INTERNATIONAL SPACE CENTRE

Annual Report

1 MAY 2023 TO 31 DEC 2024

THE UNIVERSITY OF WESTERN AUSTRALIA

Contents

Front Cover Image:
Katherine Bennell-Pegg meets a future astronaut at UWA's Octagon Theatre.
Inside Cover:
10m Centrifuge housed at UWA's Centre for Offshore Foundations System

INTERNATIONAL SPACE CENTRE | THE UNIVERSITY OF WESTERN AUSTRALIA

Foreword

> Our motto, 'Space for Everyone,' is more than a slogan—it's a challenge to the elitist perceptions often attached to the space sector."

Professor Danail Obreschkow
Director of the International Space Centre

It is hard to overstate just how much the International Space Centre (ISC) has achieved for The University of Western Australia (UWA) and the State of WA.

Over the 20 months covered in this report, the ISC has flourished. Our membership has grown to over 200 brilliant students and academics, who have launched new research initiatives, won accolades in rocket and robotics competitions, hosted astronauts, delivered unique student events, expanded UWA's national research presence, secured substantial grants, and so much more. I'm proud of every ISC member and friend, and I'm deeply grateful to our small and dynamic core team, who has made us so much more than the sum of our parts.

What sets the ISC apart is its focus on people. The exploration and use of outer space is a profoundly human endeavour—one that benefits everyone and should be open to all. Our simple motto, "Space for Everyone," is more than a slogan. It's a challenge to the elitist perceptions often attached to the space sector: the outdated view that space jobs are only for genius "Rocket Scientists" and the modern reality that space is commercially accessible to a highly privileged class of "Space Billionaires."

The ISC works to bridge these divides, bringing space to the people and the people to space, by inspiring our members and wider community and by paving the way into space-related careers.

In 2024, the global space economy reached unprecedented heights, with nearly one successful orbital launch per day and approaching a trillion-dollar valuation (AU $948 billion). The socio-economic benefits were immense. Yet Australia risks missing this wave, often hesitating to invest unless immediate returns to existing industries are guaranteed. While scrutiny is always healthy, we must also consider the cost of inaction: missed opportunities to diversify our economy, develop sovereign capabilities, retain talent, foster innovation, and inspire the next generation.

I am hopeful and confident that together with our allies in government, industry, partner universities and the public, we will be able to reach for the stars. What's needed is a shared vision, great people, and smart investments.

Fly safe,

PROFESSOR DANAIL OBRESCHKOW
Director of the International Space Centre

> The ISC is building a people-focused space industry that seeks more universal benefits across sectors."

Professor Harvey Millar
Chair of the Board of the International Space Centre

As Chair of the ISC Board and speaking on behalf of all the Board Members, it has been inspiring to see the activities, opportunities and achievements of the ISC in 2024 under Danail Obreschkow's leadership.

Observing how the 12 research capabilities of the ISC collaborate and draw strength from each other to complete projects, spark new initiatives, and work together in outreach and education is a testament to why the Centre was initiated and named.

Collectively the ISC aims to show that space is for everyone in Western Australia and through it for the world. It strives for inclusivity not exclusivity, adopting the power of people from all research disciplines, ages and perspectives.

It reaches across cultures to bring together the experiences, inspiration and challenge that space represents for humanity. It is building a people-focused space industry that seeks more universal benefits across sectors. It looks to partner with other organisations in a more personal way through agility, expertise and common purpose to discover better solutions that bring space benefits to more people.

That's why it is the International Space Centre.

"Space is for everybody. It's not just for a few people in science or math, or for a select group of astronauts. That's our new frontier out there, and it's everybody's business to know about space." - Christa McAuliffe, Teacher and Challenger Astronaut

The Board membership reflects this diversity of expertise. It provides advice to the Director and the ISC leadership team as they prioritise its opportunities, considers new ways to engage external partners, and strategically plan the use of ISC resources. The Board remains committed to work with the UWA Executive to maintain and strengthen the ISC to achieve its goals in the years ahead.

Warm regards,

PROFESSOR HARVEY MILLAR
Chair of the Board of the International Space Centre

ASTRONAUT KATHERINE BENNELL-PEGG visits the International Space Centre at UWA in August 2024, touring many of UWA's space research teams and facilities. Bennell-Pegg is pictured here with International Space Centre members who came to hear her speak on a Q&A panel at the International Centre for Radio Astronomy Research's morning tea.

Highlights

ENGAGEMENT. Strategically, the ISC trades on UWA's reputation as a global top 100 institution with a rich tradition of academic excellence and innovation, and leverages this strength to create great relationships with impactful partners to:

- Build the ISC and UWA's profile;
- Facilitate new projects;
- Enable research commercialisation; and
- Become a trusted source in the space industry to become the 'go-to' for connections, and advice for government, academia and industry.

Internally, through our strong industry engagement, we can provide extra opportunities for students and researchers to widen their scope. At a broader level, we open up opportunities for diversified funding sources and promote our research infrastructure. We aim to see the ISC become a leading player in the development of West Australia and Australia's burgeoning space industry.

Hosting Astronaut Dr Katherine Bennell-Pegg

Australian astronaut Bennell-Pegg touched down in WA to share insights from her training and inspire students to pursue STEM careers, at the invitation of the ISC, in partnership with the Forrest Research Foundation, the WA Museum Boola Bardip, the Foundation for the WA Museum, and the Australian Space Agency.

Bennell-Pegg completed her astronaut training at the European Astronaut Centre (EAC) in Germany in April 2024, making history as the first candidate from an international partner to receive basic training from the European Space Agency. She was selected from 22,500 applicants and became one of only six to graduate, making her space-flight ready.

Now back at the Australian Space Agency, Bennell-Pegg visited Perth from 27 August 2024 on invitation from the ISC and supporters to share knowledge from her time at ESA.

"I'm excited to get over to Western Australia as part of my mission to inspire the next generation STEM workforce, and to share insights from my astronaut training with local industry," said Bennell-Pegg.

"Western Australia has a lot of expertise and potential to contribute even further to global space missions—from cutting-edge research to harnessing the knowhow of the resources sector. That in turn improves life on Earth—whether it's health breakthroughs, responding to climate change, uplifting our industries, or energising our kids to dream big and develop the skills needed to solve future challenges."

Over the course of six days, Katherine attended and hosted a massive 22 events run by the International Space Centre in partnership with many impactful organisations.

Of special note was the Leadership Dinner held at the WA Museum Boola Bardip, in the To the Moon exhibition area. Through new partnerships and generous support from the Foundation for the WA Museum, Forrest Research Foundation, the Department of Jobs, Tourism, Science and Innovation and WA Museum Boola Bardip, Bennell-Pegg was interviewed on stage about the importance of driving a space industry for Australia, stimulating important discussion and driving essential new partnerships supporting the space sector in Western Australia.

We'd like to extend our appreciation to Katherine Bennell-Pegg and the team at the Australian Space Agency who worked so hard to make this week of inspiration and knowledge-sharing in Western Australia possible.

TUESDAY 27 AUGUST

- Tour of Curtin University
- Private Welcome at Government House
- *An Evening with Katherine Bennell-Pegg*, WA Museum Boola Bardip

WEDNESDAY 28 AUGUST

- Forrest Foundation *Scholar's Breakfast*
- *Meet the Media* at UWA
- Channel 9 and SevenWest Interviews (UWA)
- Forrest Research Foundation Governors' Lunch
- UWA Interview and PhotoShoot (The West and Sunday Times)
- Live In-Studio Interview for Channel 9 Evening News
- *Ngalang Koort* (Foundation for the WA Museum)

THURSDAY 29 AUGUST

- Visit to the Square Kilometre Array (low) on Inyarrimanha Ilgari Bundara, with great thanks to the SKAO and the CSIRO
- Forrest Research Foundation Scholar's Dinner

FRIDAY 30 AUGUST

- NOVA 937 Breakfast Radio Interview (In-Studio)
- Tour of the International Space Centre, UWA
- Morning Tea Q&A with the International Centre for Radio Astronomy Research
- Lions Eye Institute Microgravity Demonstration
- WA Space Science Education Centre LiveStream to all participating schools in Western Australia (87)
- Triple M In Studio Live Radio Interview (Rush Hour)

SATURDAY 31 AUGUST

- UWA Octagon Theatre *How to Become an Astronaut*
- Australian Women's Pilots' Association
- WA Museum Boola Bardip *Ask an Astronaut*

SUNDAY 1 SEPTEMBER

- Tour of Air Traffic Control tower at Perth Airport

Reducing astronaut blindness

Professor Danail Obreschkow, Aleksandar Vukmirovic, Dr Andrew Mehnert, Dr Robert Gallagher, Katherine Bennell-Pegg, Professor William (Bill) Morgan and Jasmine Quin-Conroy in the Oculinx laboratory.

A cross-disciplinary team from the Lions Eye Institute and the International Space Centre developed a revolutionary technique to measure pressure changes in brain fluid.

Professors Bill Morgan and Danail Obreschkow and team have adopted a common tool from astronomy to measure brain fluid pressure in humans, which may reduce vision damage experienced by astronauts on long-haul space flights, leading to the publication of two Nature articles.

"The so-called Space Associated Neuro-ocular Syndrome is one of the most serious risks for astronauts on long-duration flights and one that NASA identified as a significant challenge on future crewed missions to Mars," Professor Obreschkow said.

Then-Lions Eye Institute Managing Director and lead author Professor Bill Morgan said human bodies had evolved to counter the effects of gravity by pushing blood upwards into the head.

"In microgravity, this can lead to an increased average pressure in the cerebrospinal fluid, which adversely affects the retina and deteriorates vision and other important functions," Professor Morgan said.

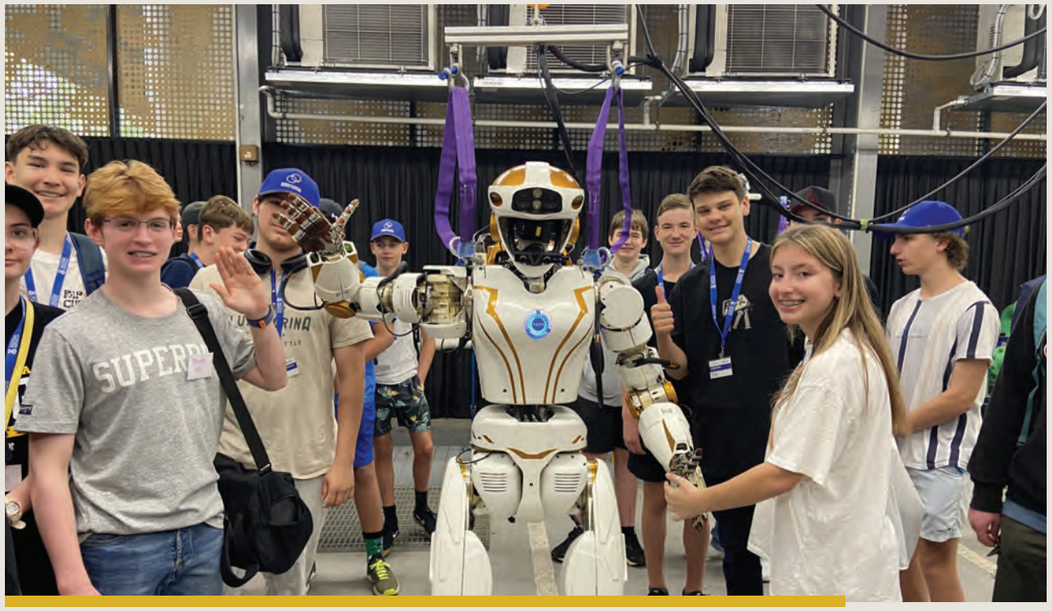
Until recently, this pressure could only be detected through invasive methods such as a lumbar puncture or skull burr hole, techniques which are painful, risky, and cannot be performed well in microgravity.

The team has now developed a space-safe and non-invasive method to measure cerebrospinal fluid pressure changes.

The team has been collaborating with JAXA astronaut Koichi Wakata, who visited the lab with Canadian astronaut Shawn Pandya in November 2024. The team was connected by Katherine Bennell-Pegg, who watched a demonstration of the technique during her visit two months earlier.

Lions Eye Institute

Space Boot Camp



2023 Space Boot Camp students visit Woodside's Karda Robotics Laboratory, and work with one of only five NASA Valkyrie humanoid robots in the world.

The ISC's Space Boot Camp continues to inspire and fast-track highly engaged high school students through to space related careers.

With the generous support of the Fogarty Foundation, Space Boot Camp provides the opportunity for secondary students with a passion for STEM to get a taste for the careers of academic researchers and experience industry environments.

Partnerships are key in the success of the continuing Space Boot Camp series. With support from the **Australian Space Agency, Fugro SpAARC, First Mode, Woodside, the European Space Agency, CSIRO, AROSE, the SKAO-Low and other agencies**, West Australian students can access a full range of career choices and subject matters to spark and inspire their decision-making process at such a critical time.

The 2023 Space Boot Camp saw 60 students attend a three-day camp. 20 positions were sponsored by the Fogarty Foundation, and this support has increased over time to 2025. The students attended six information sessions, four intensive workshops, and three major industry excursions .

How well did SBC introduce my child to the potential of working in the space industry? 5/5 (SBC 2023 Survey Results)

September 2023 Survey Responses:

"The best part about the course was meeting new people with similar mindsets! I've made some great new friends who I hope to stay in touch with."

"The thing I liked most about the course was the number of experts we were able to hear from and ask questions of."

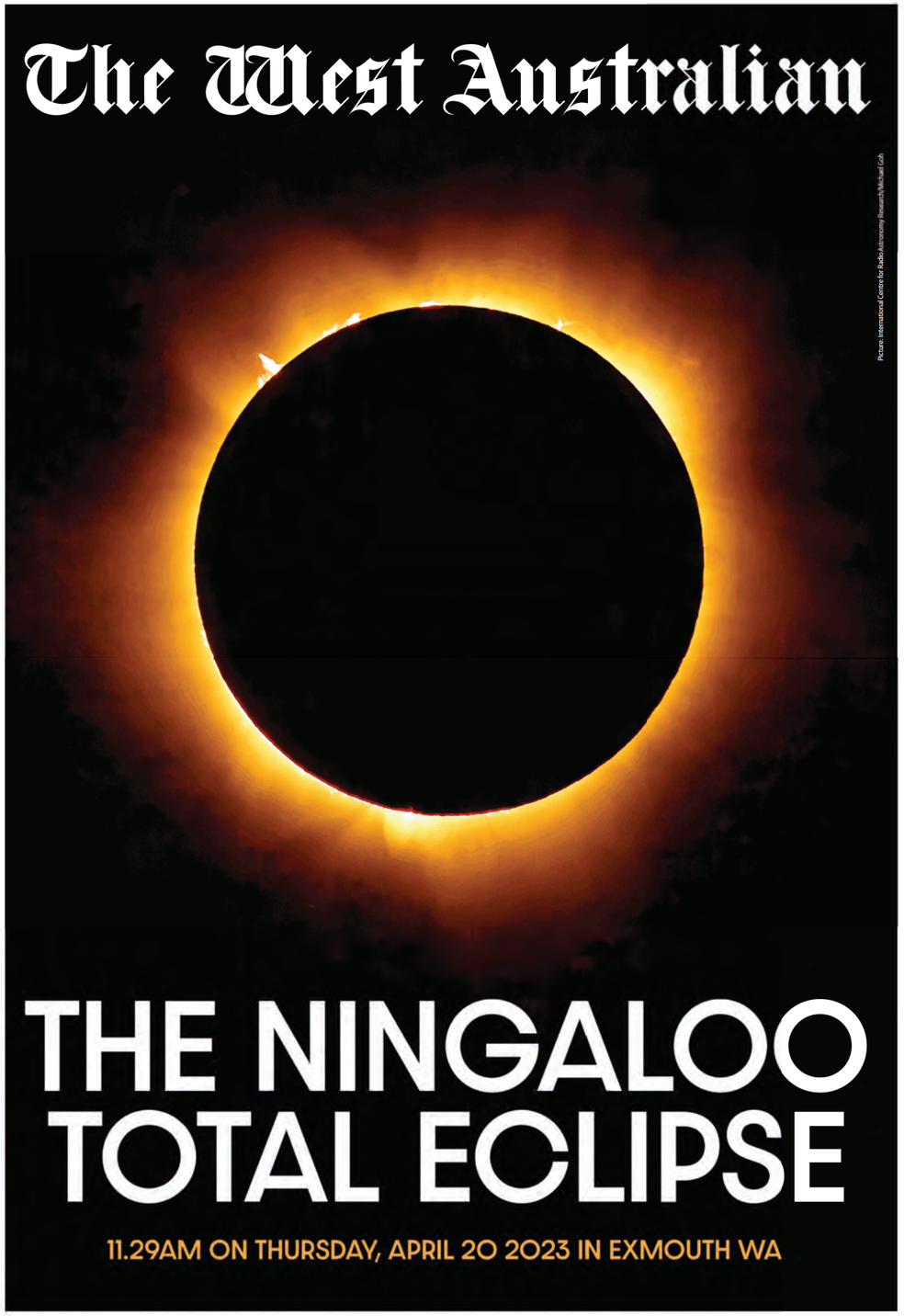
"They were passionate about what they taught, and encouraged the students to challenge their own thinking and knowledge."

"The best part about Space Boot Camp was seeing how massive and vital WA and Australia played in the world space industry, which was refreshing. The teachers were enthusiastic and fun to be around."

"The Zadko Observatory was dazzling. The study of gravitational waves as a whole is an amazing thing, and such tools are even greater than the waves themselves."

With grateful thanks to the

Fogarty Foundation

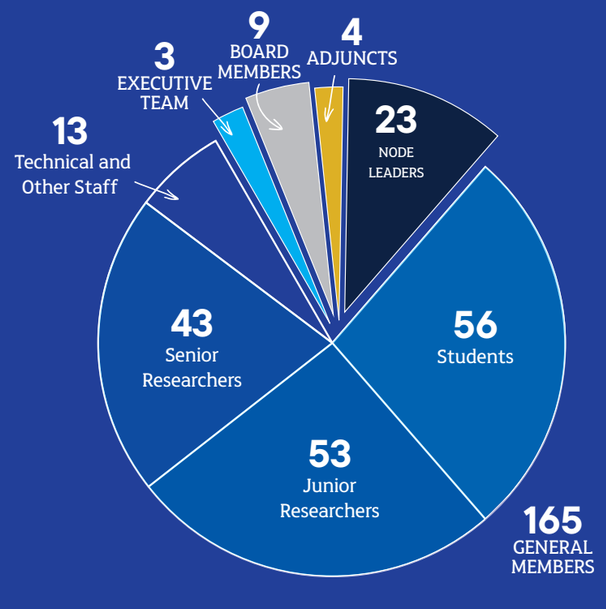


ABOVE The ISC supporting the International Centre for Radio Astronomy Research with communication strategy and a PR campaign to leverage interest in the April 2023 total solar eclipse. This photograph featured on the front page of The West Australian and streamed footage across prime time news was taken by Michael Goh for the International Centre for Radio Astronomy Research.

PREVIOUS The 2023 ISC Space Boot Camp.

The ISC in Numbers

The Numbers That Make Up The ISC



Engagement

38
Events led and supported

51
Publication bylines

20
Early Career Researchers supported with travel grants

68
Members of Mission Control

Social Media Network

2,451
LinkedIn Followers

16K
Facebook Views

1,241
ISC News Subscribers

	Editorial Stories	Editorial Reach	Advertising Value Equivalency
2023-2024	219	304.4M	$263K
ICRAR (SOLAR ECLIPSE 2023)	193	525M	$4.86M
IPSEC 2024	115	32.4M	$300K
KATHERINE BENNELL-PEGG VISIT	134	177M	$1.6M

New Grants - within the Capabilities*

$11M / $1.5M
Cash / Services and Resources

Ongoing Grants - within the Capabilities

$7M
Cash

New Grants - ISC Central

$253K
New external cash funding received through ISC Central

Ongoing Grants - ISC Central

$203K
Continued external cash funding, active during reporting period

Funding Provided to Members

$35K
Awarded to support space research activities

* excludes ICRAR/SKA/astronomy, except for where data is obtained using space-based facilities.

Only directly space-related grants are included in this reporting.

ABOVE Professor Danail Obreschkow engaging with the crowds at Raising the Bar.

External Stakeholders

Major Partners

- Australian Space Agency (ASA)
- International Centre for Radio Astronomy Research (ICRAR)
- Thales Alenia Space (FR, CH, AU)
- Fogarty Foundation
- Fugro SpAARC
- National Geotechnical Centrifuge Facility (NGCF)

Partners Within the University

- Future Energy Exports CRC
- OzGrav
- The UWA Data Institute
- The UWA Defence and Security Institute
- ARC CoE for Engineered Quantum Systems (AU)
- UWA Aerospace
- The UWA Public Policy Institute
- UWA Robotics Club

Associations/Networks

- Australian Women's Pilots' Association
- Chamber of Minerals and Energy of WA
- American Association of Petroleum Geologists
- Geological Society of Western Australia
- International LISA Consortium for Space GW Detection
- Amira Global
- AUSIF
- Integrated Marine Observing System
- Chamber of Commerce and Industry

Government (Domestic)

- Department of Jobs Technology Science and Innovation (JTSI)
- Geoscience Australia
- SmartSatCRC
- CSIRO Oceans and Atmosphere
- Andy Thomas Space Foundation
- Defence Science and Technology Group
- Australian Institute of Marine Science (AIMS)
- DefenceWest
- Australian Defence Force (ADF)
- Australian Remote Operations for Space and Earth
- Space Command
- CSIRO
- Defence Science Centre
- WA Health
- Department of Education (WA)
- AusIndustry

Government (International)

- US Air Force Academy
- Polish Space Agency
- European Space Agency (ESA)
- NICT (Japan)
- Aselsan A.S. (Turkey)
- Space Telescope Science Institute
- Australian Nuclear Science and Technology Organization
- US State Department
- CNES
- NASA
- Royal Commission for ALULa (Saudia Arabia)
- NASA (Goddard)
- Russian Astro-Space Centre
- German Space Agency (DLR)
- The Swedish Space Corporation
- JAXA
- NASA (JPL)
- NASA (Kennedy Space Centre)
- The French Ministry for Europe and Foreign Affairs

Industry/Commercial

- SpaceLab Technologies (SpaceLab)
- Vertical Future
- OnePoint One (OPO)
- GAIA Project Australia
- Metso Outotec
- Covalent Lithium
- Amberg Engineering AG
- Nova Systems
- Starsite
- Novespace
- Anglo American
- Lundin Mining
- ST Group
- L3 Harris
- Samsung Heavy Industries
- Mining and Processing Solutions
- First Mode
- LatConnect 60
- Marketforce
- Perth Airport
- Inpex
- EntX Energy
- Rio Tinto
- Gold Fields
- MineARC Systems
- Tianqi Lithium Australia
- DUG
- Airbus S.A.S.
- Space Angel
- ArianeGroup
- Infinite Green Energy
- Agincourt Resources
- CGG Services UK
- Axiom Space
- Power Mation
- LeoLabs
- KPMG
- VGW
- Numerica
- Woodside
- BHP
- 3vGeomatics
- Yuri
- Concept ARD LLC
- Slingshot Aerospace
- Gilmore Space Technologies
- QL Space
- WA SpacePort

Research Partners or Educational Centres

- ETH (Switzerland)
- Rice University
- Curtin University
- University of New South Wales
- Griffith University
- University of Grenada (Spain)
- University of Cambridge (UCam)
- International LIGO-Virgo-KAGRA Collaboration
- University of Arizona
- The Chinese Academy of Sciences
- The University of Leicester (UK)
- University of Nottingham (UoN)
- ARC Centre of Excellence for Gravitational Wave Discovery
- European Space Agency (ESA)
- Tsinghua University
- Universite Laval
- French National Institute for Agriculture, Food and the Environment (INRAE)
- TU München
- Le SYRTE
- University of Newfoundland
- Julich Research Centre
- UB München
- The Fraunhofer IAF (Germany)
- Ohio State University
- Bar-Ilan University
- The Swiss Federal Institute of Technology Zurich (ETH)
- Max Planck Institute for Experimental Physics
- Arizona State University
- Institute of Geosphere Dynamics of Russian Academy of Sciences
- James Cook University
- The Imperial College of London
- PEARLS
- University of Melbourne
- Moscow Institute of Physics and Technology
- Queensland University of Technology
- Oxford University
- Andy Thomas Centre for Space Resources
- University of Adelaide
- Bathurst Observatory Research Facility
- University of Cergy Pontoise (France)
- La Trobe University
- École normale supérieure de Lyon
- Salk Institute for Biological Studies
- University of the Sunshine Coast
- Gustave Eiffel University (France)
- University of Georgia
- University of Florida
- Centre National de la Recherche Scientifique
- Ecole des Ponts ParisTech (France)
- University of California Berkeley (UCB)
- University of California Davis (UCD)
- University of Wisconsin Madison (UWM)
- Lions Eye Institute
- University of Utah
- The Australian National University
- Macquarie University
- University of Milan
- The Forrest Research Foundation
- SKA
- The University of Southern Queensland
- The Swinburne University of Technology
- Joseph Banks
- Secondary College
- West Australian Space Science Education Centre
- Victorian Space Science Education Centre

Telescopes & Observatories

- ESO
- Hubble
- JWST
- Euclid
- eROSITA
- Roman
- Perth Observatory

Users

- JAXA
- Ariane

Suppliers and Service Providers

- University of New South Wales
- Pawsey Centre for Supercomuting

Media

- SevenWest Media
- MySecurity Media
- SBS
- Whitespark Pics
- ABC
- Southern Cross Austereo
- Space Connect
- Red Empire Media
- Nova Entertainment
- Faircount Media
- The Australia Radio Network
- Channel Nine
- Momentum Media
- Channel 10

Regulatory Bodies

- National Institute of Standards and Technology (US)

Other

- One Giant Leap
- WA Museum Boola Bardip
- SA Botanic Gardens and Herbarium
- Hamilton Secondary College Space School
- Foundation for the WA Museum

As collected from Capability survey results 2023. Capability leaders listed their partners and gave them a relationship weighting from 1-10. Score of 6 and above were listed. Scores of 10 were listed as Major Partners.

Education

ABOVE ISC Director Danail Obreschkow speaks at Jolimont Primary School.

Space Boot Camp

Space Boot Camp (see page 9) is an opportunity for the ISC to expose space-interested secondary students to the possibilities available to them in the tertiary sector, should they wish to follow their hearts into space. Deliberately held before they make their final choices for Year 11 and 12, 80 students are brought on campus to hear from experts in cosmology, space law, rocketry, space biology, satellite technology and space architecture. Supported by the Fogarty Foundation, scholarship places are made available for students from socially and geographically disadvantaged regions.

School Events

Speaking to local primary schools is a regular activity for many of the members of the ISC – including the Director of the ISC, Danail Obreschkow. These activities are performed on a purely voluntary basis, but bring a lot of joy to the team and postdocs around the Centre.

WA Space Science Education Centre

The ISC also values its relationship with the WA Space Science Education Centre, at Joseph Banks Senior College. As a member of the steering committee for WASSEC, we have the unique opportunity to deliver quality education and industry touchpoints to students in their high school years, strengthening the education pipeline to space research at a tertiary level. Staff have also delivered programs to primary school students, sparking their interest in space education.

WASSEC currently runs three programs – Mission to Mars, Plants for Space and Cyber Security.

Studying at UWA

There are many degrees at The University of Western Australia that will lead you to a space career. We've listed just some of the specialist units taught by our researchers that may interest you below. Wider degree and more information is available in the UWA Handbook. If you'd like more advice on working towards a space industry career, we're happy to help. Call the Centre on 6488 1135 or email isc@uwa.edu.au.

Our Universe [SCIE1121]

Explore the deep questions humans have asked for millennia about time, space, and our place in the universe across different cultures.

Our Place in Space [SCIE2212

Journey from traditional cultural astronomy, including Aboriginal perspectives, to modern planetary science and solar system formation.

Russia and the Soviet Union 1900–2000 [HIST2917]

Emerging from the Stalin regime as a global superpower, the Soviet Union, expanded to an empire spanning now from Berlin to Japan, locked horns for planetary supremacy with the USA.

Data Structures and Algorithms [CITS2200]

Study the specification, implementation and time-and-space performance of a range of commonly used ADTs and corresponding algorithms in an object-oriented setting.

Stellar Astrophysics and Frontier Astronomy [PHYS2100]

Learn about the astrophysics of stellar evolution, stellar objects and black holes; and the astronomy techniques used to observe these and other systems.

Astrophysics and Space Science [PHYS3003]

The physical principles underlying radiation mechanisms, planetary astronomy, stellar birth and evolution, astronomy techniques, neutron stars and supernovae, optical telescope projects and computer modelling laboratories.

Embedded Systems [ELEC3020]

Design and build embedded systems using microcontrollers, sensors, and actuators, culminating in an autonomous robot.

Mechatronics [AUTO3002]

Work in teams to design, build a robotic system from scratch to compete in the Warman competition.

Robot Manipulators and Automation [AUTO4507]

Gain hands-on experience programming industrial robot arms.

Gravitational Wave and High Energy Astronomy [PHYS4420]

Study gravitational wave sources, detection methods, and high-energy astrophysical phenomena.

Galaxies and Galactic Dynamics [PHYS4419]

Investigate the structure, evolution, and dynamics of galaxies and large-scale cosmic structures.

Mobile Robots [AUTO4508]

Work with real and simulated driving robots; Use the EyeSim simulator and the ROS-2 libaries.

Space and Satellite Law [LAWS5577]

Explore a comprehensive introduction to two interrelated areas: the laws relating to outer space; and the regulation of satellites.

Research Proposal in Astronomy and Astrophysics [PHYS5562]

Develop a literature review and research plan on a focused topic in astronomy or astrophysics.

Dissertation in Astronomy and Astrophysics [PHYS5563]

Finalise and report on the research that was planned in the unit "Research Proposal in Astronomy and Astrophysics", and then executed in the units "Research Project Parts 1 – 4".

Radio Astronomy and the Interstellar Medium [PHYS5514]

Learn about the various constituents and physical processes taking place in the interstellar medium (ISM) of galaxies, and how to use radio telescopes to detect the gas reservoirs out of which new stars are made.

Engagement

Internal Engagement

ABOVE Mission Control group photo & Lunch at the Earth Sciences Museum.

Mission Control

Our Mission Control ECR network is made up of postgraduate and early career researchers who, under the umbrella and funding of the ISC, choose to pursue their interests in space.

Mission Control gives them access to industry events, cross-collaboration projects, social connection and volunteering opportunities, immersing them in the local space industry while they continue their research.

Once every two months, the International Space Centre hosts a Mission Control lunch as a social event, with an invited guest speaker. This is a way for these researchers to make friends with students who may be from a different school of study, yet could share similar interests. It also allows the researchers to meet people researching different specialties and expand their network, and also see what activity is happening in research amongst their peers.

Some of the most popular lunches have included a Space Materials and Resources-led (run by Capability member Professor Tony Kemp) lunch with special guest CEO WA Museum Boola Bardip Alec Coles with a geology specimen demonstration, and a Plants for Space-led lunch in the Bayliss Building, with a guest lecture on our solar system by Professor Danail Obreschkow.

UWA Aerospace

UWA Aerospace is a student-led technical team focused on developing high-powered rocketry capabilities in Western Australia. They design, build, and launch rockets for high-altitude.

The International Space Centre is proud to support UWA Aerospace with over $10,000 in funding to date, as well as promote their activities in the community. Every year the team workshops rocket propulsion with Western Australia's most passionate Year 11 students at the ISC's annual Space Boot Camp, which consistently receives top mark reviews by the students. In 2023 the team completed a successful launch at the Spaceport America's Cup, with travel and sponsorship supported by the ISC. They had a successful launch placing 16/119 teams in the competition; 8/60 in their category; and as the only team from WA, placed 3/7 of Australian teams. The team was supported by the ISC through SESS funding.

ABOVE UWA Aerospace compete at Spaceport America Cup

ABOVE The original rover model, now modified for use in competition

UWA Rover Club

The UWA Rover Club was supported by the ISC with a commitment of $6,000 to assist in their goal of competing in the annual Australian Rover Challenge at the University of Adelaide.

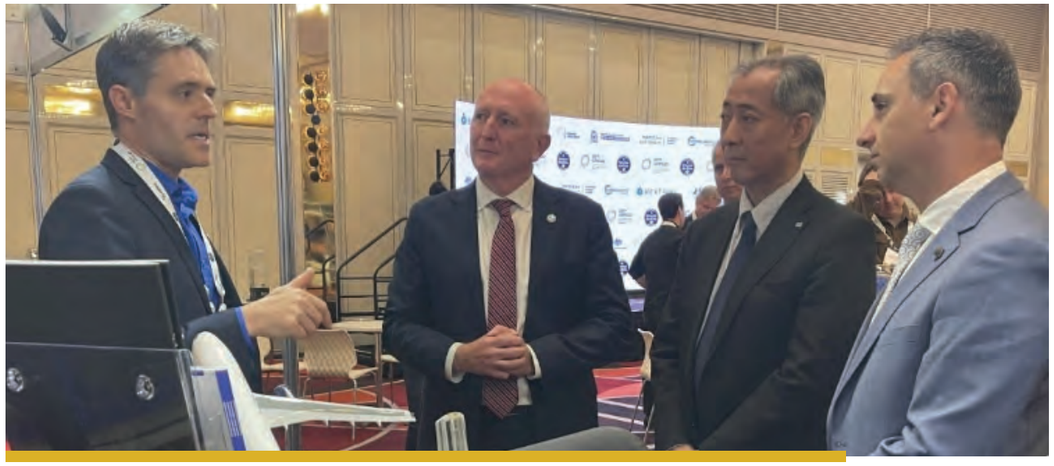
This journey is further strengthened by the opportunities made available to them to support their robotics studies via the ISC. In 2024, the team were invited to visit the AROSE Trailblazer launch of their lunar prototype at the Australian Automation and Robotics Precinct, and the remote automations experts at Nova Systems and Fugro SpAARC spent time with the rover team providing advice and fine-tuning their entry.

The first competition was finally held in 2025 (outside the scope of this document).

> **From funding to expert mentoring, the ISC is helping student teams like UWA Rover Club take their robotics to the next level."**

External Engagement

Indo-Pacific Space and Earth Conferences



ABOVE Professor Danail Obreschkow at the UWA stand with Minister Dawson, Head of JAXA Yamakawa Hiroshi and Head of the Australian Space Agency Enrico Palermo

Over the course of two years the representatives from the ISC have sat on the steering committees for the inaugural and second Indo-Pacific Space and Earth Conferences, run by MySecurity Media.

The challenge for the space research community at UWA at these space conferences is to equalise exposure in terms of branding, speaker opportunities, influence and exposure without necessarily a large cash budget to support sponsorship. The ISC leveraged its strong industry partnerships and good relationship with MySecurity Media to profile UWA on an existing footing with other space-aligned Universities. This was achieved both through garnering internal financial support from space-adjacent and supportive Institutes such as the UWA Defence and Security Institute, Oceans Institute, the Institute of Agriculture, the International Centre for Radio Astronomy Research and the UWA Data Institute, to fund and man booth and exhibition space – and, in the case of the combined IPSEC and APRSAF conferences, support from UWA Brand Marketing and Recruiting with graphic design and funding.

Profile

These were hugely successful conferences in terms of UWA's exposure and increased connections and relationships within the space and adjacent industries. At the conferences the WA Premier Roger Cook, Minister for Science Stephen Dawson and the Head of the Japanese Space Agency Yamakawa Hiroshi stopped at the UWA booth for a photo opportunity. The exhibition booth also provided an opportunity for students to engage directly with international industry, as well as access the seminal presentations and media announcements.

ABOVE Professor Sascha Schediwy, Dr Koichi Wakata, Dr Shawna Pandya and Professor Danail Obreschkow ready for an acquisition and tracking exercise off Cottesloe Beach, supported by the West Australian State Government and the Town of Cottesloe.

Media Opportunities

ABOVE Dr Katherine Bennell-Pegg and Dr Shawna Pandya being interviewed on Nova 937, arranged by the ISC.

Media opportunities to highlight UWA's role in the global space industry were seized upon. The ISC organised significant media opportunities for two astronauts – Dr Shawna Pandya and Dr Katherine Bennell-Pegg – to speak to the media on WA's highest rating breakfast show, Nathan Nat and Shaun on Nova 937.

Capturing the opportunity to spread knowledge and awareness through the astronaut contingent, we arranged for astronauts Wakata and Pandya, and local journalists, to visit the research laboratory of the Space Physiology and Life Sciences Capability at the Lions Eye Institute to view the transformational work being undertaken in Space Acquired Neuro-Ocular Syndrome by Professor Danail Obreschkow and William Morgan (Bennell-Pegg had visited earlier in the year). The day the astronauts visited coincided with the work's publication in Nature.

https://thewest.com.au/news/wa/legendary-astronauts-koichi-wakata-shawna-pandya-get-quokka-selfies-at-rottnest-to-mark-end-of-wa-space-week-c-16907702

This visit to the OcuLinx lab (mentioned page x) with Pandya and JAXA folk hero and astronaut Koichi Wakata led to a tour to the FugroSpAARC remote operations complex. Back at the conference, the ISC organised a photo opportunity for all three astronauts with a critical piece of UWA infrastructure - the TeraNet-3 mobile optical ground station (OGS). This was featured in The West Australian the next day. Further to this, an ISC conversation with State Government (JTSI and Tourism WA) resulted in the funding of a helicopter to shuttle Pandya and Wakata to Rottnest for a classic 'quokka photo shoot'. En route the helicopter flew past Cottesloe Beach, where the TeraNet-3 OGS was again stationed ready to demonstrate its tracking and acquisition capabilities by locking onto the astronaut-laden helicopter, with photographers and media at the ready. All of these opportunities have led to wonderful relationships with the teams of these figures' space agencies – Canada and Japan, and Axiom Space. Many projects have been spurned from these close connections since.

Breakfast by the Bay, The University Club

ABOVE Danail Obreschkow (moderator), Siriana Nair, Aude Vignelles, Linda Dawson and Sarah Pearce discuss how Australia can best place itself as a nascent space economy.

To coincide with the inaugural Indo-Pacific Space and Earth Conference, the ISC held a Breakfast by the Bay at the University Club: Transforming Mindsets towards the Space Economy. Panel speakers included Linda Dawson (Deputy Director General JTSI), US Consul-General Siriana Nair, SKA-Low Director Sarah Pearce and Chief Technology Officer Australian Space Agency Aude Vignelles, moderated by Prof. Danail Obreschkow.

The panel discussion was followed by a private tour of UWA space facilities for invited guests. The event was attended by many members of the media including Senior Reporter at The West Ben O'Shea and ABC Producer Sinead Mangan to keep them up to date on movements in the space sector.

With grateful appreciation to David Matrai and his team from MySecurity Media for providing events such as IPSEC that are the catalyst for many of these opportunities that occur throughout the year.

List of Events

DATE	EVENT	NOTES
5/9/23	Launch of the WA Space and Science Education Centre	Attended Preview Launch for Steering Committee
27/9/23	Space Boot Camp	
23/10/23	Indo-Pacific Space and Earth Conference	
25/10/23	Breakfast by the Bay: Transforming Mindsets to the Space Economy	
	ISC Tour	
	Stargazing at Forrest Hall	Invited guests included the international council of the SKA, Consulates-Generals, and academic researchers from UWA and Curtin.
27/10/23	NASA Panel Session	
30/10/23	Meet and Workshop with Novespace	Bordeaux, France
2/11/23	Tour of the European Astronaut Centre w/ Katherine Bennell-Pegg (KBP) in training	Cologne, Germany
21/11/24	QuantumWest at UWA	Attended by Minister for Science Stephen Dawson
24/11/23	TedX Kings Park	Prof. Sascha Schediwy
1/1/24	Stargirls+	Plants for Space presented at ICRAR's Stargirls+ Camp
23/1/24	NASA Q&A Visitor Evan Laske	
29/2/24	The Space Race – Film Showing and Panel Discussion	Prof James Arvanitakis (moderator), Dr Newton Campbell Jnr (Space Director, AROSE), Renu Sharma (COO ICRAR), Prof. Katarina Miljkovic (Planetary Sciences, Curtin University), Larissa Wiese (MC)
29/2/24	IAC 2025 Space Sector Workshop	SIAA
13/3/24	WA Space Strategy Workshop	JTSI
10/4/24	International and Life Science Node Space Symposium	Lions Eye Institute, Prof. Bill Morgan and guests.
	Public Talk – Dr James Lloyd and Dr Suruchi Roychoudhry	Plants for Space Event
22/4/24	South Korean Space Agency Delegation	Visit and Tour
5/6/24	JAXA and Australian Space Agency	Visit and Tour
7/6/2024	Mission Control Lunch (Plants for Space)	Presenter: Danail Obreschkow
14/8/24	Martian Gardens – Plants for Space (National Science Week)	Primary and High Schools workshop and design sprint on site at Bayliss.
16/8/24	Panel Session – Plants for Space (National Science Week)	Evening Event, ticketed
20/8/24	CNRS Visit, Thierry Correge	Prof. Danail Obreschkow
22/8/24	Public Lecture – Wernher von Braun	Dr Andrew Broertjes
27/8/24	ISC meet the Governor General with Katherine Bennell-Pegg	Prof. Danail Obreschkow
	An Evening with Katherine Bennell-Pegg – Q&A with Katherine Bennell-Pegg and Larissa Wiese	Invite-only dinner at the WA Museum Boola Bardip
28/8/24	Scholar's Breakfast with KBP at Forrest Hall	
	Meet the Media	Press Conference at UWA
	FRF Governor's Lunch	KBP
	Private and Public Interviews	The West and Nine News (live, evening news)
	Ngalang Koort	Public Conversations with KBP at the WA Museum Boola Bardip
29/8/24	Road trip to the SKA	KBP, The West, Nine News, Larissa Wiese, Rebecca Wheadon, Angela Teale
30/8/24	Tour of the ISC	KPB
	Q&A with KBP - ICRAR	
	Tour of the Space Physiology and Life Sciences Lab with KPB	Lions' Eye Institute
	Live Q&A with schools across WA with KPB from Joseph Banks Senior College at WASSEC	
31/8/24	How to Become an Astronaut (and other amazing careers) with KBP, Fighter Pilot Sue Freeman, Prof. Sascha Schediwy, Qantas First Officer 737 Amy Edwards, Zoologist and Microlight pilot Milly Formby and the Prof. Danail Obreschkow as MC.	Public Q&A at Octagon Theatre
	Ask an Astronaut	Live Q&A at WA Museum Boola Bardip
15/10/24	Department of Foreign Affairs and Trade – Presentation to EU Ambassadors	Prof. Danail Obreschkow
14/11/24	Launch of the Critical Resources for the Future ITTC	Moderator Larissa Wiese, University Club.
20/11/24	Raising the Bar – Public Talk at The Stables	Prof. Danail Obreschkow
26/11/24	Indo-Pacific Space and Earth Conference and Asia-Pacific Regional Space Agency Forum	
28/11/24	TeraNet Acquisition/Tracking - Jandakot to Rottnest Campaign	Jandakot to Rottnest Campaign

Media

Raising awareness, enabling the Capabilities

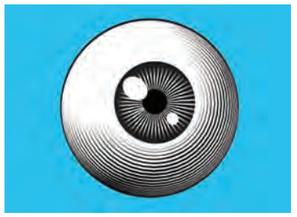
The International Space Centre promotes its Capabilities through outreach and PR, in turn benefitting the Schools they belong to, raising awareness of their research and capabilities. Below are just a few examples of exposure the ISC has enabled over the 2023/4 year.

28 MAY 2023
UWA IMPACT

To the Moon and back: Australia-first communications network paves the way for high-speed data in space.

Professor Sascha Schediwy explains how UWA's optical ground station technology is helping lay the groundwork for future lunar communications.

https://www.uwa.edu.au/news/article/2023/june/to-the-moon-and-back-australia-first-communications-network-paves-the-way-for-high-speed-data-in-space



16 JUL 2023
SCITECH (PARTICLE)

Space makes astronauts blind, but we can see how.

Professor Danail Obreschkow commented on a new eye test developed to prevent space blindness could revolutionise how we diagnose glaucoma and ocular hypertension right here on Earth.

https://particle.scitech.org.au/tech/space-makes-astronauts-blind-but-we-can-see-how/

20 JUL 2023
ABC NEWS

Expert warns of more space junk after Green Head discovery.

"This is only going to become more common," Associate Professor David Coward said, as he explained the growing risks of space debris re-entering Earth's atmosphere.

https://www.abc.net.au/news/2023-07-20/expert-warns-of-more-space-junk-after-green-head-discovery/102621332

12 JAN 2024
ABC INTRODUCTIONS

Introduced Broadcaster Craig Smart and Professor Sascha Schediwy for ongoing story production.

30 JAN 2024
ABC PERTH EARLY MORNINGS

Robotics Team interviewed by Craig Smart

19 FEB 2024
UWA IMPACT

Rising star Lorian launches into space internship.

Lorian Marshall shares her journey from UWA student to securing a competitive space internship with Fugro, highlighting the value of hands-on industry experience.

https://www.uwa.edu.au/news/article/2024/february/rising-star-lorian-launches-into-space-internship

08 APR 2024
UWA IMPACT

Funding gives plants in space a growth boost.

Professor Harvey Millar discusses how new funding will support research into growing plants in space, helping pave the way for future long-term space missions.

https://www.uwa.edu.au/news/article/2024/april/funding-gives-plants-in-space-a-growth-boost

23 APR 2024
KOREAN JOURNALIST DELEGATION

Enabled through ISC's relationship with JTSI

24 APR 2024
AUSTRALIAN INSTITUTE OF INTERNATIONAL AFFAIRS

Australia's Growing Space Agency Amid a Renewed Push to the Stars.

Associate Professor David Coward provides expert insight into Australia's expanding role in space exploration and the importance of sovereign capability in a shifting geopolitical landscape.

https://www.internationalaffairs.org.au/australianoutlook/australias-growing-space-agency-amid-a-renewed-push-to-the-stars/

10 MAY 2024
OI NEWSLETTER

Professor Harvey Millar featured on the front cover.

15 MAY 2024
UWA IMPACT

Space junk comes to life in Ceridwen Dovey's aching and profound tales of fallen astronauts.

Professor Tony Hughes-d'Aeth reflects on the emotional and philosophical dimensions of space debris, exploring its impact through the lens of literature.

https://www.uwa.edu.au/news/article/2024/may/space-junk-comes-to-life-in-ceridwen-doveys-aching-and-profound-tales-of-fallen-astronauts

15 MAY 2024
UWA IMPACT

Research on the Record: Meet Dr Bhagya Dissanayake and Dr Samalka Wijeweera

Bhagya Dissanayake shares her journey into space science and how her research at UWA is helping unlock the mysteries of galaxy evolution.

https://www.uwa.edu.au/news/article/2024/may/research-on-the-record-meet-bhagya-dissanayake

16 MAY 2024
AROSE

Dr Renae Barker Article about Newton's AROSE Space Law

TERANET MEDIA RELEASE

ISC assisted Professor Sascha Schediwy with a media release for the Flying Laptop Signal.

21 MAY 2024
UWA IMPACT

Programming plants for Earth and beyond.

Professor Ryan Lister and Dr Adil Khan discuss their breakthrough in epigenetic reprogramming, which could enable plants to better adapt to extreme environments – including space.

https://www.uwa.edu.au/news/article/2024/may/programming-plants-for-earth-and-beyond

16 JUL 2024
UWA IMPACT

TeraNet captures laser signals from German satellite.

Professor Sascha Schediwy highlights a major milestone for TeraNet, successfully receiving optical signals from a German satellite as part of Australia's growing space communications capability.

https://www.uwa.edu.au/news/article/2024/july/teranet-captures-laser-signals-from-german-satellite

16 JUL 2024
COSMOS MAGAZINE

TeraNet project paves the way for laser communications in Australia.

Professor Sascha Schediwy explains how the TeraNet project is advancing optical ground station technology to support high-speed laser communications with satellites.

https://cosmosmagazine.com/space/astronomy/teranet-laser-communications/

19 JUL 2024
UWA IMPACT

Australian astronaut to touch down in Perth.

Katherine Bennell-Pegg's upcoming visit to Perth highlights her historic journey as Australia's first astronaut trained under the Australian flag, inspiring the next generation of space scientists.

https://www.uwa.edu.au/news/article/2024/july/australian-astronaut-to-touch-down-in-perth

23 JUL 2024
DEUTSCHLANDFUNK

Sky Beam: Satellite Laser Communication Offers Ever Higher Data Rates

Professor Sascha Schediwy discusses the TeraNet project's role in advancing laser satellite communications, enabling faster and more secure data transmission from space.

https://www.deutschlandfunk.de/himmelsstrahl-laser-kommunikation-per-satellit-bietet-immer-hoehere-datenraten-dlf-be905e96-100.html

01 AUG 2024
IEEE SPECTRUM

Laser Satellite Communication Gets a Boost in Australia.

The TeraNet project, led by researchers at UWA, is featured for its pioneering work in optical ground stations enabling high-speed laser communication with satellites.

https://spectrum.ieee.org/laser-satellite-communication

16 AUG 2024
THE NATIONAL

TeraNet is featured for its successful laser satellite communication test, enabling faster, more secure data transmission from space.

https://www.thenationalnews.com/news/2024/07/16/breakthrough-paves-way-for-faster-communications-from-space/

17 AUG 2024
SCIENCE ALERT

New laser network could make space-to-Earth contact 1000x faster.

ScienceAlert spotlights TeraNet's laser communication breakthrough, which could dramatically increase data transfer speeds between satellites and Earth.

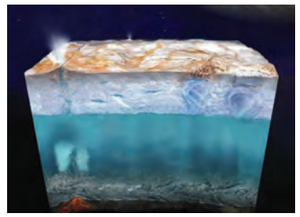
https://www.sciencealert.com/new-laser-network-could-make-space-to-earth-contact-1000x-faster

20 AUG 2024
UWA IMPACT

Inspiring researchers win awards for contributions to science.

Associate Professor David Coward provides expert insight into Australia's expanding role in space exploration and the importance of sovereign capability in a shifting geopolitical landscape.

https://www.uwa.edu.au/news/article/2024/august/inspiring-researchers-win-awards-for-contributions-to-science

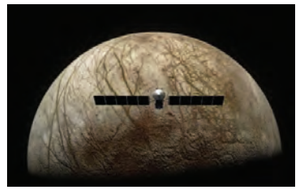


07 OCT 2024
THE CONVERSATION

NASA is launching a major mission to look for habitable spots on Jupiter's moon Europa.

Dr James Lloyd explains the significance of the upcoming Europa Clipper mission and what it could reveal about the potential for life beyond Earth.

https://theconversation.com/nasa-is-launching-a-major-mission-to-look-for-habitable-spots-on-jupiters-moon-europa-239928?utm_source=linkedin&utm_medium=bylinelinkedinbutton



09 OCT 2024
ABC RADIO NATIONAL – DRIVE

Europa Clipper mission and the search for life beyond Earth.

Dr James Lloyd discusses NASA's Europa Clipper mission, its scientific goals, and the possibility of finding habitable conditions on Jupiter's icy moon.

https://www.abc.net.au/listen/programs/radionational-drive/1607-europa-clipper/104451328

12 OCT 2024
ABC NSW SATURDAY BREAKFAST

Exploring Jupiter's moon: what we hope to learn from Europa Clipper.

Dr James Lloyd speaks about the Europa Clipper mission and what it could uncover about Jupiter's moon and the search for life in our solar system.

14 OCT 2024
CHANNEL 9 NEWS AFTERNOON

Professor Sascha Schediwy interviewed by Monika Kos on TeraNet's latest advancements, discussing Australia's growing role in laser satellite communications and future space infrastructure.

09 OCT 2024
UWA IMPACT

UWA team designs a happy, homesick future for lunar living.

Dr Rob Palermo shares insights into designing emotionally supportive lunar habitats, blending space science with human-centred architecture.

https://www.uwa.edu.au/news/article/2024/november/uwa-team-designs-a-happy-homesick-future-for-lunar-living

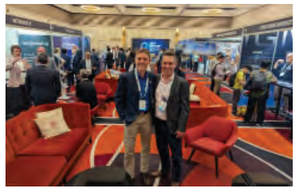
21 OCT 2024

UWA RAISING THE BAR

Researchers bring conversation and cheer to CBD bars.

Professor Danail Obreschkow takes science to the public, leading engaging space-themed discussions as part of an initiative to spark curiosity in unexpected places.

https://www.uwa.edu.au/news/article/2024/october/researchers-bring-conversation-and-cheer-to-cbd-bars



27 NOV 2024

WA TODAY

Out of this world: What's drawing Earth's best space minds to WA.

Professor Danail Obreschkow is featured discussing WA's emergence as a hub for cutting-edge space research and the collaborative ecosystem attracting global talent.

https://www.watoday.com.au/national/western-australia/out-of-this-world-what-s-drawing-earth-s-best-space-minds-to-wa-20241126-p5ktpu.html

29 NOV 2024

THE WEST AUSTRALIAN

Legendary astronauts Koichi Wakata, Shawna Pandya get quokka selfies at Rottnest to mark end of WA Space Week.

TeraNet was among the featured projects during WA Space Week, showcasing Australia's advances in laser satellite communication to international space leaders.

https://thewest.com.au/news/wa/legendary-astronauts-koichi-wakata-shawna-pandya-get-quokka-selfies-at-rottnest-to-mark-end-of-wa-space-week-c-16907702

01 DEC 2024

THE WEST AUSTRALIAN

Space oddity: Perth researchers' pioneering device to monitor astronaut blindness, medical conditions.

Dr Bill Morgan is featured discussing a new space-adapted diagnostic device aimed at monitoring astronaut health, including vision changes in microgravity.

https://thewest.com.au/news/health/space-oddity-perth-researchers-pioneering-device-to-monitor-astronaut-blindness-medical-conditions-c-16895664

09 DEC 2024

ABC RADIO PERTH DRIVE

Interview with Fugro Australia Space Systems Director Dawn McIntosh and Andre Collins from ABC Radio Perth

OPPOSITE Masters research student Jasmine Quin-Conroy and Professor Bill Morgan are among the Perth researchers working with UWA's International Space Centre to develop cutting-edge diagnostic tools for treating eye conditions on earth and in space. Credit: Andrew Ritchie/The West Australian

ABOVE TeraNet-3 running a tracking and acquisition demo on the ISS (Image – the Bold Park astro image of the Jeep taken by Michael Goh, edited by Aliesha Aden)

Capabilities

→ Laser Communications and Timing

The Astrophotonics Group uses free-space laser communication to revolutionise a wide variety of applications at the International Centre for Radio Astronomy Research.

Transmitting information to and from space is not as easy as the movies make it seem.

We've become so used to instant communications on Earth that it may surprise you to know that there is not even a 4G data connection in space.

To communicate with spacecraft, you typically need the support of a Ground Station Network, whose antennae are ready to receive data as the spacecraft pass by. TeraNet-1 (formerly the WA Optical Ground Station) at UWA is the first in a new planned network of optical ground stations across Australia and New Zealand.

As we want to improve the rate of communications with space, we need to look for a more solid bandwidth. The most common electromagnetic frequency used for space communications is radio – but optical bandwidths have a much higher capacity and can transmit data at rates much faster than before: in fact, tens of thousands of times faster. Using optical communications (also called laser or infrared optical communications) we can transmit 4K video from the Moon.

Radio transmission would only give us the equivalent of the grainy videos we saw on the Apollo missions!

The challenge with optical communications is that the data transfer is easily disturbed by turbulence in the atmosphere. It's a little like making the change from a cassette to a CD – the quality is much better, but they are more fragile and prone to contamination.

The Optical Communications and Timing Node of the International Space Centre has produced world record-breaking results by transferring data across great distances through turbulence with little loss. They use amplitude- and phase- stabilisation technology, which is achieved using a very fast steering mirror that corrects for turbulence hundreds of times per second. Last November, this group achieved a data transfer rate from ground to a drone of 100GB/s (or the equivalent of 100SD movies per second!). The drone was flown to simulate a low Earth orbit satellite passing overhead. Optical communications also have the advantage of greater security. They can be pinpointed to a position on Earth, making them much harder to intercept.

Updates

- → Construction of the second optical ground station in Mingenew (TeraNet-2, or TN-2) began.
- → Construction of the mobile optical ground station completed (TeraNet-3, or TN-3) began.
- → Fundamental Communication Systems Installation and Commissioning
  - » TeraNet-1 (TN-1) and TN-3 optical system detailed design, simulation, and prototype testing continuing.
  - » TN-1 and TN-3 tip-tilt hardware testing complete.
  - » Uplink pickoff mirror design completed.
  - » Mechanical focusing stage hardware identified.
  - » L-band uplink beacon components procured.
  - » TN-1 and TN-3 optical network handover simulation complete.
  - » TN-3 New Norcia commissioning campaign upgrade.
  - » Jeep suspension upgraded.
  - » Telescope raising mechanism fabrication completed.
  - » Mechanised canopy reference design completed.
  - » Engineering firm commissioned for construction.
  - » Rapid deployment improvements from new IMU and fast acquisition algorithm.
- → Advanced Communication Systems Installation and Commissioning
  - » TN-1 deep-space communications commissioned and installed.
  - » SNSDPs installed and undergoing testing.
  - » On-sky sensitivity tests using stellar sources.
  - » 10 pW detected from Alpha Centauri.
  - » TN-2 high-speed coherent comms confirmed.
  - » Advanced Optics uplink pre-compensation experiments and algorithm development completed.
  - » TN-2 pulsed satellite laser ranging.
- → Highly skilled training
  - » Drs Shane Walsh and Mike Kriel qualified as drone pilots to support outreach activities.
  - » PhD candidates Alex Frost and Senior Research Officer Nicolas Maron worked with collaborator HartSCI in the US for four weeks, and also attended Advanced Optics Summer School at UC Santa Cruz.
  - » PhD candidate Ayden McCann's paper was accepted with minor revisions in Nature Scientific Reports.
  - » Frost gave a presentation on Advanced Optics work with HartSCI, and McCann and Dr Shawn Walsh presented posters at the 25th AIP Congress, December 2024.
  - » Frost invited to give similar presentation at the DLR Communications and Observations through Atmospheric Turbulence Workshop in Munich, April 2025.
- → Community and Stakeholder Engagement
  - » TinyTeraNet at the International Astronautical Congress in Milan.
  - » Jeep under body lighting and TVs (broadcasting telescope view) installed.
  - » TN-3 live astronomy viewing at Astronomy WA Astrofest.
  - » Promotional material produced: Jeep cutout handouts, TeraNet banners, brochures.
  - » Commissioned a video showcasing the rapid deployment capabilities of TN-3.
  - » Prof. Sascha Schediwy attended WA Space Industry Strategy launch.
  - » Hosted Rear Admiral Philip Spedding.
  - » Schediwy interviewed on Perth Channel 9 TV news.
  - » Frost, Walsh and Schediwy attended ICSO.
  - » McCann and Walsh presented posters related to TeraNet.
  - » Schediwy attended the ESA ACES Workshop 2024.
  - » TN-3 display at Warnbro Community High School.
  - » Participation in WA Space Week: APRSAF, IPSEC, and ASEF.
  - » TN-3 on display at conference entrance.
  - » Display of TinyTeraNet models at UWA exhibition booth.
  - » Schediwy presentation at IPSEC and on panel at ASEF.
  - » Astronaut-assisted helicopter tracking demonstration at Cottesloe beach.
  - » TN-1 and TN-3 showcase at the UWA International Space Centre Space Boot Camp 2025.

PROFESSOR SASCHA SCHEDIWY
International Centre for Radio Astronomy Research

Avionics for Remote Sensing

ABOVE Professor Lorenzo Faraone demonstrates the Molecular Beam Epitaxy machine to visitors as it cultivates mercury cadmium telluride for use in sensor chips.

The UWA avionics research team develops world-leading electro-optic sensors, imaging devices, and electronic systems for space-based earth observation and space situational awareness.

The sensors created for satellites to collect information about the Earth are critical to the quality and range of data used to research important topics such as climate change, defence, disaster zones and agricultural monitoring. At UWA, we have a unique and complete supply chain to create hyperspectral and infra-red sensors.

The research team, led by Professor Lorenzo Faraone, develops world-leading electro-optic sensors, imaging devices, and electronic systems for space-based earth observation and space situational awareness.

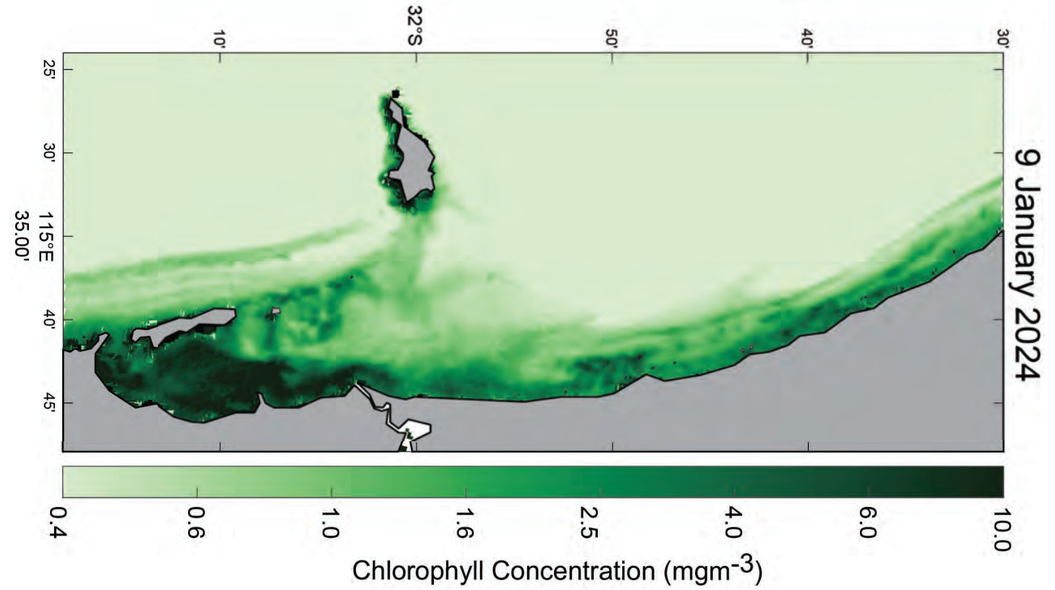
Professor Faraone's team focus on:

- Material production for infra-red sensors and imaging arrays (molecular beam epitaxy (MBE) growth of device-grade HgCdTe);
- Tuneable filters for IR spectroscopic sensing (MEMS-based);
- Design and fabrication of IR imaging arrays up to 640×512 pixels;
- Modelling of atmospheric effects on optical propagation;
- They are also active developers of cutting-edge quantum sensing technologies, working in collaboration with UWA Professor Michael Tobar of the Quantum Technologies and Dark Matter Research Lab.

Updates

- Display of avionics capabilities at the 2023 and 2024 Indo-Pacific Space and Earth Conferences.
- In 2023 established a satellite network that can provide a maritime monitoring system in the Indo-Pacific.

PROFESSOR LORENZO FARAONE
UWA School of Engineering
Head of the UWA Microelectronics Research Group (MRG)



ABOVE Surface Chlorophyll image obtained by the Sentinel-3 satellite along the Perth coastal margin on 9 January 2024. Image showing the presence of a phytoplankton bloom in Cockburn Sound with maximum concentrations exceeding 10 mg/m3. The concentrations rarely exceed 3 mg/m3 under 'normal' conditions.

Earth Observation from Space

Satellites provide a uniquely efficient way of making repetitive observations of Earth's land, coast and oceans that allow for a wide range of applications, especially as past observations now provide decades of data to analyse.

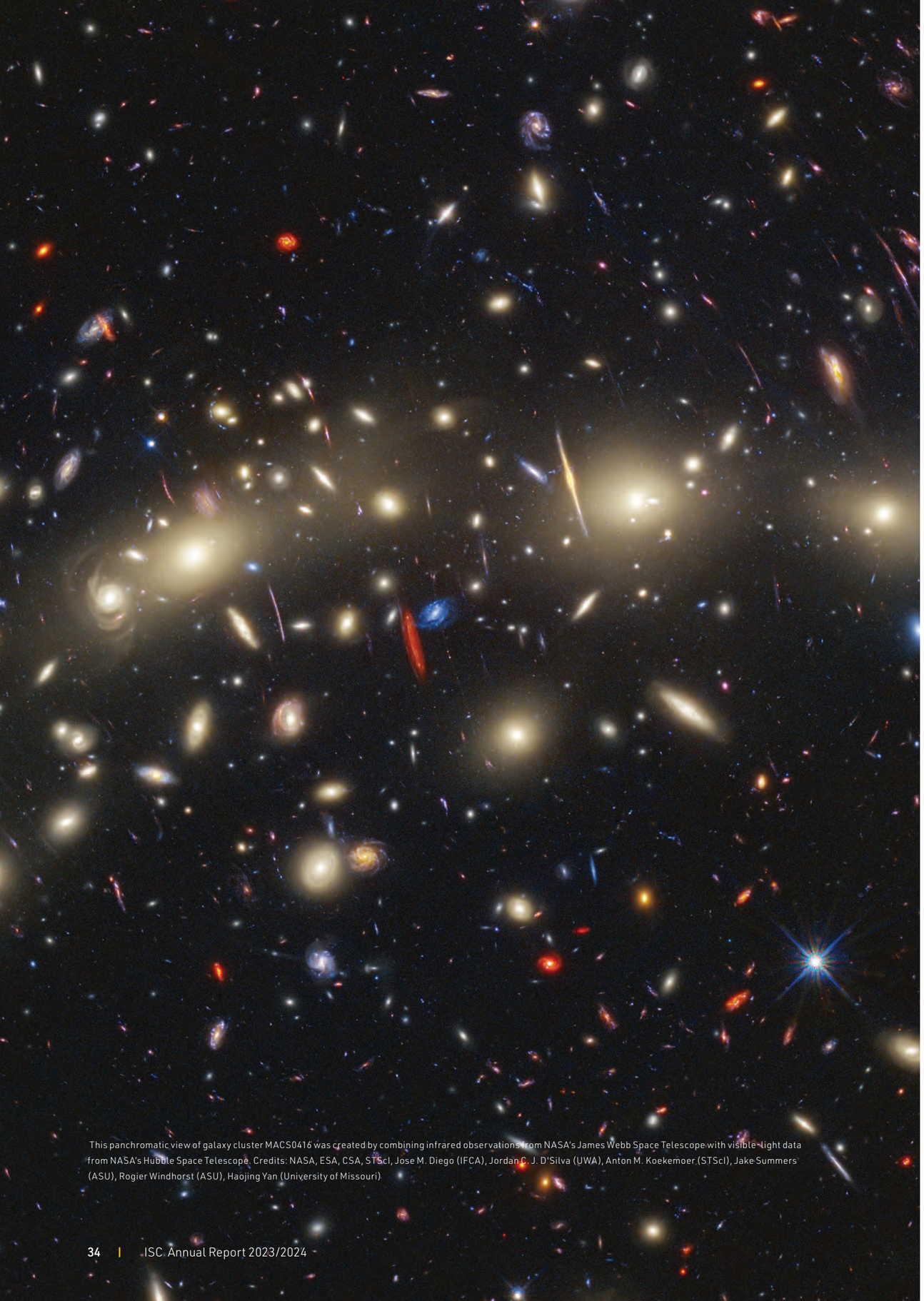
UWA's research team, overseen by Professor Charitha Pattiaratchi, focuses on:

- Seasonal and inter-annual variability of sea surface temperature, surface chlorophyll, ocean circulation and kinetic energy around Australia
- Mesoscale and sub-mesoscale eddy activity off WA
- Island wakes and ocean fronts in the Indian Ocean
- Marine heat waves and cold episodes around Australia
- Prediction and impacts of tropical cyclones in WA
- Quantifying vertical and lateral ocean transport due to fronts and eddies
- Meaningful monitoring of Tailings Storage Facilities using established and emerging monitoring technologies
- High-return rate measurements of coastal bathymetry (ocean depth)
- The Aerial Archaeology in the Kingdom of Saudi Arabia (AAKSAU) project
- Enhancing maritime safety, security, compliance, and law enforcement with the use of satellite data
- Hydrology from space: measuring floods and water resources using satellite remote sensing
- Satellite governance and remote sensing legislation

Media

https://thewest.com.au/news/environment/perth-beach-health-questioned-ahead-of-summer-as-residents-find-tampons-cotton-buds-waste-along-shorelines-c-16752591

PROFESSOR CHARITHA PATTIARATCHI
UWA School of Engineering
UWA Oceans Institute



This panchromatic view of galaxy cluster MACS0416 was created by combining infrared observations from NASA's James Webb Space Telescope with visible-light data from NASA's Hubble Space Telescope. Credits: NASA, ESA, CSA, STScI, Jose M. Diego (IFCA), Jordan C. J. D'Silva (UWA), Anton M. Koekemoer (STScI), Jake Summers (ASU), Rogier Windhorst (ASU), Haojing Yan (University of Missouri)

Distant Universe from Space Telescopes

Extragalactic astrophysics is a stand-out strength at The University of Western Australia's node of the International Centre for Radio Astronomy Research. Professor Simon Driver is leading the ISC Capability for studying the distant universe using space telescopes.

Galaxies typically emit radiation at all wavelengths and only a small fraction of this energy penetrates to the ground, in doing so the images that do reach the ground become blurred and distorted. Space telescopes are critical for both high-resolution imaging at optical and near-infrared wavelengths and to sample wavelength ranges not possible from the ground such as the x-ray and far-infrared.

This group specialises in "fusing" data from leading space and ground-based facilities to study the distribution of dark-matter, the evolution of galaxy properties over time, and the primary energy production pathways operating across the timeline of the Universe. This involves the processing of large and disparate data flows from many of NASA and ESA's flagship space telescope missions as well as those from other agencies.

Key focusses at the moment are the use of the Hubble and James Webb Space Telescopes to study the formation of the first galaxies, and to reconstructing the cosmic star-formation history and the cosmic black hole accretion history over the age of the Universe. Future efforts will focus on the recently launched ESA Euclid and NASA SPHEREx missions, and the upcoming Nancy Grace Roman mission.

Much of the space-telescope data processed by this Capability is downlinked through Australian-based facilities at Tidbinbilla, ACT and New Norcia, WA. The group also acts as a liaison with NASA and ESA around downlink activities and exploration of new and novel pathways for rapid data analysis at the downlink site and data fusion.

Updates

- Publication of over 40 refereed papers in A*journals using space-telescope data and including data from eROSITA (DLR), HST (NASA), JWST (NASA), GALEX (NASA), WISE (NASA), Spitzer (NASA) and Herschel (ESA) missions.
- Development and publication of a software suite and pipeline for improved reduction of JWST data and used by the US PEARLS team to process all their JWST data.
- Award of major NASA grant to process all JWST archival data to study the extragalactic background light and dust in the Solar System.
- Reanalysis of all Hubble Space Telescope data to produce a homogeneous catalogue of over 100 million galaxies.
- Detailed study of the gas and dust properties of highly dust obscured galaxies at very high redshifts.

Grants

- Dark-SKY: A NASA JWST Cycle 3 Archival grant (led from ASU but including Driver & Robotham) and awarded approximately A$1million by NASA
- https://www.stsci.edu/jwst/science-execution/program-information?id=4695
- ARC Discovery Grant: Looks aren't everything, to Dr Luke Davies and Prof Aaron Robotham A$525,225.00
- https://research-repository.uwa.edu.au/en/projects/looks-arent-everything-the-coevolution-of-galaxy-structure-enviro

Media and Engagement Examples

https://webbtelescope.org/news/news-releases?keyword=PEARLS&itemsPerPage=15&page=1

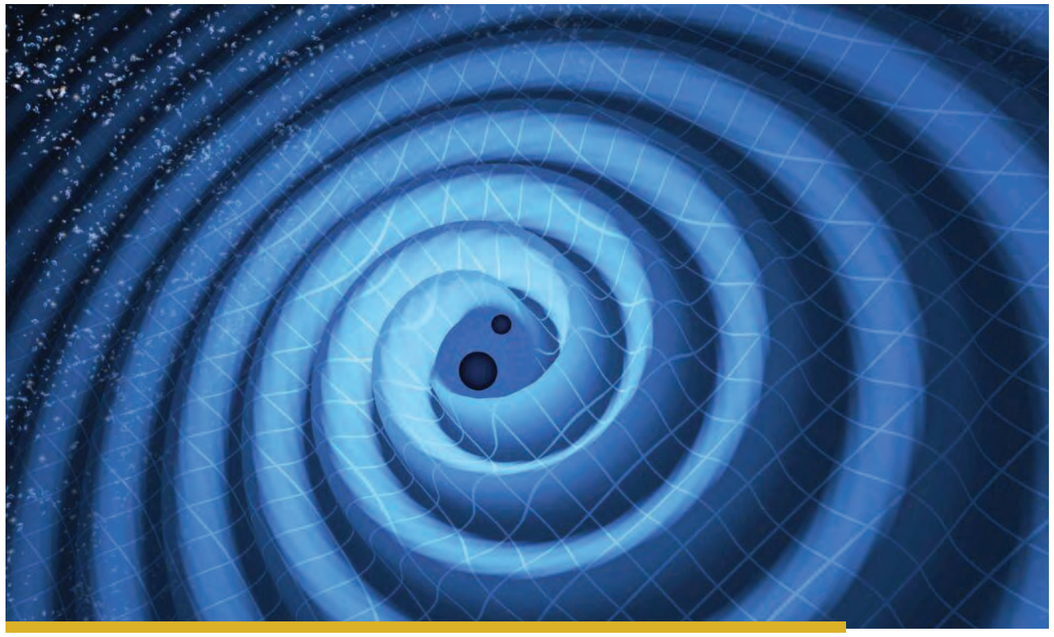
Driver presented at the ISC's Space Boot Camp, and introduced the students to the configurations of deep space networks before they visited ESA's DSN in New Norcia.

As Chair of the AAL Space Science Leads Committee Professor Simon Driver organised the Advancing Australian Participation in Space-Based Astronomy workshop.

PROFESSOR SIMON DRIVER
International Centre for Radio Astronomy Research

Gravitational Wave Astronomy

This team is probing our Universe using the emerging astronomical messenger of gravitational waves (GW).



ABOVE Artist's impression of merging binary black holes and the ripples of space and time.

They will transfer signal-processing technologies developed for ground-based gravitational wave detectors to observations from space, as well as combine gravitational wave and electromagnetic (EM) information for breakthrough science and for a better understanding of our astrophysical Universe.

Their strengths include:

- Methods and strategies to detect gravitational waves from space;
- Studies of GW sources suitable for joint space-ground detections;
- Joint GW-EM coincidence detection and astrophysical implications; and cosmology using GW signals detected from space and the ground.

Updates

- Investigation of signature of gravitational waves from triple black hole systems to be detected by the space gravitational wave detector LISA
- Detection of stellar-mass binary black holes to be detected by both space gravitational wave detector LISA and ground-based detectors including LIGO, Virgo and KAGRA.
- 2023 Finalist, International Quantum Short Film Festival, Singapore, music video Continuum, with Linqing Wen as the STEM partner (https://equs.org/news/melbourne-quantum-shorts-wrap)

PROFESSOR LINQING WEN
UWA School of Physics, Maths and Computing

Radio Interferometry Observations from Space

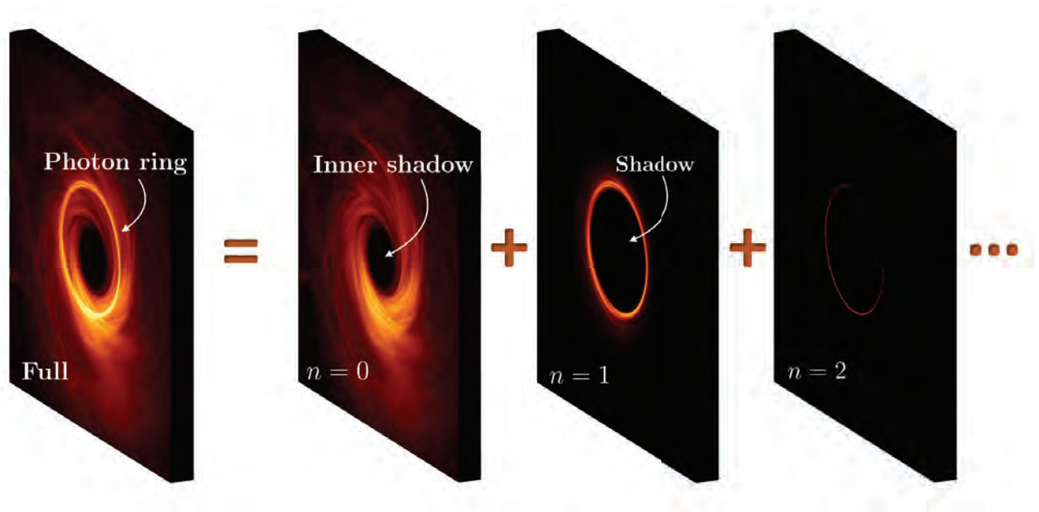
The group for Radio-astronomy Interferometric Observations from Space (RIOS), co-led by Associate Professors Richard Dodson and Maria Rioja, is part of the UWA node of the International Centre for Radio Astronomy Research with strong international collaborations into next-generation observatories.

They are currently defining the instrumental specifications and requirements for the Russian Astro-Space Centre mission Millimetron. This extremely challenging mission proposes to improve the Event Horizon Telescope results by increasing the frequency by 50% and locating one antenna in space for joint observations with ground-based telescopes. Both of these two aspects introduce huge challenges, that can only be overcome with innovative observational and analysis methods.

Updates

The major development for the RIOS has been involvement in the Black Hole Explorer mission, which will add space VLBI baselines to the ground based Event Horizon Telescope (EHT). This is the instrument that made the ground-breaking images of the shadows of black holes in the past few years. Adding space baselines will increase the resolution several times over, allowing the detection of the "photon rings". These are precise probes of predictions of general relativity and physical parameters of the black holes themselves (mass, spin, etc).

ASSOCIATE PROFESSORS MARIA RIOJA AND RICHARD DODSON
International Centre for Radio Astronomy Research



ABOVE Figure show Snapshots of a black hole display distinctive features, including a narrow photon ring composed of a stack of increasingly sharp subrings. Each subring is produced by photons that orbited around the black hole times before reaching the observer. These subrings combine to give the full image. To observe these photon rings we require the resolution from a sub-mm Space VLBI mission. from The Black Hole Explorer: Photon Ring Science, Detection and Shape Measurement by Alexandru Lupsasca (https://arxiv.org/abs/2406.09498)

Space Situational Awareness and Planetary Defence

Led by Associate Professor David Coward, the SSA Capability uses UWA's Zadko Observatory to pursue a space situational awareness and space surveillance program involving international agencies and partners.

The Zadko Observatory, or the ISC's Space Situational Awareness team, supports the operation of a suite of space surveillance detectors and maximises research and development via joint projects. The Observatory itself is hosted at the Gingin Gravity Precinct, on the Swan Coastal Plain, 80km north of Perth and UWA's campus. Established in 1998 with support of the Western Australian Government, the 4.7-hectare site is surrounded by natural woodland with high species diversity. The Observatory is home to the 1.0 metre f/4 fast-slew Zadko Telescope, the only metre-class research grade optical facility at this southern latitude.

Planetary Defence

The Zadko team, as part of the International Asteroid Warning Network (IAWN) uses The University of Western Australia's Zadko Telescope to pursue a space situational awareness and space surveillance program involving numerous international partners. Space Situational Awareness refers to keeping track of objects in orbit and predicting where they will be at any given time.

The Zadko Observatory hosts:

- two fully autonomous ground based optical stations for space surveillance and space traffic management for French based Ariane Group SAS.
- One fully autonomous optical station used for Space Domain Awareness for USA based company Numerica contracted to the US Defence Department.
- An autonomous, remotely-operated, alt-azimuth mounted PlaneWave Instruments CDK500 Telescope aligned with a ASA-300 optical instrument used for Space Situational Awareness contracted to the Polish Space agency (POLSA). This partnership with the Polish Space Agency has been recognised and supported by the Federal Government via an Australian Research Council Industry Linkage grant - Characterising satellites using un-resolved optical observations (LP210300698).
- In collaboration with Curtin University, light curves from lunar impact flashes using the Zadko Telescope and a specialized camera with a frame rate of 400 frames per second will provide high temporal resolution light curves that require less external validation and provide new insights into the behaviour of lunar meteoroid impacts.

To complement the Zadko Telescope, the Australian Space Academy (ASA) have recently installed within the Zadko Observatory a Celestron 14" (C-14) telescope which will be dedicated to the near-Earth space environment, with particular emphasis on space situational awareness and planetary defence.

The Zadko Observatory team has installed three VHF antennas across northern Australia, used for the global space-based multiband astronomical Variable Objects Monitor (SVOM) network. SVOM is a Chinese French space mission dedicated to the detection and study of gamma-ray bursts and their use for astrophysics and cosmology. Gamma-ray bursts are considered as the brightest and the most energetic events in the Universe since the Big Bang.

The observatory hosts an autonomous, remotely operated wide field of view optical telescope used for Space Domain Awareness (SDA) campaigns of Low Earth Orbit objects for the Space Debris team at the Japan Aerospace Exploration Agency (JAXA).

The Capability is a member of the NASA International Asteroid Warning Network, and is a partner with UNSW (Canberra), CSIRO, UTas, Curtin in planetary defence research.

The site also hosts the Falcon Telescope - a joint initiative between the United States Air Force Academy (USAFA), UWA and the Catholic Education Office of WA. The Falcon Telescope Network is a global network of small aperture (20 inch) telescopes developed by the Centre for Space Situational Awareness Research (CSSAR) in the Department of Physics at the U.S. Air Force Academy, in collaboration with educational partners. Falcon will be shared with U.S. and international university partners for the purpose of undergraduate space situational awareness (SSA) and astronomy research education as well as community STEM outreach.

Updates

- New systems manager for the Zadko Observatory
- Upgrade of the Zadko Telescope control system
- SSA research to be published in Australian Space Research Conference proceedings
- PhD student Dorota is awarded first prize at Australian Space Research Conference

ASSOCIATE PROFESSOR DAVID COWARD
UWA School of Physics, Maths and Computing
Zadko Observatory

OPPOSITE The Zadko telescope during Space Boot Camp 2023.

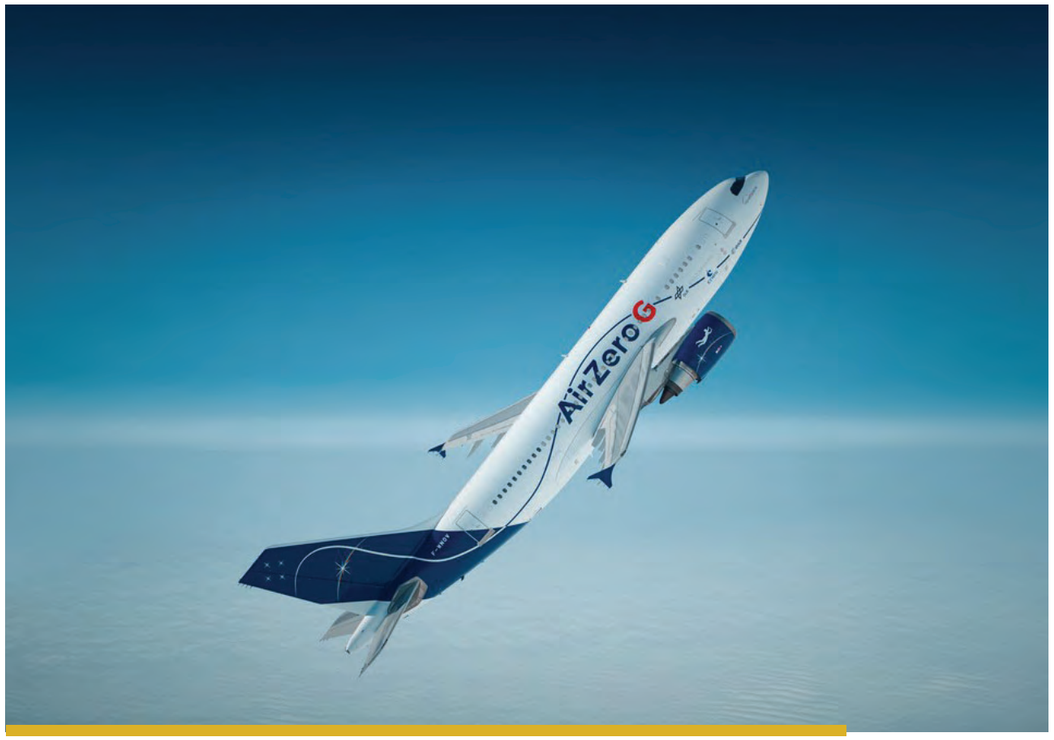
ABOVE 10m Centrifuge housed at UWA's Centre for Offshore Foundations System

Experiments in Hypergravity

ISC's researchers maintain strong links to the National Geotechnical Centrifuge Facility (NGCF), hosted at the Centre for Offshore Foundation Systems at UWA and directed by Professor Conleth O'Loughlin.

The NGCF is the largest geotechnical centrifuge facility in the world, and the only such facility in Australia.It hosts three large centrifuges: a 1.2m drum centrifuge, as well as 3.6m and 10m diameter beam centrifuges, for hypergravity experiments up to 350g.

PROFESSOR CONLETH O'LOUGLIN
School of Earth and Oceans
UWA Oceans Institute



ABOVE Novespace's Zero-G A310 Airbus, modified to perform science experiments in microgravity.

Experiments in Microgravity

The microgravity research programme, led by Professor Danail Obreschkow, regularly partners with the European Space Agency (ESA) to conduct experiments aboard the Airbus A310 Zero G, the world's largest suborbital microgravity facility.

These parabolic flights offer repeated phases of 20-25s of microgravity (~0.001g), as well as comparable phases of hypergravity (~1.8g). Depending on experimental design, it is also possible to request intermediate levels of gravity, such as lunar (0.17g) and martian (0.38g) gravity.

UWA Professor and private pilot Dongke Zhang has also led drop tower experiments, which offer even better levels of microgravity (~0.000001g) than parabolic flights but exhibit shorter phases of microgravity (<10s) and high accelerations (>5g) before and after.

Updates

- Started investigating pathways towards WA-based microgravity facilities.
- Worked with Lions Eye Institute to develop a breakthrough method to measure the brain fluid pressure in humans, which may reduce vision damage experienced by astronauts on long-haul space flights
- Article published in Nature (njp Microgravity)
- Article published in Nature Scientific Reports.

PROFESSOR DANAIL OBRESCHKOW
International Centre for Radio Astronomy Research

Plants for Space (P4S)

Humans rely on plants for food, oxygen, and psychological wellbeing. To support a long-term presence in deep space it will be essential to have plants as our partners.

To achieve this we will need to breed and modify both plants themselves, as well as the habitats we grow them in. The Plants for Space Capability was recently awarded part of a $35m Centre of Excellence by the ARC, in a consortium of P4S universities and partners led by the University of Adelaide, to create food and medicine for space explorers. This Centre aims to create on-demand, zero-waste, high-efficiency plants and plant products to address grand challenges in sustainability for space and on Earth. Significant advances in plant, food, and sensory science; process and systems engineering; law and policy; and psychology are expected to deliver transformative solutions for space habitation – and create enhanced plant-derived food and bioresources to capitalise upon emergent and rapidly expanding domestic and global markets. Anticipated outcomes include industry uptake of innovative plant forms, foods, technologies, and commodities; and an ambitious education and international co-ordination agenda to position Australia as a global leader in research supporting space habitation.

Updates

- Clifford Bradley Robertson and Gwendoline Florence Robertson Fund – Fellowship (UWA) to Dr James Lloyd
- Space Research Support Scheme (International Space Centre, UWA) – to Dr James Lloyd. $5,000
- Education and Engagement
- 13/9/24 UWA Shenton Park Open Day
- 14/9/24 Public Engagement Kings Park and Botanic Gardens (KPBG)
- 14/8/24 National Science Week – Three schools visited for activities and workshops (Cottesloe Primary School, Mundaring Christian College, Joseph Banks Secondary College)
- 13/9/24 Shenton Park Field Station & KPBG Public Engagement Event
- 2/12/24 School Event showcasing FarLabs – Joseph Banks Secondary College and Homeschools
- 31/7/24 Oberthur Primary School – Outreach (Plants Show and Tell)
- 2/8/24 Bob Hawke College – Outreach (Plants Show and Tell)
- 10/4/2024 "Plants in Space: How Plants Respond To Gravity and How We Can Engineer Plants for Space " – joint public lecture delivered by Dr James Lloyd and visiting academic Dr Suruchi Roychoudhry (University of Leeds, UK).
- 14/8/24 Martian Gardens – School interactions (Cottesloe Primary School, Mundaring Christian College, Joseph Banks Secondary College) – Gallery Walk and Design Sprint.
- 14/8/24 Martian Gardens Q&A Panel – Evening Event with KPBG and the International Space Centre
- 27/4/2024 Q&A Scitech, Meet a Scientist event.
- 27/2/2024 AROSE Networking
- 9/10/2024 Guest Lecture for SCIE2212
- 15/6/2024 "Future WA" Royal Society of Western Australia Symposium – Lecture, "Developing a role for WA plant and agricultural sciences in Moon to Mars space exploration 2025-2050'"
- 26/1/2024 Indo-Pacific Space and Earth Conference, Speaker, "Growing Plants in Space: A challenge framework for driving innovation in sustainability related to plant-based food production."
- Dr James Lloyd > Research Collaboration Application (2023/GR001354) for exchange of staff with the University of Leeds, UK to develop climate-smart plants with Dr Suruchi Roychoudhry ($20,600)
- Dr James Lloyd > Winner of UWA School of Molecular Science's Mid-career Research Award
- Farley Kwok van der Giezen > Perth Protein Group ComBio ECR Encouragement Grant to present his research on plant RNA editing factors, and how they can be used to control gene expression in chloroplasts.

Example Publication

- 22/7/2024 Lister, Ryan. CRISPRi-based circuits to control gene expression in plants.

PROFESSORS HARVEY MILLAR, RYAN LISTER, IAN SMALL
UWA School of Molecular Sciences
ARC Centre of Excellence in Plants for Space

ABOVE Katherine Bennell-Pegg visits the Plants for Space laboratories (2024).

Space Physiology and Life Sciences

Changes in brain fluid pressure in astronauts can adversely impair their vision while in space. The research group, headed by Professor William Morgan, uses pulse wave properties of the eye's blood vessels to estimate pressures in the brain fluid.

ABOVE Professor Bill Morgan demonstrating the OcuLinx to astronauts Koichi Wakata (far left) and Shawna Pandya (back left), and news and media representatives from The West Australian.

The Capability has been studying the relationship between brain fluid pressure, also known as intracranial pressure (ICP) and the eye for over twenty years. Recently, with collaborations with neurology and neurosurgery, they have found that the pulse waves that travel along the blood vessels at the back of the eye are produced by and travel from the brain fluid.

This discovery allows them to use sophisticated mathematical and imaging techniques to measure these pulse waves and infer the ICP. Until now, ICP could only be measured by drilling a hole through the skull and into the brain or passing a needle into the lower back, both of which are quite invasive, prone to some risks and tend to be rarely performed.

They are currently refining this technique to make it useful in hospitals and clinics as well as potentially in space. The need for a small size and fast analytical speed in space should accelerate its development as an important health tool on Earth.

In space, they anticipate that this breakthrough will allow regular monitoring of astronaut ICP and allow testing of treatments to reduce or eliminate dangerous elevations in ICP. In parallel, we are working on techniques that should favourably alter orbital and ICP that can be applied in space.

Updates

- Conducted three International Life Science Capability Presentations.
- 1 large grant application to the Future Health Research and Innovation Fund (FHRIF) to fund parabolic flight experiments (submitted December 2024).
- 4 publications related to intracranial pressure and retinal pulse wave dynamics relevant to space.
- Received Telethon grant for childhood hydrocephalus awarded in December 2024. This will fund clinical trials of the new portable intracranial pressure device, designed also for space application.

PROFESSOR WILLIAM MORGAN
UWA School of Medicine
Lions Eye Institute

Space Data Analysis

Data science, data management and processing, and software engineering.

The Data Intensive Astronomy (DIA) research group at the UWA Node of the International Centre for Radio Astronomy Research, led by Professor Andreas Wicenec, brings a unique mixture of internationally recognised expertise in space-relevant computer science topics, including:

Machine learning and deep learning on general image and video object recognition, detection and classification, also applied to more general problems like time series analysis and general optimisation problems.

Development and operation of very large scale, globally distributed data management systems, including remote areas and space.

Exa-scale distributed processing software systems: These systems have been deployed and processed data on the largest super-computers in the world and very diverse platforms, including small- and large-scale cloud systems.

Development and optimisation of algorithms and generic solvers.

Development of large scientific software applications using modern professional software development practices and following strict delivery schedules. We have a pool of people practicing and certified in the Scaled Agile Framework (SAFe) for very large distributed agile development projects.

Their space-relevant projects include:

- Various radio astronomy projects, including the Square Kilometre Array, Murchison Widefield Array, Australian SKA Pathfinder as well as data reduction and support projects for the wider community.
- Projects in computer vision, object detection and classification.
- Operational ocean swell prediction improvement system:
  - Wind forecast model for WA using data fusion from ground based and satellite sources.
  - Gravitational wave detection.
  - Previous involvement in various satellite projects including HIPPARCOS, DIVA and GAIA.

Updates

- Updates to the ocean swell prediction system to fuse satellite data and buoy data and allow prediction updates for different locations.
- Development of the wind forecast model and extension to include solar irradiance and rain data.
- Further development of the SKA data life-cycle management system.

Publications

- Spatial Temporal Approach for Gridded Wind Forecasting across Southwest Western Australia. / Chen, Fuling. Vinsen, Kevin. Filoche, Arthur.
- In: IEEE Access, Vol. 12, 2024, p. 185905-185917. Research output: Contribution to journal › Article › peer-review
- Data Assimilation as Variational Inference. / Filoche, Arthur.
- 2024. Paper presented at ISDA online: Advancements in Variational Data Assimilation, Virtual. Research output: Contribution to conference › Conference presentation/ephemera

PROFESSOR ANDREAS WICENEC
International Centre for Radio Astronomy Research

Automation and Robotics

The Robotics and Automation laboratory, led by Professor Thomas Bräunl, has designed and built over 100 robots over the last two decades.

They have built mobile robots from a small scale to full size cars and buses, and robots that drive, walk, sail, dive or fly.

Robot communication and control is a central topic of their work. They have designed and built web-based and app-based remote robot command and control systems, and combine the latest sensor technology in Lidars, cameras, IMUs and (when possible) RTK-enhanced GNSS.

They employ deep-learning AI technologies for end-to-end learning for autonomous driving and detection tasks. They aim to establish a command and control centre as well as a planetary rover testing ground similar to the 'Martian field' at NASA/JPL, Pasadena.

Updates

The lab has recently acquired its fourth autonomous shuttle bus. Three buses are driving on the UWA campus, while one is conducting a trial on a public road in the suburb of Eglinton.

The UWA Robotics Lab has a long history of building humanoid robots from the ground up. They started in 1998 with a robot called Johnny Walker, followed over the years by Jack Daniels, Rock Steady, and Andy Droid. All these robots were about 30 cm high and had been built from the ground up at UWA, including all mechanics, hardware, and software.

The lab's latest humanoid robot, called 'Stuwart' stands about 140 cm tall and uses a commercial platform, as the research team is concentrating on the autonomous control software, including navigation, path planning, and manipulation, but also perception and interaction with humans using local LLMs (large language models), similar to ChatGPT.
Two PhD students are working with 'Stuwart', Oliver Zhang and Xiangrui Kong, alongside four final-year BE Automation & Robotics students, supervised by Prof. Thomas Braunl.

Web link: REVproject.com

Example Grants, Events and Publications

- ARC Training Centre for Automated Vehicles in Rural and Remote Regions
- REV 15-Year Anniversary for students, alumni, and sponsors Fri 22 Sep. 2023
- T. Bräunl Mobile Robot Programming – Adventures in Python and C, Springer Nature, Singapore, 2nd Ed,.2023
- T. Drage, K. Quirke-Brown, L. Haddad, Z. Lai, K. Lim, T. Bräunl, Managing Risk in the Design of Modular Systems for an Autonomous Shuttle, IEEE Open Journal of Intelligent Transportation Systems, 2024
- Z. Lai, T. Bräunl, End-to-End Learning with Memory Models for Complex Autonomous Driving Tasks in Indoor Environments, Journal of Intelligent & Robotic Systems, March 2023, no. 107, vol. 37, pp. (17)

PROFESSOR THOMAS BRÄUNL
UWA School of Engineering

OPPOSITE UWA Robotics' newest robot StUWArt. PhD students Oliver Zhang and Xiangrui Kong and four final-year BE Automation & Robotics students are working with StUWArt on autonomous control software, including not only navigation, path planning, and manipulation, but also perception and interaction with humans using local LLMs (large language models), similar to ChatGPT.

Psychology in Space

The human mind and body are central to the success of space exploration.

The Psychology in Space research Capability at the ISC leverages the expertise within the School of Psychological Science and Business School to tackle the psychological, organisational, and physiological challenges of space travel. Our strengths in cognitive psychology can help optimize astronaut decision-making and problem-solving in high-stakes environments. Psychopathology and resilience research can inform strategies to maintain mental health and adaptability during long-duration missions. Psychophysiology, including sleep science, is relevant to understanding the impact of microgravity and disrupted circadian rhythms on performance and well-being. Human factors research can enhance spacecraft design and mission protocols to improve safety and efficiency, while social psychology and management research relates to teamwork, leadership, and group dynamics in isolated, confined, and extreme environments.

By integrating these psychological perspectives, we contribute to the development of evidence-based strategies that support astronaut performance, well-being, and mission success—both in orbit and beyond.

ASSOCIATE PROFESSOR LIES NOTEBAERT
UWA School of Psychological Science

ABOVE Tackling the psychological, organisational, and physiological challenges of space travel

Propulsion and Cryogenics

This research team focuses on studying the ignition, combustion and explosion characteristics of propellants used in rocket engines under different environmental conditions.

We also investigate improving the efficiency, reliability and safety of long duration storage of large quantities of cryogenic fluids used for space missions.

Long duration storage of large quantities of cryogenic fluids is essential for space missions, including orbit transfer vehicles, upper stages of rockets, and deep space exploratory missions. This team study the effect of thermal stratification and boil-off of rocket propellant tanks which is critically important due to the impact on tank pressure, structural weight and the accompanying pressurisation system weight. Boil-off is particularly crucial during atmospheric departure and re-entry, where frictional drag forces result in substantial heat entering the containment vessel, increasing vapour temperature and pressure.

The non-convective, low-gravity environment (microgravity) of spacecraft strongly influences the processes of combustion and consequently fire safety.

This group looks at the fundamental ignition and combustion behaviour of solid materials in low gravity that may be relevant to spacecraft fire prevention and control, and determine the effect of pressure, temperature and fuel composition on the ignition and heat release.

Finally the team look at the possibilities of utilising lunar in-situ resources to support NASA missions, instead of bringing everything from Earth. This can lead to significant reductions in launch and landing mass, crew health and mission risks, and life-cycle costs for human exploration beyond Earth's orbit.

Sustainability in Space

Researching the catalytic cracking of waste methane for H2 production to support oxygen and water production processes in space missions, inspired by methods used on the International Space Station.

Exploring Weathering on Extraterrestrial Bodies

Collaborating with NASA's Jet Propulsion Laboratory (JPL) and the Australian Nuclear Science and Technology Organisation (ANSTO), the team is investigating the weathering processes on Saturn's moon Titan and several Jovian moons.

Lunar Propellant

Working closely with NASA, the team is focused on developing a specialized model for liquid hydrogen and LNG boil-off gas (BOG).

Partnering with ETA Space, the team is dedicated to developing a Lunar Propellant Production Plant to create cryogenic oxygen and hydrogen propellants from water sources near the Lunar poles.

Propellants and Propulsion

Research efforts are aimed at understanding the ignition, combustion, and explosion characteristics of rocket engine propellants. Computational Fluid Dynamic (CFD) modelling plays a key role in designing injectors and combustion chambers.

Fire Safety in Spacecraft

Exploring fundamental ignition and combustion behaviours of solid materials in low gravity to enhance spacecraft fire prevention and control measures.

Microgravity

Investigating the ignition process of solid and gaseous fuels, radiative heat transfer in small-sized flames, soot formation mechanisms, and bubble formation during water electrolysis in microgravity environments.

Updates

- Construction of the BOG (boil-off gas) and cryogenic coolers completed, and the Capability received funding from University for lab retrofitting all the necessary safety requirements. The facility cost around $1m including the retrofit. This includes 3 cryogenic coolers which can cool down to 5 or 6K.
- The Capability also received a Discovery Project grant in 2023, which supports research into the endothermic (part-auto) implication in liquid hydrogen.
- Dr Saif Al Ghafri visited Eta Space in the US and looked at their facilities. In particular he reviewed their project with NASA (storing liquid hydrogen in the Earth's orbit).
- Dr Saif Al Ghafri participated in the ASA Technical Advisory Committee for Access to Space.
- The Capability managed to liquefy hydrogen at UWA for the first time.
- The 2nd hydrogen liquefier is 90% completed. This is based on magnetic refrigeration - a novel technology to liquefy hydrogen and other gases such as methane.
- The 100 kg/day hydrogen liquefier, based on the use of magnetic refrigeration, is expected to be delivered to WA in the 2nd half of 2026. This will be supplied and delivered by GenH2.
- UWA now have a fully refurbished hydrogen lab equipped with all safety features required to conduct measurements on cryogenic and liquid hydrogen.

DRS SAIF AL GHAFRI AND ARMAN SIAHVASHI
UWA School of Engineering

Space Energy

Energy is essential to all forms of life and fundamental to any human activity. In space exploration, energy supply, conversion and use are critical in every step of the journey, from rocket propulsion to life support and maintenance.

ABOVE Concept image of Gen-X Battery.

Energy will be a key factor in enabling off-Earth habitation, a sustained human presence and robotic operations in space. We will require the development of new energy technologies capable of delivering long-term, reliable power.

The Space Energy Capability is part of a consortium that won a $2.4m CRC-P grant, led by EntX Energy in 2022. The consortium includes the University of South Australia, the University of Adelaide, the ISC, as well as industry partners Duromer Products and DEWC Systems.

Updates

In space, extreme temperatures pose a serious challenge for engineers trying to keep sensitive instruments and electronics operational, especially during long lunar nights or deep-space missions where sunlight is either scarce or intense. The ISC Space Energy Capability has been undertaking research, funded by entX/CRC-P to develop a computational tool to advise on thermal management system that regulates the temperature of critical electrical components using a small but powerful device called a Radioisotope Heater Unit (RHU). Under the supervision of Mr Dongke Zhang FTSE, Mr Brad Skajko and Mr Ali Mohammadi have recreated the behaviour of an RHU system under both scorching lunar daytime and freezing nighttime conditions, helping us better understand its role in protecting electronics and conserving energy across mission cycles. It has been shown that how a small RHU, combined with thermal design features like a heat sink and thermal bridges, can manage the direction and amount of heat that is transferred. The modelling also revealed how subtle adjustments in material properties and geometry can reduce the impact of extreme temperatures. This baseline thermal management system paves the way for more reliable designs for future space missions, particularly those focused on deep-space exploration.

PROFESSOR DONGKE ZHANG
UWA School of Engineering

Planetary Geoscience

Planetary geoscience is the geological characterisation of space materials and extra-terrestrial life environments.

The Planetary Geoscience research capability focusses on mineralogical and geochemical studies of geological materials from space that have been ejected from the lunar surface, Mars and the Asteroid Belt. The research projects span across planetary geology, petrology, microanalysis, geochemistry, geobiology, sedimentology and stratigraphy.

Updates

- Mission Control in August 2024, held at the Edward de Courcy Clarke Earth Science Museum, showcasing the museum's collection of meteorites.

PROFESSOR TONY KEMP
UWA School of Earth and Oceans

Planetary Mapping

Understanding the tectonics of terrestrial planets.

This team uses Synthetic Aperture Radar (SAR) data to map planetary surfaces, and understand surface and tectonic processes on Venus and other terrestrial planets. Earth is the only planet in our solar system that has plate tectonics as a driving process. Plate tectonics, driven by heat escaping from the core of our planet, drives everything else, and forms continents, mountains, oceans, volcanoes and affects climate.

PROFESSOR MYRA KEEP
UWA School of Earth and Oceans

> Life is a process of combustion, often spontaneous, converting energy from one form to another."
>
> **Professor Dongke Zhang**

Space Crystallography

Led by Professor Stephen Moggach, the Space Crystallography Capability aims to determine the crystal structures of molecular co-crystals that are likely to form on the surface of Titan – Saturn's largest moon.

Titan has geological features that are somewhat similar to those found on Earth, with seas, lakes and sweeping dunes. Unlike the Earth, however, the temperature hardly varies, sitting at a constant value of around 92K. In addition, the surface composition is quite different to the Earth, and dominated by molecular materials, much of which are photochemically produced in the moon's atmosphere. These range from simple compounds such as ethane and acetylene, to more complex molecules (e.g. methylcyanoacetylene). These more complex molecular compounds first form as a haze layer in Titan's atmosphere, before being deposited onto the surface.

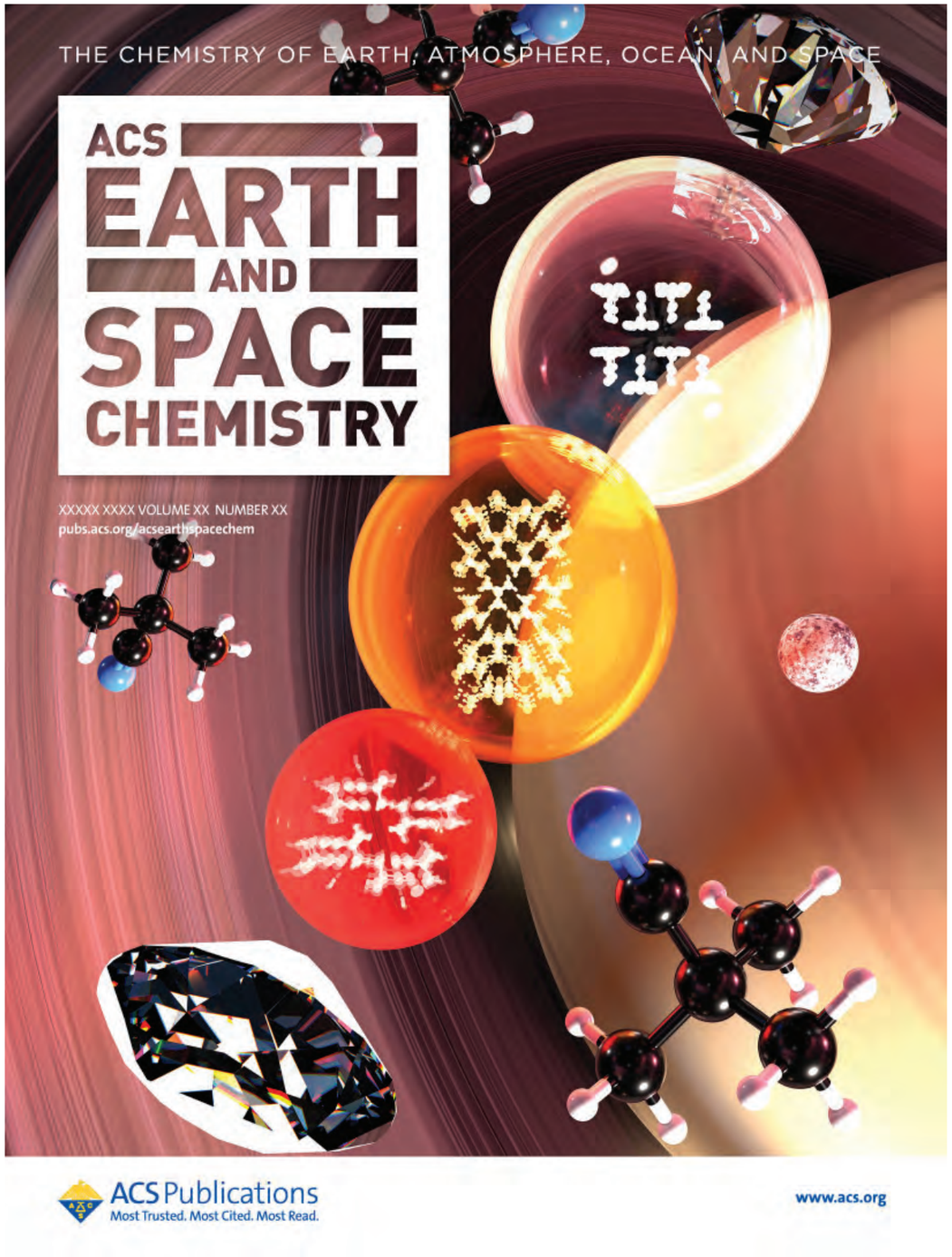
Interestingly, because of the active weather system on Titan, these deposited 'pure' compounds can mix by being buried in subsequent layers of organic material, or by dissolution in the liquid hydrocarbon seas, and could lead to the formation of molecular co-crystals.

Updates

- Published the study "Structural Evolution of Trimethylacetonitrile under Pressure: A Combined X-ray Diffraction and Computational Study" in the August 2024 issue of ACS Earth and Space Chemistry.

  This work, investigating material behaviour under pressure relevant to planetary science, was highlighted as the front cover artwork for the journal issue, showcasing its significance.
- Student Bec Blake presented her work at the Crystal35 conference in Fremantle on 'High-Pressure Co-crystallisation of Acetonitrile and Trimethylacetonitrile.'
- We also commissioned the low-temperature DSC. We can now routinely collect DSC data under Titan relevant temperatures - lots more papers to follow in the coming year!
- Honours student Sonya Emmett received a AINSE PATHWAY SCHOLARSHIP (announce 18th April 2024, but given in May 24).
- Moggach was elected to the ANSTO User Advisory Committee (representing users for diffraction at central facilities).
- We were successful in our Collaborative Access Program (CAP) application for beamtime at the Australian Synchroron on the MX beamline joint with academics from Melbourne, UTas, and UWA. Total funding from May-Dec 24 was $278,664 (June-Aug) and $245,880 (Oct-Dec).(based on the number of beamtime hours)
- Moggach made a Cambridge Structural Database Champion (one of 2 in Australia). Look out for planned space crystallography outreach!
- School visit from St George's Anglican school, where Space Crystallography was talked about to visiting year 11 students.

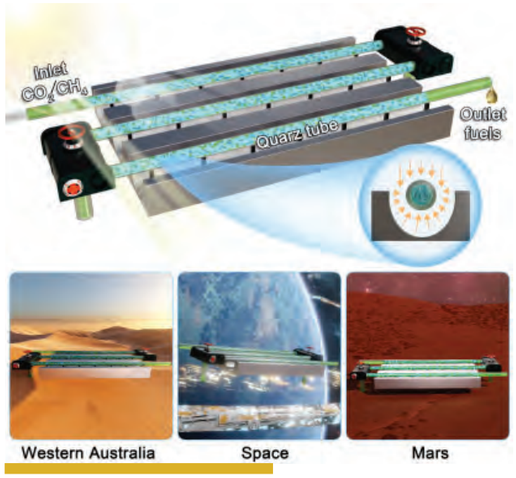
PROFESSOR STEPHEN MOGGACH
UWA School of Molecular Sciences



ABOVE August 2024 issue of ACS Earth and Space Chemistry, featuring the Capability's article "Structural Evolution of Trimethylacetonitrile under Pressure: A Combined X-ray Diffraction and Computational Study".

Chemicals for Space

Unlike Earth, space, the Moon, and Mars lack fossil fuel resources such as coal, petroleum, and natural gas.



While solar panels can power space stations and habitats, there are currently no solutions for supplying fuels, chemicals, pharmaceuticals, fertilisers, and daily consumables in these environments. This Capability aims to address this critical challenge by leveraging astrochemistry and astrochemical engineering, with a focus on astrocatalysis, to develop innovative strategies that ensure the sustainability of human life beyond our blue planet.

From gases to gases

Gas conversion processes play a crucial role in sustaining life support systems, particularly in the context of space exploration. Oxygen (O_2) generation is of paramount importance for space stations and future space habitats, as it is essential for human survival. To address this critical need, cutting-edge catalytic technologies are being developed to efficiently produce scalable quantities of oxygen from abundant resources such as water (H_2O) and carbon dioxide (CO_2).

In addition to oxygen production, other vital gas conversion processes include ammonia (NH_3) synthesis and decomposition, methane (CH_4) cracking, and methane dry reforming. These reactions are key to generating valuable products and managing waste gases in space environments. To optimise these processes for space applications, innovative catalyst materials, reactors, and reaction pathways are being engineered, considering the unique challenges and constraints of space missions. Solar energy will be the primary driving force, either converted into electricity for electrochemical reactions or directly utilised for photocatalytic, photothermal catalytic, or photoelectrochemical processes.

By integrating cutting-edge catalytic technologies with efficient solar energy utilisation, researchers aim to develop sustainable and self-sufficient gas conversion systems for space applications, supporting immediate needs and contributing to the long-term goal of establishing self-sustaining habitats beyond Earth.

Updates

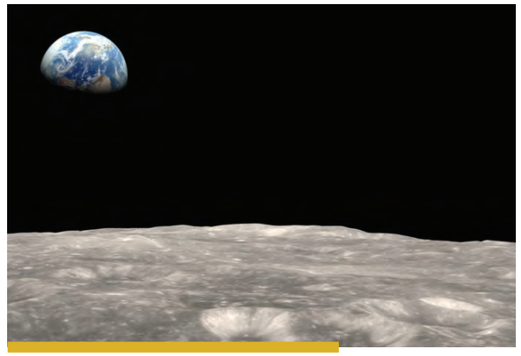
- Contacted ISC in May 2024 for discussing a funding application;
- Joined ISC in June 2024, and
- With the support from ISC, developed an ARC Discovery Project, which successfully received over 1.2 million funding for a Mars-related project at the end of 2024. (Hongqi Sun, Photothermal catalytic panels to produce fine chemicals for space exploration and interstellar settlement, DP250104787, AUD 1.269 million).

PROFESSOR HONGQI SUN
UWA School of Molecular Sciences

> The ISC played a key role in helping establish our Node by offering strategic support and encouraging interdisciplinary collaboration, which proved vital in securing our ARC Discovery Project."
>
> **Professor Hongqi Sun**

Space Civil Engineering

Development of techniques for in-space construction using space materials.



This research develops new methods of mortarless construction and mining extraction that are suitable for the low gravity and harsh environment found on extraterrestrial bodies. The team also investigate methods for deflecting those bodies that are on a collision course with Earth.

Updates

- Loading device for thermal spallation investigation – designed, manufactured and updated to include protective screens.
- Mortar samples for initial testing are being manufactured.
- Model of block rotations and interaction is developed. A new phenomenon of inverse block rotation has been discovered.
- Model of thermal spallation drilling is being developed.
- Technology of the topological interlocking for extraterrestrial construction is being developed.

Publications

Journals

- Guo, Y., A.V. Dyskin, E. Pasternak, 2024. Thermal spallation of dry rocks induced by flame parallel or normal to layering: Effect of anisotropy. Energy, 288, 129697. (Q1, Eng.)
- Guo, Y., A.V. Dyskin, E. Pasternak, X. Li, L. Huang, 2024. Mechanics of thermal spallation and fracturing of dry rocks produced by surface heating. Acta Geotechnica, DOI: 10.1007/s11440-024-02260-9. (Q1, Eng.)
- Zhang, M., E. Pasternak and A.V. Dyskin, 2025. Complex rotation patterns of one-dimensional chain of blocks with elbowing. Communications in Nonlinear Science and Numerical Simulation (under Review)

Chapters

- Wong, R.X., E. Pasternak and A.V. Dyskin, 2022. Anomalous fall-off in velocity power spectra caused by sliding with asymmetric friction. In: Multiscale Processes of Instability, Deformation and Fracturing in Geomaterials. (Pasternak, E. and Dyskin A., Eds), Springer Cham, 182-189.

Abstracts

- Zhang, M., E. Pasternak and A.V. Dyskin, 2023. Rocks with rotating blocks: 1D displacement, rotation and wave propagation. NP7.1 "Non-linear Waves and Fracturing" at European Geosciences Union General Assembly 2023, Vienna, Austria (EGU2023).
- Zhang, M., E. Pasternak and A.V. Dyskin, 2025. Triggering inverse rotation in 1D model of blocky rock mass. NP7.1 "Non-linear Waves and Fracturing" at European Geosciences Union General Assembly 2025, Vienna, Austria (EGU2025).
- Dyskin, A.V. and E. Pasternak, 2025. Hybrid structures for extraterrestrial bases. 76th International Astronautical Congress, Sydney 2025.

Grants

- **ARC DISCOVERY DP 250103594**
  Controllable spallation. Theory and applications for environmentally friendly drilling. Arcady Dyskin, Elena Pasternak ($604,909 for 3 years) One of the perceived applications: "With the development of space industry in Australia thermal spallation is another exciting application enabling drilling in low or microgravity environments such as other planets and asteroids, where the weight of drilling equipment is a major limitation. This expands the exploration activities beyond Earth."

PROFESSORS ARCADY DYSKIN AND ELENA PASTERNAK
UWA School of Engineering

Governance and Leadership

ISC CAPABILITY LEADERS

PROF SIMON DRIVER
Distant Universe from Space Telescopes

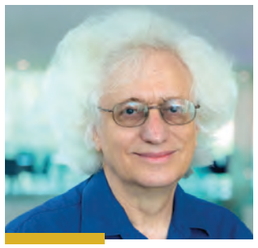
PROF LINQING WEN
Gravitational Wave Astronomy

A/PROF MARIA RIOJA CAPELLAN
Radio Astronomy Interferometric Observations from Space (RIOS)

A/PROF RICHARD DODSON
Radio Astronomy Interferometric Observations from Space (RIOS)

PROF CONLETH O'LOUGHLIN
Experiments in Hypergravity

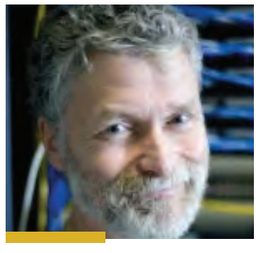
PROF DANAIL OBRESCHKOW
Experiments in Microgravity



PROF ARCADY DYSKIN
Extraterrestrial Civil and Resource Engineering

PROF ELENA PASTERNAK
Extraterrestrial Civil and Resource Engineering

PROF THOMAS BRAUNL
Automation and Robotics



PROF ANDREAS WICENEC
Space Data Analysis

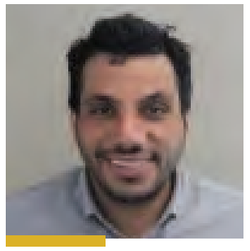
PROF SASCHA SCHEDIWY
Laser Timing and Communications

A/PROF LIES NOTEBAERT
Psychology in Space

PROF HARVEY MILLAR
Plants for Space

PROF IAN SMALL
Plants for Space

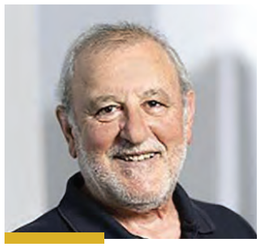
PROF RYAN LISTER
Plants for Space



DR SAIF AL GHAFRI
Propulsion and Cryogenics

PROF DONGKE ZHANG
Space Energy

PROF CHARITHA PATTIARATCHI
Earth Observation from Space

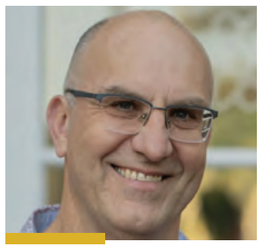


PROF LORENZO FARAONE
Avionics for Sensing and Imagery

PROF STEPHEN MOGGACH
Space Crystallography

PROF HONGQI SUN
Chemicals for Space

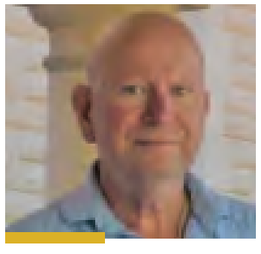
PROF MARCO FIORENTINI
Space Materials and Resources



PROF TONY KEMP
Planetary Geoscience

PROF MYRA KEEP
Planetary Mapping

PROF BILL MORGAN
Space Physiology and Medicine



A/PROF DAVID COWARD
Space Situational Awareness

MR JOHN MOORE
Space Situational Awareness

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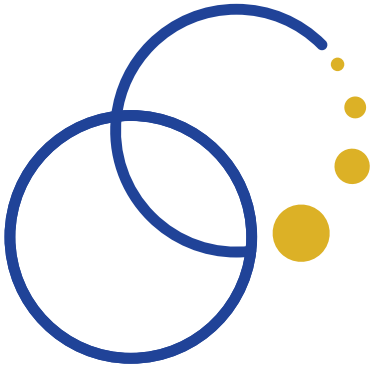

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