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TALK ABSTRACTS

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Chris LIDMAN
ANU
Siding Spring Observatory in the era of Australia's strategic partnership with ESO and LSST

Siding Spring Observatory is home to the 3.9m AAT, the ANU 2.3m, the UK Schmidt Telescope, and SkyMapper. It also hosts telescopes from eight organisations, a number that is likely to grow in the years to come. In this talk, we examine the role of Siding Spring in the context of Australia's strategic partnership with ESO, the start of LSST in the early 2020s, multi-messenger astronomy and the era of ELTs

Chris TINNEY
UNSW
The Anglo-Australian Telescope One Year into its New Operating Model

On July 1, 2018 the AAT transitioned into a new governance and operational model, with its handover from the AAO to the AAT Consortium. This group of Australian Universities is now funding the AAT and governing its operations through the AAT Council, managing its operations through Astronomy Australian Limited, with telescope operations being run (under contract) by the ANU. This has necessitated a few changes to the model we have all been used to for the AAT, and will require further evolution in the years ahead.

Rob SHARP
ANU
The Giant Magellan Telescope Status and Evolution

With excavation of the of the telescope pier and enclosure foundations now complete, GMT is well on its way to delivering ELT access to the Australia community. I will present resent development highlights for the project and map out the evolving capabilities of the telescope as developed for the recently refreshed scientific vision driving the observatory.

Andrew SHEINIS
CFHT
Update on the Maunakea Spectroscopic Explorer

Australia is a partner in the Maunakea Spectroscopic Explorer (MSE), a massively multiplexed spectroscopic survey facility that will be built in the coming decade on the Canada-France-Hawaii telescope site on Maunakea, Hawaii. MSE will be a dedicated, 11.25 m, wide-field telescope that will observe more than 4000 targets distributed over 1.5 square degrees in every pointing. MSE will use 8 fibre-fed spectrographs to capture ~3000 low resolution spectra (R~3000) and ~1000 high-resolution spectra (R~40,000) covering the full 1.5 sq. degree field contiguously with each resolution. MSE will have a survey speed that is ~6x faster than PFS and ~20X faster than MOONS based on aperture size x field of view x multiplexing x observing time. Furthermore, it will produce the same number of spectra as the full SDSS Legacy Survey every 7 weeks. Some of the initial science goals will be to identify the astrophysical location and details of stellar nucleosynthesis; unveil the composition and dynamics of the faint universe through chemical abundance studies of stars in the outer Galaxy; measure the masses of thousands of black holes at the cores of galaxies; weigh neutrinos; and test exotic models of cosmology where dark energy properties vary at high redshift. Australian scientists make up approximately 10 % of the MSE Science Team that now involves close to 400 astronomers from 30 countries. Furthermore, Australia has been picked to develop the fibre positioner system based on the systems AAO produced for Subaru and 4Most. Here, I will review the technical aspects of the facility and discuss scientific potential of the only dedicated 10-meter class spectroscopic facility planned for the coming decade.

Philip EDWARDS
CSIRO Astronomy & Space Science
SKA Activities in Australia

A number of important milestones have been passed in the last 12 months, with the signing of the SKA treaty to establish the Square Kilometre Array Observatory (SKAO), the passage of design consortia through their Critical Design Reviews, and progress in the SKA Science Working Groups and Focus Groups. This talk will include updates from the Australian SKA Office (part of DIIS), the Australia--New Zealand SKA Coordination Committee, and the Science Working Groups to keep the community informed of progress towards construction of this transformational telescope.

Randall WAYTH
Curtin University
The SKA-Low Aperture Array Verification Systems: results and plans

As SKA-Low moves towards the construction phase, several prototype/verification stations have been deployed including the Aperture Array Verification Systems and the Engineering Development Arrays. The stations consist of 256 dipole antennas in a 35-40 metre diameter area and have been undertaking verification and limited science observations. This presentation will give an overview of the design and performance characteristics of the stations, and the road to SKA-Low.

Kate CHOW
CSIRO Astronomy and Space Science
The MRO, Australia's radio quiet site: enabling world-class radio astronomy

The Murchison Radio-astronomy Observatory (MRO) is located in an extremely radio quiet region of the planet, approximately 800 kilometres north of Perth, within the boundaries of the Boolardy Station pastoral lease. This unique observatory is now the most well protected radio astronomy site in the world. The MRO is currently the site of the Australian Square Kilometre Array Pathfinder (ASKAP), operating over the frequency range 700; 1800 MHz, the Murchison Widefield Array (MWA), operating over 50; 350 MHz, and EDGES, observing between approximately 50; 200 MHz. The Australian component of the international Square Kilometre Array (SKA) telescope project is also to be sited in the same region. The extremely remote nature of this location makes it an ideal site for radio astronomy. Since 2005, a number of regulatory measures have been introduced by the Commonwealth government (through the Australian Communications and Media Authority) and the Western Australian government (through the Department of Mines, Industry Regulation and Safety) to prevent or control radio frequency interference (RFI) to radio astronomy at the MRO. In total, these measures provide unprecedented radio quiet protection; in frequency coverage, in geographic extent, and in the range of potential interference sources. The protections in place cover the frequency range 70 MHz to 25.25 GHz, an area 260 km in radius, and address both intentional radiocommunication transmitters and incidental emissions from electrical equipment. The best way to demonstrate the success (or failure) of these radio quiet measures is to use the radio telescopes themselves. The success was shown in 2018 when EDGES announced possible evidence of an indirect detection of signals from the birth of the first stars, in the cosmic dawn; era, which would not have been possible without the excellent radio quiet environment at the MRO. The presentation will include more recent RFI measurements at the site using improved monitoring equipment as well as data from the MWA and ASKAP telescopes which show the very low RFI achieved. A brief description and explanation of the radio quiet protection will also be presented.

Eric THRANE
Monash University
OzHF: A high-frequency gravitational-wave detector

Gravitational waves from coalescing neutron stars encode information about nuclear matter at extreme densities, inaccessible by laboratory experiments. The late inspiral is influenced by the presence of tides, which depend on the neutron star equation of state. Neutron star mergers are expected to produce remnant hyper-massive (and/or supra-massive) neutron stars. These rapidly rotating remnants emit gravitational waves, providing clues to the hot post-merger environment; a likely source for r-process elements. The signature of nuclear matter in gravitational waves becomes most important at frequencies of 2-4 kHz, outside of the most sensitive band of current detectors. We present the design concept and science case for OzHF, a gravitational-wave detector optimised to study nuclear physics with merging neutron stars. The OzHF concept uses high laser power along with quantum squeezing in order to achieve the sensitivity necessary to probe nuclear matter using high-frequency gravitational waves.

Roger CLAY
University of Adelaide
The Pierre Auger Observatory – a cosmic ray directional telescope.

The Pierre Auger Observatory has been fully operational since 2008. In that time, it has continued to be the pre-eminent ultra-high energy astrophysical observatory, recording and measuring cosmic rays (UHECR) having energies up to ~10^20 eV with unprecedented precision, and setting important upper limits to the fluxes of photons and neutrinos above 10^18 eV. The Observatory is continuing to map cosmic ray arrivals and will soon be enhanced with a significant upgrade to enable it to estimate the mass composition of all the recorded particles. At the highest energies accessible to Auger, the highest particle energies known to exist, deflections of cosmic ray nuclei in passing through the galactic magnetic field become sufficiently small that it has become possible to map the sky in charged cosmic rays. The current results of that mapping, and discussion of its limitations and future prospects with improved composition data, will be presented.

David PARKINSON
Korea Astronomy and Space Science Institute
Cosmology with TIANLAI and DESI

The last two decades have seen an immense growth in our understanding of the physics of the birth and evolution of our Universe. However, there are still many unanswered questions relating the nature of the dark energy and gravity on large-scales. In order to investigate these problems, upcoming wide area surveys in the radio and optical will measure the baryon acoustic oscillation standard rulers and redshift-space distortion growth rate of structure. In this talk we discuss the cross-correlation of two such surveys: TIANLAI, a large-area survey of neutral hydrogen in the radio, and DESI, an optical galaxy redshift survey. By cross-correlating the two, the science will be enhanced while systematic errors are mitigate. We show results made using the Horizon Run 4 cosmological N-body simulation.

Mark KRUMHOLZ
Australian National University
Star formation, turbulence, transport, and feedback: towards a unified model for the dynamical state of galactic discs

In this talk I review attempts to build a self-consistent model for the dynamical state of the ISM in star-forming galactic discs. Ideally such a model would incorporate star formation, stellar feedback, gravitational instability, the maintenance of turbulence, and perhaps the transport of gas through the ISM, into a unified framework, simultaneously explaining the relation between gas content and star formation (the Kennicutt relation), the observed correlation between galaxies' star formation rates and velocity dispersions, and a variety of other observations. I summarise the various ways that theorists have attempted to fit together physical ingredients to reach this goal, the differing physical pictures behind these models, and the strengths and weaknesses of each when it comes to reproducing the observations. I then show that it is possible to combine the best elements of these models into a single, unified picture that successfully reproduces most of the major observations. I suggest future observations and numerical experiments that can be used to test this unified model.

Cathryn TROTT
ICRAR - Curtin University
New signal estimators toward the detection of the Epoch of Reionisation

The detection of the 21cm neutral hydrogen signal from the Epoch of Reionisation is an ongoing goal for international radio astronomy teams, but progress has been hampered by the complexity of the instrumentation and the bright foreground sky obscuring the signal. In this talk I will briefly review two new methods that attempt to detect signals from this early period of the Universe using data from the Murchison Widefield Array. First, we use a kernel density estimator to study the distribution of the data and show that we are able to discriminate foregrounds from signal more easily than the typical power spectrum. Second, we attempt the first observational measurement of the 21cm bispectrum, the Fourier Transform of the three-point correlation function. We show that this is a promising technique for current radio interferometer experiments.

Reference 1: Trott, Fu, Line, Murray, Jordan, et al, MNRAS, accepted, 2019; Reference 2: Trott, Watkinson, et al, PASA, accepted, 2019

Cherie DAY
Swinburne University of Technology
The population of localized Fast Radio Bursts seen by ASKAP

Fast Radio Bursts (FRBs) are one of the great mysteries of modern astronomy. The fact that these millisecond bursts of radio emission remain detectable across cosmological distances implies a hitherto-unknown and incredibly energetic emission mechanism. Beyond the tantalizing prospect of discovering their origins, these bursts also encode information about all the ionised plasma encountered along their lines of sight and thus promise to be highly valuable cosmological probes. The key to unlocking both of these applications is associating FRBs with their host galaxies -- a task requiring arcsecond precision localisations. In this talk I will present the results of searches for FRBs with the Australian Square Kilometre Array Pathfinder (ASKAP), which -- with its 6-km maximum baseline -- has achieved FRB localisations with (sub-)arcsecond precision. I will discuss the FRBs localised to date by ASKAP along with the method used to pinpoint their origins, before briefly summarising what these FRBs have revealed about the potential progenitors and hosts.

Moritz Thomas HUEBNER
Monash University
The search for gravitational-wave memory

Gravitational-wave memory is a strong field effect of general relativity that manifests as a permanent displacement in spacetime after a gravitational wave has passed. I present our ongoing efforts to detect gravitational-wave memory with the LIGO/Virgo network. Although the signal is expected to be extremely weak, I show how the Bayesian Inference software; Bilby; can be used to detect memory. Using a simulated population of binary black hole detections in LIGO/Virgo based on our current best estimates, I show how long it will take in practice to detect memory. Furthermore, I present how far events in the first two LIGO/Virgo observation runs have brought us to a memory detection.

Rebecca MAYES
University of Queensland
The formation of ultra-compact dwarf galaxies and their black holes in a cosmological simulation

Ultra-Compact Dwarf galaxies (UCDs) are intermediate objects between star clusters and galaxies. One theory of UCD formation is that they are the stripped nuclei of dwarf galaxies that were tidally disrupted by mergers with other galaxies. Recent observations have detected supermassive black holes in a few massive UCDs, supporting this formation hypothesis. However previous simulations have not had the resolution to model the presence of UCDs and their black holes. We have used the state-of-the-art EAGLE simulation to model the formation of UCDs. We have done this by tracking the most bound particles of galaxies that are stripped in the simulation, which we then identify as UCDs. The EAGLE simulation allows us to determine the size of the black hole that was in the progenitor galaxy and now resides in the surviving UCD. We first tested the radial distribution and masses of the simulated stripped nuclei against observed UCDs and found them to be consistent, suggesting that UCDs likely are stripped nuclei. Our next step will be to determine the black hole masses of the simulated stripped nuclei and compare them with observations. This will allow us to test the masses of the simulated UCD black holes against observed UCDs. In my talk, I will discuss UCDs and the simulation in greater detail, highlight some of our results and discuss future work to be done.

Nigel MAXTED
University of New South Wales Canberra at Australian Defence Force Academy
The apparent importance of gas clumps for cosmic-ray acceleration in Supernova remnants

Gamma-ray astronomy may offer answers to a long-standing question of high energy astrophysics: Where do cosmic rays come from? The gamma-ray emission seen from some middle-aged supernova remnants is now known to be from distant populations of cosmic-rays interacting with gas, but there is still much work to be done in accounting for the Galactic cosmic-ray flux. I will present analyses of the interstellar medium gas surrounding young and middle-aged Galactic supernova remnants such as W28, RX J1713.7-3946, HESSJ1731-347, Vela Jr, HESS J1534-571 and others using data from the Mopra radio telescope. By making the connection between supernova remnant high energy emission and gas, as traced by molecules such as CO, CS and NH3, we can test the potential of these objects to accelerate hadrons beyond TeV energies.

Rhys POULTON
International Centre for Radio Astronomy Research
Studying the orbits and interactions of satellite galaxies in the next generation of simulations

With the latest generation of galaxy surveys capable of detecting galaxies with stellar masses of down to $10^{7.7} M_{\odot}$, it is crucial that the prescriptions used by Semi-Analytic Model (SAM) to model smaller galaxies, especially satellites, has greater accuracy and better match observations. In particular, it is common practice for SAMs to use a simplified treatment of satellite mergers. Orbital analysis is a potential technique to investigate the validity of these prescriptions. I present a revised study of orbital properties, tidal mass loss and mergers using a new analysis tool, OrbWeaver that is available on Github. I use the merger trees extracted using state-of-the-art phase-space halo finder and merger tree builder (VELOCIraptor & TreeFrog) and several large N-body simulation from the GENESIS simulation suite to reconstruct the orbits of satellites. I find the orbital evolution in the eccentricity and period of satellites depends on the initial mass ratio and circularity. I also show merger timescale predictions used by SAMs overpredicts the merger timescale of small satellites as it ignores tidal mass loss.

Hao QIU
University of Sydney
Temporal properties of ASKAP fast radio bursts

The Australian Square Kilometer Array Pathfinder (ASKAP) has now discovered over 27 fast radio bursts (FRBs) in fly's-eye mode and interferometry mode. The temporal properties of FRBs such as dispersion, scattering and pulse profile reveals the effects of propagation through large columns of plasma. This provides an insight to the intergalactic medium and the dense media in the host galaxies. In this talk we present a detailed study focusing on the temporal properties of ASKAP FRBs. We present a study of the Fly's-eye FRB population for any evidence of scattering or intrinsic temporal structures. We compare the Fly's-eye FRBs with the published Parkes and CHIME FRBs and discuss the relation between scattering and dispersion measure/redshift. We also present the temporal structure of FRBs detected in interferometry mode with high time resolution and discuss how this helps with understanding the host environment of the burst.

Manodeep SINHA
Swinburne University of Technology
Towards Accurate Modelling of Galaxy Clustering on Small Scales: Testing the Standard ΛCDM + Halo Model

The large-scale distribution of galaxies can be explained fairly simply by assuming i) all galaxies are hosted by halos and ii) a cosmological model. This simple framework, called the 'halo-model', has been remarkably successful at reproducing the large-scale clustering of galaxies observed in various galaxy redshift surveys. However, none of these studies have truly tested the 'halo-model' by carefully modelling the systematics. We present the results from a fully-numerical, accurate 'halo-model' framework and show that the theory cannot simultaneously reproduce the galaxy projected correlation function and the group multiplicity function in the SDSS main samples. In particular, the bright galaxy sample shows significant tension with theory. We discuss the implications of our findings, as well as how to constrain different aspects of galaxy formation by simultaneously fitting multiple statistics.

Dougal DOBIE
University of Sydney
Constraining properties of neutron star merger outflows with radio observations

The detection of the first neutron star merger, GW170817, heralded the dawn of a new era in multi-messenger astronomy. Observations of the radio lightcurve helped constrain merger parameters including the jet opening angle, the energetics of the merger and the circum-merger density. However, these observations alone were insufficient to distinguish between two competing models for the merger geometry - where a relativistic jet launched along the merger axis either successfully breaks out of the dense surrounding medium, or dissipates within it ("choked"; jet or cocoon). The tension between these models was not resolved until observations using Very Long Baseline Interferometry detected superluminal motion, suggesting that the late-time emission was jet-dominated. In this talk I will discuss prospects for the detection of future events and how we can place constraints on merger geometry using VLBI and observations of interstellar scintillation. I show that while the late-time outflow structure can be constrained using VLBI observations to either directly image the outflow, or detect centroid motion produced by the presence of a jet, these observations are unable to be used to determine early-time behaviour. Instead we can place meaningful constraints on the early-time source size via the detection of interstellar scintillation from high-cadence multi-frequency observations.

Hosein HASHEMI
ICRAR
The Emergence of Bulges and Disks in the Universe.

Fundamentally, galaxies consist of different components with different physics. The two most significant components could be considered as disk and bulge. Having different studies, we know that the dynamic, star formation, kinematic and stellar population in these two components are different. So the question is what physical processes and evolutionary history have leaded galaxy components to the shape we observe today? By structural decomposition of galaxies over a high dynamic range in both redshift and stellar mass, I investigate how the most resolved imaging data from the Hubble Space Telescope in COSMOS/DEVILS field can help us to disentangle galaxies into their components and study the evolution of mass and size of the components. This will tell us how the components of galaxies assemble their mass and how they relate to their size. Such a mass and size exploration of the components of galaxies might reveal how/why we see a heterogeneous population of galaxies having at least two very disparate ingredients.

Garima CHAUHAN
ICRAR/UWA
How HI populates haloes: Simulations vs. Observations

All HI surveys are affected by selection effects, which in some cases can be quite complex. To understand these biases and how they affect our understanding of how galaxies populate dark matter halos, we have modelled HI emission lines of the galaxies in the semi-analytic model of galaxy formation SHARK, built on the LCDM SURFS suite of N-body simulations. We use the latter to create a mock ALFALFA survey with the same selection function and instrumental effects as the real survey. We explored the long-standing problem of the over-production of low circular velocity galaxies and found our simulated ALFALFA survey to reproduce the observed HI velocity width distribution very well; hence, concluding that the discrepancies previously reported are due to the complex selection effects of HI surveys. We also found that these biases affect galaxies even at the dwarf galaxy regime. During this talk, I will present these results, and also show which biases might affect the upcoming HI surveys like WALLABY and DINGO, and how best to tackle them.

Chris TINNEY
UNSW Sydney
Exoplanetary Science with Veloce

The new Veloce spectrograph for the AAT aims to provide the AAT with an internationally competitive precision Doppler facility targeting the exoplanetary science of both transiting and non-transiting planets. It is also the first facility-class instrument at the AAT in over 2 decades to be almost totally externally funded (via the ARC LIEF scheme and University contributions). I will review the lessons learned from this new process for building instruments, and update the exoplanetary results emerging from the combination of Veloce and the NASA TESS mission

Richard N MANCHESTER
CSIRO Astronomy & Space Science
New Tests of GR from Timing the Double Pulsar

The great stability of millisecond pulsar periods and the existence of pulsars in binary systems make possible a range of tests of theories of relativistic gravitation, in particular, Einstein’s general theory of relativity (GR). In this talk I will discuss new results from 15 years of timing the Double Pulsar, PSR J0737-3039A/B, using the Parkes, Green Bank and European radio telescopes. These have enabled measurement of six relativistic parameters, giving five independent tests of GR in strong gravitational fields. The most stringent of these are fully consistent with GR at a level of 0.01%. They have also revealed the effects of Lense-Thirring precession and gravitational light-bending leading to constraints on the moment of inertia of the neutron star

R N Manchester[1], M Kramer[2], N Wex[2], I H Stairs[3] and M Burgay[4]

1. CSIRO Astronomy and Space Science, Sydney, Australia
2. Max Planck Institute for Radio Astronomy, Bonn, Germany
3. University of British Columbia, Vancouver, Canada
4. Cagliari Astronomical Observatory, Cagliari, Italy

FEI QIN
The University of Western Australia
Testing cosmology using peculiar velocity surveys

In the local Universe, the gravitational effects of mass density fluctuations exert perturbations on galaxies' redshifts on top of Hubble's Law, called 'peculiar velocities'. These peculiar velocities provide an excellent way to test the cosmological model in the nearby Universe. In this talk, we present new cosmological constraints using peculiar velocities measured with the 2MASS Tully-Fisher survey (2MTF), 6dFGS peculiar-velocity survey (6dFGSv) and the cosmicflows-3 compilation. Firstly, the dipole and the quadrupole of the peculiar velocity field, commonly named 'bulk flow' and 'shear' respectively, enable us to test whether our cosmological model accurately describes the motion of galaxies in the nearby Universe. We develop and use a new Bayesian estimator that accurately preserves the error distribution of the measurements to measure these moments. In all cases, our results are consistent with the predictions of the Λ cold dark matter model. Additionally, measurements of the growth rate of structure, $f\sigma 8$ in the low-redshift Universe allow us to test different gravitational models. We developed a new estimator of the 'momentum' (density weighted peculiar velocity) power spectrum and use joint measurements of the galaxy density and momentum power spectra to place new constraints on the growth rate of structure from the combined 2MTF and 6dFGSv data. We recover a constraint of $f\sigma 8=0.404+0.082-0.081$ at an effective redshift $z_{eff}=0.03$. This measurement is also fully consistent with the expectations of General Relativity and the Λ Cold Dark Matter cosmological model. Finally, we discuss the implications for future peculiar velocity surveys (i.e., WALLABY, TAIPAN or from LSST) and how the new techniques we have developed could be used on these data to produce even more accurate tests of our cosmological model.

Prakrut CHAUBAL
University of Melbourne
Cluster Cosmology

Galaxy clusters are among the largest structures in the Universe and form the highest peaks in the matter density on megaparsec scales, which makes them one of the most sensitive probes of the late time Universe. I will discuss the lensing of cosmic microwave background (CMB) radiation by galaxy clusters. CMB-cluster lensing is an especially valuable tool to constrain galaxy cluster masses at high redshifts. In particular, this talk will focus on a new method to incorporate the CMB lensing mass information into parameter constraints from galaxy cluster cosmology. The improved constraints from CMB lensing are expected to improve constraints on the Dark Energy equation of state ww, the rmsrms value of amplitude fluctuations σ8σ8, and the total neutrino mass ΣνΣν.

Paul LASKY
Monash University
Inferring the physics and astrophysics of gravitational-wave sources

Bayesian parameter estimation is fast becoming the language of astrophysics. It is the method by which gravitational-wave data is used to infer the sources & astrophysical properties. We introduce a user-friendly Bayesian inference library for gravitational-wave astronomy, Bilby. This python code provides expert-level parameter estimation infrastructure with straightforward syntax and tools that facilitate use by beginners. It allows users to perform accurate and reliable gravitational-wave parameter estimation on both real, freely available data from LIGO/Virgo and simulated data. Bilby is versatile enough to perform inference on any data set; I will present examples from radio pulsar observations, x-ray astronomy, and more.

Federico BIANCHINI
University of Melbourne
A new CMB lensing measurement from 500 deg^2 of SPTpol temperature and polarisation data

The cosmic microwave background (CMB) anisotropies provide a snapshot of the universe at the time of recombination, and their accurate measurements have advanced our understanding of the origin, composition, and evolution of the universe. However, the path of CMB photons is gently deflected by the intervening large-scale structure (LSS), perturbing our view of the primordial universe. This effect, dubbed weak gravitational lensing, introduces non-Gaussian features in the observed CMB temperature and polarisation anisotropies which can be exploited by high-sensitivity experiments to reconstruct the projected mass distribution out to the surface of last scattering. Thus, CMB lensing offers a unique window on the dark universe by being sensitive to the geometry and growth of LSS, which in turn can place tight constraints on the sum of neutrino masses and on the mechanisms sourcing the cosmic acceleration. In this talk, I will present a new measurement of the CMB lensing potential power spectrum using data from 500 eg^2 of the southern sky observed with SPTpol, a millimeter-wavelength polarisation-sensitive receiver installed on the South Pole Telescope, and discuss its cosmological implications.

Shanika GALAUDAGE
Monash University
Selection effects in gravitational-wave astronomy

With the latest LIGO/VIRGO observing run well underway, gravitational-wave detections are being recorded at a rate of roughly one a week. Some of these events are easier to detect than others. For example, it is easier to detect binaries with higher masses than lower masses. Detection efficiency depends on other variables as well including sky location, distance, and the orientation of the binaries. The non-uniformity of detection efficiency leads to selection effects, creating bias in astrophysical inferences. In this talk I discuss how selection effects impact a range of astrophysical inferences, from the sky maps sent to electromagnetic astronomers to binary masses. I describe how to fold selection effects into inference calculations in order to yield unbiased inferences.

Luke DAVIES
University of Western Australia
Growing up in a bad neighbourhood - probing the last 8Gyr of environmental impact on the growth of galaxies.

To first order the growth of stellar mass in galaxies is governed by two fundamental processes: star-formation and mergers. It is the combination of these processes over a galaxy's lifetime which shapes its evolutionary trajectory to z~0, ultimately governing its macroscopic properties that we observe today. Both star-formation and mergers are intimately liked to a galaxy's local environment, via the regulation of gas supply (starvation, strangulation, stripping, harassment) and likelihood of galaxy interactions. Hence, local environment can have a significant impact on a galaxy's evolution. Within SDSS and GAMA we have explored, in detail, the impact of local environment in the relatively nearby Universe. However, at higher redshifts there is a paucity of high-completeness samples required to identify and study the environmental impact on galaxies - especially outside of the cluster regime and/or for statistically robust sample sizes

Here I will present our recent z~0 work exploring the impact of group-scale environments and mergers of star-formation and the growth of stellar mass in GAMA (Robotham et al 2014, Davies et al 2015b, 2016a, 2016b, 2017, 2019a, 2019b). These results highlight a complex picture with local environment both enhancing and suppressing star-formation to varying degrees, depending on properties such as stellar mass, pair mass ratio, central/satellite status, halo mass, etc. I will then introduce DEVILS and WAVES as unique samples with which to expand this analysis over the last 8 Gyr of Universal history and explore how these trends have evolved since z~1. Finally, I will show how the exciting synergy of DEVILS and WAVES with SKA precursors will allow us to parameterise, in situ, the diverse array of astrophysics which govern the growth of stellar mass in galaxies.

NANDINI SAHU
Swinburne University of Technology
Supermassive black hole scaling relations and the pursuit of long-wavelength gravitational waves

Our analysis of 84 early-type galaxies (ETGs) with directly-measured super-massive black hole (SMBH) masses nearly doubles the number of such galaxies with multi-component photometric decompositions. We establish new robust scaling relations between the black hole mass and the host galaxy properties, including spheroid/bulge stellar mass, total galaxy stellar mass, central velocity dispersion, spheroid Sersic index, and spheroid half-light radius. We explore the scaling relations for various sub-populations of ETGs and discover intriguing results which also hold ramifications for formation theories, simulations, and specific virial factor measurements used to convert AGN virial masses into black hole masses. Combining our work with all 48 late-type galaxies

(LTGs) having directly-measured SMBH masses, we provide a clear picture of how black hole mass scale in galaxies. Implications for predictions of long-wavelength gravitational wave detection by the Parkes Pulsar Timing Array, MeerKAT, and LISA will briefly be mentioned.

Elizabeth MANNERING
AAO Macquarie
Why you need the Australian All-Sky Virtual Observatory

The All-Sky Virtual Observatory (ASVO) is enabling researchers to access data across a federated network of datasets, from all types of astronomical facilities in Australia. This talk is split into two sections. Firstly, we provide a short overview of the 5 nodes currently comprising the ASVO (SkyMapper, TAO, Data Central, MWA, CASDA) to re-familiarise astronomers with their current capabilities, as well as planned development going forward on a per-node basis. In the second half of this talk we present the future vision of the ASVO as a coordinated group of virtual observatories serving the astronomical community. We report on the planned interoperability between the nodes and compliancy with IVOA protocols, as informed by the community through the 2018 ASVO User Survey. Finally, we present possible use-cases for the planned future upgrades to the nodes, showcasing the scope of the scientific investigations that are possible with the ASVO.

Nicholas BORSATO
University of New South Wales
Identifying Stellar Streams in Gaia DR2 with Data Mining Techniques

Streams of stars from captured dwarf galaxies and dissolved globular clusters are identifiable through the similarity of their orbital parameters, a fact that remains true long after the streams have dispersed spatially. We calculate the integrals of motion for 44855 stars, out to a distance of four kiloparsecs, with full 6D phase space positions in the Gaia DR2 catalogue. We then apply a novel combination of data mining, numerical and statistical techniques to search for stellar streams. This process returns seven high-confidence streams (including four that were not known to exist) that display tight clustering in the integral of motion space. Colour-magnitude diagrams of the stars in each stream indicate that they are relatively simple, old, metal-poor populations with energy, angular momentum and eccentricity values that suggest they are captured dwarf galaxies. The success of this project demonstrates the advantages of using data mining techniques in exploring large survey data sets.

Janie HOORMANN
University of Queensland
Measuring Black Hole Masses with the Australian Dark Energy Survey

The Australian Dark Energy Survey (OzDES) completed its sixth and final year of observations this past December. As part of OzDES the Reverberation Mapping (RM) program regularly targeted 771 AGN out to a redshift of $z < 4.5$ with the goal of measuring black hole masses. With this data we will be able to verify the radius-luminosity relationship out to high redshifts, study black hole mass evolution, and test whether or not AGN can be used as standard candles in cosmology. I will overview the OzDES RM program and present the results obtained using the first five years of data.

Xingjiang ZHU
Monash University
Multimessenger search for supermassive binary black holes

Binaries of supermassive black holes at sub-parsec separations, which are thought to be natural products of galaxy mergers, have yet to be discovered. On the one hand, pulsar timing arrays provide a promising way of detecting the gravitational waves emitted by such systems. Many believe that such a breakthrough detection is likely to happen in the next few years. On the other hand, there have been hundreds of binary candidates reported in the last several years from electromagnetic surveys. For example, a large number of candidates have been claimed based on the apparent periodic variations in quasar light curves. However, the intrinsic stochastic variability of quasars, usually termed as red noise, can lead to false detections with the standard periodogram search, making such claims ambiguous. In this talk, I will first summarise multimessenger efforts to detect such binary black holes. Then I will describe a new detection technique that can unambiguously identify supermassive binary black hole candidates in quasar light curves. I will present my findings on several well-known candidates.

Shivani BHANDARI
CSIRO astronomy and space science
Fast radio bursts and their multi-wavelength follow-ups.

Fast Radio Bursts (FRBs), exotic millisecond duration bursts which are now established as a bona fide astrophysical phenomenon are currently the hottest topic in the field of transient astronomy. The discovery of FRBs has stimulated a range of theoretical investigations to understand their origin and physics as well as observational efforts around the world to search for more such bursts. New instrumentation capable of real-time detection has enabled prompt multi-wavelength follow-ups upon detection. The ongoing SUPERB project at the Parkes radio telescope is discovering FRBs in real time and effecting rapid multi-wavelength follow-ups which are a key to determining FRB progenitors. In this talk, I will present the latest SUPERB FRB discoveries and the results of their radio, optical and X-ray follow-ups. I will also summarise what is happening around the world for the follow-up of FRBs at all wavelengths to motivate further discussion. There is no more exciting time to be involved in the field!

Lara CULLINANE
The Australian National University
Exploring origins of stellar substructures in the Magellanic Periphery using 3D kinematics

The Large and Small Magellanic Clouds (LMC/SMC), as two of the closest and most massive satellites of the Milky Way, have significant effects on the local Universe; including the distribution of ultra-faint satellites, and the orbits of tidal streams. Ongoing survey efforts with the Dark Energy Camera have revealed a wealth of low-surface-brightness stellar substructures in the periphery of the Clouds; characterising these structures will provide significant insight into the currently poorly-constrained masses and interaction history of the Clouds. In order to elucidate the properties of the structures, we have used 2df+AAOmega at the Anglo Australian Telescope to instigate a large-scale spectroscopic follow-up of stars across the Magellanic periphery. We are able to detect the kinematic signature of the Clouds up to projected distances of 23 degrees from the centre of the LMC. Combining our spectroscopically derived radial velocities with Gaia DR2 astrometry provides the first 3D kinematics for these regions. Our initial set of measurements, along a large substructure to the north of the LMC, reveal radial velocities near the extremity of the substructure are significantly different from those expected from an extrapolation of the LMC rotation curve; this discrepancy may indicate a strong warp in the LMC disk. Our ultimate aim is to use these 3D kinematics to assess dynamical models of the Clouds; this will shed new light on the origin of the substructures, and the evolution of the Magellanic/Milky Way system.

Hannah MIDDLETON
University of Melbourne
Adaptive noise cancellation with LIGO noise lines

The observation of gravitational waves from merging compact objects has marked the beginnings of gravitational waves astrophysics for ground-based gravitational-wave observatories like LIGO and Virgo. However, these instruments are also searching for other gravitational wave sources. Continuous gravitational waves from rotating neutron stars are persistent, long duration signals at close to monochromatic frequencies. Noise sources can also introduce monochromatic signals into the interferometer data, which proves challenging if searching for a continuous gravitational wave signal near to the affected frequencies. One such noise source in the LIGO observatories originates from the 60Hz American electricity grid. Here we investigate whether signal processing techniques (similar to those used in noise-cancelling headphones) can be used to help continuous gravitational wave searches.

Lister STAVELEY-SMITH
University of Western Australia
Decadal Plan Mid-Term Review

The mid-term review (MTR) of the 2016-2025 Decadal Plan for Australian astronomy is due to be published in mid-2020, with community input being requested during the second half of 2019. On behalf of the NCA, I will summarise the MTR process and timeline, and discuss the process for community input. The status of 2016-2025 Decadal Plan priorities will be discussed; potential opportunities that have arisen in the last few years will also be highlighted.

Aidan HOTAN
CSIRO
The countdown to ASKAP survey science

This year, CSIRO’s latest national facility radio telescope became fully operational. The Australian SKA Pathfinder offers a new rapid survey capability in the frequency range 700 to 1800 MHz with its 30 square degree field of view. I will describe the capabilities of the telescope, some of the highlights from our early science observations and the remaining steps that will verify the telescope and its associated data processing pipeline are ready to commence multi-year survey projects.

Andrew PENTON
University of Queensland
Toward accurate black hole masses with time-lapse spectra from OzDES

OzDES has been monitoring 771 supermassive black holes across redshifts $0.3 < z < 4.5$ for the last six years. With this treasure trove of time-lapse spectroscopic data we are in the process of measuring “reverberation mapping” masses for these black holes. This technique uses the time delay between continuum and spectroscopic emission spikes to measure the radius of the region around the black hole, and line widths to measure velocities of orbiting clouds - with orbital distance and velocity we can calculate the central mass.

This talk will examine the effectiveness of our time-lag recovery techniques and the accuracy of our recovered black hole masses.

Karen LEE-WADDELL
CSIRO Astronomy and Space Science
WALLABY Science results with ASKAP

The Australian Square Kilometre Array Pathfinder (ASKAP) uses revolutionary phased array feeds (PAFs) to provide wide-field observations with the sensitivity and resolution required to resolve faint and extended radio emission. I will present the some of the Widefield ASKAP L-band Legacy All-sky Blind surveY (WALLABY) Early Science results being achieve with ASKAP. WALLABY will survey three quarters of the entire sky in neutral hydrogen (HI) to probe the properties of galaxies and their environments. With only a fraction of the array - during the commissioning and Early Science phases of ASKAP - we are already detecting newly resolved HI features, such as tidal streams, intragroup gas and previously unknown HI galaxies. Using ASKAPsoft, the custom-built processing pipeline, we are now producing science-ready image cubes and source catalogues. Our most recent results verify that ASKAP is poised for full operations.

Henry ZOVARO
The Australian National University
Searching for Signatures of Negative Feedback in Nearby Compact Radio Galaxies

Young jets from active galactic nuclei can inhibit star formation in their host galaxies by injecting heat and turbulence into the interstellar medium (ISM). Near-infrared adaptive optics-assisted integral field spectroscopy is a valuable tool for probing the ISM conditions in the hosts of these sources, enabling us to search for jet-driven feedback on sub-kpc scales. I will present our recent studies of jet-ISM interactions in the nearby compact radio galaxies 4C 31.04 and UGC 05771, which we observed using Gemini/NIFS and Keck/OSIRIS respectively. We detected shock-heated molecular hydrogen and [Fe II] emission in both sources. We also find shocked gas out to kpc scales in UGC 05771 using optical integral field spectroscopy from the CALIFA survey. In both sources, the extent of shocked gas is up to ~100x larger than the extent of the radio source in existing interferometric radio observations, implying that such observations fail to detect kpc-scale jet plasma. This is consistent with our hydrodynamical simulations, which show that the main jet stream may become temporarily halted behind a dense clump whilst secondary plasma streams can percolate through the ISM, forming an expanding bubble. Using IRAM CO observations, we find that UGC 05771 sits below the Kennicutt-Schmidtt relation, although we are unable to conclude whether the jets are inhibiting star formation due to shock contamination in our SFR estimate. Our findings demonstrate the important role that young jets may have in regulating star formation in the host galaxies of compact radio sources, which has implications for galaxy evolution.

David MCCONNELL
CSIRO Astronomy and Space Science
RACS - The Rapid ASKAP Continuum Survey

This talk introduces the first large-area survey completed with the full 36-dish Australian SKA Pathfinder (ASKAP) telescope, the Rapid ASKAP Continuum Survey (RACS), and presents some of the first science results. RACS has two main aims: to provide the first iteration of the Global Sky Model that will be needed to calibrate future deep ASKAP surveys, and to provide the astronomical community with a powerful new radio imaging survey of the southern sky. RACS has covered the whole sky visible from the ASKAP site in Western Australia (dec -90 to +40), initially at 744-1023 MHz. The RACS images are significantly deeper than the existing NVSS and SUMSS radio surveys, as well as providing a factor of four improvement in spatial resolution and full polarization information - opening up an exciting new view of the southern radio sky. All RACS survey products will soon be public. They include radio images (with ~12 arcsec resolution) published on CASDA, and catalogues of about 2 million source components with spectral index and polarization information.

Christian WOLF
ANU
The SkyMapper Southern Survey DR2 - and glimpses of science enabled

The second data release of the SkyMapper Southern Survey has been available to Australian astronomers and their collaborators since March 2019. It improves over DR1 by adding the first batch of deep Main Survey images, by adding data at more epochs and with improved homogeneity of calibration. In this talk I will highlight several science projects pursued by us and enabled by this release, in order to showcase the survey's capacity and entice future users. The science highlights range from luminous QSOs and rare types of QSOs over colour maps of nearby galaxies to black-body stars and blue large-amplitude pulsators. I will close with an outlook for future releases and synergy between SkyMapper and LSST.

Scott CROOM
University of Sydney
Environmental quenching and morphological transformations as seen by SAMI

The SAMI Galaxy Survey has now completed its observations of over 3000 galaxies. The sample spans a diverse range of environments from the field to rich galaxy clusters. It provides a powerful opportunity to better understand the physical processes that influence galaxy transformations. In this talk I will focus on what SAMI can tell us concerning the transitions driven by environment. Using the spatial distribution of star formation in SAMI galaxies we show that quenching happens from outside to in, in both clusters and groups. However, the timescale for this quenching appears different between clusters and groups, and I will present stellar population measurements to demonstrate this. By combining SAMI data with self-consistent dynamical models I will also discuss the role of environment in morphological transformations, in particular focusing on the evolution of spirals into S0s. We find that while some of the dynamical and structural change in this transformation is caused by the fading a quenched disk, this is not sufficient. Further dynamical processing is required to make the S0s we see in groups today.

Adam STEWART
University of Sydney
Searching for Radio Transient and Variable Sources in the Rapid ASKAP Continuum Survey

The completion of the Australian Square Kilometre Array Pathfinder (ASKAP) now provides the ability to study the transient radio sky to an unprecedented level. The ASKAP survey for Variables and Slow Transients (VAST) aims to fully explore the transient and variable parameter space, from local to cosmological transient phenomena on time scales from seconds to decades. The Rapid ASKAP Continuum Survey (RACS) is the first full southern sky survey being performed by ASKAP covering 27,000 deg^2. The survey is designed to provide a base sky model for future observations and reaches a sensitivity of 0.2 mJy/beam using 15 minute integrations. In this talk I will discuss the ongoing VAST analysis where past surveys such as the Sydney University Molongo Sky Survey (SUMSS) and the NRAO VLA Sky Survey (NVSS) are compared with RACS to search for transient and variable sources, to a peak brightness limit of 2 mJy. The search has a timescale of two decades, where AGN activity is expected to be the dominant form of variability, however, there is the prospect of detecting more "decades-long" transients such as that found by Law et al., 2018 - a candidate orphan afterglow of an off-axis gamma-ray burst. I will also detail the upcoming VAST survey plans for the ASKAP pilot survey period and beyond, including summarising current predictions of what will be detected.

Peter TUTHILL
University of Sydney
Nearby Earth-Analogs with TOLIMAN

Although discovery technologies are now populating exoplanet catalogs into the thousands, contemporary astronomy is poorly equipped to find the most compelling exoplanetary real-estate: earth-analog systems within the immediate solar neighbourhood. The TOLIMAN space telescope is a low-cost, agile mission concept dedicated to astrometric detection of exoplanets within 10PC, and in particularly targeting the Alpha Cen system. It accomplishes this by deploying an innovative optical and signal encoding architecture that targets the most promising technique for this critical stellar sample: high precision astrometric monitoring. Two pathfinder missions, the first a cubesat slated for launch this year, and the second a 10cm space telescope planned to fly in 2021, are now both fully funded. We will present an overview of the family of missions and the novel technologies underlying the signal detection strategy.

Amol UPADHYE
University of New South Wales
Cosmology as a search for neutrinos and new light particles

Cosmological measurements are becoming sensitive enough to provide the first-ever measurement of the neutrino masses, and to search for completely new particles suggested by recent experiments. I will discuss the effects of these light, fast particles on the formation of large-scale cosmic structure, as well as my recent constraints on them. Then I will describe ongoing work to tackle one of the most difficult problems in theoretical cosmology, the prediction of the non-linear clustering of massive neutrinos, which will be essential for making full use of next-generation cosmic surveys as probes of fundamental physics.

Tara MURPHY
University of Sydney
Radio follow-up of gravitational wave events

Radio observations of GW170817, the first binary neutron star merger detected by LIGO, were critical in distinguishing between theoretical models for the explosion. Our long term monitoring for a year after the event allowed detailed modelling of the non-thermal emission and subsequent VLBI observations ruled out isotropic ejecta and showed the emission was likely jet-dominated. In this talk I will review what we have learned so far from GW170817 and outline our plans for radio follow-up of gravitational wave events in LIGO O3 and beyond. I will also discuss unbiased radio surveys for short and long gamma-ray burst afterglows which have the potential to discover binary neutron star and neutron star-black hole mergers where the search for prompt optical emission is inhibited by the geometry of the event, the environment of the event, or even terrestrial weather at the time of observations. I will focus on the capability of Australian radio telescopes to contribute to this exciting area of research.

Brett ADDISON
University of Southern Queensland
Measuring the Masses and Orbital Obliquities of sub-Jovians, Warm Jupiters, and Multi-Planet Systems Discovered by TESS Using the MINERVA-Australis Telescope Array

The recently commissioned MINERVA-Australis telescope array is a facility dedicated to the follow-up, confirmation, characterization, and mass measurement of planets discovered by the Transiting Exoplanet Survey Satellite (TESS) orbiting bright stars (V<10). The facility is located at the University of Southern Queensland's Mount Kent Observatory in Australia. Its flexible design enables multiple 0.7m robotic telescopes to be used both in combination, and independently, for high-resolution spectroscopy and precision photometry of TESS transiting planet candidates. MINERVA-Australis is already delivering a radial velocity precision of 3m/s and continued improvements to the spectrograph's thermal stability are expected to result in a precision of 1m/s in the near future. It is expected that TESS will discover a large number of planet candidates orbiting bright stars in the coming years, and dedicated facilities such Minerva-Australis are urgently needed to confirm the candidates and characterize them. The predecessor to the TESS mission, Kepler, discovered thousands of exoplanets, the majority of which were between the size of Earth and Neptune ("super-Earth" or "mini-Neptunes"). Unfortunately, the great majority of stars targeted by Kepler were too faint for detailed follow-up work to be performed by all but the world's largest telescopes. In this sense, TESS is a game changer. It is expected to discover a plethora of Neptune and super-Earth candidates orbiting bright stars that are suitable for high-precision radial velocity follow-up on dedicated facilities such as with MINERVA-Australis. I will discuss the current efforts being made by the MINERVA-Australis consortium to follow-up the planet candidates discovered by TESS to confirm their planetary nature, and to measure their masses and orbital properties. The mass measurements we obtain, when combined with the planetary radii given by the TESS transit observations, will allow us to determine the bulk compositions of those objects and to distinguish them as either rocky, watery, or gaseous worlds. In addition to confirming and measuring the masses of TESS planet candidates, I will also discuss our efforts to probe the processes involved in planet formation and migration. Using MINERVA-Australis, we are measuring the sky-projected spin-orbit angles (i.e., the angle, λ, between the spin angular momentum vector of a host star and the orbital angular momentum vector of its planet) of exoplanets by observing the Rossiter-McLaughlin effect. Of particular importance are spin-orbit measurements of the least explored parameter space such as sub-Jovian planets, warm Jupiters and long-period planets, and multi-planet systems. These measurements are critical in determining the dominant mechanisms responsible for planet migration, whether it is disk-driven migration, or dynamical-migration mechanisms (e.g., planet-planet scattering, Lidov-Kozai cycling with tidal friction, and secular chaos).

Isobel Marguarethe ROMERO-SHAW
Monash University
Eccentricity in Binary Black Hole Coalescences Observed with Gravitational Waves

In 2015, Advanced LIGO made the first detection of gravitational waves. We now detect gravitational waves on a nearly weekly basis. The signals we observe come from coalescing compact binaries, which can be formed through numerous scenarios. Measurements of orbital eccentricity encoded in the gravitational waveform can be used to distinguish these different scenarios. When two stars co-evolve in the field, they are expected to have negligible eccentricity at detection, whereas dynamically formed binaries can retain measurable eccentricity. In this talk, I explain how different formation channels lead to different distributions of eccentricity. I present the results of a search for eccentricity using ten events from the first gravitational-wave transient catalogue. Finally, I show how future detectors will enable us to trace the evolution of globular clusters by tracking the relationship between redshift and eccentric merger rate.

Georgina TAYLOR
Australian National University
Supernova cosmology and controlling systematics from light curve fitting

Type Ia supernovae (SN Ia) have been used as cosmological distance indicators for the past two decades. The quality of SN Ia observations has increased dramatically over time, and so too must our methods for fitting their distances. In particular, we must work to minimise systematic errors, as further understanding of dark energy is now limited by systematic rather than statistical errors. In this talk, I will introduce the current state of supernova light-curve and distance fitting. I will show the issues and improvements to fitting methods that I've been researching in the context of the Dark Energy Survey, and show how the improvements propagate through to improvements in the measurements of dark energy.

Samuel CREE
Perimeter Institute for Theoretical Physics
Vacuum Fluctuations and the Cosmological Constant

The cosmological constant problem arises because the magnitude of vacuum energy density predicted by quantum field theory is about 120 orders of magnitude larger than the value implied by cosmological observations of accelerating cosmic expansion. Recently, a stochastic toy model of quantum vacuum fluctuations was developed which suggests a new resonance-based mechanism for the slowly accelerating expansion of the universe, potentially resolving this tension [Wang et al, Phys. Rev. D 95, 103504, 2017]. In recent work [Cree et al, Phys. Rev. D 98, 063506, 2018], we thoroughly investigated the dynamics of this model, extending it in new ways. I'll present our results showing the effects of varying both the number of particle fields and the choice of ultraviolet cutoff for vacuum fluctuation frequencies. I'll also introduce a new analytic method using the Mathieu equation (a prototypical example of parametric resonance) that closely matches numerical results. We find that this toy model provides evidence that resonance of fluctuations can explain the slowly accelerating expansion of the universe.

Harrison James ABBOT
Australian National University
Real Time Detection of Shock Physics in TESS

While hunting for exoplanets, the Transiting Exoplanet Survey Satellite (TESS) serendipitously provides us with 30 minute cadence photometry of large patches of the local universe, allowing us to analyse extragalactic transients. By utilising ground based telescopes to discover supernovae (SNe) that occur within the TESS fields, we have triggered early spectroscopic time series of young SNe, allowing us to see the spectral signatures of shocks unfold before peak brightness. The high cadence photometry of TESS enables us to produce exquisite light curves of these shocks in real time; a feat which has seldom been successful in the past. In this talk, I will present the work done to date in finding these shock signatures and subtle features in exotic transients.

Madhooshi SENARATH
Monash University
A systematic survey for "changing look" AGNs

We are conducting a systematic survey for z <0.04 active galactic nuclei (AGNs) that have changed spectral class over the past two decades. We use Skymapper, PanSTARRS and the Veron-Cetty \Veron catalogue to search most of the sky for these "changing look" AGNs using a variety of selection methods. We use *riz* aperture photometry to identify changing look AGNs, using *r-i* color as a proxy for Hα equivalent width. We measure change in photometry over time by calculating the difference between PanSTARRS and Skymapper photometry and SDSS photometry, where a change in photometry may indicate a change in spectral type. NEOWISE multi-epoch photometry is also used to select changing look AGN candidates that change photometry over time. Our recent observations with the 2.3m Siding Spring Telescope WiFeS has discovered two new changing look AGNs. We identify a new changing look AGN, NGC 1346, using archival data alone, which changed spectral type from type 1 to type 2 between 2001 and 2004. Using photometry we attribute the change in spectral type of NGC 1346 to accretion rather than a simple lumpy torus.

Guillaume DROUART
Curtin University
The GLEAMing of the first supermassive black holes

Powerful radio galaxies - by displaying simultaneously active supermassive black hole (SMBH) and vigorous on-going star formation - are unique laboratories to study the impact of the SMBH feedback on its host galaxy. Moreover, the orientation in the plane of the sky allows the dusty torus to act as a natural coronograph, shielding us from the intense radiation from the accretion disc, thus, enabling the possibility to study the host galaxy. Using the efficient steep-spectrum selection technique from low-frequency radio surveys, we were able to build large samples of galaxies confirmed out to z=5.2 more than two decades ago. This provided us with the unique chance to study the physical properties of the progenitors of our local massive elliptical galaxies during the peak of the activity of the Universe (z~2-3). However, progress in finding more distant sources has been slow due to the lack of deep all-sky surveys at low frequencies. We designed a new technique making use of the new generation of low-frequency radio surveys in order to push our samples beyond the twenty-years old limit of z=5.2. I will present the results of our pilot programme on the VLT, ALMA and ATCA for a selection of sources from the GLEAM (an all-sky survey at 70-230MHz executed by the MWA). This technique has already shown its efficiency to detect a z=5.55 source with a potential candidate at even higher redshift.

Jinglin ZHAO
University of New South Wales
Fourier transform of spectral line profiles for detecting line shifts and line deformations

The intrinsic variability of stars can hinder the search of terrestrial-mass planets and the precise characterisation of these planets. Such stellar variability can induce spurious radial velocities, generically referred to as “jitter”, mimicking the presence of exoplanets. The key to this line of research is understanding the radial velocity impact of line profile variability in a measurable way.

I have developed a Fourier phase spectrum analysis (FIESTA) technique to study a spectral line profile in the Fourier domain. A pure shift of a line profile is equivalent to shifting all the decomposed Fourier basis functions of all Fourier frequencies by the same amount, while a line deformation is effectively the result of applying different shifts of the Fourier basis functions at different Fourier frequencies. As a result, it translates an abstract line deformation into the measurable shifts. Besides, FIESTA enables differentiating an intrinsic line shift from an intrinsic line deformation, which had not been robustly attainable by previous methods (e.g. employing stellar activity indicators). FIESTA may also be universally used to quantitatively identify a signal shift versus a signal deformation.

Josh CALCINO
University of Queensland
Signatures of an eccentric disc: Dust and gas in IRS48

Observations of protoplanetary disks at multiple wavelengths have revealed spectacular disk morphologies, including spiral arms, circular and eccentric dust cavities, and azimuthally asymmetric dust horseshoes. All these can be caused by the interaction of companions, of planetary or stellar mass, embedded within the disk. Using numerical simulations, I have been exploring how changing the properties of a companion in a disk changes the disk morphology. By including a stellar companion, I have found it is possible to create dust horseshoes with high contrast ratio, as observed in IRS48, without vortexes. Although no high mass companion has yet been confirmed in this disc, I will show how a companion with mass on the order of 0.4 Msun can explain the dust trap, and the asymmetric CO kinematics in this disc. My results indicate that asymmetrical dust horsehoes are the result of dynamical interactions between the host star, the companion, and the disc. These results bring in to question the common interpretation that dust traps in protoplanetary discs are caused by large scale vortices, which has consequences for some planet formation hypotheses. This interpretation makes clear predictions about the CO kinematics of the IRS48 which may be detectable with ALMA.

Patrick YATES
University of Tasmania
Radio sources in asymmetric environments

Active Galactic Nuclei (AGN) play an important role in the evolution of galaxy clusters and groups. One way they influence their host is through feedback from radio jets, which do work on their host hot atmospheres through supersonic outflows, shocks, and gas uplifting. Modelling the evolution of these radio jets is key to understanding their effects on the surrounding environment. Analytic models are able to predict large-scale radio lobe properties, or smaller-scale jet properties, but they can't capture all physical processes relevant to jet-environment interaction; this is where numerical models of radio jets are needed. Observational studies using data from the Radio Galaxy Zoo citizen science project (Rodman et al. 2019) have shown that there is often an observed environment asymmetry between the lobes of a radio source; this is something that cannot be studied properly with analytic models, but is expected to have a large effect on radio source evolution. We have studied the effect of asymmetric environments on radio source evolution, through state-of-the-art numerical three-dimensional simulations of a pair of relativistic jets. We find that environment asymmetry affects jet collimation distance, large-scale lobe morphology, and the observable radio source properties. Because the two bipolar jets are intrinsically identical, the observed asymmetry provides a probe of the jet's hot gas environment, a quantity which is notoriously difficult to measure. These models provide tools for interpreting environment-sensitive surveys with next-generation radio and optical/IR facilities. We present methods for understanding observations of asymmetric radio sources, and detail how they can provide information about the underlying structure of galaxy groups and clusters.

Jonti HORNER
University of Southern Queensland
Which ExoEarths should we search for life? The impact of planetary architecture on the Milankovitch cycles.

In the coming years, we will begin to discover the first truly Earth-like planets orbiting other stars, and the race will be on to search for any evidence of life upon them. But how will we choose where to look? In this presentation, I will examine one piece of that puzzle, showing how we might be able to use dynamical methods to filter the list of potentially habitable worlds for those that should be considered the most promising targets for that search. I will present the results of detailed n-body simulations of alternative versions of the Solar system. By examining how the long-term evolution of the Earth's orbit changes as a function of the initial orbits of the other planets, I will demonstrate how we can assess the amplitude and frequency of the Milankovitch cycles that will control the scale and pace of periodic climate variation on the alien worlds we discover.

Isabella PRANDONI
Istituto Nazionale di Astrofisica (INAF)
Towards a better understanding of the origin of radio emission in RQ AGN

To properly understand the detailed process of galaxy formation and evolution there is an urgent need to identify and quantify the role of AGN feedback, not only through detailed studies in the local Universe, but also at high redshifts, where most of the accretion occurred. While the bright radio sky is dominated by the emission driven by radio-loud (RL) AGNs, at fainter flux densities (<0.5-1 mJy) the contribution from star-forming galaxies (SFGs) and radio-quiet (RQ) AGNs (i.e. AGN which do not display large scale jets and lobes) becomes increasingly important. The detection of large numbers of RQ AGNs, traditionally studied at optical/IR or X-ray wavelengths, opens new exciting perspectives for deep continuum-radio surveys, providing a unique and powerful dust/gas-obscuration-free tool to get a global census of both star formation and AGN activity up to high redshifts; hence tracing the apparently simultaneous development of the stellar populations and the black hole growth in the first massive galaxies. In this talk I will give an overview of our current understanding of radio-selected RQ AGN and of the origin of their radio emission.

Pat SCOTT
Imperial College London / University of Queensland
Searches for dark matter with GAMBIT

I will give an overview of searches for different dark matter candidates within the global-fitting framework GAMBIT. I will touch on supersymmetric, Higgs portal and axion theories, and draw together constraints from direct and indirect detection, cosmology, solar physics, laboratory experiments and high-energy colliders.

Suk Yee YONG
The University of Melbourne
Orientation Tracer of Quasars in the UV/Optical

Orientation has long been envisioned to play a role in the basic unification scheme of quasars. Though the true structure of quasars remains unclear, it is often portrayed to be axially symmetric, suggesting that there is some dependence with the angle of viewing. A number of orientation indicators have been suggested in the optical, yet none has provided a convincing easy-to-measure test. We present a UV-optical orientation tracer using the correlation between the velocity shifts and the line width ratio of CIV and MgII lines. Comparison tests with other orientation indicators and simulations are shown to be consistent with our idea

Julian B. CARLIN
The University of Melbourne
Pulsar Glitches: Predictive Statistical Modelling

As the number of observed rotational glitches in pulsars grows, thanks to UTMOST and other observing programs, it is useful to not only disaggregate the data into individual pulsars, but to also consider the time-ordered nature of these events. The shape of waiting time and glitch size distributions, cross-correlations, and autocorrelations are all avenues that can test the applicability of a generic, statistical, stress-release model for glitches. The model produces precise, quantitative, falsifiable predictions regarding long-term glitch statistics. Reconciling observations with the model leads to implications as to which physical mechanism may be causing glitches in pulsars.

Shi DAI
CSIRO Astronomy and Space Science
Ultra-Wideband Polarized Radio Emission from the Newly Revived Magnetar XTE J1810-197

We present studies of magnetar XTE J1810-197 during its recent radio revival using the new Ultra-Wideband Low receiver system of the Parkes radio telescope. Ultra-wideband (704-4032 MHz) polarization pulse profiles, single pulses, and flux density measurements are presented. The anomalous X-ray pulsar XTE J1810-197 was the first magnetar found to emit pulsed radio emission. After spending almost a decade in a quiescent, radio-silent state, the magnetar was reported to have undergone a radio outburst in 2018 December. We observed dramatic changes in polarization and rapid variations of the position angle of linear polarization across the main pulse and in time. The pulse profile exhibits similar structures throughout our three observations (over a week timescale), displaying a small amount of profile evolution in terms of polarization and pulse width across the wideband. We measured a flat radio spectrum across the band with a positive spectral index, in addition to small levels of flux and spectral index variability across our observing span. The observed wideband polarization properties are significantly different compared to those taken after the 2003 outburst, and therefore provide new information about the origin of radio emission.

Sabine BELLSTEDT
International Centre for Radio Astronomy Research, University of Western Australia
Using the SED-fitting code ProSpect to measure the cosmic star formation history.

Measuring the cosmic star formation history (SFH) is essential to our understanding of the build-up of stellar mass in our Universe. SED fitting techniques, which use multi wavelength photometry from galaxies in the low-z Universe to infer their SFHs, are becoming increasingly popular to measure the cosmic SFH as an alternative to star formation rate measurements at different epochs of the Universe. Up until now, however, the cosmic SFHs derived from such techniques have not shown good agreement with observations. In this talk, I will present results using a new nonparametric SED fitting code \textsc{ProSpect} to derive star formation histories of ~ 6000 low-z galaxies from the GAMA survey to infer the cosmic SFH. I will show that this implementation has provided a marked improvement when compared with the results of other SED fitting techniques. These results highlight the power of ProSpect as an SED fitting technique to produce more realistic SFHs of galaxies.

Saeed SALIMPOUR
Deakin University/Edith Cowan University
Recent Developments in Astronomy Education in a Global context

2019 is appearing to be a turning point for Astronomy Education worldwide. The International Astronomical Union (IAU) has called for bids to host the fourth and final official IAU office, the Office of Astronomy Education. This is expected to be finalised by the end of the year. The IAU, involving a group of international collaborators led by Leiden University, has also recently completed a Proposed Definition of Astronomy Literacy, now available online for comment and critique. A similarly large and similarly international group led by the speaker has also recently completed a complimentary review of the K-12 curricula around the OECD countries (including South Africa and

China). The speaker will provide an overview of the recent international developments in astronomy education focussing on the projects mentioned above, but also summarising some of the current smaller, but equally important, Astronomy Education-related activities spread around the globe. Australia, in particular, has played a central and continuing role in many aspects of international astronomy education with three Division C (Education) executive positions held by ASA members at the IAU and multiple international projects involving Australian collaborators in leadership positions. The talk will conclude with potential directions forward in Australian and International Astronomy Education. (Only available on the 9th)

Rami ALSABERI
WSU
Discovery of a pulsar-powered bow shock nebula in the Small Magellanic Cloud supernova remnant DEM S5

We report the discovery of a new Small Magellanic Cloud pulsar wind nebula (PWN) at the edge of the supernova remnant (SNR) DEM S5. The pulsar powered object has a cometary morphology similar to the Galactic PWN analogues PSR B1951+32 and “the mouse”. It is travelling supersonically through the interstellar medium. We estimate the pulsar kick velocity to be in the range of 700-2000km s-1 for an age between 28 and 10kyr. The radio spectral index for this SNR-PWN-pulsar system is flat (–0.29 $\pm$ 0.01) consistent with other similar objects. We infer that the putative pulsar has a radio spectral index of –1.8, which is typical for Galactic pulsars. We searched for dispersion measures up to 1000cm-3pc but found no convincing candidates with an S/N greater than 8. We produce a polarization map for this PWN at 5500 MHz and find a mean fractional polarization of p ~ 23 percent. The X-ray power-law spectrum (Γ ∼ 2) is indicative of non-thermal synchrotron emission as is expected from PWN-pulsar system. Finally, we detect DEM S5 in infrared (IR) bands. Our IR photometric measurements strongly indicate the presence of shocked gas that is expected for SNRs. However, it is unusual to detect such IR emission in an SNR with a supersonic bow shock PWN. We also find a low-velocity Hi cloud of ~107km s-1 that is possibly interacting with DEM S5. SNR DEM S5 is the first confirmed detection of a pulsar-powered bow shock nebula found outside the Galaxy.

Devika KAMATH
Macquarie University
Bridging the uncertainties in the modelling of stellar nucleosynthesis.

The chemical evolution of galaxies is governed by the chemical yields from stars, especially from Asymptotic Giant Branch (AGB) stars. This underlines the importance of understanding how AGB stars produce their elements by obtaining accurate stellar nucleosynthetic yields. Although AGB nucleosynthesis has general validity, critical uncertainties (such as the treatment of convective-driven mixing processes and mass loss) exist in current stellar models. Furthermore, AGB nucleosynthesis is highly dependent on initial mass and metallicity. For instance, depending on the initial mass and metallicity at which the hot bottom burning process is activated, the model predictions on third dredge-up efficiency, final C/O ratios, and elemental abundances (such as C, N, O, Na, Mg, Al, Li, F etc.,) significantly vary. Observations from Post-Asymptotic Giant Branch (post-AGB) stars serve as excellent tools to confront predictions from a dedicated suite of stellar models, quantify the strongest discrepancies, and eliminate crucial uncertainties that hamper stellar modelling. Past attempts have been hampered by non-systematic and small samples of post-AGB stars, and poorly determined parameters such as initial mass. By strategically integrating the Gaia survey with detailed chemical abundance studies of post-AGB stars in our Galaxy, and the LMC/SMC, we are building a comprehensive data set of elemental and isotopic abundances of post-AGB stars as a function of initial mass and composition. In this talk, I will present our unique data set and our efforts to eliminate and unify the treatment of uncertainties in theoretical stellar models.

James PAYNTER
The University of Melbourne
Gravitational Lensing of Gamma-Ray Bursts

The cosmological origin of gamma-ray bursts necessitates gravitational lensing. Yet in the 50 years since their discovery not a single convincing candidate has been found. We present what we believe to be the first gravitationally lensed gamma-ray burst pair. The lens candidate is of order 100,000 solar masses, and we will discuss the likelihood of this object being a stellar cluster or compact object.

Tessa VERNSTROM
CSIRO
Detecting Cosmic Magnetic Fields with Faraday Rotation

Magnetic fields are everywhere: from our Galaxy, to powerful active galactic nuclei (AGN), to galaxy clusters, and the intergalactic medium (IGM). The overall distribution of magnetic field strengths in the IGM, and their dependence on redshift, is a “must know” feature in uncovering the history of magnetic field evolution. While we cannot measure cosmic magnetic fields directly, they do affect light in ways we can observe. One of the most powerful techniques to investigate magnetic fields is through Faraday rotation, or rotation measures. Rotation measures provide information about the magnetic fields along the line of sight, including contributions from the Galaxy, extragalactic sources, the IGM, and the environment local to the emitting source. This can be useful, however, precise RM measurements are needed (and many of them), along with detailed information about the emitting sources, are needed to disentangle the cosmic magnetic field information from all the rest. There are several different possible methods for using the rotation measures of extragalactic sources to try to detect the IGM. This talk will cover recent works using different methods with currently available data, and show why SKA and SKA pathfinder polarisation surveys can’t come soon enough.

Jean-Pierre MACQUART
International Centre of Radio Astronomy Research/Curtin University
Weighing the Universe’s Baryons

Much has been made of the potential of fast radio bursts (FRBs) to discern the whereabouts of the large reservoir of all baryonic material of the Universe that resides in intergalactic space. The dispersion measures of FRBs are capable of accounting for all the ionized baryons along their lines of sight. This renders them the ideal instrument both to weigh the baryonic content of the Universe and to investigate how galactic feedback processes pollute the intergalactic medium. We use the redshifts of several well-localised CRAFT FRBs to weigh the baryonic content of the Universe. We also directly examine the baryonic halo of a massive intervening system intersected by an FRB sightline to derive its density, magnetic field and turbulence properties. In addition, we describe the environments of the FRBs themselves.

Ryan SHANNON
Swinburne University
MeerTime: Early results from MeerKAT’s pulsar timing project

Radio pulsars provide one of the great natural physical laboratories. The pulsar timing technique enables tests of strong-field gravity, constraints on nuclear equations of state and the strong nuclear force; probes the extremes of electromagnetism; and is being used to detect low-frequency gravitational waves. However, pulsars are faint sources, and these experiments have been limited by the sensitivity of existing radio telescopes. There is about to be a paradigm shift in pulsar timing, in the form of the MeerKAT telescope in South Africa, which is a factor-of-eight more sensitive than comparable southern facilities and has commenced regular pulsar timing observations this year. In this presentation, I will outline the capabilities of MeerKAT that make it a game changer for pulsar timing. I will provide an overview of MeerTime, a MeerKAT project that will spend 5,500 hours over the next 5 years monitoring pulsars. This will include an overview of the major science goals of the project, namely the detecting of low-frequency gravitational waves through pulsar timing array observations, testing of general relativity by tracing the shapes of binary-pulsar orbits, and establishing the pulsar emission mechanism through regular observation of every pulsar in the southern sky. I will highlight some of early results from the telescope. These include the highest precision observations of a pulsar ever obtained and new views on faint pulsars in the Magellanic Clouds. I will conclude by discussing the outlooks for pulsar timing with MeerKAT and the Square Kilometre Array (SKA), and how MeerTime is being used to prototype SKA regional data centre activities.

Jake Thomas CLARK
University of Southern Queensland
Can stellar abundances help explain the architecture of planetary systems discovered by TESS?

Ever since the exoplanet era began, we astronomers have come across some truly bizarre and diverse exoplanetary systems. The physical and chemical processes that produce these systems, along with planetary atmospheres, surfaces and bulk compositions are incredibly complex. Yet, there seems to be some tantalizing evidence suggesting that stellar abundances are playing an integral role in determining certain aspects of the chemical, geological and physical constraints of exoplanets and exoplanetary systems. For example, C/O ratios of stellar hosts and planetary atmospheres could potentially aid us in understanding the formation mechanisms of hot-Jupiters whilst Mg/Si and Fe/Si ratios can help determine the geological and chemical structure of larger terrestrial and smaller gassier worlds. Obtaining high precision measurements of stellar chemical abundances, in addition to stellar physical properties, is crucial for this understanding. However, relative uncertainties in stellar properties, some as high as 100% (e.g TESS Candidate Target List), hinders astronomers and planetary scientists alike in accurately shaping an exoplanetary system's structure. Until now. By cross-matching stars from Australia's GALactic Archaeology with HERMES (GALAH) with stars being observed by NASA's Transiting Exoplanet Survey Satellite, we have derived the stellar mass and radii of 40,000 potential planet-hosting stars to 3-5% precision using high resolution spectra. The self-consistent stellar parameters (Teff, Logg, Vsini, Radius, Mass, Age etc.) combined with the chemical abundances for 30 elements ([X/Fe]) including iron, silicon, magnesium, carbon, oxygen, aluminium, nickel to name a few, will assist follow-up teams to determine the chemical and geological makeup of newly found exoplanets like never before. This newly derived catalogue already contains several planet-hosting stars, which I will summarise general patterns with other known planet hosts from the K2-HERMES survey. Lastly, I describe how the Southern Hemisphere's only dedicated observatory to TESS follow-up, Minerva-Australis, is aiding other astronomers in determining stellar abundances from spectra used to discover and confirm TESS candidates.

Colm TALBOT
Monash University
Astrophysics with gravitational waves after advanced LIGO/Virgo's second observing run and beyond

During the first two observing runs of advanced LIGO/Virgo we detected eleven sources of gravitational waves. The sources identified in the first gravitational-wave transient catalog have enabled many novel astrophysical inferences from constraints on the nuclear equation of state, to independent measurement of the Hubble constant, to inferences about the mass and spin distribution of merging binary black holes. In this talk, I will describe the state of astrophysical inference with gravitational waves and the potential discoveries which will be possible in the coming years.

Adam THOMAS
Australian National University
Charlene Heisler prize talk: The ionising radiation and gas-phase metallicity in the narrow-line regions of Seyfert galaxies

The physical conditions in the narrow-line regions (NLRs) of active galactic nuclei (AGN) may be constrained by comparing spectroscopic observations with photoionisation models. The key parameters are the gas-phase abundances, the ionisation parameter, the gas pressure, and the shape of the ionising spectrum. A model of the ionising continuum radiation in Seyfert AGN is discussed. The full data release of the Siding Spring Southern Seyfert Spectroscopic Snapshot Survey (S7) is presented. Three-dimensional data cubes, two-dimensional emission-line fits, and other products have been provided to the astronomical community, along with a large number of maps of gas kinematics across the S7 sample. A Bayesian code is presented that compares photoionisation model grids with observed emission line fluxes. This code NebulaBayes is agnostic to model parameters, dimensionality, and the chosen emission lines. Grids of MAPPINGS photoionisation models have been calculated and used with NebulaBayes to infer physical parameters in two dimensions across four “pure Seyfert” galaxies selected from the S7 sample. The results are the first robust two-dimensional measurements of gas-phase metallicity in Seyfert NLRs, and show steep metallicity gradients into extraplanar ionisation cones in the case of edge-on galaxy NGC 2992, and an inverse metallicity gradient in the galaxy ESO 138-G01. The near-constant ionisation parameters suggest that radiation pressure regulates the density structure of NLRs on multi-kiloparsec scales. The ionising radiation is measured to be harder in ionisation cones than elsewhere, but the results are sensitive to spectral contamination. We also consider mixing of NLR emission with emission from HII-regions in star-forming galaxies. A “mixing” grid (combining HII and NLR model grids) is coupled with a statistically powerful sample from the Sloan Digital Sky Survey (SDSS) to constrain the HII-AGN “mixing fractions” using NebulaBayes. It is found that for the majority of Seyfert-classified SDSS spectra, the majority of the Balmer emission arises in HII regions as opposed to NLRs. We also make the first systematic and robust measurements of the gas-phase metallicities of active galaxies in the SDSS. The metallicities associated with Seyfert-classified emission are shown to be consistently high and the SDSS AGN follow the upper locus of the SDSS stellar mass-metallicity relation.

Matthew ALGER
The Australian National University/Data61
Radio luminosity functions with machine learning and Radio Galaxy Zoo

Studying extended radio source populations is challenging. Determining the host galaxy of these extended sources is usually a manual task, as the sources can have complex morphologies. We developed a machine learning model for radio-infrared cross-identification, trained this model on crowdsourced citizen science data from Radio Galaxy Zoo, and applied it to the VLA Faint Images of the Radio Sky at Twenty-centimeters (FIRST) survey. Our resulting catalogue of 157~007 radio sources and their infrared hosts is the largest sample of cross-identified radio sources ever. Using this catalogue, we estimate radio luminosity functions split by different host galaxy criteria: redshift, physical extent, and mid-infrared colour. We estimate the mechanical energy contribution of inferred active galactic nuclei jets to the inter-galactic medium. Our machine learning training methods, cross-identification approach, and radio luminosity function estimation method will be applicable to large upcoming surveys in the lead-up to the Square Kilometre Array. Such applications will boost the sample size even more and allow for even more detailed and precise radio luminosity functions.

James Edward DAVIES
The University of Melbourne
Thermal Memory of Hydrogen Reionisation

Intergalactic medium temperature is a powerful probe of the epoch of reionisation, as information is retained long after reionisation itself. However, mean temperatures are highly degenerate with the timing of reionisation, with the amount heat injected during the epoch, and with the subsequent cooling rates. We find that these degeneracies can be broken using the scatter in temperatures, allowing tighter constraints on reionisation timing. We post-process a suite of semi-analytic galaxy formation models to characterise how different thermal statistics of the intergalactic medium can be used to constrain reionisation. Temperature is highly correlated with redshift of reionisation for a period after the gas is heated. However, as the gas cools, thermal memory of reionisation is lost, and a power-law temperature-density relation is formed. Constraining our model against electron optical depth and temperature at mean density, we find favourable models with a late reionisation, finishing at a redshift of 6.5 with a soft UV spectral slope of 2.8.

Anshu GUPTA
The University of New South Wales
MOSEL survey: Kinematics of star-forming galaxies at z~3.0

Galaxies at z~3.0 lie at an important juncture in the rise and fall of cosmic star formation density. The strong burst of star formation at z~3.0 is required to explain the appearance of massive galaxies with suppressed star formation rates at z<3.0. In this talk, I will present my resent results on the kinematics of star-forming galaxies at z~3 from MOSEL survey. We find that massive galaxies (Mstar > 10^10 Msun) at z~3.0 have lower velocity dispersion compare to the same stellar mass galaxies at z~2.0. Comparison with IllustrisTNG simulation indicates that mergers in galactic outskirts are responsible for a rapid rise in the dark matter content of massive galaxies between z=2-3. Our results suggest that strong dissipational processes such as mergers and disk-instabilities are driving the evolution of massive galaxies between z=2-3.

Kieran LUKEN
Western Sydney University
Using machine-learning to estimate the redshift of radio selected datasets

In the near future, all-sky radio surveys are set to produce catalogues of tens of millions of sources with limited multi-wavelength photometry. Spectroscopic redshifts will only be possible for a small fraction of these new-found sources. In this talk, I provide the first in-depth investigation into the use of the k-Nearest Neighbours (kNN) algorithm for the estimation of redshift of these sources, comparing with Linear and Logistic Regression, and Random Forests. We use the Australia Telescope Large Area Survey (ATLAS) radio data, combined with the Spitzer Widefield InfraRed Explorer (SWIRE) infra-red, the Dark Energy Survey (DES) optical and the Australian Dark Energy Survey

(OzDES) spectroscopic survey data. We then reduce the depth of photometry to match what is expected from upcoming Evolutionary Map of the Universe (EMU) survey, testing against both data sets. To examine the generalisation of our methods, we test one of the sub-fields of ATLAS against the other. We achieve an outlier rate of ~5%, showing that the kNN algorithm is an acceptable method of estimating redshift given an appropriate distance metric, and would perform better given a sample training set with uniform redshift coverage.

Bradley GREIG
University of Melbourne
Interpreting recent upper limits on reionisation from MWA and LOFAR

While a detection of the epoch of reionisation from the 21cm signal remains a few years away, ongoing experiments such as the MWA and LOFAR have recently published upper limits on the 21cm power spectrum amplitude. These new limits are now aggressive enough to begin to rule out interesting regions of astrophysical parameter space. Using 21CMMC, an MCMC sampler of 3D semi-numerical reionisation simulations I will explore which astrophysical models are disfavoured by the observational limits. Further, these limits arise only from small subsets of the existing observational data as such I will also discuss the future prospects as the MWA and LOFAR continue to improve their analysis pipelines and process more observational data.

Jie LI
International Centre for Radio Astronomy Research
Angular momentum-related probe of cold gas deficiencies

Recent studies of neutral atomic hydrogen (HI) in nearby galaxies find that all isolated star-forming disk galaxies are HI saturated, in that they carry roughly as much HI fraction as permitted before this gas becomes gravitationally unstable. By taking this HI saturation for granted, the atomic gas fraction fatm of galactic disks can be predicted as a function of a stability parameter q $\propto$j/M, where M and j are the baryonic mass and specific angular momentum of the disk (Obreschkow et al. 2016). The (logarithmic) difference Δfq between this predictor and the observed atomic fraction can be seen as a physically motivated way of defining a “HI deficiency”. While isolated disk galaxies have Δfq > 0, objects subject to environmental removal of HI are expected to have Δfq ≈ 0. Within this framework, we revisit the HI deficiencies of satellite galaxies in the Virgo cluster and in clusters of the EAGLE simulation. We find that observed and simulated cluster galaxies are HI deficient and that Δfq increases as we get closer to the cluster centres. Hence, the (q, fatm)-plane offers a practical diagnostic of environmental effects. The Δfq values are found to be similar to traditional HI deficiency estimators. By tracking the simulated HI deficient cluster galaxies back in time, we confirm that Δfq ≈0 until the galaxies first enter the cluster, at which moment they quickly lose HI by environmental effects. Finally, we use the simulation to investigate the links between Δfq and quenching of star formation.

Kathryn GRASHA
Australian National University
Star clusters as the engines of ionization in local HII regions as a tool to calibrate photoionization and star models

Integral field spectroscopy with instruments such as MUSE provide an extraordinary dataset to study the resolved spatial and spectral properties of ionized HII regions in nearby galaxies. Having self-consistent stellar tracks and atmosphere modelling are crucial to accurately interpret observations of HII regions. To date, only a handful of stellar evolution models are available, and they all use the same metallicity abundances. We know now that the assumed metallicity abundances greatly impact the relative scaling of the lines ratios for the HII regions, and hence, the input elemental abundances will have a non-insignificant on the resulting parameters, such as metallicity, geometry, temperature, and ionization parameter. We now have empirical actual abundance sets that we use to create stellar models that are physically accurate and self-consistent with their stellar atmosphere modelling. We will present the impact of the different assumed elemental abundances has on the observable spectral energy distributions.

Kristof ROZGONYI
ICRAR -- UWA
Considerations of gridded visibility storage for DINGO

For future deep imaging surveys, like DINGO, long-term visibility storage is desired to enable reprocessing and the mitigation of potential low-level systematic errors. However, due to the sheer volume of raw observational data generated, only compressed visibility storage is possible. DINGO will to use gridded visibilities to overcome the storage bottleneck. Gridded visibility storage enables data combination prior imaging, thus giving the option for improving final image quality, if needed, via ‘pixelated’ processing steps equivalent of the traditional ungridded case, such as preconditioning, RFI flagging or continuum subtraction. However, such processing requires the development of new algorithms, and the testing and mitigation of any algorithmic errors introduced by the pixelated imaging methodology. We present the implementation of an initial gridded imaging pipeline, and the first results on simulated spectral line observations. We examine these results to assess the impact and magnitude of the introduced errors, and discuss potential solutions and implementation strategies. Our pipeline lays down the foundations of a new scientific data product and thus opens new possibilities for deep spectral line surveys on SKA and it’s precursors.

Andrew BATTISTI
Australian National University
MAGPHYS+photo-z: Constraining the Physical Properties of Galaxies with Unknown Redshifts

We present an enhanced version of the multiwavelength spectral modeling code MAGPHYS that allows the estimation of galaxy photometric redshift and physical properties (e.g., stellar mass, star formation rate, dust attenuation) simultaneously, together with robust characterization of their uncertainties. The self-consistent modeling over ultraviolet to radio wavelengths in MAGPHYS+photo-z is unique compared to standard photometric redshift codes. The broader wavelength consideration is particularly useful for breaking certain degeneracies in color vs. redshift for dusty galaxies with limited observer-frame ultraviolet and optical data (or upper limits). We demonstrate the success of the code in estimating redshifts and physical properties for over 4,000 infrared-detected galaxies at $0.4 < z < 6.0$ in the COSMOS field with robust spectroscopic redshifts. We achieve high photo-z precision, high accuracy (i.e., minimal offset biases, and low catastrophic failure rates over all redshifts. Interestingly, we find that a weak 2175A absorption feature in the attenuation curve models is required to remove a subtle systematic photo-z offset that occurs for dusty galaxies when this feature is not included. As expected, the accuracy of derived physical properties in MAGPHYS+photo-z decreases strongly as redshift uncertainty increases. The all-in-one treatment of uncertainties afforded with this code is beneficial for accurately interpreting physical properties of galaxies in large photometric datasets.

Alex KEMP
Monash University
K-enhanced and possibly Mg-depleted stars throughout the Milky Way

Stars with unusual elemental abundances offer clues about rare astrophysical events or nucleosynthetic pathways. Stars with significantly depleted magnesium and enhanced potassium ($[\mathrm{Mg/Fe}] < -0.5$; $[\mathrm{K/Fe}] > 1$) have to date only been found in the massive globular cluster NGC 2419 and, to a lesser extent, NGC 2808. The origin of this abundance signature remains unknown, as does the reason for its apparent exclusivity to these two globular clusters. In this talk I present data from 112 field stars - identified out of 454,180 LAMOST giants - that show significantly enhanced [K/Fe] and possibly depleted [Mg/Fe] abundance ratios. The sample spans a wide range of metallicities ($-1.5 < [\mathrm{Fe/H}] < 0.3$), although none show abundance ratios of [K/Fe] or [Mg/Fe] that are as extreme as those observed in NGC 2419. Our findings suggest that the nucleosynthetic process producing the anomalous abundances ratios of [K/Fe] and [Mg/Fe] occurs at a wide range of metallicities. I will also discuss the implications of our analysis, arguing that the spread in metallicity in our data means that pollution scenarios limited to early epochs (such as Population III supernovae) are unlikely to be responsible for this abundance signature.

Charlotte SOBEY
CSIRO Astronomy and Space Science
Probing the large- and small-scale ISM using pulsars

Polarisation observations of pulsars, facilitated by SKA precursor/pathfinder radio telescopes, provide insightful probes of astrophysical plasmas. For example, measuring (and monitoring) dispersion and Faraday rotation measures elucidates the ISM electron density and magnetic field strength and direction parallel to each line of sight. I will highlight recent results from LOFAR and Parkes, which provide an estimate of the magnetic scale height in the Galactic halo, and a characterisation of small-scale turbulent structures in the Vela supernova remnant, respectively.

Sarah MARTELL
University of New South Wales
Galactic archaeology with the Maunakea Spectroscopic Explorer

The Maunakea Spectroscopic Explorer is a future observatory and survey project that will bring highly multiplexed spectroscopy to a 10m-class telescope. The science case for MSE is broad, and ranges from dark matter and neutrino cosmology to galaxy evolution, exoplanets and stellar astrophysics. I will describe the plans for MSE studies of the Milky Way and resolved stellar populations in the Local Group. MSE will carry out the ultimate spectroscopic follow-up of the Gaia mission, and conduct in situ chemodynamical analysis of individual stars across all Galactic components. It will gather spectra for an order of magnitude more stars in Local Group dwarf galaxies across the full luminosity range ($103-107L_\odot 103-107L_\odot$) and enable the chemo-dynamical deconstruction of M31 and M33 across their entire spatial extent.

Nikki NIELSEN
Swinburne University of Technology
Galaxy Outflows in the Circumgalactic Medium at Cosmic Noon

The star formation history of the universe reveals that galaxies most actively build their stellar mass at cosmic noon, roughly 10 billion years ago, with a decrease toward present-day. The resulting metal-enriched material ejected from these galaxies due to supernovae and stellar feedback is deposited into the circumgalactic medium (CGM), which is a massive reservoir of diffuse, multiphase gas out to radii of ∼200∼200~kpc. The CGM is the interface between the intergalactic medium and the galaxy, through which accreting filaments of near-pristine gas must pass to contribute new star formation material to the galaxy, and outflowing gas is later recycled. Simulating these baryon cycle flows is crucial for accurately modeling galaxy evolution. We examine these multiphase CGM gas flows with the quasar absorption line technique, primarily focusing on the low-ionization MgII absorption doublet (T∼104∼104~K), with additional multiphase ions such as Lyman alpha, FeII, and CIV. With the combination of HST images, high-resolution UVES/VLT quasar spectra, and cutting-edge IFU data from the Keck Cosmic Web Imager, we quantify the gas kinematics and metallicities of outflowing gas at 69 kpc along the minor axis of an edge-on (i=85∘i=85∘) galaxy at cosmic noon (zgal=2.070zgal=2.070). Connecting these results to our Multiphase Galaxy Halos Survey at z∼0.3, we study the evolution of CGM kinematics and metallicities over nearly 10 billion years.

Yuxiang QIN
Scuola Normale Superiore
An Illumination of the Dark Ages - Probing the 21cm signature of first stars

The measurement of the cosmic 21-cm signal with the SKA will transform our understanding of the epochs of reionization and cosmic dawn. The properties of the first stars and galaxies are encoded in the patterns of the signal. Interpreting these patterns requires accurate and efficient models. I will present an update of the 21cmFAST semi-numerical simulation, which separately accounts for star-formation inside the very first galaxies. This unseen and transient population of galaxies obtain their gas through molecular cooling from the intergalactic medium, and could have markedly different properties from the more massive galaxies observed with Hubble and eventually JWST. I demonstrate that if the recently-reported EDGES signal at z~17 is genuinely cosmological, these molecularly-cooled “mini-halo” galaxies must have played a dominant role during Cosmic Dawn.

Rachel WEBSTER
University of Melbourne
Changing Look AGN: variable AGN or nearby explosions?

Changing Look AGN (CLAGN) are quasars whose emission lines change from broad to narrow or vice versa. Since these changes appear to occur on timescales of a few years or less, there has been considerable interest in the physical processes which might cause such changes. We present a sample of CLAGN discovered during the SkyMapper Southern Survey, highlighting the value of all-sky surveys for time domain astronomy. We then consider to what extent Supernovae IIn could explain some of the CLAGN cases.

Debatri CHATTOPADHYAY
Swinburne University of Technology
Population Synthesis of Double Neutron Stars with COMPAS

Pulsars in binaries with neutron stars or pulsars form one of the most exciting astrophysical systems observed. Not only do they allow tests of General Relativity for the strong gravity regime, or act as high accuracy clocks, their merger can produce gravitational waves detectable by current ground based and future space based GW detectors. For predicting and studying the properties of such binaries detailed modeling of their populations are required. We model the population of Galactic double neutron stars using the population synthesis code COMPAS, including a model for the evolution of the pulsar parameters (spin period and magnetic field). We compare the observed double neutron star population to our models, accounting for radio selection effects. Our suite of models show broad agreement with the observed properties of Galactic double neutron stars. We highlight the physical assumptions to which our models are most sensitive. We also use these models to predict the masses and spins of neutron stars which will be observed in gravitational-waves.

Umang MALIK
The Australian National University
Reverberation Mapping with the Dark Energy Survey

One part of the Australian Dark Energy Survey was the observation of nearly 800 Active Galactic Nuclei, with the aim to measure the mass of the central supermassive black holes. By measuring the time lags in the AGN disks, AGN can be turned into standardisable candles, allowing us to determine distances in the Universe far beyond what is currently possible using supernovae. We find that the current OzDES spectroscopic cadence (approximately monthly) poorly samples the emission-line light curves of the lower luminosity AGN at $z < 1$. This is a critical limitation as these sources anchor the calibration of high-z AGN as cosmological distance probes, and overlap with the region where type Ia supernova measurements are abundant, allowing cross-probe analysis. I will present results showing the impact of cadence on AGN light-curves and subsequent measurements, and how this can be fixed for future facilities and surveys such as SDSS-V and LSST.

Ilya MANDEL
Monash University
Double Neutron Star Populations and Formation Channels

In the past five years, the number of known double neutron stars (DNS) in the Milky Way has roughly doubled. We argue that the observed sample can be split into three distinct sub-populations based on their orbital characteristics: (i) short-period, low-eccentricity binaries; (ii) wide binaries; and (iii) short-period, high-eccentricity binaries. These sub-populations also exhibit distinct spin period and spindown rate properties. We focus on sub-population (iii), which contains the Hulse-Taylor binary. Contrary to previous analysis, we demonstrate that, if they are the product of primordial binary evolution, the second-born NSs in these systems must have been formed with small natal kicks (<25 km/s) and have pre-SN masses narrowly distributed around 3.2 solar masses. These constraints challenge binary evolution theory. Motivated by the similarity of these DNSs to B2127+11C, a DNS residing in the globular cluster M15, we argue that this sub-population is consistent with being formed in, and then ejected from, globular clusters. This scenario provides a pathway for the formation and merger of DNSs in stellar environments without recent star formation, as observed in the host galaxy population of short gamma ray bursts and the recent detection by LIGO of a merging DNS in an old stellar population.

Daniel ZUCKER
Macquarie University
The Southern Stellar Stream Spectroscopic Survey (S5)

Over a dozen new stellar streams in the halo of the Milky Way have been discovered in the southern hemisphere with the Dark Energy Survey (DES) in recent years, with other datasets yielding additional stellar substructure. To study these we have embarked on an ongoing spectroscopic program, S5, which has been mapping these southern streams with 2df+AAOmega on the AAT. An international collaboration, S5 is the first systematic program pursuing a complete census of known streams in the southern hemisphere. The radial velocities and stellar metallicities from S5 - together with proper motions from Gaia DR2 - provide us with a unique dataset for understanding the stellar populations of the Milky Way's halo, the progenitors and formation processes of the streams, the mass and overall morphology of the Milky Way's gravitational potential, and ultimately potential clues to the nature of dark matter. Thus far, the S5 program has obtained 6D+1 phase space information for 10 streams in the DES footprint, all of which are the first such measurements for these southern streams, and we now are expanding our program beyond the DES footprint to cover more southern streams. I will give an overview of the S5 program, including target selection, observation, and data analysis, and I will finish with a discussion of the early science results from S5.

Vaishali ADYA
Australian National University
Practical realisation of a high frequency matter detector: OzHF

17th of August 2017 was a great day for multi-messenger astronomy when the two LIGO detectors detected the inspiral signal from the merger of a binary neutron star system [1]. The advanced VIRGO detector aided the localisation of this system in the sky thereby allowing astronomers to look at a precise patch in the sky to perform electromagnetic follow up of the source. While this event allowed us to gleam an insight into short gamma-ray bursts, neutron star mergers, jet formation and topology, r-process nucleosynthesis [2] but information about the merger and post-merger phases of the system are still unknown to us. These parameters can be obtained around the actual merger, and occur in the 1 kHz to 5 kHz regime. A gravitational wave detector engineered to focus on these signal frequencies would allow us to probe the exotic nuclear physics in the cores of neutron stars in a regime not accessible with the current terrestrial experiments [3]. This science case has prompted a design study focussed on a high frequency Australian gravitational wave detector , OzHF . In addition to the current technology, new technology that builds on the Australian research strength will be developed for the same which will be suitable for future third generation detectors planned around the world. The design concept is based on an advanced LIGO like detector, with a dual recycled Fabry Perot Michelson interferometer with squeezed light technology, Silicon test masses and cryogenic suspensions all of which would allow a competitive strain [4] sensitivity of 1x10-25 /√Hz between 1-5 kHz all with relative short Michelson arm lengths. References : [1] LIGO Scientific Collaboration and Virgo Collaboration , “GW150914: The Advanced LIGO Detectors in the Era of First Discoveries”. Phys. Rev. Lett., 116:131103, Mar 2016. [2] B. P. Abbott et al. (LIGO Scientific Collaboration and Virgo Collaboration), “GW170814: A Three-Detector Observation of Gravitational Waves from a Binary Black Hole Coalescence”, Phys. Rev. Lett. 119, 141101 [3] OzHF, paper in preparation [4] Evans, M & Harms, Jan & P. Abbott, B & Abbott, Randy & Abbott, Thomas & Abernathy, Matthew & Ackley, K & Adams, C & Addesso, Paolo & X. Adhikari, R & Adya, Vaishali et.al. (2016). Exploring the Sensitivity of Next Generation Gravitational Wave Detectors. Classical and Quantum Gravity. 34. 10.1088/1361-6382/aa51f4.

Sarah SWEET
Swinburne University of Technology
Stellar angular momentum distribution sets galaxy morphology

A galaxy’s angular momentum is a fundamental property in its evolutionary history, as it encodes the impact of cumulative tidal torques over its lifetime. Together with stellar mass, angular momentum regulates disk thickness and colour, dictates star formation efficiency, and predicts morphology. The mean specific angular momentum j of the baryons agrees with the dark matter halo, but the probability density functions (PDFs) differ due to further physical processes: baryonic material with low j is ejected by AGNs and stellar winds, while high-j material is removed by tidal stripping. In this talk I will demonstrate that the galaxy stellar specific angular momentum distribution is a robust tracer of morphology via higher-order moments of the PDF(j). Galaxies with bigger bulges have more strongly-tailed PDF(j)s due to an excess of dispersion-dominated material, while disks of all sizes rotate similarly. However, the PDF(j) is not well-described by theoretical predictions for well-ordered rotating disks and dispersion-dominated bulges. Finally I will present the utility of the PDF(j) as a photokinematic decomposition tool, encoding more physical information than photometry or kinematics alone.

Katie JAMESON
CSIRO
The first large, unbiased ALMA survey of CO at parsec resolution in the Small Magellanic Cloud

The Small Magellanic Cloud (SMC) at only 1/5 solar metallicity is the only galaxy near enough to study the effect of a low metallicity environment on the physics of star formation and the ISM on small spatial scales. Understanding the effects of low metallicity is crucial for understanding galaxies in the early universe and the evolution of galaxies over cosmic time. Initial ALMA observations in the SMC show similar compact CO clumps (Jameson et al. 2018), but only small areas targeting specific star-forming regions have been mapped to date and we lack a statistically significant sample of the CO structure throughout the galaxy. We used ALMA in ACA standalone mode to map a 1.0 deg x 0.5 deg (~1 kpc x 500 pc) area of the Southwest Bar of the SMC at ~6.5" resolution and cover an unprecedented range in size scales from ~1.5 pc to 1 kpc. Our new map shows previously undetectable small (~ pc) molecular gas clumps, similar to what is seen in WLM (Rubio et al. 2015) and NGC 6822 (Schruba et al. 2017), but across a much larger scale. I will discuss the properties of the CO-emitting gas and how it compares to the HI gas from our new ATCA HI absorption survey and GASKAP HI map and what that reveals about the atomic-to-molecular transition at low metallicity.

Christene LYNCH
ICRAR-Curtin/ASTRO3D
First results from the long baseline epoch of reionisation survey

One of the principal systematic constraints on the Epoch of Reionisation (EoR) experiment using the Murchison Widefield Array (MWA) is the accuracy and depth of the foreground calibration and signal model. Given the large field of view of the MWA, the MWA EoR fields contain several bright, extended sources located either at the edges of the MWA primary beam or in the primary beam sidelobes. Recent results have shown that accurately modeling and removing bright sources at the edges of the field and in the sidelobes, removes more contaminating signal than just removing sources at the center of the primary beam. To improve the models of sources in the MWA primary beam sidelobes of the EoR0 and EoR1 fields, we are conducting the Long Baseline Epoch of Reionisation Survey (LoBES). This survey consists of multi-frequency (between 103 --230 MHz) observations of EoR0, EoR1, and their eight neighboring fields using the MWA Phase II extended array. These observations will provide high-resolution, uv-components to complement the existing uv-plane sampling of these fields. Additionally, observations of the neighboring fields will provide high-resolution observations of sidelobe sources within the center of the MWA primary beam, where the primary beam is well modeled. This talk will present the first results of LOBES for the MWA EoR1 field, a field that is of particular interest given the locations of both Pic A and Fornax A within the field's primary beam and sidelobes.

Amanda KARAKAS
Monash University
Chemical evolution of the heaviest elements in the universe

The chemical evolution of the Universe is governed by the nucleosynthesis contribution from stars, which in turn is determined primarily by the initial stellar mass. Elements heavier than iron are predominantly formed by neutron captures, where two main processes are theorised to be responsible: the slow and rapid processes. The rapid processes likely occurs in merging neutron stars but may occur in other explosive sites as well. In contrast, the slow neutron capture process is mostly made in evolved low and intermediate mass stars. In this talk I present new predictions for the slow neutron capture process, with an emphasis on exploring uncertainties. The new yields are used in an updated Galactic chemical evolution (GCE) model for all elements from carbon to uranium based on the work of Kobayashi et al. (2011). I describe this model and discuss results. The new predictions a good match for observations of some heavy elements (e.g., strontium) but not others (e.g., an overproduction of barium). I finish with a discussion of possible solutions.

Rory SMITH
Monash University
Inferring the population properties of unresolved binary black holes at cosmological distances

The population properties of compact binaries - such as their merger rates, mass spectrum, and spin distribution - can be inferred from unresolved, sub-threshold signals that form the astrophysical gravitational-wave background. This enables redshift ≈ 2 cosmology with the current generation of ground-based gravitational-wave observatories. The reconstructed distributions of unresolved binaries may be compared to the distribution of nearby, resolved binaries, enabling us determine how population properties have evolved over the course of cosmic time. By expanding our analysis to include both resolved and unresolved events, we eliminate bias from selection effects. Simultaneously, we provide a unified framework for rate and population inference using compact binary detections and measurements of the gravitational-wave background.

Christopher RISELEY
CSIRO Astronomy & Space Science
Probing the Magnetoionic Medium of the Giant Radio Galaxy ESO 422-G028

The role played by magnetic fields is a key missing piece of the puzzle in the evolutionary picture of radio galaxies. These sources play a crucial role in driving the evolution and chemical make-up of the Universe, through (for example) feedback processes and mixing of gas. The largest radio galaxies - known as giant radio galaxies (GRG) - typically reside in poor clusters or groups of galaxies, and are thought to trace the warm-hot intergalactic medium (WHIM), the tenuous medium that is thought to comprise much of the missing baryon fraction of the Universe. As such, polarisation studies of GRG can be used to probe the magnetic field configuration of the large-scale structure of the Universe. ESO 422-G028 is one such GRG. In the Polarised GLEAM Survey (POGS), ESO422 was found to exhibit low-frequency polarisation properties that imply complex underlying physics, indicative of interaction with the ambient medium. In this talk, I will present the results of our subsequent observing campaign on ESO422, involving the first joint study with the full 36-dish Australian Square Kilometre Array Pathfinder (ASKAP) and the expanded Phase II Murchison Widefield Array (MWA), as well as ultra-deep data from the Australia Telescope Compact Array (ATCA). This campaign has provided a unique broad-band full-polarisation dataset spanning the frequency range 88 MHz to 35 GHz. The spectral properties of the diffuse radio emission strongly suggest multiple epochs of AGN activity, while the polarisation properties provide further evidence of rich physics, suggesting a magnetic “cocoon” on the surface of the lobes. This broad-band dataset also allows us to probe the physics of the host galaxy and jets in unprecedented detail for a mJy-level radio source, two orders of magnitude fainter those discussed in previous studies.

Matt OWERS
Macquarie University
The properties of transition galaxies identified in the SAMI Galaxy Survey

A full understanding of how the environment affects star formation in galaxies is yet to be realised. A key hindrance here is that environmental interactions modulate galaxy star formation in a spatially non-uniform way whereas, until recently, large galaxy surveys that enable galaxy demographic studies have relied on single, unresolved spectra. I will present recent results from the SAMI Galaxy Survey, which provides resolved spectroscopy for more than 3000 galaxies spanning a range in environments from the low-density field, to the dense cores of rich galaxy clusters. Using the SAMI data, we have identified a rare population of galaxies that harbour localised regions with very young stellar populations (<1.5Gyr) in the absence of current star-formation. This signature indicates that these galaxies are in the process of having their star-formation quenched, and are in a transition phase. I will highlight key differences between the transition galaxies found in the dense cluster environments and those found in lower density regions. In particular, we use the resolved data provided by SAMI, along with the exquisite ancillary data, to show that the cluster transition galaxies are currently being quenched by ram pressure stripping on their first passage through the cluster. I will also discuss how the next generation Hector Galaxy Survey will help us understand the future evolution of these transition galaxies.

Jeremy BAILEY
UNSW Sydney
Polarized Reflected Light in Early-Type Binary Systems

Early type binary systems often show phase dependent linear polarisation variations with two peaks and troughs in an orbital cycle. In the past this has usually been interpreted as due to scattering from circumstellar gas. We show that the actual dominant mechanism is light reflected from each star reflected off its companion. We are investigating the use of this effect to measure binary inclinations and hence masses for non-eclipsing systems. It may also be a way of detecting previously unknown binary systems.

Nichole BARRY
University of Melbourne
The Future of EoR Structure Limits

Radio interferometers have collected vast amounts of low-frequency data in order to detect the structure of the Epoch of Reionization in the 21cm power spectrum. While we are no longer data-limited, lower limits are still orders of magnitude above expected EoR levels. We discuss the future of the EoR field, and the potential limitations that culminate in a lower limit plateau. In our newest MWA data analysis, we address these subtle systematics to measure the lowest EoR structure limit thus far: Δ2≤(47Δ2≤(47mK)22 at k=0.23k=0.23\, Mpc−1−1 and z=7. While our effects are presented within an MWA-specific framework, they have repercussions to any general instrument and imaging power spectrum analysis.

Lorenzo SPINA
Monash University
Are open clusters chemically homogeneous?

We are currently living in the era of big stellar galactic surveys that aim at reconstructing the history of the Milky Way. One of their most important assumptions is that stars born in the same group are chemically homogenous. At what level can this assumption be supported by observations? To date, several important tests have confirmed that unevolved stars in open clusters are chemically homogeneous at the level of the measurement uncertainties, typically the 15% of the elemental abundances. Nevertheless, recent controlled experiments using twin stars have revealed underlying chemical inhomogeneities that may limit our capability of chemical tagging at higher precision. In this talk I will review the results of these studies and investigate the possible origins of the chemical anomalies.

C Renee JAMES
Sam Houston State University
What is the Impact of Collaborative Exams on Learning and Attitudes in Introductory Astronomy Classes?

Students in large lecture classes often indicate that they lack a sense of community within their universities. The creation of collaborative groups is one way to address this concern, but many instructors are unsure whether collaborations actually improve understanding. We will discuss results of a two-year study to gauge the impact of collaborative two-stage exams on student learning and attitudes in university-level introductory astronomy classes for non-science majors. In the collaborative two-stage exam setting, students first completed an exam individually, and then they retook a portion of that exam within their previously established groups. During the collaborative phase, students were free to discuss the questions with their peers and arrive at a common answer. Students took three to four exams during the semester using this format. At mid-semester, we surveyed the students to gauge their attitudes about collaborative work and its perceived influence on their exam preparation and performance. At the end of the semester, students sat an individual-only final exam, which contained all previous questions from the collaborative phase, as well as a subset of questions seen only on the individual portions. When we compare student performance on final exam questions that were included in the collaborative portions to those found in only the individual portions, we find generally higher student performance for questions encountered on the collaborative portions of the exams. The opportunity to work as a group was reported by students to have a positive influence on their overall learning and their study habits. **CO-PRESENTERS: C. Renee James and Scott T. Miller

Laura MCKEMMISH
University of New South Wales
Research collaborations between high school students and early career researchers

Internationally, many countries are extremely concerned about the low levels of STEM participation and expertise, particularly from females and those with disadvantaged socioeconomic backgrounds. Simultaneously, there are various excited but time consuming research projects that the scientific community would like to pursue. In the Original Research By Young Twinkle Students (ORBYTS) program, we aim to tackle both of these goals by creating an environment in which small teams of high school students work with a doctoral or post-doctoral researcher to undertake original scientific research, ideally contributing to a publication in the peer-reviewed literature (4 are currently published with student co-authors). This project simultaneously fulfils many outreach, training and research objectives. It is particularly notable for allowing junior researchers the opportunity to supervise, direct and manage a research project and research team. ORBYTS started in the UK, but has now expanded internationally, including in Australia with pilot programmes. I will discuss the history of research-in-schools programmes, the challenges and opportunities of these programmes, and highlight exciting opportunities in the Australian context that I am starting to explore and pilot.

Gary HILL
University of Adelaide
IceCube observations of neutrinos from a distant blazar

The IceCube Neutrino Observatory at the South Pole has started the field of neutrino astronomy, recording many hundreds of neutrinos from the distant Universe. In 2018, IceCube revealed that a distant blazar, TXS0506+056, is likely the first identified high-energy neutrino source. This discovery came from a multi-messenger campaign, where an IceCube neutrino alert was followed-up by other observatories, which saw high activity in gamma-rays. Together, these observations suggest a common origin of the neutrinos and gamma-rays following particle acceleration in the jet, and subsequent interaction, where the produced pions decay to yield the observed neutrinos and gamma-rays. In this talk I will discuss how this discovery was made, the astrophysical implications, and the prospects for a future expansion of IceCube, to further enhance its neutrino astronomy capabilities.