INTERNATIONAL SPACE CENTRE

ANNUAL REPORT TO MARCH 2022

THE UNIVERSITY OF WESTERN AUSTRALIA

INTERNATIONAL SPACE CENTRE

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INTRODUCTION

THE ISC AT UWA

During its first year, the new International Space Centre (ISC) has boosted the coordination and impact of space-related research and education at The University of Western Australia (UWA). Thanks to the ISC, it has become apparent that this University gathers a breathtaking range of space expertise that puts us on a par with the highest-performing space institutions in the country.

The ISC was created to proactively leverage the rapidly growing global and domestic space economy, whose turnover is poised to triple over the next ten years, creating tens of thousands of jobs in Australia. The launch of the Australian Space Agency (ASA) as a new national vehicle to coordinate international partnerships and domestic investments has resulted in a wealth of opportunities.

As demonstrated by all space-capable nations, a flourishing space economy is always paralleled by a close dynamic relationship between emerging industries, government and academia. The ISC has taken a lead in building towards such a "triple-helix" culture by forging strong new partnerships with the ASA, the State Government, several domestic industry partners, as well as by creating a common forum with other academic space centres in the country.

Through its breadth of expertise, the ISC aims to contribute to WA's growing space sector by

- leading basic research, expanding our knowledge and fueling our long-term economic and cultural evolution;
- pursuing applied research in areas too risky for private venture;
- offering world-class tertiary education to creative young minds;
- engaging with industry partners and government to drive ambitious projects;
- inspiring public interest and engagement in all things space-related.

Although the Centre is still in its infancy, this report highlights a remarkable range of early achievements. They are a clear indication that we are moving in the right direction and inspire us to keep growing the ISC.

I would like to sincerely thank all those who have invested countless hours making this fantastic Centre a reality.

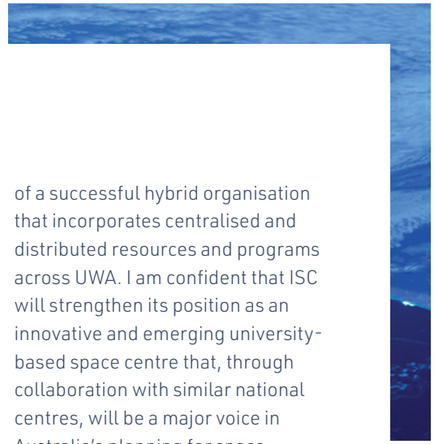
Fly safe,

Associate Professor
Danail Obreschkow
Head International Space Centre

FROM THE CHAIR

It is now just over a year since the formation of the International Space Centre at UWA. The creation of the ISC was motivated by the growing national and international interest and investment in a space-enabled economy, combined with UWA's broad expertise in space technologies and research.

The Scoping Study for the ISC commissioned by the Vice-Chancellor in August 2021 highlighted the research and teaching excellence that already existed at UWA across 22 distinct and diverse space research nodes. These nodes now form the workforce of ISC that will create and expand space education, space industry engagement and forefront space research at UWA. The Advisory Board of the ISC is looking forward to working with the ISC Director as the Centre evolves in 2022. This evolution will see ISC strengthen the links and coordination of the research nodes as they identify new opportunities for funding, industry engagement and initiate new educational programs. The ISC will also endeavour to expand its dedicated staff and funding to create the basic of a successful hybrid organisation that incorporates centralised and distributed resources and programs across UWA. I am confident that ISC will strengthen its position as an innovative and emerging university-based space centre that, through collaboration with similar national centres, will be a major voice in Australia's planning for space.



Professor Peter Quinn
Chairman of the Board
International Space Centre

ABOUT THE ISC

THE INTERNATIONAL SPACE CENTRE HARNESSES UWA'S WORLD-LEADING SPACE RESEARCH CAPABILITY TO BUILD PARTNERSHIPS THAT WILL CONTRIBUTE TO THE ONGOING GROWTH OF AUSTRALIA'S SPACE INDUSTRY.

In response to the federal government's investment in the civil space sector, UWA formed the International Space Centre (ISC), which unites over 100 UWA researchers across 25 nodes of speciality.

With the $700 million investment by the Commonwealth government – and intent to grow the sector to $12 billion and add 20,000 jobs by 2030[1] – Australia requires a wide range of experience across the board in space expertise, manufacturing and education.

Crewed flights to the Moon and Mars, with permanent bases, are now a core objective of major space agencies and private space companies alike. These advances will touch and transform all aspects of our lives, from the internet of things, to high-speed secure communications, land and sea management, defence and conflict, resource exploration and extraction, knowledge and discovery, aspirations and dreams.

THE ISC IS UNIQUELY PLACED TO RESPOND TO THE DRIVE FOR SPACE INVESTMENT.

Western Australia has many advantages that are aligned with the declared Australian Space Agency (ASA) priorities, including:

- Geographic location on the Indo-Pacific rim, allowing for the provision of continuous communications, positioning, navigation and timing on missions to the Moon and beyond, as well as in space situational awareness across one sixth of the globe.
- Relevant industry sectors with critical capabilities in robotics, automation, and remote operations.
- The State's size, biodiversity, agriculture and fisheries sectors that provide unique Earth observation and space-based positioning for optimal management, study, and surveillance.
- Our stable, self-sufficient, expansive and growing modern tech capable population and economy (as best exemplified through the Square Kilometre Array and Pawsey Supercomputing Centre facilities).

As a top-100 University, and with a strong mandate to pursue space from the West Australian government, UWA has pulled forces together to create the ISC. The breadth is remarkable, including 22 disciplines engaged in space-related activities.

These include specialities such as fundamental physics, planning and governance frameworks, design and construction, oceanography, energy, propulsion and combustion, psychology, medicine and physiology, food, emotions, literature and musicology.

By converting these specialities into Nodes (shown in our Capabilities chapter), our research aligns directly into the primary areas that align with the Australian Space Agency and SmartSat CRC priority areas.

- Space communications (ESA, NASA and JAXA operations): radio to lasers, secure, quantum;
- Space tracking and monitoring (Gingin, Dongara and Exmouth): research, civil and defense;
- Earth observation including sea and land management from space;
- Explorations and operations in remote hostile environments: AROSE;
- Data analytics of space platform data: big, rapid and/or AI-based;
- Habitation: including health, sustenance, energy and wellbeing; and
- Positioning, navigation and timing: optical lasers and radio interferometry.

1 The global space sector now has an annual turnover of US$350 billion, growing at a steady rate of 57% per annum over the past decade, and is forecast to reach US$1.1 trillion by 2040.

ABOUT THE ISC

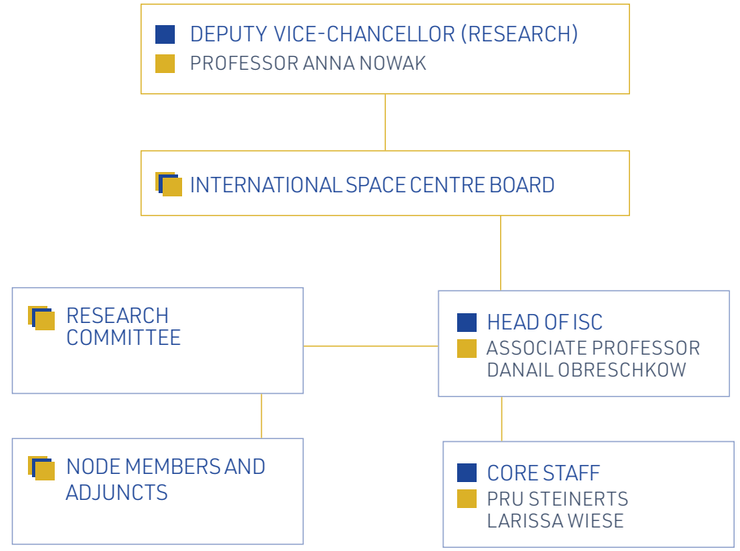
GOVERNANCE

The International Space Centre Board was established under the authority of the Vice-Chancellor of UWA, Amit Chakma, in February 2021. The Board is responsible to the Deputy Vice-Chancellor (Research) of UWA.

The Board comprises the Deputy Vice-Chancellor (Research) or nominee, Head of the ISC, Executive Director International Centre for Radio Astronomy Research, UWA's nominee to the Australian Remote Operations for Space and Earth (AROSE) Board, the ISC's Industry and Innovation Engagement Manager, up to five other persons elected by the Deputy Vice-Chancellor (Research), and other non-voting members who may be co-opted by the Board for additional expertise or representation. The Manager of the International Space Centre fufills the Executive Officer function of the Board.

The quorum for the Board is four voting members.

GOVERNANCE MODEL



CENTRE HIGHLIGHTS

OVERALL ACHIEVEMENTS

January 2021 The ISC launched on January 28, 2021, marking the first step in building an internationally recognised centre that empowers UWA's research, education and engagement in the space sector to advance the space frontiers of the 21st century. The launch was highly publicised, receiving national and international coverage.

January 2021 The Lions Eye Institute joined the ISC. LEI works with NASA to further develop research into intracranial pressure in astronauts, which can lead to vision loss. Intracranial pressure can rise to unsafe levels in astronauts who are in space for more than six months. Not only can intracranial pressure be an issue for astronauts, it is also known to affect recovery from traumatic head injury, brain tumours, optic nerve swelling, and glaucoma. Professor Bill Morgan represented the ISC at the Third Australian Space Biology x Health Summit presenting on Spaceflight Associated Neuro-ocular Syndrome.

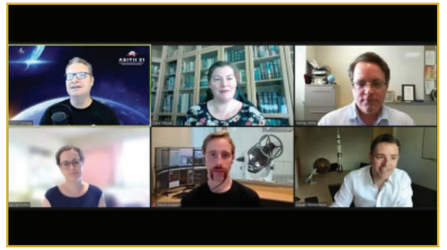
February 2021 The ISC was awarded Federal funding to advance optical communications between Earth and space. Optical lasers enable the transfer of data through space at rates thousands of times greater than can currently be achieved using radio signals. The three-year research project received $1 million funding from the SmartSat Cooperative Research Centre, a consortium of universities and research institutions partnered with industry to advance our ability to operate from space. Astrophysicist Dr Sascha Schediwy from the ISC won Academic of the Year and the overall Excellence award in the 2021 Australian Space Awards for his work in this field.

May 2021 Head of the Australian Space Agency and UWA alumni, Enrico Palermo, visits the UWA and the International Space Centre.

"Follow your passions and say yes to every opportunity to develop your skills," he said during his tour.

"This all comes together to build a skillset that enables students to lead and do amazing things in space."

December 2021 The International Space Centre hosted a 'Thriving in Space' session for the Australian Space Industry Technology Infrastructure and Investment (ASITII) online panel session. Speakers provided included Associate Professor Danail Obreschkow (Head of International Space Centre), Professor Harvey Millar (Director, ARC CoE Plant Energy Biology), Dr Clare Mouat (Geography and Planning), Dr Laura Fruhen (Psychological Sciences) and Dr David Gozzard (Forrest Fellow, International Centre for Radio Astronomy Research).



January 2022 Year 9 and 10 students from around WA were treated to the International Space Centre's inaugural Space Boot Camp, where they heard from experts on all aspects of space research and industry. Sixty students learnt about the origins of the universe, plants in space, robots and living on the ISS, innovation in space, designing lunar habitats, aspects of space law, and how they can pursue careers in space from WA.

CENTRE HIGHLIGHTS

FORMATION OF THE ISC

2020

AUGUST 2020

Vice-Chancellor of UWA Amit Chakma requests Executive Director of the International Centre for Radio Astronomy Research Professor Peter Quinn to develop a concept for the space activities currently undertaken at the University.

SEPTEMBER 2020

Creation of a scoping team an Interim Board to lead a scoping study.

DECEMBER 2020

Decision made to launch the International Space Centre.

2021

JANUARY 2021

Launch of the International Space Centre as a completely virtual entity.

FEBRUARY 2021

Vice-Chancellor Amit Chakma signs the Constitution of the International Space Centre.

MAY 2021

Submission of the scoping study to the Deputy Vice-Chancellor (Research) Tim Colmer.

JUNE 2021

Deputy Vice-Chancellor (Research) Tim Colmer provides central operations support for 18 months.

SEPTEMBER 2021

Launch of subcommittees for Engagement and Research.
Recuitment begins for ISC Manager.

OCTOBER 2021

Appointment of Centre Manager Larissa Wiese.

NOVEMBER 2021

The ISC finds a temporary home at the University of Western Australia at 7 Fairway, in the Ken and Julie Michael Building.

2022

FEBRUARY 2022

ISC established as a permanent Business Unit.

ENGAGEMENT PROGRESS

FUNDING PROGRESS

Successful SmartSat CRC research contract of nearly $1M for three years

Submission of a $2.4 million CRC-P proposal, based on a new ISC-driven collaboration.

Initiated conversations with philanthropic donors.

COMMUNITY ENGAGEMENT

Significant public engagement such as Space Boot Camp (4 members), City of Perth Library talks x 2 (DO), Winthrop Society 'Falling into a Black Hole' (DO), Ian Constable Lecture (DO), Glyde-In Community Centre 'Space Law ' (ET), NASA Space Apps Challenge, TedX Talk (SS), Australian Information Industry Association (ET).

ADJUNCT INCLUSIONS

Dr Benjamin Kaebe appointed Adjunct Senior Lecturer January 2022.

GROWTH

Two new Nodes added - Tracking and Locating Earth-Bound and Deep Space Missions (Space Situational Awareness) and Radio Astronomy from Space (Astronomy from Space).

INTERNAL ENGAGEMENT

An ISC Meet and Greet and an Astrophotonics Movie Night were held in 2021. Weekly Research Committee lunches as a social engagement are now held each Thursday.

RECOGNITION

Dr Sascha Schediwy was the winner of the Academic and overall Excellence Awards from the Australian Space Awards (2021).

PhD student Skevos Karpathakis won the Andy Thomas Space Foundation Award.

GOVERNMENT

Successful engagement with government agencies such as ACMA, Australian Space Agency and WA State Government. Effected change of policy with ACMA to remove the costs for optical communication licences.

INDUSTRY ENGAGEMENT

Conferences Quantum TechX, West Australian European Business Association, ASBX Conference - Physiological Adaptations to Space (BM).

Submissions Airbus – co-funding for industry-based PhD scholarships as part of Airbus' Team Project Maier submission. PhosEnergy submission (PS).

ASA Technical Advisory Groups Earth Operations (LF), Robotics and Automation (PS), Optical Communications (SS), and Life Sciences (BM).

AROSE UWA is a founding partner of the Australian Remote Operations in Space and Earth (AROSE). UWA continues to work with AROSE to build projects and transferring knowledge for automation, robotics and communications.

RESEARCH

First ISC-driven research publication accepted (Social Sciences, March 2021).

First external research collaboration with other space centres (Curtin SSTC Binar payload opportunity).

Goonhilly initiated collaboration to build an optical ground station in WA and the funding of honours student Alex Frost of a UWA Research Associate position with the Laser Comunications and Timing Node.

Dr Sascha Schediwy – successful submission to the Moon to Mars Demonstrator Program.

Contribution to the decadal plan 2021-2030 of the National Committee for Space and Radio Science.

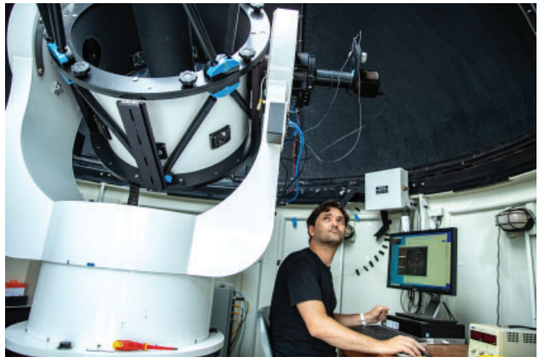
OTHER

Australian Defence Force visit in May with Fiona Dowse and Nicholas Hogan; ISC became a member of the Space Law Council of Australia and New Zealand; SSA Node made a new contract with CNES to deploy more antennas to monitor spacejunk – the greater vision is to deploy a national network of ground-based receivers; sponsorship of UWA Aerospace Club and NASA Space Apps Challenge; CRC SmartSat Seminar (AW); 12th Australian Space Forum (PS).

CENTRE HIGHLIGHTS

HIGHLIGHT - LASER COMMUNICATIONS AND TIMING

FEBRUARY 2021 Our Laser Communications and Timing team received $1 million in funding from the SmartSat Cooperative Research Centre for a three-year research project to advance optical communications between Earth and space.



Optical lasers could enable the transfer of data through space at rates thousands of times greater than can currently be achieved using radio signals.

The funder, the SmartSat Cooperative Research Centre, is a consortium of universities and research institutions partnered with industry to advance our ability to operate from space. The advanced free-space communication technologies being developed will be integrated into the Western Australian Optical Ground Station, currently based at UWA.

Unlike standard optical fibre networks that carry the bulk of the world's internet traffic, data rates over free-space optical communication laser links are limited by the destructive impact of atmospheric turbulence on the transmitted optical signals. The UWA team will investigate a unique combination of atmospheric turbulence mitigation technologies, including adaptive optics and coherent phase stabilisation, to correct unintended variations in the optical signal.

Project lead Dr Sascha Schediwy said the project aimed to develop and demonstrate high-speed, free-space optical communications via laser links between a ground station and airborne vehicles.

"We will demonstrate optical fibre-like data rates to drones, aircraft, and stratospheric balloons, as means to prove this technology prior to its deployment on future satellites," said Dr Schediwy.

HIGHLIGHT - SPACE BOOT CAMP

Years Nine and Ten students were granted the opportunity to attend our inaugural Space Boot Camp in January 2022, to strengthen their educational pathway to a career in space.

Sixty fourteen- and fifteen-year olds heard from those at the frontier of the Australian space industry and ex-NASA scientists. "It's the perfect time for kids to think about a career in WA's space sector, as our local space industry is quickly expanding its capabilities while witnessing a world-wide boom of exciting space missions," Associate Professor Obreschkow said.

"In fact, the Australian Space Agency looks to create another 20,000 space jobs over the next eight years."

The group of students learned about space plant biology, law, rocketry and propulsion, and even designing architecture for space. The teenagers also experienced a rocket launch with the UWA Aerospace Club.

"As kids, we used to think working in space meant becoming a rocket scientist or an astronaut – but the industry is so much broader than that, and that's what the students this week had a chance to experience," said Obreschkow.

"They learnt about things like human physiology in space, growing plants to support long-term missions, space debris and whose problem it is, robotics on the ISS and designing their own lunar habitats.

"All of these elements are crucial to our success in space as it becomes an increasingly civil industry. And of course, the students got the chance to build and launch their own rockets as well, because space is fun!"

Students also had a chance to quiz the brains of the International Space Centre's stellar team of experts on the questions everyone wants to know such as: Who owns the moon? How expensive is it to store stuff in space? Are we alone? How does an astronaut go to the toilet?

SPEAKERS Executive Director of the International Centre for Radio Astronomy Research Professor Peter Quinn, Head of Robotics at Woodside Mark Micire, Chief Technologist (New Energy) Woodside Dr Jitendra Joshi, Centre Director at ARC Centre of Excellence in Plant Energy Biology Professor Harvey Millar, GM (Australia) at First Mode Jan Haak, Professor of Law Erika Techera, Founding Director Aurora Space Startup Cluster Conrad Pires, Head of the International Space Centre Associate Professor Danail Obreschkow, lecturers Craig McCormack and Dr Clare Mouat and UWA Aerospace.

ACTIVITIES

HIGHLIGHT - ENRICO PALERMO'S VISIT

The ISC was pleased to host the Australian Space Agency (ASA) CEO, Enrico Palermo, and CTO, Aude Viganelles, on 14th May 2021.

The full day was spent on UWA campus and meeting with a range of stakeholders. The day started early with breakfast at Broadway Eatery with the ISC Board which was followed by a meeting with ISC and a tour of the optical communications group. This was followed by a meeting with ICRAR.

As a UWA Alumni, Enrico spent lunch with a range of UWA Student Clubs including the club that he established The UWA MotorSports Club. James Dingley from UWA Aerospace Club led a dialogue that was engaging and inspiring across a range of levels.

"Follow your passions and say yes to every opportunity to develop your skills," Palermo said on the day. "This all comes together to build a skillset that enables students to lead and do amazing things in space."

Following this, AROSE and ISC co-hosted an engagement and networking event for space start-ups and SMEs to have the opportunity to pitch, ask questions and network with Palermo and Viganelles in OceanWorks for the afternoon.

These events all provided students, researchers and industry to showcase their space expertise and meet new connections to build the WA capability.

CAPABILITIES & PROGRESS

LASER COMMUNICATIONS AND TIMING

FREE SPACE LASER LINKS FOR COMMUNICATION AND TIMING

NODE LEADER Dr Sascha Schediwy

NODE MEMBERS Dr David Gozzard, Dr Shane Walsh, Mr Benjamin Dix-Matthews, Ms Millicent Heber, Mr Shawn McSorley, Mr Joshua Collier, Mr Alex Frost, Mr Charles Gravestock, Mr Skevos Karpathakis, Mr Brett Nenner, Professor Jingbo Wang

EXPERTISE

STATUS
ESTABLISHED

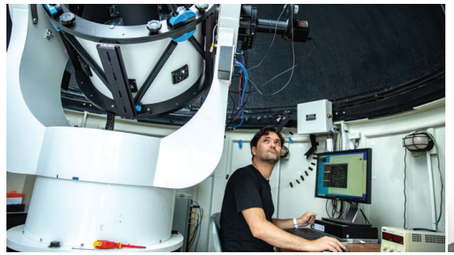
Reliable communication between ground users and space assets has become an integral part of our lives. The adoption of optical communications will lead to globally significant advancements in areas that span from fundamental physics and geodesy, to translation outcomes with immediate economic impact, such as improved space situational awareness and high-speed satellite communications.

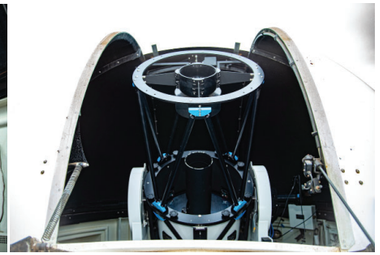
Our team has demonstrated a system for simultaneously suppressing both the phase- and amplitude-noise resulting from atmospheric turbulence. This capability allows us to transmit data through the atmosphere at rates thousands of times greater than otherwise possible, and also increase the stability rate of the transmission of timing signals by a factor of thousands.

PROGRESS 2021

- → The research group has received an additional $1 million in funding from the SmartSat Cooperative Research Center to extend our coherent communications research project by a further three years.
- → Goonhilly Earth Station Ltd's Australian office confirmed the progress of its plans to build a major new ground station in WA with the Laser Communications and Timing Node of the ISC.
- → Goonhilly also has agreed to fund ISC Laser Comms and Timings honours student Alex Frost a UWA Research Associate position in Semester 2, 2022.

Inside the WA Optical Ground Station with Dr Shane Walsh. Credit: Red Empire Media.





LASER COMMUNICATIONS AND TIMING

ULTRA PRECISE ATOMIC CLOCKS IN SPACE

NODE LEADER Professor Michael Tobar

EXPERTISE

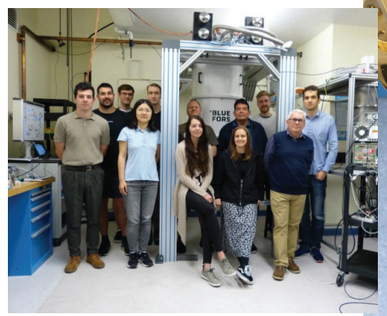
STATUS
DEVELOPING

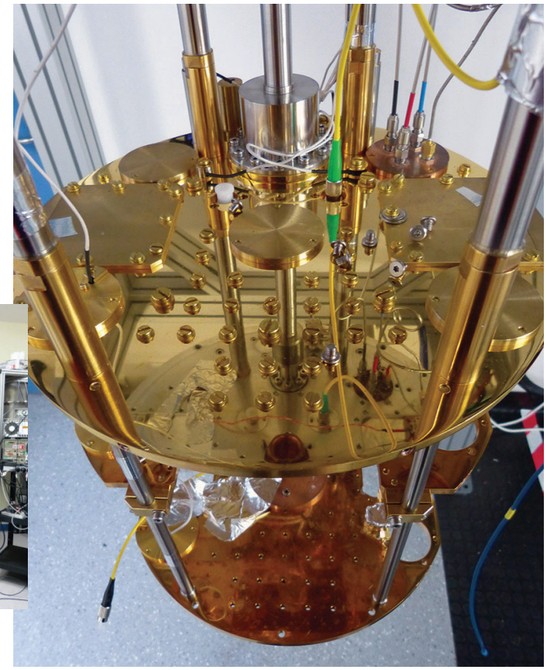
UWA Professor Michael Tobar of the Quantum Technologies and Dark Matter Research Lab is the only non-European science coordinator of the European Space Agency's Atomic Clock Ensemble in Space (ACES) experiment. ACES will undertake some of the most precise tests ever completed on gravitation and fundamental physics in space. Our research group also conduct robust tests on fundamental physics here on Earth, including on Quantum Gravity, Local Lorentz Invariance including the constancy of the speed of light and direct detection of dark matter. Professor Tobar has also been involved in a number of other proposals to test fundamental physics in space.

PROGRESS 2021 Node established.

RIGHT The ISC's Ultra Precise Atomic Clocks In Space Team.

FAR RIGHT This resonant mass detector can read out very tiny displacements.

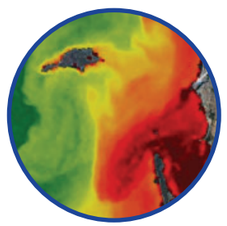




CAPABILITIES & PROGRESS

SATELLITE REMOTE SENSING

APPLICATIONS OF SATELLITE REMOTE SENSING



NODE LEADER Professor Charitha Pattiaratchi

NODE MEMBERS Professor Erika Techera, Professor Annette George, Dr Jeff Hansen, Associate Professor Nicole Jones, Associate Professor Nik Callow, Dr Cristina Vulpe, Professor Ryan Lowe

EXPERTISE

STATUS
DEVELOPING

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.

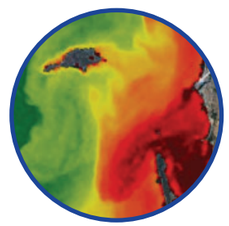
The SRS Node focuses on:

- 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 Western Australia;
- Island wakes and ocean fronts in the Indian Ocean;
- Marine heat waves and cold episodes around Australia;
- Prediction and impacts of tropical cyclones in Western Australia; and
- 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; and
- Satellite governance and remote sensing legislation.

PROGRESS 2021 Node established.

SATELLITE REMOTE SENSING

AVIONICS FOR SENSING AND IMAGERY



NODE LEADER Professor Lorenzo Faraone

NODE MEMBERS Professor Michael Tobar, Dr Dilusha Silva, Professor Brett Nener

EXPERTISE

STATUS
DEVELOPING

Our research team has been developing world-leading electro-optic sensors, imaging devices, and electronic systems for space-based earth observation and space situational awareness.

The team focuses on:

- material production for IR 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 640x512 pixels; and
- 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

PROGRESS 2021 Initiated research collaboration with local space SME LatConnect 60. The aim is to develop a mid-wave hyperspectral infra-red sensor to use on their satellite for imaging.

ISC's Avionics Research Team

CAPABILITIES & PROGRESS

ASTRONOMY FROM SPACE

GALAXY EVOLUTION SEEN THROUGH SPACE TELESCOPES

NODE LEADER Professor Simon Driver

NODE MEMBERS Associate Professor Aaron Robotham, Dr Luke Davies, Dr Sabine Bellstedt, Dr Elisabete da Cunha, Associate Professor Luca Cortese

EXPERTISE

STATUS
DEVELOPING

Galaxy Evolution is heavily involved in many of the space telescopes operated by NASA and ESA, such as the James Webb Space Telescope. They provide ground-based measurements of spectra as well as the rapid analysis of space imaging data, which we then combine to produce both impactful research and advanced databases for use by astronomers around the world.

As much of the space-telescope data is downlinked through Australian based facilities, this Node is expanding their capabilities to provide robust and rapid data analysis on behalf of NASA's Nancy Grace Roman Telescope and ESA's Euclid Telescope. They are also developing the capacity to process data from upcoming Australian Space Telescopes such as the Space Industry Responsive Intelligent Thermal satellite joint funded by the Australian Space Agency, Australian space industry companies, and the Italian Space Agency.

Galaxy Evolution 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.

PROGRESS 2021

- → Four PhD students have commenced in 2021 using space telescope facilities including Hubble and James Webb Space Telescopes;
- → As part of our collaboration with US astronomers (A$2M NASA grant), we have established a copy of the Hubble Space Telescope Imaging repository at ICRAR; and
- → ISC members have been awarded time on the JWST and should be amongst the first Astronomers in the world to be using JWST data.

IMAGE First aligned image of a star from the James Webb Space Telescope. Credit: NASA

ASTRONOMY FROM SPACE

GRAVITATIONAL WAVE ASTRONOMY

NODE LEADER Professor Linqing Wen

NODE MEMBERS Dr Qi Chu, Dr Fiona Panther, Dr Bruce Gendre

EXPERTISE

STATUS
DEVELOPING

GWA is probing our Universe using the emerging astronomical messenger of gravitational waves (GW). They transfer signal-processing technologies developed for ground-based gravitational wave detectors to observations from space, as well as combining gravitational wave and electromagnetic (EM) information for breakthrough science and for a better understanding of our astrophysical Universe.

Strengths include:

- → Methods and strategies to detect GWs 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.

PROGRESS 2021 Node established.

RADIO ASTRONOMY INTERFEROMETRIC OBSERVATIONS FROM SPACE (RIOS)

NODE LEADERS Drs Richard Dodson and Maria Rioja

EXPERTISE

STATUS
DEVELOPING

RIOS is part of the UWA Node of the International Centre for Radio Astronomy Research with strong international collaborations into next-generation observatories.

RIOS is 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 telescopes.

PROGRESS 2021 The Node leaders co-signed the application to ESA for mission support and the VLBI calibration and orbit determination working group has been formed. Monthly meetings addressing the issues and progress are being held, as we work towards the final design.

CAPABILITIES & PROGRESS

SPACE SITUATIONAL AWARENESS (SSA)

ZADKO TELESCOPE TEAM

NODE LEADER Associate Professor David Coward

NODE MEMBERS Dr Bruce Gendre, Mr John Moore, UWA Adjunct Dr John Kennewell, Ms Eloise Moore, Dr Fiona Panther

EXPENSE

STATUS
DEVELOPING

This Node uses UWA"s Zadko Telescope to pursue an SSA and space surveillance program involving international partners. In 2020 the Zadko Telescope was contracted by the ESA to track potentially hazardous bodies and provide data for impact hazard assessment. The French Space Agency (CNES) is also using the Zadko Telescope to monitor space asset launches and space debris risk. CNES is building a new global array of receivers for low Earth orbit satellites; the Australian part of that network is led by the Zadko team.

The Zadko Telescope shares its location in the high-tech robotised Zadko Observatory just outside Perth with other international space surveillance companies. Recently, UWA has also entered a hosting contract and research collaboration with the Polish Space Agency for monitoring space assets over Australasian skies.

PROGRESS 2021 During the later half of 2021 the Zadko Telescope has been upgraded with a new camera and other critical components). They have entered into an important hosting and collaborative agreement with the Japan Aerospace Exploration Agency (JAXA). In March 2022, new JAXA detectors are bring installed by Observatory Manager John Moore. The detectors at this longitude will be important for tracking satellites across Australian skies. Increase in Node members from 3 to 6.

SPACE SITUATIONAL AWARENESS (SSA)

TRACKING AND LOCATING EARTH-BOUND AND DEEP SPACE MISSIONS

NODE LEADERS Drs Maria Rioja and Richard Dodson

EXPERTISE

STATUS
DEVELOPING

The team are investigating how to improve the tracking and precise location of earth-bound and deep space missions, in conjunction with the American National Radio Astronomy Observatory and the next generation Very Large Array in New Mexico.

Our tracking node is also heavily involved in designing the next-generation methods for the new observatories, and identifying potential spin-off opportunities from these instruments. They are exploring improving the atmospheric measurements from GPS satellite observations which are used in astronomical data reduction, in collaboration with the GPS division of KASI in Korea.

PROGRESS 2021 Most effort in the last period has been in exploring and identifying suitable simulation packages that will allow us to develop on the previous work. The best solution has been identified.

CAPABILITIES & PROGRESS

EXPERIMENTS IN VARIABLE GRAVITY

MICROGRAVITY EXPERIMENTATION

NODE LEADERS Associate Professor Danail Obreschkow, Professor Dongke Zhang

EXPERTISE

STATUS
DEVELOPING

Our microgravity research programme 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.

Our research has collected over 10 hours of microgravity via such flights, mainly dedicated to experiments aiming to unravel the mysterious physics of collapsing cavitation bubbles.

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.

We also offer expertise on the design and conduct of microgravity experiments, as well as essential partnerships for accessing parabolic flight capabilities and drop tower facilities.

PROGRESS 2021 New PhD student appointed at EPFL via a Swiss grant held jointly between EPFL and UWA.

HYPERGRAVITY EXPERIMENTATION IN CENTRIFUGES

NODE LEADER Professor Conleth O'Loughlin

EXPERTISE

STATUS
DEVELOPING

Our team maintain strong links to the National Geotechnical Centrifuge Facility (NGCF), hosted at the Centre for Offshore Foundation Systems at UWA. The NGCF is the largest geotechnical centrifuge facility in the world, and the only such facility in Australia.

The NGCF centrifuges are mainly used to simulate the response of engineering systems at or within the seabed, but are also used in other scientific disciplines where enhanced gravity is required.

PLANTS IN SPACE

NODE LEADERS Professor Harvey Millar, Professor Ryan Lister

NODE MEMBERS Dr Nathan Tivendale, Dr Hui Cao, Dr Brendan Kidd, Dr Adil Khan, Dr James Lloyd, Dr Marina Oliva, Ms Glenda Oh, Mrs Bhagya Dissanayake

EXPERTISE

STATUS
ESTABLISHED

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. Plants in Space focus on:

- plant respiration modification to maximise growth and minimise CO_2 release;
- plant growth habitat design for the International Space Station and other off-Earth missions;
- plant protein production system design and optimisation;
- understanding plant cell responses to altered environments and growth conditions; and
- engineering plant gene activity through programmable genetic computation for optimised plant performance and modified function.

PROGRESS 2021

- Plants in Space have supported a team of six undergraduates to be part of the national SynBio Challenge. They are working on making nutritionally balanced proteins to express in plants to allow a single plant to provide all the human nutrition required for the space to Mars trip and beyond. Students receive credit for this project through a 3rd year Unit BIOC3003 or BIOC3005 that allows students to do a research project rather than lab classes for a semester.
- Perspective paper for plants in space, looking at how human needs need to shape the process of defining the types of plants and farming practices needed for space in collaboration with researchers at University of Melbourne.
- Science Week: three members of the Node performed school visits in Perth's northern suburbs on the topic 'Food by Design' as part of a national survey on what plant scientists should be researching to take to space and make grow in space - with a response tally of 150. A similar exercise was performed in South Australia and Victoria through colleagues.
- Submitted and EOI for an ARC Centre of Excellence in Plants for Space (to lead from University of Adelaide, but with nodes at UWA, University of Melbourne and La Trobe University). The full application is due in 2022.
- Plants in Space hosted an online cross-disciplinary seminar on design in space on 21 September 2021: *Synthetic Biology, Biodesign and Mars* by Dr Jestin George, University of Sydney.
- Node increased from 8 to 10 members

BELOW
Plants in Space written in *Physcomitrella patens* on a plate. This is a model organism (a moss) for plant evolution and plant genetics.

Photo Credit: Dylan Moss

CAPABILITIES & PROGRESS

SPACE MEDICINE

SPACE PHYSIOLOGY AND MEDICINE

NODE LEADER Professor William Morgan

NODE MEMBERS Dr Barry Doyle, Associate Professor Ferdous Sohel, Professor Danny Green, Dr Howard Carter, Professor Shane Maloney, Harrison Caddy

EXPERTISE

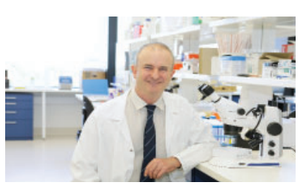
STATUS
DEVELOPING

Our research groups focus on:

- Modified photoplethysmography (PPG) for retinal pulse wave measurement;
- Non-invasive ICP measurement using PPG;
- PPG in eye disease: diabetes, glaucoma, retinal vein occlusion;
- Direct orbital pressure and ICP measurements and relationships to and orbital volume using in-vivo models, with PPG assessment as a tool for orbital pressure assessment. Human imaging of conjunctival lymphatics;
- Tilt table experiments to mimic low gravity (modified goggle wearing to alter eye/orbit/ICP pressure relations);
- Microgravity effects upon body fluid systems;
  - Space associated neuro-ocular syndrome (SANS);
  - Role of CSF pressure in SANS;
    - Changes in microgravity;
  - Endothelial cell changes in SANS, microgravity and space;
- Thermal regulation and body temperature stability in space environments; and
- Cardiovascular system changes in altered environments, including space

Other collaborative partners are working on the body fluid shifts and how the blood vessels around the eye are altered in space, and how altered environments affect heart and blood vessel function.

PROGRESS 2021 Node members increased from 4-7.



Professor William Morgan at the Lions Eye Institute

INFORMATION TECHNOLOGY IN SPACE

SPACE INFORMATION TECHNOLOGY

NODE LEADER Professor Andreas Wicenec

NODE MEMBERS Mr Kevin Vinsen, Dr Foivos Diakogiannis, Mr Rodrigo Tobar, Mr Dave Pallot, Mr Mark Boulton, Professor Mark Reynolds, Professor Mohammed Bennamoun

EXPERTISE

STATUS
DEVELOPING

Our data intensive astronomy (DIA) research group covers:

- 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;
- Gravitational wave detection; and
- Previous involvement in various satellite projects including HIPPARCOS, DIVA and GAIA.

PROGRESS 2021 Secured multi-year contracted software development work for the SKA construction. Started industry supported project using on-ground time-series data together with satellite images and physical modelling to predict ocean currents

AUTOMATION AND ROBOTICS

NODE LEADER Professor Thomas Bräunl

NODE MEMBERS Adjunct Associate Professor Robert Reid

EXPERTISE

STATUS
DEVELOPING

Our *Automation and Robotics* lab has designed and built more than 100 robots over the last two decades, including 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. They combine the latest sensor technology in Lidars, cameras, IMUs and (when possible) RTK-enhanced GNSS.

Automotion and Robotics 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.

PROGRESS 2021

- Conducted a full-week workshop on ROS with 45 participants.
- Set up 5 (lunar) rover robots for student experimentation.
- Added Node member.

CAPABILITIES & PROGRESS

LIVING AND WORKING IN SPACE

WORKING AND THRIVING IN SPACE

NODE LEADER Dr Lies Notebaert

NODE MEMBERS Professor Erika Techera, Dr Clare Mouat, Dr Laura Fruhen, Dr Renae Barker, Mr Craig McCormack

EXPERTISE

STATUS
ASPIRATIONAL

Human activities in space requires rethinking the ways we work and live, and developing effective working and living environments to maximise human performance and wellbeing in space.

Our research crosses and extends a range of social science disciplines including governance, law, policy, religion, cultural studies, media and communications, architecture and design, ethics, management, psychology, and philosophy.

We focus on:

- → Governance of human activities in space;
- → Architecture and designed environments in space;
- → Communications, media and public engagement with space;
- → Moral and ethical dimensions of space and space travel;
- → Research ethics and the regulation of space research;
- → Mental health and resilience in space;
- → Leadership in space;
- → Optimising human work performance in space; and
- → Optimising the balance between task automation and human manual control in space.

PROGRESS 2021 Across several meetings, our node has furthered critical understanding of the significant contributions our various disciplines can make to space exploration. It is critical that the human element is not forgotten, and node members are committed to represent our capacity to enable humans to work and thrive in space across teaching, research, and community engagement activities.

Mouat, C.M., Techera, E.J.E., Notebaert, L., Blake, M. and Barker, R. (2021). (Un)earthly governance: Beyond functional frameworks to flourishing spacescapes. Journal of Property, Planning and Environmental Law, 13(2), 122-138. https://doi.org/10.1108/JPPEL-02-2021-0015

IMAGE Design for a Mars surface architecture by UWA School of Design Masters of Architecture student Nik Cutten, 2018. This architectural design studio was a collaboration between the UWA School of Design and space architects based at the NASA Johnson Space Center, Houston.

LIVING AND WORKING IN SPACE

TEAMWORK IN SPACE

NODE LEADER Dr Ramón Rico

EXPERTISE

STATUS
ASPIRATIONAL

Teamwork is a key driver of space crews and mission control teams to successfully deal with the complexity and unpredictability of events that occur in every space mission.

Our research focuses on several areas relevant for space crews and mission control teams.

Firstly, by highlighting how team adaptation is a central process through which teams and multi-team systems (i.e., teams of teams) respond to unanticipated changes in extreme environments.

Secondly, when operating in dynamic and unpredictable contexts, the role of leadership in enabling team adaptation is crucial. For that reason, unraveling how team leaders adapt their leadership style to more accurately understand the situation and help the team to adapt to it, is a central topic of our research.

Finally, teams in space develop their activities by interacting with other teams and organisations to achieve their complex goals. For that reason, and because there is a lack of research focused on systems composed of such teams, we conduct research that improves our understanding of the coordination and motivational processes leading to performance in interdependent systems of teams.

GROWTH Node established.

EMOTIONS IN SPACE

NODE LEADERS Professor Yasmin Haskell

NODE MEMBERS Dr Daniel Juckes, Associate Professor Suzanne Wijsman, Dr Andrew Broertjes, Dr Francesco de Toni, Associate Professor Monica Azzolini, Associate Professor Alice Gorman, Dr Nicholas Bannan Janice Lally (LWAG)

EXPERTISE

STATUS
DEVELOPING

For most of human history our emotions about space have been embedded and embodied in our terrestrial experience. This node brings together historians of emotion, science and literature, archaeologists and linguists, with creative practitioners and performers to explore the history and future of emotions in space.

Our interdisciplinary group has interests in fiction, poetry, visual and performing arts, orbiting a core of research projects on emotions in space. reas for exploration include feelings and emotions, space and poetry, religion and space, space archaeology; and language and music in space.

PROGRESS 2021 The Emotions in Space Node has been exploring ways to use space as a vehicle for humanities, arts and literacy enrichment in WA schools.

CAPABILITIES & PROGRESS

PROPULSION AND CRYOGENICS

NODE LEADER Dr Saif Al Ghafri

NODE MEMBERS Dr Arman Siahvash, Professor Dongke Zhang, Dr Mingming Zhu, Mr Zhezi (Zeno) Zhang, Professor Eric May, Professor Michael Johns, Associate Professor Paul Stanwix

EXPERTISE Our research team focuses on:

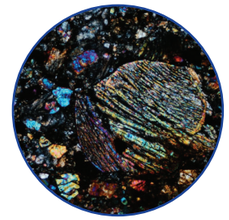
STATUS
DEVELOPING

- → Propellant Boil-off: We are working with NASA to develop a specialized liquid hydrogen and LNG boil-off gas (BOG) model (case study on the ISC website);
- → Cryogenic Solid Freeze-out and Dissolution Geology: With NASA's Jet Propulsion Laboratory (JPL) and the Australian Nuclear Science and Technology Organisation (ANSTO) we are investigating the weathering processes occurring on the surface of Saturn's moon Titan and several Jovian moons.
- → Propellant and propulsion: We aim to study the ignition, combustion and explosion characteristics of propellants used in rocket engines. Computational Fluid Dynamic (CFD) modelling will be used to assist the design of injector and combustion chamber.
- → Combustion and flame in space craft: We study fundamental ignition and combustion behavior of solid materials in low gravity that may be relevant to spacecraft fire prevention and control.
- → Microgravity experiments for science discovery: We are interested in the ignition process of solid and gaseous fuels, the radiative heat transfer in small-sized flames, soot formation mechanisms and bubble formation during water electrolysis. Experiments under microgravity without the effect of the gravity-induced buoyancy are necessary to validate such numerical models to obtain key transport and chemical reaction phenomena.
- → Life support in space: We are interested in the catalytic cracking of waste methane for H2 production to help close the loop of oxygen and water production using standard methods, such as those used on the International Space Station.

PROGRESS 2021 Professor Zhang participated in a CRC-P application on behalf of the ISC - *Development of the GenX Betavoltaic Battery Pilot Manufacturing Process*, led by PhosEnergy. Zhang's role in this CRC-P is to take a lead in heat transfer management. Additional collaboration with NASA on the boil of gas of cryogenic fluids.

Al Ghafri, Saif Z.S. et al. "Advanced Boil-Off Gas Studies Of Liquefied Natural Gas Used For The Space And Energy Industries". Acta Astronautica, vol 190, 2022, pp. 444-454. Elsevier BV, https://doi.org/10.1016/j.actaastro.2021.10.028.

SPACE MATERIALS AND RESOURCES



PLANETARY GEOSCIENCE

NODE LEADER Associate Professor Anthony Kemp, Professor Myra Keep

NODE MEMBERS Professor Marco Fiorentini

EXPERTISE Planetary Geoscience focusses on mineralogical and geochemical studies of geological materials from space that have been ejected from the lunar surface, Mars and the Asteroid Belt. We also work on the characterisation of ancient rock sequences on Earth.

STATUS
DEVELOPING

Our research projects span across planetary geology, petrology, microanalysis, geochemistry, geobiology, sedimentology and stratigraphy:

- → Characterisation of chondritic meteorites;
- → Martian meteorites;
- → Terrestrial hot springs and the origin of life (e.g. characterisation of the geochemical and metallogenic composition of the 3.5 billion-year-old Dresser Formation from Western Australia; experiments on prebiotic organic chemistry); and
- → Paleoecology of modern and deep time microbial depositional systems.

Current projects are mainly through student Honours and Masters students. Current collaborations include with the University of Minnesota (Duluth), with Professor Vicki Hansen, and with Ray Pickard at the Bathurst Observatory Research Facility (meteorite studies).

Planetary Mapping
This team also uses Synthetic Aperture Radar (SAR) data to map planetary surfaces, and understand surface and tectonic processes on Venus and other terrestrial planets.

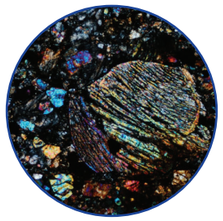
Surface mapping of Venus indicates that plate tectonics does not operate at all, and that other processes drive the formation of mountains and volcanoes. Mars appears to have had early attempts at plate tectonics that did not evolve, yet Mars hosts the largest volcano yet known in the solar system. Mars also has a number of water- and wind-driven surface processes in operation.

PROGRESS 2021 Discussions have commenced regarding a research proposal for a scientific study on samples of the C-type near-Earth asteroid Ryugu, recovered by the Hayabusa2 probe, launched in 2014 by the Japan Aerospace Exploration Agency.

CAPABILITIES & PROGRESS

SPACE MATERIALS AND RESOURCES

MINING AND MINERALS IN SPACE



NODE LEADER Associate Professor Ali Karrech

EXPERTISE Mining and Minerals in Space is interested in developing new technologies that apply to off-Earth mining and mineral processing. Like on-Earth, a successful mine cycle requires proper exploration and prospecting, mine design and planning, mine construction, and production methods.

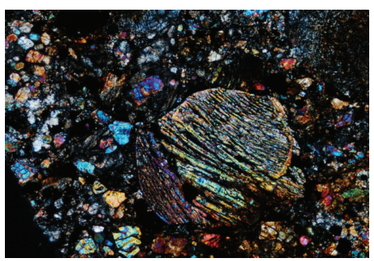
STATUS
DEVELOPING

The focus for space is on:

- → Water mining in space;
- → Space mine optimisation, planning and scheduling;
- → In-situ processing of precious metals; and
- → Off-Earth construction and building materials.

PROGRESS 2021 Node established.

ISC's Space Materials and Resources



EXTRATERRESTRIAL CIVIL AND RESOURCE ENGINEERING

NODE LEADER W/Professor Arcady Dyskin, Professor Elena Pasternak

NODE MEMBERS Dr Mohamed Elchalakani, Broadus Jeffcoat-Sacco, Dr Nazanin Nourifard, Dr Igor Shufrin, Dr Hongyu Wang, Rui Wong

EXPERTISE Our research, led by Professor Arcady Dyskin, aims to develop 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.

STATUS
DEVELOPING

- → Methods of mortarless extraterrestrial construction based on Topological Interlocking;
- → Developing the methods of drilling/cutting of extraterrestrial bodies using thermal spallation;
- → Extraterrestrial fracture mechanics; and
- → Asymmetric friction locomotion for deep exploration of extraterrestrial bodies.

PROGRESS 2021 The node increased the number of members from 5 to 8.

Mortarless Engineering

OUR TEAM

NODE LEADERS

DR SAIF AL GHAFRI
PROPULSION AND CRYOGENIC FLUIDS

PROFESSOR THOMÄS BRAUNL
Robotics and Automation
SPACE INFORMATION TECHNOLOGY

DR MARIA RIOJA CAPELLAN
Radio Astronomy from Space
ASTRONOMY FROM SPACE

ASSOCIATE PROFESSOR DAVID COWARD
Zadko Telescope Team
SPACE SITUATIONAL AWARENESS

DR FRANCESCO DE TONI
Emotions of Space
LIVING AND WORKING IN SPACE

DR RICHARD DODSON
Radio Astronomy from Space
ASTRONOMY FROM SPACE

PROFESSOR SIMON DRIVER
Distant Universe and Space Telescope Science
ASTRONOMY FROM SPACE

PROFESSOR ARCADY DYSKIN
SPACE CIVIL ENGINEERING

PROFESSOR LORENZO FARAONE
Avionics for Sensing and Imaging
SATELLITE REMOTE SENSING

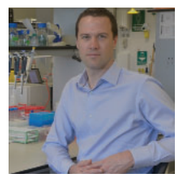
PROFESSOR MARCO FIORENTINI
Planetary Geoscience, Mining and Minerals in Space
SPACE RESOURCES AND MATERIALS

PROFESSOR YASMIN HASKELL
Emotions of Space
LIVING AND WORKING IN SPACE

ASSOCIATE PROFESSOR ALI KARRECH
Mining and Minerals in Space
SPACE RESOURCES AND MATERIALS

PROFESSOR MYRA KEEP
Planetary Mapping
SPACE RESOURCES AND MATERIALS

ASSOCIATE PROFESSOR ANTHONY KEMP
Planetary Geoscience
SPACE RESOURCES AND MATERIALS



PROFESSOR RYAN LISTER
PLANTS IN SPACE

...NODE LEADERS CONT'D

PROFESSOR HARVEY MILLAR

PLANTS IN SPACE

DR RAMON RICO MUNOZ

Teamwork in Space

LIVING AND WORKING IN SPACE

MR JOHN MOORE

Zadko Telescope Team

SPACE SITUATIONAL AWARENESS

PROFESSOR BILL MORGAN

SPACE PHYSIOLOGY AND MEDICINE

DR LIES NOTEBAERT

Working and Thriving in Space

LIVING AND WORKING IN SPACE

ASSOCIATE PROFESSOR CONLETH O'LOUGHLIN

Hypergravity Experimentation in Centrifuges

EXPERIMENTS IN VARIABLE GRAVITY

PROFESSOR ELENA PASTERNAK

SPACE CIVIL ENGINEERING

PROFESSOR CHARITHA PATTIARATCHI

Applications of Satellite Remote Sensing

SATELLITE REMOTE SENSING

DR SASCHA SCHEDIWY

Free Space Laser Links for Communication and Timing

LASER COMMUNICATIONS AND TIMING

DR ARMAN SIAHVASHI

PROPULSION AND CRYOGENIC FLUIDS

PROFESSOR MICHAEL TOBAR

Ultra-precise atomic clocks in space.

LASER COMMUNICATIONS AND TIMING

PROFESSOR LINQING WEN

Gravitational Wave Astronomy

ASTRONOMY FROM SPACE

PROFESSOR ANDREAS WICENEC

Data Science, Data Management and Processing and Software Engineering

SPACE INFORMATION TECHNOLOGY

PROFESSOR DONGKE ZHANG

PROPULSION AND CRYOGENIC FLUIDS

OUR TEAM

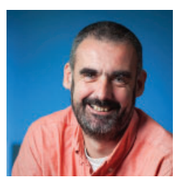
BOARD OF THE ISC

PROFESSOR PETER QUINN (CHAIR)

Executive Director of the International Centre for Radio Astronomy Research

PROFESSOR HARVEY MILLAR

Appointed Nominee to the Board



PROFESSOR SIMON DRIVER

Appointed Nominee to the Board

PROFESSOR GIA PARISH

Appointed Nominee to the Board

PROFESSOR STEPHEN SMITH

UWA Appointee to AROSE

MS PRU STEINERTS

Industry and Engagement

MR ANTHONY FORTINA

DVCR Nominee

PROFESSOR WILLIAM MORGAN

Appointed Nominee to the Board

ASSOCIATE PROFESSOR DANAIL OBRESCHKOW

Head of the International Space Centre

PROFESSOR ERIKA TECHERA

Appointed Nominee to the Board

MRS LARISSA WIESE

Executive Officer
Non-voting member

OUR TEAM

EXECUTIVE TEAM

A/PROF DANAIL OBRESCHKOW
HEAD, ISC
ARC Future Fellow, ICRAR/UWA

PRU STEINERTS
INDUSTRY ENGAGEMENT, ISC

LARISSA WIESE
MANAGER, ISC

The International Space Centre gratefully acknowledges the support provided by the International Centre for Radio Astronomy Research in its first year.

LEFT
ISC grown in duckweed on a plate by the *Plants in Space* Node.

Photo Credit: Red Empire Media

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THE UNIVERSITY OF WESTERN AUSTRALIA

INTERNATIONAL SPACE CENTRE