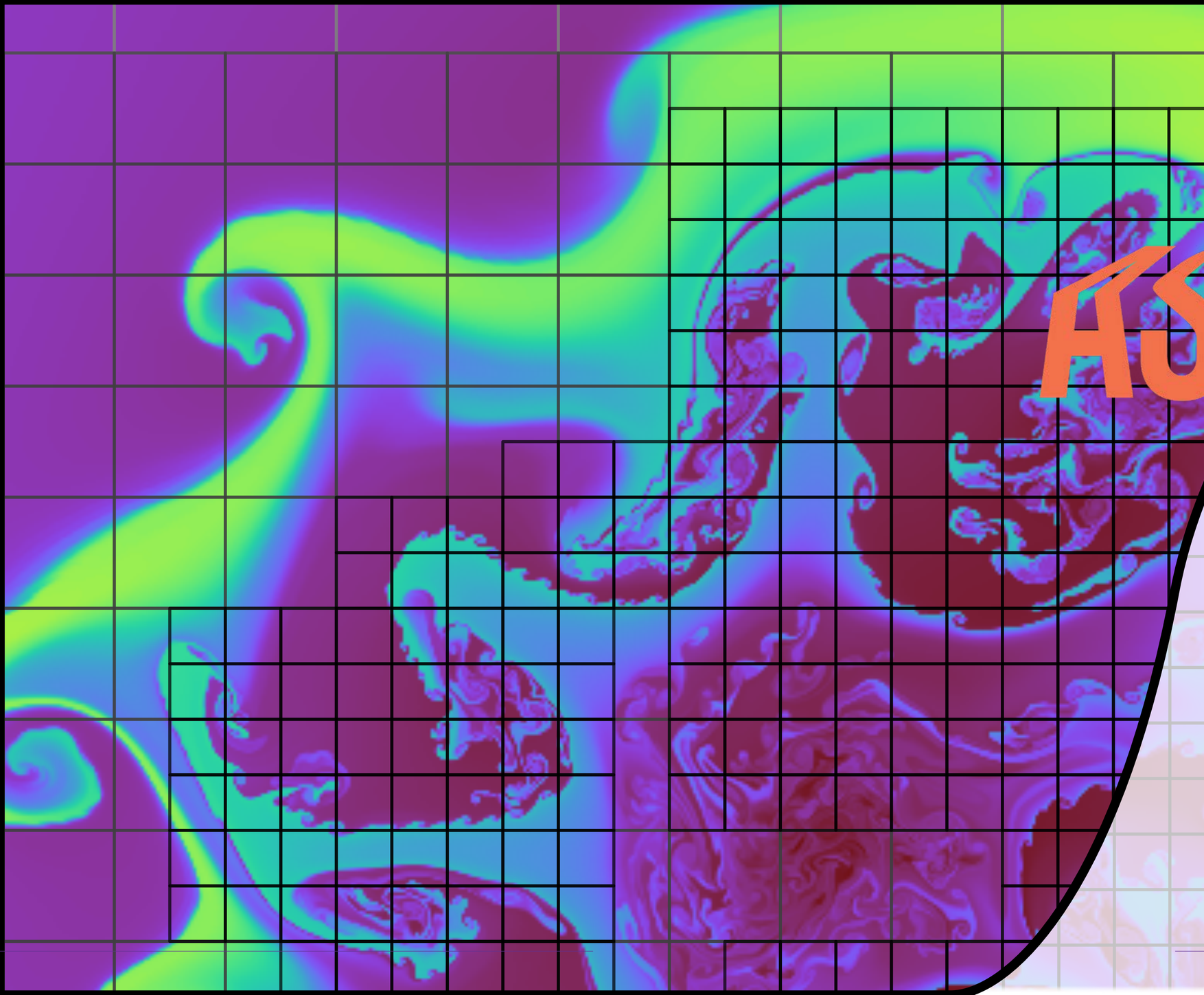

AUSTRALIAN RESEARCH COUNCIL
CENTRE OF EXCELLENCE FOR ALL SKY
ASTROPHYSICS IN 3 DIMENSIONS

ASTRO 3D 2022 ANNUAL REPORT

Australian Government
Australian Research Council

Contents

Our Collaborators

OUR COLLABORATING UNIVERSITIES

Australian National University
Curtin University
Macquarie University
Monash University
Swinburne University of Technology
The University of Melbourne
UNSW Sydney
The University of Sydney
The University of Western Australia

OUR PARTNER INSTITUTIONS

ASTRON
California Institute of Technology
Chinese Academy of Sciences
CSIRO
NCI Australia
University of Hertfordshire UH
University of Oxford
University of Toronto
University of Washington

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ACKNOWLEDGEMENT

ASTRO 3D acknowledges the support of the Australian Research Council and all of the collaborating and partner institutions in the Centre.

EDITORIAL BOARD

2022 Governance

EXECUTIVE

Executive Management Committee

The Executive Management Committee works collaboratively to oversee day-to-day operations, including financial and risk management, the development of the strategic plan and monitoring performance against agreed outcomes. All collaborating universities are represented on the committee.

Director | Prof. Lisa Kewley (ANU) and Prof. Stuart Wyithe (UniMelb)

Deputy Director | Prof. Cath Trott (Curtin)

Chief Operating Officer | Ms Ingrid McCarthy (ANU)

Node leaders at each collaborating university

Prof. Matthew Colless (ANU)

Prof. Scott Croom (Sydney)

A/Prof Amanda Karakas (Monash)

Prof. Richard McDermid (Macquarie)

Prof. Chris Power (UWA),

Prof. Emma Ryan-Weber (Swinburne)

A/Prof. Kim-vy Tran (UNSW)

Prof. Michele Trenti (Melbourne)

Prof. Cathryn Trott (Curtin).

Collaboration Leader | Prof. Joss Bland-Hawthorn (Sydney)

Committee Leads

Equity, Diversity and Inclusions (EDI) - A/Prof Kim-Vy Tran, (UNSW)

Junior Early Career Researchers (ECRs) - Dr Sven Buder (ANU)

Snr Early Career Researchers (ECRS) - Dr Jack Line (Curtin)

Students - PhD Student Jennifer Hardwick (UWA)

Black Lives Matter (BLM) - Krystal de Napoli (Swin)

Advisory Board

The advisory board meets at least annually to provide support and advice to the director and executive committee on the effectiveness of the centre in reaching its scientific, technical, and operational goals. This year the Advisory Board met at the Science Meeting held 31 May to 2 June at the Burnley Campus, University of Melbourne.

2022 Advisory Board Members

Chair: Prof. Tim De Zeeuw and Professor Anne Green

Dr Linda Tacconi, Scientist, Max Planck Institute for Extra-terrestrial Physics.

Professor Lars Hernquist, Mallinckrodt Professor of Astrophysics, Harvard-Smithsonian Centre for Astrophysics.

Sue Weston, CEO of Comcare, previously Deputy Secretary of the federal Department of Industry, Innovation and Science. Sue Is also a Chartered Accountant and a Fellow of CPA Australia.

Dr Bobby Cerini, Deputy Director, Director of Science and Learning at Questacon - the National Science and Technology Centre.

Professor Mary Putman, Professor of Astronomy, Columbia University.

Our Strategic Goals

BUILD

Build and maintain the infrastructure, skills and expertise required to maximise Australia's investment in the new era of mega-scale optical and radio telescopes through our research programs, skills workshops, mentoring, leadership and succession planning, we will train young Australian scientists to drive the future world-leading programs on the next generation of telescopes.

CREATE

Create an innovation culture to facilitate the transfer and commercialisation of astronomical technology to other disciplines by identifying fresh ideas and aiding the commercialisation of new astronomical technology through our Intellectual Property and Innovation Committee, comprised of experts in commercialisation.

INSPIRE

Inspire, train and mentor the next generation of diverse Australian scientific leaders. We will inspire students to study science, technology, engineering and mathematics (STEM) through new teacher education programs and our ambitious nation-wide public outreach campaigns.

NEXT GENERATION

Provide young Australian scientists with transferable skills for the modern workforce by training the new generation of young Australian astrophysicists in transferable skills including data intensive science, providing a broad range of career options outside astrophysics, including market analysis, population statistics, medical science, bioinformatics, genomics, and commercial sector data analytics.

TRANSFORM

Transform our understanding of the Universe and how we got here. We will conduct ground breaking new 3-Dimensional surveys alongside an observationally-driven theory program with dedicated telescope and supercomputing facilities.

Why ASTRO '3D'?

ABOUT ASTRO 3D

The ARC Centre of Excellence for All Sky Astrophysics in 3 Dimensions (ASTRO 3D) commenced in July 2017 and is a Research Centre of Excellence led by the Australian National University (ANU) from its Research School of Astronomy and Astrophysics at Mt Stromlo.

The Centre is comprised of nine collaborating universities: Australian National University, the University of Melbourne, the University of Sydney, Swinburne University of Technology, the University of Western Australia, Curtin University, Monash University, the University of New South Wales and Macquarie University — and a number of world-class Australian and international partners, including:

California Institute of Technology, USA (Caltech)

Chinese Academy of Sciences (CAS)

Commonwealth Scientific and Industrial Research Organisation (CSIRO)

National Computational Infrastructure (NCI)

Netherlands Institute for Radio Astronomy (ASTRON)

University of Hertfordshire, UK

University of Washington, USA (UW)

University of Toronto, Canada

University of Oxford, UK

The Centre has been funded over seven years with a $30.3m grant from the Australian Research Council (ARC), $9.995m in cash from the nine Australian universities and $134m of in-kind resources from across the collaborating and partner institutions.

OUR VISION

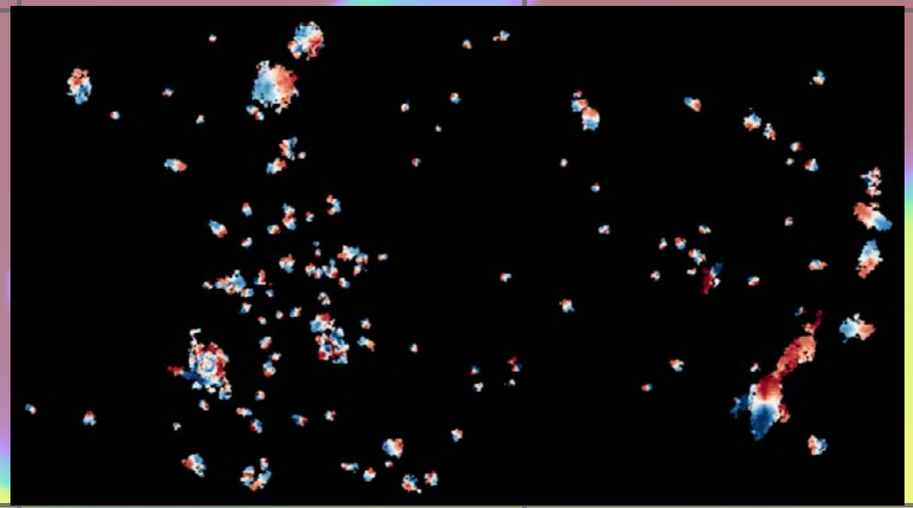
To unlock the mysteries of the Universe using innovative 3D technology, while sharing the excitement and wonder of astronomy to inspire the broader community.

OUR MISSION

To propel Australia to the forefront of astronomical research by combining Australia's radio, optical and theoretical expertise to understand the origins of our Universe and the galaxies within it.

To train future Australian astronomers to lead breakthrough science on the next generation of telescopes.

To share our discoveries and passion for research with the broadest possible audience and inspire the scientists of the future.



Colour often describes density or temperature variations. But in this image, colour is all about movement. This is a map of galaxies that indicates how each individual galaxy is moving. Blue means it is rotating towards us, red away. So, can you work out how each galaxy is moving? For ease, the galaxies have been magnified by a factor of four. Spinning in space, WALLABY. Image credit: T. Reynolds.

WHY ASTRO 3D?

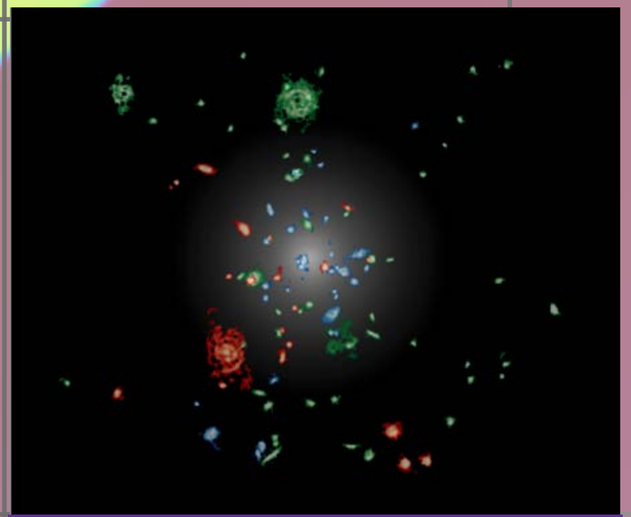
The most fundamental question in astrophysics, "How did we get here?", covers vast ground - from the Big Bang and the stars that first lit the cosmos, to the evolution of the diverse Universe that surrounds us today. No single telescope or theoretical simulation can answer this question. This problem requires new panchromatic all-sky surveys that cover thousands of square degrees of sky to capture the light from hundreds of thousands of galaxies.

Critically, it also requires 3D; the extra dimensions of time and motion are required in addition to the typical space or frequency dimensions in previous surveys. Using new 3D Integral Field Technology (IFU) for every pixel of light we receive from a telescope, we can generate a datacube, that gives us information about:

- spatial properties (what is where)
- spectral properties (what chemical elements are present)
- velocity information (are the stars and the gas moving away from us or towards us)

ASTRO 3D strategically combines new 3D radio, optical, and infrared technology with new supercomputing infrastructure. 3D surveys allow us to track how the different phases of matter, neutral hydrogen gas, ionised gas, stellar mass, and dark matter accumulated and spread across the history of the Universe.

As a consequence of this cutting-edge 3D data and modelling, ASTRO 3D will be able to utilise tools such as virtual reality, 3D movies, 3D printed models and files, coupled with links to school curriculum to help both the general public and students understand and appreciate the new era of discovery in astrophysics.



The WALLABY (Widefield ASKAP L-Band Legacy All-Sky Blind Survey) team look at hydrogen gas in the Universe. In this image, data from the gas shows the movement of galaxies in the Hydra galaxy cluster. The white haze represents the density of hot intra-cluster gas and dust that is typical of massive clusters. The galaxies' colour represents their orbital movement within the cluster. Red galaxies are moving away from us, blue is moving towards us, and green is in between! Orbiting patterns of galaxies in the Hydra cluster, WALLABY. Image credit: Jing Wang et al.

Director's Welcome and Report

PROFESSOR STUART WYITHE ASTRO 3D DIRECTOR

Professor Stuart Wyithe is Associate Dean, Research in the Faculty of Science. He was awarded his PhD from The University of Melbourne in 2001, and was a Hubble Fellow at Harvard University before returning to Australia in 2002.Professor Wyithe' s research focus is on the evolution of the earliest galaxies and how this evolution may be studied with the next generation of telescopes. He has received several awards for this work, including the 2009 Pawsey Medal for physics from the Australian Academy of Science, the 2011 Malcolm McIntosh Prize for Physical Scientist of the Year and the Australian Institute of Physics Boas Medal for 2014.

Professor Wyithe has also played numerous leadership roles including President of the Astronomical Society of Australia and Chair of the Australian National Committee for Astronomy. In the latter role he chaired the Australian Astronomy Decadal Plan 2015-2025.

ASTRO 3D aims to understand our origins. Our Centre has three goals:

(1) to understand the origin of the ionising radiation in the universe,

(2) to understand how matter accumulated into galaxies in the universe, and

(3) to understand how the chemical elements formed and proliferated in the stars and galaxies across cosmic time.

Our surveys and projects cover the full history of the universe from right after the Big Bang to the present day Universe and our own Milky Way.

In 2022, ASTRO 3D continued to make major strides in scientific discovery, education/outreach, and diversity. Following the challenges associated with COVID 19 that impacted our education and outreach programs we successfully re-engaged in a number of in-person programs. At the same time, our ongoing regular communications and effective on-line collaborations and meetings which allowed the Centre science to continue unabated during 2020-2021 meant that the centre was able to operate at full efficiency in 2022, with our surveys and projects producing 297 publications in refereed journals and 7 press releases. We continue to increase our collaborations across all Surveys and Projects, and develop new data catalogs, analysis tools and theoretical predictions to help us obtain a 3D picture of how the gas, the first stars and galaxies formed and evolved across 13.7 billion years of cosmic time.

This annual report outlines the discoveries, achievements and successes across all ASTRO 3D projects

This year our inaugural ASTRO 3D Director Professor Lisa Kewley was appointed as the Director of the Harvard-Smithsonian Centre for Astrophysics. This is an extremely prestigious role, which is a reflection of the amazing work done by Lisa in leading ASTRO 3D and the success of the Centre in its range of activity across science, culture and education. It was a privilege to support Lisa in this work as Deputy Director. I took over as Interim Director in April and was appointed as Director by the ARC in July. In the second half of 2022 I have been focussed on the challenge of ensuring that ASTRO 3D maintains this success by achieving the goals set out for the Centre. I have been fortunate to have Cath Trott as the ASTRO 3D Deputy Director as well as COO Ingrid McCarthy and her team supporting me in this work.

A significant milestone in 2022 was the reaching of 50:50 gender balance in the ASTRO 3D membership, a goal that was set at the beginning of our Centre. A highlight of the year was the celebration of this milestone at Mount Stromlo Observatory Visitor Centre which included many ASTRO 3D members in attendance, alongside leaders in the scientific community including ANU VC Brian Schmidt, Academy of Science CEO Anna-Maria Arabia. Lisa Kewley presented our approach to achieving 50:50, with a focus on how to do balanced recruitment as well as building a positive culture. All members of the Centre should be proud of the tremendous job in building a culture that embodies our centre values.

Our Centre has increased its focus on raising representation of Aboriginal and Torres Strait Islander people in astronomy for the final years of the Centre. We held a second Indigenous Awareness training workshop at our Annual Retreat. In 2022, our Black Lives Matter Committee formed an Indigenous Advisory Committee in 2022 to help us deliver programs that meet the needs of Aboriginal and Torres Strait Islander students.

Some of our education outreach programs which were largely on hold due to COVID 19 have been active in 2022. For example, the STARS program reached twenty-three schools across six states, and the Indigenous Work Experience program at Mt Stromlo welcomed eight students to ANU for a week. We look forward to continuing and expanding this program in 2023.

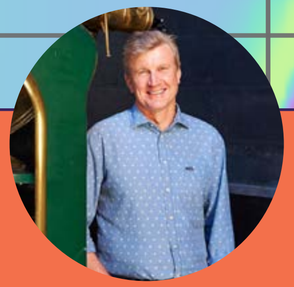
In addition, our Virtual Reality program development continued, with three modules now complete!

In October I was delighted that Professor Anne Green AC agreed to be the new Chair of the ASTRO 3D Advisory Board for the remainder of the Centre. I am very pleased to have Anne joining ASTRO 3D and greatly look forward to working with her and the Board during the next phase of the Centre.

Our COO Ingrid McCarthy, our management team, and our administrative and education/outreach staff continued effective, efficient, and highly professional work in the Centre. This team keeps the Centre running smoothly, as well as leading and contributing to many of the Centre's education initiatives, committees, training programs and workshops.

I am delighted to share this Annual Report with you. Following its success in 2021 we have again presented it in a fully virtual and sustainable format.

Chief Investigators (CI)



PROFESSOR JOSS BLAND-HAWTHORN

Professor Joss Bland-Hawthorn from the University of Sydney is an ARC Laureate Fellow renowned for innovative and broad-reaching science of both theoretical and observational astronomy, covering optical, infrared and radio wavelengths. Joss also develops astronomical instrumentation, having developed SAMI and HERMES instruments that will be used in the SAMI and GALAH surveys.

Joss and his team are using the GALAH survey to trace the chemical and mass assembly history of the Milky Way. In combination with the Genesis dynamical models, Joss is untangling the many complex processes involved in shaping a typical spiral galaxy like ours. He is also identifying the science areas that require more collaboration. He is prioritising visits for these areas, identifying, and directing key participants to facilitate and encourage collaboration.

Joss is the ASTRO 3D GALAH Survey lead and the ASTRO 3D Collaboration lead.

PROFESSOR JULIA BRYANT

Professor Julia Bryant from the University of Sydney is an extragalactic astronomer and astronomical instrumentation specialist. She is an expert in the development and integration of photonic devices into astronomical instrumentation in order to study the evolution of galaxies. She developed the hexabundle technology underpinning the SAMI instrument, was a founding member of SAMI and led the target selection for the SAMI Survey. Her research focusses on how gas is accreted into galaxies to fuel star formation and the growth of galaxies of different morphologies and kinematics.

Julia heads up the Hector project, including the build of the Hector instrument and the Hector Galaxy Survey which will take spatially resolved spectra of 15,000 galaxies in the nearby Universe.

She is Director of one of three nodes of Australia's astronomical instrumentation consortium, Astralis, which built Hector.

A/PROFESSOR BARBARA CATINELLA

Associate Professor Barbara Catinella from the University of Western Australia is an expert in multi-wavelength studies of cold gas in nearby galaxies. Her main research interest is understanding the gas-star formation cycle in galaxies and its connection with their local environment and cosmic web. She led state-of-the-art radio surveys that provided the deepest observations of cold gas in the local Universe, uniquely probing the vastly unexplored gas-poor regime and yielding strong constraints to theoretical models and simulations of galaxy evolution.

Barbara is co-PI of of the ASKAP WALLABY survey, which will provide the largest census of atomic hydrogen in the nearby Universe, and a member of DINGO. In addition to ensure that WALLABY and DINGO are scientifically exploited to their fullest potential, she is very interested in maximizing their synergy with state-of-the-art optical surveys with integral field spectrographs such as SAMI and Hector.

PROFESSOR MATTHEW COLLESS

Professor Matthew Colless from the Australian National University has made major contributions to astronomical research in the fields of galaxy evolution, clusters of galaxies, the large scale structure and motions of galaxies, and observational cosmology. As part of ASTRO 3D, he is leading a research team using the SAMI and Hector instruments to investigate the dynamical structure of galaxies and the accretion of angular momentum, and how these affect their star formation histories and stellar populations.

Matthew is the ASTRO 3D Node leader for the ANU and also Director of the Research School for Astronomy and Astrophysics (RSAA) at the ANU. He plays a significant role in supporting ASTRO 3D, as RSAA provides some of the Centre's key facilities, through the wide-field optical capabilities of the ANU-owned SkyMapper Telescope and the ANU-operated Anglo-Australian Telescope.

PROFESSOR SCOTT CROOM

Professor Scott Croom is from the University of Sydney and brings over a decade of experience leading large spectroscopic surveys to ASTRO 3D.

Scott leads the SAMI Survey and plays a major role in the Hector survey. SAMI results include new insights into galaxy scaling relations, the discovery of outflows in star-forming galaxies, and greater understanding of the formation mechanism behind dispersion-dominated galaxies. Scott is also the University of Sydney Node Leader for ASTRO 3D.

SAMI was replaced by the Hector instrument during 2022. Hector will survey 15,000 galaxies within a five year period and be significantly faster than SAMI. Scott is also facilitating collaborations with the Genesis team to compare the theoretical star-formation history of galaxies with observation.

Chief Investigators (CI)

PROFESSOR DARREN CROTON

Professor Darren Croton from Swinburne University of Technology is an internationally-known theoretical astrophysicist who works on the formation of galaxies in the nearby and distant Universe. He conducts massive cutting-edge supercomputer simulations and mines large observational data sets from some of the world's largest telescopes. He is the ASTRO 3D Co-lead of the Genesis Simulations Thread.

Darren is using his extensive experience working as a theorist within large survey teams to lead the development of new galaxy formation models. These models will be applied to the interpretation of the vast amounts of data ASTRO 3D astronomers will have on hand across the Centre.

Darren will also assist the Data Intensive Astronomy team to create a single, cohesive interface where astronomers can query both the Genesis Simulations and the observational data simultaneously.

A/PROFESSOR DEANNE FISHER

Associate Professor Deanne Fisher is based at Swinburne University of Technology. She received her PhD from the University of Texas in 2010. Deanne has since been a CARMA Research Fellow, Swinburne Director's Fellow and ARC Future Fellow. She is an Associate Professor in the Centre for Astrophysics and Supercomputing.

Her research focuses on multiwavelength studies of galaxies from the very nearby Universe at z=0 to galaxies just emerging from Reionisation at z=5. Deanne works in detailed observations spanning from UV observations, common use of Hubble Space Telescope and 10 m Keck and VLT optical telescopes and further to infrared and radio interferometry.

Along with a career in research she has been awarded for her efforts in equity and diversity, not just in astronomy, but within the national academic sector. She is among the founding members of the first nationwide, Australian LGBTQI support organisation for scientists.

A/PROFESSOR AMANDA KARAKAS

Associate Professor Amanda Karakas from Monash University is a leading expert in the field of theoretical stellar evolution and nucleosynthesis for low and intermediate-mass stars, and on the impact of these stars on the chemical evolution of galaxies. In particular, she specialises in the evolved phases of stellar evolution, which is when stars produce metals and heavy elements deep inside their interiors. In recent years she has concentrated on the production of elements heavier than iron, which are produced in low-mass stars via the “slow neutron capture process”.

Within the GALAH project the chemical evolution models that utilise Amanda’s predictions will be compared to the abundances of stars in the Milky Way Galaxy, and within the First Stars project her theoretical models can be directly compared to carbon enhanced metal-poor stars, which can result from binary mass transfer from an evolved companion. These comparisons improve our understanding of element formation at the earliest times.

Amanda is also the ASTRO 3D Monash Node Leader.

PROFESSOR RICHARD MCDERMID

Professor Richard McDermid from Macquarie University is an expert in the field of stellar dynamics and stellar populations in galaxies, and combining these to deconstruct galaxy formation histories. He has pioneered the use of integral field spectroscopy in this area, and developed new techniques to understand the archaeological record of stellar orbits and chemistry in galaxies beyond the Milky Way.

Richard leads the Macquarie University ASTRO 3D Node, and works closely with Data Central as part of the Data-Intensive Astronomy thread. He is also lead scientist for MAVIS – a major new instrument that Australia is developing for the European Southern Observatory that aims to build on the scientific legacy of ASTRO 3D.

DR MATT OWERS

Dr Matt Owers from Macquarie University is an extragalactic astronomer with extensive experience in using large-scale surveys to understand the impact of environment on galaxy properties. He is best known for his work on galaxy clusters at X-ray and optical wavelengths.

Matt has made significant contributions to the SAMI Galaxy Survey, where he led both the target selection and quenching-related science undertaken for the cluster portion of the SAMI galaxy survey. Matt is the Science Lead (Environments/halos) for the Hector Galaxy Survey, and is also leading the target selection and characterisation of the cluster regions.

Chief Investigators (CI)

PROFESSOR CHRIS POWER

Professor Chris Power from the University of Western Australia (UWA) is a computational astronomer who works on a broad range of problems in galaxy formation and cosmology.

Chris is leading the development of the Genesis Simulations that will track the birth, growth and the ultimate fate of galaxies from the earliest epoch of galaxy assembly, through the epoch of reionisation to the present-day. Chris is also the ASTRO 3D UWA Node Leader.

Chris' interests are in dark matter – what is its nature? what kinds of observations will allow us to discriminate between alternative models? - and galaxy formation - how does feedback from stars and black holes (i.e. the deposition of energy and momentum into their surroundings) impact the formation and evolution of galaxies? He also has an interest in scientific high performance computing. Chris models large supercomputer simulations (comprising of ~100 billion particles) to construct the most detailed and sophisticated prescriptions for galaxy formation that we have.

PROFESSOR EMMA RYAN-WEBER

Professor Emma Ryan-Weber from Swinburne University of Technology is an international expert on the Intergalactic Medium. She brings leadership in the research field of high redshift intergalactic metals to ASTRO 3D. She is the Swinburne Node Leader for ASTRO 3D.

Emma's pioneering near-infrared spectroscopic observations were the first to demonstrate the viability of detecting intergalactic metals towards the end of the Epoch of Reionisation. Ryan-Weber currently leads the metal absorber project of the ESO Large Program XQR-30, producing a legacy data set of high redshift intergalactic metals.

Within the Galaxy Evolution Project Emma is overseeing work on ionisation: directly measuring the ionising radiation from galaxies at redshifts in the broad range z~3–4 and developing calibration for escaping flux. The results will be applied to galaxies at higher redshifts to ultimately understand how the Universe was reionized.

PROFESSOR ELAINE SADLER

Professor Elaine Sadler's research expertise covers both optical and radio astronomy and she has led several large radio surveys of the southern sky. She is a Professor of Astrophysics at the University of Sydney and also holds a part-time appointment as Chief Research Scientist at CSIRO Space and Astronomy. Within ASTRO 3D Elaine leads the 'Origin of Matter and Periodic Table' Theme and is co-leader of the 'ASKAP Surveys' project. She is co-PI of the ASKAP FLASH survey and also brings extensive science management experience.

Elaine is a Fellow of the Australian Academy of Science, and served as the Academy's Foreign Secretary from 2018-22. In 2019 she was appointed as an Officer of the Order of Australia (AO) for distinguished service to science as an astrophysicist in the field of galaxy evolution and to gender equality.

PROFESSOR LISTER STAVELEY-SMITH

Professor Lister Staveley-Smith from the University of Western Australia (UWA) is the Interim Executive Director of ICRAR and has over two decades of experience in leading major surveys on new radio telescope facilities and in developing and applying new software and computation techniques.

Lister is co-leading the ASKAP HI Surveys project and is PI of ASKAP WALLABY project to image the southern sky in the 21-cm line of neutral hydrogen. Lister is also co-leader of the Data Intensive Astronomy Program which facilitates the analysis of our petascale datasets, provides curation, visualisation and cross-linking capability for advanced data products, and provides the means to compare with theoretical models.

A/PROFESSOR KIM-VY TRAN

Associate Professor Kim-Vy Tran is based at the University of New South Wales (UNSW). Her research program advances our knowledge of how galaxies assemble over cosmic time by capitalising on the high resolution, extreme sensitivity, and broad wavelength coverage of ground and space-based telescopes. Kim-Vy helps lead the ASTRO 3D Galaxy Evolution project that bridges the first galaxies and the present-day Universe by tracking the mass assembly, chemical evolution and ionising radiation in galaxies. She is the managing chief investigator of the AGEL, ZFIRE, and ZFOURGE galaxy surveys that integrate multi-wavelength imaging and spectroscopic campaigns to track how galaxies evolve. Kim-Vy also co-leads the MOSEL survey and is the ASTRO 3D UNSW Node Leader

Kim-Vy is currently President of the Galaxies & Cosmology Division in the International Astronomical Union, the largest society of professional astronomers. Kim-Vy is devoted to promoting Equity, Diversity, and Inclusion (EDI) at all levels and helping people achieve their full potential. In addition to her science leadership, she Chairs the ASTRO 3D EDI committee and contributes to a range of professional development workshops at ASTRO 3D meetings.

Chief Investigators (CI)

PROFESSOR MICHELE TRENTI

Professor Michele Trenti from the University of Melbourne is an expert on cosmic dawn who has built an international reputation for combining theoretical simulations and observations to understand the first galaxies in the Universe. Michele is using the current Hubble Space Telescope and will use the future JWST to observe the chemical elements within the First Galaxies of the Universe.

Michele is also connecting theorists with observers to understand galaxy formation from both a theoretical and observational practice, aiding in linking the First Galaxies observations with the deep understanding of galaxy evolution that ASTRO 3D will provide.

Michele is not only a user of space telescopes, but he is also leading the development of the first space mission funded by the Australian Space Agency, the SpIRIT satellite, which will both promote space industry growth and carry out innovative observations of the variable sky at high energies (gamma and x-rays) with the ambition to spot Gamma Ray Bursts originating at cosmic dawn.

PROFESSOR CATHRYN TROTT

Professor Cathryn Trott from Curtin University is ASTRO 3D Deputy Director and Curtin Node Leader. She is using the current and expanded MWA and in the future, the SKA to explore the evolution of ionised hydrogen in the early Universe.

Cath is leading the ICRAR MWA Epoch of Reionisation (EoR) project for the Origin of the Ionised Universe Theme. Cath is using the supercomputing facilities at the Pawsey Centre for EoR data storage, triage and analysis, augmented by existing and future-developed sophisticated signal processing algorithms.

She is also assessing the scientific progress of the Centre against goals as part of the Science management Committee, and developing her team with leadership and mentoring skills.

PROFESSOR RACHEL WEBSTER

Professor Rachel Webster is a Redmond Barry Distinguished Professor in the University of Melbourne School of Physics. She is an expert in the field of reionisation and is a member of the Board of Directors for Australian Astronomy Limited (AAL). She brings extensive leadership expertise to ASTRO 3D.

Rachel is co-leading the data reduction and analysis of the Epoch of Reionisation signals observed with the MWA. The improvement in the measured limits on the signal are allowing fundamental parameters of the Early Universe to be constrained.

Professor Webster's other research interests include quasar emission regions, gravitational lensing and cosmology; with a side interest in the physics of geothermal energy.

A/PROFESSOR EMILY WISNIOSKI

Associate Professor Emily Wisnioski from the Australian National University specialises in studies of the interstellar medium and its evolution over cosmic time. She is a world-recognised expert on early star-forming galaxies. As a PI of the MAGPI Survey, a 340hr ESO MUSE Large Program, she is co-leading a group of 60+ researchers across Australia, Europe, Asia, and South America facilitating science across a range of key questions in galaxy evolution. Her extensive experience utilising the facilities provided by VLT/ESO, in particular with spatially resolved spectroscopy, has led to her scientific leadership in a number of planned instrumentation projects on 8-30m class telescopes. As part of the near-infrared IFU KMOS3D survey at cosmic noon she led pioneering work on the turbulent evolution of marginally stable disk galaxies.

Within the Galaxy Evolution thread, Emily is leading efforts to connect resolved kinematics and metallicity information at early times to local galaxies including studies of the Milky Way from the GALAH team.

ASSOCIATE INVESTIGATORS

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Data Intensive Astronomy (DIA)

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CSIRO
ASKAP - WALLABY

Dr ChanDrashekar Murugeshan
CSIRO
ASKAP - WALLABY

Dr Ivy Wong
CSIRO
ASKAP - WALLABY

Dr Elizabeth Mahony
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ASKAP-FLASH

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GALAH

Dr Devika Kamath
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Dr Tayyaba Zafar
Macquarie University
MAGPI

Dr Simon O'Toole
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Data Intensive Astronomy (DIA)

Professor Richard de Grijs
Macquarie University
GALAH

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Professor John Lattanzio
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GALAH

Dr Taissa Danilovich
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GALAH

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Galaxy Evolution

Professor Alan Duffy
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GENESIS Theoretical Simulations

Dr Marianne Girard
Swinburne University of Technology
Galaxy Evolution

Professor Karl Glazebrook
Swinburne University of Technology
First Galaxies

Dr Colin Jacobs
Swinburne University of Technology
Galaxy Evolution

Associate Professor Glenn Kacprzak
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Galaxy Evolution

Professor Virginia Kilborn
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Incoming Advisory Chair Report

EMERITUS PROFESSOR ANNE GREEN AC ADVISORY BOARD CHAIR

Anne Green is Emeritus Professor of Astrophysics at the Sydney Institute for Astronomy in the School of Physics at the University of Sydney. Anne's research focussed on deep radio images of the Milky Way Galaxy, in particular the contribution to its structure and evolution by supernova remnants and astrophysical masers. She was the Director of the Molonglo Observatory for more than a decade and was appointed the first female Head of Physics at the University of Sydney in 2007.

Anne was President of the ASA from 2003 to 2005 and was named a Companion (AC) in the Order of Australia in 2022 for eminent service to science, particularly physics and astrophysics, as an educator and researcher, as a mentor to colleagues and students and a role model to women.

The Anne Green Prize is awarded annually by the Astronomical Society of Australia for a significant advance or accomplishment by a mid-career scientist. She is very committed to mentoring the next generation of scientists.

It is an honour to have taken on the role of Chair of the Advisory Board for the final two years operation of the ARC Centre of Excellence for All Sky Astrophysics in 3 Dimensions (ASTRO 3D). This is a great opportunity for me to contribute to the continuing achievements of this amazing Centre. In 2022 most activities and collaborations have been able to grow strongly after the disruption caused by the global pandemic. The goals of the Strategic Plan to advance a three-dimensional understanding of the Universe, a wide range of astronomical instruments together with sophisticated theoretical simulations and data analysis are being achieved.

It is also timely to focus on the ongoing legacy of the Centre as a nurturing training for the next generation of scientists and to ensure that the ASTRO 3D young astrophysicists have transferable skills and capabilities to allow them to achieve careers in areas encompassing both academia and industry. There have been many innovative and significant research outcomes and many of the world's leading astronomical telescopes have been used. This is a credit to the quality of the projects proposed. As well as publications, there will be a rich store of analysis tools and software packages available for future use. A strong outreach program has ensured the global reach and impact of the programs. Also aligned with our vision, it is important for all of us to work together in an inclusive and respectful way ensuring all members of ASTRO 3D feel valued and welcome.

Student Committee

"The group discussion time was so valuable! It was good for ice-breaking, also for sharing ideas"

"The student retreat was a great opportunity to develop our project management skills and learn about careers in academia as well as industry"

"I would like to thank the organising committee for the great work and good memories"

This year the student committee has been through some big changes. We welcomed new members Marcie Mun, Antonia Fernandez, Jaiden Cook, Ryan Bagge and Zara Osborn. We also implemented a new structure for the committee, to ensure the running of the committee is a bit smoother in the future. We wrote a student committee charter which can be found on the ASTRO 3D website and includes how the committee is to be run, what roles there are within the committee and their responsibilities, our aims and how we plan to achieve our aims. A big thank you to Jennifer, Marcie and Caro for putting this document together. Once the document was written we held a vote to elect a chair and secretary of the committee, which resulted in Jennifer being elected chair and Marcie the secretary.

The Student Committee hosted two events this year; a student session at the ASTRO 3D science meeting and the student workshop. The student session was held on the morning of the 31st May and included a professional development session by Dr Rebecca Allen on science communication, followed by a social activity of Trivia. We had approximately twenty students arrive early in Melbourne to attend, and it was well received by students. The science communication session was very engaging and informative, and the trivia forced students to interact with people from other nodes that they may have not interacted with previously.

The student workshop was held over three days from 19th to 21st November and was our largest event of the year. We secured the funding needed from ASTRO 3D, then had a call for an LOC to help organise this. A big thank you to Aishwarya Selvaraj, Emily Kerrison and Miftahul Hilmi who are not on the student committee but volunteered to be on the LOC. Thanks also goes to outgoing members Manasvee Saraf and Hasti Nateghi who continued on the LOC despite leaving the Student Committee. This was a hybrid workshop held at the Rydges Hotel Adelaide and included 6 personal development sessions; Science Communication, Careers in academia, Networking and social skills, Project management and Worklife Balance. These sessions were all received extremely well, with extra praise going to sessions held in person. We sent out an anonymous feedback survey to students after the workshop and received these comments:

Over the next year, the Student Committee will continue to meet monthly and discuss issues arising within our student community. We are currently organising another student workshop for 2023 given the positive feedback we received.

Chair: Jennifer Hardwick (The University of Western Australia)

Committee: Marcie Mun (Australian National University), Balu Sreedhar (The University of Melbourne), Caro Derkenne (Macquarie University), Yifan Mai (University of Sydney), Antonia Fernandez (Swinburne University), Jaiden Cook (Curtin University), Ryan Bagge (The University of New South Wales), Zara Osborn (Monash University)

Junior ECR Committee

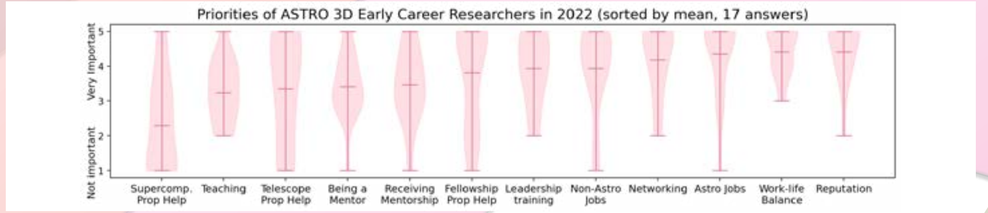
After the difficult years of COVID 19 lockdowns and travel restrictions, the year 2022 allowed ASTRO 3D junior early career researchers (ECRs) to finally experience some of their first in-person conferences and meetings. The importance of such opportunities for networking and earning reputations can be exemplified by their rise towards the most important priorities of junior ECRs for 2022. They are ranked first and fourth place in the ranked importance of junior ECR priorities for 2022, based on the annual poll displayed below (answered by 17 ECRs, that is, 60% of the members). In comparison to the previous years, both earning Reputation (rise from 3rd to 1st priority) and Job opportunities in Astronomy (1st to 3rd) stayed the top priorities. The importance of Work-Life balance increased towards the 2nd most important priority, while networking climbed 4 ranks towards the 4th most important priority. The importance of help for proposal writing decreased.

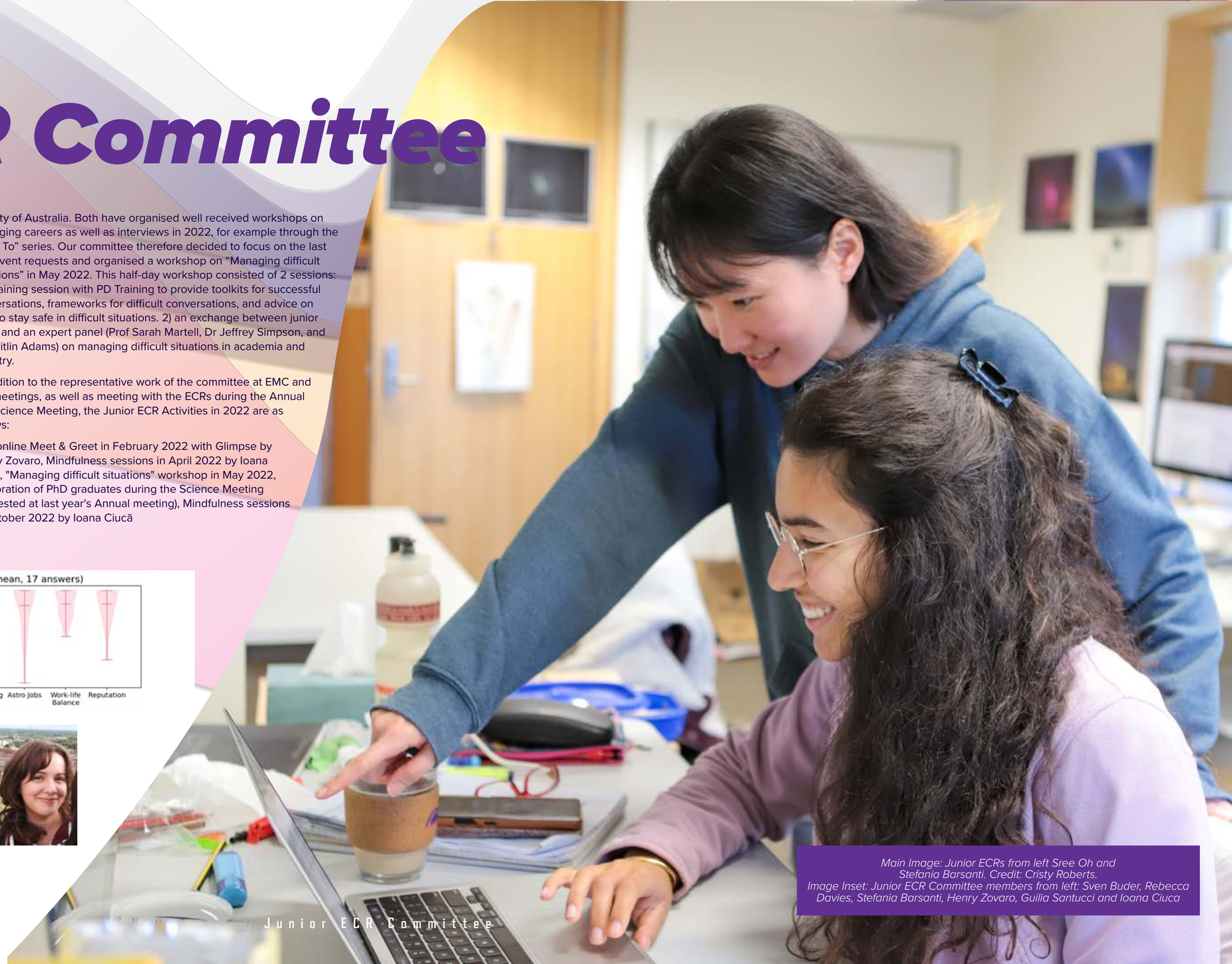
In the same poll, Junior ECRs expressed a strong interest in the following events (ordered by number of requests): - Session on interview skills (10 requests), How to manage your career & set research milestones (10), How to document research via GitHub, python packages, etc. (9) Networking events (9), Job offer negotiation skills (9), How to handle difficult conversations/ situations (9).

To best support Junior ECRs, our committee coordinated events with the ASTRO 3D EDI committee as well as the ECR chapter of the Astronomical Society of Australia. Both have organised well received workshops on managing careers as well as interviews in 2022, for example through the “How To” series. Our committee therefore decided to focus on the last two event requests and organised a workshop on “Managing difficult situations” in May 2022. This half-day workshop consisted of 2 sessions: 1) a training session with PD Training to provide toolkits for successful conversations, frameworks for difficult conversations, and advice on how to stay safe in difficult situations. 2) an exchange between junior ECRs and an expert panel (Prof Sarah Martell, Dr Jeffrey Simpson, and Dr Caitlin Adams) on managing difficult situations in academia and industry.

In addition to the representative work of the committee at EMC and IAB meetings, as well as meeting with the ECRs during the Annual and Science Meeting, the Junior ECR Activities in 2022 are as follows:

ECR online Meet & Greet in February 2022 with Glimpse by Henry Zovaro, Mindfulness sessions in April 2022 by Ioana Ciucă, "Managing difficult situations" workshop in May 2022, Celebration of PhD graduates during the Science Meeting (requested at last year's Annual meeting), Mindfulness sessions in October 2022 by Ioana Ciucă





Main Image: Junior ECRs from left Sree Oh and Stefania Barsanti. Credit: Cristy Roberts.
Image Inset: Junior ECR Committee members from left: Sven Buder, Rebecca Davies, Stefania Barsanti, Henry Zovaro, Guilia Santucci and Ioana Ciuca

Senior ECR Committee

2022 was the Senior ECR Committee's third year of operation. Towards the end of the year, Kate Harbourne (UWA) replaced Lilian Garratt-Smithson (UWA). Thanks for your work Lilian! Themiya Nanayakkara (Swin) and Andrew Battisti (ANU) remained, as well as Jack Line (Curtin), who is stepping down from Chair in 2023 to be replaced by Katie Grasha (ANU) who will be joining.

Activities we undertook included:

- Setting up a new channel on the ASTRO 3D Slack (#job-opportunities),
- Created a google spreadsheet to collate job offers not captured by the AAS job register;
- Held an SECR social event at the science retreat where we went bowling;
- Organised a workshop on supervising graduate students at the annual retreat.

As always, if you are a Senior ECR member and need some help from your committee, feel free to reach out to any of us. We'd love to hear from you!

Main Image: Senior ECR Chair Jack Line participates in the Amazing Race Challenge at the Annual Retreat. Credit: High Z Exploders

The Equity, Diversity and Inclusion Committee

The ASTRO 3D Equity, Diversity & Inclusion (EDI) Committee is committed to cultivating a sense of belonging for all ASTRO 3D members. We strive to engage with individuals and institutions to identify best practices and empower everyone to make positive change. We are constantly learning and adapting how to better support our communities within ASTRO 3D and beyond.

Particularly notable for 2022 is that ASTRO 3D maintained gender representation and half of the referee publications were led by women. In contrast, the typical fraction of astronomy papers with women first authors is 20-25%.

Now that we are in the second half of the seven year Centre of Excellence, our attention is shifting to providing ASTRO 3D resources to the broader Australian community. The EDI Committee coordinated with the Executive Management Committee to define EDI priorities and ASTRO 3D legacy.

Activities in 2022 focused on updating the existing EDI resources, providing direct access to resources on the website and through presentations, and professional development sessions. We will also broaden our scope to support more intersectionalities including gender identities and cultural heritage.

Thanks to our fantastic members in 2022: Vy Tran (UNSW; chair), Giulia Santucci (UNSW), Qianhui Chen (ANU), Sven Buder (ANU), Pipit Triani (ANU), George Heald (CSIRO), Christene Lynch (Curtin), Amanda Karakas (Monash), Tanner Wilson (Monash),Tayyaba Zafar (MQ), Balu Sreedhar (Melb), Katie Auchettl (Melb), Michael Hayden (USyd), Marie Partridge (USyd; secretariat), Deanne Fisher (Swinburne), Hasti Nateghi (Swinburne), and Glenn Kacprzak (Swinburne). The EDI liaisons were Christene Lynch with the BLM committee, Hasti Nateghi with the Students committee, and Sven Buder with the ECR committee. The EDI Committee has zoom meetings on the second Wednesday of every month.

Career and Community Support in 2022

A highlight in career support included the inaugural inSTEM networking conference for under-represented groups held in July at the University of Queensland. The conference was supported by 11 Centres of Excellence in STEM to build and support a network for students and early-careerresear chersinAustralianscience. VyTran(UNSW)servedontheSteering Committee, Deanne Fisher (Swinburne) was an invited speaker, and several ASTRO 3D members participated remotely and in-person. It was inspiring to hear the diverse range of personal narratives that included challenges and successes.

Especially powerful were the Indigenous Cultural Awareness and Respect activities held at the ASTRO 3D annual retreat in Adelaide. Marie Partridge and Pipit Triani coordinated with the BLM committee to organise the activities with Bookabee Australia, an Aboriginal owned and operated consultancy. The tour of the botanical gardens linking plants to the Aboriginal narrative and the session on Cultural Awareness provided a new and valuable perspective.

Another highlight for 2022 was the session on “Demystifying Reference Letters” organised by Vy Tran and Giulia Santucci. The session was held during the ASTRO 3D annual retreat and included Matt Owers, Chris Power, Mary Putnam, Emma Ryan-Weber, and Jesse van de Sande as panelists. The session was chaired by Vy and Giulia for a very lively and informative discussion.

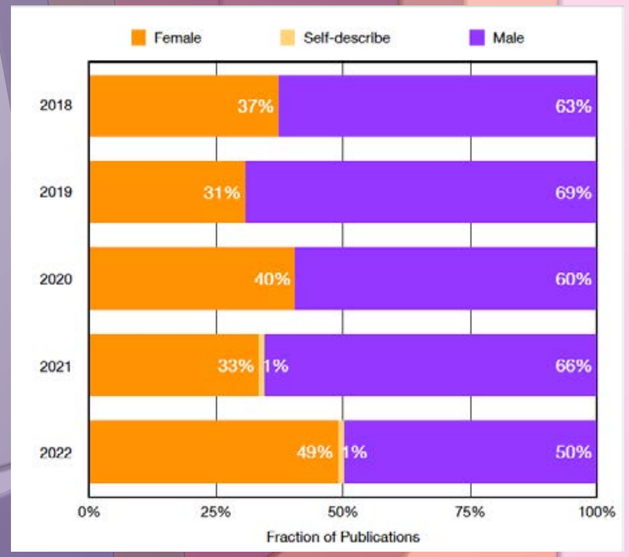
EDI Documents Updates in 2022

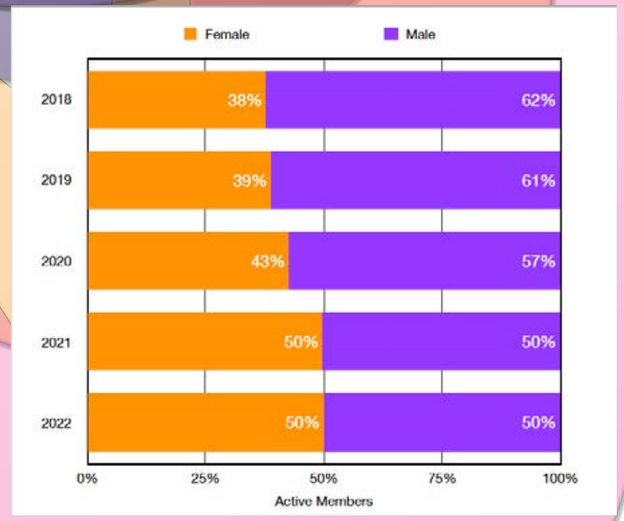
To ensure that the EDI resources reflect current best practices, the committee regularly reviews the ASTRO 3D documents and revises as needed. In 2022, the inclusive hiring guidelines were updated with examples of Achievements Relative to Opportunity (ARO) in job applications. Marie Partridge and Vy Tran revised the EDI Terms of Reference to reflect how the committee is run. Ingrid McCarthy and Vy Tran also updated the ASTRO 3D “Guide for Inclusive Meetings” to include hybrid support, health safety recommendations, templates for registration forms and surveys, and a short checklist at the top of the guideline.

Sharing ASTRO 3D Resources with the Community

Having met our goal of gender representation, the EDI committee is now working to share best practices and resources across the ASTRO 3D nodes and with other science communities. Ingrid McCarthy and Vy Tran developed a comprehensive and outward facing EDI webpage where EDI resources are now directly linked as a tab on the ASTRO 3D landing page.

Vy has met with and been advising the EDI committees for the CQC2T Centre of Excellence and SmartSat Cooperative Research Centre. Vy gave talks about ASTRO 3D EDI strategies to both CQC2T and SmartSat, as well as the University of Melbourne and Monash. Vy will continue the ASTRO 3D EDI roadshow with visits to the Perth nodes in coordination with the ASTRO 3D science meeting in May 2023.





The fraction of active ASTRO 3D members who identify as female has steadily increased from 33% in 2018 to 50% in 2021 and 2022. Right: The fraction of refereed ASTRO 3D publications with female first-authors (orange) has increased during the same period from 35% to 49%. The ASTRO 3D average for females over the five years is 38.2% compared to 20.6% during the same period in the Astrophysics Data System. (Boehm & Liu 2022).

Black Lives Matter Committee

The Black Lives Matter (BLM) Committee has emerged from the efforts of the previous Black Lives Matter Working Group. The BLM Committee assist the Director and Executive with the development of strategies and activities that address racial inequity within the Centre, with the aim of taking steps to combat academic institutional inequities and racial biases in order to make astronomy more accessible to Indigenous and Black identifying people within Australia.

This past year has welcomed many developments from the hard work of the BLM Committee including the establishing of an Indigenous Advisory Board to provide advice and insight to the BLM Committee and the Executive.

The board members are:

Professor Bronwyn Carlson, Head of Indigenous Studies at Macquarie University

Associate Professor Rowena Ball, Applied Mathematician and Chemist at ANU

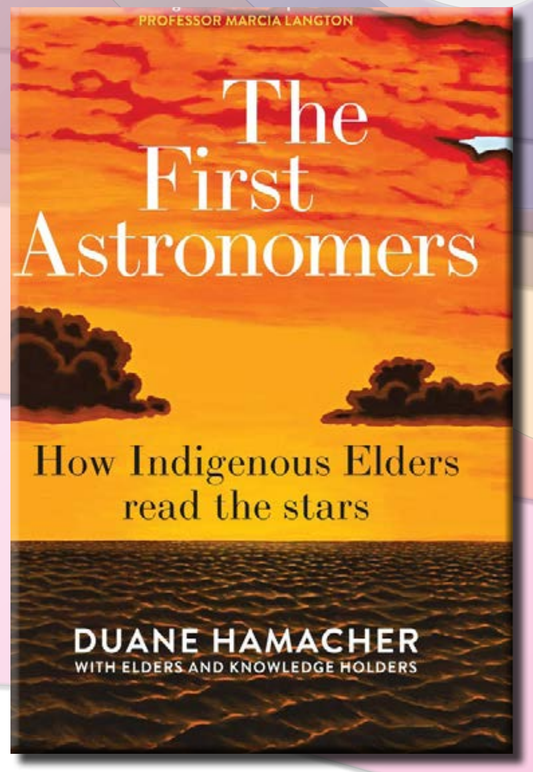
Dr Stacy Mader, Radio Astronomer at CSIRO

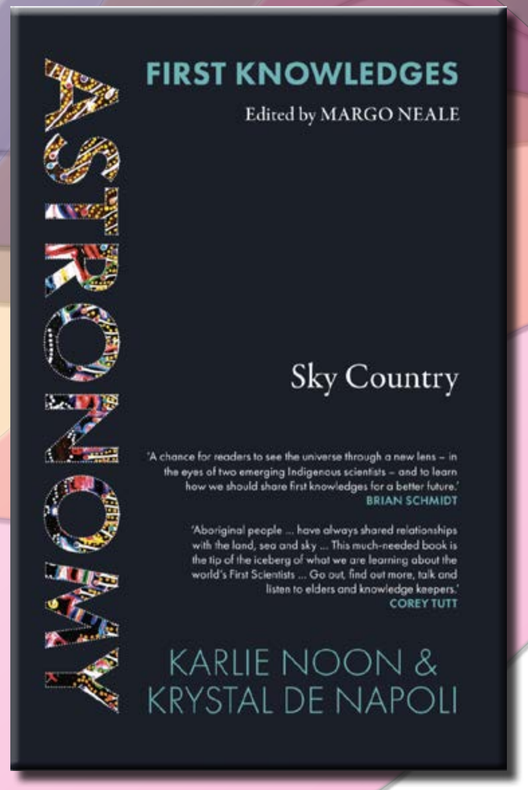
Krystal De Napoli, Education & Outreach Officer for ASTRO 3D at Swinburne University

Kirsten Banks, PhD Candidate at UNSW

Peter Swanton, PhD Candidate at ANU

A core objective of the BLM Committee's Action Plan is to celebrate the astronomy of Aboriginal and Torres Strait Islander communities. Their traditions have been sustained over 65,000+ years and their astronomical practices are the oldest known in the world.





ASTRO 3D Node, the University of Melbourne, have made strides in incorporating Indigenous astronomy in their course offerings, with the development of three breadth-subjects by Associate Professor and co-Chair of the BLM committee, Duane Hamacher.

These courses are:

PHYC10010: Indigenous Astronomy, where students develop a deep understanding of the cultural astronomy with respect to Indigenous Knowledge.

PHYC20017: Archaeoastronomy, where students engage with the research, practices, and debates in archeoastronomy with respect to ancient cultures.

PHYC30025: Safeguarding Dark Skies, where students are introduced to challenges faced when aiming to sustain dark skies in the face of growing artificial light pollution.

The two co-Chairs of the BLM committee, Duane Hamacher and Krystal De Napoli, have released two published works in 2022 that introduce the reader to the world of Aboriginal and Torres Strait Islander astronomy.

These works are:

The First Astronomers: How Indigenous Elders Read the Stars by Duane Hamacher. (See image far left)

Astronomy: Sky Country by Karlie Noon and Krystal De Napoli. (See image near left)

The BLM committee is entering 2023 with a fresh excitement for continuing to tackle racial inequity within ASTRO 3D and to make astronomy a safe and accessible field for all.

50:50 Gender Achievement

Ambitious Goal

In 2017, the ASTRO 3D set an ambitious goal of achieving 50% women by the end of 2021. We achieved this milestone across our 290-person Centre in March 2022, including 56% women postdocs and 55% women students, through a series of recruitment, retention and culture change initiatives.

Why 50:50?

We need to:

1. Provide role models for students and early career researchers
2. Provide an inclusive environment for all
3. Provide balanced role models for education and outreach in schools
4. Avoid inducing stereotype threat at schools and in the workplace

Resources

To access the strategies and framework documents that we developed within ASTRO 3D to help achieve our goal of gender diversity you can visit the ASTRO 3D website. These documents were developed by EDI committee members with feedback from the ASTRO 3D community. We hope these resources are shared broadly and adapted as needed by leadership across the science community.

We are grateful to the ASTRO 3D community and especially the EDI committee members. Without their sustained engagement and effort, we could not have achieved our goals.

"Over the course of this Centre, we seek to achieve a fraction of 50% females at all levels including the executive, the Advisory committee, and at all Centre sponsored events (including speakers), as well as equity in salaries and opportunities."

2017 ASTRO 3D Proposal to the Australian Research Council

CAASTRO introduced some core initiatives, aimed at making the Centre more family-friendly. ASTRO 3D, with it's bold targets, through the EDI Committee, added a broad range of diversity initiatives. Those in orange were directly aimed at achieving the 50% women at all levels of ASTRO 3D. Those in black are aimed at increasing all forms of diversity, making the Centre more equitable and inclusive (source: Kewley, 50:50 Gender Celebration presentation)

50:50 Celebration

On 13 April 2022, we celebrated this remarkable achievement at the Mount Stromlo Observatory Visitor Centre. There was a great turnout with many ASTRO 3D node members, including some from Melbourne and Sydney and many leaders in the scientific community in attendance, including ANU Vice Chancellor Professor Brian Schmidt, Academy of Science CEO Anna-Maria Arabia, representatives from the SAGE program, and the Australian women in STEM Ambassador's Office, Directors and Deans from across the ANU campus, and our advisory board members Sue Weston and Bobby Cerini.

At ASTRO 3D we are very proud of the tremendous job we've done in building a culture that embodies our Centre values. We now look to shift gears to focus on continuing to improve the support for and representation of astronomers from other under-represented groups, including indigenous astronomers.

Professor Lisa Kewley will be preparing the strategies and framework the centre developed into an article to be submitted to Nature Astronomy to share what we have learned and achieved with the broader academic community. The article is expected to be released mid 2023.

(50:50 Celebration images: clockwise from top left): Image 1: From Left: Isabelle Kingsley (UNSW), Sue Weston (Comcare), Anna-Maria Arabia (AAS), Tamzen Armer (SAGE), Mei Leo (SAGE) Image 2: From Left: Prof Ute Roessner (ANU), Liz Visher (ARC), Prof Stu Wyithe (ASTRO 3D UniMelb), Prof Dragomir Neshev (TMOS ANU) Image 3: From Left: Richard Barry (Astronomy SKA), A/Prof Christian Wolf (ANU), Prof Ann McGrath (ANU), Prof Lisa Kewley (ASTRO 3D ANU) Image 4: From left: Dr Sven Buder and Dr Andrew Battisti (ANU) Image 5: From Left: A/Prof Luca Casagrande (ANU), Prof Matthew Colless (ANU), Dr Roger Haynes (AITC, ANU) All photos by Cristy Roberts (ANU)

Science Management Committee

ASKAP SURVEYS

DINGO

1. Process DINGO pilot phase 2 data

2. Process full DINGO survey data

FLASH

1. Implement and test AusSRC FLASH post-processing workflow for full surveys

2. Public release of FLASH multi-frequency database (CHAD)

3. Data release of post-processed/value-added data from FLASH Pilot Surveys (Dr1)

4. Investigate machine-learning options for classifying FLASH line finder output

5. Data release from first six months of full FLASH survey (Dr 2)

6. Updated data release from full FLASH survey (Dr3)

WALLABY

1. Finalise preliminary WALLABY field selection

2. Internal release of first WALLABY survey data

3. Public release of WALLABY phase 2 pilot data

4. Organise annual WALLABY science meeting and/or busy week

DATA INTENSIVE ASTRONOMY (DIA)

1. Report on results of Pawsey PACER programs for ASTRO 3D science projects (DINGO)

2. Report on results of AusSRC programs for ASTRO 3D science projects (WALLABY, FLASH)

3. Initial internal release of Hector data products through the Optical Data Centre (ODC) archive interface

4. Report on prototype ‘archive’ interface to Genesis-related numerical/hyDro simulation outputs through ODC

5. Release interoperability of ASTRO 3D IFU survey archive data with Sky Mapper

6. Report on initial public ‘ASTRO 3D simulation archive’ release

7. Release enhanced interoperability of ASTRO 3D IFU survey archive data with CASDA and ESO

8. Release interoperability functions of ASTRO 3D simulation and observation archives

FIRST GALAXIES PROJECT

1. Contribution to JWST PASSAGE survey: identification of z>8 galaxies from large area slitless spectroscopy

2. Adaptation of BoRG pipeline for applications to NIRCAM parallel data for identification of z>6 sources

3. Analysis of spatial correlations between z~2 and z~8 Lyman Break galaxies and connections to contamination in high-z samples

4. Analysis of NIRCAM parallel data for identification of z>6 sources

5. Spatial clustering of galaxies in the epoch of reionisation

FIRST STARS PROJECT

1. Analyse the VLT/UVES spectra of probable extremely metal-poor stars that are members of the LMC (candidates selected from SkyMapper photometry and 2.3 spectroscopy)

2. Obtain high-resolution UV spectra from UVES/VLT for the most metal-poor stars known. Together with archival data, use these to determine abundances of O (together with C and N), for comparison with extragalactic sources at high redshift.

3. Mass-loss in metal-poor Galactic globular cluster stars. will use Kepler space telescope (K2) data to determine precise asteroseismic masses of stars in globular clusters.

4. By targeting stars in various phases of evolution we can measure the integrated mass-loss of each evolutionary phase. This work will extend our knowledge of stellar mass-loss down to the low-metallicity regime.

5. Chemical evolution of the heaviest elements and the rates of neutron star mergers in the Milky Way Galaxy

GENESIS SIMULATIONS

1. Direct ingestion of Genesis data by SAGE

2. Development of tools to incorporate Genesis data into TAO

3. Get feedback from the astronomy community about the datasets they produce/want.

4. Study coupling of jet feedback to ambient medium in galaxies, combining detailed PLUTO AMR simulations with results from GADGET cosmological simulations

5. Develop suite of controlled non-cosmological simulations, cosmological zoom counterparts, and small cosmological volumes

6. Apply WhereWolf to N-body merger trees, and use OrbWeaver to classify orbits and interaction histories.

Activity Plan 2023

Science Activity Plan for 2023

GALAXY EVOLUTION PROJECT

1. DUVET: upgrade threadcount in collaboration with ADACS. ADACS delivered new fitter, needs to be integrated into software
2. DUVET: Generate new method to nonparametrically map outflow velocity distribution
3. DUVET: Apply Reichardt Chue+2022 to more targets (with thread_count0)
4. DUVET: Apply method from Cameron et al. 2022 to more targets
5. DUVET: Establish method to measure edge-on outflows
6. DUVET: Apply method for edge-on outflows to more targets
7. CGM Imaging of accretion in face-on galaxy
8. Manage - assemble current AO/HST data for WDM analysis
9. Lead KCWI observing for CGM science with AGEL targets
10. AGEL: HST observing
11. CGM HI Kinematics
12. Analysis of HST data for CGM imaging
13. XQR30: Paper on XQR-30 metal absorber catalog (submitted)
14. XQR30: Paper on redshift evolution of CIV cosmic mass density (submitted)
15. Kinematics: Reduce & Analyse current XSHOOTER data
16. Rosetta Stones paper (lensed dE at z~1)
17. SAMI Zoom catalogue paper
18. Kinematics: Paper - Disk settling
19. Kinematics: Paper - Disk thickness
20. AGEL: Manage first paper using CNNs for WDM substructure
21. Discovery of a z~6 protocluster in MAGPI
22. Connection between LINER emission and radio core
23. Analyse Xshooter data for EoR analogs
24. Metallicity gradient paper for TYPHOON spirals (Grasha+)
25. TYPHOON HII region catalog (Grasha+)
26. JWST Planning

MWA EOR SURVEY

1. Process EoR2 field data through independent pipeline to test systematics introduced by RTS
2. Complete the HyperDrive paper
3. Develop HyperDrive redundant calibration and spectral regularisation
4. Develop and implement data quality visualisation with DuG
5. Explore the effect of diffuse emission on EoR end-to-end pipeline
6. Interferometric Effects of Deformed Beams I: Depolarisation & Rotation Measure
7. Develop HyperDrive DD calibration
8. Compute skew and bispectra of foregrounds and 21cm signal

SAMI/HECTOR SURVEY

1. Hector science verifiction data is available.
2. Hector First Science: Stellar kinematic properties of Milky Way Analogues - comparing Hector and SAMI (needs commissioning data)
3. Hector target selection paper, after completion of commissioning
4. The SAMI Galaxy Survey: impact of black hole activity on galaxy spin-filament alignments
5. Linking spatially-resolved properties of galaxies to X-ray proxies for group environment using SAMI and eROSITA
6. The MAGPI Survey: kinematic alignments of stars, gas and halos in the cosmic web
7. The Hector Galaxy Survey: galaxy spin-filament alignments in the cluster outskirts
8. Paper investigating the future fate of ram-pressure stripped galaxies using SAMI and early Hector data
9. The Hector Galaxy Survey: Investigating the role of preprocessing on galaxy transformation in the outskirts of clusters.
10. Hector Cluster redshift survey: Characterising cluster membership, dynamical properties, targets for Hector
11. Complete Hector data reduction pipeline, based on modified SAMI pipeline and dependent on Hector science verification data.
12. Confirmation and testing of hector astrometric model
13. Different radial anisotropy between star-forming and quiescent galaxies in the SAMI, MAGPI and LEGA-C surveys
14. The hyperplane of early-type galaxies: a sharper tool for cosmology?
15. Development of simspin code to run in both spectral and kinematic mode

development of spinspin to become containerised web application, running on Data 1

16. Central servers and producing synthetic datacubes of simulations from the EAGLE, Illustris TNG, Magneticum, and Horizon AGN simulations

GALAH SURVEY

1. Trace back the role of accretion onto the Milky Way by comparison with different scenarios provided by cosmological simulations
2. Infer the yields of element production from the element patterns of accreted structures, constraining uncertain theoretical yields
3. The influence of mergers on the formation and velocity dispersion of thick discs
4. Identifying red clump stars via increased neutron-capture abundances
5. Revisit twilight/photonic comb calibration of GALAH data for approved abundance in time for Dr4

Too much heavy metal stops stars producing

STARS EVOLVE ACCORDING TO THE ELEMENTS THEY MANUFACTURE

Stars are giant factories that produce most of the elements in the Universe – including the elements in us, and in the Earth's metal deposits. But what stars produce changes over time.

Two new papers by a team of ASTRO 3D and Monash University researchers, published in MNRAS, shed light on how the youngest generation of stars will eventually stop contributing metals back to the universe.

"We know the first two elements of the periodic table – hydrogen and helium – were created in the Big Bang," said Amanda Karakas, first author of a paper studying metal-rich stars.

"Over time, the stars that came after the Big Bang produce heavier elements."

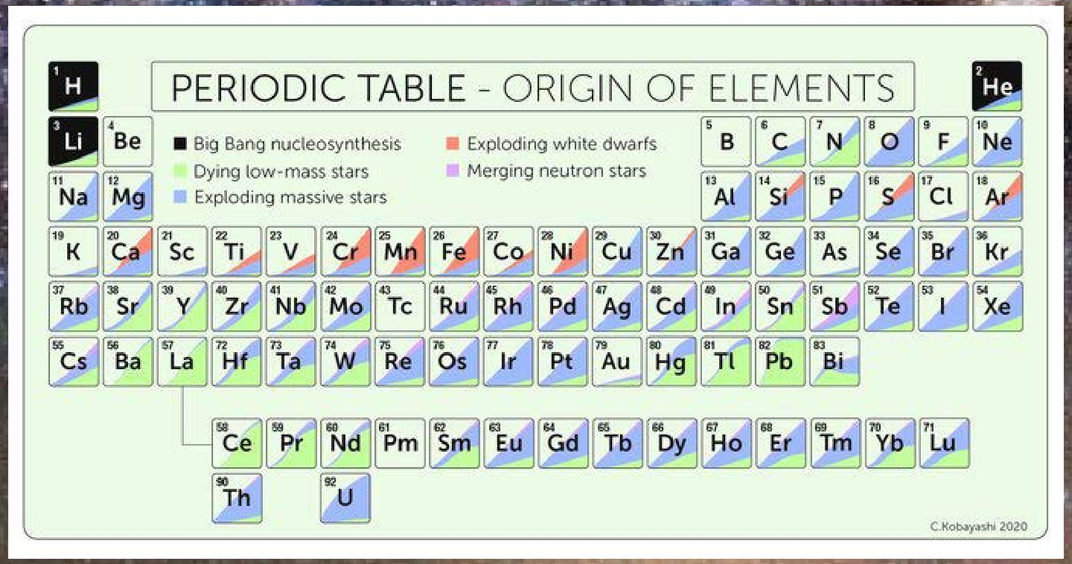
These "metal-rich" stars, like our Sun, spew out their products into space, changing its composition over time.

These systems affect us directly as around half of the carbon and all elements heavier than iron are synthesised by stars like our Sun.

About 90 per cent of all the lead on Earth, for example, was made in low-mass stars which also produce elements such as strontium and barium.

But this ability to produce more metals changes the way they work.

"Introducing just a tiny bit more metal into the stars' gas has really large implications on their evolution," said Giulia Cinquegrana, whose paper uses modelling from the earlier paper to study the chemical output of metal-rich stars.



"We discovered that, at a certain threshold of initial metal content in the gas, stars will stop sending more metals into the Universe over their lifetime," Cinquegrana said.

The Sun, born about 4.5 billion years ago, is a typical "middle-aged" star. It is "metal-rich" compared to the first stellar generations and has a heavy element content similar to many other stars in the centre of the Milky Way.

"Our papers predict the evolution of younger (later generations) stars which are up to seven times more metal-rich than the Sun," said Karakas.

"My simulations show that this really high level of chemical enrichment causes these stars to act quite weirdly, compared to what we believe is happening in the Sun," said Cinquegrana.

"Our models of super metal-rich stars show that they still expand to become red giants and go on to end their lives as white dwarfs, but by that time they are not expelling any heavy elements. The metals get locked up in the white dwarf remnant," she said.

"But the process of stars constantly adding elements to the Universe means that the make-up of the Universe is always changing. In the far distant future, the distribution of elements will look very different to what we see now in our Solar System," said Karakas.

Background image: Many stars in the centre of the Milky Way have high heavy metal content. Credit: Michael Franklin. Inset image: Periodic table with origin of the elements. Credit: created by Chiaki Kobayashi & Amanda Karakas, artwork by Sahm Keily.

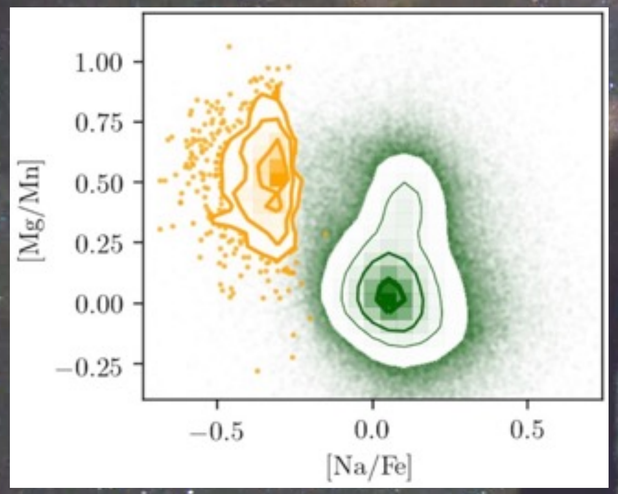
Galactic Blender

WHAT INGREDIENTS WENT INTO THE GALACTIC BLENDER TO CREATE THE MILKY WAY?

Our galaxy is a giant 'smoothie' of blended stars and gas but a new study tells us where the components came from

In its early days, the Milky Way was like a giant smoothie, as if galaxies consisting of billions of stars, and an enormous amount of gas had been thrown together into a gigantic blender. But a new study picks apart this mixture by analysing individual stars to identify which originated inside the galaxy and which began life outside.

"Although the Milky Way is our home galaxy, we still do not understand how it formed and evolved," said researcher Sven Buder from the ARC Centre of Excellence for All Sky Astrophysics in 3 Dimensions (ASTRO 3D) and the Australian National University (ANU).



His paper, published in the Monthly Notices of the Royal Astronomical Society, analyses the light from stars in detail, helping to understand what elements went into the creation of the Milky Way we know today.

"The Milky Way ate up lots of smaller galaxies but, until recently, we did not have enough evidence of that to say for sure," Buder said.

"That's because simple images of stars in our Milky Way look the same – whether they were born inside the galaxy or outside and then blended into the galaxy."

Buder and colleagues in the Galactic Archaeology with HERMES (GALAH) team used Australia's largest optical telescope, the Anglo-Australian Telescope (AAT), at Siding Spring Observatory to split light from more than 600,000 stars into wavelengths with the HERMES (High Efficiency and Resolution Multi-Element Spectrograph) instrument.

This effectively creates 600,000 stellar rainbows known as spectra.

Within each of these rainbows are specific bands of light – rather like tiny unique barcodes – that vary depending on a star's chemical composition.

"If an image is worth a thousand words, these spectra are worth more than a thousand pictures," said Buder. "By 'scanning' these stellar barcodes, we measured how abundant 30 elements, such as sodium, iron, magnesium, and manganese, were, and how they appeared in different concentrations depending on where the star was born."

This discovery is an early step towards reconstructing a picture of the "childhood" of the Milky Way to get an idea of the size of the galaxies that it consumed in the process.

"It could also help us understand how several of the features of the galaxy we know today came into being," said Buder.

One mystery the new observations could help solved is why there are two distinct groups of stars in the disc that we see as the "milky" band in the night sky.

"The Milky Way spread out across the night sky is a familiar sight, and when we look at it, we are actually gazing into the centre of our galaxy with its billions of stars," said Buder.

"But we are looking at two populations of stars, one much older than the other. The old stars have moved so they look like they bulge out of the main plane of the Milky Way, while the younger stars form a much thinner band in the plane.

"But we don't know why this has happened and our latest findings of the remnants of gigantic, galactic collisions may help us understand," said Buder.

Buder's paper provides the latest revelations relying on data from the Gaia project – an ambitious satellite mission to chart a three-dimensional map of the Milky Way to help understand its orbits, composition, formation, and evolution.

The Gaia satellite measurements can help us to find candidates of previously extragalactic stars, because they still move differently from a typical Milky Way star. But the extragalactic origin of a star can only be confirmed by its chemical fingerprint.

The GALAH survey is an Australian-led Large Observing Program using the HERMES instrument to obtain the highest spectral resolution multi-dimensional datasets for more than a million stars of all ages and locations in the Milky Way, to trace the full history of the Galaxy.

The HERMES instrument was built by the Australian Astronomical Observatory, which has since become the Astralis Instrumentation Consortium. Astralis receives $5M per year from the NCRIS programme, and combines expertise from Macquarie University, the University of Sydney, and ANU. Astralis will strengthen Australia's competitiveness for instrumentation contracts at major observatories world-wide.

young disk population

old disk population

Background image: The Milky Way has two distinct populations of stars, one older than the other. The older stars have moved so they look like they bulge out of the main plane of the Milky Way, while the younger stars form a much thinner band in the plane .
Image inset above left: Origins of Stars" Just by looking at how abundant are sodium, iron, magnesium, and manganese in a star, we can tell apart stars born in the Milky Way (green) or outside (yellow).
Image inset above right: "Galactic Mergers" A simulation of a collision between the young Milky Way and a smaller galaxy – Dr Tobias Buck (AIP/MPIA/NYU).

What will Australians see with JWST?

US PRESIDENT BIDEN RELEASED FIRST PICS FROM THE $US10 BILLION JAMES WEBB SPACE TELESCOPE TUESDAY 12 JULY 2022

Aussie astronomers in Melbourne, Sydney, Brisbane, Perth and Canberra were quoted on seeing the first pictures available from the James Webb Space Telescope.

They're using Webb to look for the first stars, the first galaxies, baby planets, massive black holes.

Over the past 30 years, Hubble has transformed science and culture, revealing a Universe of 200 billion galaxies. Webb will see further, solving today's mysteries and creating new ones.

On 12 July Joe Biden released 'the first picture' then NASA released a suite of images early the following morning from the James Webb Space Telescope, the successor to Hubble.

Nearly 40 researchers across Australia eagerly awaited data from Webb for their projects. Many of them gave interviews about what they were hoping to see with Webb and about their reaction to the first pictures.

Much of the Webb data is flowing back to Earth through Tidbinbilla, and some comes from an instrument designed by Peter Tuthill at the University of Sydney. He was relieved and excited. "This is a day I have been looking forward to for a big part of my career. Everything about the Webb is so over-the-top audacious - from the titanic articulated mirror down to its orbit out in the cold voids of interplanetary space."

"This entire huge, complicated machine flew out and everything seems to have unfolded and deployed like clockwork."

The first stars and galaxies

"Hubble took my favourite astronomical image of all time: the Hubble Ultra Deep Field," said Elisabete da Cunha at UWA and ASTRO 3D in Perth. "It was taken by pointing Hubble to a dark patch of sky) and just collecting photons for about 10 days. That tiny dark patch of sky reveals over ten thousand distant galaxies. This completely revolutionised our view of the Universe: there are many more galaxies than we imagined"

We will be able to observe even more distant galaxies than with the Hubble — in fact, we expect to observe the very first galaxies that lit up the Universe!

"Webb will allow us to view the birth of stars within the hearts of the densest, dust-enshrouded cores of molecular clouds," said Kathryn Grasha from ANU and ASTRO 3D. "The "unknown unknowns" are the most exciting prospect for the next decade. And the breathtaking views of the Universe are guaranteed to ignite the excitement and imagination of the public and inspire the next generation of astronomers," she said.

"Webb's primary mission will be to witness the birth of the first stars and galaxies in the early Universe," said Melbourne's Karl Glazebrook, from Swinburne University and ASTRO 3D. "The first billion years of cosmic history has barely been explored. We don't know when or how the first stars formed. This is a complex question as stars produce heavy elements when they die.

All current star formation we can observe, such as in the Milky Way, is from enriched interstellar gas. We haven't yet seen how stars form in pristine gas, which is without any heavy elements – as such a state hasn't existed for more than 13 billion years," he said.

Hubble showed us the brightest ancient galaxies," said Nicha Leethochawalit an ASTRO 3D researcher at the University of Melbourne. In fact, there are a lot more low-mass or 'mediocre' galaxies than massive and bright ones. Webb will help us work out the distribution of mass (or light) among galaxies, a bit like wealth distribution in nations..

Massive galaxies

"Among the first images will be of the galaxy cluster SMACS 0723, one of the most massive objects in the Universe," said Kim-Vy Tran, a UNSW and ASTRO 3D astrophysicist. "This galaxy cluster bends light from objects at the edge of our observable horizon and may reveal how the very first galaxies form."

New planets

"I'm looking for faint whispers and motes of light that betray the presence of planets nestled up against the overwhelming glare of the host star," said Tuthill.

"I used Hubble to find brown dwarfs – halfway between suns and planets," said Benjamin Pope from the University of Queensland. "Now we can look for much smaller planets with Webb to help us understand how Earth and the Solar System formed."

I hope to see baby planets being born. Are they born hot or cold?" said Christophe Pinte, Monash University, Melbourne.

Black holes

"We're hoping to use the Webb to find out how feeding black holes launch powerful beams of outflowing matter and energy known as jets, said James Miller-James at Curtin University/ICRAR in Perth. "Jets from the most massive black holes can affect the evolution of entire galaxies."

"As a teenager, I was awed by Hubble's powerful images of the cosmos," he said. "The day I received the first Hubble data for one of my own science programs was extremely exciting. I hope that the Webb will similarly inspire the next generation of scientists in Australia and around the world."

The James Webb Space Telescope

30 years in development. Delayed by a decade. Now in orbit 1.5 million km from Earth. It has a 6.5 metre gold coated mirror made of 18 hexagonal segments, each aligned to 25 millionths of a millimetre. It is cold, about -233 degree C, and protected from the Sun by a 20-metre-wide sunshield.

Background image: Webb's near- to mid-infrared sensitivity, and high-resolution imaging and spectroscopic capabilities have already revealed parts of the universe hidden to our eyes, such as stars among clouds of dusts, water in the atmospheres of other worlds, and the deepest image of the universe ever taken. Artwork: Elizabeth Wheatley (STScI)

Aussie astronomers react to NASA JWST first images

WOW, WOW, WOW! GALAXIES COLLIDE AND TUMBLE IN A COSMIC DANCE

Nearly 40 researchers across Australia eagerly awaited data from Webb for their projects. Many of them are gave interviews to talk about their reaction to the first pictures.

“Wow, wow, wow!!! The Webb telescope continues to absolutely amaze and delight with these first images!” said Kim-Vy Tran, a UNSW and ASTRO 3D astrophysicist.

“Stephan’s Quintet is a fabulous system of close galaxies. You can almost feel the shockwaves as these galaxies collide and tumble in their cosmic dance. Bound together by gravity, these galaxies are important for understanding the future of galaxies like our Milky Way.”

“The Carinae Nebula is also just superb. It’s a stellar nursery full of baby stars where we’re seeing incredible levels of details for the first time. It’s like before we could see just the trees in the forest, but now we can see down to the branches and even the leaves of individual trees. Some of these baby stars are super-charged giants that are radiating huge amounts of energy. Imagine a UV index of a gazillion!”

The first stars and galaxies

“I’ve been looking at this picture non-stop since I woke up, I can’t stop looking at it,” said astrophysicist Elisabete da Cunha at UWA and ASTRO 3D in Perth.

“There are thousands of galaxies in the deep field image... We are seeing them with amazing amounts of detail that we couldn’t see with Hubble... JWST is really blowing it out of the park. It’s amazing.

“Hubble took my favourite astronomical image of all time: the Hubble Ultra Deep Field,” she said. “That tiny dark patch of sky reveals over ten thousand distant galaxies. This completely revolutionised our view of the Universe.

“We will be able to observe even more distant galaxies than with the Hubble — in fact, we expect to observe the very first galaxies that lit up the Universe!”

“Webb will allow us to view the birth of stars within the hearts of the densest, dust-enshrouded cores of molecular clouds,” said astrophysicist Kathryn Grasha from ANU and ASTRO 3D.

Image: This image shows the galaxy cluster SMACS 0723 as it appeared 4.6 billion years ago, with many more galaxies in front of and behind the cluster. Much more about this cluster will be revealed as researchers begin digging into Webb’s data. This field was also imaged by JWST’s Mid-Infrared Instrument (MIRI), which observes mid-infrared light. Credit: NASA, ESA, CSA, and STScI

“The ‘unknown unknowns’ are the most exciting prospect for the next decade. And the breathtaking views of the Universe are guaranteed to ignite the excitement and imagination of the public and inspire the next generation of astronomers,” she said.

“It is quite humbling to see the sharpest images of our birth clouds in our cosmic neighbourhood,” said Themiya Nanayakkara, Chief Scientist, James Webb Australian Data Centre at Swinburne University and ASTRO 3D.

“With the help of different instruments in JWST we can now cut through many layers of dust to see what is really going on in these regions. They demonstrate to us the cosmic recycling processes: a remnant of a dead star resulting in thousands of newer generation young stars, many of which we have never seen before.

“As a person who have spent many nights using the largest telescopes on Earth to detect the faintest signatures of the early cosmos, I feel JWST will be game changing. The released spectra show that we not only detect one faint line but also the full suite of chemical elements in these galaxies. This, for the first time, gives us unique human DNA-like signatures of the first galaxies in the Universe to build up the origin story of life and everything around us.”

“The newly released James Webb Space Telescope images are beautiful and exciting in their own right, and in terms of the fantastic prospects they highlight for the future,” said astrophysicist Ilya Mandel from Monash University and ASTRO 3D.

“There is much more to come — and I am looking forward with great excitement to seeing the capabilities of the James Webb Space Telescope trained on other astrophysical puzzles, including cosmic transients such as the mergers of two neutron stars, which may be responsible for the production of much of the gold in the Universe.”

Background image: Image of the Cosmic Cliffs, a region at the edge of a gigantic, gaseous cavity within NGC 3324, captured by Webb’s Near-Infrared Camera (NIRCam), This image shows invisible near-infrared wavelengths of light that have been translated into visible-light colors. The color key shows which NIRCam filters that were used when collecting the light. The color of each filter name is the visible light color used to represent the infrared light that passes through that filter. Credits: IMAGE: NASA, ESA, CSA, STScI IMAGE PROCESSING: Joseph DePasquale (STScI), Anton M. Koekemoer (STScI)

Thousands more potential lenses await assessment

DOZENS OF NEWLY DISCOVERED GRAVITATIONAL LENSES COULD REVEAL ANCIENT GALAXIES AND THE NATURE OF DARK MATTER

Early in 2022 a machine learning algorithm identified up to 5,000 potential gravitational lenses that could transform our ability to chart the evolution of galaxies since the Big Bang.

Astronomer Kim-Vy Tran from ASTRO 3D and UNSW Sydney and colleagues assessed 77 of the lenses using the Keck Observatory in Hawai'i and Very Large Telescope in Chile. She and her international team confirmed that 68 out of the 77 are strong gravitational lenses spanning vast cosmic distances. This success rate of 88 per cent suggests that the algorithm is reliable and that we could have thousands of new gravitational lenses. To date, gravitational lenses have been hard to find and only about a hundred are routinely used.

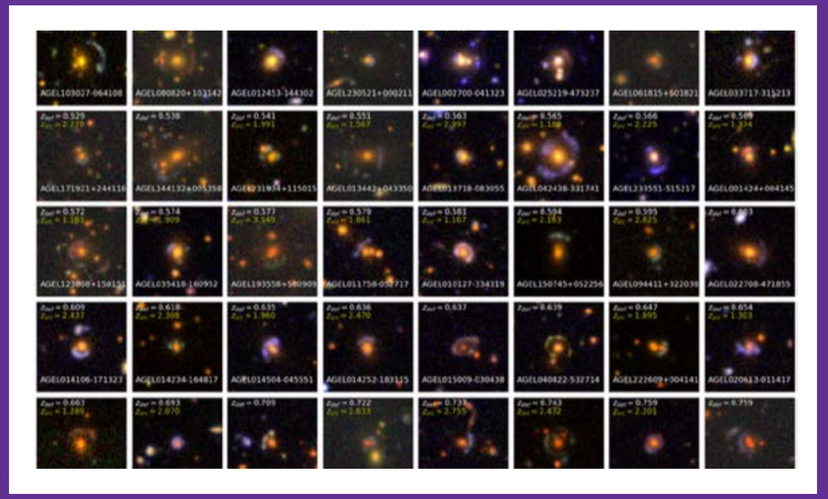
Kim-Vy Tran's paper published in the Astronomical Journal presents spectroscopic confirmation of strong gravitational lenses previously identified using Convolutional Neural Networks, developed by data scientist Dr Colin Jacobs at ASTRO 3D and Swinburne University. The work is part of the ASTRO 3D Galaxy Evolution with Lenses (AGEL) survey. "Our spectroscopy allowed us to map a 3D picture of the gravitational lenses to show they are genuine and not merely chance superposition," said corresponding author Dr Tran from the ARC Centre of Excellence for All Sky Astrophysics in 3-Dimensions (ASTRO 3D) and the University of NSW (UNSW). "Our goal with AGEL is to spectroscopically confirm around 100 strong gravitational lenses that can be observed from both the Northern and Southern hemispheres throughout the year," she said.

The paper is the result of a collaboration spanning the globe with researchers from Australia, the United States, the United Kingdom, and Chile. The work was made possible by the development of the algorithm to look for certain digital signatures. "With that we could identify many thousands of lenses compared to just a few handfuls," said Dr Tran.

Gravitational lensing was first identified as a phenomenon by Einstein who predicted that light bends around massive objects in space in the same way that light bends going through a lens.

In doing so, it greatly magnifies images of galaxies that we would not otherwise be able to see.

While it has been used by astronomers to observe far away galaxies for a long time, finding these cosmic magnifying glasses in the first place has been hit and miss. "These lenses are very small so if you have fuzzy images, you're not going to really be able to detect them," said Dr Tran. While these lenses let us see objects that are millions of light years away more clearly, it should also let us 'see' invisible dark matter that makes up most of the Universe. "We know that most of the mass is dark," says Dr Tran. "We know that mass is bending light and so if we can measure how much light is bent, we can then infer how much mass must be there."åeline going back almost to the Big Bang.



"The more magnifying glasses you have, the better chance you can try to survey these more distant objects. Hopefully, we can better measure the demographics of very young galaxies," said Dr Tran.

"Then somewhere between those really early first galaxies and us there's a whole lot of evolution that's happening, with tiny star forming regions that convert pristine gas into the first stars to the sun, the Milky Way. "And so with these lenses at different distances, we can look at different points in the cosmic timeline to track essentially how things change over time, between the very first galaxies and now." Dr Tran's team spanned the globe, with each group providing different expertise. "Being able to collaborate with people, at different universities, has been so crucial, both for setting the project up in the first place, and now continuing with all of the follow-up observations," she said. Professor Stuart Wyithe of the University of Melbourne and Director of the ARC Centre of Excellence for All Sky Astrophysics in 3 Dimensions (Astro 3D) said each gravitational lens is unique and tells us something new.

"Apart from being beautiful objects, gravitational lenses provide a window to studying how mass is distributed in very distant galaxies that are not observable via other techniques. By introducing ways to use these new large data sets of the sky to search for many new gravitational lenses, the team opens up the opportunity to see how galaxies get their mass," he said.

Professor Karl Glazebrook of Swinburne University, and Dr Tran's Co-Science Lead on the paper, paid tribute to the work that had gone before. "This algorithm was pioneered by Dr Colin Jacobs at Swinburne. He sifted through tens of millions of galaxy images to prune the sample down to 5,000. Never did we dream that the success rate would be so high," he said. Now we are getting images of these lenses with the Hubble Space Telescope, they range from jaw-droppingly beautiful to extremely strange images that will take us considerable effort to figure out."

Associate Professor Tucker Jones of UC Davis, another co-science lead on the paper, described the new sample as "a giant step forward in learning how galaxies form over the history of the Universe".

"Normally these early galaxies look like small fuzzy blobs, but the lensing magnification allows us to see their structure with much better resolution. They are ideal targets for our most powerful telescopes to give us the best possible view of the early universe," he said. "Thanks to the lensing effect we can learn what these primitive galaxies look like, what they are made of, and how they interact with their surroundings."

The study was conducted in collaboration with researchers from the University of New South Wales, Swinburne University of Technology, Australian National University, Curtin University, and the University of Queensland in Australia, the University of California, Davis, in the US, the University of Portsmouth, in the UK, and University of Chile.

Background image and inset: Pictures of gravitational lenses from the AGEL survey. The pictures are centred on the foreground galaxy and include the object name. Each panel includes the confirmed distance to the foreground galaxy (zdef) and distant background galaxy (zsrc).

Spin flips show how galaxies grow from the cosmic web

THE ALIGNMENT BETWEEN GALAXY SPINS AND THE LARGE-SCALE STRUCTURE OF THE UNIVERSE REVEALS THE PROCESSES BY WHICH DIFFERENT COMPONENTS OF GALAXIES FORM.

Like our own Milky Way, most galaxies have two components: an extended disk in which new stars form from gas and a central bulge of mostly older stars that grows over time.

An observational study published in Monthly Notices of the Royal Astronomical Society found that the size of the galaxies' bulge changes how their spins align with the surrounding structure.

The large-scale structure of the universe is traced by the distribution of galaxies. This 'cosmic web' consists of giant filamentary structures linking massive clusters of galaxies.

The study found that galaxies with bigger bulges tend to spin perpendicular to the filaments in which they are embedded, while galaxies with smaller bulges tend to spin parallel to these filaments.

"It all relates to the mass of the bulge," said astrophysicist Dr Stefania Barsanti from the Australian National University, lead author of the paper and a member of the ASTRO 3D Centre of Excellence.

"Galaxies which are mostly disk, with a low-mass bulge, tend to have their spin axis parallel to the nearest filament. This is because they form mainly from gas falling onto the filament and 'rolling it up'. Galaxy bulges grow when galaxies merge, generally as they move along the filament. So mergers also tend to 'flip' the alignment between the galaxy spin and the filament from parallel to perpendicular."

"We think that mergers must be more likely as galaxies move along the filaments towards each other. The direction of these mergers drives the spin flip," said Prof. Scott Croom, an astronomer at the University of Sydney and a co-author on the paper.

This discovery sheds light on the formation of two main components of galaxies, and how they relate to the large-scale structures and motions of matter in the cosmic web.

"Our motivation was to try to understand why galaxies spin and how they acquire their angular momentum from the material that forms them," said Dr Barsanti.

"Through this study, we can understand how mergers play an important role in the formation of galaxies, both the central bulge component and the spin flipping," she said. "This points to particular formation channels for how galaxies start to spin and how the spin changes as the galaxy evolves."

Although this evolution has been suggested by computer simulations, this study is the first time scientistic have used direct observation to confirm the growth of a galaxy's central bulge can cause it to flip alignments.

"This is a subtle signal that is really hard to detect in the observations," said Dr Barsanti.

It has been made possible with the advent of integral field spectroscopy, a technique in which an optical instrument combines spectrographic and imaging capabilities to build a 3D image of a galaxy and at the same time resolve its internal motions.

This study used a spectroscope called SAMI, attached to the 3.9-metre wide Anglo Australian telescope located in Siding Spring, NSW.

Researchers used SAMI to survey 3,068 galaxies between 2013 and 2020. This staggering amount of data has taken years to study and supplied direct evidence for the paper.

"With the SAMI Galaxy Survey we have spatially resolved spectroscopy allowing us to map the galaxy, with spectra at many points across the galaxy," said Dr Barsanti. "This tells us the internal motions of the stars and gas within the galaxy, so we can measure its overall spin."

"The SAMI Galaxy Survey allowed us to map the galaxy," said Dr Barsanti. "Its measurements tell us the internal motions of stars and gas within agalaxy, so we can determine its overall spin."

These results will inform the next big stage of our research, the Hector Galaxy Survey. Hector is the next-generation spectrograph replacing SAMI at the Anglo-Australian Telescope, which we'll use to survey around 30,000 galaxies."

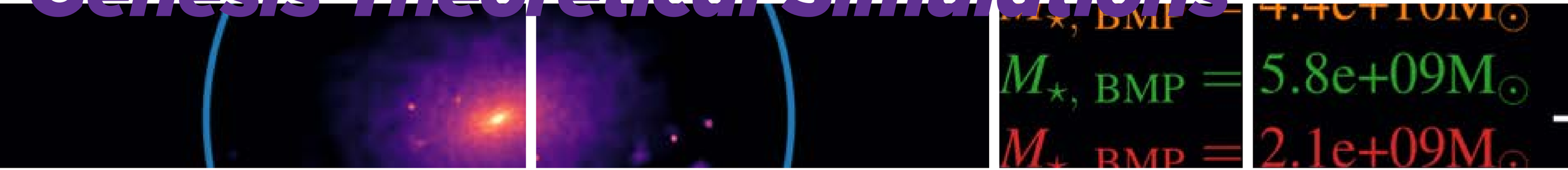
Professor Stuart Wyithe of the University of Melbourne, who is Director of ASTRO 3D, said the paper advances the Centre's key goals of tracing the distribution of matter from the earliest times in the Universe to the present day, and to build a 3D picture of the formation and evolution of the Universe that we see today.

"Using the power of the SAMI galaxy survey, which measured the 3D structure of individual galaxies as well as their position in space, this paper shows how the motions of mass in galaxies and positions of galaxies are connected, which is an essential piece in understanding how galaxies assembled," said Professor Wyithe

The study was conducted in collaboration with researchers from the Australian National University, University of Sydney, Johns Hopkins University, University of Hamburg, University of Cambridge, and Macquarie University.

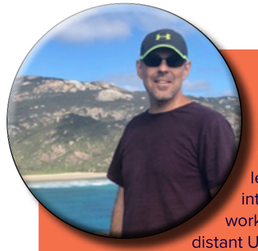
Background image: Examples of SAMI galaxies with central bulge and surrounding disc. Credit: Hyper Supreme-Cam Subaru and Pan-STARSS
Inset image: Examples of SAMI galaxies with central bulge and surrounding disc. Credit: Hyper Supreme-Cam Subaru and Pan-STARSS

Genesis Theoretical Simulations



Professor Chris Power from the University of Western Australia (UWA) is co-lead of the ASTRO 3D Genesis Simulations Thread. He is a computational astronomer who works on a broad range of problems in galaxy formation and cosmology.

Chris is leading the development of the Genesis Simulations that will track the birth, growth and the ultimate fate of galaxies from the earliest epoch of galaxy assembly, through the epoch of reionisation to the present-day. Chris is also the ASTRO 3D UWA Node Leader.



Professor Darren Croton from Swinburne University of Technology is also co-lead of the Genesis Simulations Thread. He is an internationally-known theoretical astrophysicist who works on the formation of galaxies in the nearby and distant Universe.

Darren conducts massive cutting-edge supercomputer simulations and mines large observational data sets from some of the world's largest telescopes.

Project Background

The ASTRO 3D Genesis Simulation program focuses on three key science areas:

1. Simulating the birth of the first stars and their impact on early universe chemical enrichment, proto-galaxy formation, reionisation and the evolution of the IGM.

2. Tracking galaxy growth through star formation and mergers, and the build-up of angular momentum at all galactic scales, leading to the emergence and evolution of large-scale structure and the epoch of quasars.

3. Uncovering the history of the local galaxy population, including radio galaxies and AGN, by following the dynamical, stellar and chemical evolution of the galaxies across cosmic time to the present day.

These questions are being addressed through the concurrent development of a new generation of integrated N-body/hydrodynamical galaxy formation simulations coupled to sophisticated semi-analytic galaxy models, the "Genesis Suite". Genesis will be available to both the ASTRO 3D and wider astronomical community through an update to the Theoretical Astrophysical Observatory (TAO++), opening up Genesis to be easily usable to address all the key ASTRO 3D science goals.

The Genesis Simulations thread combines suites of large N-body simulations that are coupled to semi-analytical models to produce synthetic galaxy populations across cosmic time, all run in-house, with bespoke analysis of state-of-the-art hydrodynamical simulations, such as EAGLE (Schaye et al. 2015) and Illustris-TNG (Pillepich et al. 2016), and their successors, and our own in-house runs targeting individual galaxies (both non-cosmological and cosmological zooms), which address specific problems with an ASTRO 3D focus.

2022 Project Highlights

The Genesis team has been working with the developers of the Swift simulation code to run (1) large, high resolution, volume dark matter simulations, and (2) targeted zoom galaxy formation simulations of galaxies and galaxy groups. The dark matter simulations have the resolution to resolve low-mass dark matter halos that powered the growth of the ionizing background during the Epoch of Reionisation (EoR), whilst also having the large volume to capture not only reionisation by ultra-violet radiation from the first stars, but also X-rays generated by the first black holes. The zoom simulations allow us to study, for example, galaxy transformation in group environments, which supports our work with the likes of SAMI/HECTOR and the ASKAP surveys.

University of Melbourne ASTRO 3D PhD student, Balu Sreedhar, has used the Genesis dark matter simulations to predict the 21-cm global signal and power spectra during the Epoch of Reionisation using the Meraxes semi-analytic galaxy formation and reionisation model, which has been updated to include X-ray heating and thermal evolution of the intergalactic medium. Balu exploited a technique to augment the merger trees drawn from N-body simulations and extend the halo and merger tree mass range that can be probed in the model - this allowed him to study, for example, how including ionizing radiation from X-rays modifies the 21-cm global signal (see Figure 1). This work represents the first model of both reionisation and galaxy formation which resolves low-mass atomically cooled galaxies while simultaneously sampling sufficiently large scales necessary for exploring the effects of X-rays in the early Universe.

ASTRO 3D PhD student, Matt Wilkinson, from the International Centre for Radio Astronomy Research node of The University of Western Australia, has used idealised N-body simulations of individual galaxies to study the impact of spurious heating of stars by dark matter on the kinematics and

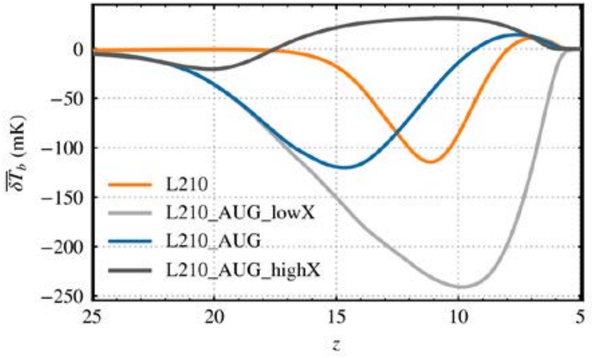


Figure 1: This shows the effect of X-rays on the 21-cm global signal from period encompassing the cosmic dawn and the Epoch of Reionisation. Models in which X-rays are important (dark grey) cause the signal to be observed in emission earlier than those in which there is a deficit of X-rays (light grey), which show a deeper absorption feature. Credit author: Balu Sreedhar

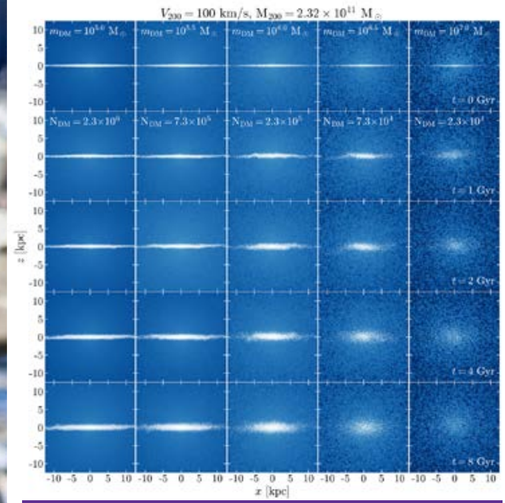


Figure 2: This shows an edge-on view of the evolution of a simulated galactic disc consisting embedded in a dark matter with a virial circular velocity of 100 km/s. Different rows correspond to different output times - t = 0, 2, 4 and 8 Gyr, respectively - while different columns correspond to halos with different particle numbers of dark matter particles - from 2.3M to 23k.The stellar disc thickens over time at a rate that increases with decreasing particle number, and become progressively more spheroidal with time, particularly if the resolution is low. Credit author: Matt Wilkinson

morphology of simulated discs. Matt showed that spurious collisional heating leads to a systematic increase of the azimuthal velocity dispersion of stars and a corresponding decrease in their mean azimuthal velocity. The rate of heating is driven by the number of dark matter halo particles and by radial variations in the local dark matter density in the disc. This has the effect of transforming simulated discs from flattened structures into rounder spheroidal systems (see Figure 2), causing them to lose rotational support in the process, and modifies their kinematics, impacting their rotational velocities and angular momenta.

Recently graduated ASTRO 3D PhD student, Ruby Wright, from the International Centre for Radio Astronomy Research node of The University of Western Australia, used the EAGLE simulations to study cold gas stripping and starvation of gas inflow in the quenching of satellite galaxies. This required careful treatment of the interstellar medium in satellites, to ensure that mass loss could be reliably tracked (see Figure 3). By examining the balance of gas inflows, outflows, and star formation rates, Ruby showed that on average intermediate-mass satellites will be quenched at first pericenter in massive group environments, and at second pericenter in less massive group environments. Interestingly, Ruby's results indicate that starvation alone can quench satellite galaxies, albeit slowly, and so direct gas stripping, particularly at pericentric passage, is required for rapid quenching.

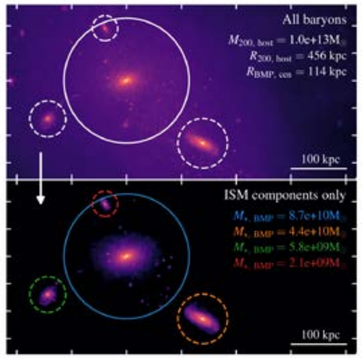
2022 Personnel Highlights

Well done to Adam Stevens, who was awarded the 2022 ASA Louise Webster Prize for outstanding research by a scientist early in their post-doctoral career, recognising the impact of his work modelling neutral atomic and molecular hydrogen in galaxies.

Cross-Project Collaborations

Kate Harborne has been using the latest version of her SimSpin package, which generates integral field spectroscopic datacubes from simulated galaxies, to generate samples of galaxies Drawn from simulations such as EAGLE, Illustris-TNG, Magneticum, and Horizon for the SAMI/HECTOR and MAGPI survey. Kate is working closely with several ASTRO 3D projects, providing the bridge between Genesis data products and the specific project requirements.

Figure 3: This shows how simulated galaxies in a galaxy group are separated into distinct systems with their own interstellar media. The top panel shows all baryons within the group, while the bottom highlights the interstellar media. The stellar masses internal to each distinct structure are quoted in the bottom panel. Credit author: Ruby Wright



Member Spotlight

My research.

The broad topic of my research is galaxy evolution. I study how galaxies formed and evolved through cosmic history using multi-wavelength surveys and the world's largest telescopes. In particular, I use the information encoded in the light emitted by galaxies from the ultraviolet to the far-infrared, allied with spectral energy distribution models, to measure their key physical properties such as their star formation rates, stellar masses, and interstellar dust content. I am especially interested in knowing how cosmic dust formed and evolved, and to do so, I use observations from the Atacama Large Millimetre Array (ALMA), that can observe the thermal emission from dust grains all the way to the epoch of reionisation. This dust can tell us a lot about star formation and early metal enrichment in galaxies.

I am also leading JWST observations of the dustiest, most star-forming galaxies in the Universe (sub-millimetre galaxies), which are perfect laboratories for us to understand intense star formation and interstellar dust.

How I came to astronomy.

Watching the night sky and reading books about Astronomy -- particularly Carl Sagan's "Cosmos" -- when I was a child. By age 13 I had decided I was going to be an astronomer, even though I was first generation in my family to go to University and my parents had no idea what an astronomer was or did! But regardless of that they supported me to pursue my dream.

What I love about astronomy.

In general, I love that, as human beings, we can use physics, maths, technology, and our imagination to understand our vast Universe from this little planet we live in. It's a science that answers big questions that all humans are interested in, so I love how it connects me to people in that way.

By far the highlight of 2022 for me has been seeing the first images and spectra obtained by the JWST! It was a very exciting time when we all got to see the first images in July and tell the general public about it through outreach events and media interviews!

In terms of my day to day job, I love being an academic astronomer because it's challenging, fun, and never boring! I love it that I can follow my ideas, I love working hard on a problem, and I especially love the team work aspect and interacting with younger researchers and students, and with colleagues from all over the world. I also think we are becoming a more and more diverse and inclusive science, although there is still a lot of work to do in that sphere.

What I don't love.

I think the hardest part is that in this career we have to learn to deal with rejection quite a lot. There are a lot of good people and few resources available (be it grant money, jobs, or telescope time), so inevitably no matter how good you are or how hard you work, you have to deal with rejection at some point. The trick is to learn to live with that, learn your lessons (if there are any), and move on. But I think it's a challenge especially for early career researchers, understandably.

I also find it hard to deal with sometimes over-competitive or toxic sub-fields/collaborations, but fortunately I think our work culture is maturing and there are fewer issues like that than in the past. Or at least I hope so.

If I wasn't an anstronomer, I would be...

I have no idea, because I always wanted to be an astronomer! But I think if I stopped being an astronomer I would love to move to a job where I can help people or the planet somehow.

Regarding grant proposals: "Yes it's a lottery, but you only win the lottery if you buy a ticket!" [I'm pretty sure Matthew Colless told me this]

A highlight for me in 2022.

By far the highlight of 2022 for me has been seeing the first images and spectra obtained by the JWST! It was a very exciting time when we all got to see the first images in July and tell the general public about it through outreach events and media interviews! And, in the last few months, to see the JWST data from the Cycle 1 programme of which I am a co-PI of -- the data are just stunning, and better than I could have imagined! Very excited to start doing some science with those data in the coming year!

Something that not many people know about me

I'm Portuguese but I was actually born in Paris and raised there until I was seven. The institute where I did my PhD (Institut d'Astrophysique de Paris) is two blocks away from the hospital where my twin brother and I were born. Of all the hospitals in Paris we were born in the one next to the old Observatory (even though we lived in a different arrondissement), so I guess Astronomy was meant to be!

The best piece of advice (professional or personal) I've ever been given?

Regarding grant proposals: "Yes it's a lottery, but you only win the lottery if you buy a ticket!" [I'm pretty sure Matthew Colless told me this]

DR ELISABETE DA CUNHA | ASTRO 3D FELLOW AT THE UNIVERSITY OF WESTERN AUSTRALIA

Data Intensive Astronomy - DIA

Professor Richard McDermid

from Macquarie University is co-leader of the Data Intensive Astronomy Program.

Richard is an expert in the field of stellar dynamics and stellar populations in galaxies, and combining these to deconstruct galaxy formation histories. He has pioneered the use of integral field spectroscopy in this area, and developed new techniques to understand the archaeological record of stellar orbits and chemistry in galaxies beyond the Milky Way.

Professor Lister Staveley-Smith

from the University of Western Australia (UWA) has over two decades of experience in leading major surveys on new radio telescope facilities and in developing and applying new software and computation techniques.

Lister is co-leader of the Data Intensive Astronomy Program which facilitates the analysis of our petascale datasets, provides curation, visualisation and cross-linking capability for advanced data products, and provides the means to compare with theoretical models.

Project Background

The Data Intensive Astronomy (DIA) program facilitates better access to tools, technology, infrastructure and training for ASTRO 3D researchers working with large datasets and in high-performance computing environments. This is achieved by working with national infrastructure providers and facilitating the sharing of expertise between ASTRO 3D researchers. As much of the ASTRO 3D science involves world-leading surveys and large data sets, our ability to process our data in a timely and efficient manner is critical to the success of the Centre.

The DIA program also facilitates collaboration on key data sets across the ASTRO 3D program through the e-research platform developed and maintained by Data Central - part of Australian Astronomical Optics (AAO) hosted at Macquarie University, and partnering with ASTRO 3D. Data Central hosts several ASTRO 3D survey data sets, including SAMI, GALAH, MAGPI, and the Hector Galaxy Survey, providing collaborative data access, wiki hosting, and public data releases..

2022 Project Highlights

The Theoretical Astrophysics Observatory (TAO) continues to be used for ASTRO 3D science, and more widely by the astronomy community. Last year the TAO team shipped their new Vis3D galaxy survey visualisation tool. Ongoing work includes new data being ingested into TAO, including the SHARK semi-analytic galaxy formation model by UWA ASTRO 3D Fellow Dr Claudia Lagos. More recently, TAO has been used by Swinburne ASTRO 3D AI Associate Professor Michelle Cluver and students to study galaxy groups and environments in the local universe.

In collaboration with the NCRIS-funded Astronomy Data and Compute Services (ADACS) and Data Central, ASTRO 3D Research Associate Dr Kate Harborne (ICRAR/UWA) led the development of a new web interface for the SimSpin mock observation generator code (Harborne et al. 2020). This allows users to quickly and easily generate 3D mock observations from numerical simulations, mimicking the characteristics of real observations such as those from ASTRO 3D surveys. SimSpin has already been used by SAMI (van de Sande et al. 2021; Croom et al. 2021) and forms a key part of the MAGPI theory activities (Foster et al. 2021). With this new web interface, SimSpin is now even more easily accessible.

2022 Personnel Highlights

Macquarie University became an official ASTRO 3D node, bringing with them new members interested in Data Intensive Astronomy. Node leader Professor Richard McDermid has played key roles in developing instrumentation for world-leading observatories throughout his career, as well as conducting pioneering research on the stellar populations and kinematics of nearby galaxies. He is particularly interested in using new tools and techniques to combine the wealth of astronomical data available to ASTRO 3D members in novel and exciting ways, and to facilitate collaboration across the Centre. Dr Simon O'Toole leads the Data Central team, bringing extensive experience in data archiving, interoperability, and data management. He forms an integral part of the DIA activities of ASTRO 3D, supporting the storage, team access, and ultimately the public availability of key data sets from ASTRO 3D programs.

The Macquarie node welcomed two new postdoctoral researchers into the DIA team. Dr Sam Vaughan was previously an ASTRO 3D postdoc at the University of Sydney, working with the SAMI and Hector teams. He aims to apply cutting edge statistical techniques to ASTRO 3D surveys whilst continuing his role as Target Selection coordinator for the forthcoming Hector survey. Dr Suk Yee Yong joined ASTRO 3D as a postdoc from the Space & Astronomy Future Science Platform at CSIRO. She is interested in developing tools and machine learning methods for astronomical discoveries.

2022 Cross-Project Collaborations

At the Annual Retreat in Adelaide, DIA postdocs Sam Vaughan and Suk Yee Yong ran an engaging session with the rest of the Centre, discussing where and how the different surveys could most benefit from the DIA program. They were joined by Simon O'Tool from Data Central. A number of interesting projects were proposed, including expanding the capabilities of the online SimSpin tool to facilitate the simple generation of samples of mock data cubes, making use of various publicly available hydrodynamical simulations. This is now in the works, with a proposal for technical support from ADACS recently submitted.

Banner image: istock image

Member Spotlight

My research.

Broadly, my research interests are related to how a galaxy's surrounding environment affects its internal properties. I like to focus on the environments found in rich clusters of galaxies, where the environmental processes can be relatively extreme. I get excited by finding galaxies that are in the process of being transformed, and understanding their properties in detail. Integral Field Spectroscopy is probably the most powerful tool for studying these oddball galaxies because it allows for the simultaneous detection and detailed investigation of their properties. Even better are multi-object IFS surveys like SAMI and Hector, which are extremely important for building the large samples required to understand the demographics of these rare galaxies.

How I came to astronomy.

I was a bit of a latecomer to astronomy. I don't recall being overly interested in astronomy while I was at school. I was more interested in cricket and other things. After high school I tried (and failed) Electrical and Mechanical engineering at University, and then had a stint working in a factory making high-pressure hydraulic hoses. I was in my early twenties when my thoughts about how the Universe came to be, where it ends, the nature of black holes etc. began to compete for time with my thoughts about how to improve my hook shot in cricket. With a "baggy green" unlikely, I decided to enroll in a Physics degree at the University of Wollongong (UoW) with the aim of pursuing a career in astronomy.

At UoW, I was fortunate to do an Honours project with Paul Nulsen, who had me work on data from the recently-launched Chandra X-ray Observatory. Paul moved to the Harvard/Smithsonian Centre for Astrophysics midway though my Honours project, and connected me with Warrick Couch for a PhD. Warrick and Paul's influence led me to the field of galaxy clusters and their impact on galaxies.

"I was in my early twenties when my thoughts about how the Universe came to be, where it ends, the nature of black holes etc. began to compete for time with my thoughts about how to improve my hook shot in cricket."

What I love about astronomy.

There are a couple of things I love about astronomy. First and foremost I find the discovery aspect the most exciting. It's kind of cool to be the only person that knows about some obscure object that you've discovered before telling everyone about it.

Second is the problem solving aspect. One of my favourite parts of being an astronomer is sitting down with a problem and working my way though some code to solve it.

What I don't love.

Given the last year, I think that if you ask any Hector team member what the hardest thing about astronomy is, the answer would be the same: poor weather.

If I wasn't an anstronomer, I would be...

In terms of dream careers, I'd probably say an archaeologist or paleontologist. My backup plan during my undergrad was medical physics, but if I lost my job tomorrow I'd likely go into data science.

A highlight for me in 2022.

For me the highlight in 2022 was completing my first Hector observing run at the Anglo-Australian Telescope (AAT). This was made more special by the fact that I was able to share a portion of this experience with my Dad, who had never seen a big 'scope, as well as current student Gabby and former student Stefania.

Something that not many people know about me

For an uncomfortably large period of my life, I was under the impression that limes were simply unripe lemons. I can't remember when the penny dropped, but not many people know this about me for obvious reasons. If you're reviewing one of my grant or telescope proposals, please don't hold that against me!

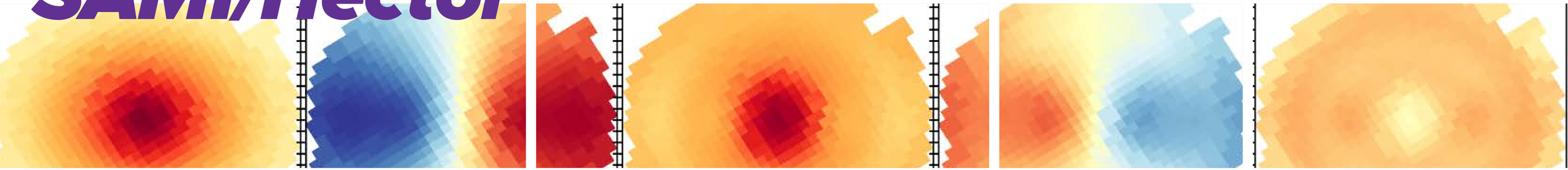
The best piece of advice (professional or personal) I've ever been given?

Don't believe your own publicity (my Mum).

"Don't believe your own publicity." {My Mum}

DR MATT OWERS | CHIEF INVESTIGATOR AT MACQUARIE UNIVERSITY

SAMI/Hector



Professor Matthew Colless from the Australian National University has made major contributions to astronomical research in the fields of galaxy evolution, clusters of galaxies, the large scale structure and motions of galaxies, and observational cosmology.

As part of ASTRO 3D, he is leading a research team using the SAMI and Hector instruments to investigate the dynamical structure of galaxies and the accretion of angular momentum, and how these affect their star formation histories and stellar populations.

Professor Scott Croom is from the University of Sydney and brings over a decade of experience leading large spectroscopic surveys to ASTRO 3D.

Scott leads the SAMI Survey and plays a major role in the Hector survey. SAMI results include new insights into galaxy scaling relations, the discovery of outflows in star-forming galaxies, and greater understanding of the formation mechanism behind dispersion-dominated galaxies. Scott is also the University of Sydney Node Leader for ASTRO 3D.

Project bacground

SAMI and Hector are two integral field spectrographs that allows the measurement of a huge range of galaxy properties that are impossible to obtain from single fibre surveys and allows direct tests of the latest galaxy formation simulations.

Observables include gas and stellar internal and bulk kinematics, the spatial distribution of star formation, stellar metal content and age gradients, gas oxygen abundance distributions, resolved ionisation diagnostics and many others.

The SAMI Galaxy Survey of over 3000 galaxies is the first integral field sample that is sufficiently large to disentangle the competing roles of galaxy mass and environment. As a result, we can address the following three key questions:

1. What is the physical role of environment in galaxy evolution?

2. What is the interplay between gas flows and galaxy evolution?

3. How are mass and angular momentum built up in galaxies?

Hector will build on SAMI using a new instrument with higher spectral resolution, a wider field of view, and the ability to target more galaxies at once. From the start of 2022 Hector will be carrying out a survey of up to 15000 galaxies.

2022 Project Highlights

The SAMI/Hector team has had two main aims across 2022. The first is to continue exploitation of the completed SAMI Galaxy Survey data set. The second was to complete commissioning of the Hector instrument and start galaxy observations.

The SAMI team published a dozen science papers across 2022.

The paper by ASTRO 3D postdoc Dr Stefania Barsanti (ANU) on the correlation of bulge mass with galaxy spin alignment with filaments was the subject of a press release. https://ASTRO 3D.org.au/spin-flips-cosmic-web/ .

Stefania found that bulge mass was the most important driver of alignment (or misalignment) of galaxy spin with the large-scale structure of the Universe. This points to the merging of galaxies as the flow along filaments as a primary driver of spin flips.

Another paper by PhD student Andrei Ristea (UWA) studied the misalignment between stellar and gas kinematics in SAMI galaxies, showing that these can be caused by a variety of physical processes. The results suggest that both morphology and star formation/gas content are significantly correlated with the prevalence and timescales of misalignments. A third paper linked galaxy spin to large scale structure, with Yifan Mai (Sydney) looking at the relationship between galaxy spin and cosmic flows.

The was significant work on efforts to understand the heavy metal content of galaxies. Amelia Fraser-McKelvie (UWA) explored the difference between stellar and gas phase metallicity. Sam Vaughan (Sydney) found that the difference in metal content between star forming and passive galaxies could largely be explained by their difference in size and that metal content seems to correlate best with gravitational potential. Two papers by PhD student Peter Watson (Oxford) examine how the detailed chemistry of galaxies depends on their kinematics, morphology and environment. Connecting SAMI to the earlier Universe, Tania Barone (ANU) used the high redshift LEGA-C sample to explore how metallicity and age varied with cosmic time.

Various works focused on the stellar dynamics of SAMI galaxies. PhD student Guilia Santucci (UNSW) investigated how the stellar orbits in passive galaxies vary with environment. Luca Cortese (UWA) looked at the relationship between galaxy spin and central stellar density.

PhD student Di Wang (Sydney) has used SAMI star formation maps to show that star formation is more concentrated in galaxies that inhabit dense environments. This points to outside-in quenching of star formation. Combining the star formation measurements with stellar populations Di was able to show that there is a significant delay in quenching for galaxies in group environments. Also combining gas and stellar measurements Sree Oh (ANU) to show what drives the relationship between gas and stellar velocity dispersion.

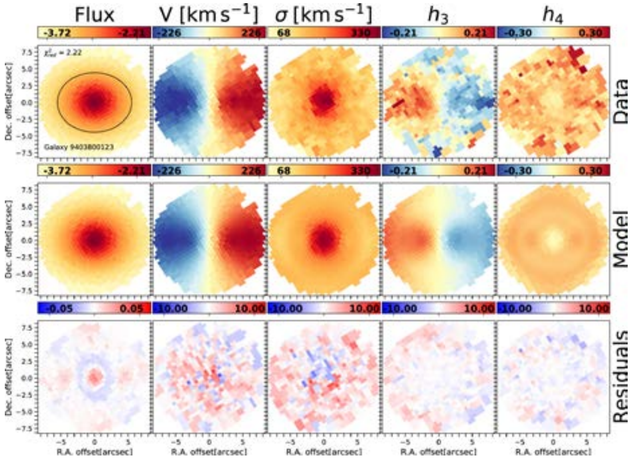
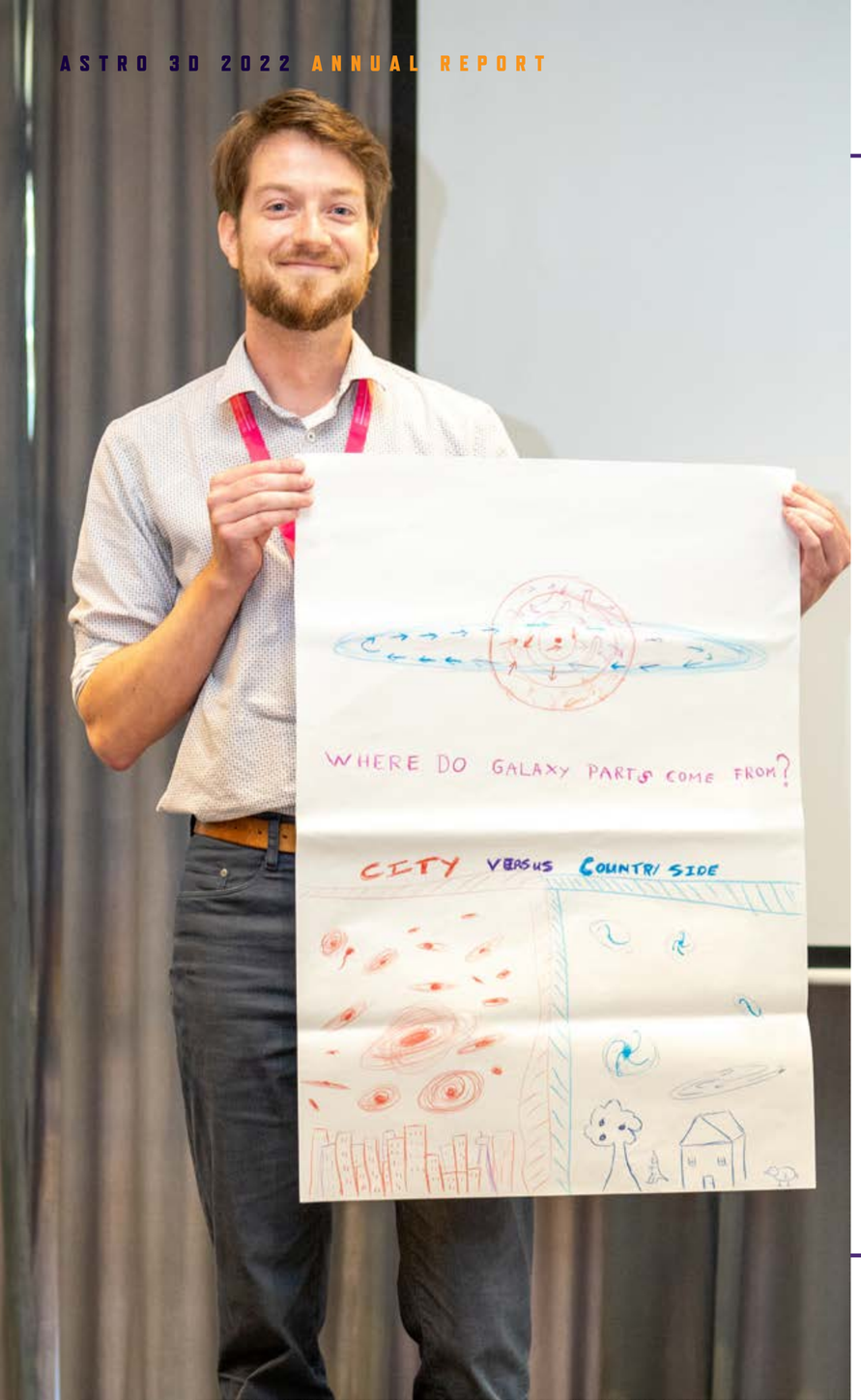


Figure 1. Maps of SAMI galaxy kinematics and mdoel fits from Santucci et al (2022). Columns show 2D maps for, from left to right, flux, velocity, velocity dispersion, h3 (skewness) and h4 (kurtosis). The first row shows the observed maps, second row shows the best-fit maps derived from the Schwarzschild modeling and the third row shows the residuals, calculated as the difference between the observation and the model, divided by the observational uncertainties.



The Hector team, led by Julia Bryant (Sydney) has been busy this year finalizing the commissioning of the instrument and confirming its performance. This has included a large number of science verification observations of galaxies. There has been intense work on the pipeline (led by Sree Oh and Madusha Gunawardhana), borrowing methods from the SAMI survey and optimizing for Hector. Part of this included a Hector-SAMI busy week hosted at AAO-MQ that allowed the team to focus on preparing the data products for science.

2022 Personnel highlights

Giulia Santucci completed her PhD at UNSW and has since taken up a postdoc role at UWA. Adeline Wang (Sydney) completed her PhD this year and has since taken on a role at Astralis-USYD. Mina Pak has joined MQ as a postdoc. Sam Vaughan has moved from Sydney to MQ. Susie Tuntipong (Sydney) and Oguzhan Cakir (MQ) both started PhDs this year.

2022 Cross-project collaborations

In December the "Linking the galactic and extra-galactic" conference was held. Organised by DECRA fellow Jesse van de Sande, this conference succeeded in bringing together researchers working in galactic archeology (e.g. GALAH) and extra-galactic astronomy (SAMI, galaxy evolution etc).

New projects are active comparing the distribution of star formation in SAMI to simulations. This SAMI/GENESIS collaboration is led be Di Wang (Sydney) and Claudia Lagos (UWA). SAMI to EAGLE comparisons are also actively been explored by studying the connection between galaxy spin, age, environment and mass.

Connections between SAMI and MAGPI are a natural and fruitful route for collaboration. Current work focuses on the evolution of higher order stellar kinematics (Francesco D'Eugenio, Cambridge) and gas phase velocity dispersion (Yifan Mai, Sydney).

Finally, the first analysis of HI measurements of SAMI galaxies is not complete (led by Barbara Catinella, Luca Cortese and Adam Watts, UWA). The first papers on this topic will be published in early 2023.

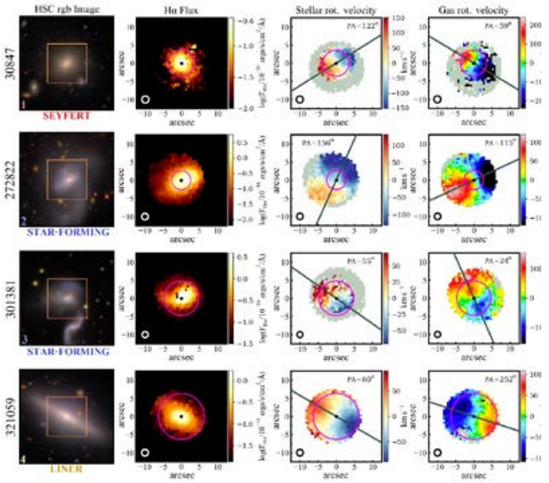


Figure 2: Example misaligned galaxies from Ristea et al (2022), showcasing each of the dominant physical causes of the kinematic decoupling. From top to bottom we have (1) CATID 30847: gas outflow from a Seyfert galaxy; (2) CATID 272822: recent merger (galaxy in a post-merger stage); (3) CATID 301381: tidal interaction / close pair; (4) CATID 321059: gas accretion from other sources, i.e. filaments, outer halo or a past merger. The columns show, from left to right: colour images of the galaxy; SAMI Ha flux map; stellar rotational velocity map; ionised gas rotational velocity map. The kinematic PA of each stellar and gas velocity map is shown by the dark green line, with the angle's value (measured counterclockwise from North = 0) displayed on the plot.

Images far left adn above: SAMI/Hector members participate in the Draw your Science activity at the Annual Retreat. Credit: Cristy Roberts.

Member Spotlight

My research.

My research focuses on understanding the formation and evolution of galaxies across different environments and cosmic epochs. I utilise high-resolution imaging to disentangle galaxies into their structural components, such as the central bulge and the surrounding disk. I explore the kinematics and star formation properties of galaxies and their components by taking advantage of spatially-resolved spectroscopic data, such as the SAMI and Hector galaxy surveys in the local Universe and the MAGPI galaxy survey at intermediate redshift.

How I came to astronomy.

During high school I studied Latin, ancient Greek and philosophy. I was fascinated by how humans would study and interpret the night sky. I got curious and I wanted to know more about the science that there is behind nature. I studied Physics in my Bachelor Degree - the word physics itself is derived from the Greek word "phusis" meaning nature. Then, I moved to Astronomy to investigate how we think our Universe works.

"I grew up in a tiny village in Tuscany, Italy. My parents own a hill and a farm. I have worked a lot on the farm... helping my parents to produce delicious olive oil"

What I love about astronomy.

I love the big questions that we are trying to answer such as: How do galaxies evolve? How does the Universe work? Are we alone? I like that the answers are often full of surprises. There is such a variety of objects that populate our Universe and still when we point different instruments to the same object, or we use different techniques to analyse it, we discover new results.

Finally, I appreciate how powerful astronomy is to attract people's interest into scientific fields.

What I don't love.

I don't love the instability. I think this is related to academic careers in general, not only to astronomy. I use to love moving from place to place from culture to culture for my studies and career, but it is becoming harder. Leaving the life I built to start new all over is becoming more challenging every time.

If I wasn't an astronomer, I would be...

I think I would still be some kind of researcher or in a problem-solving job. I love asking myself questions and looking for the answers, playing with data, having new ideas on how to solve a problem and contribute to advancing our knowledge. I would probably research more into climate change and sustainability.

A highlight for me in 2022.

This year had many highlights! I guess it made up for the past two years.

On a professional level, my latest publication about understanding the spinning of galaxies in the cosmic web of our Universe was an ASTRO 3D media release. This was very exciting for me and it followed interviews with journalists! We discovered that galaxies spin in different directions with respect to the cosmic filament they are embedded within and that the direction of spinning depends on the mass of the central bulge component.

On a personal level, I got engaged, I became an Australian citizen and I was finally able to visit my family in Italy after three years.

"I studied Latin, ancient Greek and philosophy. I was fascinated by how humans would study and interpret the night sky...I love the big questions that we are trying to answer"

Something that not many people know about me

I grew up in a tiny village (1000 people) in Tuscany, Italy. My parents own a hill and a farm. I have worked a lot on the farm (and still do when I am visiting!), especially helping my parents to produce delicious olive oil.

One of my passions is also yoga, I practice it every day. I find it extremely beneficial for my body and mental health.

The best piece of advice (professional or personal) I've ever been given?

"Take a break"...and I think it works for both professional and personal levels! When I feel overwhelmed by a situation I follow this advice to take a break, breathe, focus on something else, and then I come back to it with a calmer mind and sometimes a different perspective.

DR STEFANIA BARSANTI | POSTDOCTORAL RESEARCHER AT THE AUSTRALIAN NATIONAL UNIVERSITY

Murchison Widefield Array Epoch of Reionisation - MWA EoR

Professor Cathryn Trott

from Curtin University is ASTRO 3D Deputy Director and Curtin Node Leader. She is using the current and expanded MWA and in the future, the SKA to explore the evolution of ionised hydrogen in the early Universe.

Cath is co-leading the ICRAR MWA Epoch of Reionisation (EoR) project for the Origin of the Ionised Universe Theme. Cath is using the supercomputing facilities at the Pawsey Centre for EoR data storage, triage and analysis, augmented by existing and future-developed sophisticated signal processing algorithms.

Professor Rachel Webster

from the University of Melbourne) is co-leading the data reduction and analysis of the Epoch of Reionisation signals observed with the MWA. The improvement in the measured limits on the signal are allowing fundamental parameters of the Early Universe to be constrained.

She is an expert in the field of reionisation and is a member of the Board of Directors for Australian Astronomy Limited (AAL). She brings extensive leadership expertise to ASTRO 3D.

Project Background

The Murchison Widefield Array (MWA) is a low-frequency radio telescope located at Inyarrimanha Ilgari Bundara, the Murchison Radio Astronomy Observatory, in outback Western Australia. This radio quiet site is crucial for undertaking precision science experiments away from interference caused by human-made communications and broadcast radio.

The Cosmic Dawn and Epoch of Reionisation (EoR) are two key periods in the early Universe, encompassing the birth of the first generations of stars and galaxies, and the transformation of the hydrogen gas that filled space from neutral to ionised.

These chapters in the story of the Universe are known to have occurred in the first billion years after the Big Bang, but have not been explored with observations. Hydrogen gas in its neutral form emits a photon of light at a specific rest wavelength of 21 centimetres, which can be observed at much longer wavelengths today due to the cosmological redshift from the expansion of the Universe (150-600 centimetres), frequencies accessible to telescopes like the MWA. The signal is extremely weak, however, and embedded within the contaminating radio signals from our own Galaxy, and other galaxies in the Universe, demanding a precision experiment and hundreds of hours of observations.

The MWA Epoch of Reionisation experiment commenced in 2013, and has been collecting data for the past nine years. In ASTRO 3D, we have invested a large amount of effort in ensuring the cleanest and most well-understood dataset, including creation of the deepest and most complete low-frequency sky survey for telescope calibration (LoBES), an understanding of the tolerance of the experiment to ionospheric activity, and modelling and measurement of the instrument's response to the sky across different frequencies.

2022 Project Highlights

In December 2021, Dr Christene Lynch's LoBES work was publicised in the media through a release coordinated by ASTRO 3D and supported by ICRAR. One major output of the group in this period was the commissioning of the new MWA Correlator, MWAX. Dr Jack Line's WODEN software was also published. This end-to-end simulation pipeline generates accurate radio interferometric data for testing of our data analysis and calibration methods. PhD student Mike Kriele, with A/Prof Randall Wayth, published his 159 MHz all-sky image using the EDA2 array and the transit m-mode method, which estimates the sky brightness decomposed into spherical harmonics, and is used for our diffuse sky calibration model.

The MWA EoR project held a Busy Week at the Curtin node from May 2-6, with some joint discussions with Melbourne node members. Dr Bart Pindor travelled to Perth for the meeting. We progressed the Hyperdrive calibration software, and discussed paths forward for use of diffuse emission models and simulations.

PhD student Jaiden Cook published his paper entitled "Investigating the contribution of extended radio sources in the EoR power spectrum". This paper detailed the modelling and analysis of the large number of diffuse and structured supernova remnants (SNR) and radio galaxies (e.g., Centaurus A) in the sidelobe of the EoR2 observing field, earlier suggested to be the cause of contamination in our data.

Dr Nichole Barry and PhD student Aman Chokshi had a paper accepted describing the limitations of different calibration choices for EoR science.

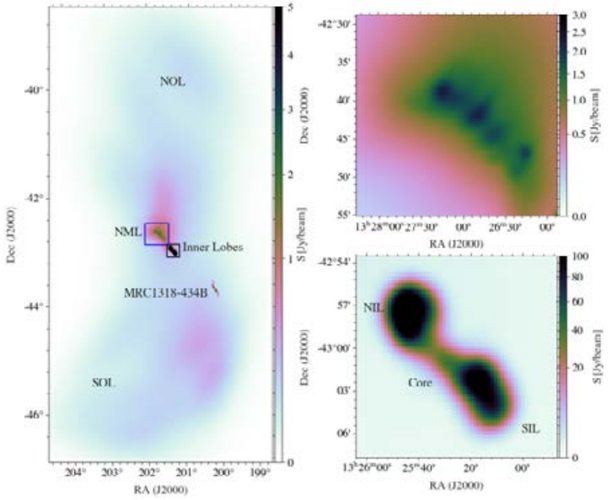


Figure 1: "Model of the nearby and extended radio galaxy Centaurus A used to understand its effect on the Epoch of Reionisation power spectrum, and created by student Jaiden Cook."

Banner image: MWA Credit: Dr John Goldsmith/Celestial Visions (2012)

The Curtin group worked with industry partner Downunder Geosolutions to calibrate and perform quality assessment on several hundred hours of observations, using the new Hyperdrive software developed by Dr Chris Jordan and the LoBES sky catalogue produced by Dr Christene Lynch. Dr Ridhima Nunhokee has worked to develop and optimise all of the data quality metrics for the dataset. The 300 hours of raw data have been assessed post-calibration and QA to then feed into a deep integration power spectrum. Dr Bart Pindor then worked to characterise the calibration solutions to understand the best way to keep our spectral smoothness while retaining accuracy in the results, and Dr Jack Line's WODEN software was used to simulate the full signal chain. Prof Cathryn Trott worked with an international team to apply an alternative data analysis method to MWA data.

PhD student Kariuki Chege is in the final stages of his PhD at the Curtin node, and is working toward a separate deep integration by applying new techniques to the existing RTS calibration pipeline. This work builds on his knowledge of the impact of ionospheric activity on the data. Aishwarya Selvaraj has been working with the CRAM MWA tile to assess the impact of near-horizon foregrounds on the EoR signal extraction.

The EoR group in ASTRO 3D has submitted a team for the SKAO 3rd Data Challenge, SDC3. The challenge is to extract multi-redshift EoR power spectra from a data cube that contains 21cm signal, complex foregrounds, noise and instrumental errors, and is thefirst challenge to simulate the SKA-Low telescope.

A/Prof Randall Wayth and PhD student Aishwarya Selvaraj travelled to Inyarrimanha Ilgari Bundara to do maintenance on the CRAM tile for future use. Ash has been using 2019 observations to measure the system temperature of the instrument. CRAM provides a smaller view of the sky, and can be combined with MWA to understand the contamination caused by sources close to the horizon.

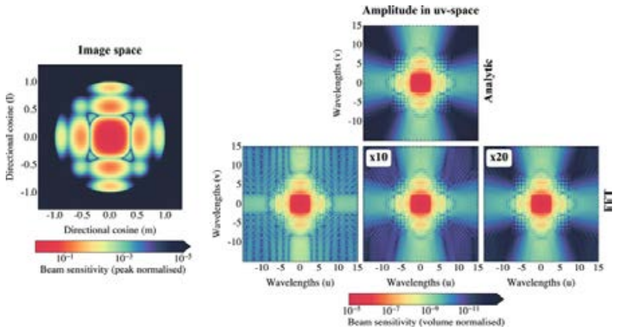


Figure 2: Representations of the Murchison Widefield Array's view of the sky, demonstrating the complexity of the beam when trying to model it (Nichole Barry).
Images far left and below: MWA members participate in the Draw your Science Activity at the Annual Retreat. Credit: Cristy Roberts

2022 Personnel Highlights

We welcomed two new PhD students to Curtin; Ravi Jaiswar, working with ASTRO 3D Fellows Dr Anshu Gupta and Dr Elisabete da Cunha, and Aishwarya Selvaraj working with Prof Cath Trott and A/Prof Randall Wayth. ASTRO 3D postdoc Ridhima Nunhokee arrived in Australia, joining the Curtin node early in 2022. postdoc Dr Christene Lynch finished with ASTRO 3D in June. We had a nice morning tea, and presented her with gifts and a card. Christene has been a CAASTRO and ASTRO 3D postdoc, and will be missed by the EoR group. She has started a tenure track position at UNC Asheville in August but will continue working with MWA EoR. We also said goodbye to two of our long-standing ASTRO 3D members at the end of August. AI Dr Ben McKinley moved into the public service to work on climate policy with the Federal Government, and Outreach Officer Teresa Slaven-Blair (creator of the Epoch of Bubbles activity and Monthly Media) has moved to a full-time role for her PhD. In November, we had a lunch to say farewell to PhD student Kariuki Chege, who has moved to a postdoctoral position at the Kapteyn Institute to work on LOFAR and NenuFAR.

2022 Cross-project collaborations

PhD student Jaiden Cook used outputs from the Genesis team to estimate the skew spectrum of the 21cm signal, a metric that quantifies the non-Gaussianity of the signal.

PhD student Ravi Jaiswar is working with post-reionisation EoR analog galaxies to understand the properties of the earliest galaxies, and estimate their escape fraction. This work feeds into predicting the properties of the 21cm line being observed with the MWA.

First Stars




Emeritus Professor Gary Da Costa is based at the Australian National University. His research interests include the stellar populations of dwarf galaxies, the origin of abundance anomalies in globular cluster stars, the Magellanic Clouds, and the formation of the halo of the Milky Way. Gary is the lead of the ASTRO 3D First Stars Project.

Project Background

The Universe was created in the Big Bang some 13.8 billion years ago. A few hundred million years later the first stars formed. They were made up of only hydrogen, helium and trace amounts of lithium, but we know very little about their other properties. For example, how massive they were, how they influenced their surrounding environment, and how they ended their lives. The study of the nature and role of the first stars is therefore one of the hottest topics in modern cosmology and astrophysics.

The First Stars team aims to investigate the characteristics of the first stars through several different approaches, including performing supercomputer simulations to predict how the first stars formed and evolved. No genuine first stars are known at the present time. This likely indicates, in line with the simulation results, that the first stars were substantially more massive than the Sun. Massive stars have short lifetimes and thus no first stars could have survived to the present-day.

Simulations of how the first stars end their lives in supernova explosions are also carried out. These calculations are crucial, as the elements created by the nuclear reactions in the first stars are distributed by the supernova explosions into the surrounding interstellar gas, enriching it in elements such as carbon, oxygen and heavier elements. Low mass stars that then form from this enriched gas can survive to the present-day becoming the oldest stars we can study.

The team searches for and studies in detail these oldest stars measuring their chemical composition. In particular, since different elements are made in different amounts in first stars of different mass, we can use the element abundances and element-to-element abundance ratios in the oldest stars to learn about the properties of the first stars. At the same time these studies allow us to understand how the chemical composition of the gas and stars (and planets) changed as our Galaxy evolved over time.

2022 Project Highlights

Star formation models predict the initial mass function (IMF) for metal-poor stars can be substantially different from that observed in the metal-rich Milky Way, in having larger relative numbers of higher-mass stars. This occurs because lower abundance gas clouds cool inefficiently, favouring the formation of more massive stars. Current predictions rely on the assumption of solar-scaled abundances, i.e., the relative abundance of one element to another is the same as in the Sun. There is, however, evidence that elements such as C and O, which dominate metal-line cooling in the interstellar medium (ISM), do not follow solar-scaling at low metallicities. Former ANU PhD student Piyush Sharda has led a recent paper where he investigated the effect of non-solar abundance ratios. Models that predict the variation in the characteristic IMF mass as a function of metallicity were extended using carbon-to-oxygen [C/O] ratios derived from observations of metal-poor systems, which show [C/O] < 0 at low oxygen abundances. This leads to a substantially different IMF in the low metallicity range where C I and C II cooling dominate the ISM thermodynamics: there is a significant additional shift in the characteristic IMF mass to larger masses in low metallicity environments with [C/O] < 0. The results are published as Sharda et al., 2022, MNRAS, in press (DOI: 10.1093/mnras/stac3315).

M 22 (NGC 6656) is a complex globular cluster-like system reported to harbour heavy element abundance variations, though the extent of the variations and the origin of the cluster are debated. ANU PhD student Madeline McKenzie has led an investigation using high quality spectra of six carefully chosen cluster members. The data allow very low abundance uncertainties (2% or less) that confirm that M22 hosts two stellar populations: there is a spread of ~0.24 dex in [Fe/H] and an average spread of 0.65 dex in the slow neutron capture (s-process) elements. This suggests that M22 is either the nuclear star cluster of a now disrupted dwarf galaxy, the product of the merger of two clusters, or an original building block of the Milky Way. The results are published as McKenzie et al., 2022, MNRAS, 516, 3515 (DOI: 10.1093/mnras/stac2254).

Mass-loss remains a major uncertainty in modeling the evolution of stars. In low-mass stars, mass-loss occurs primarily on the red giant branch (RGB). Determining the mass lost in different evolutionary phases is, however, a difficult problem. Monash PhD student Madeline Howell led an innovative approach to the problem. Masses were derived for 75 red giants in different evolutionary phases in the globular cluster M4 from asteroseismic information. The masses constrain the mass lost between the lower RGB and the red horizontal branch, a post-RGB phase of evolution. The mean mass loss is 0.17 + 0.01 (20%) solar masses consistent with earlier less precise determinations and with the predictions of standard mass loss models. Figure 1 shows the asteroseismic stellar masses as a function of their G magnitude. The results are published as Howell et al., 2022, MNRAS, 515, 3184 (10.1093/mnras/stac1918).

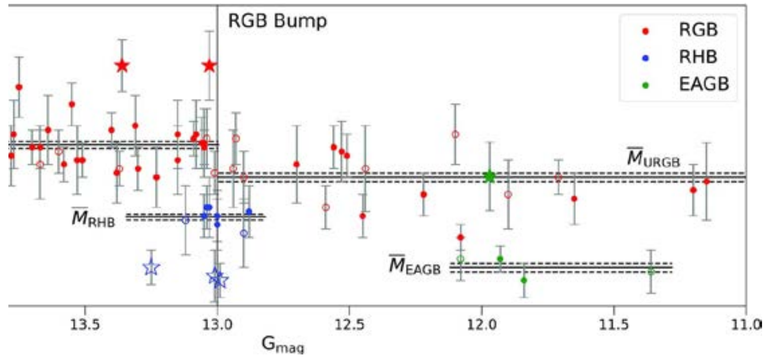
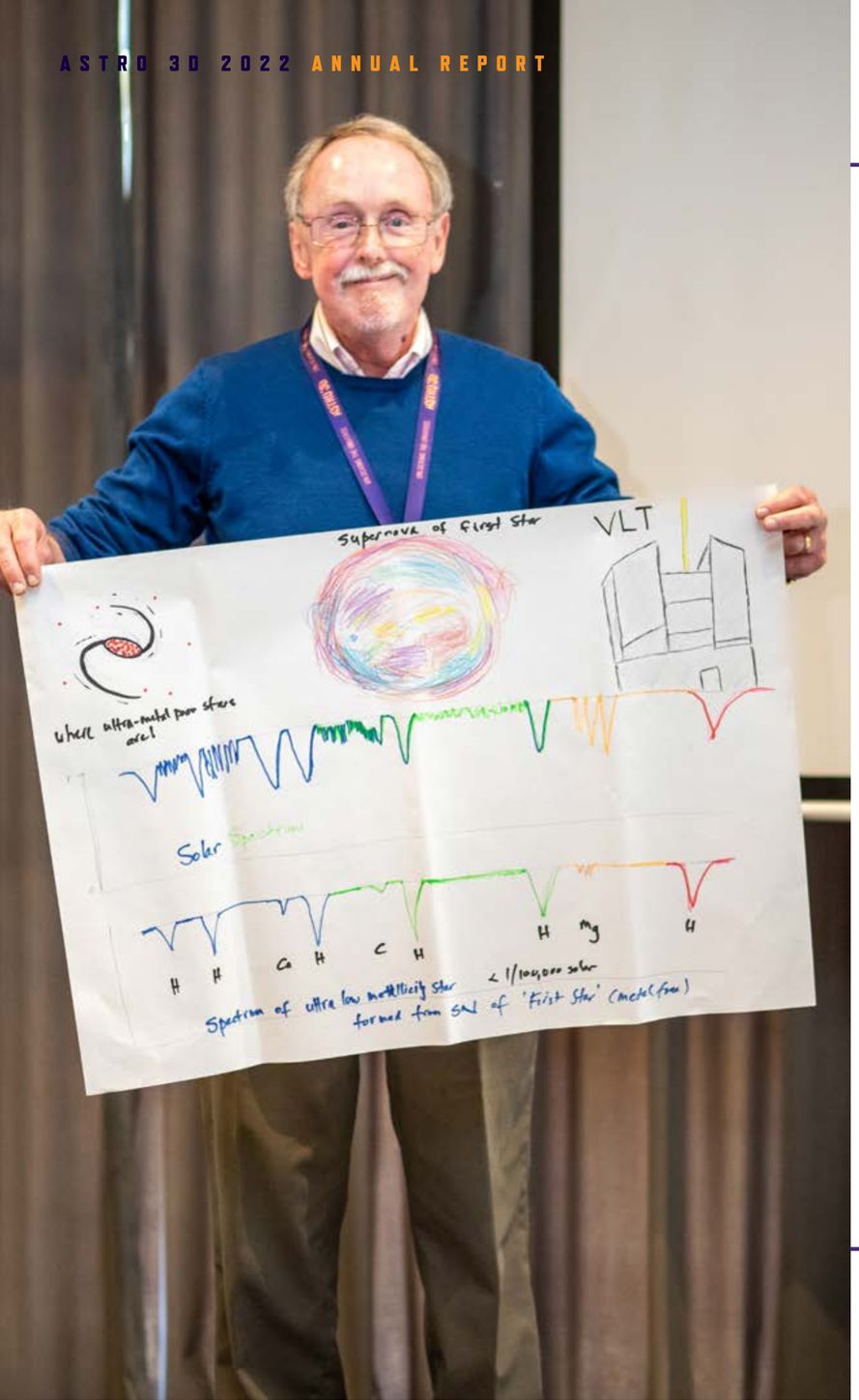


Figure 1. Stellar masses, in units of solar masses, for the entire sample Analysed by Howell et al., 2022, with the random uncertainties in the mass estimates represented by the error bars, plotted against the G magnitudes of the stars (more luminous stars lie to the right). The open symbols indicate stars with marginal asteroseismic detections. The mean masses for the red giant branch (RGB), split by the RGB bump magnitude that is represented by the vertical black solid line, are shown by the black solid horizontal lines across the magnitude range for each evolutionary phase, and are appropriately labeled. Black dashed lines indicate the 1σ uncertainties on the means. The derived masses for the red horizontal branch (RHB,) and early asymptotic giant branch (EAGB) stars are also shown. The RHB and EAGB stars are in later evolutionary phases than the RGB stars. Mass outliers are shown by star symbols. Figure from Howell et al., 2022, MNRAS, 515, 3184 (10.1093/mnras/stac1918).

Banner Image: An artist's impression shows a primordial quasar as it might have been, surrounded by sheets of gas, dust, stars and early star clusters. Credit: NASA/ESA/ESO/Wolfram Freudling et al. (STECF)



Personnel Highlights

First Stars team member Piyush Sharda completed his PhD at the Australian National University and was subsequently awarded a prestigious Oort Fellowship to continue his studies of the formation of the first stars at Leiden University in the Netherlands.

Cross - Project Collaborations

The oldest and most metal-poor stars in our Galaxy are extremely rare compared to stars like our Sun (here the term "metal" refers to the abundance in a star of all elements heavier than helium). As a result the rarity of extremely metal-poor stars (EMP; [Fe/H] < -3, i.e., Fe abundances less than 1/1000th of the solar iron abundance), large-scale surveys are required to find them. Such surveys can either target EMP-specific photometric or spectroscopic characteristics, or simply conduct a survey of large areas of the sky without any EMP-specific bias. An example of the latter approach is the GALAH survey that aims to study the history of the Milky Way as revealed by the motions, ages, and chemical composition of up to a million individual stars. The GALAH survey should contain EMP-stars but the large number of objects and the extreme rarity of EMP stars require the implementation of machine learning techniques to isolate the likely tiny number of EMP-star candidates present. In a paper published in the Astrophysical Journal, Macquarie PhD student Arvind Hughes has applied the t-SNE statistical approach to identify candidate EMP stars among the ~600,000 stellar spectra in Data Release 3 (DR3) of the GALAH survey. In essence, the t-SNE approach reduces high-dimensional data of the GALAH survey to a 2D map in which stars with similar characteristics are close together and dissimilar stars are well separated. Consequently, stars that fall near known EMP stars in the t-SNE map are likely also to be EMP stars.

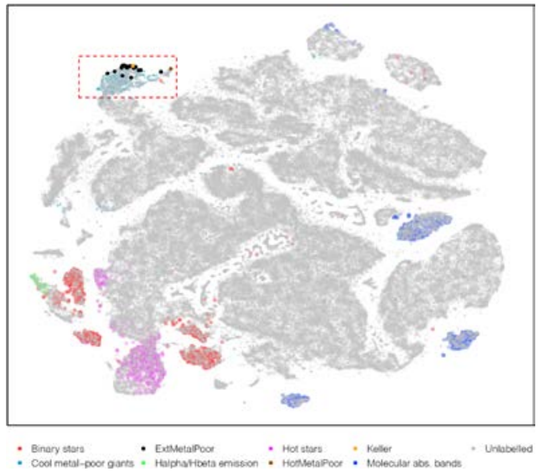


Figure 2. The t-SNE map derived from analysis of the GALAH DR3 survey data. The orientation and axes are in a sense arbitrary, but stars with similar characteristics lie in similar locations in the map. Known extremely metal-poor stars are overlaid in black, brown, and orange, while unknown stars plotted in gray. A region containing the known EMP-stars is located to the top left of the map. The dashed box represents the "island" selected for further analysis, with the EMP stars focused on the upper "coast" of the island. Figure from Hughes et al., 2022, ApJ, 930, 47 (DOI: 10.3847/1538-4357/ac5fa7).

Images far left and right: First Stars members participate in the Draw your Science activity at the Annual Retreat. Credit: Cristy Roberts

The approach is illustrated in Figure 2, which is taken from Hughes et al., 2022, ApJ, 930, 47 (DOI: 10.3847/1538-4357/ac5fa7). It shows a t-SNE map calculated from the GALAH DR3 in which known EMP-stars are located in an "island" in the top-left of the map. The stars in the dashed box were then subjected to further analysis ultimately yielding a list of <100 likely EMP candidates (out of 600,000+ stars in GALAH DR3!). However, because of the limited wavelength coverage of the HERMES spectrograph used to obtain the GALAH spectra, independent analysis is required to confirm the EMP-nature of the candidates.

The First Stars team then followed up the GALAH EMP-candidates with low-resolution spectroscopy using the WiFeS integral field spectrograph on the ANU 2.3m telescope at Siding Spring Observatory. The observations and analysis approach was identical to that employed in the follow-up of EMP-candidates derived from SkyMapper photometry. The 2.3m observations showed that the t-SNE based approach is efficient with a false-positive contamination rate ([Fe/H] > -2) of only ~5% and a success rate of ~35% in identifying stars with [Fe/H] < -2.75. Five genuine EMP stars were identified for subsequent detailed follow-up. The outcome demonstrated the success of the statistical approach and indicates that it should be equally productive when applied to forthcoming even larger stellar spectroscopic surveys that will reach fainter magnitudes.

Galaxy Evolution

A/Professor Deanne Fisher

is based at the Centre for Astrophysics and Supercomputing at Swinburne University of Technology and leads the ASTRO 3D Galaxy Evolution Project.

Her research focuses on multiwavelength studies of galaxies from the very nearby Universe at z=0 to galaxies just emerging from Reionisation at z=5. Fisher works in detailed observations spanning from UV observations, common use of Hubble Space Telescope and 10 m Keck and VLT optical telescopes and further to infrared and radio interferometry.

Project Background

Galaxy Evolution is the largest and broadest project theme within ASTRO 3D. We cover studies of galaxies ranging from the nearest galaxies in the Universe to the first ones observed with James Webb Space Telescope. Overall, the project is trying to understand how the ionised Universe contributes to, and can be used as a probe for, the mass growth across cosmic time.

The launching of James Webb Space telescope made significant changes to the team. This altered the way we view the first galaxies, bringing these results much closer to what we call “Galaxy Evolution”. We have, therefore, combined the research of these groups. This work is headed by team members Michelle Trenti and Karl Glazebrook, and their respective teams. The launch of the James Webb marked a dramatic time of productivity, with those relevant members of Galaxy Evolution being involved in ~20 papers each in only a 6-month period after the launch to the end of 2022.

Similarly, members within the Galaxy Evolution team are working with data from James Webb Space Telescope to study the explosive events called galactic winds around nearby galaxies. They received their data in late 2022, and are working toward publications in 2023. The study of galactic winds is the main focus of the DUVET team, which is a significant component of Galaxy Evolution lead by Deanne Fisher. They are using data from the Keck telescope to study how gas responds to the explosion of stars. This gas is extremely faint, yet the process is very important for understanding how galaxies evolve. Members of the DUVET team are organising an international conference about their research in 2023. The number of submissions for talks is 2.5 times larger than the numb er of spots available, indicating the high demand and interest in the topic internationally.

The XQR30 program uses data from the Very large Telescope, in Chile, to study the gas outside of galaxies. The XQR30 program is a large international project including researchers in Italy and around Europe. They use extremely distant sources of light as probes to search for gas between the source. It is a useful means of creating inventory of the gas content in the Univserse. The local team, led by Emma Ryan-Weber and Rebecca Davies, was a part of a very high level publication in Nature. Davies submitted multiple publications and led one of the important main-survey papers for the program.

The AGEL team uses the phenomenon of gravitational lensing, in which large massive objects bend the light of background sources. The AGEL team makes an innovative use of machine learning to find lenses. Historically, lens catalogues are very small, due to the time required for humans to identify the lens. This is very different with AGEL. The team was successful in securing time on the Hubble Space Telescope, and they are now working to generate models of how the light is being bent by the lensing object. The team will study how dark matter is distributed in galaxies.

2022 Project Highlights

Rebecca Davies and XQR30 project

In 2022 Rebecca submitted for publication multiple paper in the XQR30 project. These papers represent an important benchmark in studying galaxies in the very distant Universe (z=2-6.5). Rebecca led a main paper for an international team of researcher on a VLT large project. The paper features the largest set of high-quality quasar absorption line measurements to date, with over 700. These serve as methods to study the presence and kinematics of gas in high redshift galaxies. This data set will likely serve as a benchmark reference for years to come, and places Rebecca in a lead position in a large program. Not to rest on her success, Rebecca also submitted a second paper in which she used the catalogue of systems from the previous paper to estimate the decline in metal-enriched gas at early epochs. She uses this to estimate reasons behind the enrichment of gas in the Universe. In 2022 Rebecca also made contributions to a Nature paper on the same survey.

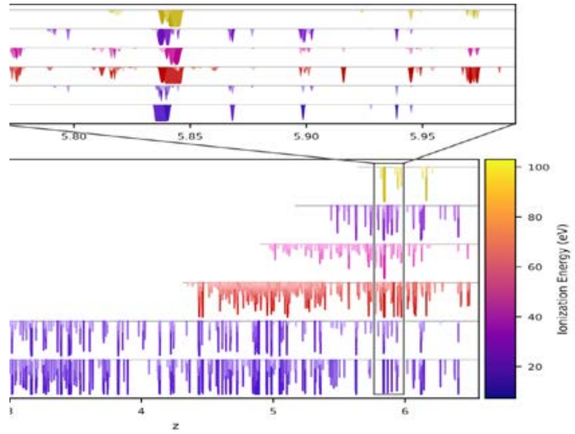


Figure 1: (Press play) Visualisation of the absorber catalog presented in this paper. In the bottom panel, each row shows all of the absorption systems detected in one of the six primary ions across all of the E-XQR-30 spectra combined. For each system, the hue represents the energy required to ionize the relevant ion (according to the color scale on the right). To increase the contrast between different systems, stronger systems are plotted in darker shades in the background and weaker systems are plotted in lighter shades in the foreground. The horizontal lines show the redshift range over which each ion can be detected. The grey shaded bands indicate areas where one or more transitions of the relevant ion fall in noisy spectral regions (see Section 5.2). The top panel shows a zoom-in on the redshift range 5.77> z > 6, and illustrates the range of different kinematics and ionisation structures found within the absorber sample. In this panel, every second component is plotted using a slightly darker shade for clarity.

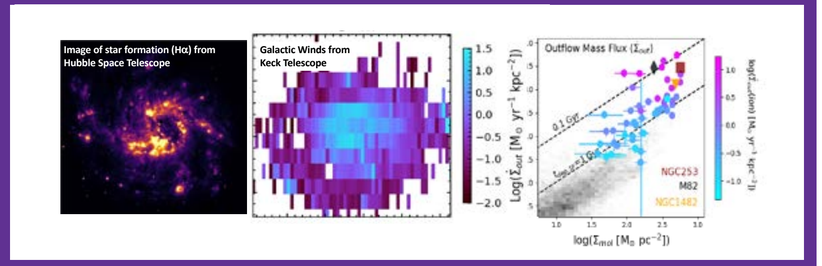
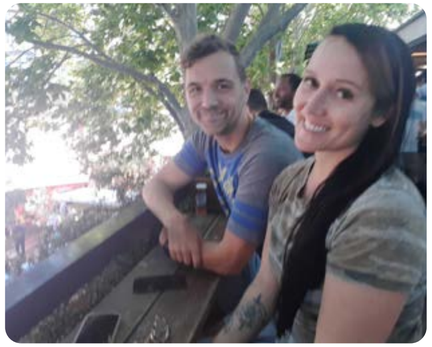


Figure 2: This figure combines results from two papers lead by student member Bron Reichardt Chu, from the DUVET team (Reichardt Chu et al. 2022a,b). The left most panel shows an image of a highly star forming galaxy, observed with Hubble Space Telescope. The image shows where the star formation occurs. The middle panel shows the result of Reichardt Chu et al. (2022a) in which the student developed a method to identify and measure the galactic winds, gas that is driven out of galaxies by the energy from supernovae that result from new formed stars. It is hypothesized by many theories that this process is responsible for regulating star formation. The third panel shows the combination of multiple observational projects, including Reichardt Chu's work with high-resolution radio interferometry carried out by CI Deanne Fisher to measure the molecular gas in the galaxy (Fisher et al. 2022). The location of data points shows the relationship between the star formation rate and the gas mass in regions within the galaxy. The dashed lines represent the time it will take for the star formation to remove the gas in the galaxy. In Reichardt Chu et al. 2022b the two results are combined, and the points are colored by the strength of the galaxy wind. They showed that the shortest time-scales for star formation are occurring in the regions of the galaxy with the strongest winds. This indicates that it is indeed the galactic winds that remove most of the gas from galaxies. Moreover, this type of work shows the usefulness of radio-optical connections, and points in directions for future work.

Bronwyn Reichard Chu – DUVET project

In 2022 Bron published Fa2 DUVET papers, including the pilot observations for one of the main aims of the program. Bron developed her own method for decomposing the faint extra features in emission lines in order to find the gas that is leaving galaxies. In the second paper, Bron made an innovative comparison of the strength of outflows to the position of the galaxy to the relationship between gas and stars (the Kennicutt-Schmidt relationship). It is thought that the main role outflows play is in regulating (slowing down) the star formation in galaxies by directly removing the gas available to make stars. Bron combined a result from a paper by Deanne Fisher using high resolution radio observations of molecular gas in a nearby galaxy with her new technique for measuring the galactic wind material. Through this comparison she can determine what the impact on the galaxy is of the gas that is removed by the wind. She made the first-ever direct connection of the outflows to the slowing down of star formation, and thereby showed that indeed outflows are regulating star formation. Recently, Bron successfully applied for a job, and will be moving to Durham University later this year.

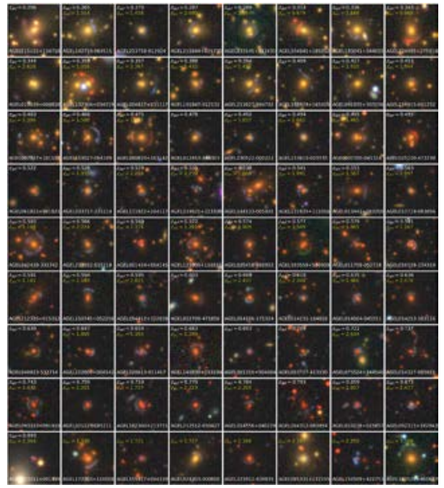
Visiting Professors – DUVET project



In November/December of 2022 we had two professors (John Chisholm and Danielle Berg - *pictured left*) from the University of Texas visit ASTRO 3D. Their visit included attendance at the annual retreat, several weeks in Swinburne, and trips to Monash and ANU. Berg is lead investigator of an HST Treasury program (called CLASSY), which studies highly ionised galaxies and is very appropriate to work in ASTRO 3D. Chisholm is a world expert on studies of outflows, and is beginning programs with ultra-widefield IFUs that is likewise highly relevant for ASTRO 3D. Both made several contacts with ASTRO 3D personnel and are already planning a return visit to Australia. They were particularly impressed by the Equity & Diversity discussions at the Annual Retreat and intended to take inspiration for similar effort back to Texas.

Vy Tran – AGEL project

The main survey paper for AGEL was published in 2022. Tran et al. 2022 publishes redshifts and lens confirmations for 68 new lenses. The paper outlines the methods used to train the convolutional neural network to find the lenses and then discusses the observing campaigns that were undertaken to confirm those lenses as actually having multiple redshifts. The survey paper marks a turning point in the project as it will now be able to pivot to begin using the lenses for scientific follow up.



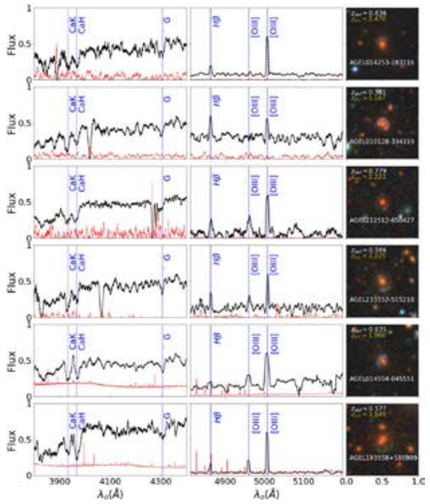


Figure 3: These panels show results from Tran et al. (2022), which is the main survey paper for the AGEL program. The left panel shows all AGEL lens targets found by the machine learning algorithm with confirmed redshifts from Keck and VLT. In each small panel there is a red galaxy in the center and a wispy blue arc. The red galaxy is the "lens" this is the galaxy that is bending the light, and the blue arc is a distant galaxy that is stretched and bent by gravity into the arc shape. The right panels show examples of the spectra of some of these galaxies. The two windows of spectra represent the two different redshifts of galaxies. This spectroscopic confirmation proves that the machine learning gravitational lens finding method works. This milestone paper means the AGEL team can now pivot to applying these observations to learning more about galaxies and their dark matter.

2022 Personnel Highlights

New members joining Galaxy Evolution

Barbara Mazzili-Ciraulo (postdoc Researcher, Swinburne);

Magdalena Hamel-Bravo (Graduate Student, Swinburne);

Antonia Fernandez (Graduate Student, Swinburne);

Alma Sebastian (Graduate Student, Swinburne began in late December 2021);

Nandini Sahu (postdoc Researcher, UNSW);

Takafumi Tsukui (AI postdoc, ANU)

Michelle Cluver (AI Faculty, Swinburne)

Steven Janssens (AI postdoc, Swinburne)

Joel Pfeffer (AI postdoc, Swinburne)

Lydia Haacke (Graduate Student, Swinburne)

Jonah Gannon (AI postdoc, Swinburne)

Manisha Caleb (postdoc Researcher, Syndey)

Zefeng Li (Graduate Student, ANU)

Trever Mendel (AI, ANU)

Monse Martinez (Graduate Student, Swinburne)

Galaxy Evolution members who took on a new role in the Centre

Nikki Nielsen (previously postdoctoral researcher) accepted the position as ASTRO 3D Research Fellow

Deanne Fisher took over as lead of Galaxy Evolution project

PhD Thesis Submissions

Juan Espejo – Supervisors Karl Glazebrook and Deanne Fisher

Liyualem Ambachew (successfully defended VIVA) – Supervisor Deanne Fisher

2022 Cross-project collaborations

Galaxy Evolution – ASKAP Collaboration: The lead of Galaxy Evolution, Deanne Fisher, has begun an effort to promote radio observation projects for members of Galaxy Evolution. The aim is to improve engagement with the Square Kilometre Array (SKA), which is a major Australian investment (over $150 million) that is scheduled to come online in the second half of the decade. The availability of SKA will almost certainly change the landscape of Australian astronomy, opening up unprecedented resolution of faint observations of the fuel that galaxies need to make new stars. The current SKA precursor, MeerKAT, is well suited for many Galaxy Evolution projects that can serve as pathfinders and pilot projects for larger scale future work with SKA. Fisher began in late 2022 to highlight possible projects with MeerKAT. She is helped by MeerKAT user Michelle Cluver, a new AI to ASTRO 3D in 2022, to promote the telescope's use. The outcomes of the collaboration will include proposals to MeerKAT; HI-based journal articles from galaxy evolution members; and ideally new observing programs on MeerKAT. In 2023, already there is uptake with a planned MeerKAT proposal going in from the MAGPI group as well as Fisher's group. In the future, the project will seek to bring South African astronomers to Australia to strengthen ties. Fisher has been invited to visit the Kapteyn research institute in The Netherlands, which is one of the world-leading institutes for research relevant to SKA, and is also invited to workshops on HI. These will be used to promote optical-radio collaborative projects, which a research area that Fisher has been expert in her entire career.

MAGPI-SAMI Publication: A natural fit for combined analysis is the SAMI and MAGPI projects. Both are large, ASTRO 3D led, integral field spectroscopy surveys that cover different time periods in the Universe. SAMI covers the nearby galaxies and MAGPI covers galaxies at z=0.3, roughly 3.5 Gyr ago. We can use the comparison to study the recent evolution of galaxies. This was done by a recent paper D'Eugenio et al. (2023) that compared these two surveys along with the LEGA-C survey.

Images far left, above and below: Galaxy Evolution members participate in the Draw your Science activity at the Annual Retreat. Credit: Cristy Roberts.

Member Spotlight

My research.

I study galaxies from redshift zero all the way to those right after reionisation. I am very interested in strong star forming galaxies and studying the gas response to feedback from supernovae and star formation. This fits well into studies of how the elements in the Universe came to be, as the supernova disperse these elements and in the build of matter.

How I came to astronomy.

When I was eight I asked my parents for a chemistry set, and they listen so well they gave me a telescope. I used to take it out in the yard and look at the moon (that was all it could do since it didn't have a sight or coordinates). That and a lot of episodes of Star Trek and here I am.

What I love about astronomy.

I think its fun to use telescopes. When I worked at the Combined Array for Research in Millimeter-wave Astronomy (CARMA) we got to do hands on work on the electronics to the telescopes and, occasionally, help move the telescopes. There's something very sciency about needing heavy equipment to do your research.

What I don't love.

At the risk of getting too serious, we have built a community that doesn't punish bad behavior. It is a competitive field, and many people take the easy path of treating their subordinate researchers harshly. It is very difficult to see this pretty much across the field. It also means we have to navigate working relationships with people that we don't want to engage with.

"I grew up on a farm in Texas. My relatives were in the rodeo. I wore a cowboy hat & boots and rode around in giant pickups with shotguns."

If I wasn't an anstronomer, I would be...

I think a few twists and turns and I could have gone into the arts, instead of science. When I was an undergraduate I was saving to take an internship with a painter, but I found out about an exchange program to study physics in Germany so I did that instead. When I was a teenager I wanted draw comic books, but even successful people don't really make a living doing that. I think I would enjoy working in a bookstore or library. It might be a lot more calm.

A highlight for me in 2022.

Its hard to not say travel. I spent a month in Germany and also attended several conferences. I have a lot of friends that I've known for many years that I see this way. It was very good to see them, and visit towns I like to travel to. It was also very motivating to get to speak at a high level with other experts in my research field. I think I had forgotten how exciting it was to speak with someone that works on exaclty my research field.

"Make sure you are taking part in the big changes in the field. This also means not staying with what you've always done, but changing as the field changes."

Something that not many people know about me

I'm not sure if people know that I grew up on a farm in Texas. My relatives were in the rodeo. I wore a cowboy hat & boots and rode around in giant pickups with shotguns. Basically picture the most stereotypical Texas image you can. We farmed cows, pigs chickens and also grew corn and hay. My first job was helping at a granary. It was really hard work, outdoors all day in the hot Texas sun.

The best piece of advice (professional or personal) I've ever been given?

You have to put yourself forward for things. I was told that when you are young (and even still) you have to make your research relevant. Convince others why it is important to them, and also make sure you are taking part in the big changes in the field. This also means not staying with what you've always done, but changing as the field changes.

ASSOCIATE PROFESSOR DEANNE FISHER | CHIEF INVESTIGATOR AT SWINBURNE UNIVERSITY OF TECHNOLOGY

Member Spotlight

My research.

I study the circumgalactic medium (CGM), which is a multiphase, enriched reservoir of gas residing between the galaxies' interstellar medium (ISM) and the intergalactic medium (IGM). I use ground-based telescopes like Keck and also space telescopes like Hubble Space Telescope (HST) to obtain the spectra of galaxies and bright background quasars. By comparing the gas properties obtained from the quasar spectra to the galaxy properties, I examine how the CGM influences the evolution of galaxies. Recently I have been tracing gas accretion onto galaxies to better understand how the galaxies acquire their fuel to sustain star formation and how the lack of accretion could quench the star formation. I use the kinematics of the CGM to determine whether the gas is accreting and, by comparing it to the host galaxy metallicities and star formation rates, determine if the galaxy properties are consistent with the presence or absence of accretion in the CGM.

How I came to astronomy.

In the simplest word, I can just say love. As far as I remember I was mad about the night sky, the blinking stars, and the mysterious dark, vast universe. I had a very simple small telescope that I could watch the moon from my bedroom window.

"I wanted to uncover the secrets of the universe. ...my name, Hasti, also means Existence/Universe in Persian, so maybe it wasn't just a coincidence!"

My favourite gift was the Astronomy Encyclopedia, and the topic of my research in school was always Astronomy. I never wanted to choose an ordinary field of study or job, I wanted to do something unique and special, I wanted to uncover the secrets of the universe. It might be fun that my name, Hasti, also means existence/universe in Persian, so maybe it wasn't just a coincidence!

What I love about astronomy.

When I'm drowning in my research, I look at the HST images and spectra of my galaxies and quasars and I forget about the earth and my routine concerns as a human being. When I look up, I see what a little speck we are in the universe. Also, I love the way that Astronomy blows my mind when I learn something new about this universe; the more I learn the more I realise that I don't know anything and I must try harder to learn more and more. Every time, this feeling reminds me of this quote from Albert Einstein: "*The most incomprehensible thing about the word is that it is comprehensible.*"

What I don't love.

I can never provide a convincing answer to some of the questions from public:

"So what? This thing happened to a very far galaxy...?" and "Why do astronomers care about the ionisation states of the gas around galaxies...?" and many other questions. As astronomers, we find these questions very interesting but to the public, it is not as important because it does not impact people's life directly or indirectly. So the fact that I can never have a solid answer to these sorts of questions is the hardest thing I find with Astronomy.

If I wasn't an astronomer, I would be...

I would be a businesswoman for sure, but I am not sure which business. I was always interested and knew that I could be successful in building up my own business of medical equipment, which my dad is a super expert in and would support me, or starting a fashion business, which I like because it could add color and style to routine life.

A highlight for me in 2022.

A highlight in 2022 was a comprehensive study of the galaxy–CGM relative kinematics using CGM HI gas, looking for evidence of baryon cycle processes like accretion and outflows. This second project of my thesis addresses whether the CGM cares about the galaxy rotation and if there is any signature of CGM gas co-rotation/accretion along the disc of galaxies. We developed a new method and studied a sample of 70 galaxy-CGM HI absorption pairs using Keck/ESI and HST/COS data which is the largest sample to date and found that there is a high co-rotation fraction along both galaxies' major (disc direction) and minor (outflow direction) axes within the virial radius of galaxies and so many other suprizing results that are explained in my papers.

"I never let this pain in my heart show up on my face and affect my science and PhD life."

Another highlight in 2022 was getting involved in 2 interesting projects and observing with KCWI. One is a study of a compact group of galaxies at cosmic noon where we used a similar method as my first paper/project to disentangle the origin of the complex multiphase CGM in this compact group. This is challenging because the CGM of groups is affected by different processes and very complex compared to isolated galaxies. The second was a part of the AGEL survey in which we explore the surprising presence of the CGM very close to quiescent galaxies. Given there is fuel very close to these galaxies, it is surprising why they are no longer forming stars.

It was also a highlight for me that I could play a major role in organising the ASTRO 3D student retreat/workshop. The idea of this retreat started in the center's 2021 annual retreat where we (a couple of student committee members) decided to organise a workshop for ASTRO 3D students after 2 years of COVID 19 and lockdowns. We (the LOC) put lots of effort into this workshop in the last 6 months and I hope the students were happy with the outcome.

Something that not many people know about me

My kindness and smile is not because of weakness, I just love and respect humanity. I have learnt to be nice and respectful to seniors, elders, juniors, and youngers, and I have a smile on my face when talking to people but sometimes I use this smile to cover and hide my pain and problems. For example, it has been 4 months that the women in my country (Iran) have been fighting for their life and freedom and getting brutally killed. I never let this pain in my heart show up on my face and affect my science and PhD life.

The best piece of advice (professional or personal) I've ever been given?

Personal: Enjoy every single moment of your life because you never know when your last day is. Professional: One of the keys to your success is a clear and consistent understanding of your own limitations.

HASTI NATEGHI | PHD STUDENT AT SWINBURNE UNIVERSITY OF TECHNOLOGY

First Galaxies

Professor Michele Trenti

is Director of the Melbourne Space Laboratory in the School of Physics at the University of Melbourne (Australia). Prof. Trenti is an expert in a broad range of astrophysics research areas and has published more than 190 peer-reviewed journal articles, primarily based on - or related to - observations with space telescopes.

In ASTRO-3D he currently serves as First Galaxies Project Leader as well as the University of Melbourne Node Leader.

Project Background

The First Galaxies project is focussed on discovering galaxies during the first billion years after the Big Bang, characterising their properties, and investigating how these objects evolve into today's galaxies. These goals are achieved through a combination of observations by some of the most powerful telescopes (space and ground-based) with theoretical and numerical modelling. We are also leading the design, fabrication and testing of Australia's first space telescope and first space mission funded by the Australian Space Agency - the SpIRIT satellite - which will contribute to discover stellar nurseries out to the edge of the observable Universe through identification and localisation of gamma ray bursts.

2022 Project Highlights

This year started with James Webb Space Telescope (JWST) finally off the ground and on its way to the L2 lagrangian point, a long-awaited moment for the team. With a fantastic launch and nominal deployment of all telescope elements, JWST finally started science observations in the middle of the year, and the first data reached our team in July. Preparations were hectic but the data did not disappoint, showing galaxies at high redshift at unprecedented spatial and spectral resolution. We contributed primarily to the GLASS Early Release Science program (PI Prof. Tommaso Treu; UCLA), analysing NIRCam imaging data, as well as NIRISS and NIRSPEC spectroscopic data. First Galaxies project leader Prof. Michele Trenti has been recognised as one of the "builders" of the NIRCam dataset by the collaboration, reflecting his extensive contribution to the design of the observations and of the data analysis strategy and pipeline.

ASTRO 3D postdoctoral researcher Dr Nicha Leethochawalit and Fellow Dr Kit Boyett both led rapid-turnaround papers from the first set of observations. Overall, eight publications based on JWST data were accepted this year, and our team contributed in total to over 20 JWST papers submitted between July and December (with the remaining dozen or so currently under peer review). The GLASS-ERS team discovered galaxies at redshift z>10 - in the first 500 Myr after the Big Bang - (see Figure 1), and surprisingly in a higher number and with higher luminosities than what was expected. This is potentially challenging current models of early galaxy formation and ongoing observations will clarify this new evidence.

In addition to working on JWST data, the team also published in the earlier part of the year an analysis of data from the Wide Field Camera 3 Brightest of Reionising Galaxies (BoRG) survey, led by ASTRO 3D CI Michele Trenti, and searched for galaxies within the first 700 million years after the Big Bang. Interestingly, we tentatively identified an excess of bright sources at redshift z~9-10 compared to other Hubble surveys, and our result now

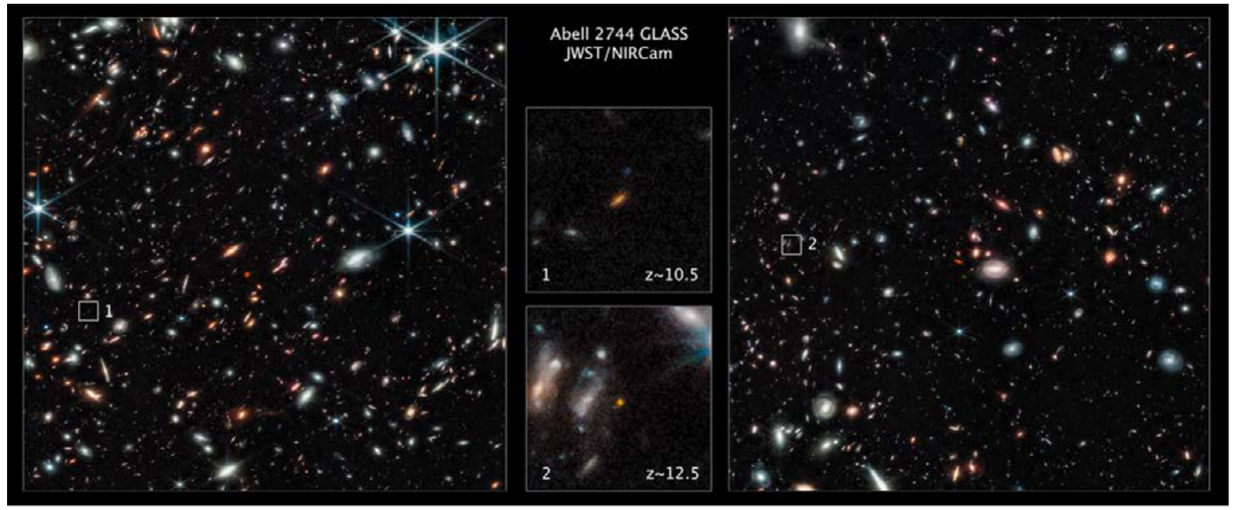
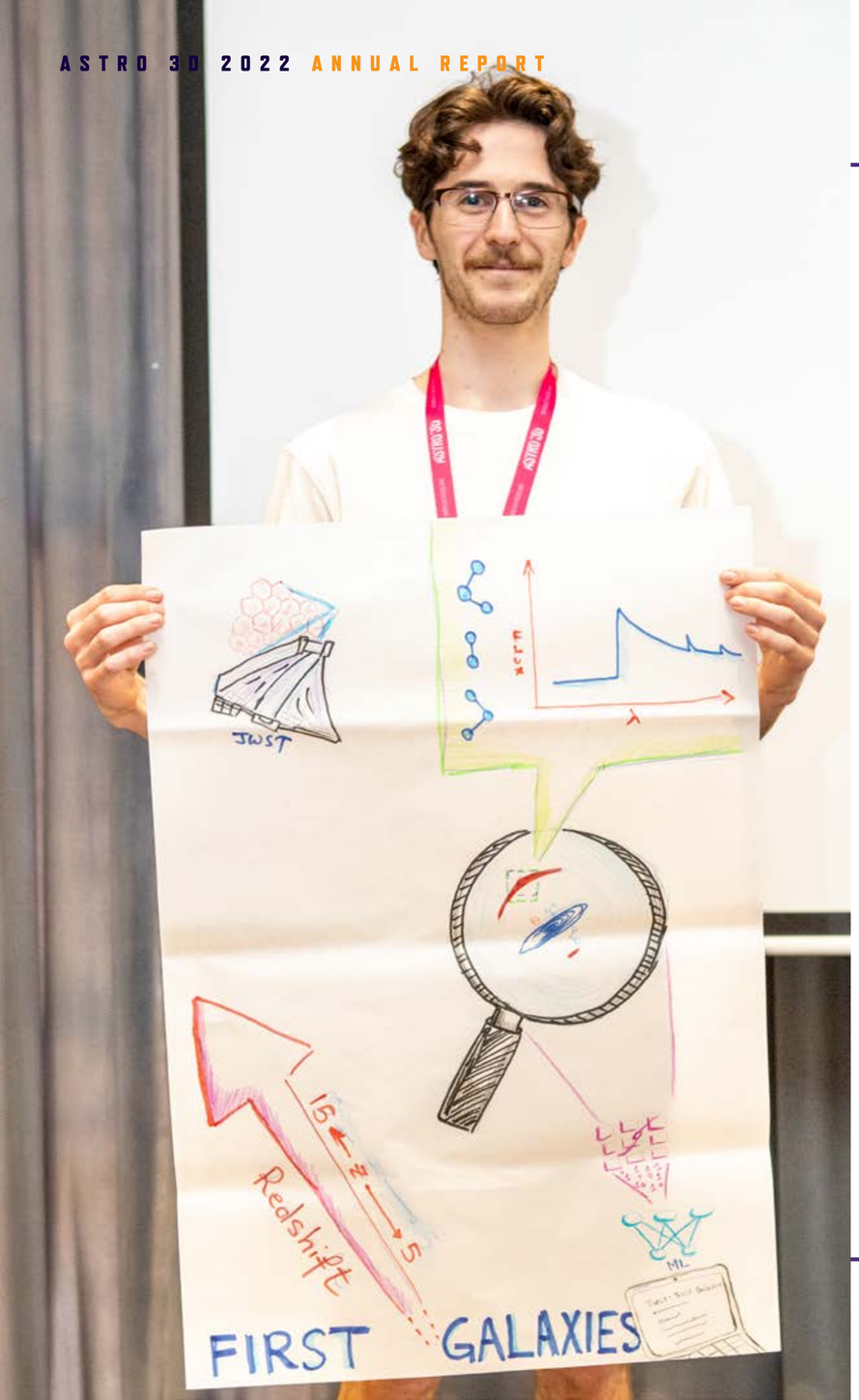


Figure 1: Two of the farthest galaxies seen to date are captured in these Webb Space Telescope pictures of the outer regions of the giant galaxy cluster Abell 2744. The galaxies are not inside the cluster, but many billions of light-years farther behind it. The galaxy labeled (1) existed only 450 million years after the big bang. The galaxy labeled (2) existed 350 million years after the big bang. Both are seen really close in time to the big bang which occurred 13.8 billion years ago. These galaxies are tiny compared to our Milky Way, being just a few percent of its size, even the unexpectedly elongated galaxy labeled (1). Image Credits: SCIENCE: NASA, ESA, CSA, Tommaso Treu (UCLA) and the GLASS/ERS team IMAGE PROCESSING: Zolt G. Levay (STScI)



seems to align with the latest JWST data. On the data analysis and modelling front, we continued investigating the use of geospatial analysis techniques to model two-dimensional galaxy maps, in particular metallicity maps from high resolution integral-field-unit like observations: PhD student Ben Metha used universal krieging to predict metallicities of HII and ionised gas regions in nearby galaxies from the TYPHOON survey, showing the modelling yields superior results to interpolation/extrapolation with a linear gradient. These tools have great potential for application to JWST observations at higher redshift.

The team is also busy developing the Space Industry Responsive Intelligent Thermal (SpIRIT) mission, an Australia-Italy mission to launch a 12kg nanosatellite for high energy astrophysics (aiming to contribute to identification of Gamma Ray Bursts at cosmic dawn as well). This year the project entered phase D (assembly, integration, and testing of the flight hardware), and launch is expected at the end of 2023. SpIRIT design and development attracted substantial engagement with industry, and Leonardo Australia, the subsidiary of Leonardo SpA, a large Defence & Space multinational signed a Memorandum of Understanding to commercialise IP generated by the Melbourne Space Laboratory led by CI Trenti.

PhD student Matt Thomas worked on a project to characterise the GRB localisation capabiities of a joint constellation that in addition to SpIRIT includes six other nanosatellites. Mr. Thomas also published a paper on the Gamma Ray Burst science case of a sibling mission under development, the SkyHopper infrared space telescope. These highlights are part of the 17 peer-reviewed articles published by the team in the last 12 months on a wide range of topics related to formation and evolution of stars and galaxies across cosmic time, and astronomical space telescopes.

This year, the team saw the addition of Mr Nithin Babu, a new MSc student who will be working on techniques to identify galaxies at high redshift, and of Mr Nicolo' Dalmasso, a new PhD student who is working on HST and JWST data. We also congratulated and said farewell to Dr Leethochawalit, now a permanent researcher at the National Astronomical Observatory in Thailand. Dr Leethochawalit remains a close collaborator of the team, continuing to contribute to the HST BoRG and JWST GLASS-ERS surveys.

Images far left, middle and bottom right: First Galaxies members participate in the Draw your Science activity at the Annual Retreat. Credit Cristy Roberts

Australia Square Kilometre Array Pathway - ASKAP

A/Professor Barbara Catinella

from the University of Western Australia is an expert in multi-wavelength studies of cold gas in nearby galaxies.

Barbara is co-PI of the ASKAP WALLABY survey, which will provide the largest census of atomic hydrogen in the nearby Universe, and a member of DINGO.

Professor Lister Staveley-Smith

from the University of Western Australia (UWA) has over two decades of experience in leading major surveys on new radio telescope facilities and in developing and applying new software and computation techniques.

Lister is co-leading the ASKAP HI Surveys project and is PI of ASKAP WALLABY project to image the southern sky in the 21-cm line of neutral hydrogen.

Professor Elaine Sadler is a

Professor of Astrophysics at the University of Sydney and also holds a part-time appointment as Chief Research Scientist at CSIRO Space and Astronomy. Within ASTRO 3D Elaine leads the 'Origin of Matter and Periodic Table' Theme and is co-leader of the 'ASKAP Surveys' project. She is co-PI of the ASKAP FLASH survey and also brings extensive science management experience.

Project background

The Australian SKA Pathfinder (ASKAP) Surveys project is investigating the evolution and buildup of neutral hydrogen (HI) in galaxies over the past 7 billion years. HI provides the reservoir of material from which new stars can form in galaxies, and so is key to understanding how galaxies evolve over cosmic time. ASTRO 3D researchers are members of three different but interlinked ASKAP surveys, DINGO, FLASH and WALLABY.

The Deep Investigations of Neutral Gas Origins (DINGO) survey (led by AI Martin Meyer) is studying the evolution of galaxies and the gas-rich Universe over the past 4 billion years. This will be achieved through both the direct detection of galaxies in the nearby Universe as well as statistical stacking studies at higher redshifts. The HI emission line data form DINGO will be combined with extensive multiwavelength data available in the GAMA G23h field to understand the connections between gas content, stellar populations and star formation history, and the underlying dark matter distribution.

The Widefield ASKAP L-band Legacy All-sky Blind surveY (WALLABY) (led by CIs Barbara Catinella and Lister Staveley-Smith) aims to detect 200,000 nearby galaxies (with a mean redshift of about 0.04) across the southern hemisphere. The goals of WALLABY include: measurement of baryonic and dark matter mass profiles of unprecedentedly large galaxy samples; and studying the effect of environment (local galaxy and gas density) on the properties of galaxies in order to better understand galaxy evolution in cosmic voids, filaments, groups and clusters.

The First Large Absorption Survey in HI (FLASH) (led by CI Elaine Sadler and AI Elizabeth Mahony) uses measurements of the 21cm HI line seen in absorption against bright background radio sources to study neutral gas in and around distant galaxies. With this technique, FLASH will probe the HI gas content of several hundred individual galaxies and study the evolution of HI over the past 4-8 billion years, where the HI emission line is too faint to be detected in even the deepest ASKAP surveys.

Image: ASKAP members participate in the Draw your Science activity at the Annual Retreat. Credit: Cristy Roberts
Banner image: ASKAP Credit: CSIRO

Figure 2: WALLABY team members visit the Pawsey Centre during their busy week

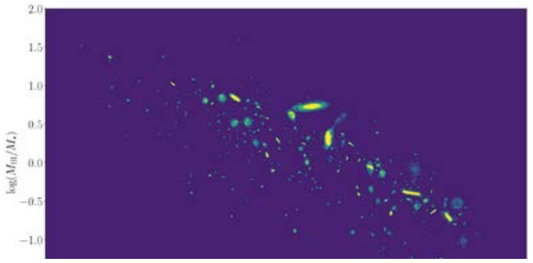


Figure 1: the gas fraction of WALLABY Pilot Phase 1 detections as a function of stellar mass.

2022 Project Highlights

WALLABY

WALLABY published six refereed papers this year with data from pilot fields. One was led by ASTRO 3D postdoc Tristan Reynolds, one was led by AI Tobias Westmeier, and four by international collaborators. The first public data release of WALLABY value-added data products (moment maps, velocity fields and rotation curves) occurred in November (see Figure 1), and was accompanied by a media release. Pilot phase 2 observations and imaging has finished, and the data is being made available to the team. In April, the Review of ASKAP Science Survey Projects allocated WALLABY 8832 hrs over the next 5 years to conduct its survey. A successful busy week was held at ICRAR/UWA and CSIRO Kensington on 22-26 August to prepare for full survey operations (see Figure 2).

DINGO

DINGO was successfully allocated 3200h of telescope time in the Review of ASKAP Survey Science Projects (RASSP). This will enable DINGO to carry out its deep HI survey goals with 4x800h integrations in the GAMA G23 field, spanning two adjacent ASKAP pointings and two redshift ranges. DINGO also completed processing of its Pilot Phase 2 data, with this now available in the CSIRO ASKAP Science Data Archive (CASDA). The team is preparing for full survey observations, tackling technical barriers, for example, removing bright continuum sources outside of individual PAF beams and implementing the uv-grid pipeline on Setonix at full scale. As part of the preparatory works, ASTRO 3D postdoctoral researcher Jonghwan Rhee reprocessed phase 1 equatorial data to improve RFI flagging and remove the artefacts of out-of-beam bright continuum sources, showing excellent improvement in the data quality, as seen in Figure 3. Along with these achievements, the first papers using DINGO's early science and pilot survey data were published, led by ASTRO 3D postdoctoral researchers Dr Jonghwan Rhee and Dr Sambit Roychowdhury, exploiting the power of HI stacking to examine HI scaling relations and the impact of environment on HI gas content (see Figure 4). Drs Rhee and Roychowdhury were also successful with proposals to obtain FAST, MeerKAT and APEX observations of a GAMA field, G23 galaxy groups, and DINGO pilot phase 1 detections, respectively.

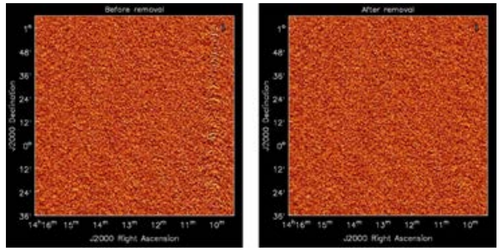


Figure 3: the removal of a bright continuum source outside of an ASKAP beam

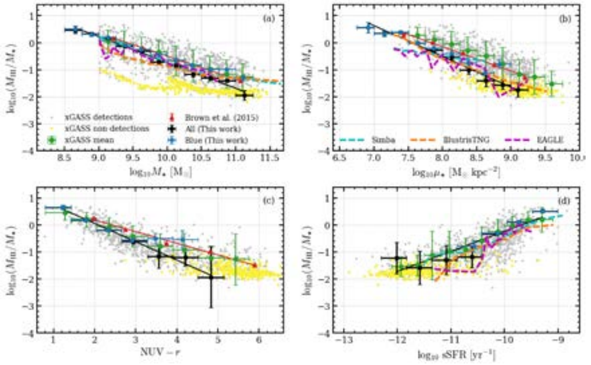


Figure 4: HI gas fraction scaling relations with: (a) galaxy stellar mass, (b) stellar surface density, (c) NUV-r colour, and (d) specific star formation rate, compared to observation and simulation data.

FLASH

FLASH completed a second 100-hour pilot survey with ASKAP this year, with the processed data products released through CSIRO's CASDA data archive. The data now available in CASDA include observations of 72 FLASH fields across the two Pilot Surveys, covering a total sky area of around 2800 square degrees. About 20 of these fields have repeat observations, which allow us both to confirm the reality of weak absorption lines and to build up a library of artefacts that can be used for future machine learning studies. Figure 5 shows the sky area covered by the FLASH pilot surveys. We have a preliminary list of around 30 new HI absorption detections and expect to add to this list as we continue to analyse the line-finder output. Two of the new FLASH detections are shown in Figure 6. The FLASH team published four papers this year, two of them led by PhD students. They included a detailed FLASH survey description paper led by James Allison that sets out the science goals for the full five-year survey. FLASH was allocated 1200 hours of observing time in the Review of ASKAP Survey Science Projects (RASSP), allowing us to survey the whole southern sky (between declination -90 and +18 degrees, and with Galactic latitude |b| > 8.5 degrees) for HI absorption over the redshift range 0.4 < z < 1. Observations for the full FLASH survey began in November 2022.

2022 Personnel highlights

After six years as a PhD student and then an ASTRO 3D WALLABY postdoc, Tristan Reynolds has departed UWA for a new adventure back home in Melbourne. Many thanks to Tristan for his hard work and enthusiastic participation. Still one more paper to go through referee comments and proof reading! PhD candidate Manasvee Saraf has kindly agreed to take over editing the WALLABY newsletter. Meanwhile, Barbara Catinella has joined Lister Staveley-Smith as co-PI of WALLABY, and Bi-Qing For has joined as Deputy Project Manager.

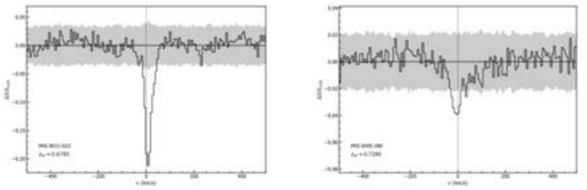


Figure 5: FLASH Pilot Survey sky coverage. Orange squares show the fields observed in Pilot Survey 1, and green squares those observed in Pilot Survey 2.

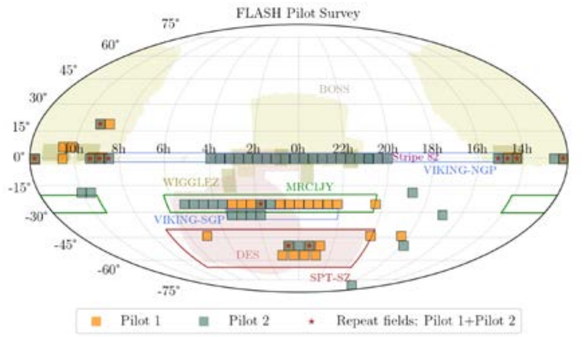


Figure 6: Two new detections of 21cm HI absorption lines from the FLASH pilot surveys, at redshifts of z=0.68 and z=0.73 respectively.

PhD student Ajay Dev commenced his thesis work on tracing the baryons in group environments, combining HI and multiwavelength data from DINGO, GAMA and aligned surveys. Abhinna Sundar also accepted a PhD position to work on DINGO, looking at the HI gas fractions of galaxies.

University of Sydney student Emily Kerrison has begun her PhD working with the FLASH team on a combined study of HI absorption and X-ray absorption in radio-loud active galaxies. PhD student Simon Weng continued his research visit to the European Southern Observatory (ESO) in Germany, supported by an ESO Studentship.

2022 Cross-project collaborations

Good representation of WALLABY science was achieved at several collaborative science meetings during the year, including the ASTRO 3D Science meeting (31 May-2 June), the ASA Annual Scientific Meeting (27 June-1 July), and ACAMAR8 (11-13 October 2022). During the May Science meeting, useful discussions were held between the DIAP team at Macquarie University and Data Central about the hosting of cutouts and optical/radio cross-matching.

DINGO continued its collaborations with other ASKAP surveys through the spectral-line working group, as well as extending collaborative efforts with AusSRC and Pawsey as part of its aligned PaCER project.

FLASH continued the technical cross-collaboration with WALLABY and DINGO through the ASKAP spectral-line working group, attended by FLASH Project Scientist Hyein Yoon. FLASH science results were presented at the 2022 IAU General Assembly in Busan, Korea, as well as other local and regional meetings. FLASH team members have continued discussions with the ASTRO 3D Genesis simulations group on modelling of cold gas in galaxies at intermediate redshift, and also had a successful collaboration with AI Aaron Robotham and Sabine Bellstedt at UWA on stellar population modelling of the host galaxies of HI absorption systems detected by ASKAP.

Image far left: ASKAP members participate in the Draw your Science activity at the Annual Retreat. Credit: Cristy Roberts

Member Spotlight

My research.

My research is focused on unraveling how galaxies evolve. I try to reach this goal by combining observations of as many baryonic components of galaxies as possible (gas, stars, dust, metals, etc.). As such, I have the privilege to use many different telescopes both on the ground and in space. The panchromatic aspect of my research is particularly suited for ASTRO 3D as it allows the connection of various projects - such as ASKAP surveys, SAMI/HECTOR, Galaxy evolution - to build a more coherent picture of the Universe.

How I came to astronomy.

My love for astronomy started during high-school, probably triggered by my general passion for physics and the fact that my parent's dining room was (and still is!) full of images of the Voyager missions as well as a gigantic sky atlas. During university, I almost changed paths to go into particle physics, but my first experience at a telescope, including having to remove snow from the dome before being able to observe, removed any doubts that astronomy was the career path I wanted to pursue.

"Getting new data from a telescope still comes with that unique adrenaline injection... after all, I am the first human getting those particular photons."

What I love about astronomy.

Inevitably, there are multiple things I love about astronomy. First, getting new data from a telescope still comes with that unique adrenaline injection... After all, I am the first human getting those particular photons. The ability to identify open issues in the field, design your own way to solve them and gradually come up with your (hopefully coherent) picture of how the Universe works still gets me out of bed in the morning.

Last but not least, the team work aspect of research. For the last few years, the privilege of building a research group and help training the next generation of scientists is quickly becoming one of the most rewarding parts of this job. I would hate this job if I was forced to work full-time in my office with the door closed with no interaction from other researchers or students.

What I don't love.

Despite my love for the profession, there have been times in my career when not everything about astronomy has made me happy. In general, most of these are due to the way sometimes success is evaluated in research, and how groupthink may replace objectivity and scientific method in deciding how to and what advances the field. This, combined with the inevitable lack of job security in the early career stages of an astronomy, represents one of the main challenges we face attracting and retaining the next generation of researchers.

If I wasn't an astronomer, I would be...

I have always been fascinated by the design of the Sydney Opera House and when I was a teenager, I wanted to be an architect. When I was a senior postdoc, having decided to move to Australia, despite not having a job lined-up, I used to say that I was going to open a rescue center for wombats. After nearly a decade in Australia, I still think that it would have been an excellent choice if I had to leave the field.

A highlight for me in 2022.

There are two, equally important, highlights from 2022. The first one encompasses the achievements of the students and postdocs in my group (Jennifer Hardwick, Andrei Ristea, Manasvee Saraf, Amelia Fraser-McKelvie and Adam Watts) who, despite many challenges, have all been able to publish their work targeting multiple questions in galaxy evolution, overlapping with ASKAP surveys, Galaxy Evolution and SAMI/Hector. Together they are one of the great example of cross-project work within a node in ASTRO 3D.

The second highlight is the success in getting awarded a significant amount of time with the VLT/MUSE instrument to carry out the MAUVE (MUSE and ALMA Unveiling the Virgo Environment) Large Program. The highlight is very much shared with ASTRO 3D CI Barbara Catinella, who co-led the entire effort. Now, we are very much looking forward in getting the data.

"I love road trips. I am secretly still dreaming to buy a camper in the future and get back on the road."

Something that not many people know about me

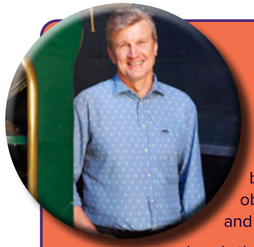
I love road trips. When I was little, my family had a camper and we managed to travel across all of Europe, from North Cape to Gibralter, and North Africa. At that time, it was super-safe to park it anyway (including under the Pyramids...there was only desert then). It was definitely true that "Home is where you park it." I am secretly still dreaming to buy a camper in the future and get back on the road.

The best piece of advice (professional or personal) I've ever been given?

When you sit at a dinner table you do not know anyone and there is awkward silence, just come up with a couple of basic questions to ask the person sitting next to you. This will break the ice and you will see that the conversation will flow nicely after that. This for me has worked at least 90% of times.

DR LUCA CORTESE | ASSOCIATE INVESTIGATOR AT THE UNIVERSITY OF WESTERN AUSTRALIA

Galactic Archeology with HERMES - GALAH



Professor Joss Bland-Hawthorn

from the University of Sydney is an ARC Laureate Fellow renowned for innovative and broad-reaching science of both theoretical and observational astronomy, covering optical, infrared and radio wavelengths.

Joss is the ASTRO 3D GALAH Survey lead and the ASTRO 3D Collaboration lead. Joss and his team are using the GALAH survey to trace the chemical and mass assembly history of the Milky Way.

Project background

The Galactic Archaeology with Hermes (GALAH) survey is a large observing program using the Hermes Instrument with the Anglo-Australian Telescope.

The formation and evolution of galaxies is one of the great outstanding problems of modern astrophysics. The goal of galactic archaeology is to uncover the history of the Milky Way and how it formed and evolved.

HERMES provides simultaneous spectra for 400 stars at a time. We are using this to obtain the highest spectral resolution multi-dimensional datasets for over a million stars of all ages and locations in the Milky Way to trace the full history of the Galaxy.

The GALAH Survey has been working for almost a decade to reveal the rich history of our Milky Way Galaxy by studying the current positions, motions, ages and chemistry of stars formed at different times and in different locations.

2022 Project highlights

The GALAH team has continued its endeavour to observe 1 million stars and reached more than 850,000 stars by the end of 2022. The survey will formally end in 2024. This year, the team has reached yet another important achievement in the extraction of chemical compositions from stellar spectra: We are now able to extract yet another element of life - nitrogen - from the high-resolution spectra. This is possible through an upgrade of the analysis to fit all stellar features simultaneously - most notable the carbon (C2) and cyanide (CN) molecular features that are imprinted at the edges of our wavelength ranges. This improvement will open up new areas of chemical exploration. The balance of the CNO abundances hold valuable information about the inner regions of stars and in particular their mass and age, because the abundance ratios of these three elements change in the later stages of stars depending on the masses of stars. The new abundances that will be made available to the public as part of GALAH's fourth data release (DR4) will therefore allow an even better age estimation for giant stars. Together with the more than 500,000 stars for which ages can already be well determined from theoretical modelling, this will improve GALAH's vanguard role in Galactic chemical evolution studies. Already now, GALAH DR3 has had a broad impact thanks to its catalogues of chemistry, ages, and orbit information - the GALAH DR3 analysis and catalogue description is the most cited paper (out of 4000!) of the Monthly Notices of the Royal Astronomical Society in 2021.

On science achievements in 2022, GALAH papers continue to have excellent impact. GALAH observations of neutron capture elements provide key constraints on the formation and evolution of the Milky Way. The slow neutron capture elements are produced from low and intermediate mass stars (<8 solar masses) during the asymptotic giant branch stage of evolution.

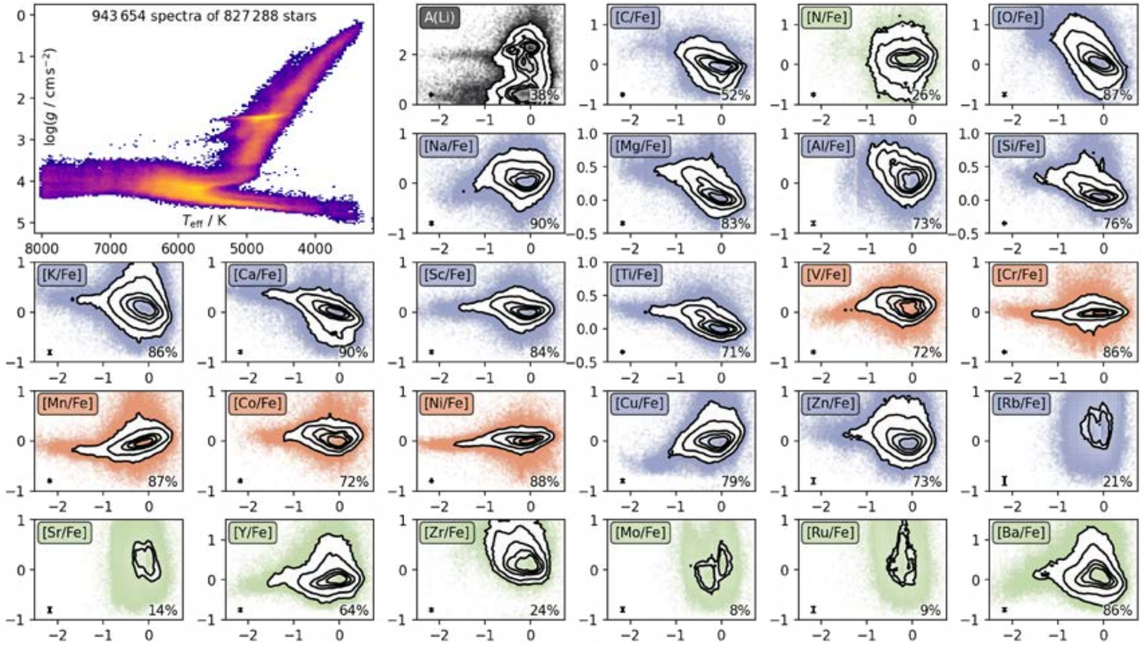
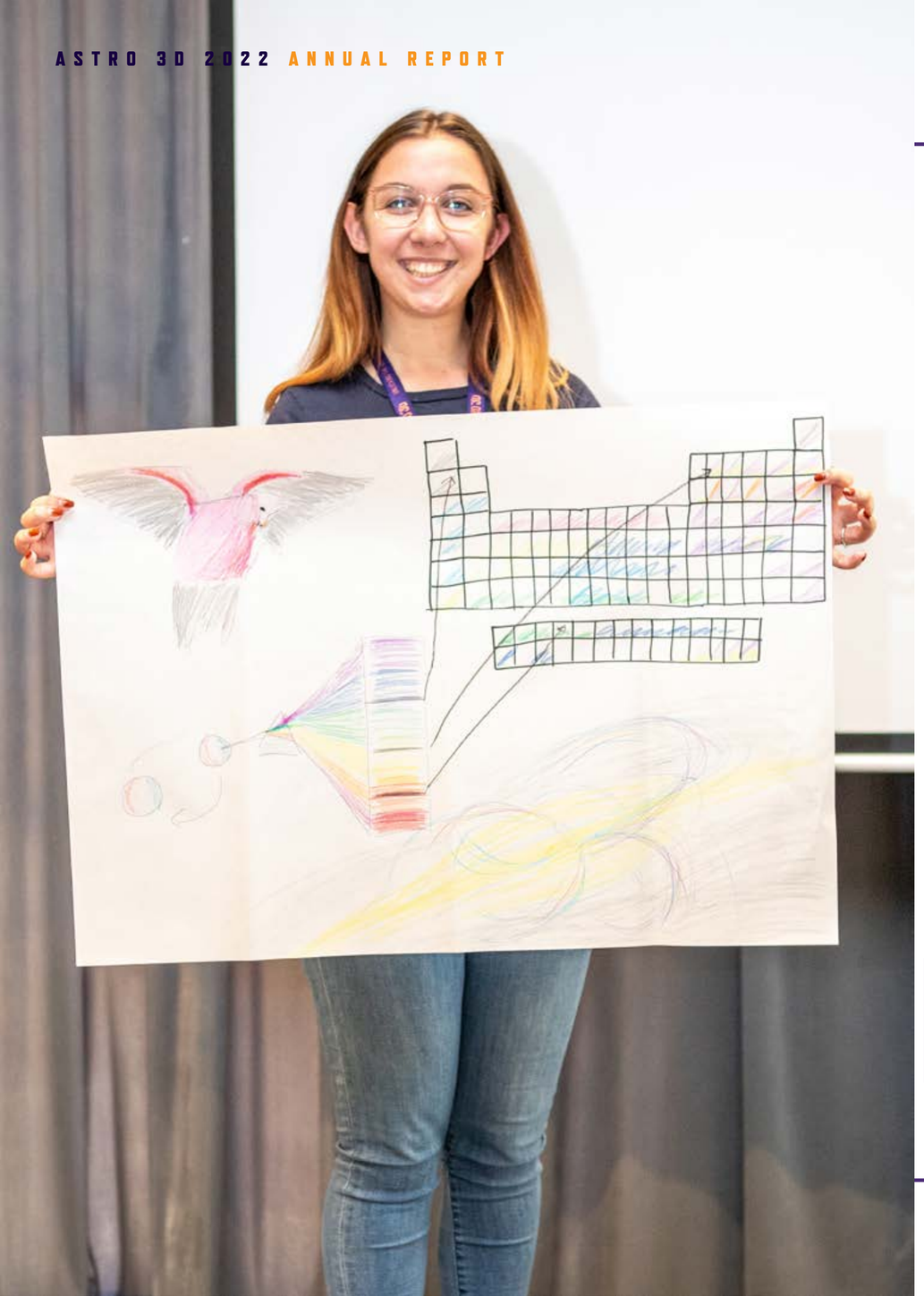


Figure 1: A preview of the types of stars (top left panel) as well as their chemical compositions for measurements that will be included in GALAH DR4. The colour coding of the density maps indicates roughly the major nucleosynthesis pathways (black: big bang nucleosynthesis, blue: massive stars, green: evolved stars, red: exploding white dwarfs, pink: neutron star mergers) and will be useful to constrain the detailed origin of elements together with ASTRO 3D's chemical evolution modellers.
Banner image: HERMES Instrument. Credit: Gayandhi De Silva

GALAH
GALactic Archaeology with HERMES



We have found an interesting evolution of the s-process elements Yttrium and Barium within the high-alpha stellar populations of the Milky Way. These stars are the oldest in the Galaxy, and one might expect that they are low in s-process elements compared to younger stars like the Sun. However, we find that the most metal-poor high-alpha stars of the Galaxy are actually enhanced in Barium (2nd peak/heavy neutron capture) and Yttrium (1st peak/light neutron capture) relative to the solar values. Barium exhibits a strong negative trend with increasing metallicity for the thick disk populations, decreasing from [Ba/Fe]~0.3 at [Fe/H]=-1 to [Ba/Fe]~-0.1 at [Fe/H]=-0.4. However, Yttrium shows slightly different behavior, starting off at [Y/Fe]~0.15 at [Fe/H]=-1 and immediately decreasing to [Y/Fe]~-0.2 for stars with [Fe/H]=-0.8, which then stays constant with metallicity thereafter. These differing trends between the s-process abundances provide key clues into the production sites for neutron capture abundances during the early Galaxy.

We can also use GALAH observations of neutron capture elements to improve our understanding of stellar evolution and stellar yields from various metal-production sites. These observations can then be directly compared to state-of-the-art chemical evolution models, such as those developed by Chen et al. 2022. This model is the first to date that reproduces the stellar distribution in [Mg/Fe] and [Fe/H] across the entirety of the Galaxy, from the bulge to edge of the disk, and takes into account

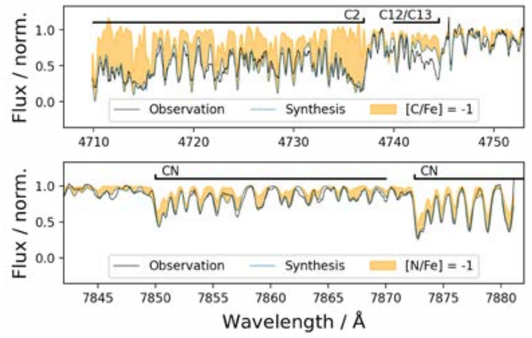


Figure 2: Molecular absorption features like C2 and CN at the beginning (top panel) and end (bottom panel) of the HERMES wavelength range are being used as of GALAH Dr4 to infer the elements of life, carbon and nitrogen, together with oxygen. These will allow both a more precise age dating for evolved stars as well as the exploration of carbon abundances of the most metal-poor stars in cooperation with ASTRO 3D's First Stars team.

various physical processes such as radial migration and the radial flow of gas within the disk. The addition of more nucleosynthetic channels (slow and rapid neutron-capture process abundances) is an avenue that can now be explored in these models with constraints GALAH. The yields for many chemical abundances are uncertain, particularly for odd Z, slow, and rapid process elements. However, we can use yields for elements which are more well understood (i.e., [Fe/H] and [Mg/Fe]) as key constraints on the physical processes governing the chemical enrichment of the Galaxy (star formation history, gas flow, radial mixing, etc). The gas and dynamical processes are constrained using [Fe/H] and [Mg/Fe], and then we determine empirically the required yields of other elements such as odd Z, slow, and rapid neutron-capture process to match GALAH and APOGEE observations for how these elements vary with age. This is a similar technique to determining astrophysical oscillator strengths in spectroscopic analysis. These yields can then be directly compared to theoretical yields from the leading stellar synthesis codes and determine where improvements need to be made.

Image far left and above: GALAH members participate in the Draw your Science activity at the Annual Retreat. Credit: Cristy Roberts

Member Spotlight

My research.

I am using the light of stars in our Milky Way galaxy split across the wavelengths in so called spectra – like stellar barcodes – to extract the chemical compositions of stars and therefore their evolution. As part of the GALAH project team, I am using Australia's biggest optical telescope to observe millions of stars and lead the working group that extracts these "stellar barcodes". The goal of our research is to trace back the ancestry of stars and with it the formation history of our Milky Way as one of the many spiral galaxies out there. Exploring our own galaxy and its chemical and dynamical evolution will help us to not understand how we got here, but how spiral galaxies can evolve to galaxies like our Milky Way and how the elements of our periodic table are created.

How I came to astronomy.

I never had a clear plan to do astronomy. Initially, I wanted to study civil engineering to become a company manager with a scientific background. Luckily - although I did only realise that later – the university I applied for did not accept me. As an act of defiance, I decided to study something different that always interested me because I never knew all the answers to its problems: physics. During my studies, astronomy then came to light as my true passion and I was lucky enough to find a PhD position that allows me to travel throughout the world and observe our night sky.

What I love about astronomy.

I am always stuck by the sheer scales that we work on in astronomy. We can learn how galaxies assemble based on small molecules in stars or dust – but to do that we need to build bigger and better telescopes and explore an unbelievably large amount of data – quite the challenge. And I love challenges!

The way that we currently fund research is neither sustainable nor does it truly allow us to do the best research.

What I don't love.

The job insecurity and funding structure. The way that we currently fund research is neither sustainable nor does it truly allow us to do the best research. Ground-breaking and daring research on the short time scales that funding agencies demand is becoming almost impossible. Researchers are losing several months per year to apply for highly competitive funding to keep a dream alive for another two to three years.

If I wasn't an anstronomer, I would be...

An environmental researcher, a manager or consultant, or maybe a political activist, or even a politician. I actually had a hard time choosing a study topic in the first place – so even during my studies I visited additional lectures to learn more about politics and management. In recent years, I am also getting more interested in figuring out how we as a society can fight the climate crisis – before it is too late!

A highlight for me in 2022.

I am currently working on identifying stars that were born in a smaller galaxy that collided with the young Milky Way more than eight billion years ago. A highlight was to find exactly such stars in what I call the "Avocado and egg" plot – in which the positions of stars born inside and outside our Galaxy fall in two separate groups when using a clever projection of chemical abundances. In my study, I then showed that there is a significant evolution of the movement of stars that were born outside of our Milky Way when only selecting them via their chemical "DNA". We are now observing more of these stars to study how much new material the smaller galaxy really brought into the Milky Way. Can this maybe explain the mystery why we see two distinct stellar populations in the disk of our Galaxy?

"I am also getting more interested in figuring out how we as a society can fight the climate crisis – before it is too late!"

Something that not many people know about me

I am actually not Swedish. It still happens at every conference and a quite a few meetings where people come up to me and say "I thought you were Swedish!". And I cannot blame them: I have a Scandinavian first name, speak Swedish because I studied at a Swedish university for some time, am often surrounded by Swedish friends and colleagues and quite often visit my brother who moved to Sweden.

The best piece of advice (professional or personal) I've ever been given?

Enjoy every day as if it is your last.

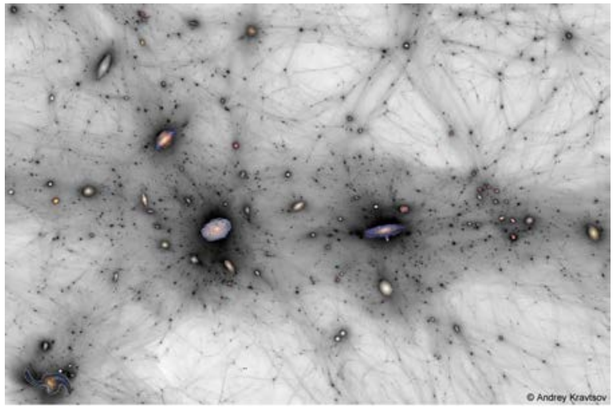
DR SVEN BUDER | POSTDOCTORAL RESEARCHER AT THE AUSTRALIAN NATIONAL UNIVERSITY

Collaborations

MAGPI (Middle Ages Galaxy Properties with Integral Field Spectroscopy) an ESO/MUSE Large Program

The Middle Ages Galaxy Properties with Integral Field Spectroscopy (MAGPI) survey is a large program on the European Southern Observatory (ESO) Very Large Telescope (VLT). It uses the Multi Unit Spectroscopic Explorer (MUSE) to obtain spatially-resolved spectroscopy of stars and ionised gas for galaxies in a range of environments 3-4 Gyrs ago.

Fundamentally, the MAGPI survey was born of and designed as a cross-node/cross-project collaboration. The MAGPI team comprises active ASTRO 3D members from Galaxy Evolution, SAMI/Hector, Genesis and Data Intensive Astronomy. The distributed leadership of the team spans three ASTRO 3D nodes (ANU, UNSW and UWA), with many active MAGPI team members based at other nodes (Macquarie, Swinburne and Sydney). This collaboration stemmed from the productive interaction of the ASTRO 3D fellows and would not have been possible without the resources and collaborative support of ASTRO 3D. For example, the initial ESO large programme proposal was developed during an ASTRO 3D proposal writing retreat and received important constructive feedback from the astronomy community.



ASTRO 3D supported the continued success of MAGPI throughout 2022 through funding for our busyweek, travel and postdoctoral researchers. The MAGPI team is an international and multidisciplinary team with members on nearly every continent, working from multiple perspectives to understand the evolutionary pathways of galaxies in the Universe around us. MAGPI facilitates the collaboration between observers and theorists, enabling comparisons of our exquisite ESO/MUSE observations of real galaxies at z~0.3, and mock observations of theoretical data sets from a number of the largest cosmological hydrodynamic simulations around the world.

With two-thirds of the observational data in hand by the end of 2022 and high-quality reduced and value-added data products now available, last year saw a real uptake in scientific research activity within the MAGPI team. Many of our PhD students are in the process of drafting papers (including one submitted). We have added a regular science highlight spot to our quarterly online team meetings, with 3-4 science highlights being presented each quarter across the team. The team has three papers currently under review based on MAGPI data.

Last year was also very productive in terms of the growth of overseas team members. In 2022, the team had the pleasure of having 15 new members (including seven based overseas) joining its ranks (76 members at the time of writing). Our members gave five oral presentations (including three by students) about their MAGPI research at international astronomy conferences in 2022. ASTRO 3D distinguished visitor Prof Martin Bureau spent time at multiple nodes interacting and sharing his expertise with many of the MAGPI team's leaders and members across many of the ASTRO 3D nodes.

Main Image: The Multi Unit Spectroscopic Explorer (MUSE) instrument on ESO's Very Large Telescope (VLT) at Paranal Observatory. MUSE is one of the largest instruments at the VLT and is connected to one of its four 8.2 m telescopes, Yepun. (Credit: Zdeněk Bardon/ESO)

ADACS Project

In 2022, ASTRO 3D-funded research associate and MAGPI Partner Investigator Kate Harborne, won support from the ADACS Merit Allocation Program to develop and host a web application implementation of the mock observation software, SimSpin. This web application will allow users and team members to visualise a curated sample of simulated galaxies in a format consistent with the real MUSE observations. In collaboration with data scientists and web developers at Swinburne University, we can now generate mock data products to answer specific science questions in a rigorous and repeatable manner.

Strong collaborations have further enabled this work with various simulation teams across the world. This collaboration will culminate in a MAGPI Theory Data Release in mid-2023.

Dynamite Workshop

In the summer of 2022, MAGPI team member, Giulia Santucci, won funding for, organised and led an international workshop facilitating collaboration between the MAGPI survey team and the Dynamite dynamical modelling team from the University of Vienna. ASTRO 3D provided funding for the travel of several members to attend this event.

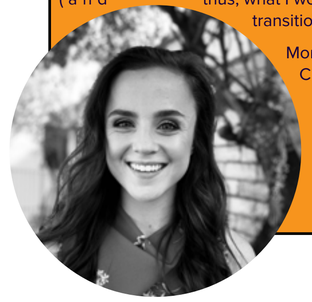
This workshop aimed to train a new team of researchers to use the Dynamite software. Dynamite builds Schwarzschild models of galaxies to explore their intrinsic shapes. This workshop used MAGPI observations as the example data set, attracting new users to engage with the dataset that the MAGPI survey can offer. Following the workshop, we had a new project proposal and team member application, as well as several contributions from associates at the University of Vienna and the Instituto de Astrofisica de Canarias.

Australian Mathematical Sciences Institute (AMSI) APR Internship

Last year, I took a three-month hiatus from my PhD research to participate in an industry internship with the Lockheed Martin Australia research and development lab (STELaRLab). I worked within the artificial intelligence and machine reasoning team on an extension of the labs current research in activity-based intelligence. For my project, we applied this to traffic. I ran a series of models simulating vehicle behaviour and used the information from these simulations to develop two detector prototypes. These detectors identify whether a given vehicle in the simulation is travelling alone, or in coordination with another actor.

The majority of my experience as a researcher is within an academic environment, so one of my goals of the internship was really just to gain some insight into how industry research works. It was quite rewarding to identify the skills I had, that-although I had built in an academic environment-transferred well to industry.

So-did I get converted to the dark side? My plan before the internship was to stay in academia, and that is still my plan. I really enjoyed the work, the people, and the environment at STELaRLab, but stars remain the best research application to me (at least for now!). However, I feel like I will be making a much more informed decision of the industry vs academia job debate once I finish my PhD, rather than choosing academia because it's all I know. And if I change my mind in the future, I now have (some) experience, connections and a general awareness of which of my skills are transferrable (and thus, what I would need to develop) if I wanted to transition out of the university sector.



Monash University PhD Student Giulia Cinquegrana

ASTRO 3D and Oxford University

In 2022 and 2023, CI Matthew Colless (ANU) is working overseas at ASTRO 3D Partner Institution, Oxford University, utilising the SAMI, Hector and MAGPI integral field spectroscopy surveys of galaxies. These surveys are obtaining spatially resolved spectra for several thousand galaxies and enabling detailed studies of their internal motions (kinematics) and the formation and evolutions of their stars (stellar populations) out to moderate redshifts. He is particularly interested in scaling relations between the mass, luminosity, size and kinematics (rotation velocities and velocity dispersions) of galaxies, such as the Faber-Jackson, Tully-Fisher and Fundamental Plane relations. Such relations, their links to the properties of galaxies' stellar populations and the surrounding environment, and their evolution with redshift (cosmic epoch) reveal the processes through which galaxies form and evolve.

Whilst at Oxford, Prof. Colless is working closely with Prof. Roger Davies (an ASTRO 3D partner investigator), Prof. Michele Cappellari and Prof. Martin Bureau (recent ASTRO 3D Distinguished Visitor) from Oxford University's Hintze Centre for Astrophysical Surveys. This is a world-leading centre for galaxy studies, with particular strengths in integral field spectroscopy surveys, the internal kinematics and stellar populations of galaxies, and the use of scaling relations as distance estimators.

Prof. Colless will also bring two ASTRO 3D postdoctoral researchers, Dr Sree Oh and Dr Stefania Barsanti, to Oxford for extended visits to work with Profs Davies, Cappellari and Bureau and their students and postdocs, using funds provided by a Royal Society Wolfson Visiting Fellowship. They will work on the analysis of integral field data from the Hector and MAGPI surveys, in order to:

i. Extend the understanding of scaling relations to lower-mass galaxies, made accessible by the higher spectral resolution and larger sample size of the new Hector survey on the Anglo-Australian Telescope;

ii. Exploit the higher-redshift data being provided by the MAGPI survey on the European Southern Observatory (ESO) Very Large Telescope (VLT) to understand the evolution over time of the scaling relations; and

iii. Use the combined SAMI, Hector and MAGPI samples (and the larger redshift surveys in which they are embedded) to study the effects of large-scale structure on the evolution of galaxies' angular momentum.

Preparing Australia for the Square Kilometre Array (SKA) (Cross node collaboration):

The Galaxy Evolution team is utilising the infrastructure and collaborative ties within ASTRO 3D to build more experience that will prepare Australian researchers for SKA. The SKA represents a $387 million investment by the Australian government, and we are trying to engage and prepare more Australian researchers for SKA related science when the telescope turns on in 4 years time. The MeerKAT telescope offers a prototype tool for SKA-mid projects, which are a good match to many astronomer's interests. In 2022 we put forward an initiative to use ASTRO 3D funds to help any astronomer's plan and write MeerKAT proposals. This project will bring together researchers in the Galaxy Evolution ASTRO 3D project with those in the ASKAP ASTRO 3D project. It is likely to build new collaborations in this area. Moreover, the plan is to use the funds to support travel by researchers from across Australia to the UWA/ICRAR node of ASTRO 3D, where there is higher density of researchers with MeerKAT proposals.

Preparing Australia for the SKA (Initiating international collaboration):

In 2022 CI Deanne Fisher initiated a collaboration with researchers at the University of Stockholm (Sweden) and Macalester College (in Minnesota, USA) towards incorporating HI observations with the ASTRO 3D funded project DUVET. DUVET studies the faint gas outside of galaxies, and is an ideal case study for projects that will make use of the SKA. The group in Sweden provided reduction and calibration of very deep, widefield observations taken on the Janksy Very Large Array. They delivered the data to Fisher in December 2022. Fisher will work with ASTRO 3D research Nikole Nielsen to reduce associated DUVET data for a combined radio-optical analysis. The program will demonstrate the unique capabilities that will be more easily achievable by combining SKA observations with ESO observations.

AGEL (Cross node and International Collaboration):

The AGEL survey was organised and initiated as part of ASTRO 3D to study lensed galaxies. AGEL is made possible by funding through ASTRO 3D, and brings together researchers at UNSW and Swinburne ASTRO 3D nodes. The team has had significant successes in the past years including winning time on the ESO VLT, Keck and Hubble Space Telescope. In 2022, they published their project survey paper and are currently working on their first science results paper. The team has initiated a collaboration with researchers in Singapore, Chile and ESO headquarters in Garching, Germany to begin discussions towards using AGEL to develop an observing program with the Atacama Large Millimeter Array (ALMA). In the past decade, ALMA was the most impactful telescope, world-wide, and would be part of a full partnership in ESO. It is therefore in support of Australian astronomy aims to collaborate with ALMA programs.

Results from the AGEL program led to a new collaboration between ASTRO 3D members Glazebrook and Fisher (both at Swinburne) with Geraint Lewis (University of Sydney). While Lewis is not officially an ASTRO 3D AI, ASTRO 3D has supported his travel in the past, and he has attended ASTRO 3D retreats. This collaboration led to a successful Discovery Project beginning in 2023.

Conference on Feedback and Outflows in Heallesville, VIC: This is a collaboration (sort of) with astronomers in other countries. Also it includes a partnership with a non-profit organisation in Australia.

In July 2023 we will hold an ASTRO 3D sponsored meeting on a topic that the US Decadal Committee rated among the highest priority in astronomy in the coming decade. The conference brings together astronomers from around the world. It is intended to be a high level discussion of this rapidly growing field within astronomy. This could only happen with the generous ASTRO 3D funding. In lieu of a typical "public lecture" associated to the conference the organiser (Deanne Fisher) is partnering with LGBT-STEMM advocacy group QueersInScience to hold an event in downtown Melbourne. The event will be called QueersInScienceFiction. Multiple LGBT speakers from the conference will engage with an audience on their experiences in science, and they will watch an episode of Star Trek and make commentary. The event will be advertised to young LGBT students and ECRs.

Main Image: A composite image of the future SKA telescopes, blending what already exists on site with artist's impressions. From left: An artist's impression of the future SKA-Mid dishes blend into the existing precursor MeerKAT telescope dishes in South Africa. From right: A artist's impression of the future SKA-Low stations blends into the existing AAVS2.0 prototype station in Australia. . (Credit: SKAO)

Media and Social Media 2022

Media

2022 saw us continue our partnership with Science in Public to help publicise and disseminate the Centre's research outputs and outreach activity.

In the twelve months of 2022, we produced or collaborated on X media releases highlighting significant research or outreach activity, including:

Social Media

Our social media engagement continues to be a useful means of engaging with different audiences. With Lara Sharp based at ANU, we now have more capacity to increase our posts and engage with audiences.

Facebook/Instagram

We increased the number of posts on Facebook by 260% in 2022 (119 posts) and increased our reach by 13.2%. Our audience grew to 641, primarily young, middle-aged adults, with a fairly even gender split.

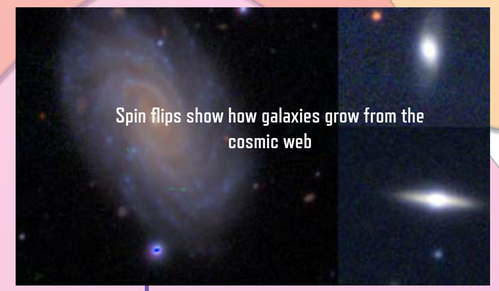
We generally post the same content on Instagram, which we hadn't done before. Consequently, our reach therefore increased by 403% to 473, the majority of which were a much younger demographic.

Twitter

Our Twitter audience grew from 1261 to 1397, helped along with 61 Tweets which got over 50,000 impressions and nearly 300 mentions by others.

11 JAN

12 JUL



5 OCT

JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

21 FEB

13 JUL

28 SEP

ASTRO 3D Member Awards

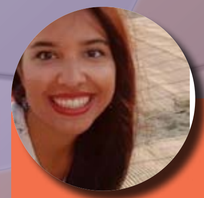
Associate Professor Katie Auchettl
Fellow (UMelb)

Awarded a DECRA

‘Katie’s project aims to understand the unexplored population of non-active or quiescent supermassive black holes (SMBHs) using tidal disruption events - the multi-wavelength outburst resulting from a star being ripped apart by the tidal forces of the SMBH.

Kirsten Banks
PhD student (UNSW)

Tied for 1st place for best student poster video at the ASA in Hobart.



Dr Stefania Barsanti postdoctoral Researcher (ANU), Zara Osborn PhD student (Monash) and Matthew Wilkinson PhD student (UWA)

Won awards for their posters at the Poster Symposium for ECRs - PoSTER 2022

Zara Osborn also won the prize for the top Honours student in the Monash School of Physics and Astronomy.

Prof. Sarah Brough
Associate Investigator (UNSW)

Awarded an ARC Linkage Infrastructure, Equipment and Facilities (LIEF) grant to fund supporting Australian access to the Rubin Observatory and data from the Legacy Survey of Space and Time (LSST).

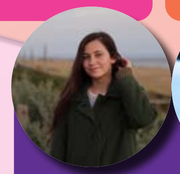
and

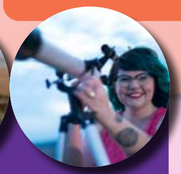
Named Fellow of the Royal Society of NSW and appointed Deputy Chair of the National Committee for Astronomy.

Professor Darren Croton
Chief Investigator (Swinburne)

Awarded a Future Fellowship for ‘The many lives and deaths of high redshift massive quiescent galaxies’.

‘This Fellowship will investigate the recent discovery of very massive, extremely early forming quiescent galaxies and explain their exceptional origin, death, and ultimate place in the local Universe. It is a multidisciplinary project that seeks to produce new knowledge using high-performance computing, software engineering, and sophisticated data analysis techniques. Expected outcomes include novel and improved supercomputer simulations of several billions of galaxies processed through a virtual observatory, providing tools and fundamental knowledge for observational, theoretical, and computational astrophysics.’





Krystal De Napoli and Karlie Noon
Education and Outreach Affiliates (Swin/ANU)

Nominated for a Victorian Premier's Literary Award for their book Astronomy: Sky Country. (Update: Awarded the People’s Choice Award)

Maria Djuric
Honours student (USyd)

Awarded the Bok Prize for outstanding research in astronomy by an Honours or eligible Masters student at the ASA ASM in Hobart.

Dr Devika Kamath
Associate (Macq)

Awarded the 2022 NSW Community Outreach to Physics Award from the New South Wales Branch of the Australian Institute of Physics in ‘recognition of her outstanding achievements in community outreach to physics and astronomy.’

Emily Kerrison
Honours student (USyd)

Awarded University medals for both of her Honours theses (Classics, Physics).

Professor Mark Krumholz
Associate Investigator (ANU)

Awarded a Laureate Fellowship for ‘Unveiling the Winds of Star- Forming Galaxies’. ‘Professor Krumholz will develop new GPU accelerated computing methods that can drive the supercomputers to peak performance and use the new computations these innovations enable to develop analysis tools and interpretation for the telescopes. This will benefit Australia culturally by answering fundamental questions about human origins, and economically by providing free, open-source software and methods to accelerate calculations in fields far beyond astrophysics, for example weather modelling and aerospace applications. This project will also produce a workforce of researchers trained to use and develop these new methods, with skills in high demand in industry and government.’

Associate Professor Sergio Leon-Saval Affiliate (USyd)

Elected as an 2023 Optica Fellow (the premier fellowship in optical science) for ‘pioneering contributions to the field of astrophotonics, and the conceptual and experimental development of photonic lanterns and their applications’.

Dr Angel Lopez-Sanchez Associate Investigator (Macq)

The most-highly cited Spanish researcher in Australia with 13,682 citations, and H- index of 62 from Google Scholar

Prof. Naomi McClure-Griffiths
Associate Investigator (ANU)

Elected as a Fellow of the Australian Academy of Science.

‘Naomi McClure-Griffiths is Australia’s pre-eminent expert on the atomic hydrogen gas distribution and evolution in our galaxy, the Milky Way, and its neighbours, the Magellanic Clouds. She has made seminal contributions to our understanding of atomic gas and magnetism within these galaxies through leadership of high- fidelity observational surveys undertaken with Australia’s radio telescope facilities. Her work includes the discovery of a new spiral arm within the Milky Way, the first detection of neutral gas out-flowing from the nucleus of the Milky Way, and the pioneering demonstration of the importance of magnetic fields in the flow of matter into the Galactic disk.’

Dr Thomas Nordlander postdoctoral Researcher (ANU)

Awarded the Stromlo Fellowship.

Hayden Park
PhD student (ANU)

Awarded the ANU Research School of Astronomy and Astrophysics (RSAA) Best presentation prize ($250) for her thesis proposal talk titled ‘Linking optical IFU data with multi-wavelength data: Probing the evolution of stars, gas, and dust in galaxies’.

Sophia Ridolfo
Honours student (ANU)

Awarded Highly Commended (top 10% of entries) in the Mathematics and Physics Category at The Global Undergraduate Awards for her entry on ‘Variations in Metallicity of the HII Regiosreens in TYPHOON Galaxy NGC 3109 at ~11pc scale’.

Piyush Sharda
PhD student (ANU)

Awarded The Oort Independent Fellowship at Leiden Observatory and an IAU 2022 Gruber Foundation Fellowship.

Dr Brad Tucker
Education and Outreach Affiliate (ANU)

Named the ACT Public Schools 2021 Volunteer of the Year for his work with primary school students across the ACT. Brad was also awarded a grant for a new initiative that will allow five schools to conduct their own experiments in space.

Di Wang
PhD student (USyd)

Awarded the School of Physics Teaching Award for Excellence in Laboratory and Workshop Teaching as part of the Physics 1 Canvas Team for their work in developing content for the first year physics program.

Ruby Wright
PhD student (UWA)

Awarded a Fulbright Future Scholarship.

Ella Wang
PhD student (ANU)

Won the J-P Macquart best student talk prize at the ANITA Summer School

and was awarded the ANU Research School of Astronomy and Astrophysics (RSAA) Best paper prize ($250) for her paper ‘Non-detection of Li in Spite plateau stars with ESPRESSO’.

2022 Science Meeting

We held our annual Science Meeting at the University of Melbourne's Burnley Campus from 31 May to 2 June, our first in-person Science meeting since 2019! We had 106 members attend in person and an additional 15 people accessing the videos live on Zoom.

The 2022 chair of the Science Organising Committee was Dr Nicha Leethochawalit from the University of Melbourne and included: Tania Barone (Swinburne), Sam Vaughan (Sydney, Chris Jordan (Curtin), Giulia Cinquegrana (Monash), Sven Buder (ANU) and Stefania Barsanti (ANU).

The SOC reviewed the presentations' abstracts, ensured a 50:50 gender split of talks, and then scheduled them in project groups over the three days.

The quality of the talks was very high and. Speakers had a chance to respond to questions from the live audience and the Zoom audience, as well as follow up conversations on our Slack channel. Each talk is now available to watch on our YouTube channel.

This was Director Lisa Kewley's last ASTRO 3D Science Meeting. At the gala dinner we wished her all the best for her new role as Harvard Smithsonian Centre for Astrophysics Director in Boston, USA.

At our Science Meetings, we give the ASTRO 3D community a chance to vote for their favourite talks from the following categories, and a trophy is sent to each winner. The 2022 winners were:

Best Presentation by a Student: - Ella Wang (ANU)

Best Presentation by a postdoc or Fellow – Kathryn Grasha (ANU)

Best Presentation by an AI/Affiliate – Amelia Fraser-McKelvie (UWA)

Best Presentation by a Chief Investigator – Deanne Fisher (Swinburne)

Best Discovery by a Student - Ruby Wright (UWA)

Best Discovery by a postdoc/Fellow – Nikki Nielsen (Swinburne)

Best Discovery by an AI/Affiliate – Henry Zovaro (ANU)

Best Discovery by a Chief Investigator – Deanne Fisher (Swinburne)

Best Use of Slides – Kathryn Grasha (ANU)

Best Use of Humour – Ella Wang (ANU)

Main Image: A composite image of members photos for Lisa Kewley's farewell gift. image above: Stuart Wyithe presenting Lisa with her gift at the science meeting gala dinner. Below: Link to science talks on ASTRO 3D YouTube channel. Link only available on web version. For PDF version go to ASTRO 3D YouTube

2022 Annual Retreat

The Playford Hotel, Adelaide 21-25 November

With travel from all states now almost back to normal, we were excited about the opportunity to gather in Adelaide, for five days of strategic discussions, updates, discussions and a chance to get to know our colleagues better. For many of our students, it was the first ever in-person conference they had attended! We also provided a live Zoom link for those members unable to attend in person and as a matter of accessibility.

Highlights included:

- Science project updates
- Committee Updates
- Cohort meetings and discussions
- Cross-project collaborations for Galaxy Evolution and First Galaxies, to incorporate JWST data, facilitated by Deanne Fisher
- Maximising use and outputs from Genesis Theoretical Simulations, facilitated by Chris Power
- Maximising legacy and return for Data Intensive Astronomy, facilitated by Richard McDermid
- Demystifying Reference Letter Panel, facilitated by Kim-Vy Tran
- Leadership survey discussion and planning, facilitated by the Dattner Group
- Aboriginal Cultural Sensitivity and Respect training delivered by Bookabee Australia
- A Virtual Reality program update from Delese Brewster
- Sketches of Science, facilitated by Lara Sharp, where all projects had to describe their science on one piece of paper
- Priorities for the rest of the Centre and Legacy, facilitated by Director, Stuart Wyithe
- Reflection on ASTRO 3D culture, facilitated by Director, Stuart Wyithe
- Operations and Professional staff update by COO, Ingrid McCarthy
- An indigenous social history and native plants tour of the Adelaide Botanic Gardens, led by Bookabee Australia
- Welcome dinner at the Tandanya National Aboriginal Cultural Institute, with an Indigenous astronomy talk by Pete Swanton (ANU)
- Team building in mixed groups using Adventure Quest challenges and GPS interactivity
- The ever-popular trivia night, hosted by COO Ingrid McCarthy
- Conference and Awards Dinner at Adelaide Zoo

Gala Awards 2023

A highlight of our Annual Retreats is the Gala Awards, where all ASTRO 3D members have the opportunity to vote for who they believe is best represents the values of ASTRO 3D. The warmth and enthusiasm of the members in the room is one of the best things about being a part of ASTRO 3D. This year's winners are: (Images from left to right.)

Promoting Equity, Diversity, and Inclusion - ***Kim-Vy Tran (UNSW)***

Supporting Education and Outreach Activities – ***Delese Brewster (ANU)***

Most Supportive Centre or Node Administrator – ***Marie Partridge (Sydney)***

Creating Centre Collaboration Opportunities – ***Deanne Fisher (Swinburne)***

Encouraging Centre Community, Culture and Cohesion – ***Katie Grasha (ANU)***

Supporting Centre Students and Early Career Researchers – ***Emma Ryan-Weber (Swinburne)***

STAR Award for the Centre Member who most embodies ASTRO 3D Values – ***Sven Buder (ANU)***

ASTRO 3D Annual Retreat

ASTRO 3D Annual Retreat 2022

Main Image: Group Shot at the 2022 Annual Retreat. (Credit: Cristy Roberts)


MARKET

PhD Completions 2022

Dr Boquan (Erwin) Chen
University of Sydney

Thesis Title: "Chemical Tagging in GALAH."

Supervisors: Prof. Joss Bland-Hawthorn and Dr Michael Hayden

Erwin has taken up a postdoctoral role at ANU. He is working on galactic chemical evolution models that simulate the production and distribution of chemical elements in a galaxy over time. He aims to recover the physical conditions of galaxies through chemical composition and connect our Galaxy's evolution with other galaxies.

Dr James Esdaile
Swinburne University

Thesis Title: "Massive Galaxies in the Early Universe."

Supervisors: Prof. Karl Glazebrook, Edward N Taylor, Ivo Labbe

James has started a role as a data scientist in the Earth observation / space tech. consulting team at Ernst & Young. They are using Earth observations and machine learning to achieve innovative solutions for clients. He has enjoyed applying his critical thinking he developed during the PhD to new problems and extend his knowledge of machine learning capabilities and applications.

Dr Garry Foran
Swinburne University of Technology

Thesis title: "The Lyman-α Project: Exploring relationships between key spectroscopic features, internal properties, and environments of galaxies over cosmic time."

Supervisors: Dr Jeffrey Cooke and Prof. Karl Glazebrook

In 2023, Garry expects to take up a position as Adjunct Research Fellow at Swinburne. This will allow him to continue to collaborate with members of CAS on applications of his thesis work, and as an active member of the Keck Wide-Field Imager (KWFI) Project team. He is also looking to expand a collaboration started during his doctoral studies that is developing sonification tools to facilitate the management and analysis of astrophysical data using sound.

Dr Anishya Harshan
University of New South Wales

Thesis title: "The role of environment on galaxy evolution in the early universe."

Supervisors: A/Prof. Kim-Vy Tran, Dr Anshu Gupta

Anishya joined as a postdoc at the University of Ljubljana to work on the CANUCS JWST survey. She will be studying reionisation and galaxy evolution in the early universe with Prof. Marusa Bradac.

Dr Alexander Kemp
Monash University

Thesis Title: “Population synthesis of Novae.”

Supervisors: A/Prof Amanda Karakas, Dr Andrew Casey

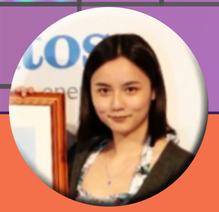
Alex started a postdoc position at the KU Leuven in Belgium in September, working with Prof Conny Aerts on astroseismology of binary stars.

Dr Mike Kriele
University of Western Australia

Thesis Title: "High Precision Mapping of the Diffused Low Frequency Sky."

Supervisors: A/Prof Randall Wayth, Dr Budi Juswardy, Prof Cathryn Trott, Dr Mark Bentum

Dr Mike Kriele is now a postdoctoral researcher in the Astrophotonics Group at ICRAR-UWA, working with A/Prof Sascha Schediwy. There he is applying his engineering skills to develop the timing system for SKA-Mid, as well as continuing his ASTRO 3D work on m-mode imaging for the Epoch of Reionisation program.



Dr Jinying (Jane) Lin
Australian National University

Thesis Title: "Galactic Archaeology: the Milky Way in the context of large scale survey."

Supervisor: Luca Casagrande

Jane is now working as data scientist for Lixia, a big-data, IoT company using remote sensors and cloud-based AI to monitor civil infrastructures.

Dr Stephanie Monty
Australian National University

Thesis Title: "Star Cluster Formation and Galactic Assembly: from observations and modelling of chemistry and dynamics to new instrumentation."

Supervisors: Ken Freeman, David Yong, Trevor Mendel and Francois Rigaut

Stephanie is now a postdoc at Cambridge and working with Vasily Belokurov and Wyn Evans in the Galactic Dynamics and Stellar Streams group for the next three years.

Dr Arthur Alencastro Puls
Australian National University

Thesis Title: "Investigating the Relationship Between Chemical Abundance Ratios and Ages in Red Giant Stars."

Supervisors: Dr David Yong (chair), Prof. Luca Casagrande, Jorge Melendez

Arthur is now in a postdoctoral position at Goethe University Frankfurt as part of the ELEMENTS research cluster, in a project that investigates the astrophysical origins of the r-process elements, like gold, silver, platinum, uranium, and other heavy elements of the periodic table.

Dr Giulia Santucci
University of New South Wales

Thesis Title: “The diversity and environments of the rarest objects during cosmic dawn.”

Supervisors: Prof Sarah Brough,

A/Prof Kim-Vy Tran

Giulia started a postdoc position in May at UWA, working on dynamical modelling of MAGPI and EAGLE galaxies with ASTRO 3D Fellow Dr Claudia Lagos.

Dr Piyush Sharda
Australian National University

Thesis Title: "The role of metals from molecular clouds to galactic discs."

Supervisor: Prof Mark Krumholz

Dr Sharda is an Oort Fellow at the Leiden Observatory

Dr Adeline (Haobing) Wang
University of Sydney

Thesis title: "The connection between cold gas reservoirs and morphology in galaxies."

Supervisors: Prof. Julia Bryant & Sergio Leon-Saval

Her work has been the detailed study of focal ratio degradation (FRD) in optical fibres and the characterisation of FRD effects that have lead to design decisions within the Hector instrument as well as characterisation of the Hector fibre system and hexabundle performance Currently working with Astralis USyd as an optical fibre specialist

Dr Ruby Wright
University of Western Australia

Thesis Title: "The role of gas flows in galaxy evolution: insight from cosmological simulations."

Supervisors: Dr Claudia Lagos, Prof. Chris Power

Ruby was awarded a Fulbright Future Scholarship at the Flatiron Institute's Center for Computational Astrophysics and will be starting as a postdoctoral fellow at the University of Helsinki in 2023.

Education and Outreach

EDUCATION

Scientists Taking Astronomy to Regional Schools (STARS)

In 2022, the STARS program visited and ran programs at seventeen schools in regional/remote NSW, Qld, Vic. and SA. An On Country collaboration in the Gwydir Wetlands in remote northern NSW was postponed due to floodwaters. Once again, visits to Kalgoorlie and Esperance in WA were delayed, but telescopes and accessories were sent to the schools so they could observe the lunar eclipse in November. A visit is proposed for mid-2023.

Two telescopes and accessories were also provided to the Academy of Future Skills in the ACT. This specialist STEM education centre supports teachers in delivering STEM lessons in low socio-economic schools. The telescopes complement the Centre's new portable planetarium.

A series of teaching and learning resources have been developed to support the continued use of the telescopes. Guides, teacher notes and student workbooks are freely available on the STARS page on the ASTRO 3D website.

Images: Main: Photo of the lunar eclipse taken with a smartphone camera adapter on the STARS telescope in Loxton, SA. (Credit: Karl Klose)
Above left: The STARS telescope (Credit: Rheanna Lang)
Above right: Affiliate Emma Barnett delivered the STARS program at her old high school, Deniliquin High School. (Credit: Emma Barnett)
Bottom right: Krystal delivering her presentation at Wangaratta HS (Credit: Jessica Burton)

WORK EXPERIENCE PROGRAMS

Indigenous Work Experience Program

The Indigenous Work Experience Program initially targeted Year 10 students from NSW and the ACT and was scheduled to take place in April 2021. It was postponed three times due to COVID and finally occurred on 23-27 May 2022.

ASTRO 3D Education and Outreach worked with the ACT Education Directorate and the NSW Education Department, so the program was officially recognised as a workplace learning placement for the students. The aim was to attract ten students, but most of the applicants from 2021 were unable to attend in 2022 due to various changes in circumstances. More promotion was conducted, but due to time constraints and the need to finalise accommodation and travel details, only four Year 11 students and two Year 10 students from Bourke, Canowindra, Moree, Tumbarumba and Blaxland in the Blue Mountains attended the program. At the last minute, two Year 10 students came from Devonport in Tasmania. Only one student was located within an hour of a capital city; most were from regional or remote locations. ASTRO 3D provided a detailed pre-program information pack for the students, their support people and the schools' careers officers/ Aboriginal liaison officers.

Many diverse experiences were included in an intensive program. The students interacted with multiple astronomers and engineers, including Dr Andrew Battisti, PhD students Ella Wang and Wei Shen Oh, and Director of the Advanced Instrumentation Technology Centre, Professor Céline D'Orgeville, learning about their work and pathways into STEM. The students had field trips to the Canberra Deep Space Communications Complex and the ANU campus to visit the National Computational Infrastructure and the Tjabal Indigenous Higher Education Centre. During their busy days and with the help of their mentors, ASTRO 3D Education Affiliates Pete Swanton and Karlie Noon, the students worked on astronomy projects, including learning about parallax and cepheid stars. They also had the opportunity to sit in on a research meeting to learn about the work of theoretical astronomers. They learned about the different types of astronomy, including Indigenous astronomy. The week finished with a more formal dinner where students were presented with a certificate of participation and signed copies of Sky Country (authored by Karlie and ASTRO 3D E&O Officer Krystal De Napoli).

The post-program evaluation was very positive. The ANU Research School of Astrophysics and Astronomy has awarded an annual $30,000 Strategic Initiative grant to enable the program to run at Mt Stromlo Observatory in 2023 and subsequent years.

Conducting a similar program at the other ASTRO 3D nodes in 2023/24s under discussion with the Black Lives Matter Committee.

Work Experience @ Swinburne

Across seven weeks of 2022, fifty-six Year 10 students attended ASTRO 3D Swinburne's Work Experience Program in Melbourne. Students across rural and metropolitan Victoria received a week-long insight into the work life of an astronomer. Students completed research modules that aimed to categorise galaxies, understand the electromagnetic spectrum's role in astronomical observations, and explore the effects of galaxy mergers. The students attended tours and demonstrations of the Centre for Astrophysics and Supercomputing's facilities, including the Discovery Wall, the Supercomputer, and the outreach VR activities by OzGrav.

Work Experience @ ANU

A Year 10 student from Farrer Memorial Agriculture College (NSW) interested in pursuing a career in astronomy and astrophysics spent a week at Mount Stromlo Observatory in early December. He worked on precision-designing 3D printing components for an optical device as part of the new optical ground station research, attended seminars, completed a depth study on dark matter, and engaged with undergraduate students, postdoctoral researchers, mechanical engineers, and professional astronomers.

Images above from left to right:
Peter Swanton at Kooringal High School, Wagga Wagga, delivering a presentation on Indigenous astronomy. (Credit: Lara Sharp)
IWEX students at the Canberra Deep Space Communications Complex (Credit: Delese Brewster)
IWEX students at the National Computational Infrastructure, ANU (Credit: Delese Brewster)
Peter Swanton building spectroscopes with IWEX students (Credit: Cristy Roberts)
IWEX students with Karlie Noon and Peter Swanton. (Credit: ANU)

VIRTUAL REALITY (VR) EDUCATION PROGRAM

Development of the VR program continued in 2022, and the intricacies of representing the science (such as the 3-dimensional movement of particles and atoms in the early Universe and the depiction of radio waves moving through space) have required very detailed programming. All five activities planned are well advanced, with activities one and two almost complete.

In Activity 1, 'The Oldest Light,' the user will travel between 10 seconds and 380,000 years after the Big Bang. They will measure the properties of sub-atomic particles, link the Universe's cooling and expansion to the formation of nuclei and atoms, visualise the origin of the Cosmic Microwave Background and measure the minute variations in its temperature.

In Activity 2, 'Exploring the first atoms in the Cosmic Dark Ages', the user measures the properties of the first neutral atoms, builds models of atoms using 'baskets' of sub-atomic particles and places the models into a life-size version (in VR) of the Periodic Table of Elements (developed by ASTRO 3D researchers). Through this activity, the user will understand that standard Big Bang nucleosynthesis predicts the abundance of hydrogen and helium in the early Universe.

The curriculum and learning resources that will complement the VR program are already under development and will be completed in time for the program's release.

ASTRO 3D is in discussion with potential organisations that can continue to promote, deliver and expand the VR program at the conclusion of the Centre.

Images: Top: Avatar of Kirsten Banks surrounded by sub atomic particles. Bottom: Exploring atoms activity where users build models of the first neutral atoms. Far right: Winner, SPIRIT Image of the year. NGC 3372, the Carina Nebula. Taken by Danny Barton, Year 7 student.

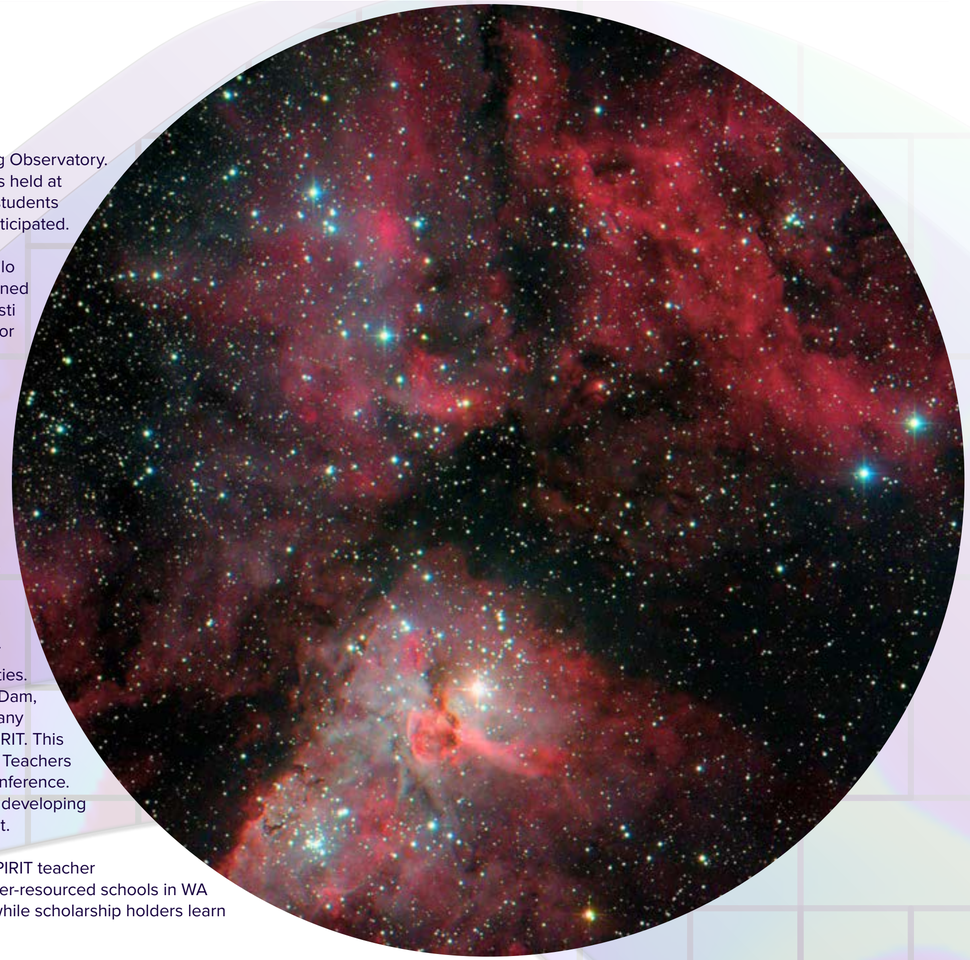
IN BRIEF:

Year 12 Depth Study at Siding Spring Observatory. Another successful Depth Study was held at SSO on 22-23 May, 2022. Over 50 students from regional NSW high schools participated. Students were involved in hands-on activities, did a tour of the 3.9m Anglo Australian Telescope (AAT) and listened to presentations by Dr Andrew Battisti and SSO Director Associate Professor Chris Lidman.

SPIRIT

In 2022, a fourth SPIRIT telescope was added to the existing suite enabling around 600 Western Australian students across various schools and programs to participate in the SPIRIT program. It played a pivotal role in the inaugural Stargirls STEM Camp, where girls and non-binary students could access SPIRIT and participate in other STEM activities. The Spirit Coordinator, Melissa Van Dam, ran professional development for many teachers to upskill them in using SPIRIT. This included a workshop at the Science Teachers Association of Western Australia Conference. The training also assists teachers in developing programs that fit their school context.

ASTRO 3D will fund some $1,000 SPIRIT teacher scholarships in 2023/24 to help under-resourced schools in WA pay for replacement teaching staff while scholarship holders learn to use the SPIRIT telescopes.

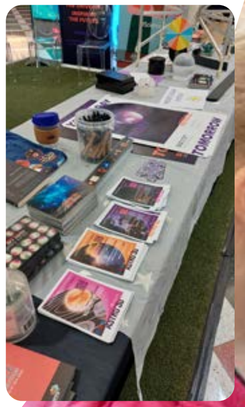


Outreach

NATIONAL SCIENCE WEEK 14-21 AUGUST

In Canberra, on the two Sundays of National Science Week, ASTRO 3D had a stall at two major shopping malls. Various activities were brought along to engage the community, including the Epoch of Bubbles, spectroscopy and the scale model of the Solar System as well as posters, postcards and information on ASTRO 3D projects. The rulers and pens were popular giveaways, and we also had a competition with a prize for the correct answer. Children and adults alike were keen to speak to the ASTRO 3D astronomers – Professor Matthew Colless, Dr Pipit Triani, Dr Katie Grasha, Dr Erwin Chen, Dr Sven Buder, Dr Aldo Mura Guzman and Dr Aditi Vijayan.

In WA, Curtin E&O Officer Teresa Slaven-Blair participated in the Victoria Park Community Centre Festival, a family event where she did activities including the Epoch of Bubbles and solar observing.



IN BRIEF:

WA: Midwest tour and Mt Magnet Astrofest: 16-18 September. SPIRIT Coordinator Melissa Van Dam visited Carnamah, Morawa, Meekatharra and Mt Magnet District High Schools and helped facilitate the Mt Magnet AstroRocks festival for the community.

ACT: The Y Canberra Space Squad was only run in January 2023 due to a change in staff. Dr Andrew Battisti presented to students.

National Youth Science Forum - January 2022 – Dr Katie Grasha presented to 627 Year 12 students.

WA: Astrofest 29 October, Perth. ASTRO 3D had a stall run by the Curtin node.

NSW: StarFest Open Day at Siding Spring Observatory October 2022 – several ASTRO 3D members participated by giving tours and public talks and assisting with coordination.

Talks by Associate Professor Luca Casagrande and Dr Sven Buder to Sutherland Astronomical Society and Tamworth Regional Astronomy Club, respectively.

Talks to schools –Professor Sara Brough, Dr Caroline Foster and Dr Andrew Battisti.

Images:
Image top: Pipit Triani showing a young girl National Science Week stickers. (Credit: ACT National Science Week Coordinating Committee)
Image above: ASTRO 3D National Science Week stall (Credit: ACT National Science Week Coordinating Committee)
Image right: Sven Buder and Katie Grasha demonstrating the model Solar System activity. (Credit: Lara Sharp)

National Science Week

TEACHER EDUCATION

Conference of the National Science Teachers Association (CONASTA)

The National Science Teachers Association Conference was held in Canberra at the end of September. Four hunDred primary and secondary teachers shared their mutual knowledge in dozens of workshops ranging from ecology to particle physics. THE ANU E&O team, Dr Delese Brewster and Lara Sharp, delivered two VR and spectroscopy workshops and coordinated off-site visits to Mt Stromlo and the Canberra Deep Space Communication Complex. ASTRO 3D affiliates Dr Brad Tucker and Matt Dodds hosted a post-conference star gazing night for forty delegates at Mt Stromlo Observatory.

E&O TRAINING

The ASTRO 3D E&O team was keen to encourage more ASTRO 3D researchers to become involved in education and outreach activities. The Centre's mid-term review also identified this need (Recommendations 5 and 6).

In October 2022, the ANU ASTRO 3D E&O team at Mt Stromlo Observatory coordinated a two-day E&O training program for members. The training program was designed to equip researchers with the skills for delivering workshops or presentations in various settings. External providers, eConnect, who specialise in practical training on communicating more effectively, handling questions and using visual aids for impact, delivered the first day. Experienced school teachers (including ASTRO 3D Education Affiliates) delivered day two of the training and focused on the school outreach component.

The workshop attracted eight participants from the ANU, Swinburne and Melbourne nodes. Feedback from participants was very positive, so it was recommended that similar state-based training be organised in 2023.

Image top to bottom: Delese Brewster and Lara Sharp delivering a session at CONASTA. Credit (Ingrid McCarthy), The group of teachers who attend the CONASTA post-conference tour at Mt Stromlo Observatory. (Credit: Matt Dodds), Associate Professor Luca Casagrande, Affiliate Themiya Nanayakkara and PhD student Stephanie Bernard working together at the E&O training day. (Credit: Delese Brewster)

E&O SPOTLIGHT

DR ANDREW BATTISTI

Andrew is a valued advocate for ASTRO 3D education and outreach. Not only is he always willing to speak to school students and the public about his work and astronomy topics in general, he is also very happy to support the E&O team by answering questions and providing suggestions.

Andrew believes that 'exposure to science at an early age can help to recruit more people to pursue scientific careers' so in 2022, Andrew volunteered for various opportunities to take his science, and that of ASTRO 3D, to young and more mature audiences. This included speaking to participants in the Canberra Y Senior Space Squad camp.

Andrew conducted an engaging activity called 'Understanding the Constellations' with a group of Year 10 Indigenous Work Experience students at Mt Stromlo Observatory in May. This activity had the students build a 3-dimensional model of a constellation, using Stellarium for information on name and distance of the stars. Each constellation was Drawn to scale on a whiteboard, and string attached to each 'star' and pulled together at the point of observation. Pom poms representing each star were then attached on their respective string, to scale at a distance of 10 light-years per centimetre from the point of observation. Students were encouraged to inspect their 'constellation' from different distances away and different angles to explore parallax.

Andrew was also involved in StarFest at Siding Spring Observatory in late September and was a guest panellist for 'Science in the Pub' where participants were treated to a fun discussion on the mysteries of the Universe.

Image: Andrew Battisti (far right) working with the Indigenous Work Experience students. (Credit: Lara Sharp)

Training and Workshops

TRAINING

Media Training

Each year, we offer all our researchers the opportunity to upskill their communications in talking to the media. In 2022, five of our students, ECRs and senior researchers took the opportunity to undertake the Media and Communications Masterclass delivered either in-person or virtually by Science in Public.

This Masterclass helps researchers find the “story” in their science and learn how to achieve media coverage that is true to their science AND which engages their audience. Journalists from television, print and radio explain what makes news for them. Researchers get the chance to ask questions and are interviewed by journalists, get feedback and practical advance.

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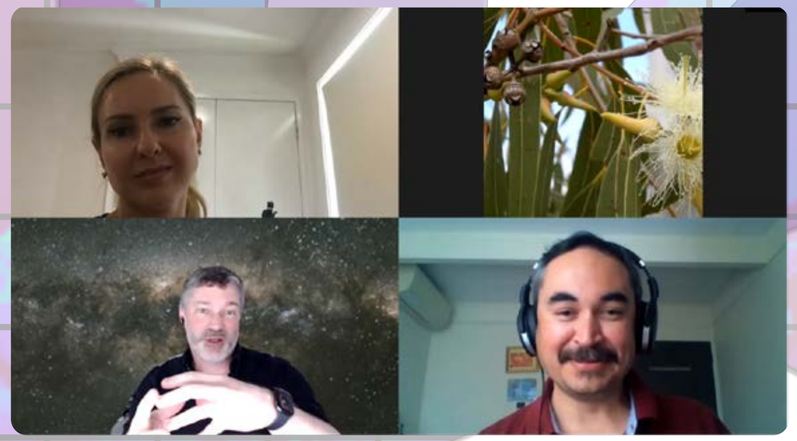

WORKSHOPS

InSTEM

inSTEM is a networking and career development conference for people from marginalised or underrepresented STEM groups and their allies. It is an initiative of the STEM-focused ARC Centres of Excellence, including ASTRO 3D. The inaugural inSTEM Conference was held at the Women’s College, University of Queensland, St Lucia campus.

ASTRO 3D co-sponsored the event and paid for three ASTRO 3D members to attend in person, and another three participated at the virtual event.

"inSTEM 2022 was the first time I was attending a conference dedicated to purely networking. The two-day event was packed with keynote sessions and parallel sessions which covered a wide range of topics- from panel discussions about career beyond academia to a practical session teaching the participants about the dark arts of small talk.

The opening keynote, given by Prof Chennupati Jagadish, was titled “Failures are pathways to success?”. He shared the story of his academic journey- from being a school student in his un-electrified ancestral village in India to his current position as the president of Australian Academy of Science. As academicians, we tend to reduce people and their academic lives to a few numbers- the numbers of paper published, the awards won, the grants received. Such a myopic view of a person’s career, though remarkable and distinguished in its own right, completely misses on the richer complexity of their struggle as a researcher. Listening to Prof Jagadish, candidly listing the number of times he read a rejection letter, was refreshing because instead of a linear progression from a motivated graduate student to a successful scientist, we saw a beautiful mosaic of grit, persistence, resilience, and sheer strength.

The second day of the conference started with a keynote by Lisa Annese, the Chief Executive Officer of Diversity Council Australia. Lisa spoke about why we should be creating inclusive workspaces. Her talk focussed on how workspaces built on the pillar of respect are not only inclusive but also more successful. Lisa also shared some recent findings from the Inclusion@ Work Index 2021-22.

I spent most of my second day in the sessions hosted by Nia Lloyd. Nia is a career coach, and her seminars were centred around building a 360-degree profile for non-academic jobs. She shared deep insights about building an online presence and one’s own brand, and about how to write effective resumes. Her seminars were perfectly designed for her audience, comprising hardcore researchers with little to zero exposure of the corporate world. I took thorough notes during these seminars and am certain I will refer to them time and again.

I truly appreciate the principle behind and the concept of the inSTEM conference. Designed as a networking conference, it gave me ample opportunity to interact with people from a very diverse academic and cultural background and build connections. The schedule was deliberate, and the seminars thought provoking. I really hope there is one, again next year! Fingers crossed for inSTEM 2023! "

By InSTEM participant.

Poster Symposium Targeting Early-career Researchers (PoSTER). - Virtual Poster Only Symposium 3-5 May 2022

PoSTER was a Galaxy Evolution poster-only virtual conference covering a broad range of astrophysical topics, held on Gather.town (a virtual interactive space with poster rooms and meeting locations to enable interaction with the presenters and other participants).
The topics were broadly related to galaxy formation and evolution. This conference will bring together experts in both theory and observations, to showcase the exciting science being done by junior astronomers.

The targeted participants were early-career astronomers (i.e. graduate students and postdocs) around the world, but anyone who was interested in attending was welcome to attend. PoSTER encouraged virtual interaction through its poster sessions, and stimulated networking among junior astronomers, and provided a platform to advertise their works to the community.

PoSTER 2022 - Galaxy Evolution is a virtual conference on topics broadly related to galaxy formation and evolution. This conference will bring together experts in both theory and observations, to showcase the exciting science being done by junior astronomers.

Linking the Galactic and Extragalactic Conference - Wollongong 28 November - 2 December 2022

From 28 November to 2 December, Jesse van der Sande from the University of Sydney chaired an ASTRO 3D-sponsored international conference at Wollongong, which linked stellar dynamics and stellar populations of the Milky Way and its siblings.

Our aims for this conference were to:

1. Bring together Milky Way research with IFS surveys and state-of-the-art simulations.

2. Challenge the long-held assumption that the Milky Way is a benchmark galaxy.

3. Build connections between the Galactic and Extragalactic community.

The recent wealth of detailed Milky Way measurements from the ESA-Gaia mission and Galactic archaeology surveys (e.g. GALAH, APOGEE, LAMOST), combined with results from spatially resolved spectroscopic surveys such as SAMI, MaNGA, and with VLT¬-MUSE, made this the ideal time to link Galactic and extragalactic research. Crucial in this discussion were the recent results from large cosmological and Milky Way zoom in simulations that show that the Galaxy might not be the ideal template for understanding disk formation as previously thought.

ANU Writing Workshop - Batemans Bay 16 -20 May 2022

In May, fourteen participants from the ANU, UNSW, and Melbourne nodes gathered for a week-long East Coast writing retreat in Batemans Bay.

Writing retreats offer fixed blocks of time dedicated to providing distraction-free writing in a create, supportive, and safe atmosphere. At our East Coast retreats, we also facilitate group discussion, goal-setting, and peer review. Getting away from the distractions of daily life is one of the prime benefits of attending a writing retreat. Research has shown that the focused engagement in the writing experience among a community of practice and reflexivity helps to prioritize and strengthen the academic writing skills through increased motivation and peer support. Last but not least, writing retreats help to support long-lasting increased academic output (hello increased number of published papers!)

East Coast Writing Workshop - Kiama August 2022

Organised by CI Kim-Vy Tran (UNSW), the Kiama writing retreat was fantastic with UNSW astronomers making up about half of the 25 participants. The weather was perfect for writing... rain and clouds that kept participants mostly inside. They did enjoy exploring Kiama during the brief moments of sunshine and ASTRO 3D is looking forward to holding future events in Kiama.

Images:
Background: Writing workshop participants at Kiama Workshop. (Credit: Cristy Roberts).
Inset far left: Linking the Galactic and extragalactic participants. (Credit: Jesse Van de Sande).
Inset middle: Batemans Bay workshop participants. (Credit: Cristy Roberts).
Inset right: Kiama workshop participants. (Credit: Cristy Roberts).

Invited and Contributed Talks

NAME AND AFFILIATION	MEMBERSHIP	LOCATION AND DELIVERY	TALK TITLE	MONTH
Adam Stevens (UWA)	Associate Investigator	XVII SOCHIAS meeting, Santiago, Chile, Online	Reduction of emissions: the ASA case	January
Jeff Cooke (Swin)	Associate Investigator	Low-latency alerts and Data analysis for Multi-messenger Astrophysics, Paris, France, Online	The Deeper, Wider, Faster program	January
Jeff Cooke (Swin)	Associate Investigator	University of California Strategic Planning Workshop, Santa Cruz, California, USA,	The Australian-led Keck Wide-Field Imager	January
Jeff Cooke (Swin)	Associate Investigator	Colloquium, Pasadena, California, In-person	Fast transients, high redshift galaxies, and the Keck Wide-Field Imager	January
Thorsten Tepper Garcia (UniSyd)	Affiliate	ANITA 2022 Workshop, Sydney, Australia, Online	The origin of the Gaia phase spiral Link to presentation (YouTube): Link	February
Randall Wayth (Curtin)	Associate Investigator	RFI2022, Perth, Online	Expected and unexpected RFI in the VHF band at the Murchison Radio-astronomy Observatory.	February
Randall Wayth (Curtin)	Associate Investigator	SKA-Low meeting, Perth, Online	History and comparison of calibration of SKA-Low prototypes	February
Jeff Cooke (Swin)	Associate Investigator	Exploring the transient Universe with the Roman Space Telescope, JPL, Pasadena, California, USA, Online	Australian New Norcia Observatory and NASA Roman Space Telescope program for very fast transients	February
Cathryn Trott (Curtin)	Chief Investigator	Sazerac 21cm, Online, international, Online	Extracting information from the Murchison Widefield Array	February
Amanda Karakas (Monash)	Chief Investigator	ANITA Summer School on Galactic Archaeology, Sydney, Australia, In-person	Galactic chemical evolution	February
Stefania Barsanti (ANU)	postdoctoral Researcher	Australian/eROSITA_DE Joint Collaboration Workshop 2022, Online event only, Online	Linking the SAMI galaxies to the eROSITA galaxy groups	February
Nicha Leethochawalit (UniMelb)	postdoctoral Researcher	SAZERAC: Learning the high-redshift Universe, (Online) Melbourne, Australia, Online	Completeness Correction methods and Biases in UV Luminosity Function determinations	February
Miftahul Hilmi (UniMelb)	Student	SAZERAC SIP: Learning the high-redshift Universe, Online (Melbourne, Australia), Online	Contamination of z~8 Lyman Break Galaxies in the Hubble Data: Correlation with z~2 Balmer Break Galaxies	February
Cristina Martinez-Lombilla (UNSW)	Associate Investigator	Invited MQAAAstro seminar at Macquarie University on Friday 4th March 2022, Sydney (Australia), In-person	Bringing out the faintest features around galaxies	March
Kathryn Grasha (ANU)	Fellow	Colloquium , Université de Montréal, Online	Massive stars in the era of JWST	March
Kathryn Grasha (ANU)	Fellow	I2I: Linking Galaxy Physics from ISM to IGM Scales., Sexten, Italy, Online	The chemical evolution of massive stars across cosmic time in the era of JWST	March
Aditya J N H S (UniSyd)	postdoctoral Researcher	SIFA morning tea, Sydney, Australia, Online	Cold gas in Galaxies, (using my recent results using EVN and MERLIN data).	March

NAME AND AFFILIATION	MEMBERSHIP	LOCATION AND DELIVERY	TALK TITLE	MONTH
Stefania Barsanti (ANU)	postdoctoral Researcher	ESO Hypatia Colloquia 2022, Online event only, Online	An observed link between spin-filament flips and bulge formation	March
Rebecca Davies (Swin)	postdoctoral Researcher	Large-Volume Spectroscopic Analyses of Galaxies in the Era of JWST, Online	Spatial and Spectral Decomposition of Star Formation, AGN Activity, and Shocks in IFU Data	March
Yuxiang Qin (UniMelb)	postdoctoral Researcher	SAZERAC: 21cm 2022, Telecon, Online	Theoretical Interpretation of the First HERA upper limits	March
Jaiden Cook (Curtin)	Student	SAZERAC, Online, Online	Investigating the Contribution of Extended Radio Sources to the EoR Power Spectrum	March
Amanda Karakas (Monash)	Chief Investigator	Nuclear reaction measurements in Underground Laboratories, Rome, Italy, Online	AGB stars as neutron sources	April
Kim-Vy Tran (UNSW)	Chief Investigator	Galaxy Clusters 2022: Challenging Our Cosmological Perspectives, Space Telescope Science Institute Spring Symposium, April 2022, Virtual, Baltimore, USA, Online	The ZFIRE Survey: Environment Matters at z 2	April
Nikki Nielsen (Swin)	Fellow	ICRAR/UWA Seminar, Perth, Australia, Online	Resolving the structures and physical conditions in the circumgalactic medium	April
Nikki Nielsen (Swin)	Fellow	ICRAR/UWA Seminar, Perth, Australia, Online	Resolving the structures and physical conditions in the circumgalactic medium	April
Kathryn Grasha (ANU)	Fellow	ANU Women in STEM Leadership Conference, Canberra, Australia , In-person	Mentoring Up: We all do better when we rise together	April
Jesse van de Sande (UniSyd)	Associate Investigator	Inward bound: bulges from high redshifts to the Milky Way, Garching, Germanry, Online	Dissecting the anatomy of the Galactic bulge through chemo-dynamic analysis of its siblings	May
Randall Wayth (Curtin)	Associate Investigator	URSI AT-AP-RASC, Grand Canary Islands, Spain, Online	Commissioning, verification and science output of the SKA-Low prototype EDA2	May
Jeff Cooke (Swin)	Associate Investigator	IAUS 361, Massive Stars Near and Far, Balleyconnell, Ireland, In-person	A new observational method to directly measure the timescales for high redshift massive star cloud collapse, formation, and lifetimes	May
Henry Zovaro (ANU)	Associate Investigator	2022 ASTRO 3D science meeting, Melbourne, Australia, In-person	Resolving winds in the SAMI galaxy survey	May
Gary Da Costa (ANU)	Associate Investigator	ASTRO 3D 2022 Science Meeting, Melbourne, Australia, Online	First Stars project overview	May
Jeff Cooke (Swin)	Associate Investigator	IAUS 361: Massive stars near and far, Ballconnell, Cavan, Ireland, In-person	Direct measure of cloud collapse and GRB progenitor masses from galaxy interactions	May
Karl Glazebrook (Swin)	Associate Investigator	ASTRO 3D Science Meeting, Melbourne,	JWST Overview	May
Kim-Vy Tran (UNSW)	Chief Investigator	2022 Spring Symposium: Galaxy Clusters 2022: Challenging Our Cosmological Perspectives, Baltimore, USA, Online	The ZFIRE Survey: Environment Matters at z ~ 2	May
Kim-Vy Tran (UNSW)	Chief Investigator	Centre of Excellence for Quantum Computation & Communication Technology, Annual Science Mtg, Hobart, Australia, In-person	How to Advance Equity, Diversity, & Inclusion within a Centre of Excellence: Strategies from ASTRO 3D	May
Kim-Vy Tran (UNSW)	Chief Investigator	virtual seminar series, Ho Chi Minh City, Vietnam, Online	Galaxy Evolution with ASTRO 3D	May

NAME AND AFFILIATION	MEMBERSHIP	LOCATION AND DELIVERY	TALK TITLE	MONTH
Amanda Karakas (Monash)	Chief Investigator	Girls in Physics Breakfast talk, Monash University, Melbourne, Australia, In-person	Stars as chemical element factories	May
Kathryn Grasha (ANU)	Fellow	IAUS 361 Massive Stars Near and Far, Ballyconnell, Ireland, In-person	Chemical abundances in hot and massive stars	May
Michael Hayden (UniSyd)	Fellow	ASTRO 3D Science Meeting, Melbourne, VIC, In-person	Chemical Clocks and Chemical Tagging with GALAH	May
Sam Vaughan (Macq)	postdoctoral Researcher	Swinburne Colloquium series, Melbourne, Australia, In-person	Scanning galactic barcodes: The stellar populations of nearby galaxies from spatially resolved spectroscopy	May
Stefania Barsanti (ANU)	postdoctoral Researcher	ASTRO 3D science meeting, Melbourne, In-person	Bulge formation correlates with spin-filament flips	May
Jack Line (Curtin)	postdoctoral Researcher	ASTRO 3D Science Meeting, Melbourne, Australia, In-person	Full-sky EoR 21cm signal simulations	May
Boquan Chen (ANU)	postdoctoral Researcher	Astro 3D Science Meeting, Sydney, Australia, Online	Multi-Zone Chemical Evolution Model with Updated Yields	May
Manisha Caleb (UniSyd)	postdoctoral Researcher	The New Transient Radio Sky, Oxford, UK, Online	Fast radio bursts with MeerKAT	May
Manisha Caleb (UniSyd)	postdoctoral Researcher	3rd URSI Atlantic Radio Science Meeting (AT-AP-RASC 2022), Spain, Online	Fast radio bursts with MeerKAT and ASKAP	May
Bronwyn Reichardt Chu (Swin)	Student	2022 ASTRO 3D Science Meeting, Melbourne, Australia, In-person	DUVET: How Galaxies Self-Regulate Star Formation with Outflows	May
Maria Buzzo (Swin)	Student	ASTRO 3D Science Meeting, Melbourne, Australia, In-person	A survey of stellar populations in Ultra-Diffuse Galaxies (UDGs)	May
Giulia Santucci (UWA)	Affiliate	ASA2022, Hobart, Australia, Online	Environmental analysis of the internal orbital structures of SAMI passive galaxies.	June
Gary Da Costa (ANU)	Associate Investigator	Astronomical Society of Australia Annual Science Meeting, Hobart, Australia, Online	Spectroscopic follow-up of statistically selected extremely metal-poor star candidates from GALAH DR3	June
Kenneth Freeman (ANU)	Associate Investigator	GWP22 - George Preston celebration, Pasadena, CA, USA, In-person	Disk RR Lyrae Stars	June
Jesse van de Sande (UniSyd)	Associate Investigator	ASA ASM 2022, Hobart, Australia, In-person	Dissecting the anatomy of the Galaxy through a chemo-dynamic analysis of its siblings	June
Thomas Nordlander (ANU)	Associate Investigator	Stagger workshop, Aarhus, Denmark, In-person	The end of the second cosmological lithium problem	June
John Lattanzio (Monash)	Associate Investigator	The 13th Torino Workshop on AGB Stars, Perugia, Italy, Online	A History of the Torino Workshops	June
Lister Staveley-Smith (UWA)	Chief Investigator	ACAMAR Astroparticle Physics, Perth, Online	New Limits on Self-Annihilating Dark Matter	June
Matthew Colless (ANU)	Chief Investigator	Oxford Astrophysics Seminar, Oxford, UK, In-person	Results on galaxy structure and dynamics from the SAMI integral field survey	June
Stuart Wyithe (UniMelb)	Chief Investigator	From the First Stars to Intelligent Life, Marthas Vinyard, USA, In-person	Reionisation and Galaxy Formation	June
Kathryn Grasha (ANU)	Fellow	ASTRO 3D 2022 Annual Retreat , Melbourne, Australia, In-person	Chemical Abundances in Stars in the Local Universe	June
Michael Hayden (UniSyd)	Fellow	ASA 2022 Meeting, Hobart, Tasmania, Online	Chemical Evolution of the Milky Way	June
Nikki Nielsen (Swin)	Fellow	ASA 2022 Annual Science Meeting, Hobart, Australia, Online	Gas Flows around a z=2.43 Compact Group of Galaxies: Outflows, Accretion, and Tidal Streams	June
Bradley Greig (UniMelb)	Fellow	ASTRO 3D Science Meeting, Melbourne, Australia, In-person	The Wavelet Scattering Transform for EoR parameter inference	June
Nikki Nielsen (Swin)	Fellow	ASTRO 3D Science Meeting, Melbourne, Australia, In-person	Directly imaging CGM structure out to 30 kpc from a starbursting galaxy	June

NAME AND AFFILIATION	MEMBERSHIP	LOCATION AND DELIVERY	TALK TITLE	MONTH
Takafumi Tsukui (ANU)	postdoctoral Researcher	240th meeting of the American Astronomical Society, Pasadena, USA, Online	“Starbursting” disk with a spiral morphology in a Hyper Luminous Infrared Galaxy at redshift of 4.4	June
Tristan Reynolds (UWA)	postdoctoral Researcher	ASTRO 3D Science Meeting, Melbourne, Australia, In-person	The Hydra I Cluster Viewed in Neutral Hydrogen with WALLABY	June
Hyein Yoon (UniSyd)	postdoctoral Researcher	2022 ASTRO 3D Science Meeting, Melbourne, Australia, In-person	ASKAP-FLASH Pilot Surveys: Searching for HI 21-cm absorption at 0.4 < z < 1.0	June
Rebecca Davies (Swin)	postdoctoral Researcher	ASTRO 3D Science Meeting, Melbourne, Australia, In-person	XQR-30: Metal Absorbers Probing Outflows and Enrichment at z > 5.5	June
Sven Buder (ANU)	postdoctoral Researcher	Uppsala University Astronomy/Space physics seminar, Uppsala, Sweden, In-person	Galactic Archaeology with the GALAH Survey - What we have learned from GALAH DR3	June
Jennifer Alyce Hardwick (UWA)	Student	ASA Annual Science Meeting 2022, Hobart, Australia, In-person	Understanding angular momentum scaling relations in the local universe	June
Esteban Jiménez (UWA)	Student	2022 ASTRO 3D Science Meeting, Melbourne, Australia, In-person	The physical drivers of gas turbulence in simulated galaxies	June
Aadarsh Pathak (UniMelb)	Student	ASTRO 3D 2022 Science meeting, Melbourne, Australia, In-person	Distinguishing reionisation models using the largest cluster statistics of the 21-cm maps	June
Sonja Panjkov (UniMelb)	Student	ASA ASM, Tasmania, Australia, In-person	The Core-Collapse Progenitor Mass Distribution of the Large Magellanic Cloud	June
Hasti Nateghi (Swin)	Student	ASA Annual Scientific Meeting, 2022, Hobart, Tasmania, Australia, In-person	The kinematics of gas flows in the CGM and galaxy disk derived from HI absorption	June
Zara Osborn (Monash)	Student	The 2022 Astronomical Society of Australia’s Annual Scientific Meeting, Hobart, Australia, In-person	The Impact of Binary Evolution on the Stellar Evolution and Nucleosynthesis of Low to Intermediate Mass Stars	June
Randall Wayth (Curtin)	Associate Investigator	MWA Project Meeting, Perth, Australia, Online	MWA Principal Engineer’s report.	July
Deanne Fisher (Swin)	Chief Investigator	A Holistic View of Stellar Feedback and Galaxy Evolution, Ascona, Switzerland, In-person	Feedback in Gas Rich Disk Galaxies	July
Jonathan Bland-Hawthorn (UniSyd)	Chief Investigator	The 2nd Donglu Astrophysics Forum: Milky Way and Cosmology in the Era of Wide Field Surveys, Donglu, China, Online	Milky Way in the Post Gaia era	July
Jonathan Bland-Hawthorn (UniSyd)	Chief Investigator	In Situ View of Galaxy Formation 2, Ringberg Castle, Germany, In-person	Local Group - what we are learning about the nature of galaxies	July
Emily Wisnioski (ANU)	Chief Investigator	In Situ View of Galaxy Formation 2, Ringberg, Germany, In-person	Where chemistry meets kinematics : the role of mixing	July
Deanne Fisher (Swin)	Chief Investigator	In Situ View of Galaxy Evolution, Ringberg, Germany, In-person	Feedback Regulated Star Formation in Gas Rich Disks	July
Nikki Nielsen (Swin)	Fellow	CAS Colloquium, Melbourne, Australia, In-person	Resolving the structures and physical conditions in the circumgalactic medium	July
Tristan Reynolds (UWA)	postdoctoral Researcher	ASA 2022 Annual Science Meeting, Perth, Australia, In-person	Hopping into a new era of extragalactic radio astronomy with WALLABY	July
Rebecca Davies (Swin)	postdoctoral Researcher	A Holistic View of Stellar Feedback and Galaxy Evolution, Ascona, Switzerland, In-person	XQR-30: C IV Absorbers Probing Outflows and Chemical Enrichment at z > 5.5	July
Xi Wang (ANU)	Student	ASA ASM, Tasmania, Australia, In-person	There is no second cosmological lithium problem	July

NAME AND AFFILIATION	MEMBERSHIP	LOCATION AND DELIVERY	TALK TITLE	MONTH
Bronwyn Reichardt Chu (Swin)	Student	A Holistic View of Stellar Feedback and Galaxy Evolution, Ascona, Switzerland, In-person	DUVET: A Comprehensive Survey of Resolved Star Formation Driven Winds	July
Jaiden Cook (Curtin)	Student	ASA science meeting, Hobart, Australia, Online	Investigating the Contribution of Extended Radio Sources to the EoR Power Spectrum	July
Giulia Cinquegrana (Monash)	Student	A Comprehensive View of Galaxy Evolution from the Milky Way to I Zwicky 18: A conference in honor of Monica Tosi, Sexton, Italy, In-person	Chemical contributions of the most metal-rich stars	July
Andrew Battisti (ANU)	Affiliate	IAUGA Div J meeting, Busan, South Korea, In-person	Sharpening our view of Dust Attenuation using TYPHOON	August
Henry Zovaro (ANU)	Associate Investigator	SAMI Videocon, Virtual, Online	Probing the origins of multiple emission line components in star-forming galaxies	August
Kim-Vy Tran (UNSW)	Chief Investigator	International Astronomical Union General Assembly, Busan, South Korea, Online	Welcome to Division J Program Days	August
Kim-Vy Tran (UNSW)	Chief Investigator	International Astronomical Union General Assembly 2022, Busan, Korea, Online	Welcome to Division J Program Days	August
Deanne Fisher (Swin)	Chief Investigator	Star Formation Within Evolving Galaxies: The Revolution of Upcoming Space Missions, Bern, Switzerland, In-person	What we can learn from clumps in DYNAMO galaxies	August
Nikki Nielsen (Swin)	Fellow	Sydney Institute for Astronomy Seminar, Sydney, Australia, Online	Resolving the structures and physical conditions in the circumgalactic medium	August
Kathryn Grasha (ANU)	Fellow	IAU General Assembly 2022, Busan, Korea, In-person	The Chemical Evolution of Spiral Galaxies with the TYPHOON Survey	August
Kathryn Grasha (ANU)	Fellow	IAU General Assembly 2022, Busan, South Korea, In-person	Chemical Abundance Evolution: ?The Intersection of Stellar Population Modeling & Resolved Star Formation Observations	August
Hyein Yoon (UniSyd)	postdoctoral Researcher	IAU General Assembly 2022 - Division J Galaxies and Cosmology, Busan, South Korea, In-person	Searching for extragalactic HI 21-cm absorption: Early results from the ASKAP-FLASH pilot observations	August
Hyein Yoon (UniSyd)	postdoctoral Researcher	IAU General Assembly 2022 - S373 Resolving the Rise and Fall of Star Formation in Galaxies, Busan, South Korea, Online	Cold Neutral Gas in Galaxies at 0.4 < z < 1.0: First Results from a Large-area 21-cm HI Absorption Survey	August
Juan Espejo (Swin)	Student	IAU general assembly, Sympossium 373 “Resolving the rise and fall of star formation”, Busan, South Korea, In-person	What drives disk instabilities and star-forming clumps at cosmic noon?	August
Di Wang (UniSyd)	Student	IAUGA 2022, Busan, South Korean, In-person	The SAMI Galaxy Survey: Using concentrated star formation and stellar population ages to understand environmental quenching	August
Jae Yeon Mun (ANU)	Student	IAU Symposium 373: Resolving the Rise and Fall of Star Formation in Galaxies, Busan, South Korea, Online	Spatially resolving the star formation activity of galaxies at 3 - 4 Gyrs of lookback time with MAGPI	August
Thomas Nordlander (ANU)	Associate Investigator	ASTRO 3D Science Meeting, Canberra, Australia,	First Stars: evidence for an unusual supernova in the early Universe	September
Karl Glazebrook (Swin)	Associate Investigator	Charting the Metallicity Evolution history of the Universe, Catania, Sicilly, In-person	The AGEL survey: Precision stellar abundances of two z>1 quiescent galaxies	September
Jeff Cooke (Swin)	Associate Investigator	The Annual Keck Science Meeting, Pasadena, California, Online	The Keck Wide-Field Imager	September

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Adam Watts (UWA)	Associate Investigator	Epoch of galaxy quenching 2022, Cambridge, UK, In-person	A sub-kpc view of cold atomic and molecular hydrogen in cluster galaxies: it is not just all about stripping	September
Adam Watts (UWA)	Associate Investigator	What matters around galaxies 2022, Champoluc, Italy, In-person	A sub-kpc view of cold atomic and molecular hydrogen in cluster galaxies: it is not just all about stripping	September
Amelia Fraser-McKelvie (UWA)	Associate Investigator	Ken Freeman's 80th birthday conference, Perth, Australia, In-person	The effect of bars on their host galaxies	September
Jesse van de Sande (UniSyd)	Associate Investigator	Epoch of Galaxy Quenching, Cambridge, United Kingdom, In-person	Connecting quenching to galaxy structure, kinematics and morphology	September
Jeff Cooke (Swin)	Associate Investigator	IR Astronomy from the Antarctic Workshop, Nice, France, In-person	Antarctic Deep Fields	September
Jeff Cooke (Swin)	Associate Investigator	UC Santa Cruz Colloquium, Santa Cruz California, Online	The Keck Wide-Field Imager	September
Elaine Sadler (UniSyd)	Chief Investigator	ASKAP Science Forum, Online,	The First Large Absorption Survey in HI (ASKAP-FLASH)	September
Jonathan Bland-Hawthorn (UniSyd)	Chief Investigator	Ken Freeman at 80 Conference, UWA, Perth, Perth Australia, In-person	Galactic seismology: the corrugated disc of the Milky Way	September
Lister Staveley-Smith (UWA)	Chief Investigator	KEN FREEMAN @80 - What is the Milky Way telling us about galaxy formation and evolution in general, UWA, Perth, Australia, In-person	Dark Matter in Galactic Remnants and Dwarf Galaxies	September
Matthew Colless (ANU)	Chief Investigator	KCF@80 workshop, Perth, Australia, In-person	SPIN-FILAMENT ALIGNMENT FLIPS ARE RELATED TO BULGE ASSEMBLY	September
Elaine Sadler (UniSyd)	Chief Investigator	ASTRO 3D Science Meeting, Online,	ASKAP Surveys Overview	September
Bradley Greig (UniMelb)	Fellow	SKA EoR Working Group Meeting, Pisa, Italy, In-person	The Wavelet Scattering Transform for EoR parameter inference	September
Nikki Nielsen (Swin)	Fellow	What matter(s) around galaxies 2022, Champoluc, Italy, In-person	The Intragroup Medium of a Compact Group at z=2.43: Outflows, Accretion, and Tidal Streams	September
Michael Hayden (UniSyd)	Fellow	Ken Freeman 80th Birthday Conference, Perth, Australia, In-person	The Chemical Evolution of the Milky Way	September
Kathryn Grasha (ANU)	Fellow	Charting the metallicity evolution history of the Universe, Catania, Italy, In-person	Chemical abundances in hot and massive stars: implications for galaxy evolution	September
Madusha Gunawardhana (UniSyd)	postdoctoral Researcher	ASTRO-3D NSW Node Meeting, University of New South Wales, In-person	Update on HECTOR Commissioning	September
Rebecca Davies (Swin)	postdoctoral Researcher	What matter(s) around galaxies 2022, Champoluc, Italy, In-person	XQR-30: Metal Absorbers Probing Outflows and Enrichment at z > 5.5	September
Rebecca Davies (Swin)	postdoctoral Researcher	Charting the Metallicity Evolution of the Universe, Catania, Italy, In-person	XQR-30: Probing the Enrichment of the CGM by Outflows at z > 5.3	September
Tania Barone (Swin)	postdoctoral Researcher	Epoch of Galaxy Quenching Conference, Cambridge, England, In-person	The impact of surface density and redshift on galaxy quenching	September
Sven Buder (ANU)	postdoctoral Researcher	ACAMAR (Australia-China) Future of Traditional Survey Science, Online	The GALAH Survey: Paving the way for million-star spectroscopic surveys	September
Sven Buder (ANU)	postdoctoral Researcher	KCF@80, Perth, Australia, In-person	Chronochemodynamics of Milky Way Stellar Populations with the GALAH Survey	September
Jae Yeon Mun (ANU)	Student	Epoch of Galaxy Quenching 2022, Cambridge, United Kingdom, In-person	Spatially resolving the star formation activity of galaxies at 3 - 4 Gyrs of lookback time with MAGPI	September

NAME AND AFFILIATION	MEMBERSHIP	LOCATION AND DELIVERY	TALK TITLE	MONTH
Hasti Nateghi (Swin)	Student	Keck Science Metting, Caltech, USA, Online	Connecting the kinematics of HI CGM gas flows to galaxy rotation	September
Andrew Battisti (ANU)	Affiliate	n/a, Amherst, USA, In-person	Sharpening our view of dust attenuation across cosmic time	October
Thomas Nordlander (ANU)	Associate Investigator	HRMOS Science Workshop, Italy/Australia online,	Simulations of stellar atmospheres and spectra of the future	October
Jeff Cooke (Swin)	Associate Investigator	UC Irvine Colloquium, Irvine, Califronia, In-person	The Keck Wide-Field Imager	October
Jeff Cooke (Swin)	Associate Investigator	UCLA colloquium, Los Angeles, California, In-person	The Keck Wide-Field Imager	October
Jeff Cooke (Swin)	Associate Investigator	UC Davis colloquium, Davis, California, In-person	The Keck Wide-Field Imager	October
Jeff Cooke (Swin)	Associate Investigator	LNBL INPA colloquium, Berkeley, California, In-person	The Keck Wide-Field Imager	October
Jeff Cooke (Swin)	Associate Investigator	UC Santa Barbara colloquium, Santa Barbara, California, In-person	The Keck Wide-Field Imager	October
Jeff Cooke (Swin)	Associate Investigator	UC San Diego colloquium, San Diego, California, In-person	The Keck Wide-Field Imager	October
Tobias Westmeier (UWA)	Associate Investigator	ACAMAR 8: Australia-China Workshop on Astrophysics, Perth, Australia, Online	Recent scientific results from WALLABY	October
Elaine Sadler (UniSyd)	Chief Investigator	FLASH Science Round Table, Online,	The FLASH survey: Overview 2009-2021	October
Kim-Vy Tran (UNSW)	Chief Investigator	Conference: Galaxy Evolution with the ESA EUCLID Mission and ESO Telescopes, Madrid, Spain, Online	The AGEL Survey: Strong Gravitational Lenses in DES and DECaLS Fields	October
Kim-Vy Tran (UNSW)	Chief Investigator	Center for Astrophysics Seminar, Cambridge, Massachusetts, USA, In-person	ASTRO 3D Guide to Inclusive Meetings	October
Kim-Vy Tran (UNSW)	Chief Investigator	Department of Physics & Astronomy, Tufts University, Special Student Seminar, Medford, Massachusetts, USA, In-person	Being Captain of Your PhD	October
Deanne Fisher (Swin)	Chief Investigator	Star-forming clumps and clustered starbursts across cosmic time, Garching, Germany, In-person	Feedback from clumps in Gas Rich Galaxies	October
Manisha Caleb (UniSyd)	postdoctoral Researcher	Ithaca, USA, In-person	Connecting the dots: From ultra-long period neutron stars to fast radio bursts	October
Aditya J N H S (UniSyd)	postdoctoral Researcher	AUSTRALIA-CHINA CONSORTIUM FOR ASTROPHYSICAL RESEARCH (ACAMAR), Australia & China, Online	FLASH: Asap survey for HI 21cm absorption at intermediate redshifts	October
Madusha Gunawardhana (UniSyd)	postdoctoral Researcher	Hector Busy Week, North Ryde/Australia, In-person	Hector Data Reduction Pipeline	October
Aditya J N H S (UniSyd)	postdoctoral Researcher	AUSTRALIA-CHINA CONSORTIUM FOR ASTROPHYSICAL RESEARCH (ACAMAR), China, Online	FLASH: ASKAP Survey for HI 21cm absorption at intermediate redshifts	October
Manisha Caleb (UniSyd)	postdoctoral Researcher	Plenty of Room at the Bottom: Fast Radio Bursts in our Backyard, Ithaca, USA, In-person	Connecting the dots: from ULPNSs to FRBs	October
Adam Batten (Swin)	Affiliate	ASTRO 3D student retreat, Adelaide, Australia,	How to not make your PhD your entire life... And actually finish it!	November

NAME AND AFFILIATION	MEMBERSHIP	LOCATION AND DELIVERY	TALK TITLE	MONTH
Randall Wayth (Curtin)	Associate Investigator	CSIRO PAFAR Workshop ; ASTRO lunch seminar., Sydney, Australia ; ASTRON Dwingeloo, Netherlands., In-person	Calibration and direct validation of station embedded element patterns for SKA-Low prototype stations	November
Duane Hamacher (UniMelb)	Associate Investigator	Oxford XII meeting of the International Society for Archaeoastronomy and Astronomy in Culture, La Plata, Argentina, In-person	How Indigenous Star Knowledge can help us understand the longevity of Oral Tradition	November
Duane Hamacher (UniMelb)	Associate Investigator	2022 The Arthur and Hilda Winch Annual Lecture in pre-colonial Aboriginal and Torres Strait Islander culture, Sydney, Australia, Recorded Video of talk.	The First Astronomers: Aboriginal and Torres Strait Islander Star Knowledge and Navigation	November
Jesse van de Sande (UniSyd)	Associate Investigator	Linking the Galactic and Extragalactic, Wollongong, Australia, In-person	Linking the Galactic and Extragalactic	November
Jeff Cooke (Swin)	Associate Investigator	NASA Roman talk series, Pasadena, California, Online	The Keck Wide-Field Imager	November
Gary Da Costa (ANU)	Associate Investigator	ASTRO 3D Annual Retreat, Adelaide, Australia, In-person	First Stars Project: Recent Science Highlights	November
Lister Staveley-Smith (UWA)	Chief Investigator	Australia Telescope Users Committee Science & Technology Day, ICRAR/UWA, Perth, Online	ASKAP in the era of SKA	November
Elaine Sadler (UniSyd)	Chief Investigator	SKA Joint WG meeting, Online,	FLASH: New HI absorption detections from an ASKAP pilot survey at intermediate redshift	November
Elaine Sadler (UniSyd)	Chief Investigator	PhD Thinkers program, University of South Australia, Adelaide, Australia, Online	Flexible work – experiences from astronomy	November
Michael Hayden (UniSyd)	Fellow	Linking the Galactic and Extragalactic, Wollongong, Australia, In-person	The Chemical Evolution of Disk Galaxies	November
Kathryn Grasha (ANU)	Fellow	ESO Delegation workshop, Canberra, Australia, In-person	Resolved CO observations of nearby star clusters	November
Elisabete da Cunha (UWA)	Fellow	Linking the galactic and extragalactic, Wollongong, NSW, In-person	Galaxy physical parameters from spectral modelling: recent successes and future challenges	November
Manisha Caleb (UniSyd)	postdoctoral Researcher	Bonn, Germany, Online	Exploring the transient landscape with Meerkat: From FRBs to ultra slow neutron stars	November
Sven Buder (ANU)	postdoctoral Researcher	Linking Galactic and Extragalactic Conference, Wollongong, Australia, In-person	Chronochemodynamics of Milky Way Stellar Populations with the GALAH Survey	November
Sven Buder (ANU)	postdoctoral Researcher	Potsdam, Germany (Online),	The GALAH Survey: Chemical tagging and chrono-chemodynamics of accreted halo stars with GALAH+ DR3 and Gaia DR3	November
Sven Buder (ANU)	postdoctoral Researcher	Bologna, Italy (Online),	The GALAH Survey: Chemical tagging and chrono-chemodynamics of accreted halo stars with GALAH+ DR3 and Gaia DR3	November
Sven Buder (ANU)	postdoctoral Researcher	Invited Talk at Universidad Diego Portales, Santiago, Chile, In-person	Galactic Archaeology with the GALAH Survey	November
Zixian Wang (UniSyd)	Student	Linking the galactic and extragalactic, Wollongong, In-person	The Milky Way in Context: Building an IFS Datacube of the Galaxy	November
Sonja Panjkov (UniMelb)	Student	Supernova 2022, Melbourne, Australia, In-person	The Supernova Progenitors of the Small Magellanic Cloud from a Morphological Perspective	November
Antonia Fernandez Figueroa (Swin)	Student	Mt Stromlo Student Seminar, Canberra, Australia, In-person	The circumgalactic medium of galaxy pairs	November

NAME AND AFFILIATION	MEMBERSHIP	LOCATION AND DELIVERY	TALK TITLE	MONTH
Katherine Harborne (UWA)	Affiliate	Dynamite Workshop, Perth, Austrlia, In-person	Building mock observables - Using SimSpin v2.4.0	December
Jesse van de Sande (UniSyd)	Associate Investigator	Dynamite workshop Perth, Perth, Australia, In-person	Turning galaxy evolution on its side with deep observations of edge-on galaxies	December
Amelia Fraser-McKelvie (UWA)	Associate Investigator	Linking the Galactic and extragalactci: stellar dynamics and stellar populations of the Milky Way and its siblings, Wollongong, Australia, In-person	Selecting the perfect Milky Way analogue	December
Jeff Cooke (Swin)	Associate Investigator	The Audible Universe 2, Leiden, Netherlands, Online	StarSound and VoxMagellan data sonification tools	December
Tobias Westmeier (UWA)	Associate Investigator	“SKA summer school” at Purple Mountain Observatory in China, Online	ASKAP/WALLABY Data Processing	December
Emily Wisnioski (ANU)	Chief Investigator	Linking the Galactic and Extragalactic congerence, Wollongong, Australia, In-person	Connecting Epochs: how the chemo-dynamical evolution of disks over cosmic time is imprinted on local galaxies	December
Elaine Sadler (UniSyd)	Chief Investigator	ASTRO 3D Retreat,, Leura, NSW, Australia,	ASKAP Surveys Overview	December
Michele Trenti (UniMelb)	Chief Investigator	There is a lot of space for collaboration - Past present and future of Italy-Australia collaboration to celebrate the Italian National Space Day, Canberra, In-person	The SpIRIT mission: Technology development and industry growth driven by scientific international cooperation	December
Cathryn Trott (Curtin)	Chief Investigator	MWA Project Meeting, Perth, Australia, Online	MWA EoR Overview	December
Emily Wisnioski (ANU)	Chief Investigator	IPARCOS astro-seminar hosted by Universidad Complutense de Madrid, Madrid, Spain, Online	Where chemistry meets kinematics : the role of mixing	December
Kim-Vy Tran (UNSW)	Chief Investigator	Faculty of Science, University of Melbourne, Melbourne, Australia, In-person	How to Advance Equity, Diversity, & Inclusion within a Centre of Excellence: Strategies from ASTRO 3D	December
Kim-Vy Tran (UNSW)	Chief Investigator	School of Physics & Astronomy, Monash University, Melbourne, Australia, In-person	How to Advance Equity, Diversity, \& Inclusion within a Centre of Excellence: Strategies from ASTRO 3D	December
Nikki Nielsen (Swin)	Fellow	ASTRO 3D Zoom Colloquium, Melbourne, Australia, Online	The Complex Intragroup Medium of a Compact Group at Cosmic Noon	December
Michael Hayden (UniSyd)	Fellow	ASTRO 3D Retreat, Sydney, Australia,	The GALAH Survey Overview	December
Aditya J N H S (UniSyd)	postdoctoral Researcher	ASTRO 3D retreat, Blue Mountains, Sydney, Australia,	Associated HI 21-cm absorption	December
Stefania Barsanti (ANU)	postdoctoral Researcher	DYNAMITE workshop, Perth, WA, In-person	Spin-filament flips of galaxies, bulges and discs	December
Madeleine McKenzie (ANU)	Student	DYNAMITE workshop, Perth, Australia, In-person	The curious stellar system M22	December
Tomas Hamish Rutherford (UniSyd)	Student	DYNAMITE Workshop, Perth, Australia, In-person	Identifying merger features in galaxy populations with SAMI - What role do mergers play in the formation pathway of slow rotators?	December
Madeline Howell (Monash)	Student	ANU Galactic and Stellar Physics Group meeting, Canberra, Australia, In-person	Using Asteroseismology to Measure an Integrated Mass Loss for Evolved Stars in Globular Clusters	December

Poster Presentations

NAME AND AFFILIATION	MEMBERSHIP	LOCATION AND DELIVERY	TALK TITLE	MONTH
Andrew Battisti (ANU)	Affiliate	Galaxy Clusters 2022, Baltimore, USA, Online	MAGPI Survey	April
Cristina Martinez-Lombilla (UNSW)	Associate Investigator	Space Telescope Science Institute Spring Symposium on Galaxy Clusters, Baltimore, USA (online), Online	First Intra-group light analysis in HSC-PDR2 data	April
Anishya Harshan (UNSW)	postdoctoral Researcher	AstroPoSTER 2022, Online, Online	The begining of the end for massive cluster galaxies at z~2	May
Jaimie-rose Sheil (Monash)	Student	PoSTER 2022 - Galaxy Evolution Symposium, Online, International, Online	LINERs/LIERs in massive, star-forming, spiral galaxies	May
Zara Osborn (Monash)	Student	PoSTER 2022 Poster Symposium Targeting Early-career Researchers, GatherTown, Online, Online	The Impact of Binary Evolution on the Nucleosynthesis and Stellar Yields of Low to Intermediate Mass Stars	May
Miftahul Hilmi (UniMelb)	Student	Poster Symposium Targeting Early-career Researchers (PoSTER) 2022 - Galaxy Evolution, Online (Melbourne, Australia),	A Novel Analysis of Contamination in Photometric Samples at High Redshift: Spatial Correlation with Lower Redshift Galaxies	May
Hasti Nateghi (Swin)	Student	PoSTER 2022 - Galaxy Evolution Poster Symposium, Fully online, Online	Connecting the kinematics of multiphase CGM gas flows to galaxy rotation using HI absorption	May
Stefania Barsanti (ANU)	postdoctoral Researcher	ASA meeting 2022, Hobart, Tasmania, Online	Bulge formation correlates with spin-filament alignments	June
Aditya J N H S (UniSyd)	postdoctoral Researcher	ASA Annual Scientific Meeting, Hobart.,	Neutral Gas in High redshift Galaxies	June
Zixian Wang (UniSyd)	Student	ASA ASM 2022, Hobart, In-person	The Milky Way in Context: Building an IFS Datacube of the Galaxy	June
Jaimie-rose Sheil (Monash)	Student	ASA Annual Scientific Meeting, Hobart, Australia, Online	LINERs/LIERs in massive, star-forming, spiral galaxies	June
Sonja Panjkov (UniMelb)	Student	ASA ASM, Tasmania, Australia,	Morphological Insights into the SN progenitors of the Small Magellanic Cloud	June
Miftahul Hilmi (UniMelb)	Student	The 2022 Astronomical Society of Australia's (ASA) Annual Scientific Meeting, Hobart, Australia,	A Novel Analysis of Contamination in Photometric Samples at High Redshift: Spatial Correlation with Lower Redshift Galaxies	June
Di Wang (UniSyd)	Student	ASA meeting, Austranlia, Online	The SAMI Galaxy Survey: Using concentrated star-formation and stellar population ages to understand environmental quenching	June
Giovanni Ferrami (UniMelb)	Student	ASA Annual Scientific Meeting, Hobart, Tasmania, Australia, Online	Rotation and relaxation signatures in the galactic component of two clusters of galaxies	June
Bronwyn Reichardt Chu (Swin)	Student	From Stars to Galaxies II: Connecting our understanding of star and galaxy formation, Gothenburg, Sweden, In-person	DUVET: A Comprehensive Survey of Resolved Star Formation driven Winds	June
Tomas Hamish Rutherford (UniSyd)	Student	ASA Annual Scientific Meeting, Hobart, Tasmania, Online	Identifying merger features in galaxy populations with SAMI - What role do mergers play in the formation pathway of slow rotators?	June
Antonia Fernandez Figueroa (Swin)	Student	ASA meeting, Hobart, Australia, In-person	The circumgalactic medium of galaxy pairs	June
Yifan Mai (UniSyd)	Student	The 2022 Astronomical Society of Australia's Annual scientific meeting; Sifa morning tea, Tasmania, Australia; Sydney, Australia, In-person	The relationship between galaxy rotation and motion of neighbours; drivers of gas turbulent	June

NAME AND AFFILIATION	MEMBERSHIP	LOCATION AND DELIVERY	TALK TITLE	MONTH
Sujeeporn Tuntipong (UniSyd)	Student	ASA Meeting 2022, Hobart, Tasmania, Australia, In-person	Milky Way Analogues: Finding Siblings of our Milky Way	July
Tomas Hamish Rutherford (UniSyd)	Student	ASA, Hobart, Australia, Online	Identifying merger features in galaxy populations with SAMI - What role do mergers play in the formation pathway of slow rotators?	July
Andrew Battisti (ANU)	Affiliate	IAUGA - Rise and Fall Symposium, Busan, South Korea, In-person	The average dust attenuation curve at z~1.3	August
Henry Zovaro (ANU)	Associate Investigator	Giant Magellan Telescope Community Science Meting 2022, Sedona, Arizona, delivered by Proxy.	Resolving galaxies at the peak of cosmic star formation with GMTIFS	August
Zixian Wang (UniSyd)	Student	IAUGA 2022, Busan, South Korea, In-person	The Milky Way in Context: Building an IFS Datacube of the Galaxy	August
Miftahul Hilmi (UniMelb)	Student	XXXIst General Assembly International Astronomical Union (IAUGA 2022), Busan, South Korea, In-person	A Novel Analysis of Contamination in Photometric Samples at High Redshift: Spatial Correlation with Lower Redshift Galaxies	August
Maria Buzzo (Swin)	Student	IAU General Assembly, Busan, South Korea, In-person	A survey of stellar populations in Ultra-Diffuse Galaxies (UDGs) in the era of LSST and JWST: the role of machine learning in finding and characterising UDGs.	August
Antonia Fernandez Figueroa (Swin)	Student	Keck science meeting, Los Angeles, USA, Online	The circumgalactic medium of galaxy pairs	September
Emily Kerrison (UniSyd)	Student	ACAMAR 8, Online, Australia/China, Online	Bayesian Radio SED fitting in the era of Big Data	October
Katherine Harborne (UWA)	Affiliate	Linking the Galactic and extra-galactic, Wollongong, Australia, In-person	From Particles to Pixels	November
Yifan Mai (UniSyd)	Student	Linking the galaxy and extragalactic, Wollongong, Australia, In-person	Drivers of gas turbulence in MAGPI and SAMI galaxies	November
Sujeeporn Tuntipong (UniSyd)	Student	Linking the Galactic & Extragalactic, Wollongong, Australia, In-person	Milky Way Analogues (MWAs): Finding siblings of our Milky Way in the SAMI galaxy family	November
Hillary Davis (UniSyd)	Student	ASTRO 3D retreat, Blue Mountains, Australia,	How does gas in the MW interact with the bar and spiral arms to affect disc evolution?	December
Tomas Hamish Rutherford (UniSyd)	Student	Linking the Galactic and Extragalactic, Wollongong, Australia, In-person	Identifying merger features in galaxy populations with SAMI - What role do mergers play in the formation pathway of slow rotators?	December

Colloquia

NAME AND AFFILIATION	MEMBERSHIP	LOCATION AND DELIVERY	TALK TITLE	MONTH
Jeff Cooke (Swin)	Associate Investigator	Caltech Colloquium, Pasadena, California, USA, In-person	Fast transients, high-redshift galaxies, and the Australian-led Keck Wide-Field Imager	January
Zara Osborn (Monash)	Student	Australian National Institute for Theoretical Astrophysics (ANITA) Workshop and School 2022, Sydney, Australia, Online	The impact of binary star evolution on the nucleosynthesis of low to intermediate-mass stars	February
Emily Kerrison (UniSyd)	Student	The 2nd Australian/eROSITA_DE Joint Collaboration Workshop, Online, Australia/Germany, Online	Connecting radio and X-ray absorption in Active Galactic Nuclei with SEAFOG	February
Hyein Yoon (UniSyd)	postdoctoral Researcher	Yonsei University - IM&GE research group meeting, Seoul, South Korea, In-person	Current status of the ASKAP-FLASH project	February
Yuxiang Qin (UniMelb)	postdoctoral Researcher	The Australian National Institute for Theoretical Astrophysics, Sydney, Australia, In-person	Data Driven astrophysics	February
Amanda Karakas (Monash)	Chief Investigator	colloquium at the Observatory of Rome, Rome, Italy, Online	The most metal-rich AGB stars	February
Lister Staveley-Smith (UWA)	Chief Investigator	ICRAR SU1 meeting, Perth, Australia, In-person	A Search for Decaying Dark Matter in Globular clusters 47 Tuc and Omega Cen	February
Hyein Yoon (UniSyd)	postdoctoral Researcher	SIfA morning tea - University of Sydney, Sydney, Australia, Online	ASKAP-FLASH: Detecting Cold HI Gas from the Distant Universe	March
Yuxiang Qin (UniMelb)	postdoctoral Researcher	Seminar, Copenhagen, Denmark, In-person	Studying high-redshift galaxies and their interaction with the intergalactic medium	March
Jesse van de Sande (UniSyd)	Associate Investigator	Colloquium UNSW, Sydney, Australia, In-person	The build-up of mass and angular momentum in galaxies like our Milky Way	March
Christene Lynch (Curtin)	postdoctoral Researcher	Swinbourne Colloquium series, Melbourne, Australia, Online	The MWA Long Baseline Epoch of Reionisation Survey	April
Lister Staveley-Smith (UWA)	Chief Investigator	ATNF Interferometry Discussion Forum, Perth, Australia, Online	Joint mosaicking techniques for interferometric and single dish data	April
Darren Croton (Swin)	Chief Investigator	Colloquium, Melbourne, Australia, In-person	How to model the Universe in N easy steps (N>>1)	April
Emma Ryan-Weber (Swin)	Chief Investigator	ATNF Colloquium, Sydney/Perth, Australia, Online	The photons that ionized the Universe	April
Luca Cortese (UWA)	Associate Investigator	HAA Institute Colloquium, Victoria, Canada, Online	Galaxy Transformation in the local Universe	April
Manisha Caleb (UniSyd)	postdoctoral Researcher	CSIRO Marsfield, In-person	Exploring the transient landscape with MeerKAT	May
Elaine Sadler (UniSyd)	Chief Investigator	Munich Joint Astronomy Colloquium, Munich, Germany, Online	The revolution in radio astronomy: an update from Australia	May
Darren Croton (Swin)	Chief Investigator	Colloquium, Sydney, Australia, Online	How to model the Universe in N easy steps (N>>1)	May
Thomas Nordlander (ANU)	Associate Investigator	Seminar, Uppsala, Sweden, In-person	Galactic Archaeology with the Rarest Fossils	May
Alexander Heger (Monash)	Affiliate	ADFA/UNSW Astronomy Seminar, Canberra, Australia, In-person	The First Stars – Massive and Supermassive	May
Alexander Heger (Monash)	Affiliate	RSAA Seminar, Canberra, Australia, In-person	Life and Death of the First Stars	May
Stefania Barsanti (ANU)	postdoctoral Researcher	Colloquia at Melbourne University, Melbourne, In-person	Bulge formation correlates with spin-filament flips	June

NAME AND AFFILIATION	MEMBERSHIP	LOCATION AND DELIVERY	TALK TITLE	MONTH
Stefania Barsanti (ANU)	postdoctoral Researcher	Colloquium at Swinburne University, Melbourne, In-person	Bulge formation correlates with spin-filament flips	June
Manisha Caleb (UniSyd)	postdoctoral Researcher	Sydney, In-person	Exploring the transient landscape with MeerKAT	June
Kathryn Grasha (ANU)	Fellow	NRC Herzberg Colloquium , NRC Herzberg, Canada, Online	Chemical abundances of hot stars in the local universe	June
Julia Bryant (UniSyd)	Chief Investigator	University of Melbourne Colloquium Series, Melbourne, Australia , In-person	Hector – new integral field spectroscopy of galaxies enabled on the Anglo-Australian Telescope (AAT)	June
Emma Ryan-Weber (Swin)	Chief Investigator	RSAA Colloquium, Canberra, Australia, In-person	The photons that ionized the Universe	June
Matthew Colless (ANU)	Chief Investigator	Oxford Physics weekly seminar, Oxford, UK, In-person	GALAXY STRUCTURE AND DYNAMICS FROM THE SAMI SURVEY	June
Caroline Foster (UNSW)	Associate Investigator	Astro Seminar, Sydney, Australia, In-person	Why galaxies slow down as they age?	June
Jeff Cooke (Swin)	Associate Investigator	Melbourne University colloquium, Melbourne University, In-person	Leaks and bursts: Escaping Lyman continuum from high redshift galaxies and GRBs resulting from galaxy interactions	June
Sree Oh Other	Affiliate	CAS Colloquia, Swinburne University, In-person	Kinematics of galaxy bulges, disks, and gas	June
Madeline Howell (Monash)	Student	Tasc6/Kasc13, Leuven, Belgium, In-person	Using Asteroseismology to Measure an Integrated Mass Loss of Evolved Stars in M4	July
Manisha Caleb (UniSyd)	postdoctoral Researcher	Joint UNSW - USyd colloquium, Sydney, Australia, Online	Exploring the transient landscape with MeerKAT	July
Manisha Caleb (UniSyd)	postdoctoral Researcher	Melbourne, Australia, In-person	Exploring the transient landscape with MeerKAT	July
Hye-Jin Park (ANU)	Student	IAU general assembly, Busan, South Korea, Online	The relation between dust-to-gas mass ratio and gas-phase metallicity in galaxies with spatially resolved manner	August
Yifan Mai (UniSyd)	Student	MAGPI busy week, ASTRO 3D NSW node meeting, Sydney, Australia, In-person	measurement of gas velocity dispersion in MAGPI galaxies	August
Madeline Howell (Monash)	Student	Univerisity of Melbourne Colloqia series, Mebourne, In-person	Using Asteroseismology to Measure an Integrated Mass Loss of Evolved Stars in Globular Clusters	September
Manisha Caleb (UniSyd)	postdoctoral Researcher	Perth, Australia, In-person	Exploring the transient landscape with MeerKAT	September
Manisha Caleb (UniSyd)	postdoctoral Researcher	Chiang-Mai, Thailand, In-person	Exploring the transient landscape with MeerKAT	September
Tania Barone (Swin)	postdoctoral Researcher	Department seminar, Durham, England, In-person	The links between galaxy structure and its stellar population	September
Michael Hayden (UniSyd)	Fellow	Swinburne Colloquia, Melbourne, Australia, In-person	Chemodynamics and Evolution of the Milky Way	September
Jonathan Bland-Hawthorn (UniSyd)	Chief Investigator	UCL Seminar Series, UCL, London, UK, In-person	Waves across the Milky Way	September
Emma Ryan-Weber (Swin)	Chief Investigator	University of Sydney Seminar, Sydney, Australia, Online	The photons that ionized the Universe	September
Jesse van de Sande (UniSyd)	Associate Investigator	Leiden, The Netherlands, In-person	Of Pyramids and Galaxies: Dissecting the anatomy of the Galaxy through chemodynamic analysis of its siblings	September
Jesse van de Sande (UniSyd)	Associate Investigator	Oxford, United Kingdom, In-person	Of Pyramids and Galaxies: Dissecting the anatomy of the Galaxy through chemodynamic analysis of its siblings	September
Sarah Martell (UNSW)	Affiliate	ASTRO 3D NSW Nodes Meeting, Sydney, Australia, In-person	Adventures in GALAH DR4 Abundance Validation	September
Rebecca Davies (Swin)	postdoctoral Researcher	RSAA Seminar, Canberra, Australia, In-person	Outflows in the era of galaxy assembly	October
Rebecca Davies (Swin)	postdoctoral Researcher	SIfA Morning Tea, Sydney, Australia, In-person	Outflows in the era of galaxy assembly	October
Rebecca Davies (Swin)	postdoctoral Researcher	UNSW Galaxy Evolution monthly meeting, Sydney, Australia, In-person	Outflows in the era of galaxy assembly	October
Rebecca Davies (Swin)	postdoctoral Researcher	MQ AAAstro Seminar, Sydney, Australia, In-person	Outflows in the high redshift Universe	October
Tania Barone (Swin)	postdoctoral Researcher	Department seminar, Melbourne, Australia, In-person	The links between galaxy structure and its stellar population	October

NAME AND AFFILIATION	MEMBERSHIP	LOCATION AND DELIVERY	TALK TITLE	MONTH
Sven Buder (ANU)	postdoctoral Researcher	GALAH Busy Days 2022, Siding Spring Observatory, Coonabarabran, In-person	The GALAH Survey Data Release 4	October
Sven Buder (ANU)	postdoctoral Researcher	ESO Workshop on extending Gaia Benchmark Stars, Santiago, Chile, In-person	High-resolution spectroscopy in the optical with the GALAH Survey	October
Kathryn Grasha (ANU)	Fellow	University of Massachusetts, USA, In-person	Chemical abundance evolution: the intersection of stellar population models and resolved star formation observations	October
Michael Hayden (UniSyd)	Fellow	Colloquia, Sydney, Australia, Online	The Chemodynamic Structure and Evolution of the Milky Way	October
Michael Hayden (UniSyd)	Fellow	Colloquia, Melbourne, Australia, In-person	The Chemodynamic Structure and Evolution of the Milky Way	October
Kim-Vy Tran (UNSW)	Chief Investigator	Department of Phyics & Astronomy, Tufts University, Medford, Massachusetts, USA, In-person	Galaxy Evolution with ASTRO 3D	October
Amanda Karakas (Monash)	Chief Investigator	Macquarie University seminar, Sydney, Australia, Online	The most metal-rich stars	October
Elaine Sadler (UniSyd)	Chief Investigator	ESO CGM meeting, Munich, Germany, In-person	ASKAP-FLASH: A 21-cm search for HI in distant galaxies	October
Deanne Fisher (Swin)	Chief Investigator	Invited Joint Colloquium to Heidelberg University & MPIA, Heidelberg, Germany, In-person	Feedback Regulate Star Formation in Turbulent Disk Galaxies	October
Bronwyn Reichardt Chu (Swin)	Student	Swinburne's Department of Physics and Astronomy PhD Seminar Series, Melbourne, Australia, In-person	Resolved star formation driven outflows in starbursting disk galaxies	November
Sujeeporn Tuntipong (UniSyd)	Student	SIfA Morning Tea, Sydney, Australia, In-person	Milky Way Analogues (MWAs): Finding siblings of our Milky Way in the SAMI galaxy family	November
Thomas Nordlander (ANU)	Associate Investigator	Monash Seminar, Melbourne, Australia,	Old stars, new spectroscopic simulations	November
Amelia Fraser-McKelvie (UWA)	Associate Investigator	AAO-ESO Technical Workshop, Sydney, Australia, Online	'A perspective from GECKOS/MAUVE'	November
Zixian Wang (UniSyd)	Student	DYNAMITE workshop, Perth, Australia, Online	The Milky Way in Context: Building an IFS Datacube of the Galaxy	December
Kim-Vy Tran (UNSW)	Chief Investigator	Astrophysics Colloquium, University of Melbourne, Melbourne, Australia, In-person	Galaxy Evolution with ASTRO 3D	December

TV & Radio Interviews

NAME AND AFFILIATION	MEMBERSHIP	LOCATION AND DELIVERY	TALK TITLE	MONTH	LINKS
Giulia Cinquegrana (Monash)	Student	Interview for the podcast 'Talkin' Science,' based on the press release myself and Amanda Karakas put out titled: 'Too much heavy metal stops stars producing.' , Online	Making Heavy Elements from Hydrogen & Helium	February	The interview can be found at: https://youtu.be/Ukal3_0JOaU
Giulia Cinquegrana (Monash)	Student	This was an interivew for a podcast, Online	The name of the podcast is 'Spacetime with Stuart Gary,' the episode I was featured on is called: 'Intriguing carbon signatures discovered on mars' [From 6 minutes+]	February	The episode can be found at: spacetimewithstuartgary.com/episode/intriguing-carbon-signatures-discovered-on-mars
Teresa Slaven-Blair (Curtin)	Affiliate	Perth, Western Australia,	3D Printing the Universe	March	Front page article printed in SCIOS, the Journal for Science Teachers' Association of WA (STAWA). Article was a follow-up on a workshop run at the STAWA conference in December 2021, showing teachers how to turn astronomical images into 3D prints. Artcile
Manisha Caleb (UniSyd)	postdoctoral Researcher	Sydney, International, Online	Outreach for a paper accepted for publication in Nature Astronomy	May	https://theconversation.com/this-newly-discovered-neutron-star-might-light-the-way-for-a-whole-new-class-of-stellar-object-184050 https://nature.altmetric.com/details/129025597/news
Jonathan Bland-Hawthorn (UniSyd)	Chief Investigator	For upcoming Quanta magazine article, Sydney Interview by Thomas Lewton Journalist, Online	The radio jet in the Milky Way	May	
Jeff Cooke (Swin)	Associate Investigator	Nature press release, multiple outlets, Melbourne, Australia, Online	Resolving the HI in damped Lyman α systems that power star formation	May	
Sarah Martell (UNSW)	Affiliate	Interviewed for an article on the physics of multiverses written by the UNSW Division of External Engagement, Sydney, Online	How physics can help us make sense of multiverse madness	May	
Stephanie Bernard (UniMelb)	Student	3CR 855AM Thursday Breakfast, Melbourne, Australia, Online	James Webb Space Telescope	July	
Cathryn Trott (Curtin)	Chief Investigator	ABC National News, ABC Online, Perth, Australia, In-person	Science with JWST	July	
Duane Hamacher (UniMelb)	Associate Investigator	10 News First, Melbiurne, Australia, Online	Indigenous Astronomy: How Aboriginal Australian Stargazing Informs Science | 10 News First	August	https://www.youtube.com/watch?v=2NQbVrIZd24

NAME AND AFFILIATION	MEMBERSHIP	LOCATION AND DELIVERY	TALK TITLE	MONTH	LINKS
Kathryn Grasha (ANU)	Fellow	ABC Canberra Drive Home, Canberra, Australia, In-person	JWST Highlights	September	
Zixian Wang (UniSyd)	Student	SBS podcast, Sydney, Australia, Online	Explore the mystery of the DART (dual asteroid reorientation test) mission	October	This interview is in Mandarin. Link here: https://www.sbs.com.au/language/chinese/zh-hans/podcast-episode/explore-the-secret-of-dart/1iwwl13mq
Elisabete da Cunha (UWA)	Fellow	Portugal,	Profiled in Portuguese weekly news magazine Revista Sábado	October	https://www.sabado.pt/entrevistas/detalhe/elisabete-da-cunha-o-astronomo-e-sempre-a-pessoa-mais-interessante-de-uma-festa
Cathryn Trott (Curtin)	Chief Investigator	SKA Construction Commencement Ceremony, Perth, Australia, Online	BBC World; 96FM Breakfast Radio	December	
Luca Casagrande (ANU)	Associate Investigator	Physics Today journal,	Interviewed about Galactic Archaeology	December	https://physicstoday.scitation.org/do/10.1063/PT.6.1.20221108a/full/
Brad Tucker (ANU)	Affiliate	189 x TV Appearances including Sky News, Channel 7 Sunrise, Channel 7 Evening News, Win News, ABC Weekend Breakfast, ABC 24		2022	
Brad Tucker (ANU)	Affiliate	1x 806 Radio Interviews across Australia		2022	

Outreach/ Public School Talks

NAME AND AFFILIATION	MEMBERSHIP	LOCATION AND DELIVERY	TALK TITLE	MONTH
Kathryn Grasha (ANU)	Fellow	National Youth Science Forum, Online, Online	Who we are in the Universe: from Earth to the edge of the Cosmos	January
Bi-Qing For (UWA)	Associate Investigator	Astronomical Society of Penang, virtual, Malaysia, Online	Interview	February
Kathryn Grasha (ANU)	Fellow	Sutherland Astronomical Society, Sydney, Australia, Online	Who we are in the Universe: from Earth to the edge of the Cosmos	February
Sarah Brough (UNSW)	Affiliate	Sydney Mechanics School of Arts, Sydney, Australia, In-person	The Mechanics of (Massive) Galaxy Evolution	April
Adam Batten (Swin)	Affiliate	Swinburne University of Technology Public Lecture Series, Melbourne, Australia,	A How To Guide To Simulating the Universe	May
Kathryn Grasha (ANU)	Fellow	ASTRO 3D Depth Study, Siding Spring Observatory, Australia, In-person	Stars in the Universe	May
Yifan Mai (UniSyd)	Student	sifa morning tea, Sydney, Australia, Online	gas kinematics of MAGPI galaxies	May
Stephanie Bernard (UniMelb)	Student	Spaghettification podcast, Melbourne, Australia, Online	Spaghettification podcast episode 11: Interview with a Hamacher	June
Stephanie Bernard (UniMelb)	Student	Spaghettification podcast, Melbourne, Australia, Online	Spaghettification podcast episode 12: Go South, Skies Are Clearer There	June
Stephanie Bernard (UniMelb)	Student	Spaghettification podcast, Melbourne, Australia, Online	Spaghettification podcast episode 13: Flash! Aaaaah From Somewhere In The Universe...	June
Adam Batten (Swin)	Affiliate	Geelong, Australia, Online	About the Sun	July
Elaine Sadler (UniSyd)	Chief Investigator	Opening Lecture of the Messel International Science School, University of Sydney, Sydney, Australia, In-person	The Revolution in Radio Astronomy	July
Stephanie Bernard (UniMelb)	Student	Spaghettification podcast, Melbourne, Online	Spaghettification podcast episode 14: He's Going Deeper Underground, Cos Dark Matter Needs To Be Found	July
Stephanie Bernard (UniMelb)	Student	Spaghettification podcast, Melbourne, Online	Spaghettification podcast episode 15: Maddie's Webb	July
Jeff Cooke (Swin)	Associate Investigator	High school student participation in a research project, Barinsdale, VIC, Online	The Deeper, Wider, Faster program	August
Jonathan Bland-Hawthorn (UniSyd)	Chief Investigator	School seminar series, Kingham Hill School, Oxford, UK, In-person	Life beyond school - science in research and industry	August
Themiya Nanayakkara (Swin)	Affiliate	Camberwell Camera Club, Melbourne, Australia, In-person	First images from the James Webb Space Telescope	September
Jonathan Bland-Hawthorn (UniSyd)	Chief Investigator	PhySoc series, Sydney, In-person	Galactic archaeology vs. distant galaxies	September
Michelle Cluver (Swin)	Associate Investigator	SSO Starfest, Coonabarabran, Australia, In-person	Science from the other Web: creating a 3D map of our local universe (that started at the AAT!)	October

NAME AND AFFILIATION	MEMBERSHIP	LOCATION AND DELIVERY	TALK TITLE	MONTH
Elisabete da Cunha (UWA)	Fellow	International Space University JWST Webinar, Online,	Panel event - A New Era in Astronomy - the science and magic of JWST	October
Sven Buder (ANU)	postdoctoral Researcher	StarFest, Sidin Spring Observatory, Coonabarabran, Australia, In-person	Stellar Rainbows	October
Sven Buder (ANU)	postdoctoral Researcher	StarFest, Siding Spring Observatory, Coonabarabran, Australia, In-person	The History of the Milky Way	October
Stephanie Bernard (UniMelb)	Student	Sealake Astro Fest, Sealake VIC, AUS, In-person	Looking back in time with Space Telescopes	October
Teresa Slaven-Blair (Curtin)	Affiliate	ASTROFEST, Curtin University, Perth, Western Australia,	Ran 2 ASTRO 3D stalls, one with the “Epoch of Bubbles” interactive outreach activity inside and one with the new “DIY Radio Telescope” build outside.	November
Michelle Cluver (Swin)	Associate Investigator	November talk for Tamworth Regional Astronomy Club, Tamworth, Australia, Online	The Quest to Chart our Local Universe: Robots and Echidnas!	November
Kim-Vy Tran (UNSW)	Chief Investigator	online forum, Quantum Photonics Club, online, Online	Searching for Strong Gravitational Lenses	November
Hye-Jin Park (ANU)	Student	2022 Mt Stromlo Student Seminar, Canberra, Australia, In-person	Dust matters	November
Luca Casagrande (ANU)	Associate Investigator	Sutherland Astronomical Society, Online	The life stories of galaxies from stellar fossils	December
Giulia Cinquegrana (Monash)	Student	International Astronomical Union Exoworlds 2022 contest, Melbourne, Australia, In-person	Exoplanets	December
Brad Tucker (ANU)	Affiliate	38 x Schools across Australia including: Orange NSW, Canberra ACT, Newcastle NSW, Muswellbrook NSW, Maitland NSW, Albury, Baranduda VIC		2022
Brad Tucker (ANU)	Affiliate	30 x Public Astronomy Talks across Australia	The Future of Space in Australia, Shocking Supernova, Space Race 2.0 Space and Problem Solving - Tournament of Minds Keynote, Sounds of Space - ANU Day of Giving Satellite, Astronomy, and Art - ANAT Symposium	2022

Industry & Government Briefings

NAME AND AFFILIATION	MEMBERSHIP	LOCATION AND DELIVERY	TALK TITLE	MONTH
Jonathan Bland-Hawthorn (UniSyd)	Chief Investigator	Science meets Parliament with Richard Marles, Sydney via Zoom, Online	Astronomy and industry	April
Cathryn Trott (Curtin)	Chief Investigator	Invited talk, Perth, Australia, In-person	SKA Science	May
Brad Tucker (ANU)	Affiliate	Meeting with World Science Festival, Brisbane		July
Jeff Cooke (Swin)	Associate Investigator	The Australian Space Agency meeting, Melbourne, In-person	The Australian-led Keck Wide-Field Imager	August
Aditya J N H S (UniSyd)	postdoctoral Researcher	GMRT proposal for cycle 43, Pune, India, In-person	Proposal review: A pilot study of ionospheric disturbances in the Northern and Southern hemispheres with the uGMRT using sub-array configuration	August
Brad Tucker (ANU)	Affiliate	CONASTA 69, Canberra	Public Tour	September
Cathryn Trott (Curtin)	Chief Investigator	DISR Quarterly Astronomy Update, Perth, Australia, Online	Science with the SKA	October
Kim-Vy Tran (UNSW)	Chief Investigator	SmartSat CRC, Adelaide, Australia, Online	How to Reach 50/50 Gender Representation: Strategies from the ASTRO 3D Centre of Excellence	November
Michele Trenti (UniMelb)	Chief Investigator	Briefing to the Victoria Lead Scientist - Dr Amanda Caples, Melbourne, Online	Astronomy space capabilities and opportunities	December
Lister Staveley-Smith (UWA)	Chief Investigator	50th anniversary of Australia-China diplomatic relations, Chinese consulate General, Perth, Australia, In-person	Australia-China Collaboration in Radio Astronomy	December

Visits to International Institutions

NAME	PROJECT/SURVEY	NAME OF INSTITUTION/FACILITY	LOCATION	MONTH	COMMENTS
Associate Investigator Jeff Cooke (Swin)	Galaxy Evolution	Caltech JPL Keck UC Irvine UCLA UC Davis UC Berkeley UC Santa Cruz UC Santa Barbara UC San Diego	Pasadena, California Pasadena, California Waimea, Hawaii Irvine, California Los Angeles, California Davis, California Berkeley, California Santa Cruz, California Santa Barbara, California San Diego, California	January	Two Caltech trips, one JPL trip, two Keck trips, and trips to 7 UC campuses
Associate Investigator Jeff Cooke (Swin)	Galaxy Evolution	W. M. Keck Observatory California Institute of Technology (Caltech) The University of Illinois Queen's Belfast University French Polynesia University	Waimea, Hawaii, USA Pasadena, California, USA Champaign, Illinois, USA Belfast, Ireland Puna'auia, Tahiti	January	Keck and Caltech in January Caltech, University of Illinois, QUB, and FPU in April-June
Post-Doctoral Researcher Hyein Yoon (UniSyd)	ASKAP-FLASH	Yonsei University	Seoul, South Korea	February	
Post-Doctoral Researcher Yuxiang Qin (UniMelb)	First Galaxies GENESIS Theoretical Simulations Galaxy Evolution	scuola normale superiore	Pisa, Italy	March	
Post-Doctoral Researcher Yuxiang Qin (UniMelb)	First Galaxies GENESIS Theoretical Simulations Galaxy Evolution	Cosmic Dawn Center, Niels Bohr Institute	Copenhagen, Denmark	March	
Associate Investigator Caroline Foster (UNSW)	Galaxy Evolution MAGPI SAMI/Hector	Oxford University	Oxford, United Kingdom	May	I visited the astronomy group at the University of Oxford in on 6 May 2022 as I was in the country for personal reasons. I had the opportunity to meet with a range of students, postdoc and staff while there.
Associate Investigator Thomas Nordlander (ANU)	First Stars	Uppsala University Aarhus University University of Hamburg	Uppsala, Sweden Aarhus, Denmark Hamburg, Germany	May	
Chief Investigator Matthew Colless (ANU)	ASKAP - WALLABY ASKAP-FLASH MAGPI SAMI/Hector	University of Oxford	Oxford, UK	June	Visited to give colloquium (recorded separately) and to discuss science with collaborators
Chief Investigator Elaine Sadler (UniSyd)	ASKAP-FLASH	European Southern Observatory (ESO)	Munich, Germany	June	

NAME	PROJECT/SURVEY	NAME OF INSTITUTION/FACILITY	LOCATION	MONTH	COMMENTS
Associate Investigator Cristina Martinez-Lombilla (UNSW)	Galaxy Evolution	Instituto de Astrofisica de Canarias	La Laguna, Spain	June	Travel for research collaboration for 10 weeks with Dr Mireia Montes and Prof. Johan Knapen at the Instituto de Astrofisica de Canarias (IAC), in Tenerife (Spain).
Chief Investigator Jonathan Bland-Hawthorn (Uni-Syd)	ASKAP-FLASH First Galaxies First Stars GALAH MAGPI SAMI/Hector	Laboratoire d'Astrophysique	Marseille, France	June	Consultation and Lectures
Chief Investigator Jonathan Bland-Hawthorn (Uni-Syd)	ASKAP-FLASH First Galaxies First Stars GALAH MAGPI SAMI/Hector	Max Planck Institute for Astronomy	Garching, Munich, Germany	June	Science Advisory Board Meeting
Post-Doctoral Researcher Sven Buder (ANU)	GALAH	Stockholm University, Uppsala University	Stockholm, Sweden Uppsala, Sweden	June	
Chief Investigator Matthew Colless (ANU)	ASKAP - WALLABY ASKAP-FLASH MAGPI SAMI/Hector	Unversity of Oxford	Oxford, UK	June	The purpose of my visit to Oxford to give a colloquium on results from SAMI, discuss SAMI science projects, and arrange for Oxford PhD student Peter Watson to visit ANU for 6 months from July 2022.
Chief Investigator Emily Wisnioski (ANU)	Galaxy Evolution SAMI/Hector	University of Vienna	Vienna, Austria	July	As visiting professor with Trevor Mendel also a visiting professor
Chief Investigator Jonathan Bland-Hawthorn (Uni-Syd)	ASKAP-FLASH First Galaxies First Stars GALAH MAGPI SAMI/Hector	Ringberg Castle, Germany	Ringberg Castle, Germany	July	Conference and ESO discussions
Chief Investigator Jonathan Bland-Hawthorn (Uni-Syd)	ASKAP-FLASH First Galaxies First Stars GALAH MAGPI SAMI/Hector	Max Planck Institute for Extraterrestrial Physics	Munich Germany	July	External Review Committee for Science

NAME	PROJECT/SURVEY	NAME OF INSTITUTION/FACILITY	LOCATION	MONTH	COMMENTS
PhD Student Giulia Cinquegrana (Monash)	GALAH	Sexton Center for Astrophysics Konkoly Observatory University of California, Santa Barbara	Sexton, Italy Budapest, Hungary Santa Barbara, United States	July	
PhD Student Zara Osborn (Monash)	GALAH	University of California	Santa Barbara, USA	August	Attended the MESA Summer school at the University of California, Santa Barbara campus.
Associate Investigator Jesse van de Sande (UniSyd)	Galaxy Evolution SAMI/Hector	Leiden Observatory, Leiden University Kavli Institute for Cosmology, Cambridge University Department of Physics, Oxford University	Leiden, The Netherlands Cambridge, United Kingdom Oxford, United Kingdom	August	
Post-Doctoral Researcher Tania Barone (Swin)	Galaxy Evolution	Durham University	Durham, UK	September	
Post-Doctoral Researcher Tania Barone (Swin)	Galaxy Evolution	Cambridge University	Cambridge, UK	September	
Chief Investigator Jonathan Bland-Hawthorn (UniSyd)	ASKAP-FLASH First Galaxies First Stars GALAH MAGPI SAMI/Hector	UCL	London	September	Seminar, discussions with Profs Ellis, Lahav, and Provost Michael Spence
Fellow Bradley Greig (UniMelb)	GENESIS Theoretical Simulations MWA EoR	Scuola Normale Superiore Centre for Computational Astrophysics, Flatiron Institute	Pisa, Italy New York, USA	September	
Chief Investigator Elaine Sadler (UniSyd)	ASKAP-FLASH	ESO	Garching, Germany	September	Visiting ESO from 20 Sep to 18 Nov 2022
Post-Doctoral Researcher Manisha Caleb (UniSyd)	Galaxy Evolution SAMI/Hector	NARIT	Chiang-Mai, Thailand	September	
Chief Investigator Deanne Fisher (Swin)	Galaxy Evolution	Heidelberg University and Max Plank Institute For Astrophysics	Heidelberg, Germany	October	
Affiliate Andrew Battisti (ANU)	Galaxy Evolution	Harvard University University of Massachusetts Amherst	Boston, USA Amherst, USA	October	
Chief Investigator Elaine Sadler (UniSyd)	ASKAP-FLASH	European Southern Observatory (ESO) Max Planck Institute for Extraterrestrial Physics (MPE)	Garching, Germany	October	Visit was from September to November 2022 - also reported under Q3 KPUs
Fellow Kathryn Grasha (ANU)	Galaxy Evolution	Center for Astrophysics, Harvard University University of Massachusetts	Harvard, Massachusetts USA Amherst, Massachusetts USA	October	
PhD Student Sonja Panjkov (UniMelb)	Galaxy Evolution	University of California Santa Cruz	Santa Cruz, United States of America	October	

NAME	PROJECT/SURVEY	NAME OF INSTITUTION/FACILITY	LOCATION	MONTH	COMMENTS
Post-Doctoral Researcher Manisha Caleb (UniSyd)	Galaxy Evolution SAMI/Hector	Cornell University	Ithaca, USA	October	
Fellow Kristan Boyett (UniMelb)	First Galaxies	University of Tucson, Arizona, USA University of California Los Angeles (UCLA), USA	Tucson, USA LA, USA	October	Trip to join the annual meetings of two seperate collaborations working on GALAXY EVOLUTION using JWST - JADES and GLASS.
Chief Investigator Kim-Vy Tran (UNSW)	First Galaxies Galaxy Evolution	Harvard-Smithsonian Center for Astrophysics	Cambridge, Massachusetts, USA	October	
Chief Investigator Kim-Vy Tran (UNSW)	First Galaxies Galaxy Evolution	Department of Physics & Astronomy, Tufts University	Medford, Massachusetts	October	
Post-Doctoral Researcher Manisha Caleb (UniSyd)	Galaxy Evolution SAMI/Hector	Cornell University	Ithaca, USA	October	
Post-Doctoral Researcher Sven Buder (ANU)	GALAH	ESO Headquarters	Santiago, Chile	November	
Post-Doctoral Researcher Sven Buder (ANU)	GALAH	Universidad Diego Portales	Santiago, Chile	November	
Associate Investigator Randall Wayth (Curtin)	MWA EoR	ASTRON	Dwingeloo, Netherlands.	December	
Associate Investigator Karl Glazebrook (Swin)	First Galaxies Galaxy Evolution	Dept.of Astronomy and Astrophysics, University of Toronto	Toronto, Canada	December	
Chief Investigator Jonathan Bland-Hawthorn (UniSyd)	ASKAP-FLASH First Galaxies First Stars GALAH MAGPI SAMI/Hector	U of Oxford	Oxford	December	Seminar on Galactic Seismology: waves in the Milky Way

Performance Indicators

PERFOMANCE MEASURE		2017 ACTUAL	2018 ACTUAL	2019 ACTUAL	2020 ACTUAL	2021 ACTUAL	2022 TARGET	2022 ACTUALS	NOTES
Number of research outputs	Papers in refereed journals	11	110	213	227	269	200	297	
	SAMI dataset	1	1	-	-	1	1	0	DR3 was released in January 2021
	ASKAP dataset	-	-	1	2	-	-	-	DINGO Pilot 1, WALLABY Pilot 1, Flash Pilot 1 all complete, data being reduced, processed and analysed
	Data Intensive middleware	-	-	-	0	1	-	1	SimSpin is a completed public tool and Vis3D will be complete in 2024
	ASVO software	-	-	-	1	-	-	-	Delayed –Macquarie University is now a partner organisation, but COVID caused delays to postdoctoral hires. This should be complete by 2024.
	GALAH dataset	-	1	1	1	-	1	0	3 Phase 1 datasets released – more than 850,000 stars observed by the end of 2022. DR4 due in 2023
	Genesis dataset	-	-	-	1	1	1	1	Suites of large N-body simulations all run in-house using EAGLE, Illustris-TNG, Swift, Meraxes across all surveys and projects
	Media releases	1	5	7	11	10	6	7	See Annual Report
	Centre Videos	-	-	15	64	93	6	34	Numbers reduced to less Science Meeting videos uploaded in 2022, but still well in excess of the target 6.
	Facebook Page posts	-	-	73	71	33	26	119	New Education and Outreach hire has significantly increased our Facebook posts and engagement.
	Twitter posts	-	-	228	119	229	52	61	Numbers reduced to less tweets by the COO, but still within target range.
	Exhibition or performance	-	-	3	2	3	3	6	Science Week stalls/displays
	STEM Education workshops	-	-	6	5	4	2	26	STARS visits (17), Indigenous WEX, WEX @ Swinburne, WEX @ ANU, VR teacher PD, SPIRIT teacher PD, Depth Study at SSO
	Website News Updates	-	-	7	21	20	12	13	
	VR Program Development	-	-	1	1	1	1	1	Universe 3D Transporter Room and astronaut training, The Oldest Light, and Exploring Atoms in Neutral Universe are complete. 21cm HI line, Experiencing the Epoch of Reionisation, and Investigating the First Stars are in development mode. Teaching resources are being developed concurrently.

Performance Indicators

PERFOMANCE MEASURE		2017 ACTUAL	2018 ACTUAL	2019 ACTUAL	2020 ACTUAL	2021 ACTUAL	2022 TARGET	2022 ACTUALS	NOTES
Quality of research outputs	% of refereed papers in journals with impact factor > 2.5	100%	100%	100%	100%	100%	80%	100%	
Number of training courses held/offered by the Centre	Professional skills workshop	1	4	2	1	1	1	3	PoSTER virtual symposium, Indigenous culture, Maximising Centre Legacy
	ECR training day	1	1	2	1	3	1	2	Student workshop, ECR workshop
	Writing workshops	2	5	6	3	4	6	2	Kiama, Batemans Bay – WA postponed. Not as much demand for these now.
	Transferrable Skills workshop	-	-	1	3	2	1	3	Media training, InSTEM, E&O training
	Centre-wide Mentoring	0	1	1	1	1	1	0	Mentoring program to recommence in 2023 with other CoE's
	Women's Leadership	0	-	1	1	0	-	-	Large-scale Women's Leadership program underway in 2023
	Emerging Leaders program	-	1	-	0	-	1	1	Leadership through Committees, SOCs, and running workshops, plus Student and ECR workshops
Number of workshops/ conferences held/ offered by the Centre	International conference	0	2	2	2	2	2	1	Linking the Galactic and Extragalactic Conference
	National conference/ workshop	1	2	2	2	2	2	2	Science Meeting, Annual Retreat
Number of additional researchers working on Centre research	Postdoctoral researchers	16	14	3	8	0	3	9	
	Honours students	2	1	3	5	3	2	3	
	Masters by coursework	0	2	3	0	4	2	4	
	PhD students	28	13	20	15	5	1	30	Large numbers of PhD students with work related to Centre Research. Not all paid with stipend support, but many supported with travel funds and training.

Performance Indicators

	PERFOMANCE MEASURE	2017 ACTUAL	2018 ACTUAL	2019 ACTUAL	2020 ACTUAL	2021 ACTUAL	2022 TARGET	2022 ACTUAL	NOTES
Number of presentations/ briefings	Public briefings/lectures	3	123	230	246	56	40	75*	
	Government briefings	5	22	29	35	7	4	3	
	Industry briefings	0	12	39	42	7	2	10	
	Non-government organisation briefings	0	5	6	7	1	6	1	
	Briefings to professional organisations & bodies	4	36	6	6	1	4	2	
	Professional conferences/ workshops presentations	68	163	123	221	209	40	281	Numbers of papers presented at astronomical conferences continue to be high.
Number of new organisations collaborating with, or involved in, the Centre	New collaborative relationships	5	7	15	11	4	4	4	
	New participating organisations	-	-	0	3	1	-	-	
Maintain a collaborative and cohesive structure	% of Cross-node authorship of publications	36%	46%	83%	37%	43%	85%	40%	
	Project team meetings with cross-node collaborations	4	12	6	6	6	6	6	
	Centre-wide climate survey	0	1	0	0	1	-	-	Decision made to undertake bi-annual Centre-wide surveys due to cost
Create a diverse Centre	% of Females at all levels	38%	39%	40%	42%	46%	50%	51%	
	% of Female visitors and speakers	44%	50%	58%	-	-	50%	54%	
	% of travel funds to females	38%	42%	42%	51%	52%	50%	54%	
	% of Centre-supported conferences with Childcare	100%	100%	100%	-	100%	100%	100%	
	Diversity Training Workshops	0	4	6	1	1	-	1	Indigenous cultural training at Retreat

Performance Indicators

	PERFOMANCE MEASURE	2017 ACTUAL	2018 ACTUAL	2019 ACTUAL	2020 ACTUAL	2021 ACTUAL	2022 TARGET	2022 ACTUAL	NOTES
Build the expertise for the next-generation telescopes	% of Students working on optical GMT pathfinder instruments	13%	29%	25%	37%	54%	20%	50%	
	% of Students working on radio SKA pathfinder instruments	10%	16%	31%	20%	19%	20%	16%	
	% of Students working on space telescope data	13%	16%	6%	15%	24%	10%	26%	
	% of Students with data intensive research experience	19%	80%	51%	44%	49%	40%	41%	
	% of PhD students and ECRs attending skills workshops	-	-	31%	30%	29%	20%	42%	
	% ECRs achieving prestigious fellowships	-	-	28%	27%	27%	20%	20%	
	% PhD students or ECRs achieving high quality jobs in other fields	-	-	-	24%	16%	20%	33%	

* Education and Outreach Affiliate Dr Brad Tucker did 189 TV appearances including Sky news, Channel 7 Sunrise and Evening News, WIN news, ABC breakfast and ABC 24, and 806 radio interviews across Australia.
Note – we did not undertake an exit survey for all skills workshops or the Annual Retreat in 2022, so do not have % satisfaction for Centre-run skills workshop.

2022 Financial Statement

NOTES TO FINANCIAL STATEMENTS

1. ARC Contract & Governance

a) During the 2022 financial year, ASTRO 3D comprised nine Australian collaborating universities (nodes) and nine domestic and international partner organisations. Funding was approved by the ARC for seven years, subject to review after four years. The Centre commenced operations on 1 July 2017, a six-month delay from the original 1 January commencement. The ARC conducted the mid-term review in June 2021 and approved future funding.

b) In line with strategic objectives, the ARC approved three new node organisations in January 20221, and all nodes signed the new funding agreements during the year. The new structure of the Centre now comprises nine nodes.

c) From an operational and financial perspective, the Centre operates as a single body, and the Australian National University disseminates all funding provided by the ARC as the Administering Organisation.

d) The Centre's operational and financial affairs are governed under defined policies and procedures.

e) Financial reporting provides institutional expenditure per node, with the Chief Operating Officer for the Centre providing Consolidated Financial Reports for review by the Director.

2. Income

a) Income received by the ARC for 2022 amounted to $4.775m, including $386k indexation amount.

b) University Contributions are contributions provided by the collaborating universities. Please note that we received the 50% of 2021 contributions owing from Sydney University in Q1 2022.

c) Please note that we received Q1 2023 contributions from ANU in Q4 2022.

d) Please note that we did not receive the total university contribution the University of Melbourne agreed upon in Q4 2022, but we expect it to be paid in full in Q1 2023.

e) All other nodes provided full agreed contributions.

f) In 2021, ASTRO 3D received a NSW State Government grant from their Kickstart Program for events held in NSW, which was used for our 2021 Annual Retreat. We received a final payment for this grant of $5,000 in Q1 2022.

g) Other income is $455, an adjustment from 2021 ANU University contributions.

3. Expenditure

a) Expenditure for the year was $6.832m, against a budget of $8.020m (85%). This variance primarily relates to delays in postdoctoral researcher visas affecting start dates.

b) The carried forward balance still primarily relates to the late start of the Centre and is budgeted to be expended in 2024.

4. Financial Management

a) We have undertaken a Centre-wide review of node balances and projected expenditure of ARC and university funds in 2023 and 2024, to forecast the end-of-Centre balances.

	2022 ACTUAL ($)
INCOME	$
ARC Grant	4,775,096
State Government Grants	5,000
Other Grants	-
University Contributions	2,014,071
Partner Contributions	-
Other Income	455
TOTAL INCOME	**6,794,621**
EXPENSES	
Salaries	5,283,853
Travel and Visitor Support	791,298
Equipment	39,735
Workshops and Conferences	105,052
Management and Administration	186,897
Education, Outreach and Communications	131,881
PHD Support	223,449
TOTAL EXPENSES	**6,762,165**
Net Surplus (Deficit)	32,456
Brought Forward Balance	**6,259,300**
CARRY FORWARD BALANCE	**6,291,756**

2022 Publications

Publications

Abdurashidova, Z., Aguirre, J. E., Alexander, P., Ali, Z. S., Balfour, Y., Barkana, R., Beardsley, A. P., Bernardi, G., Billings, T. S., Bowman, J. D., Bradley, R. F., Bull, P., Burba, J., Carey, S., Carilli, C. L., Cheng, C., DeBoer, D. R., Dexter, M., de Lera Acedo, E., Dillon, J. S., Ely, J., Ewall-Wice, A., Fagnoni, N., Fialkov, A., Fritz, R., Furlanetto, S. R., Gale-Sides, K., Glendenning, B., Gorthi, D., Greig, B., Grobbelaar, J., Halday, Z., Hazelton, B. J., Heimersheim, S., Hewitt, J. N., Hickish, J., Jacobs, D. C., Julius, A., Kern, N. S., Kerrigan, J., Kittiwisit, P., Kohn, S. A., Kolopanis, M., Lanman, A., La Plante, P., Lekalake, T., Lewis, D., Liu, A., Ma, Y.-Z., MacMahon, D., and 33 colleagues (2022) “HERA Phase I Limits on the Cosmic 21 cm Signal: Constraints on Astrophysics and Cosmology during the Epoch of Reionisation”, The Astrophysical Journal, 924, 51.

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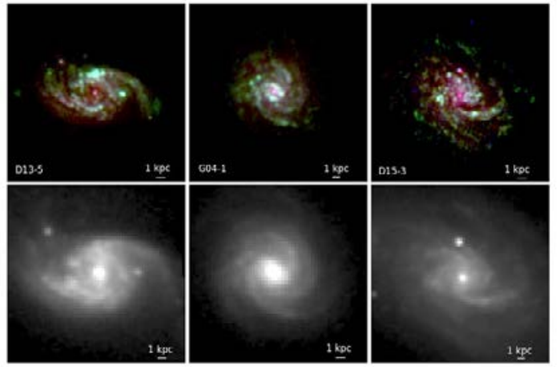

Figure 1. Ambachew, L. et al. Three colour images of DYNAMO galaxies D13-5, G04-1, and D15-3 created using F336W, F467M, and FR647M filters at 0.05-arcsec resolution (top row). Bottom row shows the same galaxies observed at 0.13-arcsec resolution in the F125W filter. The white line in the bottom right-hand corner of each image corresponds to 1 kpc. Though clumps are less prominent in the F125W image, we do still see large knots of emission.

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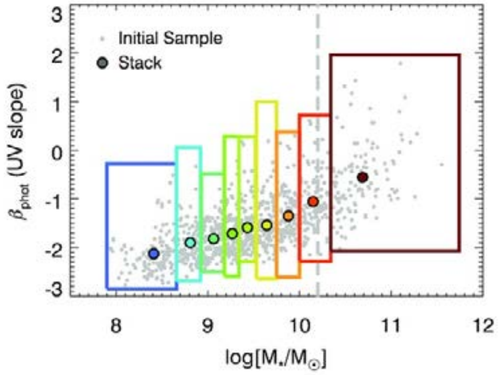

Figure 2. Battisti, A. et al. The observed UV slope, βphot, as a function of stellar mass. Coloured symbols denote the medians from stellar mass stacks. The grey points show our sample of galaxies (criteria 1–3, removing AGN candidates, poor-quality SED fits). A trend is evident that more massive galaxies have redder UV colours (larger βphot). The vertical long-dash grey line corresponds to log(M /M) = 10.2, above which we exclude from our attenuation analysis because stacked spectra in this range may be contaminated by AGNs (Section 3.4) and their corrections for [NII] blending and stellar absorption are more uncertain (Section 3.5).

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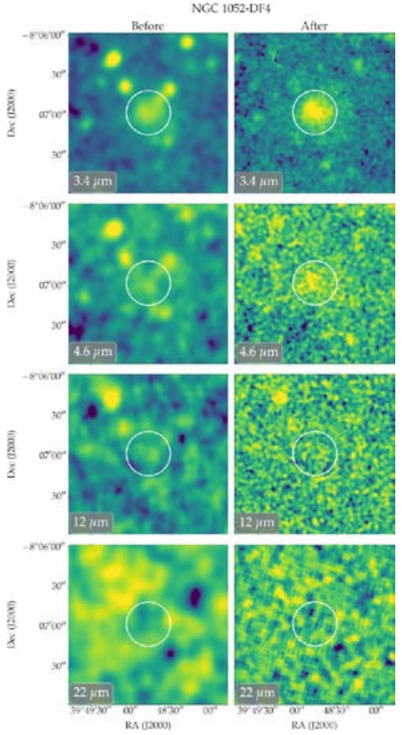

Figure 3: Buzzo, M. et al. WISE images of NGC 1052-DF4 before and after correcting for sensitivity issues and removing stellar contaminants. This technique follows the procedure described in Jarrett et al. (2019). Rows stand for the 3.4, 4.6, 12, and 22 μm bands, respectively. The 3.4 and 4.6 μm bands were measured for this galaxy, while the 12 and 22 μm bands just provided upper limits. The white circle represents the effective radius of the galaxy.

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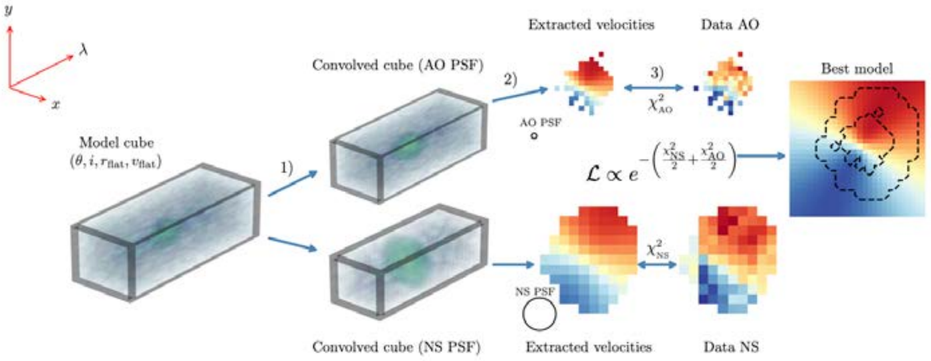

Figure 4: Espejo Salcedo, J.M. et al. Representation of the kinematic modelling of our combination method. In step 1) the model cube is convolved using the different data PSF separately. Step 2) is the extraction of the velocity fields from the convolved model cubes. Step 3) is the likelihood estimation based on the combination of the two X^2 values (X^2_{NS} and X^2_{AO}) where the best kinematic model is obtained by maximising that likelihood.

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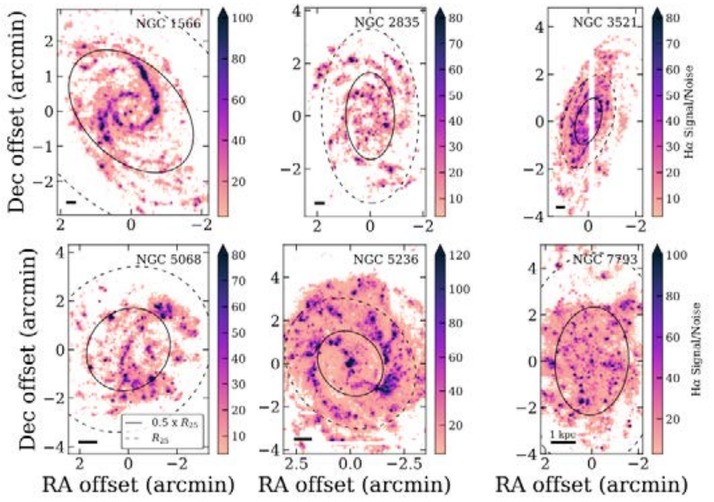

Figure 5: Grasha, K. et al. Hα signal to noise (S/N) distribution from fitting the emission line in the data cube for each of the TYPHOON galaxy in this study. Spaxels with S/N less than 3 are not shown. The solid and dashed ellipses correspond to 0.5 × R25 and R25 in the frame of the galactic disk, respectively. The black bar at the bottom left of each subplot represents 1 kpc at the distance of each galaxy.

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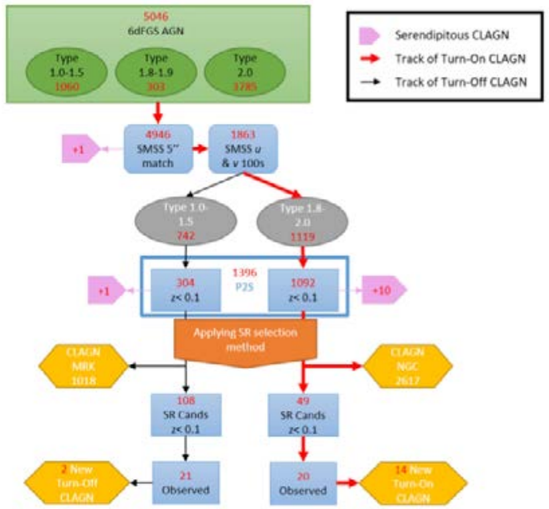

Figure 6: Hon, W. J. et al. FlowchartofthePaperIIsample(P2S) sample,breakingdowncandidateselection,andobservedtargets. Startingwiththegreenboxasthebreakdown of the 6dF AGN catalogue in terms of Seyfert types. The subsequent two blue boxes are the number of targets left after cross-matching with SMSS. The next grey circles breakdown the remaining into groups of Seyfert types. We then define the P2S sample for those with z ≤ 0.1 and apply our selection rule (SR) selection method to obtain turn-on and turn-off candidates and recovering two known CLAGN. Finally, the last blue boxes indicate the number of candidates we have observed, and the last yellow boxes indicate the number of CLAGN found. Purple boxes are the CLAGN included in this paper where we found them serendipitously (refer to Section 2.6).

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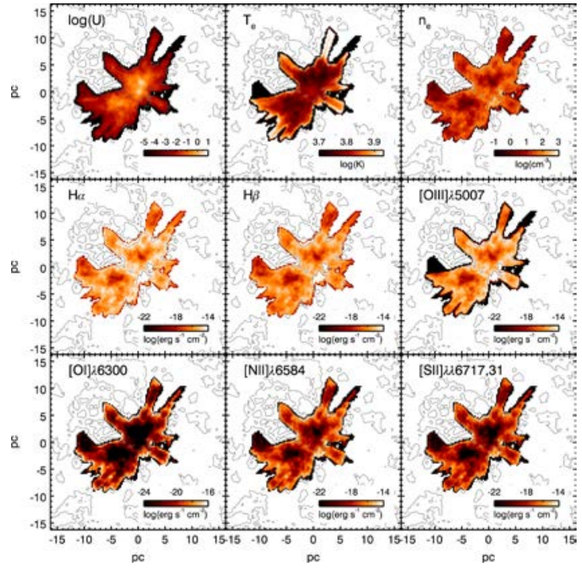

Figure 7: Jin, Y. et al. Maps of fundamental parameters across the Z = 0 pc slice of the nebula. Gray contours indicate the distribution of the input of ISM density. We present maps of the dimensionless ionisation parameter U, the electron temperature T_e, the electron density n_e and the distribution of fluxes of the Hα, Hβ, [O III], [O I], [N II], and [S II] emission lines. The nebula is assumed to be at the distance of the Large Magellanic Cloud of 48.5 kpc.

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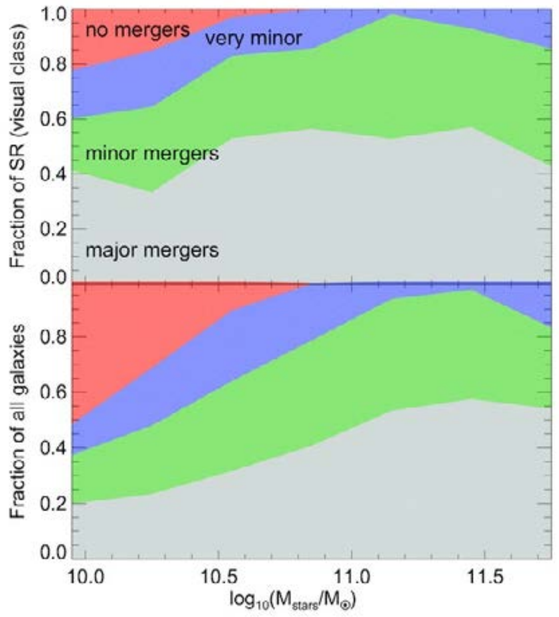

Figure 8: Lagos, C del P. et al. The top panel shows the fraction of SRs that had ≥1 major mergers (grey shaded region), no major mergers but ≥1 minor mergers (green), no minor or major mergers, but ≥1 very minor mergers (blue) and no mergers (red) over the last 10 Gyr, as a function of stellar mass. The bottom panel shows the same but for all galaxies regardless of their kinematic class.

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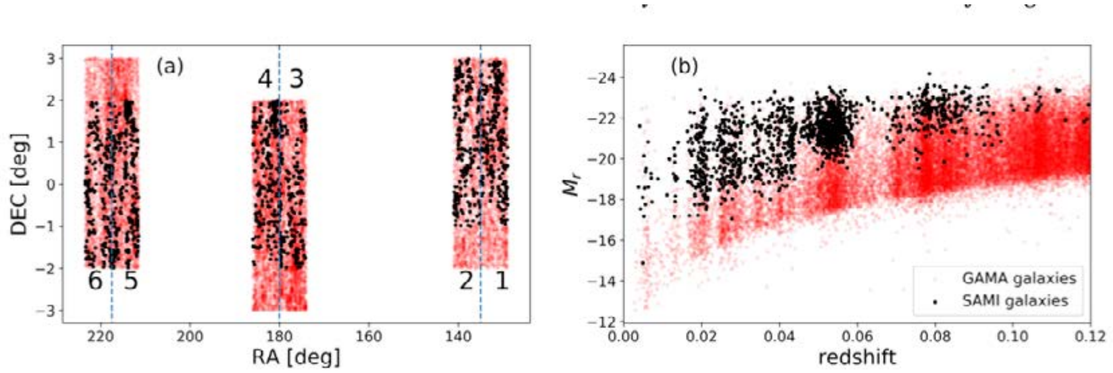

Figure 9: Mai, Y. et al. (a) Red points indicate the spatial distribution of GAMA galaxies, and black points show the spatial distribution of the SAMI galaxies. We divided the SAMI galaxies into 6 parts (as indicated by black numbers) in order to investigate the variance of large scale structure between different regions; (b) r-band absolute magnitude versus redshift diagram of SAMI and GAMA galaxies.

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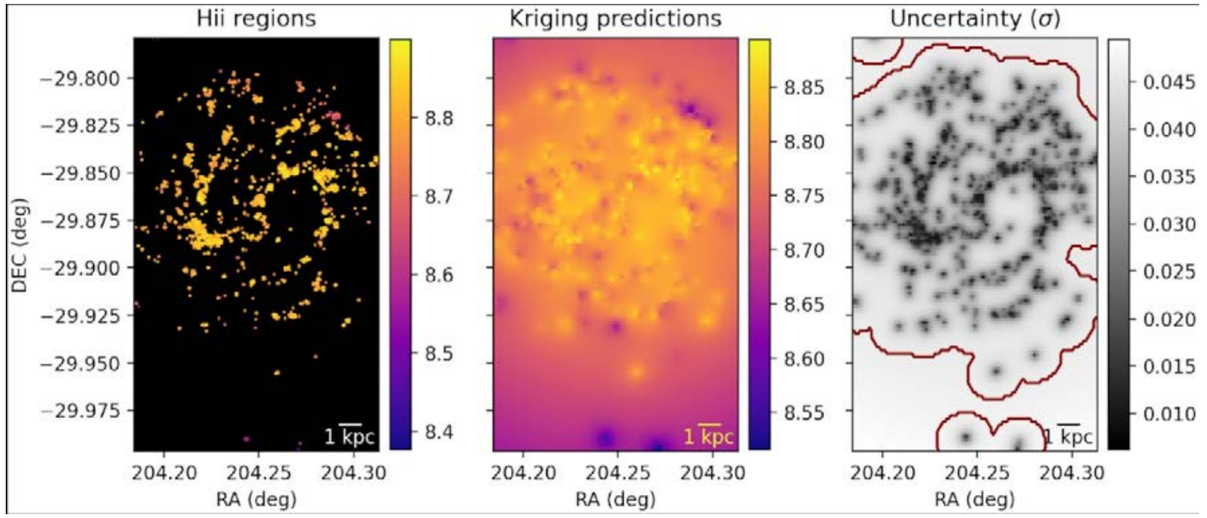

Figure 10: Metha, B. et al. Left: Measured metallicity values, in units of log([O/H]) + 12, for HII regions in NGC 5236, determined using the RS32 diagnostic. Centre: An interpolated metallicity map, computed using the technique of universal kriging, modelling small-scale metallicity fluctuations with a Gaussian model with an exponential correlation function. Right: Uncertainties (standard deviation) of the kriging predictions at each location. At distances greater than 3Φ from any HII spaxel (red contour), the uncertainty of the metallicity estimated for any point is approximately the uncertainty given by a metallicity gradient model.

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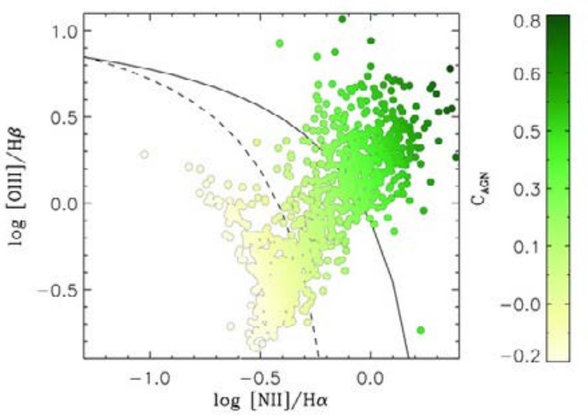

Figure 11: Oh, S. et al. Emission-line diagnostics for the 1090 sample galaxies. We used emission line fluxes integrated within 1 R_e. The solid and dashed lines are, respectively, the demarcation lines of Kewley et al. (2001) and Kauffmann et al. (2003), separating star-forming galaxies and AGN. We measure the contribution of AGN (CAGN) as the orthogonal departure (i.e. the smallest distance) in log scale from the dashed line (log [OIII]/Hβ = 0.61 / (log [NII]/Ha-0.05) + 1.3). Galaxies are colour-coded by C_{AGN}.

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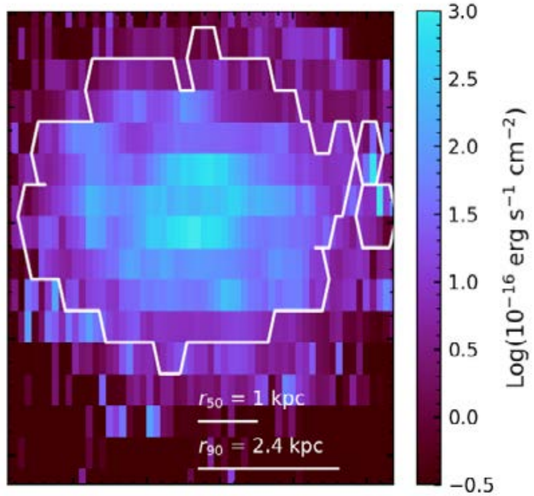

Figure 12: Reichardt Chu, B. et al. Map of the [OIII] 5007 Å emission line flux from our KCWI data. The white contours show where we have spaxels with a signal-to-noise of greater than 20 per pixel in a 5 Å-wide continuum region blueward of the [OIII] 5007 Å emission line.

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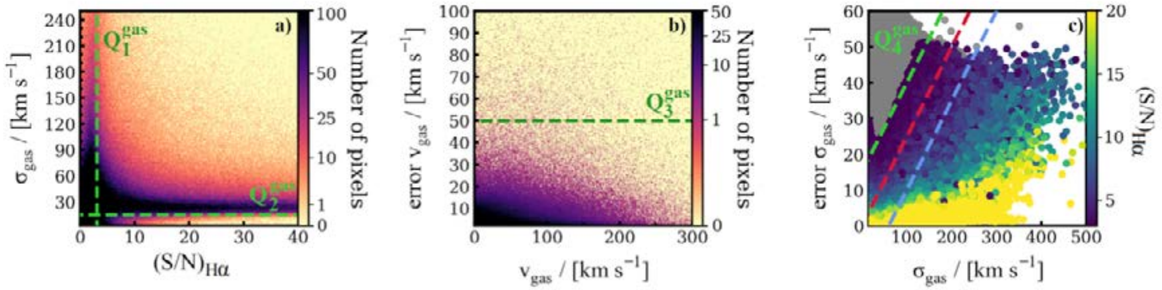

Figure 13: Ristea, A. et al. Illustration of quality cuts applied to spaxels in gas velocity maps: (a) 2D histogram showing the Hα ionised gas velocity dispersion (σ_{gas}) of spaxels in SAMI DR3 as a function of their Hα S/N. The vertical and horizontal dashed green lines show the Q^{gas}_1 and Q^{gas}_2 quality cuts, respectively. (b) 2D histogram showing the error in the ionised gas rotational velocity (vgas) vs the respective velocity value for spaxels that have passed the Q^{gas}_1 and Q^{gas}_2 quality cuts. The horizontal dashed green line shows the vgas selection criterion. (c) Scatter plot showing the error in Q_{gas} vs Q_{gas}. Spaxels passing Q^{gas}_1 and Q^{gas}_3 are shown, color-coded according to their S/N$_{Hα}$, while those with (S/N$_{Hα}$) < 3 are shown in grey. The dashed lines correspond to prospective quality cuts: (green) err(σ) = 0.25 × σ+ 15 km s^{-1} (Q^{gas}_4); (red) err(σ) = 0.25 × σ; (blue) err(σ) = 0.25 × σ − 15 km s^{-1}.

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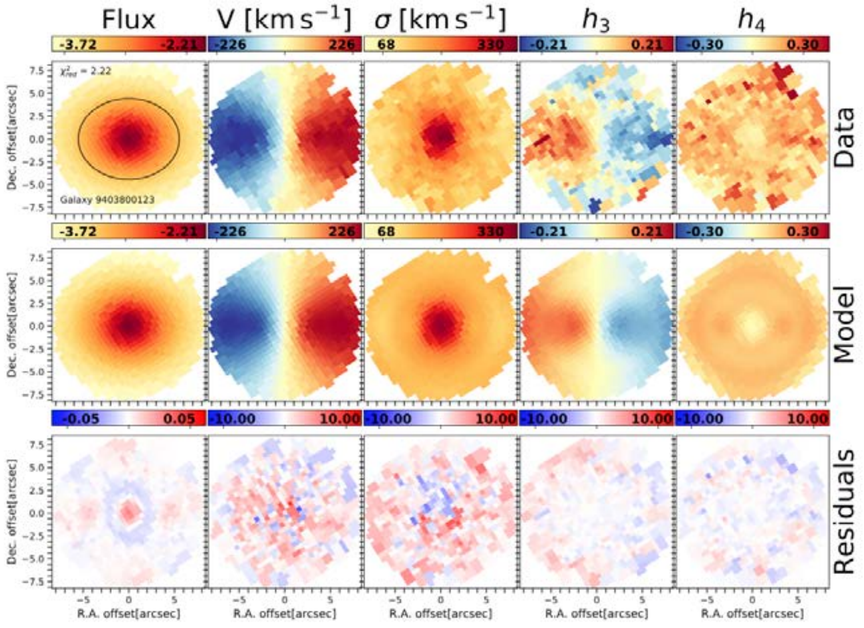

Figure 14: Santucci, G. et al. Example of a galaxy with excellent spatial sampling: SAMI CATID 9403800123 in the cluster Abell 4038. This galaxy (log M★ /$M_{\odot}$ = 11.05 and R_e = 5.52") is a non edge-on oblate galaxy and has stellar kinematic measurements up to 1.36 Re and counts 255 spatial bins within 1Re (black ellipse). Columns show 2D maps for, from left to right, flux, velocity, velocity dispersion, h3 and h4. First row shows the observed maps, second row shows the best-fit maps derived from the Schwarzschild modelling and the third row shows the residuals, calculated as the difference between the observation and the model, divided by the observational uncertainties. The best-fit model maps (χ^2_{red} = 2.22) accurately reconstruct the structures seen in the observations, not only for the velocity and velocity dispersion maps, but also for h_3 and h_4.

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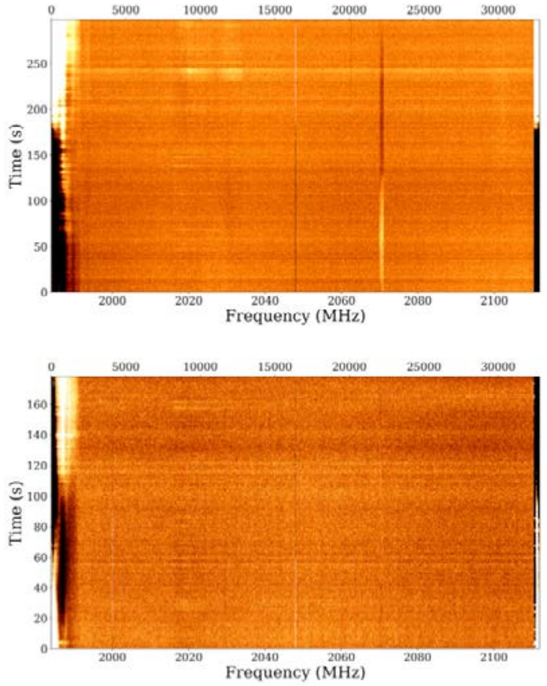

Figure 15: Staveley-Smith, L. et al. Example waterfall plot (time v frequency) for (top) 47 Tuc and (bot- tom) ω Cen where the intensity in the calibrated (quotient) Stokes I spectra is displayed as a function of time and frequency for sub-band 10 for a 300- s observation taken on UT 13:54 on 2020 October 22 and UT 13:34 on 2021 February 6, respectively. Channel number is shown on the top axis. The feature at 2048 MHz is an instrumental artefact. The features at 1984 and 2112 MHz are band-edge artefacts. RFI can be seen in the ranges 2015–2034 MHz and 2070–2071 MHz. The rest-frame frequencies for three hydrogen recombination lines (H146,147,148α at 2091.54,2049.29,2008.16 MHz, respectively) and two Ps recombination lines (Ps116,117α at 2080.72,2028.04 MHz, respectively) lie within the frequency range displayed. The intensity range is–1 to 1Jy.

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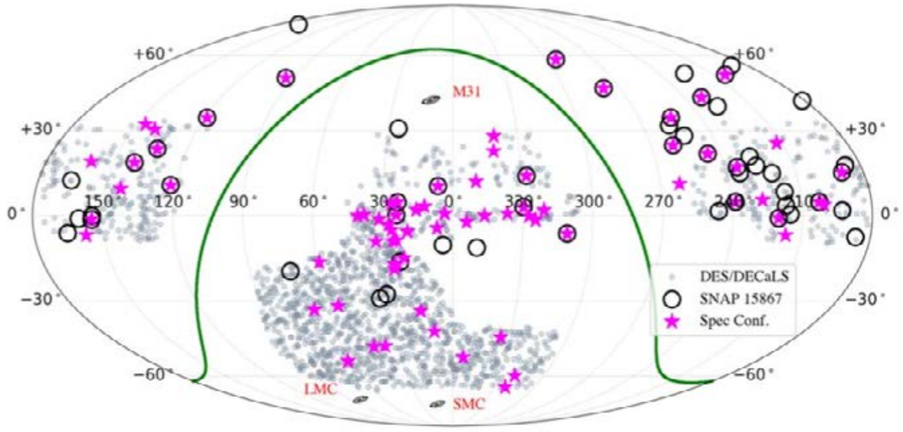

Figure 16: Tran, K.-V. et al. Spatial distribution of candidate gravitational lenses in the DES/DECaLS fields (gray circles) and the 77 spectroscopic redshifts from our AGEL survey (pink stars; Table 3) where the secured redshift is of the deflector (foreground) and/or the source (background). The confirmed gravitational lenses span a range in R.A., and most are at declinations near the equator and can be observed by telescopes in both hemispheres; the plane of the Milky Way is shown as the green curve. Several of the confirmed strong lenses are targeted in the HST SNAP program #15867 (open black circles) that provides the high-angular-resolution imaging needed to model the gravitational lenses; additional HST imaging of AGEL systems is ongoing in Cycle 29 (#16773).

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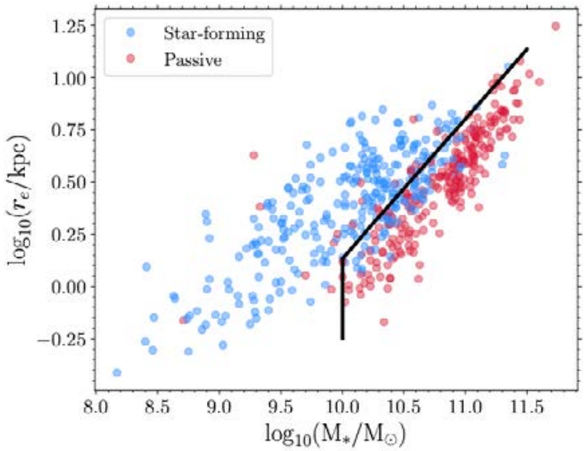

Figure 17: Vaughan, S. P. et al. The mass-size plane of the central and isolated galaxies in our sample. Star-forming galaxies are shown in blue and quenched galaxies are shown in red. When a galaxy in our toy model crosses the thick black line as it grows in mass and size, we assign it a 5% probability of quenching during the next time step (see Section 6.2 in paper for details).

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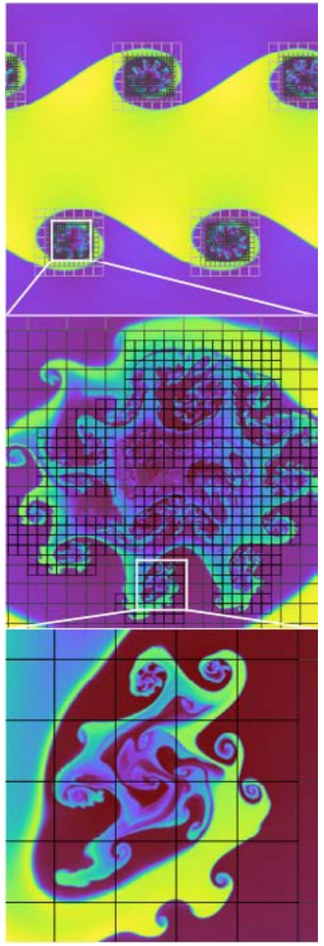

Figure 18: Wibking, B. D. et al. A simulation of the Kelvin-Helmholz instability with 4 levels of refinement. The top panel shows the full simulation domain, and the lower two panels show-successive zoom-ins on parts of the domain. Grid boundaries are shown for levels ι ≥ 2. Color shows density.

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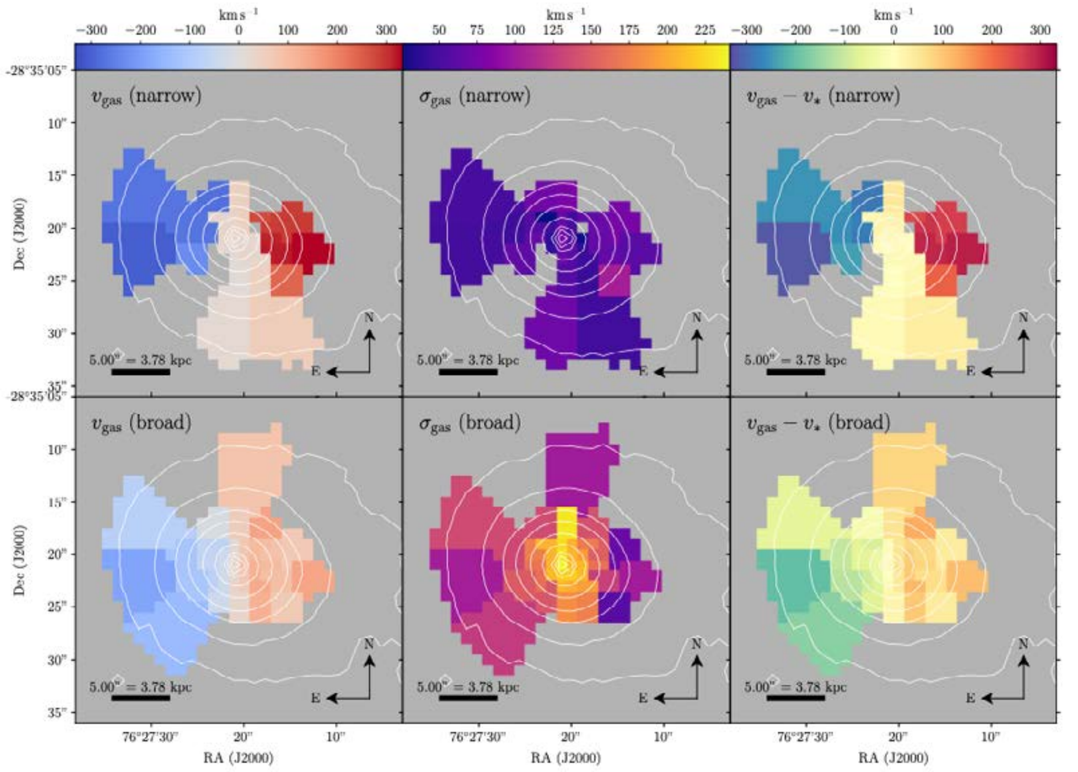

Figure 19: Zovaro, H. R. M. et al. Ionised gas radial velocity, relative to systemic (left), gas velocity dispersion (Gaussian σ, minus instrumental dispersion, right) and gas velocity relative to the stellar velocity (centre) of the narrow (top row) and broad (bottom row) emission line components in each bin.

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Acronyms and abbreviations

AAO	Australian Astronomical Observatory
AAL	Astronomy Australia Ltd
AAT	Anglo Australian Telescope
ACFR	Australian Centre for Field Robotics
ADACS	Astronomy Data and Computing Services
ADC	Atmospheric Dispersion Corrector
AGN	Active Galactic Nuclei
AGEL	ASTRO 3D Galaxy Evolution with Lenses
ALFALFA	Arecibo Legacy Fast ALFA Survey
ALMA	Atacama Large Millimeter Array
ANU	The Australian National University
AOS	Australian Optical Society
APOGEE	APO Galactic Evolution Experiment
ARC	Australian Research Council
ASA	Astronomical Society of Australia
ASKAP	Australian Square Kilometre Array Pathfinder
ASTRO 3D	Centre of Excellence for All Sky Astrophysics in 3 Dimensions
ASTRON	Netherlands Institute for Radio Astronomy
ASVO	All-Sky Virtual Observatory
ATNF	Australia Telescope National Facility
BLM	Black Lives Matter
BoRG	Brightest of Reionising Galaxies
CAASTRO	Centre of Excellence for All Sky Astrophysics
CAS	Chinese Academy of Sciences
CASDA	CSIRO ASKAP Science Data Archive
CASS	CSIRO Astronomy and Space Science
CIRADA	Canadian Initiative for Radio Astronomy Data Analysis
CMB	Cosmic Microwave Background
COCKATOO	Cosmological Chemodynamical simulations with Kinetic AGN feedback and other physics TOO
COO	Chief Operating Officer
CRAM MWA	Central Redundant Array Mega-tile
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DALiuGE	Data Activated Liu Graph Engine
DECaLS	Dark Energy Camera Legacy Survey
DECRA	Discovery Early Career Researcher Award
DES	Dark Energy Survey
DIAP	Data Intensive Astronomy Program
DINGO	Deep Investigation of Neutral Gas Origins
DLA	Damped Lyman Alpha Absorber
DSTG	Defence Science and Technology Group
DUVET	Deep near-UV observations of Entrained gas in Turbulent galaxies
EAGLE	Evolution & Assembly of GaLaxies and their Environments
ECR	Early Career Researcher
EDI	Equity Diversity and Inclusion
EMP	Extremely Metal-poor Stars
EoR	Epoch of Reionisation
ESO	European Southern Observatory
ESPRESSO	Echelle SPectrograph for Rocky Exoplanets and Stable Spectroscopic Observations
FAST	Five-hundred-metre Apeture Spherical Telescope
FLASH	First Large Absorption Survey in HI
GALAH	GALactic Archeology with HERMES
GAMA	Galaxy and Mass Assembly
GRB	Gamma Ray Burst
GMT	Giant Magellan Telescope
HERMES	High Efficiency and Resolution Multi-Element Spectrograph
HI	H one (neutral hydrogen)
HIRAX	Hydrogen Intensity and Real-time Analysis eXperiment
HITS	Heidelberg Institute for Theoretical Studies
HPC	High-Performance Computing
HST	Hubble Space Telescope
IAB	International Advisory Board
IAU	International Astronomical Union
ICRAR	International Centre for Radio Astronomy Research
IFU	Integral Field Unit
IGM	InterGalactic Medium
IMF	Initial Mass Function
ISM	InterStellar Medium
JWST	James Webb Space Telescope
K3-LARS	KMOS z=3-4 Lyα reference survey
KAPA	Keck All-sky Precision Adaptive-optics
KIAA	Kavli Institute for Astronomy and Astrophysics
KiDS	Kilo-Degree Survey
KMOS	K-band Object Spectrograph
KPI	Key Performance Indicator
KROSS	KMOS Redshift One Spectroscopic Survey
LIEF	Linkage Infrastructure Equipment and Facilities
LGBTI	Lesbian Gay Bisexual and Transgender (initalism)
LoBES	Long Baseline Epoch of Reionisation Survey
LOFAR	Low Frequency Array (currently largest radio telescope)
LTE	Local Thermodynamic Equilibrium
MAGPI	Middle Ages Galaxy Properties with Integral Field Spectroscopy
MANIFEST	Many Instrument Fiber System
MIAPP	Munich Institute for Astro- and Particle Physics
MeerKAT	South African radio telescope, precursor to the Square Kilometre Array (SKA) telescope
MOSFIRE	Multi-Object Spectrograph For Infra-Red Exploration
MOSEL	MOSfire Emission Line survey
MPIA	Max Planck Institute for Astronomy
MSTO	Main Sequence Turn-Off
MUSE	Multi-Unit Spectroscopic Explorer
MWA	Murchison Widefield Array
NASA	National Aeronautics and Space Administration
NCA	National Committee for Astronomy
NCI	National Computational Infrastructure
NenuFar	New Extension in Nançay Upgrading LOFAR
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PHISCC	SKA Pathfinder HI Science Coordination Committee
QSO	Quasi-Stellar Objects
RGB	Red Giant Branch
RSAA	Research School for Astronomy and Astrophysics
SAGE	Semi-Analytic Galaxy Evolution
SAIL	Sydney Astrophotonic Instrumentation Laboratory
SAMI	Sydney-AAO Multi-object Integral field unit
SAM	Semi-Analytic Model
SCA	Subsea Communications Australia
SED	Spectral Energy Distribution
SKA	Square Kilometre Array
SKAO	Square Kilometre Array Observatory
SMC	Science Management Committee
SNR	Structured Supernova Remnants
SOfIA	Stratospheric Observatory for Infrared Astronomy
SpIRIT	Space Industry Responsive Intelligent Thermal) nanosatellite
SPIRIT	SPICE, Physics, ICRAR, Remote Internet Telescope
STARS	Scientists Taking Astronomy to Regional Schools
STEM	Science Technology Engineering Mathematics
TAO	Theoretical Astrophysical Observatory
TESS	Transiting Exoplanet Survey Satellite
TOSCA	Topology and Orchestration Specification for Cloud Applications
TYPHOON	An integral field spectroscopic (IFS) survey
UCSD	University of California San Diego
UNSW	University of New South Wales
UAV	Unmanned Aerial Vehicle
UoM	University of Melbourne
UV	UltraViolet
UW	University of Washington
UWA	University of Western Australia
VIKING	VISTA Kilo-Degree Infrared Galaxy Survey
VISTA	Visible and Infrared Survey Telescope for Astronomy
VLT	Very Large Telescope
VO	Virtual Observatory
VR	Virtual Reality
WALLABY	Widefield ASKAP L-Band Legacy Allsky Blind Survey
WiFeS	WideField Spectrograph