

# **The University of Sydney Physics Foundation**

Annual Report 2021



THE UNIVERSITY OF  
**SYDNEY**

We acknowledge the tradition  
of custodianship and law of  
the Country on which the  
University of Sydney  
campuses stand. We pay our  
respects to those who have  
cared and continue to care  
for Country.



THE UNIVERSITY OF  
SYDNEY

# The University of Sydney Physics Foundation

## Annual Report 2021

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"The Physics Foundation core  
aim is to promote excellence  
in Science & Education"

Emeritus Professor Harry  
Messel AC CBE

# President's Report

## Michael Winternitz

It is an honour & privilege to present the 2021 Annual Report for the University of Sydney Physics Foundation.

Despite ongoing global uncertainty, I am pleased that the Foundation continues to provide consistent financial support to the School of Physics, via a range of initiatives, whilst carefully preserving the capital that has been built up, from our many very generous donors over several decades.

The School continues to excel in its pursuit of excellence in research. During 2021, the School continued to be hugely successful with ARC grants.

The School is home to five Australian Research Council Centres of Excellence (ARC), one National Health and Medical Research Council Centre of Research Excellence (NHMRC CRE), an ARC Training Centre and two Cooperative Research Centres (CRC).

A focus on excellence in Education within the School continues, with the Foundation supporting several specialised positions that underpin our ethos.

The Professor Harry Messel International Science School (ISS) is at the forefront of the Physics Foundations core objectives, in promoting Excellence in research and education. ISS Online 2021 was a tremendous success.

We hope to see greater international involvement in the ISS Online 2022, before returning back to our usual in-person ISS from 2023 onwards.

The Foundations support for The Grand Challenges continues, with several groups attracting world-wide interest in their endeavours. This continues to foster interdisciplinary collaborative work within the University, and great research outcomes, and importantly underpins the ethos of Excellence.

The Foundation has now awarded six Physics Grand Challenges, with the 2021 recipients recently announced as 'An Eye in the Sky: Remote Sensing for Advanced Ecosystem Monitoring', led by Associate Professor Maryanne Large.

The second recipient was 'Function Follows Form: Next Generation Bioscaffolds', led by Professor Simon Fleming.

During 2021, Head of School Professor Celine Boehm announced her intent to step down from the Head of School during 2022. On behalf of the Physics Foundation, I would like to thank Celine for her excellent operational and financial management of the School, during such challenging times. The Physics Grand Challenges, and continued excellence in research in the School will be a long lasting features of Celine's tenure.

On behalf of the Foundation, I would like to express our thanks to the excellent work of all the staff and students for their efforts during such challenging times.

The outlook for 2022 reflects an important year for the Physics Foundation, where we plan to reconnect with our Alumni, industry, and donors, whilst at the same time continue to provide consistent support to the School of Physics, during what will continue to be turbulent global conditions.

Holding an ISS online during 2022 will allow us us to engage & maintain our strong relationships with our partner countries, and place us as strong as possible to return to our standard in person ISS from 2023.

Finally, I would like to thank the outgoing President of the Physics Foundation, Emeritus Professor Anne Green for her immense contribution to the Physics Foundation, and continued guidance.

A sincere thanks to Deputy President Mr James Kirby for his support & guidance, and my fellow council members.

**Michael Winternitz**

President

# Physics Foundation

## Objectives and Aims



The University of Sydney Physics Foundation, established in 1954 by Emeritus Professor Harry Messel AC CBE, was the first Foundation established within the University of Sydney and the first of its kind within the British Commonwealth.

The Foundation was to support the School of Physics as a voluntary philanthropic association of individuals and private organisations dedicated to the pursuit of excellence in science education, research, training and communication. Today, the Foundation still carries out this important role.

### Aims of Foundation

To support the School of Physics and to generate philanthropy, promote careers and broaden knowledge and understanding of science (in particular physics) in the wider community.

### Objectives of the Foundation

- To increase the resources of the University (by fundraising or by otherwise securing gifts and grants or by securing the provision of services or other non-financial contributions).
- To assist the Senate and the Vice-Chancellor in the promotion of the field of physics, through the School of Physics and to cooperate with the School of Physics, the Faculty of Science and the University in promoting the significance of science and developing an understanding of its importance both within Australia and internationally.

### Foundation activities in support of its objectives

- Raising funds from fees, donations, bequests and sponsorships.
- Building a strong financial position to ensure the Foundation can continue to meet its objectives in the long term.
- Providing additional funding to support the work of the School of Physics, through its scholarships, the purchase of equipment, and the underwriting of other initiatives.
- Promoting seminars, courses and workshops in the field of physics.
- Inspiring senior secondary school students through the Professor Harry Messel International Science School (ISS) to continue studies in science, and physics in particular, and to take up science careers.
- Any other initiatives and activities as the Foundation determines appropriate.



# The Messel Endowment & Donations to the Foundation

## The Messel Endowment

The Physics Foundation established the Messel Endowment in 1999 to ensure the Professor Harry Messel International Science School (ISS) continues in perpetuity.

Currently there are over 200 supporters to the Messel Endowment. These generous supporters are acknowledged in the Messel Endowment Honour Board that is published on the Physics Foundation website.

The two largest donors to date have each donated over \$1 million. These donors are classed as Extra Galactic Donors and are:

- Australian Government through the then Department of Industry.
- Mr Lee Ming Tee, through Mulpha Australia

As of the 31st of December 2021, the Endowment holds \$7,096,219 in funds. During 2021, donations and bequests to the Foundation totalled \$6,601.

The Physics Foundation is appreciative of all our donors to the Messel Endowment.

Without this valued support the ISS could not continue its important work of honouring excellence in outstanding Year 11 and 12 science students from Australia, China, India, Japan, New Zealand, Singapore,

Thailand, the UK and the USA and encouraging them to pursue careers in science.

The Endowment seeks to accrue further funds through gifts, grants and bequests to ensure the ISS can be run in perpetuity with due allowance for inflation over the years.

Donations of \$2 dollars and over are tax-deductible. Pledged gifts (donations spread over a three to five year period) are welcome and are also tax-deductible.

## Careers and achievements

The ISS now has over 5000 alumni with many going on to outstanding career achievements in their chosen fields including science, medicine, engineering and technology.

Please help us in continuing to offer this world-class program to these talented students who come from diverse cultures and backgrounds.

Donations to the Messel Endowment can be made online, or via mail. A donation to the Messel Endowment is an investment in the future of science. For more information go to the Physics Foundation website at [www.sydney.edu.au/science/schools/school-of-physics/physics-foundation.html](http://www.sydney.edu.au/science/schools/school-of-physics/physics-foundation.html)



# 2021 Physics Foundation Members

## Foundation Staff

- Professor Celine Boehm, Head of School of Physics
- Ms Sian Edwards, Administrative Officer

## Patron

- Her Excellency the Hon. Margaret Beazley AC QC

## Past Presidents

(initial year of presidency shown)

- Dr Richard GC Parry-Okeden (1954)
- Sir James N Kirby CBE (1957)
- Sir Frank Packer KBE (1960)
- Sir Noel Foley CBE (1963)
- Sir Walter Leonard DFC (1966)
- Sir Robert Norman (1969)
- Mr James A Macpherson (1972)
- Sir Walter Leonard DFC (1973)
- Mr J Keith Campbell CBE (1975)
- Mr Herman D Huyer AO OON (1978)
- Mr Raymond J Kirby AO (1982)
- Mr John R Slade (1986)
- Mr Peter Douglas (1989)
- Dr Peter Jones AM FTSE (1993)
- Mr Paul Slade (1996)
- Mr Graham Hall (1999)
- Mr Pat Donovan AM RFD ED (2002)
- Mrs Louise Davis AM (2005)
- Mr Trevor Danos AM FTSE (2008)
- Mr Jim O'Connor (2011)
- Mr Albert Wong AM (2013)
- Emeritus Professor Anne Green FTSE, FRSN, FAIP, FASA (2017)

## Past Directors

(initial year of directorship shown)

- Emeritus Professor Harry Messel AC CBE (1954)
- Emeritus Professor Max Brennan AO FAA (1987)
- Professor Lawrence Cram AM (1991)
- Emeritus Professor Richard Collins FTSE (1997)
- Professor Bernard Pailthorpe (2002)
- Associate Professor Robert Hewitt (2003)
- Emeritus Professor Anne Green FTSE FRSN FAIP FASA (2006)
- Professor Clive Baldock (2010)
- Professor Tim Bedding FAA (2012)

## Foundation Council 2021

### Office Bearers of the Foundation

- Mr Michael Winternitz, President
- Mr James R Kirby, Deputy President

### University Officer

- Professor Iain Young, Dean of Science

### Council Members

- Dr Gregory Clark AC FTSE FAA FAPS
- Mr Trevor Danos AM FTSE (Observer)
- Professor Gemma Figtree FRACP FCSANZ FAHA
- Emeritus Professor Anne J. Green FTSE, FRSN, FAIP, FASA
- Professor Greg McRae

### University Ex Officio Council Members

- Ms Melissa Bonevska
- Ms Alexia Nicholson

## Foundation Members

### Founder

- Emeritus Professor Harry Messel AC CBE

### Life Governors

- Mrs Louise Davis AM
- Associate Professor Robert Hewitt
- Dr David Mills AM
- Mr Jim O'Connor
- Mr Martin Rogers
- Mr Paul Slade
- Mr Albert Wong AM
- Prof. The Hon. Dame Marie Bashir AD CVO
- Mr Trevor Danos AM FTSE

### Honorary Governors

- Mr Tony Aveling
- Emeritus Professor Max Brennan AO FAA
- Emeritus Professor Richard Collins FTSE
- Professor Lawrence Cram AM
- Mr Raymond Kirby AO

### Individual Members

- Dr Gregory Clark AC FTSE FAA FAPS
- Professor Gemma Figtree FRACP FCSANZ FAHA
- Emeritus Professor Anne Green FTSE FRSN FAIP FASA
- Mr James R Kirby
- Professor Greg McRae
- Mr Michael Winternitz

### Corporate Members

- The James N. Kirby Foundation
- The Nell and Hermon Slade Trust



# Physics Grand Challenges

## 2021 Round



The Physics Grand Challenges was established in 2019 and aims to support unconventional, innovative, interdisciplinary research projects with a total of \$250,000 each to be awarded to two projects to use over a period of up to two years.

The Physics Grand Challenges is an initiative conceived by the Head of School, Professor Celine Boehm and is supported by the Physics Foundation.

To boost projects to become financially sustainable, an additional co-funding initiative was introduced into the 2021 round, encouraging projects to leverage the Foundation's funding. This included any cash revenue paid toward the project from outside the University of Sydney being matched equally by the Physics Foundation of up to a maximum of \$100,000 per annum for two years.

Due to the difficulties faced by the School arising from the Covid-19 pandemic, the 2021 Grand Challenges applications were opened in late 2021 with the Pitch Event held online on February 16th 2022. Four projects presented their ideas to the Selection Panel with a 10-minute Pitch followed by a 5-minute Q&A each.

The 2021 Selection Panel included:

- Michael Winternitz, President of the Physics Foundation.
- James Kirby, Deputy President of the Physics Foundation and Director of the James N. Kirby Foundation.
- Emeritus Professor Anne Green, Chair NSW Division Australia Academy Technology & Engineering.
- Professor Gregory McRae, Hoyt C. Hottel Professor of Chemical Engineering (Emeritus), Massachusetts Institute of Technology.
- Lyn Cobley, Senior Adviser Oliver Wyman, Former CEO Westpac Institutional Bank.

The four Presentations were well received by both the audience and Selection Panel. The two Physics Grand Challenges 2021 winners were:

### **An Eye in the Sky: Remote Sensing for Advanced Ecosystem Monitoring**

A project working with Bush Heritage Australia, to develop advanced systems for monitoring ecological health, building bushfire resilience and better understanding the effects of bushfires, led by Associate Professor Maryanne Large.

The project is based around the idea of “precision conservation”, the idea that better data will inform better management of conservation reserves.

The highly diverse team includes physicists, geoscientists, robotics experts and ecologists. They will develop specialised instruments, and deploy them on UAVs and ultimately in space, to enable a data-rich understanding of whole landscapes.

### **Function Follows Form: Next Generation Bioscaffolds**

A project to develop and demonstrate novel bioscaffolds suitable for synthetic blood vessels, and cardiac tissue led by Professor Simon Fleming.

The project brings together expertise in the School on the fabrication of microstructures in bioresorbable materials and on the plasma functionalisation of their surfaces. Combining this with the expertise of collaborators in stem cell biology, the project will demonstrate a novel approach to fabrication of complex 3D bioscaffolds with application to clinical building replacement blood vessels and cardiac tissue.

This project received seed funding from the Physics Foundation following the Physics Grand Challenges 2020 round. The funding has assisted in the advancement of the project leading up to their successful outcome in the 2021 round.

The Foundation is proud to support the Physics Grand Challenges Initiative and look forward to following the 2021 winners over the next two years.

Reports from previous winning years 2019 and 2020 will follow in this report.

# Physics Grand Challenges 2019 – Update

## Mission to $\alpha$ -Centauri

Project Lead: Professor Martijn de Sterke

### Aim and Background

The Breakthrough Starshot project, coming out of the United States, aims to send small probes to the  $\alpha$ -Centauri system, the star system closest to Earth. The probes are to be propelled by an Earth based laser which accelerates the probes to 20% of the speed of light in approximately 15 minutes

It would then take approximately 20 years to reach  $\alpha$ -Centauri, which is about 4 light years away from Earth. The probes will have the shape of a sail with a diameter of a few metres, but with a mass of only a gram.

This is a very ambitious project that requires major advancements in several areas in science and in engineering including material science, space communications, lasers, heat management, etc.

The Grand Challenge project “Mission to  $\alpha$ -Centauri” aims to contribute to one aspect of this large project by analysis of the launch phase. The launch phase is very delicate as the motion of the light sail tends to be unstable. That is, any unavoidable imperfections in the light beam cause the sail to shake and to veer off course, leading to a failed mission. We have been working on the stabilisation of the light sail while it is being propelled by the laser.

### Progress Update and Achievements

Our team consists of members of the School of Physics, with backgrounds in optics, astronomy & space physics, and dynamical systems, and of the School of Mathematics & Statistics.

Our approach is schematically summarised in the figure to the right: the sail consists of different parts that can move with respect to each other (indicated in blue and in grey). However when they do so there is friction (green), which not only reduces the relative movement but also damps the shaking of the sail as whole.

Using advanced techniques in theoretical mechanics,

our analysis of the movement of the sail demonstrates that it can be stabilised in this way. We also show that the heat that is generated by the friction is likely to be small compared to the unavoidable absorption of energy from the laser beam.

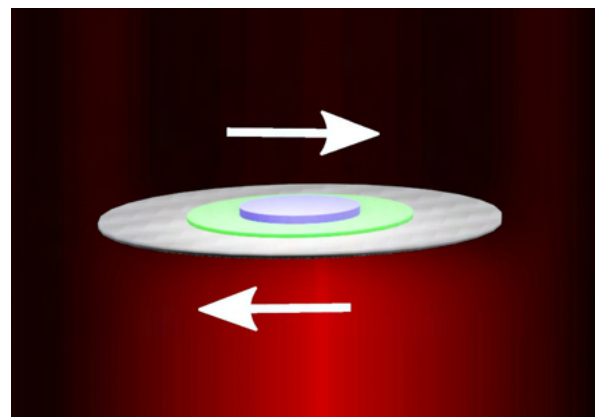
Our work has been published in Physical Review Applied. However, we also found that achieving stability is not guaranteed and appears to depend on the details of the sail properties in a way that we do not understand yet. Acquiring this understanding is on the agenda for 2022.

We are fully embedded in the Starshot program and have presented our work at several project meetings. We are also starting a collaboration with researchers at other research groups working on the project.

We have presented our work at colloquia at three different universities (Sydney, UNSW and Auckland) and our work has been picked by a Dutch popular science magazine (KIJK Magazine).

### Student Engagement

Several undergraduate students have contributed to our project and indeed three of them are authors of the journal paper mentioned above. We are also preparing an experiment for the undergraduate teaching lab demonstrating the pressure exerted by a light beam.



Schematic of a possible implementation of the passive stabilisation of a light sail consisting of two parts (grey and blue) that sandwich a region (green) that acts as a spring with damping. The arrows indicate the motion of the top and bottom parts.

# Physics Grand Challenges 2019 – Update

## The OAASIS Project

Project Lead: Dr Joy Murray

### Aim and Background

The aim of the Open Analysis to Address Slavery in Supply Chains (OAASIS) Project is to provide materials to support businesses and civil society to understand what a supply chain is and how to trace it (Stages 1 & 2); and how to recognise modern slavery and know how to address it (Stage 3).

Stages 1 & 2 are funded by the Physics Grand Challenge grant. Together they constitute the proof of concept that top down (big) and bottom up (small) supply chain data can be integrated to drive a virtual reality (VR) data visualisation environment. Stage 2 will also include 360 degree video of a small part of a farmer's supply chain.

### Progress Update and Achievements

- We have used existing supply chain big data and greenhouse gas footprint data to create a supply chain visualization tool driven by those data. The following description of the tool is taken from the International Input-Output Association Newsletter, Nov 2021:

"We have developed an online tool to conduct Structural Path Analysis (SPA), called spaJS. The tool has been written in JavaScript; it runs in the local browser, and is fully dynamic, i.e. data-driven and interactive. An additional feature (available soon) is the geographic visualisation of the links between the countries within the economic system represented by the input data. "[1]

This virtual reality architecture will allow other social and environmental supply chain issues to be addressed in future. The tool will be made available through the Industrial Ecology virtual Laboratory.[2]

- We have collected and integrated bottom-up small data from two cocoa traders and 12 cocoa farmers in Ghana.
- We have collected 360 degree video material of cocoa farmers in Ghana going about their daily business. The material is currently being edited into a Virtual Reality pitch to seek funding to undertake Stage 3 of the project. As well as a glimpse into the everyday lives of cocoa farmers the pitch will include data visualisation.

COVID and data gathering logistics have delayed the OAASIS project slightly. Despite this we have created a fully functioning data visualisation tool that can be used freely for research purposes and we have almost completed our Virtual Reality pitch to seek funding to complete Stage 3.

1. Tepper-Garcia, T., Murray, J., Malik, A., Geschke, A. and the OAASIS team (2021). spaJS: A visual interactive online tool to conduct Structural Path Analysis. In *Newsletter number 50, International Input-Output Association* (November 2021) p. 11
2. <https://ielab.info/>



OAASIS researcher Bridgette Addo from the Ghanaian Ministry of Agriculture addressing cocoa farmers from the Akote and Osino communities in the Eastern Region.

# Physics Grand Challenges 2020 – Update

## Nanoscale brain navigation for targeted drug delivery

Project Leads: Dr Ben Fulcher and Dr Shelley Wickham

### Aim and Background

This Physics Grand Challenge project seeks to design nanoscale robots which could deliver drugs to the distinct regions of the brain where they are needed, transforming treatments and patient outcomes. Using expertise in DNA nanoscience, neuroinformatics, and artificial intelligence, the cross-disciplinary team aims to develop algorithms that will allow these machines to detect region-specific molecules in the brain before delivering their drug payload.

### Progress Update and Achievements

In 2021 the Physics Grand Challenge on nanoscale brain navigation team focused on undergraduate engagement and recruitment of talented PhD students and postdocs.

Alongside this, regular interdisciplinary team meetings between Physics, Chemistry, Biomedical Engineering, Brain and Mind Centre and the Centenary Institute have built the foundation for future grant applications to the Michael J Fox Foundation (Parkinson's Disease) and the NHMRC Ideas scheme, with support from the Sydney University Development team.

### Student Engagement

Undergraduate team building has resulted in recruitment of talented Honours students (one in 2020, one in 2022).

Eloisa Perrez-Bennet's Honours thesis established a proof-of-principle for performing statistical learning on whole-brain maps to guide the design of DNA nanorobots, complemented by experiments. Eloisa's work was selected for oral presentation at the National Conference of the Australian Society for Biophysics, December 2021.

The GC project has been successful at recruiting excellent Dalyell (1 in 2021, 1 in 2022) and Denison scholars (2 in 2022), and supervised a team of 3rd year physics undergraduates for PHYS3888 Interdisciplinary Physics unit.

### PhD and Postdoc recruitment

PhD Student Annie Bryant joined in 2022, with a major

focus on developing theoretical tools for using brain maps to enable nanoscale brain navigation. Her work will build on the results of the PHYS3888 2021 project.

Postdoctoral Fellow Dr Minh Tri Luu joined the team in May 2021, his work focuses on demonstrating proof-of-concept DNA logic gate computation within vitro experiments. We are aiming to submit two papers in 2022, one experimental and one theoretical.

### Strategic planning for continued funding

Regular team meetings in 2021 have included Ben Fulcher, Shelley Wickham, Stuart Fraser (Centenary Institute, Biomedical Engineering), and Mac Shine (Brain and Mind Centre), along with students and staff. This team has brought together expertise from physics, chemistry, bioinformatics, neuroscience and stem cell biology to refine the direction of the GC towards specific neurological conditions and target brain areas.

This approach will allow us to apply for specialised funding streams. Publications and results will be used to support grant applications to be prepared for late 2022/early 2023, including the Michael J. Fox Foundation (MJFF), and the NHMRC Ideas scheme.

We have engaged with the Advancement Team to develop a strategy for targeting philanthropic opportunities, who have expertise to support the MJFF application.

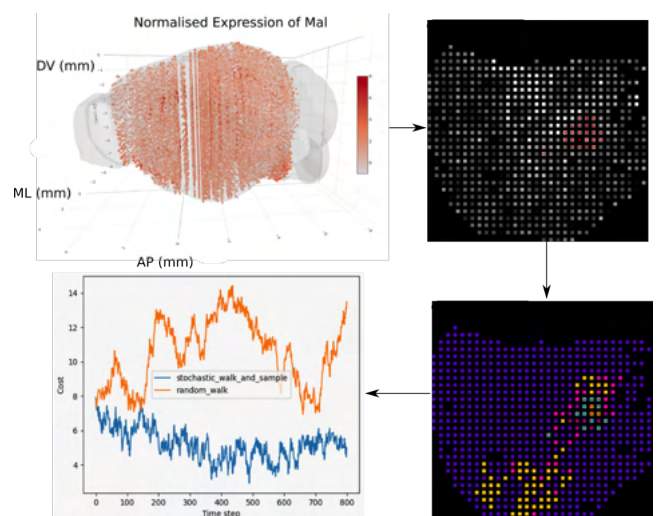


Figure 1. The PHYS3888 team demonstrated that molecular mouse-brain atlases can be used to simulate dynamic navigation strategies to optimise the targeting of specific neural populations implicated in Parkinson's Disease.



# Physics Grand Challenges 2020 – Update

## Positronium the key for cancer annihilation

Project Lead: Dr Yaser Hadi Gholami

### Aim and background

For cancer patients, time is a matter of life and death: identifying early-stage cancers will save lives. Detection of cancer well before any symptoms and micro-metastases is the key for a good prognosis.

The overall aim, is to develop a novel anti-matter marker, positronium, with quantum sensitivity and specificity for early cancer diagnosis, a medical technology not previously recognised.

### Progress Update and Achievements

We have established a deep understanding of the positronium physics in living materials. This is the basis of our Monte Carlo and experimental studies.

Figure 1 demonstrates a comprehensive picture of positronium formation and decay through all possible pathways in living materials. Our hypothesis is that due to the differences in morphology, the oxygen content and charge distribution in cancer and normal cells, they would have unique positronium annihilation parameters. Thus, cancer cells in a liquid or tissue biopsy can be detected and diagnosed with high sensitivity and specificity.

We have been invited to contribute to an upcoming new book “Radiotheranostics” in the CRC Press Series in Medical Physics and Biomedical Engineering with a chapter on the physics of positronium for medical applications including the use positronium formation and decay for cancer detection.

Currently we are in the process of establishing a positronium annihilation lifetime spectroscopy (PALS)

and experimentally derive the positronium annihilation parameters for a range of cancer cells and for the first time demonstrate a proof of principle for the use of positronium as a universal cancer marker and PALS as a novel early detection test. Unfortunately, due to our circumstances last year there has resulted in a major delay in our progress.

In May 2021, we employed a postdoctoral researcher Takanori Hioki to join our team. We have met with our collaborators from Harvard University (A/Prof Schuemann and A/Prof Grassberger) to initiate the Monte Carlo simulation platform for simulating the PALS experiments and have had meetings with a group of researchers at ANSTO (Dr. Gregg Daniel and Mr. Griffiths Grant) for establishing a collaboration. We plan to use the PALS ANSTO facility for results validation and comparison.

All biological samples have been prepared including the cancer cell samples for PALS characterisation, including prostate, colorectal, brain cancer cells. The PALS experiment protocol has been developed.

By completing this project, we hope to open new avenues of research in positron emission tomography (PET) modality to be used for obtaining much more accurate diagnostic imaging.

### Student Engagement

We offered an honours project titled “Positronium Interference in a magnetic field of PET-MR scanner”. The aim of this project is to perform in-vitro/silico studies to investigate the interference of positronium states in the MR magnetic field.

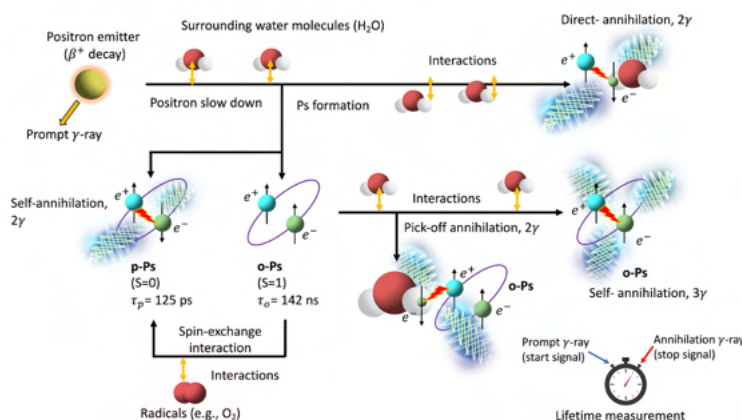
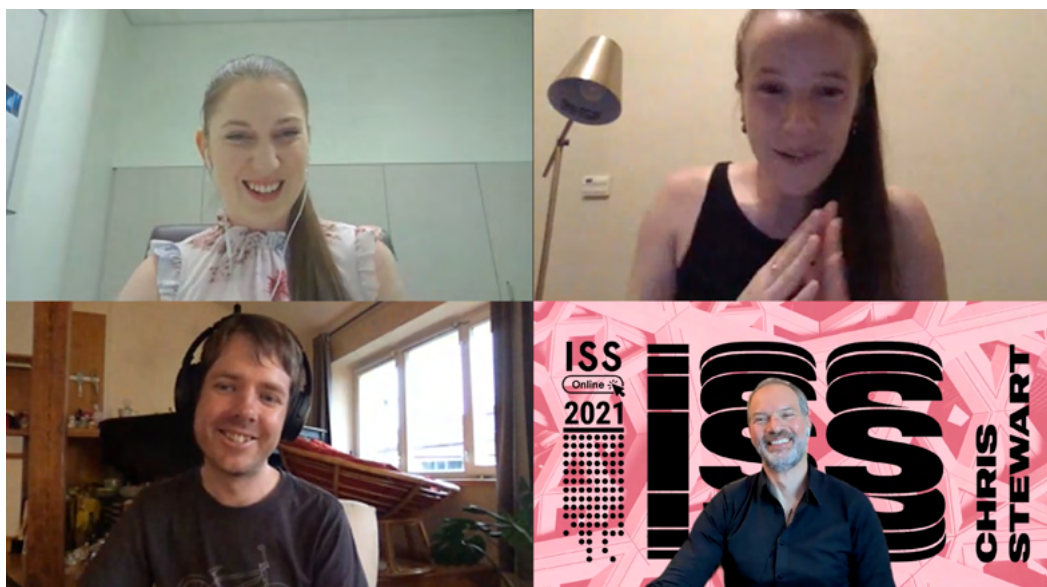


Figure 1. Schematic diagram showing the possible pathways for positronium formation and decay in living materials.

# ISS Goes Online For 2021



ISS Director Chris Stewart chatted about University and beyond with alumni Matthew Dunstan, Xanthe Croot and Natasha Bond.

The world has changed dramatically in the last couple of years thanks to the global pandemic, and the International Science School is no exception. Early in the planning process for ISS2021 we decided against hosting an in-person program, and instead threw ourselves into designing a completely new, entirely online event.

Despite initial concerns that a virtual ISS would struggle to live up to the program's very high standards, the team pulled together an astoundingly successful event.

With a group of dedicated staffies ready to welcome and enthuse the students, and inspiring workshops and speakers from across the University of Sydney and around the world, we hosted a first-rate ISS that not only gave a well-needed boost to the attending scholars, but also became an excellent model for future online ISS events.

## **The ISS Online Scholars**

For logistical reasons we restricted

this year's ISS Online program to Australian students only.

A degree of Zoom-fatigue across the Australian student population led to a lower number of applicants than we hoped — but the applications we received were all from talented and enthusiastic students. In all, 103 scholars took part from across most states and territories of Australia.

## **The ISS Online Program**

In preparing for the first fully online event, we limited the program to one week of talks and activities, broadly following the same schema as a traditional ISS.

We aimed to provide a rich variety of content, while not overloading the students with too much time on a screen.

Each day during the ISS week, scholars tuned in to three sessions hosted mostly through the Zoom video meeting platform, with discussions and interactions taking place on a dedicated ISS Online Discord server.

Scholars were divided into groups of around 25, with each group led by two of our team of volunteer staffies, all alumni from recent ISS programs.



Scholars letting their hair down at Dr Karl's House Party.

The days began with a scientific lecture, the speakers selected for their area of expertise, scientific reputation and communication prowess.

### This year the lecture series featured:

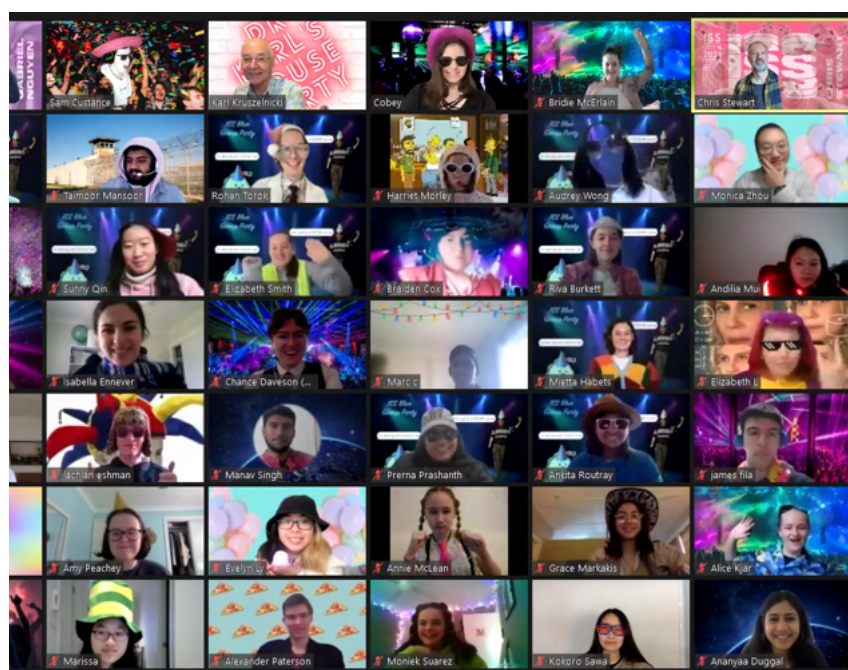
- Prof. Anita Ho-Baillie (Sydney) — Next-Generation Solar Cells
- Prof. Geraint Lewis (Sydney) — Do We Live In A Multiverse?
- Prof. Adrienne Fairhall (U. Washington, and ISS1985 alumna) — Neural Coding
- Emily Judd (NASA Langley Research Center) — Human Mars Exploration
- Dr. Micah Goldwater (Sydney) — The Psychology of Misinformation
- Dr Karl Kruszelnicki (Sydney) — Dr Karl's House Party

The lecture series was recorded and has been uploaded to the official ISS YouTube channel:

[youtube.com/TheSydneyISS](https://youtube.com/TheSydneyISS)

Prior to the first lecture from Prof. Anita Ho-Baillie, the ISS was formally opened by Foundation President Michael Winternitz, who outlined some of the history of the ISS and

Still taken from live-streamed tour of Anita Ho-Baillie's solar cell lab.



the Foundation, and formally welcomed the scholars to the program.

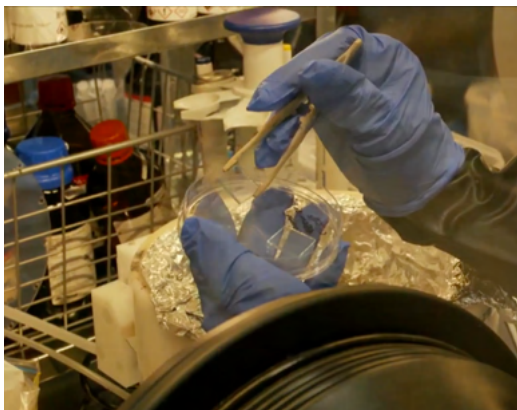
One of the highlights of a traditional ISS is visiting research spaces and labs around the university. We wanted to capture a flavour of this for the online program, and so for the second session each day we organised a series of virtual lab tours.

Despite the sudden closure of the main university campus immediately prior to the start of the ISS, we were able to run one live tour, streamed directly from Prof. Ho-Baillie's solar cell lab.

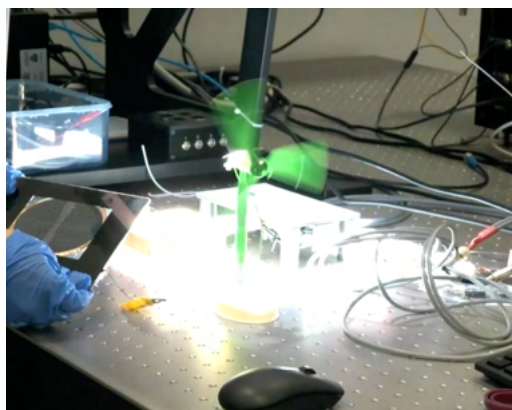
The two other tours featured live discussions and pre-recorded presentations hosted by Dr. Ann Kwan and her colleagues at the Kwan Lab, a cross-disciplinary research group based in the School of Life and Environmental Sciences, and the Australian Centre for Field Robotics.

Finally, each day the scholars took part in a series of hands-on workshops created especially for the ISS program by outreach teams across the Faculty of Science.

Running a hands-on experiment for a disperse online group is a truly challenging problem, and our workshop leaders were up to the task.



Stills from the live-streamed tour of Anita Ho-Baillie's solar cell lab.



All scholars received a box of materials in the mail prior to the ISS, complete with notes, simple DIY experimental apparatus, and even basic chemical samples and a magnetic model of chemical self-assembly!

To recreate some of the rich social life of the ISS program, the staffies hosted daily events for the scholars outside of the formal program, including quizzes, games tournaments, and an online movie night. This vital component of the virtual program was instrumental in bringing the students together and helping them to bond – the aspect of the ISS that we feared would suffer the most in shifting online. Thanks to the ingenuity, enthusiasm and dedication of the staffie team, we managed to give the scholars a truly personal and enjoyable week.

### ISS Online in 2022 – Bigger and Better!

With the pandemic continuing across Australia and around the world, the Foundation and the University took the decision in late 2021 to run the ISS in online mode again in 2022, with a view to returning to the in-person program in 2023.

ISS Online 2022 will expand to nine days of talks, activities and experiments, building on the successes of the 2021 trial to create an inspiring and exciting virtual program.

Students will attend from all states and territories of Australia, as well as several of our overseas partner countries.

## Dr Chris Stewart

ISS Director

## Student Quotes

**“Thank you so much for this incredible opportunity! The ISS is a memory that I will cherish for the rest of my life and is a key milestone in my studies and career.”**

**“Being part of such an incredible program organised and run by dedicated and passionate staff alongside other like-minded peers made ISS Online an incredible opportunity I'm so grateful to have been a part of.”**

**“It gave me an insight not only into the applications of science in the real world but also the incredible community of academics and scientists behind it.”**

**“Despite us not being able to be with each other, the amazing people organising it made it feel really like a very social and supportive program – I met and heard from some really interesting people.”**

**“Brilliant cutting-edge research, potential pathways for me to travel down – just so fascinating!”**



ISS Online





Theory of dark energy mismatches observations by

**$10^{120}$  !**

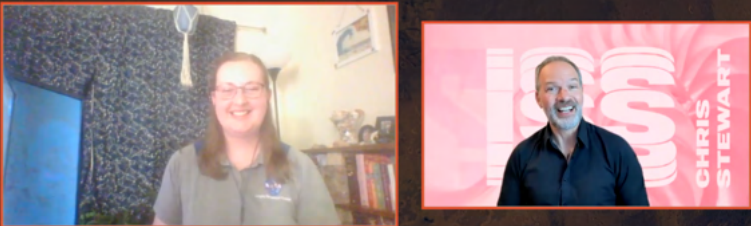
Brain-stretching cosmology with Prof. Geraint Lewis

ISS Online



ISS alumna Adrienne Fairhall joined us from Seattle

ISS Online



NASA mission specialist Emily Judd spoke about getting humans to Mars

Banner for ISS Online 2022



The Professor Harry Messel International Science School

ISS Online

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# Julius Sumner Miller Fellow

## Dr Karl Kruszelnicki AM



Dr Karl sits down with Dr Leon. ABC TV, Little Kids, Big Talk.

The Physics Foundation established the position of Julius Sumner Miller Fellow within the School of Physics in 1995. Dr Karl Kruszelnicki has been the championing Fellow since, communicating the awe and wonder of the universe through science, inspiring countless students and engaging the general public across a multitude of platforms.

### Staff

Isabelle Benton continued working alongside Dr Karl as his producer. Chris Norris continued as technical producer for the University of Sydney podcast 'Shirtloads of Science'.

### University of Sydney Events

Karl's five-part lecture series for a new first-year class in the Open Learning Environment Unit Sustainability: Climate and Energy attracted a huge enrolment from students, and led to a further collaboration with Professor Peter Tuthill from Physics. The duo produced an innovative Plenary

Presentation for the Astronomical Society of Australia on climate change from an astronomer's perspective. They went on to record an episode for Karl's University of Sydney podcast 'Shirtloads of Science'.

Karl gave an evening Sydney Science Forum presentation, COVID-shifting from an in-person event in the Great Hall to a successful zoom event. His Lunchbox Science zoom show went out to 500 eager participants. Karl's International Science School sessions were delivered to over 100 Year 11 and 12 students. Working with colleagues from the School of Physics, Karl

presented a career talk for the STEM Teacher Enrichment Academy and provided a very thought-provoking afternoon for the teachers. He also gave two Leadership in STEM seminars for students in the University's high-achievers Dalyell stream.

Student-led events included a 'How to Study' presentation with tips and tricks to use ahead of exams, and a show for the students of Sancta Sophia College. Karl presented 'Great Moments in Medical Technology' for the Faculty of Engineering's BIOTech Futures Symposium for 500 high school students from across the world.



Dr Karl's online presentation for Sydney Science Festival in Science Week.

In addition to events, Dr Karl wrote the foreword to the University of Sydney publication *Earth Cries: An Anthology on Climate Change*.

## National Science Week

It's online, accessible and interactive! Karl connected with the students in his 'Ask Me Anything' University of Sydney Instagram Story session during Science Week. The NSW Department of Education hosted Karl for an 'Education Live' online Q&A session with schools all around NSW. Karl reached a massive audience with his fun presentation, uplifting kids learning from home, while building relationships with government bodies (which are still on-going). Karl engaged with students and the general public with interactive zoom shows for Inspiring Australia in Launceston and Hobart, Sydney Science Festival, Cosmic Shambles in the UK, TikTok Live for 'ABC Behind the News', Wollongong Science Space, Royal Botanic Gardens and Australian Museum's 'Sydney Science Trail', The Science Teachers Association of NSW and University of Newcastle. August was certainly a busy month for Karl, but that did not stop him being an ambassador for Poetry Month too!

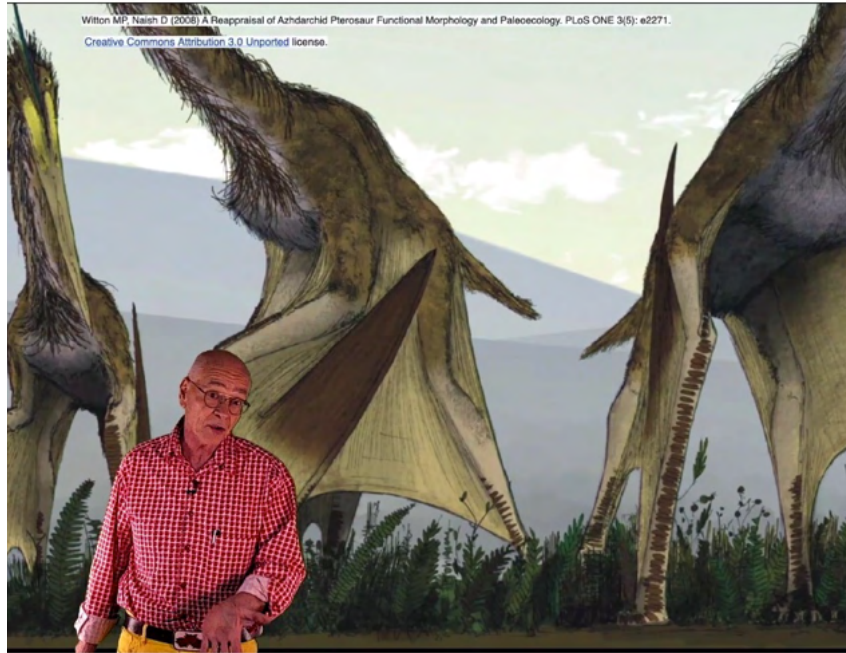
## Schools

Despite lockdown, school science Q&As continued every week. Karl chatted with 79 schools (including in Ireland and England) across three different platforms with some schools zooming in from home. He also gave an online career pathway talk for the Year 10 students of St Ives High.

The NSW Department of Education approached Karl to give an online fun and inspiring science session to assist students inside and outside the classroom environment during the lockdown period.

## Eureka School Prize

The University of Sydney Sleek Geeks Eureka Schools Prize is now into its sixteenth year. This year, students were asked to use the theme 'Big' to create 2 minute films that



communicate scientific concepts in accessible and engaging ways. The finalists in all categories enjoyed a lunchtime zoom watching their videos and chatting with Karl and later a live broadcast with Karl and the Dean of Science Professor Iain Young to announce the winners.

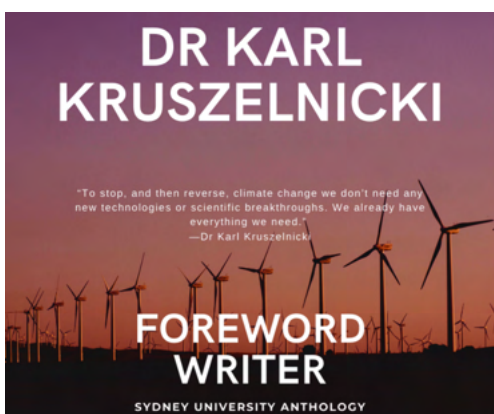
## Television

Always on demand for comment on science in the news, Karl appeared on ABC TV's Weekend Breakfast, Channel Seven's Weekend Sunrise, Channel Ten's The Project, and continued his regular Live Science Q&A on Delfi TV, Lithuania. Karl appeared on ABC's Little Kids Big Talk where he chatted to primary school kids and answered their questions about climate change and the environment. You're never too young to learn and ask questions!

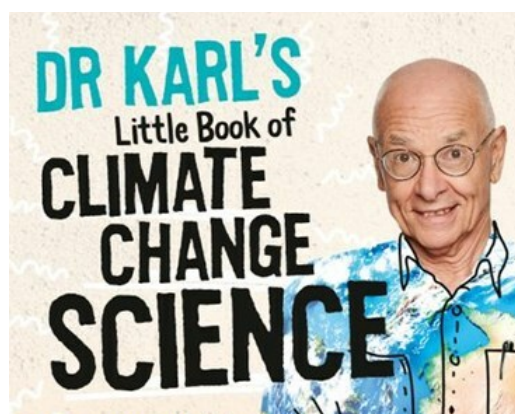
## Radio

Thanks to Dr Karl's home broadcast studio, he continued his five hours of national ABC radio segments each week. The triple j audience in just the five capital cities alone attracts over 750,000 listeners, while the podcast downloads for 2021 were just over 6 million.

Overseas radio appearances include CHAI FM in South Africa and BBC Bristol.



University of Sydney Anthology 'Earth Cries'



Dr Karl's book was launched online.

## Social Media

Karl's TikTok account followers exploded to 426K and 3.9 million likes during the year thanks to his informative and entertaining videos. His collaborations were popular and included a Myth Busting Live with Professor Sharon Lewis from the Peter Doherty Institute for Infection and Immunity. Some of Karl's TikToks have reached over 5 million views.

Karl worked more closely with the Science Faculty's marketing team this year, producing content for social media. His post for #GeekPrideDay about his favourite piece of Science Kit – the Galileo Thermometer had 140 shares and 2.9K likes and his sunscreen explainer video helped kick off the new University TikTok account for the Summer break.

Karl's social media followers continue to grow with Facebook numbers now 170K. Instagram followers are up to 105K and Twitter now sits at 340K. Karl's website, drkarl.com is the go-to hub of all things Karl.

Dr Karl's ABC Webpage is currently responsible for almost one-half of all visits to the ABC Science webpage, and about 5% of all Internet traffic to the ABC. Much of Karl's social media was about COVID-19 and getting the facts out there. He was involved in the ABC Vax Facts social media campaign, informing and encouraging people to get vaccinated and was spreading the word about the safety of vaccines in a Western Australia Vaccination Campaign. Even punk rock played a role via Dr Karl's hard hitting 'Get Vaxxed' song à la Sex Pistols. Social media was literally saving lives.

## Podcasts

Dr Karl has two ABC podcasts and a weekly University of Sydney podcast 'Shirtloads of Science' (average download per episode is 20K). Shirtloads features numerous University of Sydney academics across faculties including Professors Geraint Lewis, Peter Tuthill, Tara Murphy, Iver Cairns and Eleanor Bruce from Geosciences, and Julie Leask from Health and Medicine. Karl also interviewed the Chief Scientist of Australia Dr Cathy Foley as well as international science authors Brian Greene, Paul Davies and Johann Hari.

## Books and Writing

Book number 47 was released in March. 'Dr Karl's Little Book of Climate Change' was launched online with virtual book signings – a first for Dr Karl! Dr Karl continued his regular columns in Australian Geographic magazine and University of Sydney's Science Alliance newsletter (4000 members).

## Mentoring and Media/Speaker Training

Karl kicked off the year by presenting a fun, online science session for 600 Year 12 students attending the National Youth Science Forum, a not-for-profit organisation that runs a number of residential programs to encourage young people in their passion for STEM.

Dr Karl's mentoring of University of Sydney students continued throughout the year via phone, email, TikTok and Twitter. Students joined him at the ABC studios for radio appearances and podcasts but also from his



home broadcast studio through the COVID-19 shutdown period. Karl also gave presentations to the ABC 'Top 5 Under 35' program for early science career researchers.

Dr Karl also supports students by becoming involved in their initiatives. He was interviewed by Year 12 student (and Frankston's Youth Citizen of the Year 2020) Michaela Goggin for her school Eco Team's YouTube Channel about Australia's response to climate change. He was also interviewed by ten-year-old Sam because 'I am a huge fan of your books and I think you have done more than anyone else to make science popular and accessible for kids and adults around Australia'.

Karl was also a judge for the 'Future You' competition, an initiative led by Professor Lisa Harvey Smith that smashes stereotypes and inspires children (especially girls) to see a future for themselves in STEM careers.

## Festivals and Conferences

Early in the year the World Science Festival Brisbane welcomed Karl in person to present to schools, teachers and the general public for fun and engaging Science Q&As, talks and

Science Q&A with Brisbane State High School.



## Lunchbox Science with Dr Karl

▲ Join Dr Karl for an entertaining and mind-bending voyage through science.

panel discussions. The regional events later in the year in Mackay, Gladstone and Toowoomba were able to go ahead online. Karl also presented at Supanova Sydney, Gold Coast and Melbourne, Sydney Writers' Festival, and Byron Bay Comedy Festival. He was also invited by University of Sydney's Professor Alice Motion to present at the Australian Citizen Science Association Conference and the NSW Department of Education's Australian Virtual Astronaut Challenge.

## Covid Communication Challenges

As COVID-19 continued to sweep the world, the value of Science, and how it is communicated, became more vital than ever. Despite an unpredictable year of cancellations, disappointments and isolation, Dr Karl was able to bring science to the people via TV and internet, phones, radio, books, social media, and the written word. There was a brief window towards the end of the year when Dr Karl was physically in the Physics Building. The tearoom was suddenly alive again with lecturers and students energised by each other's latest projects and enjoying a rich exchange of ideas. The value of a University community and what it brings to the culture of learning was never more apparent. Dr Karl looks forward to bringing this culture – virtual or not – with his distinct verve into 2022.

# Physics Foundation

## Governance Statement

University Foundations are required to report to Senate. Summarised below is the Governance Statement Section to be reported upon as part of the Annual Report. The Annual Report prepared by a Foundation is to be submitted via the CFO to Finance and Audit Committee of the Senate.

The University of Sydney Physics Foundation recognises the importance and benefit of reviewing its adoption and alignment with governance principles and provides the following report.

### Principle 1 –

#### Lay solid foundations for management and oversight

##### Nature of the entity

The Physics Foundation is a part of the University of Sydney ABN 15211513464 and not separately incorporated under a state or commonwealth Act. The Foundation is required to gain prior approval for its fundraising activities from the appropriate University delegate. The Foundation's activities are not-for-profit and covered by the DGR status of the University of Sydney. The University is exempted from the requirement to hold an Authority to Fundraise and obligations upon holders of such an authority but is still required to comply with the balance of provisions of the Charitable Fundraising Act.

##### Roles of board / council and management

The Foundation operates under the

authority of the Senate of the University of Sydney, as approved in 1954, and has no powers of delegation. The Foundation conducts its affairs pursuant to the Foundation Rules and the relevant policies of the University. The Foundation had its annual fundraising plan approved and was able to meet its objectives.

### Principle 2 –

#### Structure of the council to add value

The Council of the Foundation in 2021 consisted of the following members. They were all eligible to attend three meetings in 2021, as well as the Annual General Meeting.

##### Executive

- President, Mr Michael Winternitz  
Appointment term: 2021 AGM  
Meetings attended: 4
- Deputy President, Mr James Kirby  
Appointment term: 2021 AGM  
Meetings attended: 4

- Professor Iain Young, Dean, University Officer  
Meetings attended: 0

##### Members

- Professor Celine Boehm (Ex-officio Head of School)  
Meetings attended: 4
- Dr Gregory Clark AC FTSE FAA FAPS  
Meetings attended: 0
- Mr Trevor Danos AM FTSE (Observer)  
Meetings attended: 4
- Professor Gemma Figtree FRACP, FCSANZ, FAHA  
Meetings attended: 1
- Professor Gregory McRae (Overseas Member)  
Meetings attended: 4
- Emeritus Professor Anne Green FTSE FRSN FAIP FASA  
Meetings attended: 4

Council members were elected at the Foundation's AGM on 4 March 2021. There is not a separate nomination committee of Council. All terms are annual, with the

exception of the President and Deputy President, who are elected for two years. The full Council resolves on nominations for co-opting of members to fill vacancies outside of the process of election at the AGM. There was no performance evaluation of the Council undertaken in the reporting period.

### **Principle 3 – Promote ethical and responsible decision-making**

Council members have been provided with the University of Sydney Foundation Rules, Code of Conduct, Work Health & Safety policy and the External Interests policy. All these policies are available on the University's Policy Register, as are other relevant University policies regarding harassment, grievance procedures and the Delegations of Authority.

### **Principle 4 – Safeguard integrity in financial reporting**

The annual accounts of the Foundation are prepared by the financial staff of the University, signed off by the Finance Director, Divisions of Natural Sciences, Engineering & Information Technologies and Business, and included in this Annual Report to the Senate. The Foundation is part of the University and therefore does not have its own audit sub-committee. While the Annual Financial Report of the University is audited by the Audit Office of NSW, the Annual Report of the Foundation has not itself been audited.

The Foundation undertook the following fundraising appeals during 2021: Donations.

In conducting those appeals the Foundation took all reasonable steps to ensure that commissions paid or payable to any person as part of a fundraising appeal did not exceed one-third of the gross money obtained by that person in the appeal and appropriate particulars of all items of gross income received or receivable, all items of expenditure incurred, including the application or disposition of any income obtained from the appeal and particulars of those transactions to which they related were recorded in the minutes of the Foundation.

### **Principle 5 – Make timely and balanced disclosure**

The Foundation complied with the reporting and disclosure requirements of the Senate. These include an annual budget and this Annual Report.

Members and Council have been made aware of the processes for disclosure pursuant to the Code of Conduct, External Interests policy, which include protected disclosure to the ICAC, to the Ombudsman or the Auditor General.

### **Principle 6 – Respect the rights of shareholders, members, staff, volunteers, clients, & other stakeholders**

The Foundation Council and/or membership consist of members of the community, industry bodies and the University whose input is invited via the Annual General Meeting and Council meetings of the Foundation. The following forums/mechanisms have been held during the year to involve stakeholders in election of the Council, activities of the Foundation or other stakeholder participation. Invitations are issued to the Annual General Meeting and

two Council meetings per year. Under the Charitable Fundraising Act, the University may be questioned about any appeal on details of the purpose of the appeal such as the appeal target, objectives, distribution of proceeds, and the process to provide answers. During the year the Foundation published information on its website, via email newsletter and outlines those activities in this annual report. Specific requests for information are responded to by the Foundation office. Other enquiries may have been made to other parts of the University.

### **Principle 7 – Recognise and manage risk**

The Foundation recognises its activities within University premises or other premises require risks such as health and safety, environmental protection, privacy, trade practices, and compliance with the Charitable Fundraising Act to be considered and managed. The Foundation has managed these risks during the year by adhering to University policies concerning events, publications and external relations activities.

### **Principle 8 – Remunerate fairly and responsibly**

No member of a Council is entitled to receive any remuneration for acting in that capacity except reasonable remuneration on a basis which has first been approved in writing by the University Officer (Foundations) Members of the Foundation Council may be reimbursed for reasonable expenses after written approval of the University Officer (Foundations). Any such instances are recorded in the minutes of the Council.











For more information  
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