Inaugural Australia China Workshop on Astrophysics

ABSTRACT BOOKLET

5th – 7th April 2016

Rendezvous Hotel, Perth, WA, Australia

David Blair
University of Western Australia

Australia-China Collaboration in Gravitational Wave Astronomy

Following the first successful detection of gravitational waves the case for developing and improving a world-wide array of detectors has become much more compelling. Quantitative predictions of the benefit of instrument enhancements, and expansion of the world wide array of detectors can now be given. A broad collaboration between Australia and China in gravitational wave astronomy was the subject of a design program at the Kavli Institute for Theoretical Physics, China in 2015 which was published in a special issue of Science China in December 2015.

This talk will review the scientific benefits of creating a pair of next generation laser interferometer gravitational wave detectors compared with single detectors in either Australia or China. Secondly, the talk will present a conceptual design for an 8km arm length gravitational wave detector scaled from the existing technology of Advanced LIGO

Michael Burton
University of Western Australia

Science with for KISS and DATE5

I will muse on some potential science projects for KISS - the IR camera for the third AST3 telescope. Or possibly on THz science projects for DATE5.

Junwei Cao
Tsinghua University

Gravitational-wave Burst Analysis using Machine Learning

The sensitivity of searches for gravitational-wave bursts in data from the Laser Interferometer Gravitational-wave Observatory (LIGO) is generally limited by the presence of transient noises, which occur at a high enough rate such that accidental coincidence across multiple

detectors is non-negligible. These "glitches" can easily be mistaken for gravitational-wave burst signals, and their robust identification and veto will help any search for astrophysical gravitational waves. We apply machine learning algorithms to the problem, using data from auxiliary channels within the LIGO detectors that monitor degrees of freedom unaffected by burst signals. We demonstrate the feasibility and applicability of three different methods: artificial neural networks, support vector machines, and random forests.

Barbara Catinella
ICRAR/UWA

Cold Gas in Galaxies: Single-Dish Surveys in the SKA Era

A detailed knowledge of how gas cycles in and around galaxies, and how it depends on galaxies properties such as stellar mass, star formation rate, AGN content as well as environment, is crucial to understand galaxy formation and evolution. Although HI astronomy lags behind other wavelengths such as optical, infrared and ultraviolet, where all-sky surveys measured galaxy properties for millions of systems, the Square Kilometre Array (SKA) and its precursors promise to revolutionise this field. However, even in the SKA era, there are important scientific areas where large single-dish telescopes such as Arecibo and FAST can uniquely contribute.

In this talk I will discuss some of the lessons learned from single-dish HI surveys, and will illustrate the importance of measuring the HI content for large, stellar mass selected samples in addition to blind surveys. In particular, I will present results based on the GALEX Arecibo SDSS Survey (GASS) and its on-going extension to lower stellar masses, and conclude with future prospects for FAST.

Jessica Chapman
CSIRO

The CSIRO ASKAP Science Data Archive: Progress and Plans

The CSIRO ASKAP Science Data Archive (CASDA) provides data products produced from ASKAP observations. These include calibrated visibilities, images and image cubes and catalogues. These are made available through the CSIRO Data Access Portal and through Virtual Observatory services. CASDA is able to ingest up to 25 Terabytes of data products per day, with data storage in the Pawsey Supercomputing Centre in Perth.

CASDA was first released in November 2015, together with some demonstration science data products from the Boolardy Engineering Test Array (BETA). BETA used six ASKAP antennas equipped with Mark I phased array feeds. CASDA will handle all ASKAP science data products from ASKAP Early Science onwards. In this talk I will describe the CASDA systems and capabilities and will discuss future plans and some lessons learnt from this project.

Xuelei Chen
National Astronomical Observatories, Chinese Academy of Sciences

The Tianlai 21cm Intensity Mapping Pathfinder Experiment

I will describe the Tianlai experiment, which includes both a cylinder array with 3 adjacent cylinders and a dish array with 16 dishes. The experiment is aimed at exploring the 21cm intensity mapping technique for observation of large scale structure distribution of neutral hydrogen, and probe the dark energy.

Mingmin Chi
Fudan University

SKA Science Data Processor and Computer Architecture Innovation

In this task, I will represent Chinese Consortium to present the recent progress of SKA SDP task, and give a potential solution in terms of Chinese computer architecture innovation.

Luca Cortese
University of Western Australia

Galaxy Transformation in the Local Universe: From Arecibo and SAMI to FAST and CHILI

One of the most outstanding challenges for extragalactic astronomy is to identify the astrophysical processes responsible for transforming simple dark matter haloes into the heterogenous population of galaxies inhabiting today's Universe. How did different morphological types form and evolve? Does the environment where a galaxy lives influence its evolution? Inevitably, the answers to these questions entail a detailed investigation of the cold gas content of galaxies - the fuel for future star formation - and its relation to stellar properties, kinematics and environment.

In this talk, I will take advantage of data from Arecibo HI surveys (GASS and ALFALFA) and the Australian integral field spectroscopic (IFS) survey SAMI to demonstrate how radio observations and optical IFS are critical in order to make progress in this field. I will also highlight some of the still open questions in environmental studies and discuss how upcoming Chinese facilities such as FAST and CHILI can help us unveiling the role of nurture in the local Universe.

Shi Dai
CSIRO Astronomy and Space Science

Searching for Pulsars in Radio Continuum Images

While pulsars are primarily observed and searched with high time resolution in order to resolve their narrow pulses, the phase-averaged emissions of many strong pulsars can be detected in radio continuum surveys. By selecting targets from radio continuum surveys, more rigorous and efficient single-dish pulse searches can be carried out. This is particularly important for detecting extreme objects like sub-millisecond pulsars and pulsar black-hole systems. In the near future, the ASKAP-EMU surveys will cover a large portion of the sky and reach a sensitivity of 10 μJy, which provides us an excellent chance to make exciting discoveries. I will talk about different ways of identifying

pulsars in continuum images, and particularly I will talk about scintillation of pulsars and variance image techniques.

Yeshe Fenner
Astronomy Australia Limited

All-Sky Virtual Observatory

New astronomical telescopes are producing data in volumes never previously experienced in Australian astronomy. To gain maximum scientific benefit from this flood of information, datasets must become part of an astronomical data fabric that uses international standards and services to connect data to infrastructure and users. The All-Sky Virtual Observatory (ASVO; www.asvo.org.au) is a coordinated effort to build data infrastructure and services to link significant Australian astronomy datasets to the global astronomical data fabric, beginning with the first two operational "Nodes": 1) *ASVO-SkyMapper,* - deployed at NCI/ANU and providing access to data from ANU's SkyMapper telescope that is mapping the southern sky at optical wavelengths, and 2) *ASVO-TAO (*Theoretical Astrophysical Observatory), deployed at Swinburne University and housing a growing collection of cosmological simulations and galaxy formation models, with tools to allow users to easily create virtual universes to compare with real observations.

This talk will describe the framework developed for ASVO, current status, and plans for the future of ASVO, including creating the first radio Node of ASVO to support the Murchison Widefield Array (MWA) data, and supporting new optical datasets from the Anglo-Australian Telescope.

ASVO has been funded by National eResearch Collaboration Tools and Resources (NeCTAR) and the Department of Education of Training under the National Collaborative Research Infrastructure Strategy (NCRIS).

Lisa Harvey-Smith
CSIRO

The Australian SKA Pathfinder

The Australian SKA Pathfinder (ASKAP) is one of two precursor telescopes to the Square Kilometre Array located at the Murchison Radio-astronomy Observatory in Western Australia. Comprising 36 x 12m antennas, ASKAP is an interferometer with a very wide field-of-view (thirty square degrees at 1.4 GHz) thanks to its phased array radio receivers. In this talk, the ASKAP project scientist will describe the status, early results and plans for ASKAP early science and major surveys in 2016 and beyond.

Jon Lawrence
Australian Astronomical Observatory

The AST3-NIR Camera for the Kunlun Infrared Sky Survey

AST3-NIR is a new infrared camera for deployment with the AST3-3 wide-field Schmidt telescope to Dome A on the Antarctic plateau. This project is designed to take advantage of the low Antarctic infrared sky thermal background (particularly within the 'Kdark' near infrared atmospheric window at 2.4 micron) and the long Antarctic nights to provide high sensitivity temporal data from astronomical sources. The data collected from the Kunlun Infrared Sky Survey will be used to conduct a range of astronomical science cases including the study of supernovae, exo-planets, variable stars, and the cosmic infrared background.

Di Li
National Astronomical Observatories of China

The Status of FAST and Possible Synergy between Chinese and Australian Radio Communities

I will report the current status of FAST. By the time of the conference, FAST will likely obtain real astronomical data with an integrated, albeit temporary system. I will discuss opportunities for collaboration in areas of instrumentation, all-sky HI surveys, high-Z universe, etc.

Naomi McClure-Griffiths
Australian National University

"Dark" Gas in the Milky Way and Magellanic System

The transition from atomic to molecular gas is an essential step in the evolution of galaxies. It may be a rate limiting step in the star formation process of galaxies. In the early stage of this transition atomic gas becomes optically thick and the common H2 tracer CO cannot be used as a proxy for H2. The gas, in turn, seems "dark. Evidence from the Fermi and Planck satellites suggests that between 20% and 50% of the total gas in the solar neighbourhood is in this "dark" state! I will discuss our Pacific Rim (Australia/China/US/Mexico) collaboration to study the nature of "dark"" gas in the Milky Way and Magellanic System and its role in the evolution of gas in galaxies."

Jeremy Mould
Swinburne University

The Kunlun Infrared Sky Survey

The Kunlun Infrared Sky Survey will be the first comprehensive exploration of the time varying Universe in the infrared. The survey aims to maximally exploit the unique thermal and atmospheric conditions at the high Antarctic site with China's AST3-3 telescope. With its high infrared sensitivity AST3-3 science will emphasize opportunities in the time domain where longer wavelength measurements are particularly advantageous, such as

- supernovae and the equation of state
- reverberation mapping and the physics of AGN
- Gamma Ray Burster follow up

- the Cosmic Infrared Background
- terminal phases of red giants (Miras)
- dynamics and variability in star formation
- discovery of exo-planets (esp. brown dwarfs & hot jupiters)

Attila Popping
ICRAR / UWA

FAST Detections of Neutral Hydrogen in the Intergalactic Medium

The interaction between galaxies and the Intergalactic Medium (IGM) is a crucial aspect of galaxy evolution that is not well understood. Neutral hydrogen is the best tracer of accreting and outflowing gas, however very hard to detect due to its low column density. The Five-hundred-meter Aperture Spherical radio Telescope (FAST) will be the most capable instrument to reach the required brightness sensitivities and unravel the nature of this diffuse gas.

FAST has an unprecedented collecting area and due to the filled aperture is most sensitive to extended and diffuse structures. In this talk I will present potential experiments to image the extended environment of nearby groups and galaxies to brightness sensitivities more than an order of magnitude deeper than existing and planned surveys. Even when taking into account the SKA, deep observations with FAST will really set our detection limits for the long future. Therefore such experiments would set a milestone in our understanding of the gas distribution around galaxies and could also potentially trace the dense peaks of the underlying Cosmic Web.

Peter Quinn
ICRAR

Big Data Challenges and Solutions for Astronomy in the Era of SKA

Over the past 20 years, the concept of what constitutes an observatory has grown to combine three central elements – the collectors, the detectors and the data. The delivery of data to astronomers in a form and variety that enables and accelerates the research process has become part of the fabric of new facilities in an attempt to achieve a maximal scientific return on an ever increase commitment of public funds. The capture and delivery of data of the right type, with the right quality, at the right time and with the right volume is a complex dance between collectors, detectors, those responsible for a facility and astronomers responsible for doing and communicating science. This complex network of relationships and resources needs to be identified, costed, prioritized and addressed as part of designing and building the SKA facility. The data systems that enable SKA science (collectively called SKA-data) should be regarded at the same level of scientific importance, visibility and criticality as the collectors/detectors known as SKA-low and SKA-mid. The ultimate scientific impact of SKA will be determined by the way in which we assign priorities and resources to all three of these elements of the SKA, recognizing that SKA-data supports both collecting/detecting systems.

SKA is being showcased internationally as an Exa-scale project and considerable excitement and expectation is being generated in the scientific and industrial community by the associated technological and discovery opportunities. Today we know that Exa-scale enterprises require Google-like resources and we need to understand how astronomy will scale to, and afford, challenges of this magnitude. I will examine the SKA-data requirements as determined by the set of SKA Key Science Projects and the scaling of those requirements to the collector and detector

requirements. The existing SKA-1 baseline design coupled with survey requirements already implies data volumes of processed products for a single survey to be in excess of 1 ExB. I will discuss the projected costs, timelines, challenges and capabilities of various approaches to the support of SKA astronomers and the production and delivery of SKA science products. This analysis will draw upon the experience gained across a number of major research efforts (VLT, ALMA, SDSS, LHC and LSST). I will draw attention to choices that may need to be made on the scope and capabilities of SKA-data and what those choices would imply for the reduction of science capabilities and the need to seek new or different funding sources or operational models. Finally I will outline new technological trends and innovations relevant SKA survey science data challenges and will propose we explore these new approaches in the Asia-Pacific Region via a coordinated effort between Australia and China in the coming 5 years surrounding science with ASKAP, MWA and FAST.

Nick Seymour
ICRAR/Curtin University

Exploring the Radio Universe through Continuum Surveys

We are entering a golden age of radio astronomy with a large number of powerful new telescopes coming online and many others undergoing significant upgrades. By conducting large and deep radio continuum surveys these facilities will be able to address numerous astrophysical questions, in particular relating to the evolution of galaxies and their central black holes. I will summarise current and future surveys with Australia's SKA precursors, ASKAP and MWA. I will highlight recent results and discuss how they pave the way to more sensitive observations with the SKA.

Ryan Shannon
Curtin University and CSIRO

Pulsar Science in the Era of FAST: Pulsar Timing Arrays and Gravitational Waves

Since their discovery nearly 50 years ago, pulsar observation has led to some of the most exciting findings in astrophysics. Currently one of the most hotly pursued activities is the observation of an array of millisecond pulsars to search for ultralow (nanohertz) frequency gravitational waves. The most likely source of gravitational waves in this band is from supermassive black hole binaries. These binaries are formed after galaxy mergers, so the presence or absence of gravitational waves in this band provides important information on how galaxies grow and evolve. In this presentation I will first discuss recent results from the Parkes pulsar timing array project that show how limits on gravitational wave emission can already be used to constrain the dynamics of supermassive black holes and the environments of galaxy centres. I will then discuss the potential use of FAST for pulsar observation and how it can complement existing facilities (such as Parkes and the MWA) to increase the sensitivity of pulsar timing arrays to gravitational waves.

Jing Wang
CSIRO/ATNF (CASS)

Forming the Outskirts of Massive Disk Galaxies

We show that HI gas is closely related with the building of optical disks, especially in the outer regions. At a fixed stellar mass, the galaxies with higher HI mass fraction show stronger evidence of inside-out disk formation. These galaxies are also more likely to show up-bending structures at the outskirt in the optical than normal galaxies. While stellar accretion and stellar migration are often cited as the mechanisms for building the optical disks in the extreme outskirts (outside R25), our results suggest that star formation could directly affect the mass assembly there for a considerable fraction of galaxies.

Lifan Wang
Tsinghua University

Detection of Intraday Supernovae with the Antarctic Survey Telescope

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Randall Wayth
Curtin University

The Murchison Widefield Array

The Murchison Widefield Array (MWA) radio telescope has been operational since mid 2013 and has collected approximately 10 PB of data thus far. In addition to pursuing its own ambition science program, the MWA is the precursor instrument for SKA_Low and supports development, prototyping and verification of SKA systems. In 2016, the MWA is beginning an upgrade program to double the sensitivity and resolution of the array. I will give an update on MWA status and plans and describe the strong links between the MWA and the SKA_Low Aperture Array Verification System (AAVS1), which is being constructed during 2016.

Andreas Wicenec
ICRAR

SKA Science Data Processor Prototyping Activities

Even after re-baselining the SKA will still produce unprecedented amounts of data, which will be processed in a real-time synchronous manner and reduced to a set of standard data products by the Science Data Processor (SDP). These products will be preserved long-term and made available through IVOA standard protocols. The SDP consortium and ICRAR in particular has undertaken extensive prototyping of the data system, which is underlying the SDP architecture to support the various pipelines to be developed and implemented. In this talk we will present an overview of the SDP system architecture and the prototyping efforts to test the design and potential solutions for the various SDP challenges. This will also include results of applying the prototype to real world data.

Chen Wu
ICRAR/UWA

Scheduling Data-Intensive Processing Pipelines for the SKA Science Data Processor

The DATA Layer in the SKA Science Data Processor (SDP) aims to provide a distributed data management platform to support data-intensive processing pipelines for producing SKA science ready products. In developing the SDP DataFlow Management System (DFMS) prototype for the past 16 months, we have extended the traditional dataflow model by integrating data lifecycle management, graph execution engine, and cost-optimal resource allocation into a data-driven framework. Through the DFMS prototype, we have identified the 'translation' step from logical graph (an interface to astronomers and operators) to physical graph (input to graph execution engines) as the highest risk item amongst all SDP tasks. To mitigate this risk, we developed a prototype called DropMake that automatically translates logical graphs into physical execution plans consisting of inter-connected processing components scheduled onto hardware resources in order to meet data challenges and performance requirements at minimum cost (e.g. energy consumption). This talk will introduce technical aspects of DropMake and discuss its potential applications in several SKA pathfinder projects.

Ji Yang
Purple Mountain Observatory

Antarctic Observatory at Dome A, Chinese Kunlun Station - Progress Report

Dome A has been selected as one of the goals of development for Chinese astronomy for the next decade. Major Instruments, including a 2.5m opt/NIR telescope and a 5m THz telescope, are proposed as National Mega-Science Facility. Conceptual designs have been carried out during the past several years. Significant progress has been achieved in R&D for the two telescopes. Here we update the progress of Dome A observatory preparations and some details on the THz telescope will be presented.

Xiangyan Yuan
Nanjing Institute of Astronomical Optics & Technology

Progress of Antarctic Survey Telescope

The Antarctic Survey Telescope-AST3 consists of three optical telescopes with 680mm primary mirror and 8 square degree field of view, mainly for observations of supernovas and extrasolar planets searching from Antarctic Dome A. The second AST3 was mounted on Dome A in Jan. 2015. Anti-frost methods including new electronic control for window ITO heating and active air blowing were designed for this year's maintenance. The anticipated automatic observations will be started from end of March 2016. The third AST3 is optimized mainly for K band survey. Now the telescope is under development in NIAOT and the K-band camera is under development in AAO.

Hui Zhang
Nanjing University

Looking for the Hottest Planet at Antarctica

While the space based exoplanet survey projects (e.g. Kepler) have achieved great success, there is still valuable exoplanetary science that can be done from the ground. This is especially important at some unique sites. Dome A, the highest point of the Antarctic plateau, is one of these sites. In 2008, China established a scientific site at Dome A. Now, in a significant collaboration with Australian astronomers, a large survey project is ongoing there. This is the Antarctic Survey Telescope (AST3) project, consisting of three 0.5m and one 0.1m binocular telescopes located at Dome A. The exoplanet survey is one of the two major scientific aims of AST3. I will briefly outline this project and introduce the progress of the exoplanet survey in detail. It will cover the exoplanet scientific goals, instruments, designs of survey strategy, data reduction pipeline and some recent results.
