well underway. RAVE was initiated on 11 April 2003, when the first observations were made by the AAO's Malcolm Hartley.

Figure 1: An unusual view of the UK Schmidt Telescope in access-park position, taken through the open dome during repainting in 2012. To the right of the telescope is the 6dF spectrograph enclosure, while just visible at lower left is the 6dF robot room. (*Doug Gray*.)

Stellar survey

Thus began a decade of RAVE data-gathering with the UKST. Very soon, however, the project began a series of metamorphoses that transformed the original proposal into the dataset that exists today. First, and most significantly, the bid to build Ukidna failed, and the project was left with the choice of winding up at the end of the pilot study, or extending it to a greater number of stars – although significantly less than in the original proposal.

By then, the project had an Executive Board representing its ten participating nations. (Swiss representation eventually ended, leaving Australia, Canada, France, Germany, Italy, the Netherlands, Slovenia, the United Kingdom and the United States.) The pilot project had been funded by subscriptions from institutions in these countries, with an additional contribution from AAO. While AAO funding would cease with the end of the 6dF Galaxy Survey, the RAVE Executive Board was confident of raising sufficient funds to operate the telescope on a full-time basis of 25 nights per lunation, which would cost some $500k per annum. Thus it was that in August 2005, the project took over all available time with the aim of measuring velocities for up to 10^6 stars.

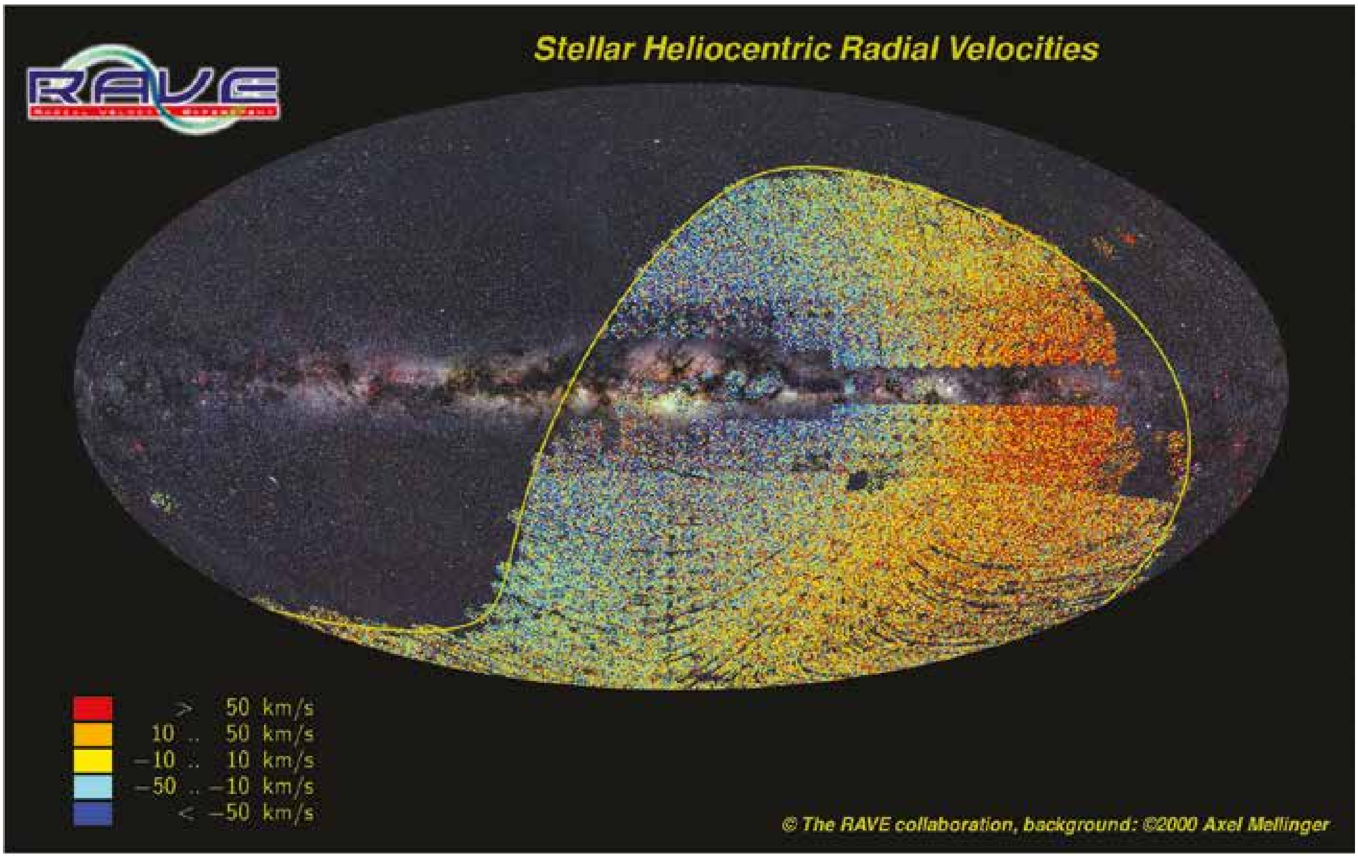

Figure 2: The RAVE DR4 dataset of almost half a million stars, colour-coded for radial velocity and projected onto the celestial sphere in galactocentric coordinates. Clearly visible are the apparent velocity streaming caused by the reflex solar motion, and spatial structure in the dataset due to such effects as input catalogue artefacts and the inaccessibility of the south polar field. (*The RAVE Collaboration*.)

It was another metamorphosis that eventually made this an unlikely target – along with the ongoing difficulty in maintaining sufficient fibre availability on the two 6dF field-plates, described below. The success of RAVE in producing accurate stellar radial velocities (~2 kms^{-1}) led to the project being expanded to yield physical parameters: T_{eff}, log g and [Fe/H]. This required longer exposure times, greatly increased calibration exposures, and more sophisticated reduction techniques. But, with continuing funding and the establishment of data reduction and server facilities in Italy (Astronomical Institute of Padova, Asiago) and Germany (Leibniz-Institut für Astrophysik Potsdam), the collaboration was able to begin issuing a series of data-releases that continues today (DR1: Steinmetz et al., 2006; DR2: Zwitter et al. 2008; DR3: Siebert et al., 2011; DR4: Kordopatis et al., 2013). These have been complemented by data releases featuring photometric distances (Breddels et al., 2010, Zwitter et al., 2010, Burnett et al., 2011, Binney et al., 2013) and chemical abundances (Boeche et al., 2011).

In March 2006, the original pilot-version input catalogue compiled by Brad Gibson using SuperCOSMOS data was replaced by one based on DENIS photometry by George Seabroke and Ken Russell. The original coarse tiling on the sky on 6-degree centres was replaced by 5-degree tiling, providing better overlap between fields. Science papers soon started flowing. The first was a highly-cited account constraining the local galactic escape speed (Smith et al., 2007), but each subsequent year produced an increasing set of publications (see http://www.rave-survey.aip.de/rave/pages/publication/index.jsp). The discovery of the Aquarius Stream (Williams et al., 2011) earned Mary Williams of AIP the Young Scientist's Award in Science and Engineering of Brandenburg. At the time of writing, RAVE has produced more than 30 science papers, with some further 10 papers expected to be published in late 2013, followed by a coodidinated poster campaign at the 2014 meeting of the American Astronomical Society in Washington.

Meanwhile, at the telescope, the observations were being carried out by a dedicated band of AAO observers working 5-night shifts, together with visiting observers from RAVE participating institutions. Many of these were supported on their visits by OPTICON, part of the European Union's sixth and seventh Framework Programmes for Research and Technological Development. Notable among the locally-based observers was John Dawe, a former Astronomer-in-Charge at the UKST, and one of the original proponents of fibre-optics spectroscopy on the telescope. RAVE was a project close to John's heart, and he came out of retirement in May 2003 to work on it. Sadly, eighteen months later, he lost his brave fight against pancreatic cancer (*AAO Newsletter* No.106, p.18).

End in sight

Not long after RAVE went full-time on the telescope, the strain on the instrumental hardware began to make itself felt. The 6dF system had been designed for a galaxy survey with relatively long integration times, but RAVE's shorter exposures were much more demanding on the robot and field plates. The fibre retractors were a particular weakness, and breakages were common. With the technical support group under pressure from the AAT, 6dF was

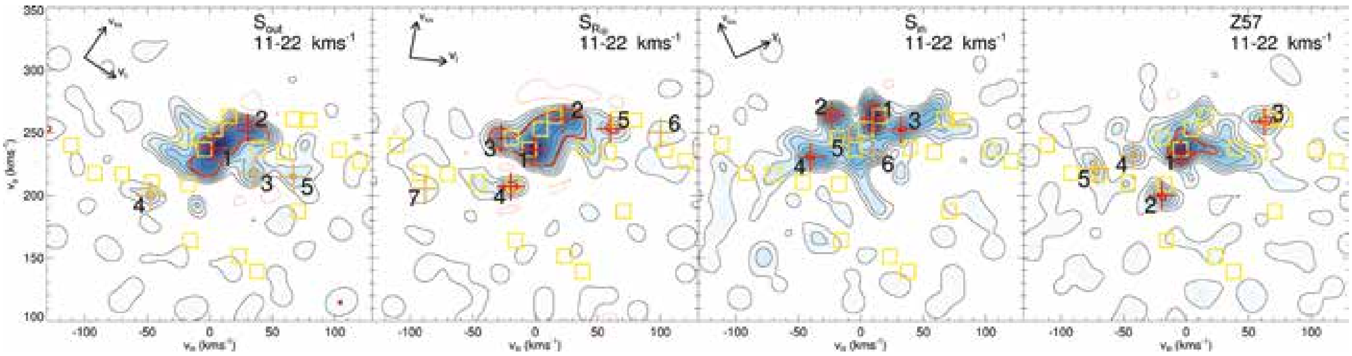

Figure 3: The first detection of moving groups of stars outside the solar neighbourhood, shown in velocity space. The four panels indicate overdensities of stars in three regions in the galactic plane, S_{out}, $S_{R\odot}$ and S_{in}, each about 1kpc from the Sun and straddling the solar circle, and a region Z57 some 650pc below the galactic plane. The persistence of these features over large scales is consistent with dynamical models of the effects of the galactic bar and spiral arms. (*T. Antoja, A. Helmi, The RAVE Collaboration.*)

often operating with highly sub-optimal fibre availability. In order to alleviate this situation, Quentin Parker of Macquarie University secured funding to build a third 6dF field plate for RAVE, which was commissioned in February 2009. Later in the project, all three field plates were refurbished with new fibre bundles that were fabricated at AIP and fitted at AAO.

Macquarie University also played a significant role in RAVE observing, with the introduction in May 2008 of Parker's 'Macquarie Model', which supplemented AAO observing with additional effort from Warren Reid and Andreas Ritter. Less cooperative, however, was the weather, which switched from astronomically-benign El Niño conditions to farmer-pleasing La Nina downpours early in the project, and never fully recovered. Similarly unfavourable to RAVE was the high value of the Australian dollar in 2009-12. With the bulk of RAVE's income being provided by overseas agencies, the high dollar eventually became the trigger that brought the project to a close.

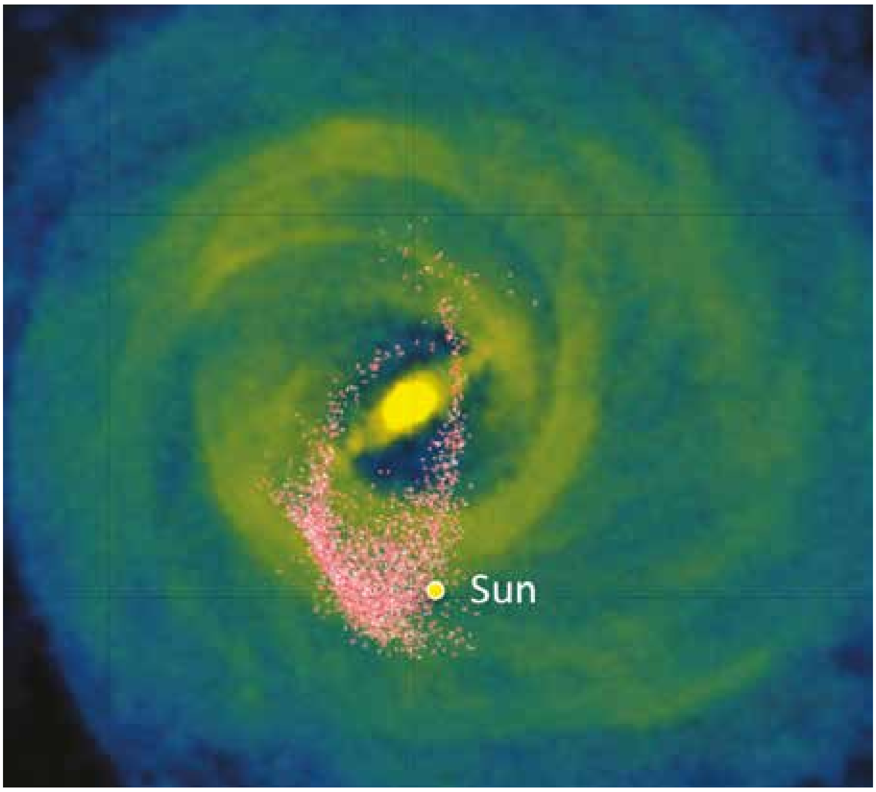

Figure 4: The Aquarius Stream. Careful analysis of RAVE data revealed the existence of this stream of stars moving at up to 200 kms^{-1} through the disc of the Galaxy. It is thought to be the remnant of a small neighbouring Galaxy or, as a more recent analysis suggests, a globular cluster that was absorbed by our own Galaxy some 700 Myears ago, making this one of the youngest and closest known star streams. (*M. Williams, A. Khalatyan (visualisation), The RAVE Collaboration.*)

It was at its annual Collaboration Meetings that RAVE's strategic planning was traditionally carried out, and, with the end in sight, the June 2011 meeting in Coonabarabran laid out the plan for the project's final year. The emphasis was to be on calibration observations and completion of fainter targets, which significantly slowed the rate of data-gathering. However, it subsequently proved possible to eke out the funding to continue the project until the end of January 2013.

This date was intended to coincide with the departure of the project's longest-serving observers and support astronomers. Paul Cass had already retired in June 2012 (*AAO Observer* No.122, p.32), but Malcolm Hartley and Ken Russell remained until the end of the project, along with Milorad Stupar of Macquarie University. Retiring on 31 January 2013, both Hartley and Russell had served with the UKST since the early photographic days, and had had distinguished careers which will be the subject of a future *AAO Observer* article.

In the event, however, there was no neat and tidy wind-up of RAVE at the end of January. The Wambelong Fire on the 13th of that month interrupted all work at Siding Spring, and it was some time before the project could be resumed. The last three nights of RAVE data-gathering took place on 2-4 April, when perfect weather and a perfectly-behaved 6dF allowed Fred Watson to obtain the final thousand or so spectra in the dataset. Two days

Figure 5: A group of RAVErs and friends of RAVE, gathered in the Sydney home of the German Consul-General, Hans Gnodtke, after the 2011 Collaboration Meeting in Coonabarabran. (*Hans Gnodtke*.)

later, on 6 April, 24 RAVErs and friends of the project—including its PI, Matthias Steinmetz, and (via Skype from Ljubljana) its Project Scientist, Tomaz Zwitter—gathered at the UKST to celebrate the end of the observational phase. With 574,630 spectra gathered on 483,330 individual stars, the revellers had much to celebrate, and they toasted not only the end of RAVE observing, but also the shut-down of 6dF.

RAVE itself continues, of course, with its scientific legacy still very much in its infancy. The project's 15th Collaboration Meeting was held in Oxford on 1-2 July 2013, and the 16th will take place in Ljubljana in mid-2014. Also continuing, it is hoped, will be the UKST, with plans well-developed for a new multi-fibre spectroscopy system based on the AAO's Starbugs technology, and two new surveys proposed to capitalise on it. Starbugs will allow the UKST's potential as a data-gathering machine to be fully realised at last, and, with 10^7 southern galaxies and a similar number of stars within its reach, the telescope's future could be rosy indeed.

Acknowledgements

The observational phase of RAVE owes a debt of gratitude to a great many people, but high on the list are former AAO Directors Brian Boyle and Matthew Colless, together with members of the former AAT Board and the AAO Advisory Committee, all of whom have given their support throughout. We also thank our many colleagues in the RAVE participating institutions throughout the world for their contributions, both scientific and financial.

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Visiting RAVE observers

Borja Anguiano, Corrado Boeche, Lionel Veltz, Mary Williams

AAO Welcomes New Director

Professor Warrick Couch joins the AAO for a second time, having worked at the AAO from 1985–1989. He was born in New Zealand, and moved to Australia in 1977 to do his PhD (on the evolution of galaxies in rich clusters) at Mount Stromlo and Siding Spring Observatories of the ANU. Most of his thesis observations were carried out on the AAT, where he had the ultimate 'joy ride' of spending many nights in the prime-focus cage taking very deep photographic plates of his distant cluster targets, under the expert supervision of David Malin.

After finishing his PhD, Warrick took up a postdoc position at Durham University, working with Richard Ellis and the cosmology and galaxy evolution group there. This allowed him to maintain strong links with Australia and the AAO, through regular visits to use the AAT. Being one of the first astronomers to use the very first CCD (Mackay) camera and the new fibre-based multi-object feed for the RGO spectrograph (FOCAP) on the AAT were major highlights of this period. Returning to Australia in 1985 to take up an Australian National Research Fellowship at the AAO was a logical next step in continuing to use these, as well as other new innovative AAT instruments (e.g. LDSS) to further his distant cluster galaxy research, as well as obtain that invaluable 'observatory' experience through undertaking instrument support and other related duties.

This 'finishing school' experience, which the AAO is renown for, was followed by 24 years in academia — 17 in the School of Physics at UNSW, and 7 in the Centre for Astrophysics and Supercomputing (CAS) at Swinburne University. While during this time research remained the main priority, with some notable successes — involvement in the Nobel Prize winning Supernova Cosmology Project, the HST MORPHS collaboration, and the 2dFGRS and WiggleZ Surveys — Warrick also took on a number of senior management roles including: Australian Gemini Scientist, Australian ELT Scientist, Head of the School of Physics at UNSW, Chair of the AAT Board, and just prior to returning to the AAO, CAS Director.

In returning to Sydney to become the AAO Director, Warrick (and his wife Maryanne) look forward to being closer to two of their three grown-up children, and reacquainting themselves with the beautiful beaches and their much warmer waters (cf. Victoria!) within the region. Being out of the 'AFL zone' will also make it easier for Warrick to pursue his interest in rugby union, in particular being a passionate All Black supporter.

Gemini School Astronomy Contest

Chris Onken (Australian Gemini Office, ANU)

As a Year 10 student in 2011, Perth's Ryan Soares finished as a runner-up in the Gemini School Astronomy Contest. In 2012, his contest entry was even more bold, resulting in Ryan being declared the winner. Ryan suggested that Gemini South take the image mosaic that appears on the cover of this newsletter, showing Lyon Galaxy Group #455.

This loose grouping of galaxies is dominated by three spirals — NGC 7232, NGC 7232B, and NGC 7233 — but also holds a "dark galaxy", 400 million Solar masses of gas that have not formed any significant number of stars. Most likely, the gas has been pulled out of one of the large spiral galaxies as the trio's gravitational pulls begin to tidally distort each other.

The colour image of LGG 455 was presented to Ryan in front of his classmates at Trinity College by three members of Perth's International Centre for Radio Astronomy Research — Jacinta Delhaize, Mehmet Alpaslan, and Pete Wheeler — along with Peter Michaud, Gemini's Public Information Outreach Manager, who appeared via video.

The runners-up for 2012 were The STAR Group from The Heights School in Modbury Heights, SA, and the Astronomy Club from St. Margaret's Anglican Girls School in Ascot, QLD. Each of the runners-up were entitled to a "Live From Gemini" session, during which the students get to learn about Gemini and its latest discoveries through a video link to the Observatory Headquarters in Hawaii.

AusGO is in the middle of a new astronomy contest for 2013. As well as continuing the student competition, for the first time we've also introduced a new contest division for Australian amateur astronomers. With Gemini South soon to produce two fantastic images, we are doubly excited about this year's results. For more details, visit http://ausgo.aao.gov.au/contest/

Jacinta Delhaize (ICRAR PhD student), Bill Cooper (Trinity College teacher), Mehmet Alpaslan (ICRAR PhD student), Ryan Soares (contest winner, Trinity College student). Credit: Pete Wheeler, International Centre for Radio Astronomy Research.

Ryan Soares with Jacinta Delhaize.
Credit: Pete Wheeler, International Centre for Radio Astronomy Research.

Improving 2dfdr

Andy Green (AAO)

The AAO's data reduction package for all of our fibre based instruments is known as *2dfdr*. Despite it's name, the same package now reduces data for 2dF+AAOmega, SPIRAL+AAOmega, SAMI+AAOmega, 2dF+HERMES, and 6dF on the UK Schmidt. Although these instruments vary considerably in their uses, the underlying data from each is similar in many respects, allowing each instrument to benefit from improvements in the data reduction process implemented for other instruments.

To meet the increasing demands of the users of these instruments, particularly the SAMI Galaxy Survey team, and in anticipation of the requirements for HERMES data reduction, several improvements need to be made to the software package. To manage this process, a working group has been convened that brings together key software developers, instrument scientists, and astronomers. This group has identified a set of key improvements in the software, and is working to develop and test new algorithms and techniques to meet those challenges. These improvements will continue to ensure that users of the AAT can easily and effectively reduce data from our world-leading fibre based instruments.

A few of the improvements the group is working on (among others):

- Improve the documentation of both the use of the package, and the algorithms used to reduce the data
- Improve the stability of the tramline mapping and fibre PSF extraction to ensure science flux is optimally extracted from the raw CCD image
- Improve scattered light identification and removal
- Take advantage of new sky subtraction techniques
- Allow scripted operation of the package to enable fully automatic reductions

Addressing these issues should resolve many of the data quality difficulties users of 2dfdr routinely report. Particular examples include poor sky subtraction, negative spectra, and inefficient extraction. These improvements and changes are primarily designed to meet the increasing demands of quality and accuracy required for modern astronomical data analysis.

The working group is committed to making sure the larger community is included in the process. To this end, the group is setting up an announcement mailing list for 2dfdr users. Through this list, and through the AAO's website, we will keep the community informed of new releases of 2dfdr, as well as developments and important changes to the package. Additionally, anyone interested in contributing new algorithms or improvements to the package should contact Andy Green.

Throughout this process, the AAO will continue to provide support to 2dfdr users.

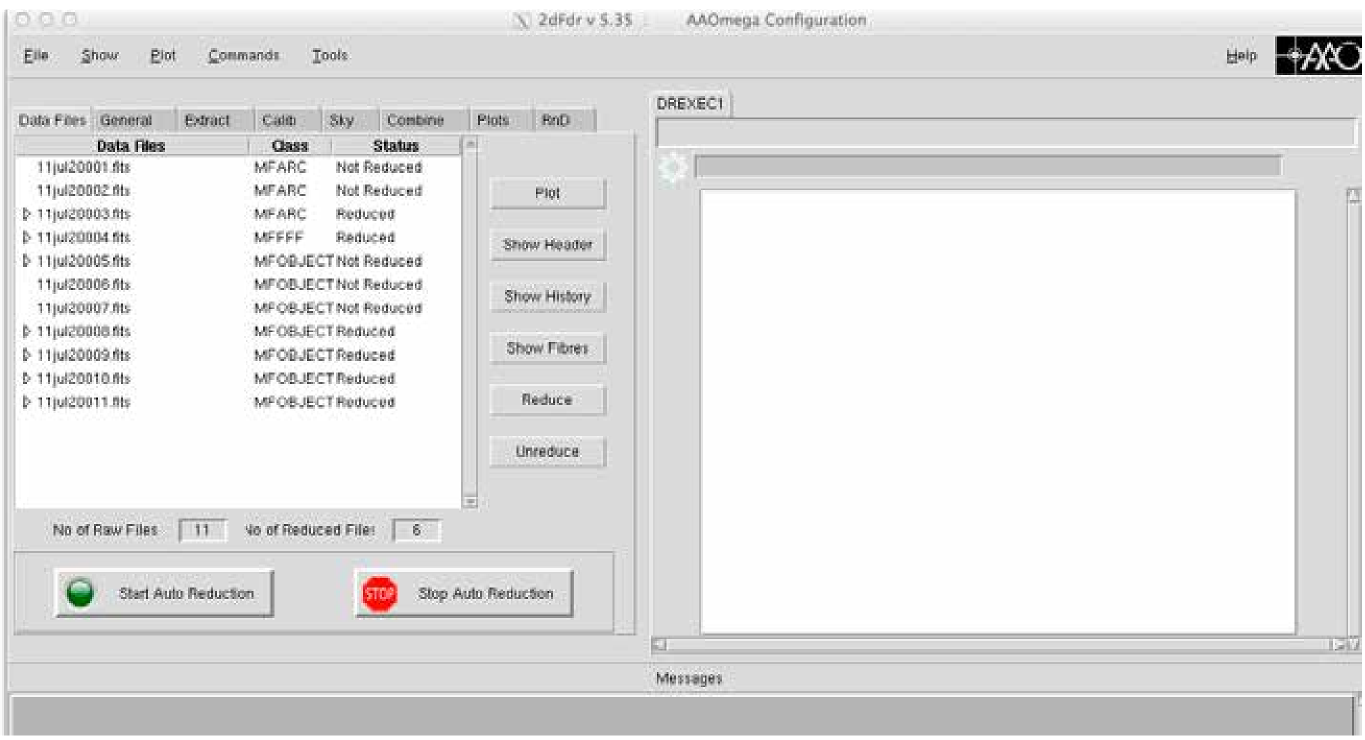

Figure 1: The 2dfdr data reduction software

AusGO Corner

Stuart Ryder (Australian Gemini Office, AAO)

New AusGO Staff

As mentioned in the last AusGO Corner, both Chris Onken's and Simon O'Toole's terms as Deputy Gemini Scientists have come to an end, though they continue to lend valuable assistance to AusGO operations in their new roles. Our new AusGO Research Fellow Dr Caroline Foster-Guanzon (Fig 1) commenced her appointment in June with a familiarisation visit to both the Gemini South and Magellan headquarters in La Serena, as well as the respective telescopes on Cerro Pachon and Las Campanas. Caroline pursued her undergraduate studies at Bishop's University in Canada, then completed her PhD at Swinburne University of Technology in 2011. Since then she has been an ESO Fellow at the Paranal Observatory supporting the VIMOS, ISAAC, and VISIR instruments.

Figure 1: New AusGO Research Fellow Dr Caroline Foster-Guanzon.

Caroline writes "*As a child, I could watch my father build or take things apart for hours. This love for understanding led me to study Physics and Mathematics as a Canadian undergraduate. In my free time, I would give public tours of the small telescope based on the roof of my University. This is one of my fondest memories of astronomy and led to a new fascination for the Universe and its structure. My research interests include chemical and assembly history of nearby galaxies, extragalactic globular clusters, and cosmological voids. During my free time, I enjoy reading, cycling and rock climbing. I am pleased to start this new appointment at the AAO as a fellow supporting Australian use of the Gemini and Magellan facilities.*"

Welcome Caroline!

Interviews have been conducted for a new 3 year joint position funded by AusGO and the Macquarie University Research Centre for Astronomy, Astrophysics, and Astrophotonics (MQAAAstro). This position will involve a mix of lecturing, research, student supervision, and AusGO support duties that will complement the roles and expertise of the other AusGO staff.

Proposal Statistics

For Semester 2013B ATAC received a total of 32 Gemini proposals, of which 13 were for time on Gemini North, 1 was for exchange time on Subaru, 15 were for time on Gemini South, and 3 were for time on both Gemini North and Gemini South. The oversubscription for Gemini North was unchanged at 2.0, while demand for Gemini South jumped from 1.6 to 2.5 with the availability of both FLAMINGOS-2 and GeMS+GSAOI. The total demand of 334 hours was the highest since 2005B, when additional time was being purchased from the UK.

Magellan time in 2013B was oversubscribed by a factor 3.4 with 11 proposals, up on the 2.6 in 2013A but well down on the peak of 4.9 in 2011B. Despite lowering the minimum time request to half a night as requested by the community at the 2012 Australian Gemini and Magellan Science Symposium, the smallest request received was 1.5 nights. MegaCam, IMACS, and FourStar were the most popular instruments, and for the first time ever there were no proposals to use MIKE.

In Semester 2012B, all but two of the 13 Gemini Band 1 programs were completed or had insufficient Target of Opportunity triggers (one of these has rollover into 2013B); 4 of the 6 Band 2 programs were completed; and just 2 of 5 Band 3 programs were started, with none completed. The fraction of time which went to programs that were completed was a healthy 85%. A further 20 hours of Poor Weather Queue time was also used, but for which Australia is not charged.

Collaborative Research Infrastructure Scheme (CRIS)

From 2008–2011, a substantial fraction of AusGO's operations was funded by the Federal government's National Collaborative Research Infrastructure Strategy (NCRIS), under a contract from Astronomy Australia Ltd. NCRIS funding also enabled the purchase of 15 nights per year on the Magellan telescopes. In December 2012 AAL was awarded nearly $3.5M for calendar years 2013 and 2014 from the Collaborative Research Infrastructure Scheme in order to sustain a number of astronomy infrastructure projects previously supported by NCRIS. Among the AusGO-related activities that will be funded by CRIS are:

- the purchase of 15 nights per year of Magellan observing time through the end of Semester 2014B;
- funding to cover the costs of Magellan observer travel over that period;
- operating the AGUSS program (see below) for 2013/14;
- seed funding for the 2014 AusGO/AAO Observational Techniques workshop to be held in Mar/Apr 2014.

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 2013/14 AGUSS program is Friday 30 August 2013 – please direct any interested Australian undergraduate students to http://ausgo.aao.gov.au/aguss.html.

Instrumentation Update

- **FLAMINGOS-2**: Following a number of thermal cycles to improve optical alignment and mechanism reliability, on-sky commissioning of FLAMINGOS-2 resumed on 25 April. Further issues with the MOS wheel and baffle alignment have since been addressed. The instrument was offered for imaging and long-slit spectroscopy only in shared-risks mode in 2013B. IQ20 performance is currently only possible within the inner 2' field of view.
- **GMOS**: Final characterisation and end-to-end software testing of the new red-sensitive Hamamatsu CCDs is underway, with the first focal plane array of 3 CCDs scheduled to be installed in GMOS-South in Oct/Nov 2013.
- **GeMS/GSAOI**: 90% of the System Verification (SV) programs were completed, and execution of 2013A queue programs in monthly week-long blocks is proceeding well. Up to 150 hrs of GSAOI time was available at ITAC in 2013B (double that of 2013A). An ARC LIEF bid has been submitted by RSAA with support from AAO and Swinburne to upgrade the wavefront sensors in GeMS to the sensitivity originally envisaged.
- **GRACES**: Issues with focal ratio degradation in the 280m fibre feed from Gemini North to the CFHT as part of GRACES (Gemini Remote Access to the ESPaDOnS Spectrograph) are close to being resolved. First light is now scheduled for Sep 2013.
- **GPI**: Acceptance tests at UCSC of the Gemini Planet Imager have been underway since Feb 2013, with only a few issues identified. GPI will then be shipped to Gemini South with on-sky commissioning to commence midway through Semester 2013B.

GeMS+GSAOI SV

Fully ¼ of the available 60 hours of SV time went to Australian-led programs, each of which now has some SV data to work with (e.g. Figure 2). Furthermore 1/3 of the available GSAOI time allocated in Semester 2013A went to Australian-led proposals, emphasising the high level of interest within the Australian community in exploiting this unparalleled new capability. As a result of the SV process, a number of bugs in the GSAOI package within the V1.12beta release of Gemini IRAF were identified by users and promptly addressed by the Gemini software group, enabling a V1.12beta2 release in mid-May. Following the Operations Working Group meeting in La Serena in mid-February, I had the opportunity to observe GeMS, GSAOI, and the laser propagation first-hand on Cerro Pachon. The remarkably rapid progression from commissioning, through SV, to queue operations has been quite impressive considering the complex interactions between several sub-systems, not to mention the frequent laser shuttering events forced by aircraft and US Space Command clearance.

Changes to *Gemini*Focus

The Gemini Observatory's newsletter, *Gemini*Focus, has undergone significant changes as it evolves into an increasingly electronic-only publication. *Gemini*Focus is moving from a twice-annual publication to a quarterly e-publication. In addition, each year in January a special edition "Year in Review" will contain highlights from the previous four quarterly e-publications as well as calendar-year summaries of operations and other milestones. Gemini will produce a printed table of contents of the "Year in Review" to circulate to all users, and will produce a limited number of hard-copies of the full "Year in Review", primarily for funding agencies, libraries, and special requests. It is expected that these changes will result in considerable savings in resources while allowing for more timely dissemination of information to users.

To help ensure that our e-mail lists of *Gemini*Focus subscribers are current and complete, please contact us with any additions or corrections to ausgo@aao.gov.au. Also please let us know if you would like to receive a hardcopy edition of the *Year in Review*. We encourage anyone who has yet to do so to sign up for the electronic distribution of *Gemini*Focus, which you can easily do at the Gemini website: http://www.gemini.edu/index.php?q=node/27

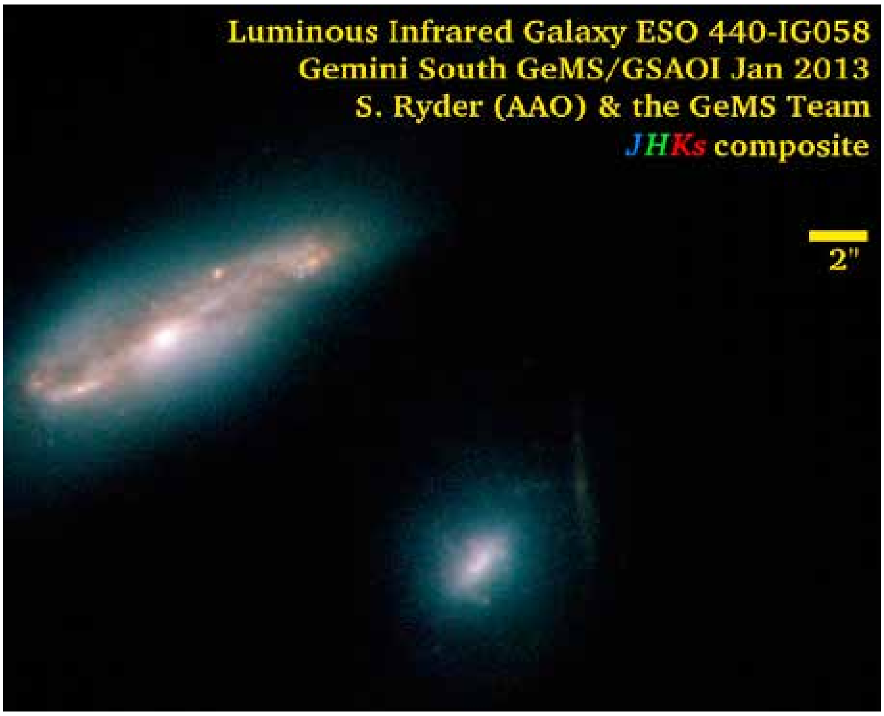

Figure 2: Colour composite near-infrared image of the star-bursting galaxy system ESO 440-IG058, obtained as part of the GeMS+GSAOI SV. The natural seeing of 0.9" has been improved by a factor of 10 through the use of multiple laser and natural guide stars.

A mountain of fire

Stuart Green

On Sunday January 13, a fire in the Warrumbungle National Park broke its containment line around lunch time accelerating as it travelled in a south easterly direction, originally towards the Mount Cencruack TV tower. Within two hours the wind had started changing direction driving the flames out of the National Park in the vicinity of the Siding Spring entry off the Timor Rd (John Renshaw Parkway). This was to be the first of three runs of fire that engulfed the mountain that day.

A group of aircraft (both fixed wing bombers and Helicopters) tasked by the NSW Rural Fire Service had been given the job of property protection in front of the fire and the AAT would be the first building on the Mountain to benefit from the use of a Gel based fire suppressant that was laid down 3,000 litres at a time, on the slope directly below the telescope. The Mountain had been advised to evacuate leaving no one to offer any ground suppression. Multiple drops from the Fixed wing bombers were made until it quickly became too dangerous for aircrew to continue. As the Air Attack Supervisor of the day, it was my job to direct the fire bombing aircraft onto their targets taking into account fuel loads, wind direction, visibility, and the fires rate of spread to make every load count.

The first run of fire hit hard, with a large ball of flame reaching most the height of the dome, but diminishing rapidly as it ran into the gel placed about 50 metres down slope on the southern side. Conditions quickly deteriorated in thick smoke and it soon became too dangerous to work with aircraft for around 45 minutes, this forced us to drop down into the Timor Valley and prepare whatever properties we could for the fire front. As the fire continued to travel east through the Timor Valley it also became too dangerous with aircraft as separation was dropping way below what was acceptable, whilst tracking out of the valley into clear air we discovered that Siding Spring had been hit with a second run of fire from the west. This run had set the Lodge on fire beyond saving and some other out buildings were well under way with fire. But the fire had burnt with such tremendous heat that all the available bush fuel had been burnt out leaving nearly no smoke to hamper aircraft operations. The decision was made to quickly return the helicopters to the mountain to start blacking out any active fire that was still burning around most buildings.

Some amazing flying was to take place that afternoon by the two medium helicopters as they dowsed any fire that threaten buildings. On several occasions Gavin Morgan in a Bell Huey (UH1H) from Precision Helicopters swung his bucket up under veranders, awnings and sheds to extinguish fire that had run through ground fuel into these buildings. Structures included homes, sheds and other telescopes on the mountain that were not considered too far gone. One incredible save was the Visitors Centre, that had a large amount of fuel burning on the rear wall. Many buckets of water and foam were used to bring the blaze to a halt.

These aircraft along with fixed wing bombers, when appropriate, continued to work on the mountain during the third run that came up from the northern side. These aircrafts left the mountain only to get water or to extinguish fire around the many dwellings at the bottom of the Timor Valley.

The AAO telescope very centre of picture disappears into the smoke

All aircrafts worked extremely hard, right up until dark (approximately 8:25 PM) with no sign of any ground crews, the first reported ground crew arrived well after 9 PM. Upon leaving, it was estimated that 90% of the fire that had been found on the mountain had been extinguished, other than the Lodge and out buildings that were considered to far gone to waste water on.

Thank you for the opportunity to explain these events, a lot of publicity has revolved around the role of the first ground crew that arrived who obviously had no idea of what had taken place before their arrival.

The third run on the Mountain from the north

Before and After

Zoe Holcombe (AAO)

On the 13th January I remember watching the fire from my boyfriend's house on the east side of town. From there we can see Siding Spring Observatory; I watched as huge walls of flames over took all the mountains...I watched in horror as it crept up the mountain towards the Schmidt telescope. We counted at least 4 helicopters flying around the mountain....then it all disappeared...

On the 29th January 2013, 16 days after the fire a few of us were allowed up the mountain to start the clean-up. While there, I took the opportunity to take these photos. I then took the photos again at the start of May. It is amazing how the scenery at the mountain is coming back, although many of the trees will never come back after the extreme fire that afternoon. The trees with green shoots only at the bottom are apparently dead, but those with shoots going up the trunk and branches will come back eventually. We are now seeing more and more kangaroos and other wildlife up on the mountain, whereas after the fire happened there was nothing, not even birds.

We are very lucky to live in Coonabarabran, the way the community came together was amazing and I am very proud that I live here. Although many people lost their homes, possessions and livestock, no lives were lost and that was the main thing. And even though the town has suffered since the fires because of a decrease in tourism slowly the people are coming back and enjoying the new scenery of the AAO and Warrumbungle National Park.

Warrumbungle National Park looking as it did in December 2012 (above) and then again after the fires 2013 (below)

Distinguished Visitors to the AAO

Professor Rogier Windhorst, (Arizona State University), visiting June–July 2013.

Prof. Windhorst (hosted by Andrew Hopkins) will be working with AAO staff on the lensing of galaxies using galaxy groups identified in the Galaxy And Mass Assembly (GAMA) survey, and taking advantage of HST imaging for a subset of these groups to develop the case for a large program of HST (and ultimately JWST) imaging to explore the significant role played by galaxy groups in modulating galaxy evolution.

Assistant Professor Marc Huertas-Company, (University of Paris 7 and Observatoire de Paris), visiting September 2013.

A.Prof. Huertas-Company (hosted by Chris Lidman) will be working with AAO staff on high redshift galaxy clusters from the HAWK-I High Redshift Cluster survey, and the measurement and evolution of galaxy morphologies in the Galaxy And Mass Assembly (GAMA) survey.

Dr Ignacio Ferreras, (University College London), visiting January–March 2014.

Dr Ferreras (hosted by Iraklis Konstantopoulos) will be working with AAO staff on understanding the mechanisms of star formation quenching in galaxies, looking in particular at galaxy environment (groups, clusters), and taking advantage of data from the Galaxy And Mass Assembly (GAMA) survey, along with the SDSS.

Dr Giovanni Carraro, (European Southern Observatory), visiting February 2014.

Dr Carraro (hosted by Gayandhi De Silva) will be working with AAO staff on high resolution optical spectroscopy of old star clusters, to measure detailed chemical abundances and constrain the formation history of these clusters relative to their environment in the Milky Way Galaxy.

Professor Chris Impey, (University of Arizona), visiting February 2014.

Prof. Impey (hosted by Fred watson) will be working with AAO staff on AAOmega measurements of supermassive black hole masses in the COSMOS field, to substantially increase the number of reliably known SMBH masses and explore SMBH accretion and feedback processes.

The AAO's Distinguished Visitor Scheme aims to strengthen and enhance the AAO's visibility both locally and internationally, and to provide opportunities for AAO staff to benefit from longer term collaborative visits by distinguished international colleagues. The AAO will typically award a small number of Distinguished Visitorships annually.

News from North Ryde

Andy Green (AAO)

Along with the arrival of our new Director, there have been several other new faces in North Ryde. **Dr. Kyler Kuehn** has joined the AAO's Instrument Science group in March of 2013 as Project Scientist for MANIFEST, the many-instrument fiber-positioner system for the upcoming Giant Magellan Telescope. He comes to us from Argonne National Laboratory, where he focused on the design, construction, and calibration of the Dark Energy Camera, a 500 Megapixel instrument that is now successfully operating on the Blanco 4m. In addition to his work with MANIFEST (and its small-scale prototype TAIPAN), Kyler is involved in developing new technologies to improve ground-based infrared spectroscopic instruments. He also continues to participate in the Dark Energy Survey, specifically focusing on the transient science that can be accomplished with the large-field imager. Away from work, he enjoys spending time with his wife Rebecca and daughter Metta. He is also a cellist, a sailor, and an avid marathon runner.

The IT group has seen quite a few changes. **Katrina Sealey** has been appointed to the IT group full time, and is serving as Acting Head of IT while Chris Ramage enjoys long service leave. Also joining the IT group is **Simon O'Toole**, who has been part of the astro group. Simon will be working primarily on the AAO's web presence as well as possible data archives to be hosted at the AAO. **Gary Kitley** has also returned to help out with IT matters, particularly finishing up the move from Marsfield to North Ryde.

Also joining the Sydney based staff is **David Brown** as our new mechanical engineer. Both **Scott Smedley** and **Ed Penny** returned temporarily to give a helping hand to the software team and with the final move from Marsfield, respectively.

Finally, long time staff member **Helen Davies** has retired. Helen has been at the AAO for over 34 years, and was one of our longest serving staff members. During that time, she has worked on many different projects/tasks, and overseen an enormous amount of evolution and change in the AAO's computer and IT systems. In her early years at the AAO, she worked on the computer control systems for the first infrared instruments deployed on the AAT: IRPS, FIGS, and IRIS. Subsequently, she was part of the inaugural group that established the internet and web access at the AAO in 1989. In more recent years she has been a member of the IT support group, where one of the major challenges has been to deal with all the requirements in the AAO moving into the Department and its quite different IT environment.

Remote observing from North Ryde has become the de facto standard mode of observing with the AAT since the January fire and the loss of the Siding Spring Lodge. Visiting observers have adapted well to this new mode of operation, and have been particularly patient while the AAO has ironed out the details. The Sydney based staff have particularly appreciated the increased number of visiting astronomers and science colloquia. The dramatic improvement in reliability of 2dF following the hardware refresh completed late last year has been a major help in making the transition to remote observing so painless.

The upgrade of the hexabundles and fibre run for **SAMI** was commissioned successfully in February, just after the Observatory restarted regular observing following the fire. The Sydney University and AAO team is now working to make this instrument available as a facility for the AAT community early in 2014.

The observing for RAVE has come to an end. The 6dF robot on the UK Schmidt telescope, which was used for the 6dF Galaxy Survey as well as RAVE, is to be retired. The AAO is considering options for the UK Schmidt telescope, including using it as a testbed and demonstrator for new technologies ultimately destined for the Giant Magellan Telescope. Look for a full article on RAVE in the next issue.

HERMES has been shipped off to the AAT, and is being reassembled in the Coudé room in anticipation of commissioning later in the year.

Letter from Coona

Zoe Holcombe (AAO)

It's been another busy six months at the AAO in Coona and before we all know

it Christmas will be here and the warm weather. Things have slowly got back into place after the fires, though it's a totally new view from up on the mountain.

We welcomed back **Martin Oestriech** who has been gone for 2 years and welcomed **Rob Brookfield** to electronics. Raelene Suckley and Brendan Jones are on extended leave.

We held Siding Spring Mountain Biggest Morning Tea and helped raised $140.00 for cancer research. We had a lot of goodies on offer and all that came along filled there tummies to bursting point.

On the 14th of April Doug celebrated his BIG 50; he was welcomed by his newly decorated office, of which Zoe had trashed with balloons, streamers and banners everywhere. That night we all went to the pub for a quiet celebration and a bit of cake.

The social club has been very busy doing BBQs, egg and bacon rolls and a special meal created by Bob Dean "Bob's Green Muck" which turned out to be Thai green curry and very nice also.

Katrina Harley left on a six week holiday to Europe, along the way she ran into James Bond! Oh and also did the tourist things at France, Spain, Portugal, UK, Poland, Czech Republic, Ireland and Scotland. Katrina and her friend had a wonderful time and by the time she got back Zoe (who became Katrina while she was tripping around) had taken over her office and Katrina had been kicked out! Zoe happily returned to her other job the next day as cleaner but is happily helping Katrina get back into things.

Katrina is already planning her next adventure, the 'little-Katrina' she is expecting.

Having been present both the day of the Wambelong Fire, and one of the first astronomers to come back to observe on the AAT just a few weeks afterwards, I must say the transformation of the Siding Spring surrounds has been extreme. Standing on the catwalk just before this newsletter (my last as editor) went to press, I was rewarded with this beautiful rainbow behind the UK Schmidt. This scene surprised me with how well it hides the recent drama, reflecting the enduring beauty of the area.

Credit: Andy Green

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