
FACULTY OF
SCIENCE AND
ENGINEERING
AAO
MACQUARIE
University
(YOU)us
YOU TO THE
POWER OF us
COULD SEE THE
FUTURE IN THE STARS
Australian Astronomical Optics

ABOUT US

Joining Macquarie University on 1 July 2018, Australian Astronomical Optics (AAO) is a recognised world leader in astronomical instrumentation. AAO-Macquarie has significant expertise in developing innovative technology for use in astronomical instruments, in developing data systems for the storage and access of data from such instruments, and in using these instruments for scientific research.

AAO-Macquarie is the Sydney arm of what used to be the Australian Astronomical Observatory, which opened in 1974. After Australia entered into a 10-year strategic partnership with the European Southern Observatory (ESO) in 2017, the observatory's operating model changed – moving from the government sector to the university research sector.

Macquarie is excited to take a significant role in growing Australia's global position in astronomical instrumentation. We are partnering with the Australian National University, the University of Sydney and Astronomy Australia Ltd to establish a new national capability for astronomical instrumentation under the banner Australian Astronomical Optics.

AAO-Macquarie is continuing and developing the team's decades-long reputation for building world-class optical instrumentation with projects that include:

- the 4MOST (4-metre multi-object spectrograph telescope)/AESOP positioner for ESO's VISTA (Visible and Infrared Survey Telescope for Astronomy) telescope, Chile
- the TAIPAN robotic starbug-based instrument for the UK Schmidt Telescope at Siding Spring Observatory, Australia
- the design, construction and delivery of a near-infrared camera for diffraction-limited operation on the Ataturk University's 4-metre DAG (Eastern Anatolia Observatory) telescope, Turkey
- MANIFEST (many instrument fibre system), a proposed fibre positioner for the Giant Magellan Telescope, Chile.

PURPOSE

Macquarie brings to the AAO a well-demonstrated track record in developing new technologies, with a commercialisation focus, alongside industry partners on campus. AAO-Macquarie's team of experts will build on the University's existing strengths in astronomy, photonics, laser technology, microfabrication, applied optics, sensing and communications.

This collaboration will combine unique capabilities in wide-field and adaptive optics, precision mechanical and optical engineering, design and test, and software to build cutting-edge instruments for the world's leading 8-metre telescope and next-generation 30-metre telescope.

Together, we also seek to increase industry engagement, identify opportunities to apply AAO-Macquarie's expertise to medicine and defence, and expand our presence in the fields of optics and sensing, as well as progress our ongoing mission of world-leading excellence in astronomical instrumentation.

RESEARCH CENTRES

AAO-Macquarie researchers collaborate with researchers from the Department of Physics and Astronomy at:

- Macquarie University Research Centre for Astronomy, Astrophysics and Astrophotonics
- Macquarie University Photonics Research Centre

Milky Way above the Anglo-Australian Telescope
PHOTO: Angel Lopez-Sanchez

RESEARCH AREAS

ASTRONOMY TECHNOLOGY

AAO-Macquarie's key technology strengths include:

- Photonics and other optical-fibre technologies that capture and filter light
- Positioning systems that place optical fibres with maximum efficiency
- Spectrographs that analyse captured light

aao.org.au/macquarie/technology

ASTRONOMY DATA MANAGEMENT

AAO-Macquarie is also at the forefront of developing an e-research platform and data archive that facilitates cutting-edge science through its Data Central capability. It provides web-based tools and archive functionality for scientists from a range of disciplines to explore, collaborate and make new discoveries.

datacentral.org.au

ASTRONOMY RESEARCH

AAO-Macquarie is home to a dynamic and diverse research group. AAO-Macquarie astronomers collaborate with astronomers across the globe and are recognised leaders in many areas of research. Our astronomers and instrument scientists work together to produce some of the world's most innovative and groundbreaking instrument technologies.

aao.org.au/macquarie/astronomy-research

CAPABILITIES

Astronomical instruments are used to collect data in the form of images and spectra from astronomical sources such as stars, galaxies and nebulae. Such instruments typically comprise bulk optics (lenses, mirrors, diffraction gratings, filters), photonic elements (optical fibres and waveguides), optomechanics (to accurately position all of the optical elements), mechatronics (fibre positioning robots and alignment mechanisms), detectors (charge-coupled device and infrared arrays), and software systems (for control and data processing, storage and management).

The techniques and competencies required for these complex and high-precision systems are provided by our staff across the following key areas.

PROJECT MANAGEMENT

- Project management using waterfall and agile approaches
- Systems engineering (documentation and requirements tracking)
- Risk analysis, mitigation and management
- Quality assurance
- Project financial forecasting and budget tracking

MECHANICAL ENGINEERING

- Mechanical conceptual design and development
- Mechatronic design
- Optomechanical mounting design
- Cryogenics design and detector development
- Mechanical fabrication (ie standard milling, lathing and computer numerical control (CNC))
- Inventor 3D modelling
- Jigs, fixture and tooling design
- Metrology (eg coordinate measuring machine)
- Vibration and earthquake analysis
- Heat transfer modelling
- Pneumatic systems
- Hydraulic systems
- Finite element analysis
- Failure modes and effect analysis

ELECTRONICS

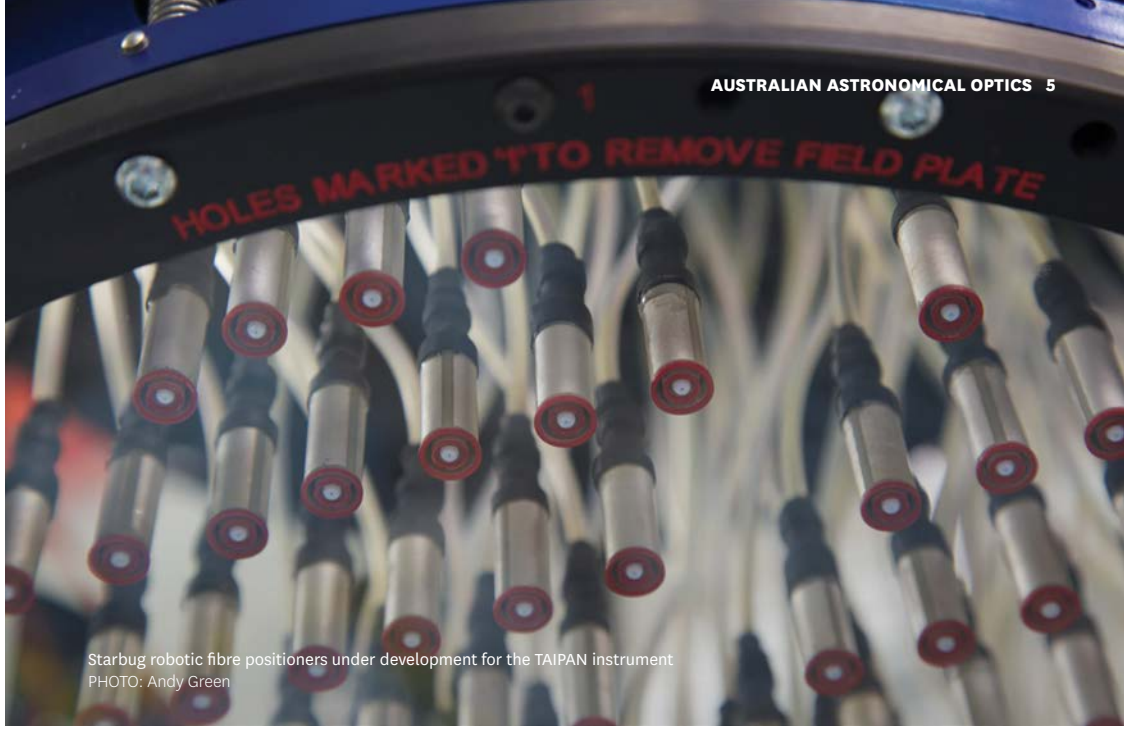
- Systems analysis, design and integration
- Schematic and PCB design using Altium CAD software
- PCB assembly and rework with through-hole and surface-mount technology components
- Electronics enclosure and front panel design using mechanical CAD software
- Electronics enclosure wiring and integration
- Electronics enclosure test and debug
- Cable assembly design and wiring
- Programmable logic controller and programmable automation controllers design and programming
- Embedded controller and microprocessor design, including C/C++ firmware development and test
- Motion control and servo systems design, build and test
- Detector controller and detector system design, build and test
- Fibre positioner design incorporating advanced robotics, including piezo actuator systems
- LTspice circuit simulation
- Radio frequency-related design, including electromagnetic compatibility compliance and antenna design
- Cryostat electronics design support and manufacture.

OPTICAL DESIGN

- Optical systems design (Zemax)
- FRED scattered light and thermal analysis
- Optical systems assembly, integration and testing
- Micron-level alignment and testing
- Photometric metrology
- Interferometric metrology
- Large volume-phase holographic grating characterisation
- Fibre characterisation
- Fibre and photonic chip polishing

PHOTONICS

- Photonic beam propagation, finite element simulations and finite difference time domain simulations
- Nanophotonic alignment and testing



Starbug robotic fibre positioners under development for the TAIPAN instrument
PHOTO: Andy Green

INSTRUMENT SCIENCE RESEARCH AND DEVELOPMENT

- Robotic fibre positioning technologies
- OH suppression with fibre Bragg gratings
- Silicon photonics for astronomy
- Photonic simulations and modelling
- Fluoride fibres
- Fibre bundles for adaptive optics wavefront sensing
- Focal plane positioning technologies for large payloads
- Low surface brightness imaging arrays from low-cost telephoto lenses

TELESCOPE INSTRUMENTATION SOFTWARE

- Software algorithm and systems design
- Astronomical instrumentation control software development, testing and integration
- Instrument control and monitoring
- Data reduction, analysis and pipeline software design and development
- Full software lifecycle for instrumentation and data reduction projects
- Main languages used at the moment include C/C++ 11+, Python, Fortran 2003, Java, Perl, Shell, Tcl/Tk running on Linux/Unix, MacOS, and VxWorks platforms

DATA

- Configuring, administering and managing: Hadoop clusters, PrestoDB, SQL databases (including MySQL, PostgreSQL, MS SQL Server), MongoDB databases
- Developing with Docker images and containers
- Building web applications using various web frameworks (Python/Django, Node.js, PHP)
- Configuring and managing web servers, including Apache httpd and Tomcat
- Managing cluster hardware, including deployment, networking (Ethernet and Infiniband) and maintenance

ASTRONOMY

Research areas include:

- Galaxy evolution
- Star formation
- Stellar evolution
- Chemical evolution of stars and galaxies
- Galaxy dynamics

Major international survey programs include:

- GAMA (**gama-survey.org**)
- GALAH (**galah-survey.org**)
- TAIPAN (**taipan-survey.org**)
- EMU (**emu-survey.org**)

DIRECTOR

MARK CASALI

PROFESSOR
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- Astronomical visible/infrared detector development
- Instrumentation for astronomical research

INSTRUMENTATION

JON LAWRENCE

PROFESSOR
HEAD OF INSTRUMENTATION
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- Astronomical instrumentation and technology development

DAVID ROBERTSON

PROGRAM MANAGER
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- Program management
- Emerging technology deployment
- Software as a platform architecture

CELESTINA LACOMBE

PROJECT MANAGER
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- Project management/ program management
- Quality management
- Continual improvement (interest and professional projection)

SCOTT CASE

PROJECT MANAGER
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- Project management
- Optical technology in photonic devices

SCOTT SMEDLEY

PROJECT ENGINEER
E: scott.smedley@mq.edu.au

- Multiplex fibre positioning instrumentation
- Optical fibre metrology systems
- International multidiscipline, multi-institution group collaboration

LEWIS WALLER

ELECTRONICS MANAGER
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- Anglo-Australian Telescope detector system support
- Instrument control systems for 4MOST/AESOP and GHOST

VIJAY NICHANI

ELECTRONICS ENGINEER
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- Multiple embedded ARM processor and interconnected via a controller area network bus
- High-voltage and high-power switching class D power amplifier for driving piezo micro-motion device
- LTspice circuit simulation and Altium for design high-density/high-speed electronic circuit
- Firmware (C/C++), Software (QT) and 3D CAD

SLAVKO MALI

ELECTRONICS TECHNICIAN
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- Exploring new techniques in PCB fabrication and assembly
- Pushing these techniques to the limit while maintaining a high standard of work
- Finding new technologies in electronics suitable to project demands

ROLF MULLER

ELECTRONICS TECHNICIAN
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- Piezo electric positioners
- Electronic design and layout
- Custom cables


Dr Jessica Zheng setting up diffraction grating measurement at AAO Optics Lab
PHOTO: Joanne Stephan

ROBERT PATTERSON

ELECTRONICS TECHNICIAN
E: robert.patterson@mq.edu.au

- Electronics design and manufacture
- Microprocessor design implementation and programming
- Robotics, motor drives, encoders, pneumatics, optics
- Scientific instrument-making design and machining components
- Biomedical engineering, life support, monitoring and chemistry analysis

JESSICA ZHENG

OPTICS MANAGER
E: jessica.zheng@mq.edu.au

- Adaptive optics and wavefront sensor technology
- Optical system scattering light and thermal analysis
- Optical metrology

REBECCA BROWN

OPTICAL ENGINEER
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- Optomechanical fibre positioning systems
- Optical fibre performance
- Diversity and equity in STEM

ROSS ZHELEM

OPTICAL ENGINEER
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- Design and analysis of astronomical optics
- Specification and procurement of optical components
- Alignment, integration and testing of optical systems

SIMON ELLIS

INSTRUMENT SCIENCE MANAGER
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- Astronomical instrumentation research and development
- OH suppression with fibre Bragg gratings and ring resonators
- Astrophotonics
- Multi-conjugate adaptive optics-assisted instruments
- Astrophysics of positronium

MICHAEL GOODWIN

INSTRUMENT SCIENTIST
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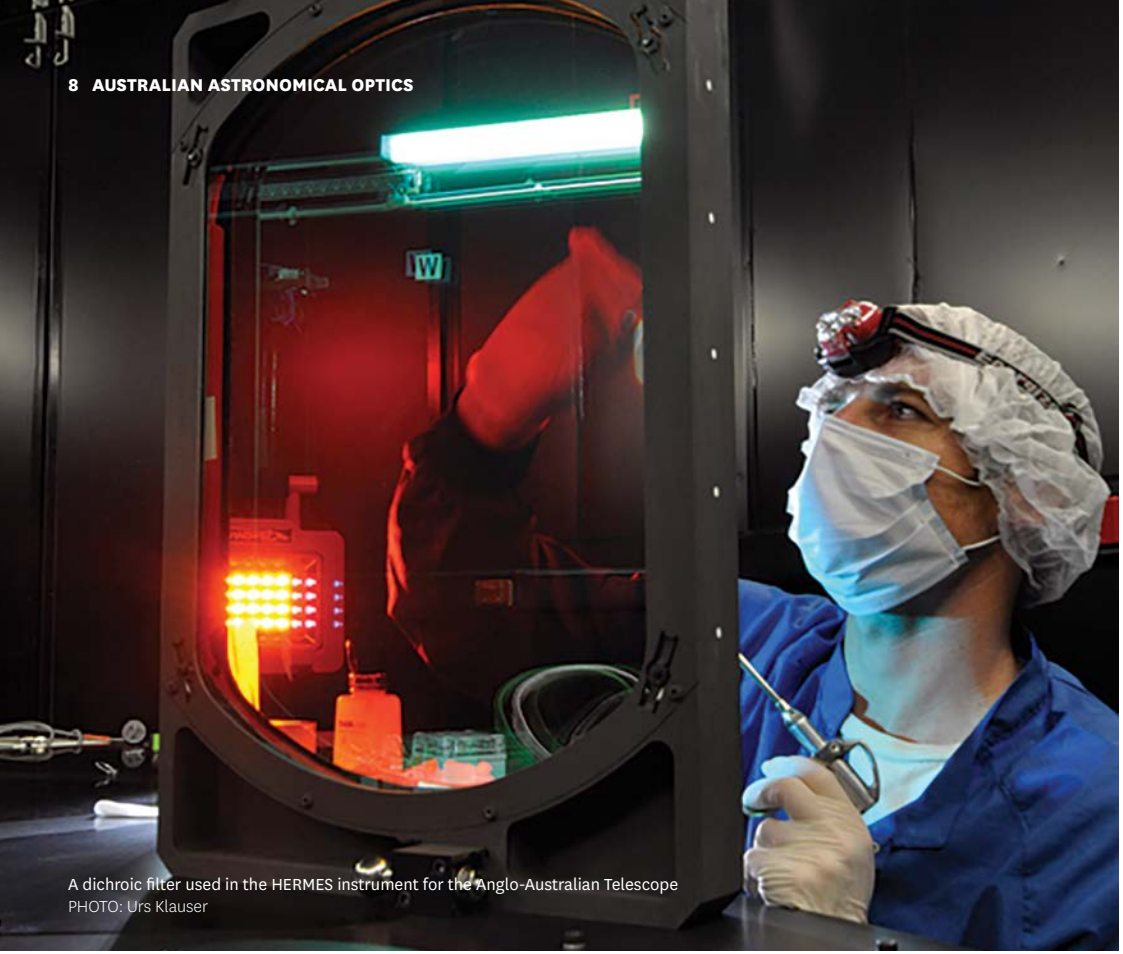
- Astronomical adaptive optics and related technologies
- Robotic positioner technologies for astronomy
- Astronomical instrumentation simulation and model analysis



A dichroic filter used in the HERMES instrument for the Anglo-Australian Telescope
PHOTO: Urs Klauser

ANTHONY HORTON
INSTRUMENT SCIENTIST
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- Optical and infrared astronomical instrumentation for imaging and spectroscopy
- Astrophotonics, in particular fibre Bragg grating OH suppression
- Smallsat space telescopes and ground-based robotic observatories

SUFYAN BAKER
INSTRUMENT TECHNICIAN
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- Software testing for the 4MOST project
- Assembling spines and gluing, polishing fibres
- Populating spines to modules

GORDON ROBERTSON
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- Optical spectrographs – design and operation
- Data reduction techniques for optical spectroscopy

PETER GILLINGHAM
INSTRUMENT SCIENTIST
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- Concept design, mechanical and optical, for novel astronomical instrumentation
- Improvements in telescope drive and encoding
- Minimising degradation of telescope performance due to local seeing

HELEN MCGREGOR
MECHANICAL MANAGER
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- Instrumentation design, development and implementation
- Fibre positioner systems
- Optomechanical design

VLADIMIR CHURILOV
SENIOR MECHANICAL ENGINEER
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- Cryovacuum engineering
- Mechanical design of the optical devices and instruments
- Mechanical design of the fibre-optical cables

JUREK BRZESKI
MECHANICAL ENGINEER
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- Development of novel instrumentation for astronomy and industry
- All technology-related materials applications, with particular focus on advanced device design, fabrication and integration, as well as new technologies based on novel materials
- All aspects of the metallurgy of engineering alloys

SUDHARSHAN VENKATESAN
MECHANICAL ENGINEER
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- Advanced finite element analysis: modal, vibration, thermal and earthquake analysis
- Advanced materials: piezo ceramics, composites, 3D printed materials
- Precision engineering and design

ELLIE O'BRIEN
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- Mechanical assembly and integration
- Mechanical test engineering

URS KLAUSER
MECHANICAL TECHNICIAN
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- High-precision machining/ design and a great in-depth understanding of methods to build modern unique instruments
- Manufacturing technologies senior adviser in manufacturing and high-precision part procurement
- Technical photography and documentation
- Running of the AAO workshop

NAVEEN PAI
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- Metrology
- CNC machining
- Cryogenic system

YEVGEN KRIPAK
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- Infrared camera design
- Spectrograph design
- Human-centred approach to design and development

MAHESH MOHANAN
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- Spectrograph design

TIMOTHY CHIN
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- Cryogenic optics mounting
- Additive manufacturing
- Optical fibre routing

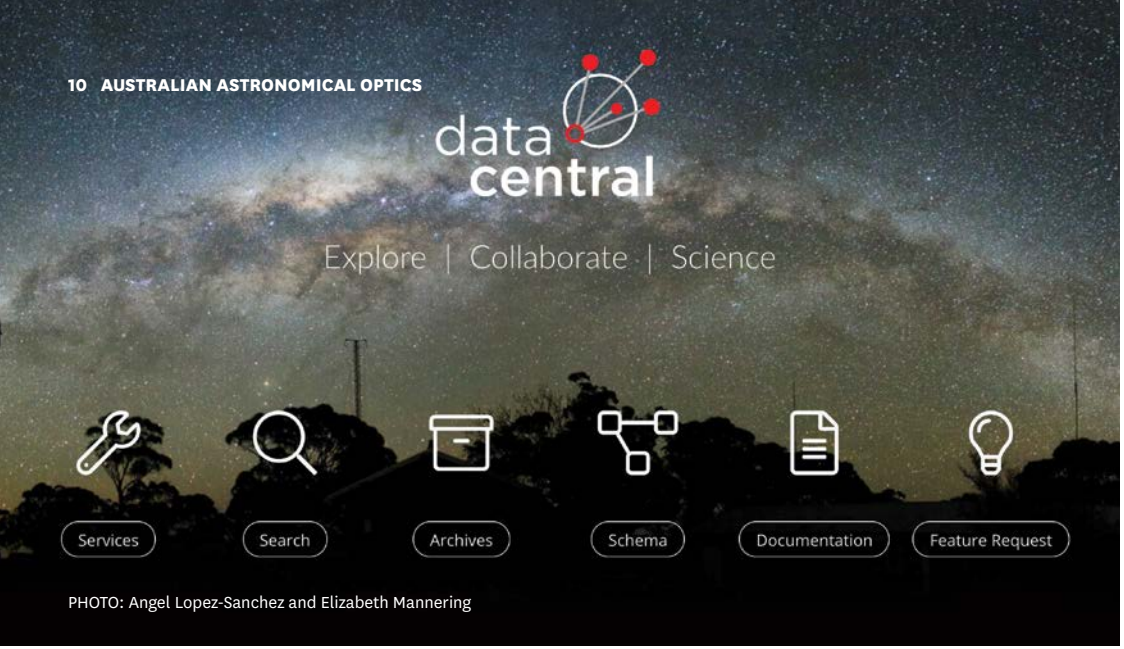

PHOTO: Angel Lopez-Sanchez and Elizabeth Mannering

RESEARCH, DATA AND SOFTWARE

KATRINA SEALEY
HEAD OF RESEARCH DATA AND SOFTWARE
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- Leadership of information technology, data and software teams
- Development of high-performance teams
- Advocate for diversity and inclusion

TONY FARRELL
SOFTWARE TECHNICAL LEAD
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- Complex control systems
- Robot control systems
- Telescope instrumentation

NURIA LORENTE
SENIOR SOFTWARE AND SYSTEMS ENGINEER
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- Astronomical instrumentation software
- Robotic fibre positioning systems
- Data reduction algorithms and software
- Astronomical data simulation
- Software engineering development within the astronomical community

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- Numerical analysis
- Statistics
- Scientific programming

GARRY KITLEY
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- IT and web software
- Electronics instrumentation

MINH VUONG
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- Software engineer of IT, data and software teams
- Development of astronomical instrument software

NUWANTHIKA FERNANDO
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- Instrument and pipeline software development
- Astronomical archival databases

SIMON O'TOOLE
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- Database technologies and data management
- Web technologies
- Research systems administration

NORRIE BENNIE
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- IT security and computer forensics
- Software engineering
- High-performance computing

LLOYD HARISCHANDRA
DATA SCIENTIST
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- Transformation of data into various formats and ingestion into Datacentral cluster
- Developing interfaces to query data in the cluster via Data Central website and other tools
- Cluster infrastructure management including installation and configuration of various software, network applications and distributed query engines in distributed set of computers

ELIZABETH MANNERING
DATA SCIENTIST
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- Developing apps to manage and serve astronomical data via cutting-edge web, database and infrastructure technologies
- User experience and interface design
- Systems architecture and software design best practises

ASTRONOMY AND PROJECT SCIENCE

ANDREW HOPKINS
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- Evolution of galaxies over cosmic history
- Processes and evolution of star formation within galaxies
- Interplay between star formation and supermassive black holes in galaxies
- Instrumentation project scientist

GAYANDHI DE SILVA
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- Galactic archaeology and stellar physics
- Globular and open star clusters
- High-resolution spectrographs

ANGEL LOPEZ-SANCHEZ
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- Linking gas and stars in nearby galaxies
- Galaxy evolution using multi-wavelength data
- Integral field spectroscopy: instrument and software development

TAYYABA ZAFAR
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- Interstellar and intergalactic medium studies
- Gamma-ray bursts, quasars and nearby galaxies – gas, metals and dust extinction studies in the near and distant universe
- Spectrophotometric studies of galaxies in the optical, near-infrared, ultraviolet and X-ray regimes

MACQUARIE University

At Macquarie, we know that research is the key to unlocking a secure future. It's central to everything we do. And everything we do is for the benefit of humanity and life. Our research is influenced by the big picture: finding solutions to critical global challenges – such as health, safety, climate crisis, and food and water security.

Ranked in the top one per cent of universities around the world*, we are home to leading researchers – a community of accomplished academics that unites collective thinking and expertise across all disciplines and areas of study.

As a researcher, research student or collaborator, you'll work alongside world-leading experts, and have access to world-class facilities and partnerships. We encourage you to find out more about our research priorities and projects.

*QS World University Rankings, 2019

FIND OUT MORE
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mq.edu.au/about/AAO

The information in this publication is correct as at time of printing (November 2019).
COVER PHOTO: Two-degree field fibre positioner on the Anglo-Australian Telescope, Angel Lopez-Sanchez
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