CAASTRO 5TH ANNUAL RETREAT

16-17 NOVEMBER, BLUE MOUNTAINS, NSW

ABSTRACT BOOKLET

DAY 1: MONDAY 16 NOVEMBER 2015

Chris Lidman
AAO

OzDES: Current Progress and Preliminary Results

OzDES is now midway through its five-year observing program. In this talk, I will present an overview of our progress and present some preliminary results.

Ixandra Achitouv
Swinburne University of Technology

Improving Reconstruction of the Baryon Acoustic Peak: The Effect of Local Environment

Precise measurements of the baryon acoustic oscillation (BAO) scale in the clustering pattern is a central goal of current and future galaxy surveys. The BAO peak may be sharpened using the technique of density-field reconstruction, in which the bulk displacements of galaxies are estimated using a Zeldovitch approximation. We use numerical simulations to demonstrate how the accuracy of this approximation depends strongly on local environment, and how this information may be used to construct an improved BAO measurement through environmental re-weighting and using higher-order perturbation theory. We outline further applications of the displacement field for testing cosmological models.

Cullan Howlett
ICRAR, UWA

New Methods for Estimating the Statistical Errors in Large Scale Structure Surveys

Measurements of the clustering of the Large Scale Structure (LSS) of the universe allow for some of the most robust and accurate constraints on the nature of dark energy and gravitational evolution. However one of the most creatively and computationally demanding aspects of the data analysis is the estimation of the statistical errors in the form of the covariance matrix. This is commonly done using large ensembles of simulations where current surveys need O(1000) simulations to obtain precise enough estimates of the covariance matrix. This number will need to be much larger for

future surveys such as LSST, Euclid, DESI and SKA but to further exacerbate this the large volume of these surveys will make running even a handful of simulations extremely difficult. To tackle this problem, this talk will present new methods for estimating the covariance matrix of LSS measurements for use with both current and next generation surveys. First, a fast, parallel simulation code, L-PICOLA, will be presented. This code can generate and evolve a dark matter simulation 3-orders of magnitude faster than a full N-Body simulation whilst still recovering the two- and three-point clustering of LSS to within 2% and 5% accuracy on all scales of interest to LSS measurements. An application of this code to the SDSS Main Galaxy Sample and the subsequent 4% measurement of the distance to z=0.15, which improves current constraints on the dark energy equation of state, will be shown. Additionally, this talk will present a novel method for optimising covariance matrix estimation using simulations. This method reduces the volumes of the simulations and hence the computational cost necessary to recover a precise covariance matrix dramatically. Equally, this method allows for much greater precision on estimates of the covariance matrix for the same computational cost. This technique will also make using simulations to accurately estimate the covariance matrix for large volume surveys such as SKA and Euclid much more feasible.

Ed Macaulay
University of Queensland

Measuring Sigma 8 with Supernovae

In order to fully understand the dark universe, it's becoming increasingly important to simultaneously measure the geometry and growth of the universe: both the expansion history and the growth of density perturbations. Supernovae are often considered as sensitive to only the expansion history. In this talk, I'll focus on modelling the effects of gravitational lensing and peculiar velocities in order to constrain the growth of density perturbations with the Dark Energy Survey Supernova Programme. While these effects are often considered as a nuisance, I'll consider how modelling these effects - particularly the characteristic skewness from gravitational lensing - can allow for novel independent measurements of density fluctuations from a signal which is often considered as noise.

Syed Uddin
Swinburne University of Technology

Influences of the Host Galaxies in Supernova Cosmology

I present techniques and results to better constrain the impact of population drift of Type Ia Supernovae (SNe Ia) on the derivation of cosmological parameters. I construct, from the literature, a sample of 595 spectroscopically confirmed SNe Ia and another sample of 755 photometrically identified SNe Ia in such a way that the SNe Ia light-curve parameters are derived consistently. I also derive the host galaxy physical properties of these SNe Ia in a consistent manner. My samples are unique in terms of uniformity and size.

The results that I obtain confirm that SNe Ia are on average more luminous in massive hosts and in hosts with low specific star formation rates after correcting for light-curve parameters. They also confirm that SNe Ia decline more rapidly in massive hosts and in hosts with low specific star formation rates. I study, for the first time, the variation of SNe Ia - host correlations with redshift and detect no evolution of these correlations. I find new evidence that the slope of the stretch-luminosity relation is steeper in SNe Ia that are exploding farther out from host centres, and confirm a previous finding that the slope of the colour-luminosity relation is shallower in massive hosts. I split SNe Ia into pairs of subsets that are based on the properties of the hosts, and fit cosmological models to each subset. I do not find any difference in the best-fit cosmological parameters. Among different subsets, I find SNe Ia in hosts with high specific star formation rates have the least intrinsic scatter in luminosity after standardisation. Finally, I show that the cosmological parameters from current and future SN Ia surveys, where redshifts will come entirely from host galaxy spectra, will remain consistent with those from present surveys where redshifts come from both the SN Ia or the host galaxy. My results are important for the ongoing (DES) and upcoming (LSST) SN surveys.

Ivo Seitenzahl
Australian National University

Modelling Thermonuclear Supernovae from Different Progenitor Systems -- Explosion Simulations, Nucleosynthesis, Observables

In 2011 the Nobel Prize in Physics was awarded to Perlmutter, Riess, and Schmidt "for the discovery of the accelerating expansion of the Universe through observations of distant supernovae. These Type Ia supernovae (SNe Ia) are also the dominant contributor to iron-group nucleosynthesis and leading candidates for the elusive sites of high energy cosmic rays the p-process isotopes and perhaps Galactic positrons. SNe Ia are thought to be thermonuclear explosions of white dwarf stars. Despite their ubiquitous importance to cosmology and astronomy their progenitor systems and the explosion mechanism(s) are still largely unknown. This "SN Ia progenitor and explosion mechanism problem" is one of the great unsolved problems in astrophysics

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Ashley Ruiter
ANU

Binary Star Evolution and the Birth of Transient Events

A long-standing paradigm was that Type Ia supernovae (SNe Ia) arise from the thermonuclear explosion of a white dwarf as it approaches a critical mass -- about 1.4 solar masses -- while accreting matter from a Sun-like or giant-like companion star. However, recent high-quality observations have made clear that SNe Ia are not a homogeneous group, thus presenting some challenges to this long-standing ""Chandrasekhar mass"" paradigm. Advancement in explosion modelling techniques has additionally shown that different explosion mechanisms are likely responsible for (at least some of) the observed diversity in SNe Ia.

In order to uncover the origin (progenitors) of these objects, one must understand how close binary stars evolve and interact. Such theoretical binary evolution calculations have already unveiled a unique formation channel of SNe Ia that originates from merging white dwarfs. Such evolutionary calculations are a necessary step in furthering our understanding of the wide variety of transient stellar objects that we expect to be discovered in the next decade. I will highlight a handful of interesting, theoretically-predicted sources that we can hope to see with upcoming deep surveys.

Alex Kim
Lawrence Berkely National Laboratory

A New Empirical Model for Type Ia SNe and Bayesian Hierarchical Modelling of Supernova Cosmology Surveys

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DAY 2: TUESDAY 17 NOVEMBER 2015

Igor Andreoni
Swinburne University of Technology

Deeper Wider Faster: Optical Counterparts to the Fastest Bursts in the Sky

Observations on very short timescales have uncovered phenomena such as gamma ray and x-ray bursts and the recently discovered fast radio bursts (FRBs). FRBs are millisecond radio bursts that are likely extragalactic in origin but whose physical mechanisms are currently unknown. Counterparts to FRBs at wavelengths other than radio have not been detected to date, hindering our understanding of their nature. I will discuss "Deeper Wider Faster", our coordinated program to search for counterparts to very fast transients at multiple wavelengths by performing simultaneous observations with the Parkes and Molonglo radio telescopes, the DECam optical imager on the 4m Blanco telescope, and Swift satellite UV/X-ray telescopes. The fast cadence (20 second continuous images) of our observations with DECam has the ability detect FRB counterparts, supernova UV shock breakouts, kilonovae, GRBs and other fast transients that have been previously difficult to detect in the optical, because of their extremely short durations and their unpredictable location in the sky.

Martin Bell
CSIRO

The Variability Properties of Southern Hemisphere Image Plane Pulsars at Low Frequencies

In this talk I will present results from the Murchison Widefield Array Transients Survey (MWATS). MWATS will provide a Southern Hemisphere census of transient and variable phenomena at low radio frequencies. This survey is currently in the second year of operations. In this talk I will present image plane results on the detection of Southern Hemisphere pulsars. We have currently detected ~100 pulsars at 154 MHz and we have calculated the variability statistics for a bright sample (25 pulsars). Three of the low dispersion measure pulsars show strong variability on hour timescales. One of the pulsars varies by as much 150%. We will present arguments that the variability observed is consistent with diffractive scintillation. In the conclusions to this talk I will discuss the potential for image plane pulsar studies in the SKA-Low era. This will include the possibility of detecting previously unknown pulsars using image plane variability studies.

Shivani Bhandari
Swinburne University

Searching and localisation of sources of dispersed radio emission

High time resolution studies of the radio Universe have led to the discoveries of unanticipated classes of transient astrophysical sources, such as Fast Radio Bursts (FRBs): bright, millisecond duration events in the radio sky. The High Time Resolution Universe (HTRU) survey at the Parkes

Radio Telescope was designed to discover Fast Radio Bursts, Rotating Radio Transients and Pulsars. All FRBs were discovered in the High latitude part of this survey and none were detected in the intermediate latitude region, which is inconsistent with the hypothesis that FRB sources are uniformly distributed on the sky (as expected of extragalactic bursts). In order to investigate this argument, I am searching for FRBs in the low latitude part of this survey, which covers the Galactic disk (-80deg < l < 30deg and -3.5deg < b < 3.5deg) with 72 minutes per pointing using the 21 cm Multi-beam Receiver. Additionally, localisation of FRB events would enable us to identify potential host galaxies and enable an estimate of the free electron density in the IGM, which in turn has the potential to address the "missing baryons" problem. Localisation can be achieved by performing rapid multi-wavelength follow-up observations in search of an afterglow. In this talk, I will present the single pulse search pipeline and initial results of the lowlat HTRU survey. I will also briefly describe the results of radio follow up observations of a recent FRB detected by Parkes.

Samuel McSweeney
ICRAR (Curtin University)

Science highlights from high-sensitivity pulsar observations with the MWA

Pulsars are exquisite probes of the turbulent interstellar medium (ISM), capable of resolving structures down to tens of thousands of kilometres. Understanding the ISM is important for many areas of astrophysics, such as galactic dynamics, the chemical evolution of the galaxy, and the identification of timing noise in the search for gravitational waves using pulsar timing arrays. Low frequency observations of pulsars are key, because the strength of propagation effects scales strongly with frequency.

We present the Murchison Widefield Array (MWA) as a key science tool for making high quality observations of pulsars at low frequencies (~80-300 MHz). Recently commissioned software for making tied-array beams and the MWA's high time resolution voltage capture system (VCS) allow an order of magnitude increase in sensitivity, vital for pulsar and other time-domain science. A pipeline has now been developed for observing the scintillation patterns of important pulsars at low frequencies, including a new computational technique for measuring the curvature of parabolic arcs in noisy secondary spectra. A program of MWA observations is being undertaken to sample a large number of millisecond pulsars. We present recent highlights including PSR J0437-4715, which yielded a new measurement of scattering screen distance of ~110 pc from Earth, consistent with a Parkes observation at ~730 MHz, and matching the predicted perimeter of the Local Bubble.

Christene Lynch
University of Sydney

Revealing Magnetic Activity in the Coolest Stellar Objects Using Multi-Frequency Radio Observations

The discovery of intense, non-thermal radio emission from the lowest mass stars and brown dwarfs implies the presence of strong magnetic fields. These fields are unexpected given the fully convective interior and observed sharp decline in chromospheric Hα and coronal X-ray emission for

these objects (collectively called ultracool dwarfs). The exact mechanism for radio emission from these sources is unclear, but the emission is likely due to a combination of the cyclotron maser instability and the gyrosynchrotron process. Due to the small number of detected sources and limited range of frequencies covered with current radio observations, emission models are not well constrained. Radio surveys of ultracool dwarfs have found that about 10% of these systems are radio luminous, with a current detection number at 15 sources. We have conducted a large observational campaign to expand the current catalog of known radio loud ultracool dwarfs and better characterize the frequency structure of the detected radio emission. A portion of these observations were obtained using the new wideband receivers on the Very Large Array and the Australian Telescope Compact Array, providing simultaneous wideband frequency coverage not previously available. Additionally, we use the Murchison Widefield Array to look for ultracool dwarfs at frequencies (154 MHz) not previously explored. The results of this large campaign will be presented and we will summarize the prospects of detecting ultracool dwarfs with other widefield radio surveys.

DAY 3: WEDNESDAY 18 NOVEMBER 2015

Laura Wolz
University of Melbourne

Intensity Mapping Cross-Correlations: Connecting the Largest Scales to Galaxy Evolution

Intensity mapping surveys of neutral hydrogen (HI) are a novel way to measure the large scale matter distribution of our Universe and thus constrain parameters describing the Universal expansion. The impact of instrumental systematics of such observations such as radio inference, calibration uncertainties and strong foregrounds can be significantly reduced by cross-correlating the HI signal with galaxy surveys. The cross power spectrum of the HI and galaxy distribution can not only provide trustworthy information on cosmological features such as the baryonic acoustic oscillations but also provide new, exciting insights into the mechanisms of galaxy evolution.

In my talk, I will give an overview on the CAASTRO Intensity Mapping project which, on the one hand, comprises on-going observations at the Parkes telescope around redshift 0.9 targeting the WiggleZ galaxy survey fields for cross-correlations. On the other hand, we model the expected signal and, particularly, the signature of the cross-correlation using semi-analytic simulations. I will present our first suite of theoretical predictions for the cross-correlations coefficient of HI and WiggleZ galaxies and also give an update on the data processing pipeline showing some preliminary cross-power spectra.

Danail Obreschkow
UWA

Low Angular Momentum as the Cause of Clumpy Turbulent Disks

Ever since the time of Kant it has been supposed that angular momentum was fundamental to the nature of the ‘spiral nebulae’, now known as galaxies. In regular galaxies of the nearby universe, angular momentum is an important driver of the global galaxy morphology. However, it is unclear what role angular momentum plays in the distant, early universe, where the appearance of star-forming galaxies is dominated by irregular, clumpy morphologies in turbulent gas-rich disks. Here, I report on the first precision angular momentum measurements of such clumpy turbulent objects taking advantage of a sample of rare local analogues, which can be probed to large radii. We find that they have a factor of three less angular momentum than typical nearby spiral galaxies. This result is in agreement with a simple physical model where the major morphological evolution of the population of star-forming galaxies is driven by the build-up of angular momentum, linked directly to the cosmic expansion. This new perspective can potentially resolve most answered questions regarding the morphological evolution of star-forming galaxies.

Sarah Leslie
ANU

Star Formation in the Local Universe

Star formation is a key aspect of galaxy evolution. The observed bi-modality of galaxies in colour-magnitude space extends to the more physical star formation rate (SFR) vs stellar mass plane: the 'red and dead' sequence galaxies are spheroidal, more massive and have low SFRs, whilst galaxies in the 'blue cloud' are blue disc galaxies which lie on the 'main sequence of star formation'. It is believed that galaxies transition from blue to red. Many evolutionary pathways have been proposed, and it is not yet clear what the dominant drivers are.

I will present recent results which indicate that AGN activity could be tied with the quenching of SFR in galaxies. I will also present my work with IFU surveys (SAMI and CALIFA), where I have focused on multi-wavelength observations of star formation in local galaxies, making use of radio continuum observations in particular.

Simon Deeley
University of Queensland

How Elliptical Galaxies Grow in Galaxy Groups

It is well established that in the high density centres of large galaxy clusters, there is a higher fraction of elliptical galaxies relative to the field. However, how the elliptical fraction varies across low-mass groups is poorly understood. We used the Galaxy and Mass Assembly (GAMA) group catalogue to determine the group mass - morphology relation across group masses from 10^11 to 10^15 Solar masses. Contrary to previous studies and expectations, we find a continual increase in the fraction of elliptical galaxies with increasing group mass at a rate of 13% per decade of group mass. This provides a strong indication that a process dependent on the group environment is driving the transformation.

We then tested if the observed mass-morphology relation can be explained by the relative merger activity of galaxies in different groups by making comparisons with a GADGET-2 Dark-matter-only simulation. Defining elliptical galaxies as those which have undergone a major merger, we find excellent agreement between the simulation-based group mass-morphology relation and our observational results, providing strong evidence that merger activity is indeed a dominant driving force of transformation within these groups.

Adam Schaefer
Sydney Institute for Astronomy

SAMI Galaxy Survey: Environmental Quenching Of Star Formation in Galaxies.

The role of the local environment in the formation and evolution of galaxies is not well understood. While previous surveys (e.g. Lewis et al. 2002, Patel et al. 2009, von der Linden et al. 2010, Wijesinghe et al. 2012) agree on a decline in the global star formation rate within galaxies at higher environment densities, the quenching timescales and mechanisms that affect this relationship

remain elusive. Some have argued that this trend is driven by the changing fraction of star forming galaxies in high density environments, while others claim the overall level of star formation is reduced in these objects. We use spatially resolved extinction corrected H-alpha measurements from the Sydney-AAO Multi-object Integral Field Spectrograph (SAMI) to quantify the distribution of star formation in ~200 galaxies. This sample covers three orders of magnitude in both stellar mass and environment density and is the largest of such samples that has been made to date.

Our data show evidence for the quenching of star formation in galaxies in high density environments. We find that galaxies in more dense environments have more centrally concentrated star formation compared to those in the field. Along with the D4000 and H-delta gradients this suggests that outside-in quenching is occurring in more dense environments on relatively short timescales.

Dan Taranu
ICRAR/UWA

Modelling and Simulating SAMI Galaxies

I will present selected results from theoretical modelling and simulations of galaxies for the SAMI survey. First, I will describe a new method for self-consistent dynamical bulge-disk decomposition of galaxies, fitting both the photometry, stellar populations and kinematics simultaneously. This method yields robust constraints on the bulge fraction, angular momentum and other interesting properties of disk galaxies. Applying this method to the hundreds of available SAMI galaxies promises to provide unique insights into the scaling relations and formation mechanisms of spiral galaxies. I will also discuss ongoing efforts to simulate the formation of early-type galaxies in groups, including modelling star formation in disks and in mergers alike.

Sarah Reeves
University of Sydney

HI Emission- and Absorption-Line Observations of Nearby, Gas-Rich Galaxies

The 21cm HI absorption-line provides a unique probe of the gas in and around galaxies. Unlike HI emission, the detectability of the absorption-line is essentially independent of distance and so can be used to study the neutral gas in galaxies out to very high redshifts. Next-generation radio telescopes, such as the Australian Square Kilometre Array Pathfinder (ASKAP) will make it possible to conduct the first large, blind absorption-line surveys. ASKAP-FLASH (the First Large Absorption Survey in HI) will search for HI absorption along 150,000 sightlines, studying the evolution of neutral hydrogen in galaxies over redshifts $0.5<z<1.0$. In preparation for FLASH we have been conducting a targeted search for intervening HI absorption in a sample of nearby, gas-rich galaxies. Using ATCA-CABB observations we obtain simultaneous HI emission- and absorption-line data. This allows us to map the galaxies in HI, and directly relate the HI distribution to the absorption-line detection rate. Our results include the detection of a deep, narrow absorption-line in the galaxy NGC5156, an example of the kinds of absorption-line systems we might expect to detect with FLASH. We also

investigate the expected detection rate for future absorption-line surveys, and what factors (e.g. background source structure, gas spin temperature) are likely to affect this detection rate. In this talk I will present the results of our ATCA survey, and discuss implications for future absorption-line surveys such as FLASH.

Bart Pindor
University of Melbourne

MWA Epoch of Reionization Experiment

The MWA EOR experiment is an attempt to open a new field of observation cosmology using low-frequency radio observations of neutral hydrogen in the early universe. I will review the design of this experiment and report on its current status.

Cathryn Trott
Curtin University

The Epoch of Reionisation power spectrum: what it tells us and how to measure it

I describe the neutral hydrogen power spectrum, as a statistical metric to probe the Epoch of Reionisation and Cosmic Dawn. After briefly describing the scientific utility of the power spectrum, I concentrate on its measurement with low-frequency radio interferometers, and describe some of the challenges inherent in the experiment. I then discuss approaches to overcoming these challenges with current and future experiments. This talk connects with the EoR calibration and science presentations.

Stephanie Bernard
University of Melbourne

Bright Galaxies at z ~ 9-10 with the Brightest of Reionising Galaxies Survey

To characterise the epoch of reionisation, it is necessary to study the galaxies that were present during the period. While more than a thousand galaxies have been identified from deep imaging at redshift z ~ 6 (t~1 Gyr), near the end of reionisation, the number of candidates decreases rapidly at earlier times, with a few hundred sources at z~8 (t~650 Myr), and only a handful at z~9-10 (t~500 Myr). I will present our search for galaxies at the highest redshift (z>8) using near-IR archival data over ~0.1 deg^2 from the Brightest of Reionizing Galaxies (BoRG) survey, a random-pointing survey with Hubble designed to identify rare, luminous (m_AB~26-27) sources in the epoch of reionization. I will also present preliminary results from the new BoRG[z9-10] survey.

Joseph Callingham
University of Sydney

The Low Radio Frequency View of Gigahertz-Peaked Spectrum and Compact Steep Spectrum Sources

Gigahertz-peaked spectrum (GPS) and compact steep spectrum (CSS) sources have been hypothesised to represent an early stage of radio galaxy evolution. However, such an interpretation is contentious as it is possible that these sources are not young but are confined to a small spatial scales due to a high density medium. One of the reasons there has not been resolution between these two competing hypotheses is because the absorption mechanism responsible for the turnover in their radio spectra still ambiguous since the spectra of these sources below the turnover has not been well enough sampled to date.

The Murchison Widefield Array (MWA) has conducted an all-sky survey at low radio frequencies (72 to 231 MHz). This survey provides an unparalleled number of GPS and CSS sources with broad spectral coverage below the turnover. In this talk I will present results of spectral modelling of these sources and discuss the impact such a frequency domain has on our understanding of the absorption mechanism. I will demonstrate that the MWA all-sky survey has identified a large population of GPS sources that have ceased activity, and will show that a portion of the ultra-steep spectrum source population will be composed of GPS sources in a relic phase.

Jennifer Riding
University of Melbourne

Using Shapelets to Subtract Bright Foregrounds for the MWA

Any astronomical observation that takes place near another bright source, particularly if it's extended, represents careful work to remove it to obtain the desired data. With the MWA it's even more difficult: the field of view of the telescope means that avoiding complex bright sources is hard and working at 150MHz means that there are many more bright sources than at other wavelengths. One method is to use shapelets to model the bright, compact sources (that are already well-known) and subtract them straight from the calibrated data, allowing access to nearby regions without leaving artefacts. The method is simple and fast with hopes that it will one day aid the MWA EoR project.

Vernessa Smolocic

Christian Wolf
RSAA Mt Stromlo ANU

The SkyMapper Southern Survey Data Release 1

The first large data release of the SkyMapper Southern Survey is planned for November 2015. I will review scope and parameters of the release as well as the future ahead.

Paul Hancock
Curtin University

Least Squares Fitting with Correlated Noise

Fitting an elliptical Gaussian to a blob in a radio image seems like a simple task, however this task is more complex than first thought. The commonly implemented approach is to use a fitting routine that relies on the MINPACK library, but without much understanding of the statistics that are involved. In this talk I will describe the problem at hand, the assumptions that are implicitly being made, how these assumptions are wrong, and then present a new implementation that makes the correct assumptions. The result is an easy to implement modification to a least squares fitting routine, that will result in smaller errors, more accurate error reporting, and a better understood bias.

Katherine Mack
University of Melbourne

Australia's First Dark Matter Direct Detection Experiment

In a joint presentation (with Prof Jeremy Mould), we will give an overview and update on the upcoming SABRE experiment to be carried out in the Stawell Underground Physics Laboratory, which will break new ground as the first dark matter direct detection effort in the Southern Hemisphere. We will discuss the current status of dark matter searches, the advantages for this detection strategy, and the astrophysical uncertainties in the detection prospects. This experiment will be searching for the annual modulation of the dark matter flux, and as such is highly dependent on the density and velocity structure of the Milky Way dark matter halo. The CAASTRO contingent of the collaboration will be working to calculate the expected event rates and uncertainties in this context, prior to the commencement of data taking. In this presentation, we will also give an update on the current status of the experiment's infrastructure and international partnerships, as well as information as to how other low-background experimental groups may use the laboratory.

Julie Banfield
Australian National University

Radio Galaxy Zoo

I will present Radio Galaxy Zoo results from the first twelve months of operation, which upon completion will provide visual inspection of over 170,000 radio sources to determine the host galaxy of the radio emission and the radio morphology. Radio Galaxy Zoo uses 1.4GHz radio images from both the Faint Images of the Radio Sky at Twenty Centimeters (FIRST) and the Australia Telescope Large Area Survey (ATLAS) in combination with mid-infrared images at 3.4 um from the Wide-field Infrared Survey Explorer (WISE) and at 3.6 um from the Spitzer Space Telescope. I will show early analysis of the WISE mid-infrared colours of the host galaxies, newly discovered radio galaxies with extreme morphologies, and our unexpected discoveries by our citizen scientists.

Brad Tucker
ANU

The Kepler Extra-Galactic Survey (KEGS)

Kepler's unique technical capabilities are not only well suited for finding and studying exo-planets, but also supernovae. I will give an overview of the Kepler Extra-Galactic survey - a program using Kepler to search for supernovae, active galactic nuclei, and other transients in galaxies. To date we have found two type Ia supernovae and two core-collapse supernovae. The 30-minute cadence of Kepler has revealed subtle features in the light-curves of these supernova not detectable with any other survey. With a high-cadence, high precision survey, shock break-out in a large number of SN can be found, improving our understanding of supernova progenitors. We can also search in nearby galaxies for very fast and faint transients, filling in a previously unaccessible parameter space. Lastly, the precision data of any discovered type Ia supernova combined with ground based data can dramatically improve our use of type Ia for determining distances and measuring the properties of dark energy.

Signe Riemer-Sorensen
University of Oslo/UQ

The Evolution of Deuterium

Consisting of a proton and a neutron, deuterium is the simplest chemical tracer we have. It is leftover from the big bang nucleosynthesis and since there are no significant astrophysical sources of deuterium production, the abundance is continuously decreasing. At high redshift the deuterium abundance can be measured from its absorption features in quasar spectra. However, present measurements feature a larger scatter than expected from their uncertainties. I will discuss the scatter in the light of significantly increased exposures from Keck and VLT providing new (re)measurements. Also the local measurements of deuterium in the Milky Way displays a significant scatter, with the highest values very close to the primordial value. Without sources of production, this can only be explained with significant infall of primordial deuterium. Combining infall from simulations with high precision measurements of the primordial deuterium abundance, we can

reproduce the high deuterium measurements for simple chemical evolution models, and thereby constrain baryonic feedback.