partners *in* excellence

The Go8's long-standing relationship with Japan

GROUP OF EIGHT
AUSTRALIA

Foreword from CEO, Group of Eight

VICKI THOMSON

As Group of Eight (Go8) Chief Executive, I hope you find this short publication informative, and its content impressive for what its snapshot says about the strength of our long standing research relationships the Go8 universities have with Japan.

The Go8 represents Australia's leading research-intensive universities, undertaking 70 per cent of the nation's university research activity. All eight universities are ranked in the world's top 100 universities, with six in the top 50 (QS World University rankings 2024).

The Australia-Japan partnership is our closest and most mature in Asia and is fundamentally important to both countries' strategic and economic interests. It is not surprising therefore that Japan is a priority partner for research and education collaboration with the Go8 universities. That partnership extends to Japan's top tier research universities as well as key industry partners.

Go8 universities top the list of Australian institutions in terms of their individual volume of research co-publications with Japan, which speaks to the strength of the partnership.

In 2019–2023 alone, there were almost 12,000 Go8 research publications involving Japanese colleagues.

Our collaborations extend beyond discovery to practical and rewarding commercial outcomes.

This publication, produced to coincide with the 2024 Go8 delegation to Japan as part of the Australia-Japan Government High Level Policy Dialogue, demonstrates the breadth, variety and depth of research engagement between our two nations. It highlights but a small sample of Go8 research projects which, in collaboration with our Japanese university, industry and government partners, deliver significant benefits to our countries, the region, and the world.

Many global challenges are addressed through the joint efforts featured in this book, including agriculture, energy, health and even going to the moon, while pure discovery remains a key goal of our collaboration including in astrophysics.

The Go8 is proud to partner with Japan to deliver research outcomes that make our communities and our region more productive, competitive, safer and stronger.

COMMITMENT TO EXCELLENCE

All Go8 universities are ranked in the **top 100** universities globally

Go8 members are responsible for **70 per cent** of research conducted by Australian universities, investing **$7.7 billion** into research annually

The Go8 has some **30,000** research students; and **almost half** of all research completions in Australia are from a Go8 university

The Go8 enrols **430,000** students, educating more than **one-quarter** of all higher education students in Australia

Japan is Go8's **11th global top** collaborator in research behind South Korea and ahead of the Netherlands

Go8 universities collectively invest **20 per cent** of the total national investment in R&D by business, governments, and the higher education sector combined

Over the past five years (2019–23), Australia has ranked the **7th highest** co-publisher with Japan

The **top research areas** of collaboration (2019–23) between Go8 and Japanese researchers are: Clinical and Life Sciences; Physics; Chemistry; and Agriculture, Environment and Ecology

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Laser Guide Star Adaptive Optics

AUSTRALIAN NATIONAL UNIVERSITY

The Australian National University (ANU) Advanced Instrumentation Technology Centre (AITC) is a national research infrastructure facility based in Canberra which supports the establishment of next generation instruments for astronomy and space science

It is involved in a major collaboration with Japan to build new instrumentation for the Subaru Telescope in Hawaii, USA.

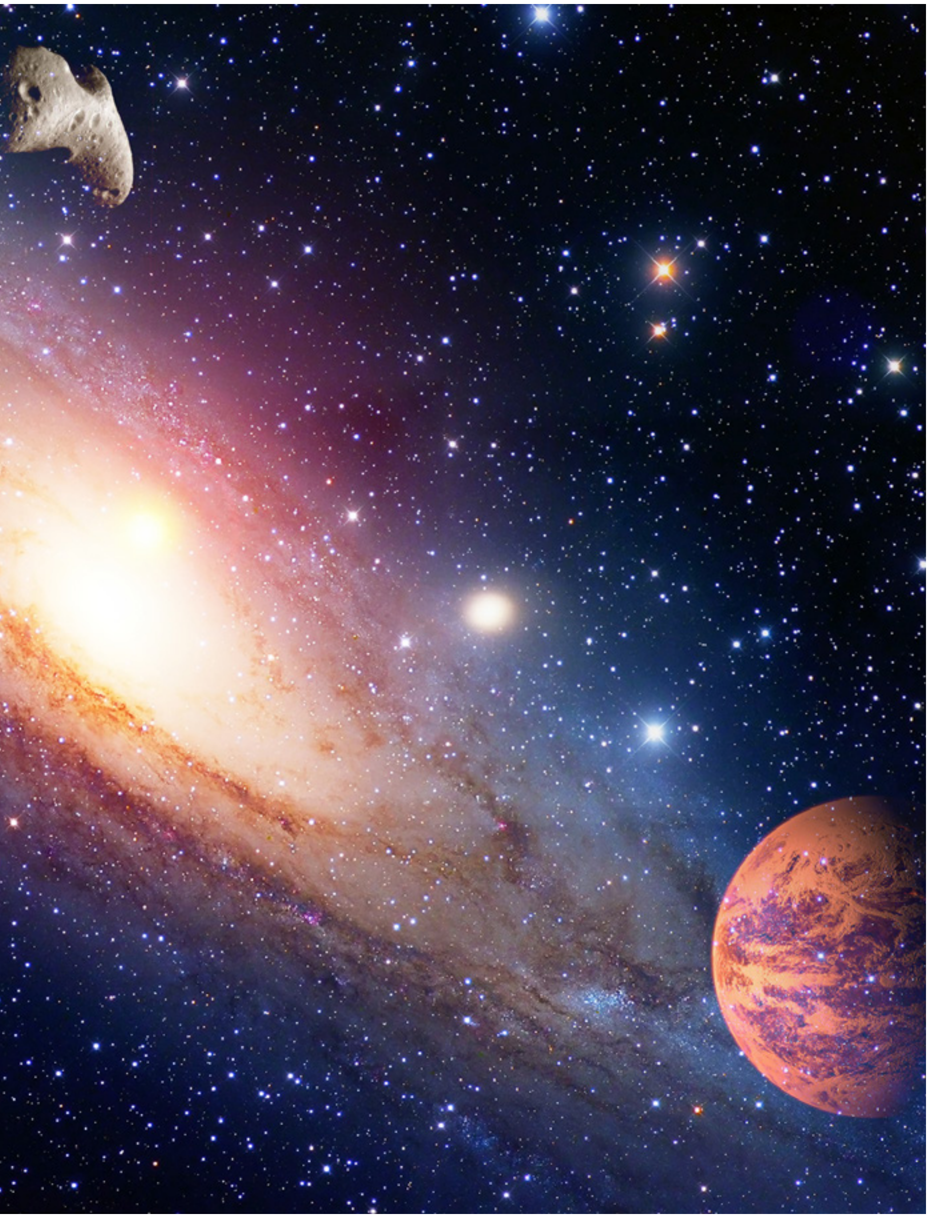
The Subaru Telescope has been used in research in almost all fields of optical and infrared astronomy, observing an extensive range of targets, including Solar System bodies, stars, interstellar medium, star and planet formation, exoplanets, galaxies, black holes, the early Universe, and cosmology[1].

The AITC specialises in Adaptive Optics for advanced astronomical instruments, as well as reliable tracking of satellites and space debris, and high-performance laser communications.

This includes Laser Guide Star Adaptive Optics (LGS AO), a powerful, Nobel prize-enabling technique that can remove the blurring effect of atmospheric turbulence above ground-based astronomical telescopes, laser ground stations used for ground-space laser communications, and laser tracking stations monitoring satellites and space debris orbiting the earth.

Collaborating with the National Astronomical Observatory Japan (NAOJ), the AITC will build an innovative LGS AO system for the 8-metre optical-infrared Subaru Telescope in Hawaii, USA[2].

1 https://subarutelescope.org/en/subaru2/collaboration/



The AU$50 million project led by NOAJ, in close collaboration with the ANU and other partners, was initiated in 2017 and is expected to continue over the next decade.

The goal is to equip the Subaru Telescope with state-of-the-art astronomical instrumentation: a wide-field near-infrared imager and a multi-object spectrograph both utilising Ground Layer Adaptive Optics (GLAO) with 4 LGS to improve seeing by a factor of 2 or more across a large field of view. The AITC is responsible for the development of the Laser Guide Star Facility and the Wavefront Sensor module as part of the project[3].

Named ULTIMATE-Subaru[4], the project will also serve as a test platform to demonstrate the benefits of LGS AO for laser communications and space situational awareness in partnership with Japan's National Institute of Information and Communications Technology (NICT) and the Japan Aerospace Exploration Agency (JAXA).

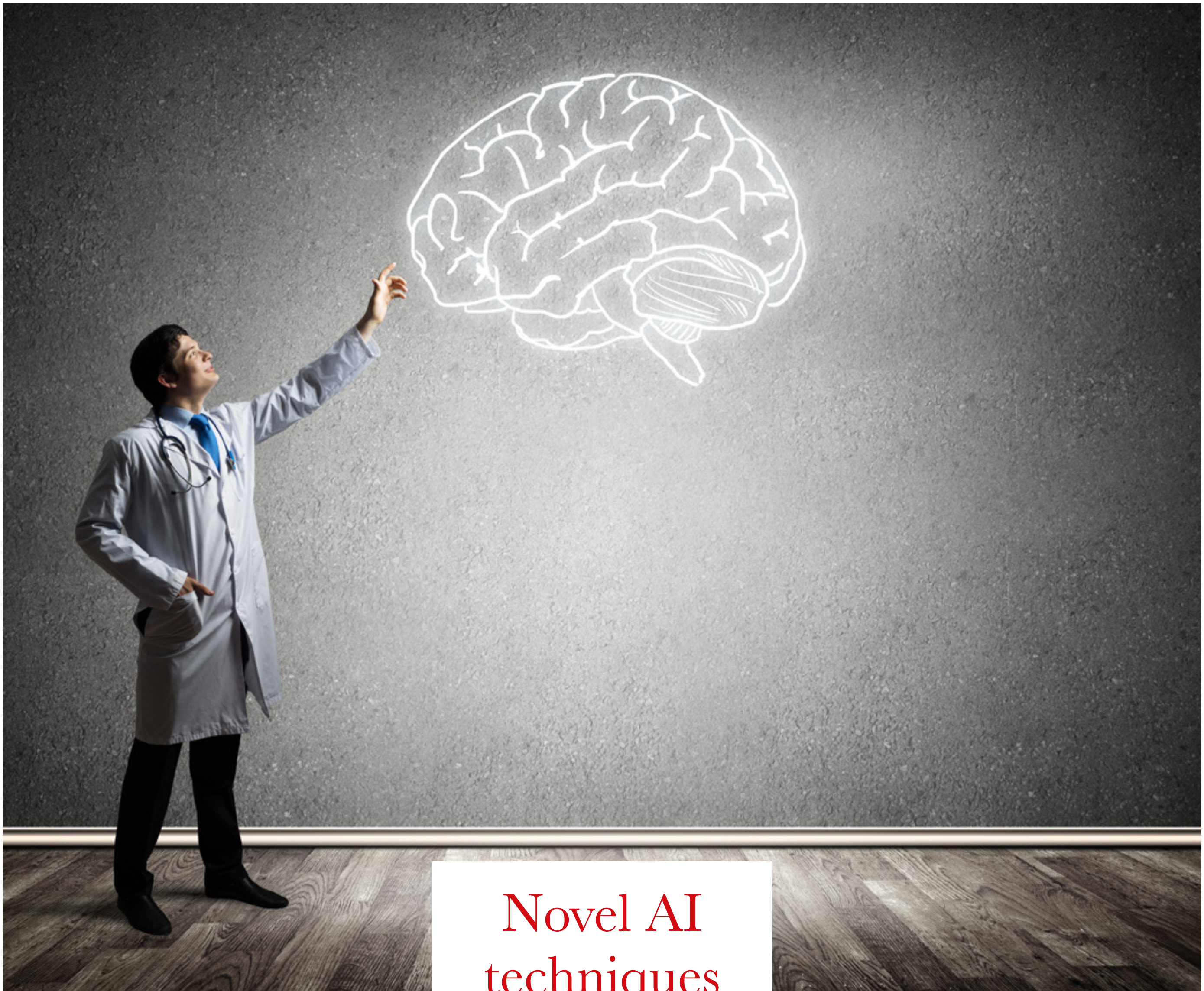
"The collaboration via ULTIMATE-Subaru has exceptional value, allowing ANU AITC staff who design and develop the Adaptive Optics enhancements to build unique skills and capability in partnership with our Japanese colleagues. ULTIMATE-Subaru is also a test-bed for future industry applications that are critical to space situational awareness, such as debris detection and the tracking of satellite orbits." – *Professor Céline d'Orgeville, Director of the AITC.*

The AU$50 million project led by NOAJ, in close collaboration with the ANU and other partners, was initiated in 2017 and is expected to continue over the next decade

2 https://rsaa.anu.edu.au/research/research-projects/ground-layer-adaptive-optics-system-8-metre-subaru-telescope-hawaii

3 https://rsaa.anu.edu.au/news-events/news/laser-guide-star-adaptive-optics-instrumentation-research-aitc

4 https://ultimate.naoj.org/



Novel AI techniques

UNIVERSITY OF QUEENSLAND

The Center for Brain Science, RIKEN, Japan, and the University of Queensland (UQ) collaborated in 2024 on a workshop on novel Artificial Intelligence (AI) techniques which allowed brain science researchers to explore a new approach to AI developed at UQ. This approach could lead to a more direct way to interpret complex systems such as brain signals, social phenomena, and human-machine interaction.

Workshop: University of Queensland and the Centre for Brain Science, RIKEN

The inaugural Synthetic Language and Information Topology Workshop introduced brain science researchers to a new approach to AI for analyzing complex neurological data.

One of the key challenges for current AI is to derive meaning from novel situations. UQ has developed a groundbreaking AI approach, based on computing entropy, which is several orders of magnitude more efficient than the existing method.

The Center for Brain Science, RIKEN, Japan, and the University of Queensland (UQ) collaborated in 2024 on a workshop on novel Artificial Intelligence (AI) techniques which allowed brain science researchers to explore a new approach to AI developed at UQ

It also allows for the potential to rapidly identify social behaviours, even without prior learning. For challenging, complex, and contested environments where there is no data to learn from, this approach offers the potential to overcome current limitations and introduce a new approach for explainable and trusted AI.

A key aspect of this approach is the fast entropy algorithm.

Funding for this successful event was provided by UQ's Dr Andrew Back's Advance Queensland and Trusted Autonomous Systems Defence Cooperative Research Centre Fellowship project.

The work has been presented in private briefings to key US and Australian Government defence personnel, and may provide capabilities for intelligence, cyber resilience, and electronic warfare.

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Solar technology SunShot

UNSW SYDNEY

The rapid growth of solar generation capacity points to its future dominance in global energy generation

At current growth rates (approximately 20 per cent per annum), solar will pass fossil gas in 2024 and coal in 2025, and will approach nine Tera-Watts in 2031, surpassing all other energy sources combined.

Australia is at the forefront of modern solar and photovoltaics research. UNSW Scientia Professor Martin Green, known as the "father of PV", has spearheaded global revolutionary advances in photovoltaic (PV) research. The PERC solar cell invented in 1983 powers more than 85 per cent of all new solar panel modules and over 50 per cent of large-scale electricity production.

Professor Green was awarded the 2021 Japan Prize in the field of "Resources, Energy, the Environment, and Social Infrastructure" for his revolutionary work in the field of photovoltaics

Professor Green was awarded the 2021 Japan Prize in the field of "Resources, Energy, the Environment, and Social Infrastructure" for his revolutionary work in the field of photovoltaics[5].

Japan is a large and growing market for solar technologies, with renewables set to account for 36 to 38 per cent of Japan's diverse energy mix by 2030. Japan also has a thriving space sector that requires new photovoltaic solutions.

Australia and Japan have been working together on solar technology for decades. As early as the 1980s, Japan hosted Professor Martin Green on an industry tour. In 1999, Professor Green presented on key aspects of silicon solar cells at the 11th International photovoltaic science and engineering conference, Hokkaido, Japan. His work has been cited more than 88,000 times[6] and he has been selected as a Clarivate "Highly Cited Researcher" (top 0.1% in field) each year since the scheme began in 2014. This includes citation by Japanese researchers and developers on the 'heterojuction' silicon cell (HJT) which ranks third as the silicon cell produced in the highest volume commercially (PERC is the first)[7].

Japan and Australia have also been working together on the International Energy Agency (IEA) Photovoltaic Power Systems Technical Collaboration Programme since the 1990s and on technology development in characterization tools, and in solar technologies for application in space and integrated on electric vehicles.

Solar is therefore a key potential focus for future significant collaboration between UNSW and Japan, including in innovation and in advanced manufacturing, and as a major pillar of the global effort towards carbon neutrality.

'Japan and Australia both have a deep technology culture that has seen us contribute to solar technology development over many decades. With both countries making strong commitments to reduced carbon emissions, we are optimistic we can continue to collaborate on delivering a future where over half our energy needs are met by solar,' says Professor Renate Egan, UNSW's School of Photovoltaic & Renewable Energy Engineering.

5 https://www.japanprize.jp/

6 https://www.researchgate.net/profile/Martin-Green-7

7 https://www.unsw.edu.au/staff/martin-green

Humanity's return to the moon

UNIVERSITY OF ADELAIDE

In an exciting venture, University of Adelaide researchers, led by Associate Professor John Culton, Director, Andy Thomas Centre for Space Resources, are working with Japanese colleagues to support Artemis III, NASA's first human mission to the lunar south pole, the southern most point on the moon

The mission, planned for 2026, will be humanity's first return to the lunar surface in more than 50 years[8]. The team will work to test a key observational experiment package to be deployed on the moon.

The Lunar Surface Dielectric Analyzer (LDA), will be tested in the University of Adelaide's Extraterrestrial Environment Simulation Lab (EXTERRES Lab) prior to it being used in NASA's 2026 Artemis III mission. The LDA will be placed on the moon's surface by astronauts to measure the dielectric properties of the lunar surface, and yield new information about the moon's bulk density. It will also study how the dielectric properties change as the surface temperature changes, which could be a key to understanding whether ice exists in the shallow lunar subsurface.

8 https://www.nasa.gov/missions/artemis/artemis-iii/

The research, supported by the University of Sydney's Centre for Wind, Waves, and Water is crucial in developing a reliable forecast tool in offshore and coastal areas and aiding maritime navigation

Unravelling the "mystery" of extreme waves

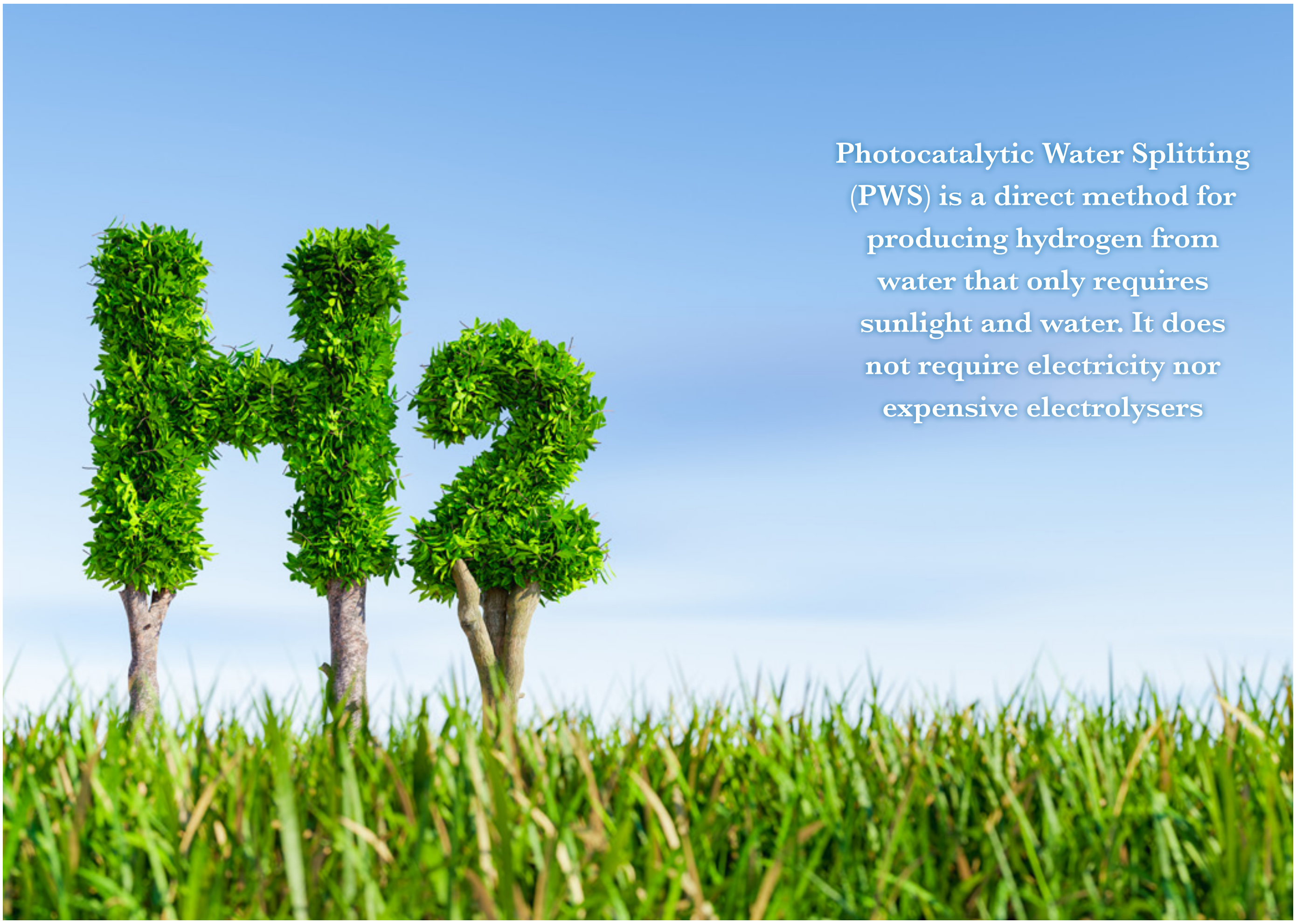
UNIVERSITY OF SYDNEY

University of Sydney and Kyoto University researchers are unlocking the mystery of how rogue waves appear from flat, calm and complex seas

The research has found that extreme or 'rogue' ocean waves – colossal walls of water that seemingly appear at random and have the potential to destroy marine infrastructure, carve out coastlines and even threaten life – could be more frequent in multi-directional wave formations than previously expected.

The research, supported by the University of Sydney's Centre for Wind, Waves, and Water is crucial in developing a reliable forecast tool in offshore and coastal areas and aiding maritime navigation.

The research has also found that extreme waves, caused commonly during storms, may pose an increasing risk in the wake of climate change.



Green hydrogen

UNIVERSITY OF ADELAIDE

University of Adelaide researchers are drawing on Japanese photocatalytic water-splitting expertise to advance development of technology to produce green hydrogen more efficiently and at lower costs

Green hydrogen is a sustainable and environmentally friendly energy source, whose future availability will be instrumental in addressing energy challenges.

Led by Professor Kazunari Domen, from University of Tokyo and Shinshu University, AARPChem – a consortium of Japanese companies and the Japanese Government – has developed a photocatalytic sheet, that directly converts water into hydrogen and oxygen by application of only sunlight (that is, with no electricity input).

The University of Adelaide group, led by Professor of Chemistry Greg Metha, is using these photocatalyst sheets by placing them in a special reactor that can operate under concentrated solar light.

The development of a unique and patent-pending (in national phase) thermo-photocatalytic reactor follows on from the group's research into photo-catalytic water-splitting under extreme conditions for over a decade.

The collaboration commenced in 2018 and has involved materials exchange including photocatalyst samples shipped from Japan to Australia, joint publications, and joint grants.

'Photocatalytic Water Splitting (PWS) is a direct method for producing hydrogen from water that only requires sunlight and water. It does not require electricity nor expensive electrolysers. For this reason, it has the potential to significantly undercut the cost of green hydrogen production compared to electrolysis. Operation under concentrated solar reduces the amount of photocatalyst material required and improves the reaction efficiency,' Professor Greg Metha explains.

The reactor was recently successfully tested at the CSIRO Energy Facility[9] in Newcastle, Australia. Intellectual property for this reactor has been secured and the technology is being developed by a spin-off company, Sparc Hydrogen. Sparc Hydrogen's patent pending PWS reactor has the potential to improve the efficiency of PWS to obtain hydrogen from water using concentrated solar. Given lower infrastructure requirements and energy use, the 'Sparc Green Hydrogen' process could deliver a cost and flexibility advantage over electrolysis.

The goal is to produce green hydrogen as cheaply as possible (ideally at less than $2 a kilo).

Sparc Hydrogen's patent pending PWS reactor has the potential to improve the efficiency of PWS to obtain hydrogen from water using concentrated solar

Photocatalytic Water Splitting (PWS) is a direct method for producing hydrogen from water that only requires sunlight and water. It does not require electricity nor expensive electrolysers

9 CSIRO is Australia's National Science Agency, an arm of the Commonwealth Government.

Industry links

MONASH UNIVERSITY

Monash University has forged strong industry links with Japanese partners in areas ranging from energy to carbon recycling to antibodies, with huge potential for significant commercial outcomes

Awarded AU$10 million by the Australian Government in 2023, through the Australian Research Council (ARC), the initiative is designed to transform carbon dioxide emissions into useful products and develop the markets for the carbon embedded products

Carbon utilisation and recycling

Japanese company, Nk Energy Frontier Pty Ltd, is a partner in the Australian Research Council (ARC) Research Hub for Carbon Utilisation and Recycling (ReCarb), led by Monash's Professor Paul Webley, Woodside Monash Energy Partnership Director. Awarded AU$10 million by the Australian Government in 2023, through the ARC, the initiative is designed to transform carbon dioxide emissions into useful products and develop the markets for the carbon embedded products.

This includes developing energy-efficient, integrated conversion processes and equipment for adoption by industry within the energy and chemical manufacturing sectors. The aim is to demonstrate pilot scale applications of carbon dioxide (CO_2) to products and CO_2 recycling at Technology Readiness Level (TRL) of 5–6 so that industry can scale up and assess these processes for their applications.

ReCarb involves partners across 26 organisations, spanning Japan, the UK and the USA, including 18 business or commercial partners. Two other Go8 universities, the University of Queensland and the Australian National University, are among the partners. Other objectives of ReCarb are to:

- Develop improved, low cost, scalable and green methods for electrochemical, thermochemical and biological conversion of CO_2 to intermediate and high value products
- Develop innovative, low cost, direct air capture technology for CO_2 recycling
- Identify methods and frameworks for embedded emissions accounting that can unlock growing markets for abated carbon products and services
- Train a highly skilled workforce with deep knowledge in carbon-to-products technology and commercialisation pathways

In 2022, Japanese company, Ono Pharmaceutical Co Ltd, awarded a research contract to Monash researchers … to discover and develop antibodies against G protein-coupled receptors (GPCRs)

Core loss mechanisms in soft magnetic nanostructures

The Toyota Motor Corporation (Japan) is the industry partner in a Monash University project to develop low-carbon vehicle technologies.

The AU$523,000 project, funded by the Australian Government's ARC Linkage Program and Toyota, will enable Monash Professor Kiyonori Suzuki to explore how power losses occur in magnetic cores used in petrol-electric hybrid cars. New knowledge is expected on the effect that magneto-mechanical interaction has on the anomalous core loss in iron-based alloys. The project is due to conclude in 2024.

Antibody therapy for the treatment of inflammation

In 2022, Japanese company, Ono Pharmaceutical Co Ltd, awarded a research contract to Monash researchers, led by Dr Remy Robert, from the Monash Biomedicine Discovery Institute, to discover and develop antibodies against G protein-coupled receptors (GPCRs). The outcomes will be used to develop novel therapeutics for the treatment of autoimmune and inflammatory diseases. Ono Pharmaceutical Co Ltd, headquartered in Osaka, is an R&D-oriented pharmaceutical company committed to creating innovative medicines in specific areas, focussing research on oncology, immunology, neurology and specialty research with high medical needs[10].

10 https://www.monash.edu/news/articles/monash-university-and-ono-pharmaceutical-announce-collaboration-agreement

Hypersonics

UNIVERSITY OF QUEENSLAND

The University of Queensland (UQ) and the Japanese Aerospace Exploration Agency (JAXA) have a long history of research collaboration in hypersonic flight and ground testing

These include hypersonic flight tests conducted from 1993 to 2005 and two recent research projects on technologies to safeguard spacecraft re-entry into planetary atmospheres.

Professor Allan Paull, UQ Professor in Advanced Hypersonics, says the partnership has worked well because 'We are more risk tolerant and have a different approach to meeting scientific requirements which complements theirs.'

HyShot II prepared for launch, at Woomera, July 2002.
Image courtesy of University of Queensland.

Initial research collaboration

In the early 1980s, UQ developed free piston shock tunnels for testing hypersonic and hypervelocity aerodynamic and propulsion systems. JAXA, with the collaboration of UQ, developed its own shock tunnels as well as a much larger facility (High Enthalpy Shock Tunnel, or HIEST) for testing supersonic combustion and propulsion.

This led to multiple exchanges of personnel and collaborations in hypersonic-related technology, including hypersonic flight test (HyShot 4). As a result, JAXA gifted its rocket launcher (Launcher for Scaled Supersonic Experimental Airplane) located at Woomera to UQ. The rocket launcher is now utilised by the Department of Defence to develop hypersonic technologies. In 2010, UQ researchers, including Professor Richard Morgan, flew on a NASA aircraft to carry out airborne observation of the 2010 re-entry of JAXA's Hayabusa spacecraft at JAXA's request.

Recent research collaboration

More recently, UQ has partnered with JAXA in two research projects funded by the Australian Research Council (ARC) Discovery program.

The rocket launcher is now utilised by the Department of Defence to develop hypersonic technologies

Better heat shields for spacecraft

The first project aims to design better heat shields for spacecraft, the *Turbulent heat transfer during Mars Venus and Earth atmospheric entry* (2017–2019) project.

Designing heat shields for re-entry vehicles requires good models for predicting aerodynamic heating. Limitations of conventional wind tunnels prevent the measurement of aerodynamic heating in ground tests at peak heating, adding uncertainty and risk to the design process.

UQ's X3 free-piston-driven expansion tunnel[11] is uniquely capable of producing flows at high enough speeds and densities to enable measurement of heating for turbulent boundary layers at the highest speeds encountered during re-entry. For the first time, theoretical and numerical models of heating to be thoroughly tested and further developed.

The project is significant because it will evaluate a new mechanism for managing the tremendous heat loads of planetary entry

Safer spacecraft entry to Earth's atmosphere using magnetic fields

The second and current project *Magnetohydrodynamic Aerobraking for Spacecraft Entry to Earth's Atmosphere* (2022) has several Japanese collaborators, including two university academics and two scientists at JAXA.

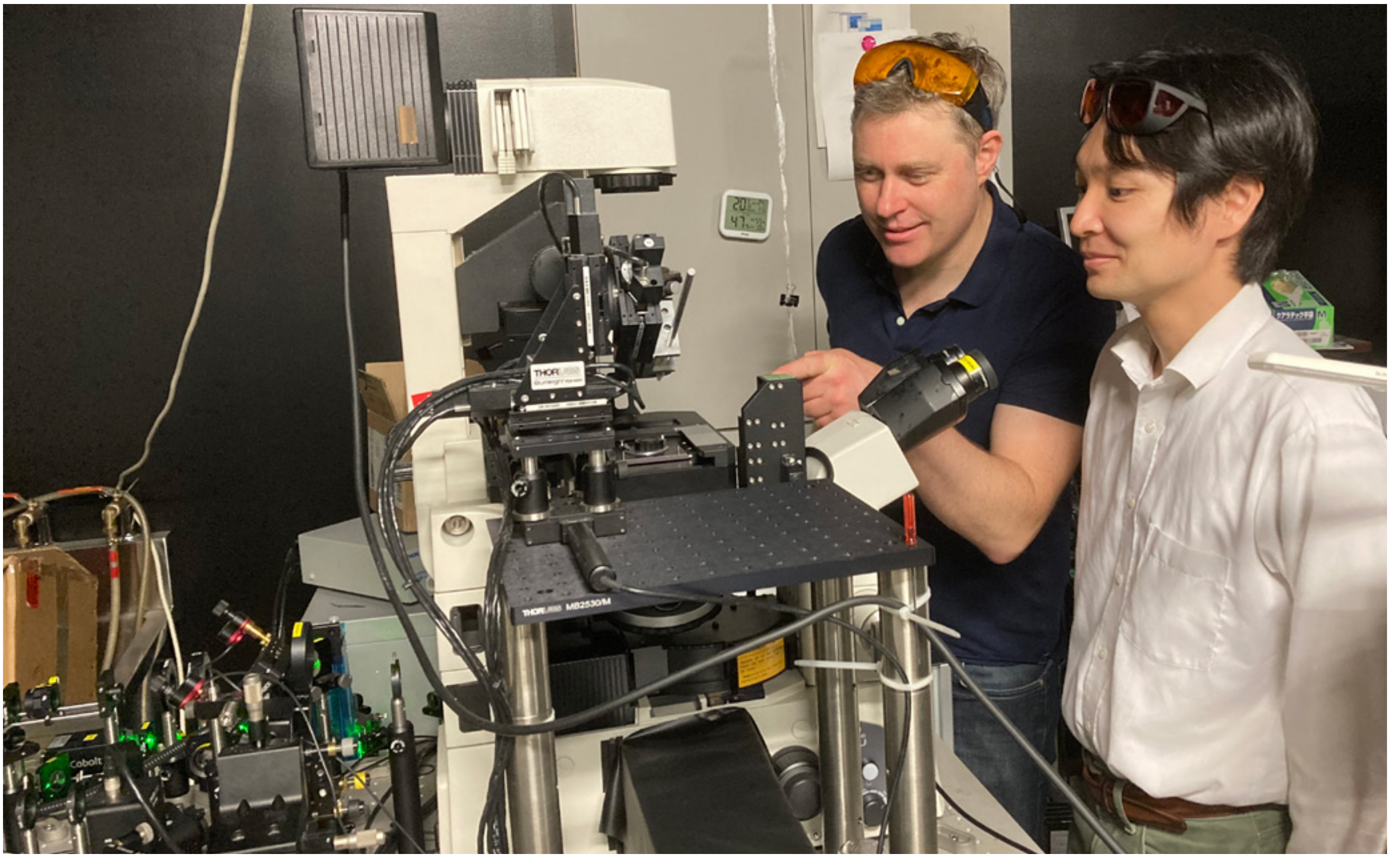
A spaceship returning from Mars will undergo unprecedented aerodynamic heating as it enters Earth's atmosphere. Magnetohydrodynamic aerobraking involves applying a strong magnetic field to the plasma which forms around the spacecraft at these speeds, theoretically protecting it by reducing structural heat loads and enabling less severe flight trajectories.

JAXA has been supporting various aspects of magnetohydrodynamic research for well over a decade, including experimental and numerical work. UQ brings experience with expansion tube testing and associated experimental techniques.

Experiments from the project, which formally commenced in 2023, will be utilised to benchmark codes and potentially radiation experiments in JAXA's super-orbital expansion tube (HEK-X).

The project is significant because it will evaluate a new mechanism for managing the tremendous heat loads of planetary entry. The expected outcome and benefit will be the development of a new technology to reduce spacecraft heating, leading to safer, more efficient, and potentially reusable spacecraft.

11 https://mechmining.uq.edu.au/research/hypersonics/x3-expansion-tube



Hokkaido-Melbourne Nanomaterials Network

UNIVERSITY OF MELBOURNE

Since 2019, the University of Melbourne and the Hokkaido University have been collaborating on nanomaterials research and activity, aided by funding from both Japan and Australia

Built upon initial collaboration between two research groups, the Hutchison group – headed by Dr James Hutchison at University of Melbourne and the Uji-I group – led by Professor Hiroshi Uji-I at Hokkaido University, the Hokkaido-Melbourne Nanomaterials Network now involves over 20 academics and multiple departments and has seeded several new collaborations.

While Melbourne has exceptional nanoparticle synthesis facilities, Hokkaido has exceptional nanofabrication and optical microscopy platforms

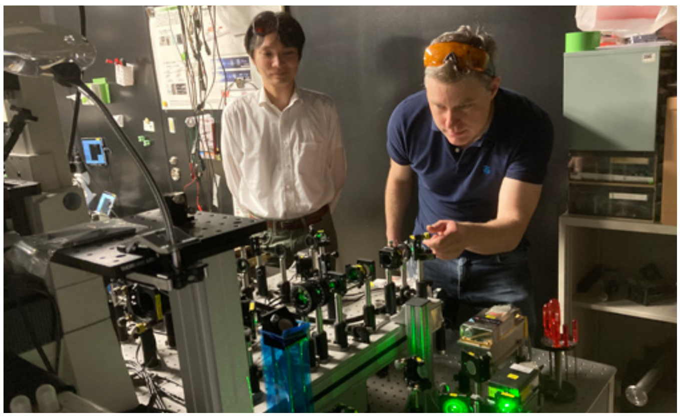
The main benefit of the Hokkaido-Melbourne Nanomaterials Network to date is expanded knowledge in nanomaterials for manipulation of infrared light (radiant heat). Such materials can manipulate thermal energy, for example by enhancing radiation through atmospheric transparency windows to drive passive cooling, by up-converting low energy photons so that they can be harvested by solar cells, or by altering the rates of thermochemical reactions. Infrared light is also critical for penetration into biological systems and nanomaterials that act as *in vitro* temperature sensors and phototoxic tumour-killers have also been developed by the network.

These advances have been possible by genuine combination of expertise at University of Melbourne and Hokkaido University. While Melbourne has exceptional nanoparticle synthesis facilities, Hokkaido has exceptional nanofabrication and optical microscopy platforms. It is hoped that in the future, connections between Melbourne University and companies associated with the Japanese team will be formed (examples are the Toray and Horiba companies).

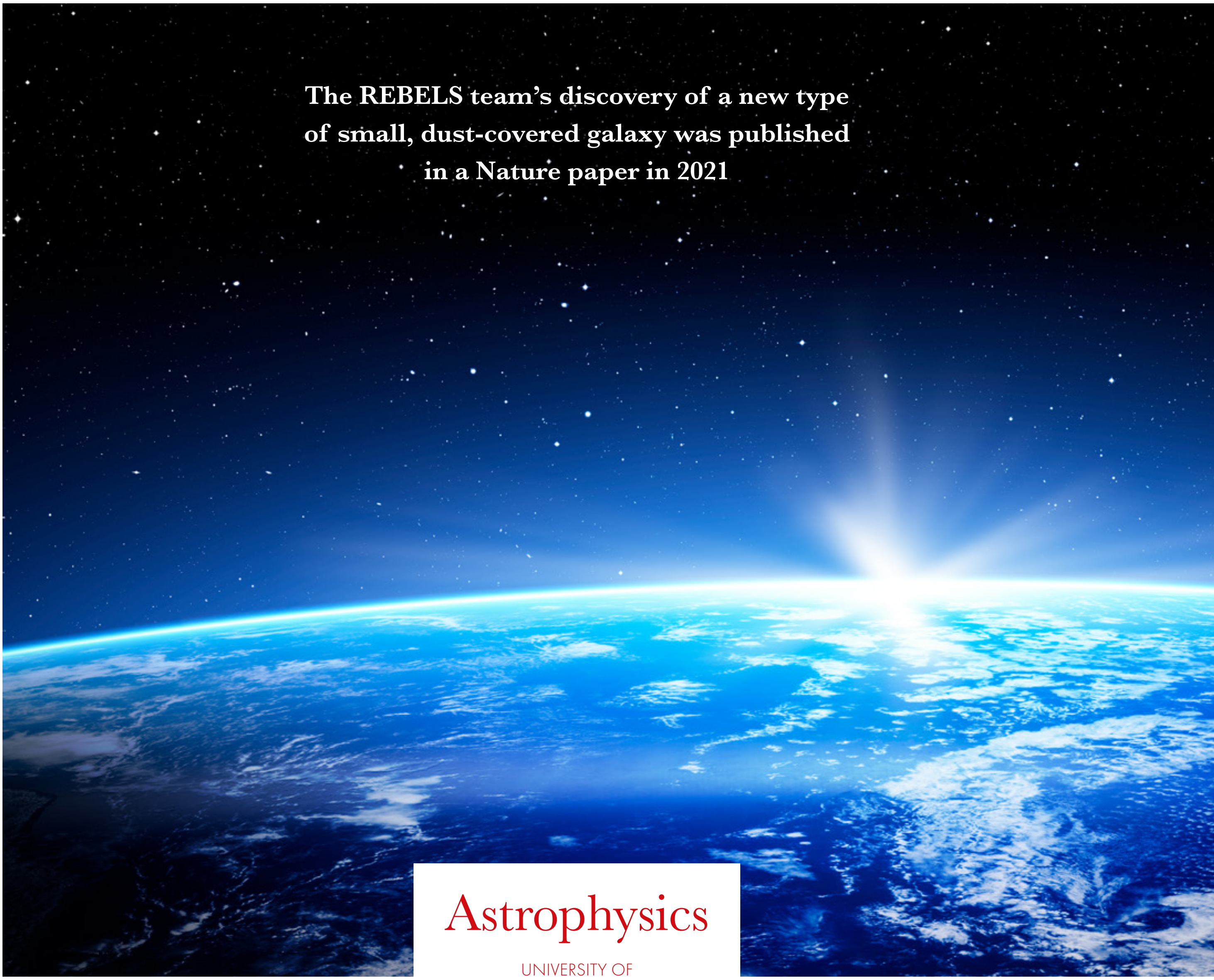
A joint PhD program is currently being established by Melbourne's Professor Hutchison and Professor Georgina Such, and Hokkaido's Professor Uji-I and Associate Professor Farsai Taemaitree. Initial focus is on nanomaterials for thermal energy manipulation and biosensing and the program will run until 2030.

This network is one of the developing areas of collaboration in the Hokkaido-Melbourne institutional research partnership, which has been further supported by inbound and outbound delegations of senior leaders across both universities.

Initial focus is on nanomaterials for thermal energy manipulation and biosensing and the program will run until 2030



Dr James Hutchison visiting Hokkaido University in 2022 with Associate Professor Kenji Hirai from Professor Hiroshi Uji-I's group at the Research Institute for Electronic Science (RIES)



The REBELS team's discovery of a new type of small, dust-covered galaxy was published in a Nature paper in 2021

Astrophysics

UNIVERSITY OF WESTERN AUSTRALIA

Reionization Epoch Bright Emission Line Survey (REBELS)

The University of Western Australia (UWA) Associate Professor Elisabete da Cunha worked with Japanese colleagues as part of a large team, the Reionization Epoch Bright Emission Line Survey (REBELS), that discovered that galaxies in their youth are dustier than expected, hinting that they might be evolving more rapidly than previously thought. Japanese collaborators were Associate Professor Hanae Inami and Dr Hiddo Algera (Hiroshima University) and Dr Yoshinobu Fudamoto, Chiba University (formerly National Astronomical Observatory of Japan and Waseda University). Given how long light takes to reach Earth, it is possible to observe what the Universe was a long time ago[12], in this case when it was less than 800 million years old – or more than 90 per cent of the way back to the Big Bang.

UWA researchers working with Japanese colleagues in large international teams have made significant and potentially paradigm shifting discoveries about galaxies

12 https://www.icrar.org/dusty-galaxies/

Given how long light takes to reach Earth, it is possible to observe what the Universe was a long time ago, in this case when it was less than 800 million years old – or more than 90 per cent of the way back to the Big Bang

To do this, the REBELS team used a highly competitive large observational programme of the ALMA telescope in the Atacama desert in the Chilean Andes to observe the Universe at wavelengths between the infrared and the radio. The largest ground-based telescope in the world, ALMA can detect the emission from gas and dust in their interstellar medium of galaxies out to the very early Universe.

The REBELS team's discovery of a new type of small, dust-covered galaxy was published in a Nature paper in 2021.

ALMA Spectroscopic Survey in the Hubble Ultra Deep Field (ASPECS)

UWA Associate Professor Elisabete da Cunha and Associate Professor Hanae Inami, Hiroshima University work together on another international project. The ALMA Spectroscopic Survey in the Hubble Ultra Deep Field (ASPECS) conducted a census of gas and dust in distant galaxies by systematically observing the best-studied cosmological deep field, the iconic Hubble Ultra Deep Field. It found that the amount of gas available to form new stars in galaxies closely follows the rate at which galaxies are forming new stars over cosmic time, implying that the star formation efficiency is roughly constant through cosmic history, and that galaxies continuously get "refuelled" with new gas through accretion processes.

The chemical evolution of galaxies

UWA Professor Kenji Bekki and Associate Professor Takuji Tsujimoto, National Astronomical Observatory of Japan are collaborating on the chemical evolution of galaxies, focusing on how chemical elements heavier than hydrogen and helium are produced, which is key to understanding their stellar, gas, and dust content. They have recently published a paper proposing a model for the chemical evolution of the mysterious galaxy GN-z11, one of the most distant early galaxies known, observed by the James Webb Space Telescope when the Universe was only a few hundred million years old.

Agriculture

UNIVERSITY OF WESTERN AUSTRALIA

Agriculture is one of Australia's key industries, with agriculture, fisheries and forestry products comprising 13.6 per cent of goods and services exported in 2022–23 at AU$80.4 billion, of which export to Japan was AU$6 billion[13]

The University of Western Australia (UWA), which ranks 22nd in the world in agricultural sciences[14], has long enjoyed a productive relationship in this field with Japanese universities.

"Agricultural Sciences is an area of significant strength at UWA. International collaborations in this field with leading universities such as Nagoya, Yamaguchi and Tokyo Nodai allow our academics to build on their research, access a wider variety of resources and drive innovation to support global food security." – *Professor Anna Nowak, Deputy Vice Chancellor (Research), University of Western Australia.*

Joint agricultural breakthroughs are providing foundations for improved breeding of both animal and plant stock, as well as boosting trade between Australia and Japan. UWA's collaboration with Japanese colleagues extends to research training, enabling strong research partnerships to support new outcomes and develop ongoing networks.

13 https://www.agriculture.gov.au/abares/products/insights/snapshot-of-australian-agriculture; https://www.agriculture.gov.au/about/news/overview-aff-exports-2022–23

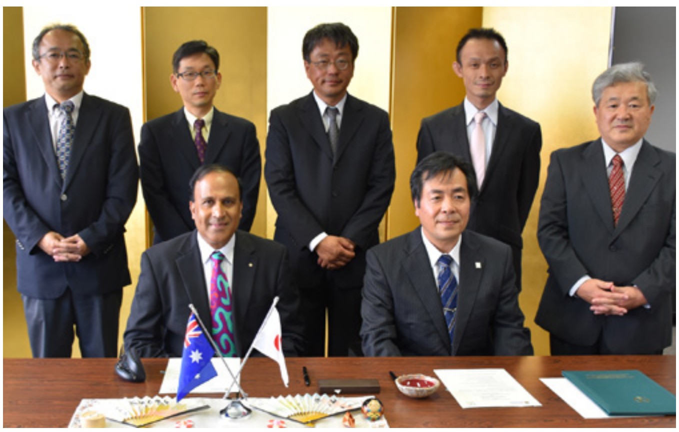
14 2023 Global Ranking of Academic Subjects available at https://www.shanghairanking.com/rankings/gras/2023/RS0303

WA lupins for wagyu cattle in Japan

Building on their 20-year collaboration on the reproductive physiology of ruminants, Professor Hiroya Kadokawa from the Faculty of Veterinary Science, Yamaguchi University, and Emeritus Professor Graeme Martin from UWA's Institute of Agriculture, explored the value of Western Australian lupin grain supplements to Japanese Black Beef cattle, one of the breeds that produce the marbled high quality Wagyu beef treasured in Japanese cuisine[15]. The project had begun with Professor Martin visiting Yamaguchi University, with Dr Stacey Rietema, to learn Professor Kadokawa's techniques for *in vitro* culture of cells from the pituitary gland and ovary of cattle and sheep.

The pair's findings raised the possibility of importing lupin grain from Western Australia for the Japanese industry.

Professor Kadokawa's collaboration with UWA was partly funded by Japan's Ministry of Agriculture, Forestry and Fisheries (MAFF), while he explored the possibilities for postgraduate student exchange between the two countries. UWA's collaboration with Yamaguchi University is underpinned by a Memorandum of Understanding signed in 2015.



Prof Kadambot Siddique (front left) signs MOU with Yamaguchi University.

15 https://www.jetro.go.jp/en/trends/foods/ingredients/wagyu.html

Nagoya University and UWA collaboration in root traits

Research being undertaken by UWA in collaboration with Nagoya University has the potential to improve rice crop production, one of the world's most important crops and a staple food for more than half the world's population.

Root system architecture (RSA) – the shape and distribution of a root system in soil – has an important role in plant anchorage, soil water and nutrient uptake, and plant growth and yield.

UWA's Professor Tim Colmer and Professor Mikio Nakazono from Nagoya University, a renowned expert in root traits, have been collaborating for decades on detailed studies of the oxygen status in stems of submerged deepwater rice. The team has combined molecular genetics and physiological approaches to improve our understanding of submergence tolerance in rice and to identify possible traits useful for future breeding.

'Our collaborative study with Nagoya University on rice RSA forms the basis for improving root phenotypic plasticity for sustainable crop production under variable environments including climate change', said UWA's Hackett Professor of Agriculture Chair and Director Professor Kadambot Siddique.

The joint research with Nagoya University had been productive, resulting in jointly authored research papers and PhD graduates

A joint PhD program with Nagoya University

Since 2019, UWA and Nagoya University have cooperated on a joint PhD degree in Agricultural Science and related disciplines. Students obtain their PhD from both universities with joint supervision, completing most of their studies at their home university and spending at least one year at the other university.

UWA Senior Deputy Vice-Chancellor Professor Tim Colmer said the joint research with Nagoya University had been productive, resulting in jointly authored research papers and PhD graduates.

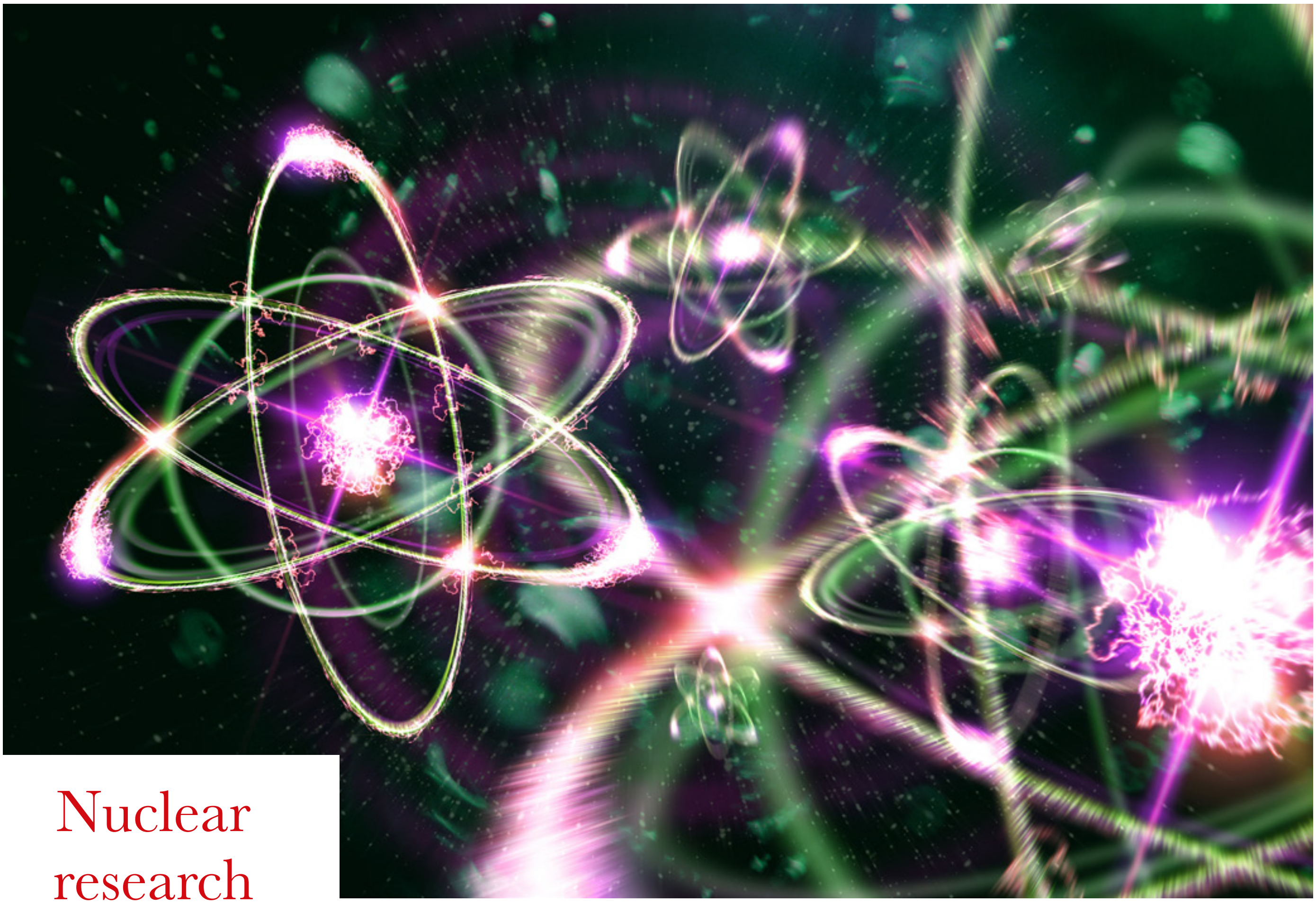
‘Sharing of facilities and expertise has provided a great environment for postgraduate student training, and it has been fun to work together. A study tour for coursework students and longer student exchanges are also important opportunities for our students.’

‘The original Joint Degree Program Agreement included four UWA Schools (Agriculture and Environment, Biological Sciences, Human Sciences, Molecular Sciences) and we have updated and re-signed the Agreement to include School of Physics, Maths and Computing, and are considering Engineering and Medical Imaging too, again to capture benefits by sharing expertise to generate new knowledge’, he said.

The first cohort of joint UWA-NU PhD candidates graduated in 2022.

> “Agricultural Sciences is an area of significant strength at UWA. International collaborations in this field with leading universities such as Nagoya, Yamaguchi and Tokyo Nodai allow our academics to build on their research, access a wider variety of resources and drive innovation to support global food security.”
>
> Professor Anna Nowak,
> Deputy Vice Chancellor (Research),
> University of Western Australia

Dr Yuri Kitagawa, Dr Tsubasa Kawai and Dr Yumika Watanabe, the first graduates of the Nagoya-UWA Joint PhD Program.



Nuclear research and training

AUSTRALIAN NATIONAL UNIVERSITY

Generating new knowledge in the fields of nuclear fusions and nuclear fission is the goal of a research collaboration between the Australian National University, Kyoto University and the University of Tokyo

Funded by the Australian Research Council and the Japan Society for the Promotion of Science (JSPS) Fellowships, the project also provides training for young researchers in nuclear physics at research institutions in Japan and Australia.

The partnership relies on access to the ANU's Heavy Ion Accelerator Facility which provides unique world-leading fission research infrastructure and the RIKEN Nishina Centre for Accelerator Science in Tokyo which examines the synthesis of new elements by nuclear fusion and discovered a new element Nihonium, the 113th in the Periodic Table.

The partnership relies on access to the ANU's Heavy Ion Accelerator Facility … and the RIKEN Nishina Centre for Accelerator Science

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The Go8's long-standing relationship with Japan

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