Australian Academy of Science

NATIONAL COMMITTEE FOR PHYSICS

Physics frontiers

A decade of Australian achievement

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About this report

The National Committee for Physics published the *Physics decadal plan 2012–2021: building on excellence in physics*, underpinning Australia's future in December 2012. This inspiring 10-year strategic vision for Australian physics, presented by the Australian physics community, identified objectives and goals for the decade between 2012 and 2021.

Key amongst these goals is to achieve a physics-literate workforce and community. Physics research and a physics-educated workforce have much to contribute to Australian prosperity. Physics graduates are valued for their skills in a diverse range of fields, including outside science and technology. In addition to critical thinking and problem solving, graduate physicists are experts in constructing simple yet realistic models and drawing quantitative conclusions from incomplete data—an indispensable skill set for evidence-based decision-making across diverse sectors.

Other fields outside science greatly benefit from the skill set of physics graduates, although these benefits may not be as visible to society. Decision-making by leaders, businesses and communities, when informed by scientific insights, can significantly enhance the wellbeing of society as a whole. Physics equips us to confront both current and future challenges of national and global significance. To achieve this, it is imperative that we ensure Australia possesses a workforce and community that are literate in physics.

The case studies contained in this document present an overview of the diverse, challenging and exciting careers that a physics background can lead to. They are presented to inspire and encourage young people to consider ways that physics can lead to a fulfilling and rewarding career, contributing to the growth and prosperity of Australia.

From radios to rockets: how physics unlocked a career in space science

Enrico Palermo, Head of the Australian Space Agency

I have always appreciated physics as a lens through which to see the world. From a young age, I wanted to grasp fundamental principles about how the world around us worked.

I discovered maths at primary school and quickly learnt that it was like a second language; I was fortunate that it came naturally to me. The more I delved into maths and science at high school, the more these disciplines unlocked my curiosity around how the physical world works.

This catalysed my university studies and my vision to work in the space industry. Being an astronaut is every child's dream, and I was determined to align my education to this career pathway. So, I enrolled in a double degree in engineering and science at the University of Western Australia (UWA) and, like maths classes in primary school and high school, I picked up physics naturally. My undergraduate experience was made fulfilling and engaging by the great faculty staff, a strong community with my fellow students and physics cohort, and the fact UWA offered many hands-on and tangible experiences as part of the physics curriculum. I especially loved being in the lab doing experiments and experiencing those 'light bulb' moments of suddenly being able to derive fundamental physical relationships from simple concepts and building on them.

In reflecting on my physics studies and their application to my career in the space industry, for me, physics remains at the centre of solving the world's—indeed the universe's—greatest challenges. Building rockets and understanding the motion of a rocket plane involves a blend of physics and engineering. Having physics underpinning my engineering degree resulted in a solid understanding of the theoretical side of engineering and ultimately made me a better engineer and a better leader. Even now, I'm seeing physics play a central role in some of the great technologies currently being developed in the space sector here in Australia—from high performing clocks and quantum technologies to advanced optics—many of which have emerged from the basements and laboratories of physics departments around the nation. At the core of many successful deep-tech hardware companies and start-up 'unicorns' that are world-changing enterprises is a strong grasp of physics and other scientific disciplines.

Recently, I was building an electric circuit radio with my nine-year-old and explaining the role of the capacitor in building a radio. Before I knew it, I was showing him my university physics textbook and he was telling me how much he likes algebra. Like my experience back in primary school, it is important we share our curiosity and passion of physics with the next generation at a young age. Passing this on will help them on their journey of discovery: of the universe, and its machinations and endless possibilities.

Universities collaborating to equip PhD students for the future

Sydney Quantum Academy

In many ways, the Australian Academy of Science's Physics Decadal Plan 2012–2021 was prescient in identifying The New Quantum Revolution and the four critical issues for the future of physics. The goals of a physics-literate workforce and community, realising human capital, building on research strengths, and engaging internationally are all shared by the recently established Sydney Quantum Academy (SQA). This is a unique partnership between four of Australia's leading quantum technology groups at Macquarie University, the University of New South Wales, the University of Sydney, and the University of Technology Sydney, along with the New South Wales Government. The vision is to build Australia's quantum economy, by harnessing our collective quantum expertise to develop diverse talent and a globally recognised quantum ecosystem.

One of our main objectives is to develop future quantum leaders, specialists and entrepreneurs through education and training. Over the past year, the SQA has invested in building a community of PhD students in quantum technology. We have awarded more than 60 PhD scholarships to attract bright minds from across the globe. We have also established a unique training PhD Experience program for our students.

Quantum technology is a manifestly interdisciplinary endeavour combining physics, engineering, computer science and mathematics. This presents a particularly acute training challenge, with new programs being developed all over the world. Australia, long a front runner in the field of quantum technologies, is no different. In 2020, the SQA established the Sydney Quantum Experience, a PhD program that allows students to leverage the expertise at all four partner universities. Combined with this world-leading academic experience is a focus on transferable skills training, such as intellectual property and entrepreneurship. This will complement their doctoral studies and equip students with technical expertise, leadership and transferable skills through in-house activities and engagement with industry.

Despite the restrictions that COVID-19 brought in the last few years, our students eagerly engaged with the PhD Experience program through a range of coursework that covered the core themes of quantum science and technology from both a fundamental theory and a practical perspective, research seminars, and a student conference organised largely by the cohort themselves.

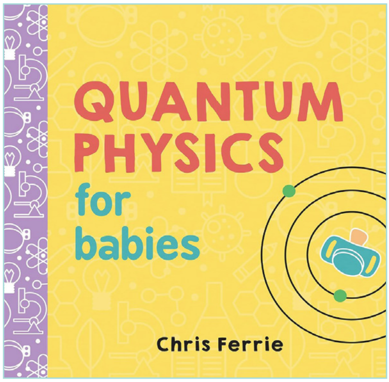
The program is a work in progress. In consultation with our students, we will develop it further to offer a range of activities and events to help students become quantum leaders. This includes activities around career development strategies in the quantum start-up space, which is placing an unprecedented demand on quantum talent and where a large proportion of graduates are being employed.

We also aim to increase diversity in our student cohort by attracting students from under-represented groups and interdisciplinary backgrounds.

The Sydney Quantum Experience, and by extension the Sydney Quantum Academy, goes a long way in following the principles set out in the Australian Academy of Science's Decadal Plan.

Educating the public through physics picture books

Quantum Physics for Babies



Associate Professor Chris Ferrie brings a unique voice to the communication of the most complex ideas of physics to the public. Primarily through the use of children's books, Associate Professor Ferrie has engaged audiences of all demographics. In 2014, Chris wrote *Quantum Physics for Babies* and posted it online. The juxtaposition of "for babies" and what is seen as the most complicated invention of the human intellect immediately excited the public and book publishers. Today, *Quantum Physics for Babies* is available in 15 different languages and has over two million readers worldwide. The popularity of *Quantum Physics for Babies* has launched an entire industry in quirky non-fiction for young children. Chris himself has published more than 50 books alongside *Quantum Physics for Babies*, in a series called *Baby University*. Many other authors and publishers have followed suit, seeing a market in the general public craving scientific content that is targeted at them rather than people with formal technical education.

The goal of Chris's books is for people who are not research scientists to have increased connection with, and appreciation of, physics—as well as science and mathematics more generally. The approach he takes to achieve this is to change negative perceptions of mathematics and science held by adults and teenagers and to avoid the establishment of such negative perceptions in young children. The negative perceptions are that (a) maths is boring, monotonous, difficult, and available only to the genetically gifted, and (b) big complex ideas of science are inherently dull, only made interesting by extravagant, explosive, shiny showcasing.

The benefit of his approach is that it does not rely on making an economic argument for valuing mathematics and science. Instead, it promotes a contagious joy and wonder in big ideas themselves, through direct interaction with those ideas.

The success of Chris's approach to increasing the Australian public's understanding and appreciation of science is demonstrated by the following:

- His books are read and reviewed in Australia and globally, e.g. through Booktopia and Goodreads. Amazon, for example, has recorded more than 3,000 reviews of the books, the vast majority of which are highly positive and usually emphasise the increased knowledge and appreciation of science the readers have gained. For example: "Considering I had no idea what a 'quantum' was, this book taught me something. Seriously, why aren't all difficult subjects taught in this manner? The basics at least. I might have done better in school in those subjects at least."

- Australian parents post a daily stream of social media messages to the world about how much they and their children are learning and appreciating science. Another example of the joyous engagement with quantum physics created by the books was a toddler dressed as *Quantum Physics for Babies* for Australian Book Week and a *Quantum Physics for Babies* birthday cake.
- Teachers use these books in classrooms. One said, "I use this to teach about quanta and the Bohr model of the atom."
- The *Baby University* books regularly appear on 'Best of' lists for both narrowly and broadly defined topics. The book *8 Little Planets* was named Amazon's Best Baby Book of 2018.
- More than 1,000 children in China entered an art competition to demonstrate what they have learned from Chris's books. As part of a cultural exchange, 80 entries were selected and brought to Australia and were displayed in an exhibit called *Physics in My Eyes*.
- Influencing the influencers in children's lives (their parents and teachers), as well as children themselves, Chris's books increase appreciation as well as an understanding of big, complex ideas among old and young alike.

‘Hidden physicist’ in high school

Dr Holly Rose

I completed my PhD in experimental atomic physics in 2003. While I enjoyed my research and being able to contribute to my field, it was the teaching and educational outreach I was taking part in at this time where I could see myself being able to make a real difference. After finishing my PhD, I completed a Graduate Diploma in Education and then started my career teaching science and physics to Year 7–12 students.

It could be assumed that this is where the story ends or at least becomes quite predictable—a person who enjoys physics starts teaching physics and then keeps teaching the same physics content each year—with not much ever changing.

This couldn’t be further from the truth! Since completing my PhD, my career has been incredibly varied (including the physics I teach) and I rely on my experiences from my PhD every day.

From beginning my career as a classroom teacher, I moved into being the head of a science department. My current role as the Deputy Director of Studies involves: creating a timetable for the school; ensuring data integrity within our systems; liaising with students, teachers, parents and regulatory bodies; overseeing and assisting with the development and implementation of curriculum and assessment across the school; and analysing a range of data about our students.

So, what are some of the skills from my PhD that I use?

- Communication: In my PhD, I needed to make my research accessible and understandable to a variety of audiences and to develop common understandings for the completion of collaborative work. This continues now, where I need to convey information to students, teachers, parents and other organisations in written and verbal form. I need my communication to be clear and audience appropriate. I also need to be able to listen to, respect and incorporate the ideas of others and to work collaboratively with groups to further learning outcomes for our students. I need to be able to communicate clearly and foster relationships with my students so that I can help them learn and develop the confidence to extend themselves further.
- Flexibility for change: A PhD is the best possible grounding for being willing and open to change. Being adaptable leads to opportunities to trial new curriculums, ideas and pedagogy to improve learning outcomes. It also means that I can react quickly when something unexpected happens, or be willing to think through and plan for future problems.
- Problem solving and innovation: A PhD is all about demonstrating problem solving and innovation in unique scenarios—starting things from the beginning gives you the confidence to trial new techniques and ideas, to analyse outcomes and decide and justify evidence-based decisions on new ways forward. Timetabling for a student body of more than 1,200 requires a lot of problem solving and asking the question ‘What if’. My PhD taught me to never think of things as being static—we are always in a state of flux, and we should lean into this. I also have opportunities to work within my state to develop a new state-wide physics curriculum and have developed new courses within my school to engage and excite students, such as astrophysics for Year 9.

- Action research: Coming from a research background, I am constantly curious. I can apply the research skills I have developed to do my own research on trials implemented in the school, as well as assisting other teachers in developing research projects.
- Stories: My PhD has provided me with a wealth of stories about how research happens—from the accidents, to the successes and even the frustrations. I can provide a glimpse for my students into a world they will not have had any experience in—they don't see it on television, like a lot of other careers. I still read journals, follow new discoveries, and speak about the research my contemporaries and friends continue in and incorporate this information into my teaching (the decaying Higgs Boson last year was very exciting). Physics is not static, but it can be difficult for students who are still only learning the basics to realise how exciting research can be and that they can play a part in it. My PhD allows me to be a conduit to that world for them.
- Data analysis: Perhaps the most important part of my PhD was the analysis of data. In my current role, I analyse large amounts of data related to student achievement and wellbeing. I need to be able to analyse data, make conclusions and suggestions for further steps, and present it in a clear format for others to be able to understand and make their own determinations.

Overall, the most important transferable skill I took from my PhD is a passion for physics. This still seeps into everything I do. Being able to encourage my students to think more critically about the physics in their everyday life, such as car safety or nuclear power, showing them the different pathways that a career in physics can take them on, to watching students decide to pursue careers in physics—if everything I gained from my PhD makes me the most effective educator I can be, then I think this is a pretty good outcome for a 'hidden physicist'.

Working magic for careers in mathematical and physical sciences

Mentoring and Guidance in Careers Workshop

The Mentoring and Guidance in Careers (MAGIC) Workshop is an annual week-long event for early-career researchers who are women or people of diverse gender identity in mathematical and physical sciences based in Australia. The workshops began in 2017 and have been held each year since then (except in 2020, due to COVID-19).

Our aim is to counter the persistent, growing trend in the number of talented women who leave the scientific workforce in Australia (whether they are in the academic, government or industry sectors), by providing early-career women with insights, reflections and information about the subtle factors that will allow them to succeed in science.

The topics range from those that directly benefit scientific careers (e.g. building collaborations and a long-term perspective in research, writing grants, and interview preparation), to those that particularly affect minority groups (e.g. women) in science. The structure enables deep conversations between the participants and a diverse spectrum of speakers, as well as peer group interactions, which continue online after the workshop ends.

The program consists of five days of panel discussions, breakout sessions and interactive workshops on public speaking and pitching your message. It engenders reflections on topics including: what success means; how to build resilience; public speaking; employer expectations in academic, industry and government sectors; leadership skills; writing grant proposals; and developing effective CVs.

Participants are chosen from applicants who are within seven years of the award of a PhD in mathematical and physical sciences. In 2019, it was expanded to include participants in the field of chemistry.

MAGIC2017 participants with organisers Mahananda Dasgupta, Merryn McKinnon, Nalini Joshi and panellist Christine O'Keefe.

CREDIT: NALINI JOSHI

Training medical physicists for Australia's health

Australasian College of Physical Scientists & Engineers in Medicine

Medical physics applies physics to the prevention, diagnosis and treatment of human disease. Medical physics is now a highly recognisable and valued area of medicine. The rapid translation of new physical techniques into medical instrumentation means that physicists are becoming increasingly essential in a wide range of clinical areas, for example, radiotherapy, radiology, magnetic resonance imaging (MRI), ultrasound imaging, positron emission tomography, pulmonary physiology, cardiology, ophthalmology or biomedical sensors, implants and artificial intelligence.

Medical physicists in Australia are certified professionals: training, examinations and certification are managed by the Australasian College of Physical Scientists & Engineers in Medicine (ACPSEM). They are committed to quality and safety in the practise of clinical science, centred on the best interests of patients, and determined to support workplace innovation and safe, evidence-based translation of research into clinical practice. Currently, there are more than 500 registered medical physicists practising in Australia.

Until 2010, there were serious workforce shortages in Australian medical physics, resulting in reliance on overseas workforce. A career in medical physics requires completion of an undergraduate degree (in physics or engineering) and a postgraduate degree with a major in medical physics, followed by clinical training. Challenges inhibiting the number of medical physicists included lack of funding for medical physicist trainee positions and lack of senior medical physicists to appropriately supervise these registrars. A significant transition in the medical physics profession took place from 2005 onwards, moving from on-the-job training to coordinated national training (and professional certification) that meets the best international standards. Training Education and Assessment Program (TEAP) guidelines were developed, streamlining training and examination processes. The ACPSEM Training course was approved by an independent international expert review in 2013. In close collaboration with ACPSEM, the Australian Government invested significant funding in registrar training, along with contributions from individual states and private health providers. Employing dedicated training preceptors has proven beneficial to improve the quality and governance of TEAP. With preceptor support, medical physicist registrars are able to access a wide variety of training opportunities, enabling the quality of TEAP graduates to be more consistent. In addition, ACPSEM has been actively involved in promotion of a physics career to school students and undergraduates, including through science and career expos. As a result of the above actions, our medical physics human capital has been realised, with approximately 140 registrars in Radiation Oncology Medical Physics having graduated since 2000, along with several registrars graduating in Radiology (around four) and in Nuclear Medicine (around eight).

Workforce shortages have been largely overcome and our universities and TEAP produce sustainable numbers of graduates for the medical physics workforce. Now in Australia and New Zealand on the ACPSEM Register of Qualified Medical Physics Specialists and Radiopharmaceutical Scientists, there are 44 nuclear medical physicists, 391 radiation oncology medical physicists, 45 radiology medical physicists, 16 radiopharmaceutical scientists, and five medical physicists who are qualified in more than one specialty.

More than 50% of all new cancer patients will require radiotherapy. The number of cases of cancer diagnosed in Australia has been predicted to increase by almost 40% from 2007 to 2020, and expected to surpass 150,000 by 2020. Australia needs 267 medical linear accelerators by 2022 to achieve the internationally accepted optimal utilisation rate. This corresponds to approximately an extra 100, in addition to replacement of the current fleet. Therefore, the need for medical physicists, and their training, will continue to be incredibly important. Their work translates directly to patient cures. As an illustration, in the year 2000, with 100 linear accelerators, 45,000 cancer patients were treated and 22,500 lives (50% cures) saved that year; in 2020, there were around 180 linear accelerators in Australia, resulting in 81,000 cancer patients treated and 40,500 lives saved.

The success story of solar power is the success of physics

UNSW School for Photovoltaics and Renewable Energy Engineering

The A$50 billion+ global solar industry of today would not exist without education in, and application of, physics. Here we introduce three UNSW physicists—Professor Martin Green, Dr Shi Zhengrong and Professor Renate Egan—who have been recognised internationally for the role they have played in developing the industry of today.

Solar energy is now the cheapest way to generate new power. There are parts of the world where solar energy costs have come to compete with the marginal costs of burning coal. Fundamental to the development of ever more efficient solar technology is the application of solar cell physics.

Nations around the world are moving to rapidly decarbonise their economies in line with meeting the 1.5 degree C temperature rise goals of the Paris Agreement, and to ensure a sustainable environmental and economic future for generations to come. In the transition to renewable energy systems, and move away from reliance on fossil fuels, solar already plays an enormous role, and it is positioned to continue to grow into an even larger sector. Serious industry projections foresee Australia running at times on 75% solar and wind energy by as soon as 2025.

PL imaging.

CREDIT: DERWIN LAU

This solar revolution has been made possible by the invention of Passivated Emitter and Rear Cell (PERC) technology at UNSW in 1983, where the team was led by **Dr Martin Green**, now Scientia Professor and widely regarded as the 'father of modern photovoltaics'. This stunning breakthrough in solar cell technology has led to PERC being used in solar panels all over the world: 90% of new solar panels globally are now using the UNSW PERC technology. For his pioneering work, Martin has been recognised with many awards, including the coveted Global Energy Prize in 2018 and the Japan Prize in 2021. In his acceptance speech, Martin thanked the "thousands of solar researchers who have worked in the field for many years, including those at UNSW Sydney … who have helped not just make PERC a reality, but also to bring it to market and to have driven such scale".

Professor Martin Green. CREDIT: ROB LARGANT

Martin's illustrious career began when he made the decision to enrol in physics at the University of Queensland. This would eventually lead him to establish the Photovoltaics Centre of Excellence at UNSW (where he would work for 40 years and counting). Now established as the School for Photovoltaics and Renewable Energy Engineering, and known as SPREE, it hosts one of the world's leading solar research laboratories. It has held the world record for the most efficient solar cell for 30 of the last 35 years.

This solar powerhouse attracts researchers from around Australia and the world. SPREE's **Professor Renate Egan** also began her remarkable 20-year career in solar as an undergraduate in physics. For her, study at Macquarie University, Sydney, was followed by postdoctoral positions at ANU, Canberra and University of Sydney, and then the solar industry. Today, Renate is described as among the "Eight Great Women in the Business of Science and Solar" by Renewable Energy World. In addition to her work at UNSW, she is a co-founder of Solar Analytics, the largest independent energy monitoring provider in Australia.

Professor Renate Egan. CREDIT: RICHARD FREEMAN UNSW

Dr Shi Zhengrong completed his PhD at UNSW in the study of solar technology after initial study in laser physics at the Shanghai Institute of Optics and Fine Mechanics. From UNSW, he co-founded the Australian solar start-up Pacific Solar, and then later returned to his native China, as a dual-Australian citizen, where he established Suntech Power, which would become the world's largest manufacturer of solar modules. This prompted the mass production and falling costs of solar panels, making them an affordable reality for homes, business and industry across the globe. In 2009, Zhengrong received the prestigious Oslo Business for Peace Award, in recognition of his contribution to "transformative and positive change through ethical business practices."

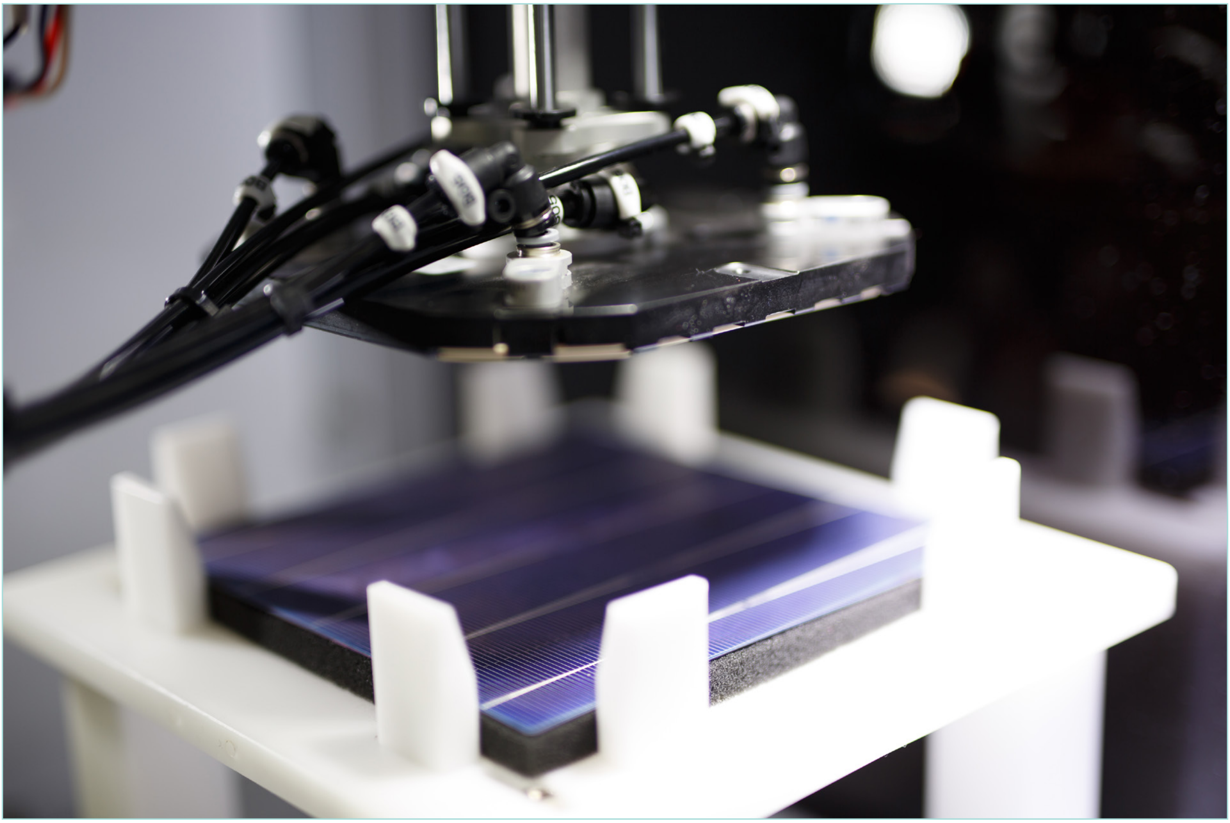
Dr Shi Zhengrong. CREDIT: ROB LARGANT

Inspired by this world-changing story, and wanting to work for a sustainable future, students and postgraduate researchers at SPREE today join an illustrious history, and are working with the fundamentals of materials science and solar cell physics to create the next generation of highly efficient photovoltaic solar modules. This work also investigates the potential to make solar technologies more resilient and longer lasting through the application of solid-state physics. These investigations are already making news.

This success story of 40 years of solar is truly global, and one of cross-cultural cooperation, yet the critical role Australian physicists have played in that success cannot be underestimated. While 40 years might sound like a long time, the story of solar is only just getting started. At SPREE, we are as excited as ever to welcome researchers from around the world and across Australia to join us in continuing to write that story.

Industrial solar cells.

CREDIT: DERWIN LAU



From public awareness of physics to researcher awareness of working environment

Australian Institute of Physics Women in Physics Lecture Tour

2018 Australian Institute of Physics Women in Physics (AIP WiP) Lecturer Dr Ceri Brenner has recently migrated from the UK to Australia to take up the leadership of ANSTO's Centre for Accelerator Science (CAS).

She first visited ANSTO's Lucas Heights and Clayton sites during her AIP WiP lectureship tour in 2018. This regular lecture tour celebrates the contribution of women to advances in physics, with presentations to schools and the general public around the nation, as well as interactions with research organisations.

During planning for the tour, Dr Brenner enquired to ANSTO's Professor Andrew Peele (then-AIP President) about industry-linked research in the NSW region. This interaction proved pivotal in engaging Ceri with ANSTO's research infrastructure platforms. In her *Australian Physics* article about the tour, published in November 2018, she remarked, "I had a great time visiting the ANSTO sites at Lucas Heights and Clayton—I work at the Rutherford Appleton Laboratory in the UK which houses, in addition to the Central Laser Facility, the Diamond Synchrotron Source and ISIS Neutron source, so these places felt most like home to me."

Ceri's role at the time, at the UK's Central Laser Facility, was focused on research and development of next-generation, laser-plasma accelerator technology and driving forward industrial applications with nuclear and aerospace users. Hence, ANSTO was requested as an additional stop on an already busy itinerary. Fortunately, the AIP WiP lecture tour organiser, Dr Joanna Turner, was able to accommodate a full day's visit to Lucas Heights, in between the Tasmanian and Western Australian legs of the tour.

Between waking up in Hobart and going to sleep in Perth, Ceri enjoyed a tour of the Centre for Accelerator Science, Australian Centre for Neutron Scattering, and the OPAL reactor. She also had the opportunity to present her lecture on laser-driven plasma-accelerators for beams of ions, x-rays, and neutrons to a packed audience of ANSTO employees, and met with a delegation over lunch hosted by then-CEO Dr Adi Paterson.

In describing why she applied for the role, Ceri added, "I recall my visit to ANSTO warmly, sensing a strong community spirit at the Lucas Heights campus and an infectious enthusiasm in everyone I met. I toured CAS that day and learnt about the long history of accelerator science in Australia, and about current capabilities and active application areas. I was particularly impressed by the development plans to expand into specialist irradiation for radiobiology and component testing.

I returned from my lecture tour inspired by the spirit of collaboration, entrepreneurship, and by the joy of discovery and innovation that Australian scientists all share. This role offers an opportunity for me to contribute to, and be a part of, that community."

The physics of hearing

Cochlear

In 2021, Cochlear celebrated 40 years of providing implantable hearing solutions for the profoundly deaf and severely hearing impaired, having sold more than 600,000 implants during that time. Today, several hundred thousand individuals can hear thanks to their Cochlear implant.

Cochlear grew out of a research program at the University of Melbourne led by Professor Graeme Clark. While Cochlear has since become a large commercial (ASX200 listed) venture, it retains a strong culture of innovation and a firm commitment to sound scientific fundamentals. The company's research and devlopment (R&D) department of more than 350 people with a budget of A$185M continues to seek improvements to our products performance, reliability, usability, and connectivity, so we can help more people hear.

Roger Leigh joined Cochlear's R&D department as a Validation Engineer in 1994, having graduated from the University of Bath in applied physics seven years previously. He progressed through everal roles within the company, including Senior Research Engineer, Technology Cluster Leader, and Specialty Devices Manager, before moving to his current role as Senior Manager, Implants Mechanical, overseeing a team of scientists, engineers, and technicians developing Cochlear's next generation of implants.

The physics skills that have enabled Roger to thrive in what is predominantly an engineering department include:

- an ability to apply scientific rigour to problem investigations. Even quite basic actions such as, 'what is the hypothesis you are testing here?' can force people to think more deeply about the problem, before rushing to a solution
- being able to shift from the broad overview of a problem down to the detail and back, often multiple times. This can include performing detailed data analysis to understand the issue, through to creative concept ideation to identify the best solution
- an abiding fascination with what makes things work. This desire to always know more leads to a passion for continuous learning (Roger is currently studying for his third master's degree!)

An additional key skill developed via physics without his realising. During graduate studies, Roger worked on a final year thesis project partnered with a fellow student. He spent many long hours with the other student, struggling to accurately measure the electrical properties of a tiny crystal smaller than a rice grain. At no point since has his career required knowledge of the static dielectric constant of naturally occurring forsterite and how it varies with temperature, but he has used the collaboration skills he developed every day.

Cochlear recognises the importance of employing talented graduates. It runs a graduate program for scientists and engineers, taking on five to 10 new graduates each year. As a feeder to this graduate intake, it has a summer internship program, in which students at the end of their penultimate year come to work in the R&D department. The company welcomes physics graduates to apply for this program, so they can apply their skills and knowledge to real issues and experience the satisfaction of attacking challenging technical problems that contribute to changing the lives of people with hearing impairment.

Physics capabilities inform risk modelling

Risk Frontiers

Dr Jacob Evans is a Risk Scientist at Risk Frontiers in Sydney. Risk Frontiers is a leading research and development company specialising in catastrophe loss modelling, climate risk and resilience. It helps organisations, ranging from the global insurance industry and infrastructure operators to government departments and emergency services, to understand, price and manage risk.

Risk Frontiers was established within Macquarie University in 1994 as a Natural Hazards Research Centre and remained there until it was spun out as a private company in mid-2017. Its research and expertise cover the major hazards affecting the region, including floods, tropical cyclones, storms, bushfires, heatwaves, drought, coastal erosion and earthquakes. Risk Frontiers also works with communities to understand the human dimension of risk and policy implications.

Jacob received a Bachelor of Science in Physics and Mathematics from Macquarie University in 2011. The next year, he received a Bachelor of Science (Honours) in Physics, building a mathematical model studying the physical and geometrical optics of optical elements within orb spider webs. Jacob then went on to complete a PhD in Condensed Matter Physics, investigating the spintronic properties of rare-earth nitride thin films.

Working as a Risk Scientist within Risk Frontiers, Jacob has developed and utilises a wide skill set, including data science and catastrophe modelling, and has gained insurance industry knowledge. A significant component of Jacob's role at Risk Frontiers is the development of probabilistic catastrophe (CAT) loss models. CAT models are decision support systems used extensively in the (re)insurance industry to assist in pricing risk and aggregate exposure management. They are Monte-Carlo simulation models comprised of hazard, exposure, vulnerability and financial modules. Standard outputs from the models include the average annual loss and exceedance probability curves.

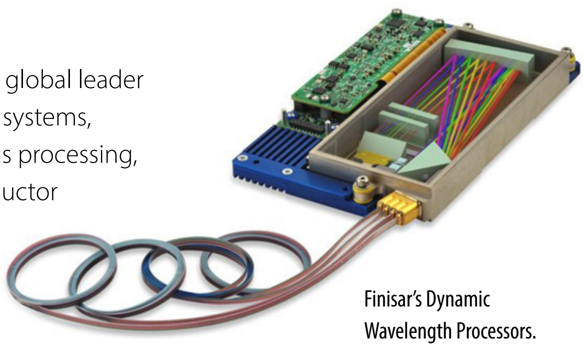
The hazard module requires a deep understanding and application of the physics of individual natural hazards and involves solving complex equations and finding unique solutions. For example, generating a large set of synthetic tropical cyclone tracks and wind fields (say 50,000 years) can involve distribution fitting, machine learning and parametric models. Developing a vulnerability module utilises skills and techniques such as data cleaning, curve fitting, machine learning and model validation.

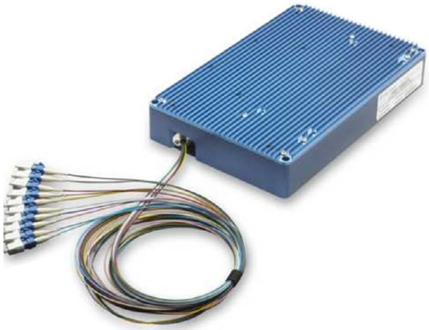
A degree in physics provides knowledge and general skills that are of direct relevance to the work at Risk Frontiers. The analytical skills developed are invaluable when working with large datasets and assessing and validating the results of modelling. The ability to write code is also a key part of a Risk Scientist's role at Risk Frontiers and the coding learnt throughout a physics degree helps with building models, running simulations and developing software. The skills developed throughout a physics degree are a great foundation for work at Risk Frontiers.

Tech industry valuing physics graduates

Finisar Australia

Finisar Australia is part of the larger company II-VI Incorporated, a global leader in engineered materials, optoelectronic components and optical systems, offering vertically integrated solutions for applications in materials processing, communications, aerospace and defence, life sciences, semiconductor capital equipment, and automotive and consumer electronics.





Finisar's Dynamic Wavelength Processors.
CREDIT: FINISAR AUSTRALIA

Finisar Australia specialises in the design, development and volume manufacture of wavelength management products to support the world's ever-growing internet demands. Our key enabling product is a wavelength selective switch, which incorporates sophisticated optical, mechanical and electronic components together with advanced algorithms and software.

We employ around 270 people at our Sydney facility, with roles ranging from Production Operators to R&D Engineers. The complex nature of the wavelength management products drives the need for skilled employees, with physics or similarly related degrees making up a significant percentage of the total employee count, which includes around 30 PhDs, 50 master's degrees and 125 bachelor's degrees.

Roles for physics graduates include:

R&D Engineer	Program and Technical Product Manager
Process Engineer	MES Configuration Engineer
Test Engineer	NPI Component Engineer
Marketing/Technical Account Manager	Reliability and Failure Analysis Engineer

The skills that benefit physics graduates for roles within Finisar include a strong understanding of optics and optical systems, photonics, lasers, optical fibres, material science, semiconductor processing, thermodynamics, problem solving, data collection and analysis, along with detailed report writing.

Entry level employment options at Finisar are routinely available for new physics graduates through our Production Engineer role. Within this role, an incumbent performs manufacturing duties across multiple areas of our assembly process. The wide range of skills and knowledge attained from these entry level production engineer roles have allowed physics graduates to be promoted within Finisar to many of the aforementioned positions, as well as to progress to careers in many other high-tech companies.

Specialisation through postgraduate qualifications, focusing on the skills listed above, has been beneficial in enabling such graduates to secure higher-level roles within the organisation. Within these scientist and engineering roles, physics graduates have progressed to more senior technical roles as well as management positions.

Growing Australia's quantum technology industry

CSIRO

A recent roadmap by Australia's national science agency, CSIRO, suggests that the global market for advanced quantum technologies could exceed A$86 billion by 2040.

Over the last century, our growing understanding of quantum physics has changed our world. Without quantum physics, there would be no internet, computers, or magnetic resonance imaging. Now scientists and engineers have unlocked unprecedented capabilities to isolate, control and sense individual quantum particles (such as electrons and photons) like never before. These extraordinary advances will enable transformational technologies including precision sensors, high-security optical communication networks, and quantum computers.

Pioneering quantum technology research

Australia has been at the forefront of quantum technology development since the late 1990s. During this time, Australia has built strong research and development capabilities, established proof-of-concept for key technologies, and attracted international talent. Australia now has a vibrant quantum research sector including four quantum technology focused ARC Centres of Excellence, and eight universities performing quantum physics research well above the world standard.

Ground-breaking quantum ventures and innovative start-ups

This long-term investment in foundational and applied research is now enabling the growth of exciting new start-ups and ventures built upon IP and skills developed in Australian research institutions. Some of Australia's leading quantum technology ventures include:

- QuintessenceLabs, which has commercialised a variety of quantum-enhanced cybersecurity solutions
- Silicon Quantum Computing, which has developed record-breaking silicon-based qubits and plans to build a 10-qubit prototype quantum-integrated processor by 2023
- Q-CTRL, which provides hardware-agnostic advanced quantum control solutions for quantum technologies including quantum computing and quantum sensing.

There are also exciting start-ups emerging from Australia's quantum research labs. For example, Nomad Atomics (precision sensing technology for monitoring water and gas resources), Quantum Brilliance (a diamond-based quantum computing platform), and Redback Systems (a compact and high-resolution spectrograph) all completed CSIRO's ON Accelerate program to fast-track the development of their high-potential innovative new ventures.

(Super)positioning Australia's quantum industry for success

Many countries have now recognised the value that will be generated by quantum technology and are actively investing to position their domestic quantum ecosystems for this opportunity. CSIRO's roadmap outlines enabling actions that could help enable the growth of a domestic quantum technology industry, generating over A$4 billion annual revenue, supporting 16,000 jobs, and unlocking productivity growth across a range of other industries by 2040.

Dissipationless physics provides path to sustainable electronics

Australian Research Council Centre of Excellence in Future Low-Energy Electronics Technologies (FLEET)

An unprecedented number of Australians working from home during the coronavirus pandemic is a stark reminder of how vital electronic connections have become to community and economy.

Computing has transformed society: we use our ubiquitous smartphones to access up-to-date weather predictions, to plot the best route through traffic, and to binge watch shows. And we expect more in the future: we want our devices to translate language in real time, and allow us to travel to new locations in 3D virtual reality. We want self-driving cars and an 'Internet of Things' where every device talks to every other device.

However, further growth of computing faces a significant barrier, formed by the energy required to power it. Energy used in ICT already represents 8% of global electricity use, and is doubling every decade. Moore's Law—the steady, exponential improvements in computing technology of the last 50 years—is now flat-lining, and along with that, the energy efficiency of computers is stalling.

Fortunately, exciting, emerging areas of physics offer potential 'beyond complementary metal–oxide–semiconductor (CMOS)' solutions: advances in quantum materials allow for radical new systems in which electricity can flow with minimal resistance and therefore minimal wasted dissipation of energy, at, or close to, room temperature. Importantly, these quantum-material fields are areas where Australian physicists have already established significant expertise over the last decade.

Emerging areas of physics reducing wasted dissipation of energy

Topological materials (recognised by the Nobel Prize in Physics in 2016) represent a paradigm shift in condensed-matter physics. Topological insulators conduct electricity in one-way paths along their edges, without the 'back-scattering' of electrons that dissipates energy in conventional electronics.

Superfluids are another quantum state in which electrical current can flow with minimal wasted dissipation of energy. With scattering prohibited by quantum statistics, charge carriers can flow without resistance. New superfluids of excitons or exciton-polaritons promise room-temperature dissipationless devices.

Two-dimensional (2D) and novel materials underpin each of the fields of physics above, as the electronic properties of a material are transformed when that material is reduced in thickness to electron-wavelength scale. Australia has established expertise in novel, atomically-thin 2D material synthesis and characterisation, such as at the Monash Centre for Atomically Thin Materials and the Institute for Superconducting and Electronic Materials in Wollongong.

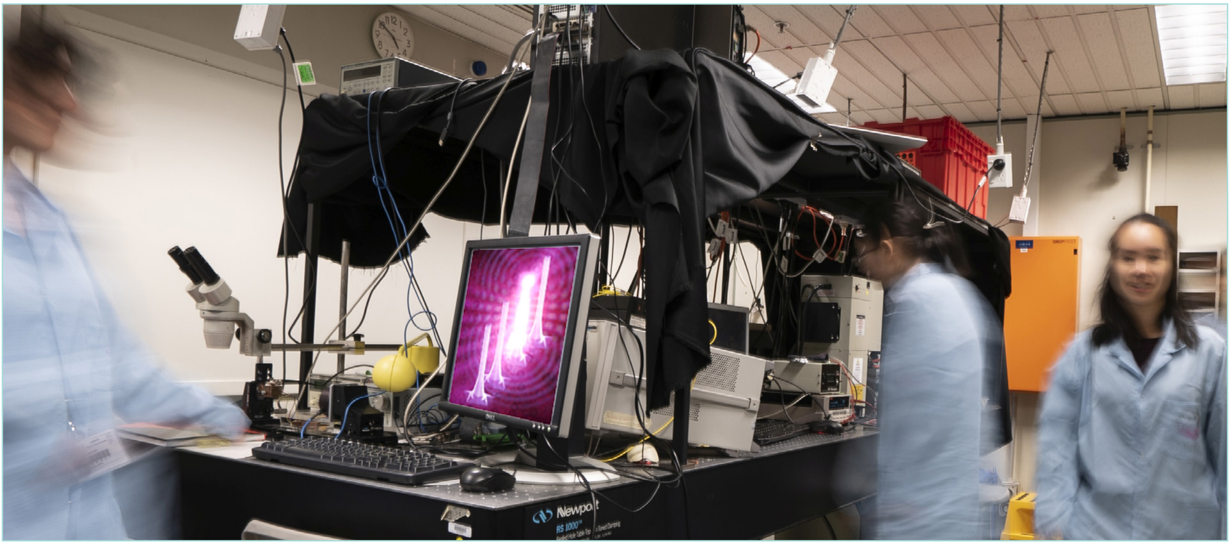
Importantly, use of 2D materials allows for technology that can operate at (or close to) **room temperature**. Systems that require ultra-cold temperatures to operate, such as superconductors, invariably use far more energy to keep cool than they save in electronic dissipation.

The application of these fields to a new generation of low-energy electronics technology sits at the very limits of what is possible in condensed-matter physics. Successful implementation in functioning devices will depend on Australian expertise in nanoscience, nanofabrication and nano-scale measurement.

Existing Australian expertise in these areas has translated to a multidisciplinary search for ultra-low energy electronics at FLEET, which is an Australian Research Council Centre of Excellence joining over 100 researchers in seven Australian universities.

Nanostructured materials bring new functionalities to optical systems

The ARC Centre of Excellence for Transformative Meta-Optical Systems



Researchers at the ARC Centre of Excellence for Transformative Meta-Optical Systems working on the optical characterisation of nanolasers.

CREDIT: JACK DURR, ANU

The massive rate of miniaturisation of personal electronic devices during the early part of the 21st century has revolutionised all aspects of our lives. These advances have enabled the fourth industrial revolution, which merges the physical and digital worlds. Industry 4.0 creates immense opportunities for innovation in sectors as diverse as automation in manufacturing, transport, defence, security, communications and health. This innovation growth has been fuelled by advances in nanotechnology, enabling the creation of new materials and devices at the nanoscale. As an example, a modern mobile phone contains more than a billion transistors.

The development of miniaturised optical technologies, on the other hand, has been significantly slower. Even though light provides a means for humans and machines to exchange information—for example, using displays and cameras—the field of optics has been using the same concepts for millennia. Many of the principles of optics, particularly the role of lenses, have remained essentially unchanged since ancient Greece and China. Although those principles have underpinned advances such as the Hubble Space Telescope and the digital camera, they cannot keep up with ever-shrinking personalised devices and new functionalities required for Industry 4.0, creating a roadblock for further system miniaturisation and integrability.

The ARC Centre of Excellence for Transformative Meta-Optical Systems (TMOS) has a vision to develop the next generation of miniaturised optical systems with functionalities beyond what is conceivable today. By harnessing the disruptive concept of meta-optics, TMOS aims to overcome complex challenges in light generation, manipulation and detection at the nanoscale, thereby aligning optics with the advances in nanoelectronics. TMOS brings together a trans-disciplinary team of world leaders in science, technology and engineering from five

Australian universities (the Australian National University, the University of Melbourne, RMIT University, the University of Technology Sydney and the University of Western Australia), to deliver scientific innovations in optics.

TMOS is building upon the legacy of strong optics research in Australia. The term meta-optics originated in Australia and our researchers have pioneered the field with novel light detectors, holograms and nanolasers. TMOS' research outcomes will underpin future technologies, including real-time holographic displays, artificial vision for autonomous systems to capture information invisible to the human eye, wearable medical devices for increasingly accurate and non-invasive health monitoring, and ultra-fast wireless optical networking technology (LiFi), to meet the evolving demands of Industry 4.0.

By engaging with key global and Australian industry partners, TMOS plans to translate its research into innovative technologies in transport, health, security, defence, agriculture, entertainment and education with benefits for our society and economy. Beyond science and technology, TMOS also has a critical mission in public engagement with science and building a diverse and inclusive workforce in the photonics industry, locally and internationally.

Extreme precision timing builds deep-tech company

QuantX Labs Pty Ltd

Built on over 15 years of university research, QuantX's first commercial product is the 'sapphire clock,' a device that can deliver a signal with a signal purity 100–1,000 times higher than that of any other device. The time-keeping ability of these sources is also world-leading: 100-fold better than the best previous solution available to the market. This performance is the equivalent of a conventional clock gaining or losing just one second in 40 million years.

It is perhaps surprising that there is a need for this unimaginable precision, but nothing could be further from the truth. Modern electronic systems, particularly when distributed over large distances, are in dire need of extreme timing synchronisation. Thus, QuantX has opportunities to apply its technology to both modern communications and computer networks to deliver enhanced performance. There has also been a market desire to access the ultra-pure signals from the sapphire oscillator, for example, radar and quantum computers both require exceedingly coherent signals in order to function at their best. One of QuantX's first customers was another physics-based start-up, Q-CTRL, who use our device to study the fundamental operations of quantum gates within quantum computers.

One of QuantX's other early customers used the sapphire clock to drive a famous radar system: the Jindalee Over-The-Horizon Radar Network (JORN). JORN is a linchpin of Australia's surveillance system, providing observations of the air and sea approaches of the nation. The

Image: The Cryoclock team in the receiver array of the Jindalee Over the Horizon Radar (near Longreach, Queensland).

CREDIT: CRYOCLOCK PTY LTD

radar works by emitting intense radio-frequency signals—if these signals intercept an object, then some of this radiation will be reflected. This reflected radiation encodes information in relation to the size, location and movement of that object. Importantly, the purity of the emitted radar signals determines the amount of information that can be derived about that object—purer signals mean that one can see smaller objects that are further away. QuantX field-tested their technology with the assistance of Defence Science and Technology Group and the Royal Australian Air Force, and with this success, are now on a path to incorporate their technology into the next generation of JORN. They are working closely with BAE Systems on that project with a firm belief that this physics research will improve the safety of all Australians.

QuantX has a diverse range of other technologies making their way along the innovation pipeline. For example, we are currently funded to build a compact optical atomic clock that will be launched into space in 2025. Many people may know that the Global Positioning System (GPS), which has become ubiquitous in our lives, depends on a constellation of high-precision atomic clocks in space. QuantX is hoping that our work will lead to a sovereign satellite navigation solution for Australia. QuantX's efforts to translate research into real-world products has been recognised by the award of the 2018 Eureka Prize for Safeguarding Australia and the 2019 Best Small to Medium Enterprise at the Avalon Innovation Awards, and we are a finalists in the 2023 InnovationAus Awards and Defence Industry Awards. Our co-founder, Professor Andre Luiten, is the 2022 South Australian Innovator of the Year.

QuantX's strong research foundation was built by physics research within universities. It is currently benefiting from the efforts of six physicists that lie at the core of its research capability. QuantX continues to partner with the university sector in the development of a wider portfolio of technologies as well as the generation of new IP. This future is predicated on using the problem-solving skills and 'blue sky' thinking for which physicists are renowned. When partnered with the right engineering and business development, this can build a powerhouse of deep-tech innovation.

QuantX has generated over A$10 million in revenue so far and is growing at 30% year on year. What is most pleasing is that this outcome, along with the economic and national security benefits that flow from its work, was derived by the intellectual efforts that arose out of fundamental physics research.

Out-of-this-world observations

The ARC Centre of Excellence for Gravitational Wave Discovery

On 17 August 2017, scientists measured the violent death spiral of two dense neutron stars via gravitational waves—ripples in space and time caused by two colliding masses. This was a landmark astrophysical discovery by an international team, including researchers from the ARC Centre of Excellence for Gravitational Wave Discovery (OzGrav) and the LIGO-Virgo collaboration. This observation occurred shortly after the discovery of gravitational waves won the Nobel Prize in Physics.

Until this detection, scientists did not know exactly where in the universe gravitational waves originated from, nor were they able to see the colossal events that created them.

"This was the first time that any cosmic event was observed through both light it emitted and the gravitational ripples it caused in the fabric of space-time," explained Professor Matthew Bailes, the Director of OzGrav.

"The subsequent avalanche of science was virtually unparalleled in modern astrophysics."

OzGrav postdoctoral researcher Dr Kendall Ackley, of University of Warwick said, "Scientists have speculated that colliding neutron stars are the factories that create most of the gold and other precious metals in the Universe. Witnessing this event makes that more likely. It feels like we're now in a scientific 'gold rush.'"

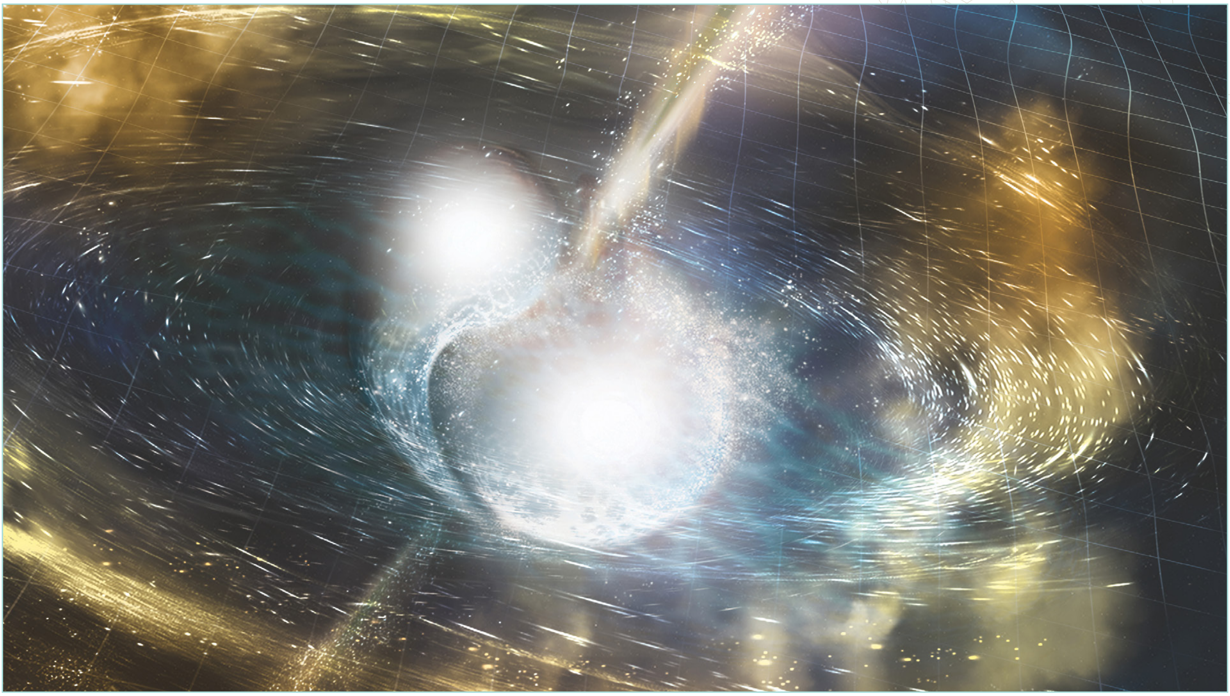
This historical event heralded a new era of gravitational wave multi-messenger astronomy.

"Before this event, it was like we were sitting in an IMAX theatre with blindfolds on. The gravitational-wave detectors let us 'hear' the movies of black hole collisions, but we couldn't see anything," explained OzGrav Chief Investigator Professor Jeff Cooke, of Swinburne University of Technology. "This event lifted the blindfolds and, wow, what an amazing show!"

Hundreds of astronomers in Australia and around the world scrambled for their telescopes to see the event. OzGrav Associate Investigator Associate Professor Christian Wolf, from the Australian National University (ANU), was literally woken up by the news and soon had the SkyMapper telescope pointing eastwards. As the Earth rotated, OzGrav Associate Investigator Dr Eric Howell, from the University of Western Australia (UWA), was waiting with the Zadko Telescope to gain crucial information about the colours and brightness of the fireball as it cooled and faded. In Sydney, a team led by OzGrav Associate Investigator Professor Tara Murphy, of the University of Sydney was the first in the world to confirm the radio emission, from the gravitational-wave counterpart initially detected by US colleagues, using CSIRO's Australia Telescope Compact Array.

Just 1.7 seconds after the merger concluded, another scientific first occurred: a burst of gamma rays hit the Earth. "This instantly confirmed that merging neutron stars were responsible for the so-called short-duration gamma-ray bursts, solving a 50-year-old mystery," said OzGrav Chief Investigator Professor Andrew Melatos, of the University of Melbourne.

This discovery also confirmed that the combination of the gravitational waves and its host galaxy redshift could be combined to measure the age of the universe, turning out to be



Artist's illustration of two merging neutron stars. CREDIT: NSF/LIGO/ SONOMA STATE UNIVERSITY/ A SIMONNET

"remarkably close to the best estimates," according to OzGrav Chief Investigator Professor Peter Veitch, of the University of Adelaide.

OzGrav Chief Investigator Professor Li Ju, of UWA, reflected that, "with one faint sound, the faintest sound ever detected, we have created one giant leap in our understanding of the universe".

Australian technology developed at ANU, University of Adelaide and UWA have been critical parts of the LIGO detectors historically. One of the key recent upgrades to the LIGO detectors employs a novel ANU-led technique called 'quantum squeezing' to reduce levels of quantum noise that can mask faint gravitational-wave signals.

OzGrav is a partnership between Swinburne University of Technology, the Australian National University, Monash University, University of Adelaide, the University of Melbourne, and University of Western Australia, along with other collaborating organisations in Australia and overseas.

LIGO is funded by the American NSF and operated by Caltech and MIT, which conceived of LIGO and led the Initial and Advanced LIGO projects. Financial support for the Advanced LIGO project was led by the NSF with Germany (Max Planck Society), the UK (Science and Technology Facilities Council) and Australia (Australian Research Council-OzGrav) making significant commitments and contributions to the project. Nearly 1,300 scientists from around the world participate in the effort through the LIGO Scientific Collaboration.

The Virgo detector is near Pisa in Italy. The Virgo Collaboration is currently composed of approximately 350 scientists, engineers, and technicians from about 70 institutes in Belgium, France, Germany, Hungary, Italy, the Netherlands, Poland, and Spain. With the field of gravitational-wave astronomy now firmly established, the international community is beginning to chart a course for the coming decades. The OzGrav team is playing a key role in this planning activity, including developing R&D for future detectors, and planning for a proposed Australian-based detector. This Australian Gravitational-Wave Pathfinder would develop and validate core technologies required for the global third-generation detector network. It is designed to detect gravitational waves from the remnants of neutron star mergers, and would provide the first measurement of the hot neutron star equation of state, where possible phase transitions to exotic states exist. In the kilohertz frequency regime, such a detector has a sensitivity comparable to upcoming third-generation detectors at a fraction of the cost. "All of this paints an incredibly bright future for the field," said OzGrav's Deputy Director Distinguished Professor David McClelland, of the ANU.

Australia's part in global enterprise searching for knowledge of the universe

Dark matter direct detection experiments in Australia

It is a remarkable fact that we do not yet know the nature of 80% of the matter in the universe. This is the dark matter mystery. The quest to uncover the particle nature of dark matter is one of the greatest challenges in 21st century science and is a major priority of fundamental physics.

Exploration of the dark matter particles is a worldwide undertaking of large scale and long duration that cannot be done by a single nation alone. Australia is poised to make a unique contribution to the global hunt for particle dark matter, exploiting our Southern Hemisphere location, and working in close collaboration with international partners. The ARC Centre of Excellence for Dark Matter Particle Physics united expertise in particle physics, nuclear physics, precision and quantum measurement, and astrophysics, enabling Australia to become a leading nation in this quest.

The SABRE experiment will be the first Australian direct detection experiment. It is poised to resolve the ongoing puzzle presented by the DAMA/LIBRA experiment, which reported a very clear signal that can be attributed to dark matter, whereas other experiments see nothing. SABRE is the first dual-site experiment of its type ever built. The Australian site will be located at the Stawell Underground Physics Laboratory (SUPL) and its northern counterpart at the Laboratory Nazionali del Gran Sasso (LNGS) Italy. The purpose of this joint Northern and Southern Hemisphere experiment is to measure the flux of dark matter particles and compare it with the predictions of a model in which the particle velocity is modulated by the Earth's orbital velocity and the latitude dependent velocity of the Sun's galactocentric motion. SABRE will be able to definitively confirm or refute the DAMA/LIBRA signal. SABRE will be carried out in collaboration with LNGS, the University of Princeton, a consortium of Italian universities and the Italian funding agency for particle, nuclear and astroparticle physics (INFN). Australian researchers are involved in the development of both halves of the experiment. SABRE will use 50 kg of ultra-pure sodium iodide as the target material, as in the DAMA/LIBRA experiment. The radiopurity of the SABRE detector crystals surpasses that of DAMA/LIBRA; to date, no other crystal experiment has achieved such radiopurity. The first full-scale crystals have been produced at Princeton, developed over seven years with University of Melbourne and ANU researchers' participation. SABRE will employ active liquid scintillator veto detectors surrounding the sodium iodide crystals to further reduce background. The result of these advances is that the expected sensitivity exceeds any other similar detector.

The next generation of dark matter experiments will also be a multi-site international enterprise. The CYGNUS experiment will be made up of several dark matter detectors operated around the world as a single experimental collaboration. These experiments will be located in underground laboratories: in SUPL, LNGS, Kamioka (Japan) and Boulby (UK). The ultimate goals are to reach the critical mass to detect dark matter.

Dark matter particle searches are also performed using above-ground precision quantum laboratories and particle accelerators. Large international collaborations are essential here as well. Australian researchers perform dark matter searches at the Large Hadron Collider at CERN in Switzerland as members of the ATLAS collaboration, and at the Super-KEKB collider at KEK in Japan as members of the Belle II collaboration. These experiments have been constructed and operated over the last 25 years at a total cost of more than A$1 billion. Australian physicists from the quantum community are key players in the ADMX experiment at the University of Washington, which uses a strong magnetic field to convert dark matter particles to detectable microwave photons.

SUPL is located 1 km underground in regional Victoria and is the only underground lab in the Southern Hemisphere. Through its unique location and international laboratory network, SUPL will greatly enhance Australia's capability in low background precision measurements. These have wide-ranging applications based on nuclear and astroparticle precision measurement techniques. SUPL is part of the international underground laboratory network, which shares best practices, instrumentation, and capabilities. It will attract scientists from outside Australia. It will be a hub for R&D activities for detector development with Australian industry for large scale scientific projects.

All the above international projects provide direct access to new areas of expertise, cutting-edge equipment and technologies, co-funding of R&D, and new opportunities for exchange of early-career researchers and postgraduate students. Thanks to its strong international collaboration with other world-leading laboratories and universities, Australia's direct detection dark matter community has been able to become a major player in this worldwide endeavour.