100 YEARS OF ANTARCTIC SCIENCE

# Science at the Shine Dome **2012**

2–4 MAY

NEW FELLOWS | AWARDS | AGM | SYMPOSIUM

Australian Academy of Science

# PROGRAM

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# President's welcome

It is a great honour and pleasure to welcome Fellows of the Australian Academy of Science, sponsors, special guests, teachers, early career researchers, policy makers and other interested observers to our flagship annual event, *Science at the Shine Dome*.

Warm congratulations to the 21 new Fellows who were elected this year. I look forward to officiating at their formal admission to the Fellowship and to hearing them present highlights from their outstanding work in science.

Day two of our 2012 celebration of Australian science will be launched with the Macfarlane Burnet Lecture presented by Professor Ruth Hall FAA. This Lecture and Medal was established in 1971 to commemorate the contributions to science of the late Sir Frank Macfarlane Burnet OM KBE MD FAA FRS, Nobel Laureate, one of Australia's greatest biologists. His experimental work on bacteriophages and animal viruses resulted in major discoveries; he was a pioneer in immunology and a Foundation Fellow and former President of this Academy. This Lecture and Medal is awarded biannually and recognises biological scientists of the highest standing.

Three other medals will be presented to career researchers: the David Craig Medal for research in chemistry, the Mawson Medal in Geology and the Thomas Ranken Lyle Medal in mathematics or physics.

The Academy is committed to supporting young researchers to establish careers in science. Presentations by our nine early career honorific award recipients will be another highlight of our proceedings.

We also welcome the participation of young researchers from around Australia, 12 of whom were generously sponsored by the CSIRO, the Antarctic Climate and Ecosystems Cooperative Research Centre, the South Australian Department of Environment and Natural Resources, Geoscience Australia, Antarctica New Zealand, the University of Otago, the University of Waikato, and the Queensland Department of Environment and Resource Management. In addition we are delighted to host the seven late doctoral and early postdoctoral students whom the Academy is sending to this year's annual meeting of Nobel Laureates in Lindau, Germany.

We gratefully acknowledge the continued involvement of the Australian Science Teachers Association in promoting and judging the Academy's Science Teacher Awards. With the generous support of Professor David Craig FAA, eight science teachers from all states and territories are attending this year's *Science at the Shine Dome*. We also welcome the recipient of the 2011 *Prime Minister's Prize for Excellence in Science Teaching in Secondary Schools* and the national winner of the 2011 *BHP Billiton Science Teacher Award*.

The teachers and young scientists will engage in professional development activities, as well as attending the highlights of the week. We know from experience that they share the enthusiasm of Fellows for science, and this will lead to many mutually rewarding and intellectually stimulating interactions.

Fellow Professor Trevor McDougall and senior principal research scientist at the Australian Antarctic Division Dr Ian Allison have brought together outstanding speakers from diverse fields for this year's Symposium, *100 years of Antarctic science*. As Sir Douglas Mawson – a founding Fellow of this Academy – set out with his team on the historic Australasian expedition to Antarctica in 1911, he remarked that 'almost every observation would be fresh material added to the sum of human knowledge'. That venture opened new and exciting opportunities for scientific exploration and endeavour. Mawson knew that Antarctica and the Southern Ocean are significant influences on Australia's weather. We now know that the region is susceptible to rapid change, and that high latitude processes involving ocean currents, sea ice and the carbon cycle affect the rest of the planet. One hundred years after the Australasian Antarctic Expedition, we present a celebration of a century of Antarctic science, and explore the diverse endeavours that have resulted.

*Science at the Shine Dome* provides a wonderful opportunity to renew old acquaintances and meet new friends while enjoying a program rich in cutting edge Australian science. This year, for the first time, as well as streaming much of our three-day program live on the web, we will be hosting a live interactive concurrent event at the Royal Institution in Adelaide, where the audience will be able to watch Symposium proceedings on a big screen and participate by asking questions through a live video feed. These new initiatives will allow a much larger audience to be part of our flagship event.

I am so pleased you could join us at this, the 58th annual general meeting of the Australian Academy of Science.

**Suzanne Cory AC PresAA FRS**

# **Program** Wednesday 2 May

7.45 – 9.30am Tea and coffee available in the Jaeger room for informal networking

## Formal admission of new Fellows and new Fellows seminar

9.00am **Welcome**
Professor Suzanne Cory AC PresAA FRS
President, Australian Academy of Science

9.05am **Formal admission of new Fellows ceremony**

Professor Michael Alpers
Professor Joss Bland-Hawthorn
Professor Paul Leslie Burn
Professor Francis Robert Carbone
Dr John Church
Professor David Albert Cooper
Professor Patrick De Deckker
Dr Peter Norman Dodds
Professor John Arthur Endler
Professor Timothy Fridtjof Flannery
Professor Michael Edward Goddard
Professor Johannes Thieo Lambers
Professor James McCluskey
Dr Graeme Moad
Professor Tanya Mary Monro
Professor John Edward Norris
Dr Louise Mary Ryan
Professor Frances Separovic
Professor Greg John Stuart
Professor Michael Edmund Tobar
Professor Jane Visvader
Professor Robert Charles Williamson

## New Fellows seminar

**Chairs:** **Professor Peter Hall FAA FRS, Professor Marilyn Renfree FAA FABiol**

### SESSION 1

9.30am **Professor James McCluskey FAA**
Department of Microbiology and Immunology, University of Melbourne
*Genetic control of the immune response*

9.45am **Professor David Albert Cooper AO FAA**
Kirby Institute for Infection and Immunity in Society
*A modern medical miracle: the history of HIV antiretroviral therapy development*

10.00am **Professor Paul Leslie Burn FAA**
Centre for Organic Photonics and Electronics, University of Queensland
*Plastic optoelectronics: using light to detect explosives*

10.15am **Professor Michael Edward Goddard FAA**
School of Land and Environment, University of Melbourne
*Genetic architecture of complex traits and prediction of genetic value*

10.30am **MORNING TEA**

11.00am **Professor Patrick De Deckker AM FAA**
Research School of Earth Sciences, Australian National University
*Palaeo-oceanography: a window into the past behaviour of the oceans in our region*

11.15am **Professor Joss Bland-Hawthorn FAA**
Institute of Photonics and Optical Science, University of Sydney
*Moulding the flow of light: photonics in astronomy*

11.30am **Professor John Arthur Endler FAA**
School of Life and Environmental Sciences, Deakin University
*Through animals' eyes: new insights into sexual selection in Australian bowerbirds*

11.45am **Professor Timothy Fridtjof Flannery FAA**
Environmental Sustainability,
Macquarie University
*Why are we failing to communicate science?*

12.00pm **Professor Johannes Thieo Lambers FAA**
School of Plant Biology, University of Western Australia
*Phosphorus: the disappearing nutrient*

12.15pm **Professor Michael Alpers AO FAA FRS**
Centre for International Health,
Curtin University
*Solving the puzzle of kuru and determining the shape of the kuru epidemic and studying malaria and pneumonia in Papua New Guinea*

12.30pm **LUNCH**

## SESSION 2

1.30pm **Dr Graeme Moad FAA**
Materials Science and Engineering,
CSIRO
*Polymer design and synthesis*

1.45pm **Professor Tanya Mary Monro FAA FTSE**
Institute for Photonics and Advances Sensing, University of Adelaide
*Harnessing light at the nanoscale*

2.00pm **Professor John Edward Norris FAA**
Research School of Astronomy and Astrophysics, Australian National University
*The search for the first stars*

2.15pm **Dr Peter Norman Dodds FAA**
Plant Industry, CSIRO
*Harnessing plant immune receptors for crop protection*

2.30pm **Dr Louise Marie Ryan FAA**
Mathematics, Informatics and Statistics, CSIRO
*Statistics – the science of uncertainty*

2.45pm **Professor Frances Separovic FAA**
School of Chemistry, University of Melbourne
*Breaking the barrier: NMR of membrane-active peptides*

3.00pm **Professor Greg John Stuart FAA**
Neuroscience Department, John Curtin School of Medical Research, Australian National University
*Neuronal computation*

3.15pm **Professor Michael Edmund Tobar FAA FTSE**
School of Physics, University of Western Australia
*Precision electromagnetic measurements with application to terrestrial and space clocks and the quest for a physical theory of everything*

3.30pm **Professor Jane Visvader FAA**
Stem Cells and Cancer Division, Walter and Eliza Hall Institute of Medicine
*Identification of the breast stem cell hierarchy and its implications for cancer*

3.45pm **AFTERNOON TEA**

4.15pm **Professor Robert Charles Williamson FAA**
National ICT Australia, Australian National University
*The scientific study of machine learning*

4.30pm **Dr John Church FAA FTSE**
Marine and Atmospheric Research, CSIRO
*Understanding sea level rise*

4.45pm **Professor Francis Robert Carbone FAA**
Department of Microbiology and Immunology, University of Melbourne
*The generation of immune protection at body surfaces*

5.00pm **CLOSE**
**Professor Suzanne Cory**

6.30 – 9.00pm Informal dinner for teachers and early career researchers
Jaeger Room, the Shine Dome

# New Fellows seminar

## Professor James McCluskey FAA

**Department of Microbiology and Immunology, University of Melbourne**

James McCluskey trained in Perth as a physician and pathologist before working at the National Institutes of Health (USA). Stints at Monash University, Flinders University and the Australian Red Cross Blood Service preceded a Chair in Microbiology and Immunology at the University of Melbourne where he is now Deputy Vice Chancellor Research. He has published more than 250 scientific articles on how genes control immunity. He received the Parr Prize from the Australian Rheumatism Association and the Rose Payne Medal from the American Society for Histocompatibility and Immunogenetics. He is a member of several Boards of Directors of medical research institutes and has consulted for the Australian Red Cross Blood Service for more than 20 years. He is Editor-in-Chief of *Tissue Antigens* and Past President of the Australasian Society for Immunology and International Histocompatibility Workshop Group. He has recently led the development of the Peter Doherty Institute for Infection and Immunity.

### *Genetic control of the immune response*

Human Leucocyte Antigens (HLA) are molecules on the surface of all cells that act as sentinels of host infection. HLA molecules contain a cleft at their surface allowing them to capture short peptides, or protein fragments from microbial pathogens, and carry them to the surface of cells for scrutiny by T lymphocytes. T cells each express individual antigen-specific T cell receptors (TCRs) designed to bind unique HLA-peptide complexes. Peptides that appear foreign to the host T cells are recognised by one or more TCRs, driving activation of T cells so they acquire effector functions that regulate specific immunity. Genetic polymorphism in HLA genes means that HLA molecules vary enormously in their amino acid sequence from one individual to another. This variation changes the peptide-binding cleft of the HLA molecule so that unrelated individuals capture different peptides from the same pathogens when interacting with T cells. This peculiarity explains T cell recognition of foreign tissues such as organ transplants leading to their subsequent rejection. It also explains differential immunity to pathogens by non-HLA identical individuals, variable risk of autoimmune diseases, patterns of allergic responses and HLA-linked drug hypersensitivity. These manifestations of natural genetic polymorphism are part of the physiological distinctiveness of every individual. This presentation will discuss the principles that underpin this phenomenon.

## Professor David Albert Cooper AO FAA

**Kirby Institute for Infection and Immunity in Society**

David Cooper is Director of the Kirby Institute for Infection and Immunity in Society, known until 2011 as the National Centre in HIV Epidemiology and Clinical Research. It was established by the Federal Government in 1986 to conduct research into the HIV/AIDS epidemic, with the ultimate aim of reducing the burden of the HIV/AIDS epidemic for the affected community. He is Director of the St Vincent's Centre for Applied Medical Research, a research facility of St Vincent's and Mater Health Sydney in collaboration with the University of New South Wales. He is also a consultant physician to the HIV/immunology infectious diseases clinical services unit at St Vincent's Hospital, Sydney. He is a past president of the International AIDS Society and Chairman of the World Health Organization-UNAIDS HIV Vaccine Advisory Committee. He is a Director of HIV-NAT, a clinical research and trials collaboration based at the Thai Red Cross AIDS Research Centre at the Chulalongkorn University Hospital in Bangkok. He has been engaged in the development and post-marketing use of every antiretroviral drug ever approved for use in HIV disease.

### *A modern medical miracle: the history of HIV antiretroviral therapy development*

The extraordinary impact of combination ART in ameliorating the HIV/AIDS epidemic cannot be underestimated. This talk will trace the natural history of the development of effective HIV therapies, one of the modern miracles of medicine, which has saved millions of lives around the world. The main benefit of the first effective antiretroviral drug trial, zidovudine (AZT), was to show that where there was one drug, there might be more. Subsequent dual-therapy trials of nucleosides were the dawning of understanding that would lead to combination therapy. After successful trials of triple drug therapy, with the addition of a non-nucleoside reverse transcriptase inhibitor or a protease inhibitor, the widespread introduction of highly active antiretroviral therapy into clinical practice profoundly affected morbidity and mortality. Almost overnight, this combination made antiretroviral therapy for HIV disease one of the most successful and cost-effective interventions of modern pharmaceutical medicine. We then understood that we had a weapon in our hands, but it needed sharpening and refining. Recent years have seen the development of second-generation protease inhibitors and new classes of antiretroviral drugs including integrase inhibitors, fusion inhibitors and an entry inhibitor. The opportunity now arises to re-examine the possibility of HIV eradication with other therapeutic approaches such as therapeutic vaccination or gene therapy.

## Professor Paul Leslie Burn FAA

**Centre for Organic Photonics and Electronics, University of Queensland**

Paul Burn was awarded a First Class Honours degree in 1984 and a PhD in 1989 from the University of Sydney. In 1988 he moved to the University of Cambridge to take up a postdoctoral position and in 1989 he became the Dow Research Fellow at Christ's College Cambridge. In 1992 he took up a University Lectureship at the University of Oxford and became the Helen Martin Fellow in Organic Chemistry at University College (Oxford). In 2006 he was awarded an Australian Research Council Federation Fellowship and in 2007 he moved to the University of Queensland to become the Head of the newly formed Centre of Organic Photonics & Electronics. In 2010 he became a Fellow of the Royal Society of Chemistry (UK), and in 2012 was awarded a University of Queensland Vice Chancellor's Senior Research Fellowship.

### *Plastic optoelectronics: using light to detect explosives*

Detection of explosives can play an important role in combating terrorism and humanitarian de-mining in war-torn countries. Many detection systems used for identifying the presence of explosives are cumbersome or not portable. Luminescent (fluorescent) conjugated polymers have been successfully used in portable detectors where the presence of the analyte is detected by a decrease in the luminescence. We have discovered that light-emitting dendrimers can also be used for effective detection of explosive analytes. Dendrimers are tree-like macromolecules that are comprised of a core, dendrons (branched units), and surface groups, which are found at the distal ends of the dendrons. In this presentation I will briefly describe how explosives can be detected with light and our recent steps in designing dendrimers that can detect explosive analytes rapidly and selectively.

## Professor Michael Edward Goddard FAA

**School of Land and Environment, University of Melbourne**

Since 1998 Michael Goddard has been Professorial Fellow in Animal Genetics at the University of Melbourne, a joint appointment by the University and the Victorian Department of Primary Industries. Previously he was Director of the Animal Genetics and Breeding Unit at the University of New England and a Lecturer in Biometry at the School of Tropical Veterinary Science, James Cook University. His research has been on quantitative genetics and the genetic improvement of livestock. His method of using genome-wide markers to estimate the genetic merit of animals for complex traits has been adopted worldwide by the dairy industry and is being adopted by other livestock and crop industries. Recently he has carried out research in human genetics and shown that common genome-wide markers track about half of the genetic variance for complex traits.

## *Genetic architecture of complex traits and prediction of genetic value*

Complex traits are those controlled by many genes and by environmental factors. They are important in human health (eg obesity), in agriculture (eg yield of wheat) and in natural evolution (eg clutch size in birds). Despite their importance, few of the genes and mutations causing variation in these traits have been identified. However, recently, the use of genome-wide genetic markers has greatly increased our knowledge of these traits. It now appears that thousands of genes cause the normal variation in most complex traits. Nearly all these genes have very small effects which explains why they have been difficult to identify. There are many situations in which it would be useful to be able to predict the genetic value of individuals for complex traits. In agriculture we use prediction of genetic value to select parents of future generations. In human medicine, we use genetic information to predict an individual's risk of a given disease. It is now possible to predict individuals' genetic value from a complex trait from genome-wide genetic markers. The most accurate method for predicting genetic value from markers is a Bayesian method that uses knowledge of the genetic architecture of the trait. The accuracy of the prediction is limited by the proportion of the genetic variance that is tracked by the markers and the accuracy with which marker effects are estimated. In cattle the markers track about 80 per cent of the genetic variance but in humans they track only about 50 per cent.

# Professor Patrick De Deckker AM FAA

**Research School of Earth Sciences, Australian National University**

Patrick De Deckker completed a PhD in the Zoology Department at the University of Adelaide investigating salt lakes, their biota and Quaternary lacustrine deposits, a field he continued to investigate. He obtained a DSc from the same institution, this time from the Department of Geology and Geophysics, for long-term accomplishment in the fields of limnology, palaeolimnology, palaeo-oceanography and micropalaeontology. In 1998, Patrick joined the Australian National University and has held a full time teaching position combined with research ever since. He led the informal Australian Marine Quaternary Program that brought together people working on many aspects of marine science and deep-sea sediment cores. He pioneered the field of Quaternary palaeo-oceanography in Australia and also tried to link environmental changes that occurred both on land and at sea by using a variety of proxies developed with his colleagues and students.

Throughout his career, Patrick's work has always been multidisciplinary in nature with a common aim: to obtain information of relevance for the reconstruction of past marine and continental environments of importance for the understanding of global and regional climatic variability.

## *Palaeo-oceanography: a window into the past behaviour of the oceans in our region*

The oceans cover more than 70 per cent of the planet and play a major role in climate. Hence, we need to know how oceans evolved in the past if we are to better understand past climates and help predict the future.

A search for proxies for determining oceanic conditions and currents in the Australian region focused primarily on microscopic organisms and their remains, which can be recovered in sediment archives deposited on the sea floor. Conditions such as sea-surface temperature, nutrient levels and the structure of the upper part of the water column can be reconstructed using those remains and their chemical composition.

I will document cases where the minute skeletons of calcareous foraminifera and their isotopic composition have been used to determine past oceanic conditions. Other proxies such as the organic composition of much smaller plankton, referred to as nanoplankton, have also been used to reconstruct past sea-surface temperatures.

Several surprises have so far been unveiled, including that a progressive decrease of sea-surface temperatures offshore South Australia commenced some 5000 years ago. Another finding was that the Leeuwin Current, which originates in the tropics offshore Western Australia, was fairly strong during part of the last glacial period at a time when the northern hemisphere registered very cold phases, with armadas of icebergs floating across the North Atlantic. The latter finding tells us that major climatic changes across the globe were asymmetric between the hemispheres. In addition, this indicates that tropical waters north of Australia play a major role in climatic variability.

## Professor Joss Bland-Hawthorn
FAA

**Institute of Photonics and Optical Science, University of Sydney**

Joss Bland-Hawthorn is an Australian Research Council (ARC) Federation Fellow at the University of Sydney. He is also co-founder and Associate Director of the Institute of Photonics and Optical Science. Joss has made major contributions to both astronomy and experimental physics. In 2001, he established the field of astrophotonics in order to investigate the use of photonics in astronomical and space instruments. His astronomical research focuses on how baryons accrete onto evolving galaxies over cosmic time.

Joss has received numerous awards in recent years. In 2008, he received the Muhlmann Award from the Astronomical Society of the Pacific, USA. In 2009, he was a joint recipient of the inaugural Group Award from the Royal Astronomical Society, United Kingdom. In 2010, Joss was the Leverhulme Professor and Senior Fellow at Merton College, Oxford. In 2011, he was elected Fellow of the Optical Society of America, becoming one of only a handful of astronomers to be recognised in this way. In 2012, Joss received the Jackson-Gwilt medal from the Royal Astronomical Society, UK.

### *Moulding the flow of light: photonics in astronomy*

For centuries, astronomers have harvested light from the cosmos with optical telescopes. But the ability to focus the light is only the beginning. Once concentrated, the light must be refocused into a complex instrument made up of optical elements and a detector. After the invention of high performance optical fibres in the 1970s, Australian astronomers realised that these could be used to observe more than one celestial source at a time. These so-called 'multi-object spectrographs' changed the face of observational cosmology. But it took several decades for astronomers to realise the benefits of more sophisticated photonic components: frequency laser combs, fibre Bragg gratings, 2D waveguides, ring resonators, and so on.

The field of astrophotonics emerged in 2001 from thinking about the next generation of telescopes and from new developments in background noise suppression, precision spectroscopy, stellar interferometry and adaptive optics. For example, frequency laser combs are now used to detect orbiting planets around nearby stars. One of the most extraordinary developments is the prospect of building microspectrographs tens of centimetres in size with the equivalent performance of the huge optical instruments on modern day telescopes. We can envisage instruments attached to space-based or ground-based telescopes that are entirely made up of photonic components. The success of these new developments was recognised by a special issue of *Optics Express* (February 2009) and a feature article in *Physics Today* (May 2012). This talk will focus on some recent advances made possible by astrophotonic technologies.

## Professor John Arthur Endler
FAA

**School of Life and Environmental Sciences, Deakin University**

John Endler was born in Montreal Canada, received his PhD from the University of Edinburgh, United Kingdom, and performed postdoctoral research with Professor Robert MacArthur at Princeton University in the USA. He stayed on at Princeton, followed by positions at the University of Utah, James Cook University, and the University of California Santa Barbara, where he spent most of his career. He set up an Animal Behaviour program at the University of Exeter (UK), and moved to Australia's Deakin University as a founding member of the Centre for Integrative Ecology in 2010. He was the Editor of *Evolution* as well as the President of the Society for the Study of Evolution. He is editor of *Evolutionary Ecology* and is on other editorial boards. He is both a Fellow and Exemplar of the Animal Behaviour Society. He is a Fellow of the American Academy of Arts and Sciences. His main interest is in the interaction between ecology, evolution, neuroethology and behaviour.

### *Through animals' eyes: new insights into sexual selection in Australian bowerbirds*

An understanding of how animals sense the world is essential because senses affect all aspects of their lives, and most animals have sensory systems radically different from ours. For example, birds and reptiles have far better colour vision than humans, and we cannot empathise with electroreception or lateral line sensation in fishes, or polarisation vision in arthropods and molluscs. Bowerbird males build and decorate bowers which are used only for attracting mates and mating. Using bird vision physiology principles we find that they choose coloured objects which significantly contrast with their own plumage, their bower and visual backgrounds. We also find that the choice of colours is innovative; the idea of bowerbirds choosing colours which elaborate their own plumage is an artefact of human vision. This also predicts hybridisation and speciation patterns. Great Bowerbirds construct a stick tunnel opening onto two display courts and females watch males from inside the tunnel. The coloured objects on the court are outside the female's field of view until he displays them, increasing signal colour contrast. The courts consist of grey objects which increase in size with distance from the female within the bower avenue, creating forced perspective which gives the illusion of a regular pattern. This pattern regularity could be a direct target of female choice but also generates further illusions with the coloured objects which hold her attention long enough for mating, and illusion quality predicts mating success. Looking at what animals see from their viewpoint yields new insights into their requirements.

## Professor Timothy Fridtjof Flannery FAA

**Environmental Sustainability, Macquarie University**

Tim Flannery has published more than 130 peer-reviewed scientific papers and has named 25 living and 50 fossil mammal species. His 32 books include *The Future Eaters* and *The Weather Makers*, which has been translated into more than 20 languages and won the NSW Premier's Book of the Year award. He has made numerous documentaries and regularly reviews for the *New York Review of Books*. He received a Centenary of Federation Medal and in 2002 delivered the Australia Day address. In 2005 he was named Australian Humanist of the Year, and in 2007 Australian of the Year. In 2011 he was made a Chevalier of the Order of St Charles. In 1998–99 he was a visiting professor at Harvard, and is a founding member of the Wentworth Group of Concerned Scientists, a director of the Australian Wildlife Conservancy, and has served on the International Board of World Wildlife Fund. In 2007 he co-founded and was appointed Chair of the Copenhagen Climate Council, and in 2011 he became Australia's Chief Climate Commissioner. He serves on the Sustainability Advisory Boards of Siemens and Tata Power (India).

### *Why are we failing to communicate science?*

There was a time when many great scientists were also great science communicators: Darwin, Rutherford, Macfarlane Burnet all wrote or spoke for a general audience and became immensely influential. Today there are more scientists than ever, but few are effective communicators. I believe that science is failing to produce effective communicators because scientists and science administrators are failing to reward science communication. Instead, the focus is relentlessly on citation indices and scientific publication. Most of my career was spent in museums, where both research and communication are rewarded. Such career pathways are now closing. Emblematic of the problem is the fact that last year Museum scientists were disqualified from applying for Australian Research Council funding. If they are to be effective communicators scientists need to learn how to write well. They also need to understand how rudimentary the understanding of science can be among even well-educated non specialists. 'Falsification of a hypothesis' can sound awfully like falsification of data to a layman, while graphs and talk of probabilities can mystify and confuse. The public is looking for heroes — leaders who are above politics and financial self-interest. Scientists are ideally suited to filling the need. But they have to put in the effort. A structure of rewards and career progression that explicitly reward communication would do more than anything I can think of to secure the social standing science needs if it is to flourish.

## Professor Johannes Thieo Lambers FAA

**School of Plant Biology, University of Western Australia**

Hans Lambers has an outstanding international reputation and a position of leadership in plant ecophysiology. He has contributed strongly to training of young researchers in Australia and elsewhere. Using integrated physiological, biochemical and ecological

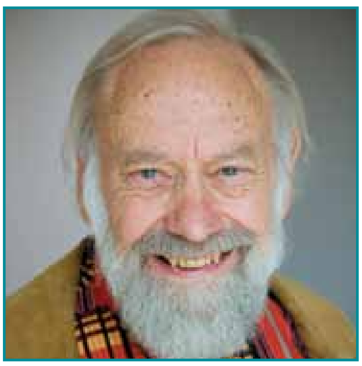
approaches, he has provided novel understanding of causes and consequences of variation in growth rate amongst plant species. His recent focus on the function of specialised roots in mineral nutrition of Australian plants embodies this approach in relation to phosphorus-limited ecosystems. His work has shown why plants evolved different strategies on highly impoverished soils. Whilst focusing on Australian plants, he has broadened this to show its relevance for nutrient-impoverished natural systems as well as agricultural systems globally.

### *Phosphorus: the disappearing nutrient*

Phosphorus fertilisers are vital for global food security. However, as we are reaching 'peak phosphorus', the world is running out of mineable phosphorus reserves, while more are needed to sustain a growing global population. The ancient, phosphorus-impoverished soils in Australia allowed the evolution of plants that are amazingly efficient at acquiring and using phosphorus. In my research group, we explore whether plants that evolved on phosphorus-impoverished soils in Australia can help us develop crops that are less reliant on phosphorus fertilisers. Balancing the phosphorus demand for increased food production with decreasing phosphorus resources can be mitigated by understanding the mechanisms in plants from phosphorus-impoverished soils. This knowledge can then be exploited for future crop plants. We also explore if a high phosphorus efficiency is traded off against a plant's potential to acclimate to different environments, for example drought or extreme temperatures. Both are essential for future crops.

## Professor Michael Alpers AO FAA FRS

**Centre for International Health, Curtin University**



Michael Alpers is John Curtin Distinguished Professor of International Health at Curtin University. A graduate of the Universities of Cambridge and Adelaide in science and medicine, he is a Fellow of the Royal Society and the Third World Academy of Sciences. Since 1961 he has worked on kuru, a disease of the Fore people in the highlands of Papua New Guinea. He spent four years at the National Institutes of Health (USA) and nine years at the University of Western Australia. For 23 years he was Director of the PNG Institute of Medical Research, where he conducted research on major tropical diseases including pneumonia, malaria and filariasis, and built up the national capacity of the Institute. His research has been interdisciplinary and collaborative with participating communities. For supporting health and development in PNG he was made Officer of the Order of Australia and Companion of the PNG Order of the Star of Melanesia.

### *Solving the puzzle of kuru and determining the shape of the kuru epidemic and studying malaria and pneumonia in Papua New Guinea*

Kuru is a fatal neurodegenerative disease that affected only the Fore people and their neighbours in the Eastern Highlands of Papua New Guinea. The Fore first joined the modern world in the 1950s and in 1957 kuru presented a challenging puzzle to medical science. By 1967 it was solved. The solution was achieved through creative integration of biomedical, veterinary, epidemiological, anthropological and experimental investigations conducted principally by non-conforming scientists in an international collaboration. Kuru is caused by an infectious agent transmitted through the mortuary practice of transumption, which had deep religious significance for the Fore but was proscribed by the Australian administration. The incubation period ranges from two to over 50 years; it has taken 50 years since the cessation of transumption for the disease to die out. Kuru is the model human prion disease and its investigation led to our understanding of Creutzfeldt-Jakob disease (CJD), a neurodegenerative disease affecting one per million humans each year throughout the world. The epidemic of bovine spongiform encephalopathy (BSE or mad cow disease) was created in the same way as kuru, through within-species recycling of infective brain. The human form of BSE, variant CJD, is similar to kuru. Surveillance of the waning kuru epidemic has been rigorously maintained for the last 35 years by the PNG Institute of Medical Research, with the active participation of the Fore people. The Institute began in 1968 as a research outpost for Australian science and was almost defunct at PNG Independence in 1975. In 1977 new research programs on the most important diseases of PNG, and the tropics, were initiated. The most innovative – and long-lasting – were studies to understand and control pneumonia and malaria, the major causes, with diarrhoea, of death in children world-wide. These and many other relevant studies were conducted by the Institute in succeeding decades. In the process the capacity of the Institute as a national medical research institution was strengthened and a cadre of PNG scientists was gradually trained. Since then the Institute has made, and continues to make, significant contributions to our knowledge of tropical diseases and the means for their control.

## Dr Graeme Moad FAA

**Materials Science and Engineering, CSIRO**

Graeme Moad was born in Orange, NSW. He obtained his BSc (Hons, First Class) and PhD from Adelaide University in organic free radical chemistry. After undertaking postdoctoral research at Pennsylvania State University (USA), he joined CSIRO in 1979 and is currently a chief research scientist. He is also a project leader within the Cooperative Research Centre for Polymers. Dr Moad is author/co-author of over 150 publications, co-inventor of 33 patent families and co-author of the book *The Chemistry of Radical Polymerization*. His h-index is 52 with more than 12,000 papers citing his work. His research interests lie in the fields of polymer design and synthesis (radical polymerisation, reactive extrusion, polymer nanocomposites) and polymerisation kinetics and mechanism. Dr Moad is a Fellow of the Royal Australian Chemical Institute and has recently been elected as a titular member of the Polymer Division of the International Union of Pure and Applied Chemistry.

### *Polymer design and synthesis*

Polymerisation is a process that comprises linking small molecules (called monomer units) together to form macromolecules or polymers. The key to synthetic polymer chemistry lies in achieving precise control over the number of monomer units in the polymers, their functionality and their arrangement. This enables the design of polymer architectures and predictable properties for a wide range of applications which range from coatings, dispersants, and surfactants to electronics, nanotechnology and medicine. This talk will attempt to show how we have sought to provide this key with the development of RAFT (Reversible Addition Fragmentation chain Transfer) polymerisation.

## Professor Tanya Mary Monro FAA FTSE

**Institute for Photonics and Advances Sensing, University of Adelaide**

Tanya Monro is an Australian Research Council Federation Fellow and Director of the Institute for Photonics and Advanced Sensing, a transdisciplinary research institute at the University of Adelaide. She is a Fellow of the Australian Academy of Technological Sciences and Engineering and a member of the National Committee for Physics. Tanya has been recognised with awards including South Australia's Australian of the Year for 2011 and the Prime Minister's Malcolm McIntosh Prize for Physical Scientist of the Year in 2008. Tanya obtained her PhD at the University of Sydney and was awarded the Bragg Gold Medal for the best Physics PhD in Australia in 1998. In 2000 she received a Royal Society University Research Fellowship at the University of Southampton in the United Kingdom. She came to Adelaide in 2005 as inaugural Chair of Photonics. She has published more than 400 papers and raised more than $70 million for research. Her research focuses on creating disruptive photonic sensing technologies.

### *Harnessing light at the nanoscale*

Advances in photonic materials research and nanofabrication technologies are creating powerful new opportunities for controlling and harnessing light. From this research new insight is emerging into the fundamental behaviour of light at the nanoscale.

A range of recent developments will be described, including the demonstration that nanoparticles embedded within an optical glass can retain their nanoparticulate properties, a discovery that paves the way for a new generation of devices. In the case of diamond nanoparticles, this approach promises practical single photon sources and devices for measuring nanoscale magnetic fields. Micro and nanostructured optical fibres are proving to be powerful new platform technologies for sensing based on the interactions of light and matter, and when combined with techniques from surface chemistry and biotechnology, offer new approaches to making measurements in previously inaccessible environments, whether that be in the vicinity of a cell or within the structure of an aeroplane. A range of new platform technologies enabled by the interface of nanofabrication and biotechnology will be presented, as well as recent developments in ultra-compact lasers and devices for optical data processing. This suite of emerging disruptive technologies promises to offer tools to facilitate rapid decision-making, underpin new research directions in other fields of research and stimulate industry. This illustrates the opportunities we have to harness physics in Australia to enable new science in a broad range of disciplines, empower the creation of new technologies, support industry and drive economic development.

## Professor John Edward Norris FAA

**Research School of Astronomy and Astrophysics, Australian National University**

John Norris is internationally recognised for his observations and analysis of the oldest stars in our galaxy and what they tell us about its formation, the properties of its globular star clusters, and how the first chemical elements were synthesised in the universe. He played a major role in demonstrating that the galaxy was not formed by the monolithic collapse of a much larger protogalactic cloud, but primarily by aggregation of many smaller fragments. He pioneered the discovery that globular clusters are chemically inhomogeneous, with abundance patterns different from those everywhere else in the Galaxy — a result still not fully understood. His searches for the most metal-poor stars contributed to the discovery of objects having only 1/400000 the solar iron abundance, with most also being relatively rich in carbon and oxygen, demonstrating that conditions during the Universe's first few hundred million years differed greatly from those that followed.

### *The search for the first stars*

The discovery and analysis of the most metal-poor and oldest stars lead to insight into conditions when the Universe and Galaxy were young. We present the rationale for studying such objects (which become progressively rarer at lowest chemical abundance), with a description of their systematic discovery. Currently, some 130 stars in the Galaxy's stellar halo are known that have less than only 1/1000 the iron content of the sun, from high-resolution, high-signal/noise spectroscopic analyses, while four of them have less than 1/30000 the solar value. As one proceeds to lowest iron abundance one finds astounding overabundances of some or all of the CNO group and of other light elements relative to iron. While this diversity among the most metal-poor stars has yet to be fully understood, there exist a number of proposed models, which shed light on conditions at the earliest times and the formation of the first stars.

## Dr Peter Norman Dodds FAA

**Plant Industry, CSIRO**

Peter Dodds received a BSc (Hons) in 1991 and a PhD degree in 1996 from the University of Melbourne. After a postdoctoral stint at the USDA/UC Berkeley Plant Gene Expression Center in Albany, California, he returned to Australia as an ARC Postdoctoral Fellow at CSIRO Division of Plant Industry, analysing disease resistance gene evolution and specificity in the flax rust disease system. He now leads a team at Plant Industry focused on understanding rust pathogen biology and host immunity mechanisms and developing genetic tools to improve the control of important rust diseases of wheat. His current research involves the identification of virulence factors from rust fungi and investigation of their role in disease as well as the molecular basis of pathogen recognition by host immune receptors and its implications for host-pathogen co-evolution. He was a recipient of the Australian Society of Plant Scientists Peter Goldacre Award in 2006 and the Academy of Science Fenner Medal in 2007.

### *Harnessing plant immune receptors for crop protection*

Rust fungi cause economically important diseases of cereal crops worldwide and are a particular threat to the Australian wheat industry. We have been studying how the plant immune system can recognise and respond to these pathogens in order to develop novel disease control strategies. Rusts are obligate parasites of plants, and have evolved an intimate cellular association with their hosts. They produce a specialised infection structure called the haustorium which directly penetrates an infected cell and is the main site of nutrient extraction for the fungus. A suite of disease effector proteins are secreted from haustoria and enter the host cells where they may allow the rust to commandeer host cell biology. It is these translocated effector proteins that are recognised by host immune receptors, known as resistance (R) proteins. This recognition is based on direct interactions between the rust effectors and the host R proteins, which leads to induction of a strong defence response that prevents pathogen infection. We are exploring the nature of the recognition and signalling activation process, which offers the opportunity to experimentally engineer new recognition capacities.

## Dr Louise Mary Ryan FAA

**Mathematics, Informatics and Statistics, CSIRO**

After completing her undergraduate degree in statistics and mathematics at Macquarie University, Louise Ryan left Australia in 1979 to pursue her PhD in statistics at Harvard University. In 1983, she took up a postdoctoral fellowship in Biostatistics, jointly between Dana-Farber Cancer Institute and the Harvard School of Public Health. She was promoted to Assistant Professor in 1985, eventually becoming the Henry Pickering Walcott Professor and Chair of the Department of Biostatistics at Harvard. She returned to Australia in early 2009 to take up her current role as Chief of CSIRO's Division of Mathematics, Informatics and Statistics. She is well known for her methodological contributions to statistical methods for cancer and environmental health research, and is a 'people person' who loves the challenge and satisfaction of scientific collaboration.

### *Statistics — the science of uncertainty*

With foundations in areas such as genetics, agriculture and the study of human populations, statistical science is all about finding predictable patterns in the rich and complex world in which we live. In our modern, information-rich times, statistical science is more important than ever in helping to find patterns in large volumes of complex data and in predicting trends that allow for more informed decision-making. However, modern technological advances in computer science and molecular biology are posing a new generation of problems to be solved. Unlike the early pioneers in the field whose tools of trade were pencil and paper, today's statisticians need a sophisticated understanding of modern computational tools. Examples from molecular biology, medical and health sciences will be used to illustrate some cutting-edge challenges and opportunities. In obesity studies, for example, researchers might attach an accelerometer around the waists of study subjects to measure their level of physical activity throughout the day. Although the resulting data are complex and messy, sound statistical thinking can be applied to identify some interesting patterns that can then be used to design intervention studies to encourage children to increase their physical activity. In quite a different setting, data collected through a state health department for administrative purposes was used to study the relationship between social stress and heart disease. Doing so required the development of some new algorithms that overcame some limitations of existing software to handle the large volume of data involved.

## Professor Frances Separovic FAA

**Bio21 Institute, School of Chemistry, University of Melbourne**

Frances Separovic is a biophysical chemist at the Bio21 Institute and Head of the School of Chemistry, University of Melbourne. She grew up in Broken Hill and did a BA at Macquarie and a PhD at the University of NSW while working full-time at CSIRO. After a postdoc at National Institutes of Health (USA), Frances joined the University of Melbourne in 1996. She has been a member of the board of the Royal Australian Chemical Institute, council of the Biophysical Society and International Union of Pure & Applied Biophysics; president of Australian Society for Biophysics; and chair of the Australian New Zealand Society for Magnetic Resonance, ANZMAG. Frances has developed solid-state nuclear magnetic resonance techniques to determine the structure and dynamics of membrane components in situ, specialising in peptide antibiotics and toxins. She was awarded the Robertson Medal for Biophysics in 2009, the ANZMAG Medal in 2011 and elected Fellow of the Biophysical Society (USA) in 2012.

### *Breaking the barrier: NMR of membrane-active peptides*

Most of us have felt the effect of a bee sting — but how does it actually work? The sting contains a peptide toxin, melittin, which kills cells by destroying the cell membrane. Understanding the mechanism by which melittin and other membrane-active peptides disrupt cell membranes may lead to new disease treatments and antibiotics. Modern nuclear magnetic resonance (NMR) techniques enable *in situ* study of the structure and dynamics of membrane molecules and the effects of toxins and antibiotics to be unravelled. Solid-state NMR studies of aligned phospholipid membranes have been used to determine the orientation and location of antimicrobial peptides obtained from Australian tree frogs and amyloid peptides from Alzheimer's disease. Although the detailed structure of these peptides in membranes is difficult to determine as they disrupt the membrane bilayer, their three-dimensional structure and mechanism of action has been elucidated. A range of solid-state NMR techniques was used to determine the conformation and mobility of these membrane-active peptides in order to understand how they exert their biological effect that leads to the disruption of bacterial or neuronal membranes. The effect of the antimicrobial peptides on a variety of model membranes is strongly dependent on the lipid composition of the bilayer and correlates with selectivity for bacterial membranes and antibiotic activity. Likewise, the membrane interactions and structural changes of amyloid peptides from Alzheimer's disease depend on the presence of cholesterol and metal ions, which have been implicated in the disease.

## Professor Greg John Stuart FAA

**Neuroscience Department, John Curtin School of Medical Research, Australian National University**

Greg Stuart is Head of the Eccles Institute of Neuroscience at the John Curtin School of Medical Research. He did his undergraduate studies at Monash University, majoring in physiology, before a PhD in Neuroscience at the Australian National University. After his PhD he worked for five years as a postdoctoral fellow in Heidelberg, Germany, before returning to Australia to establish his own laboratory. His research is focused on understanding the cellular basis of information processing in the brain.

### *Neuronal computation*

The brain is made up of literally billions of interconnected nerve cells, or neurons, which each receive input from thousands of other nerve cells. These inputs are made primarily onto processes called dendrites. Understanding how neuronal dendrites process information is critical to an understanding of how the brain works. In my presentation I will describe some key properties of neuronal dendrites and how they influence information processing in the brain.

## Professor Michael Edmund Tobar FAA FTSE

**School of Physics, University of Western Australia**

Michael Tobar is an ARC Australian Laureate Fellow in the School of Physics at the University of Western Australia. His research interests encompass a broad range of physics and engineering topics including precision measurements; frequency and quantum metrology; and precision tests of fundamental of physics. He also leads Australian involvement in the European Space Agency's Atomic Clock Ensemble in Space mission. Michael was the recipient of two Australian Professorial Fellowship presented by the Australian Research Council in 2003 and in 2008. He was also the recipient of the 2009 Barry Inglis medal presented by the National Measurement Institute, the 2006 Boas medal presented by the Australian Institute of Physics, 1999 Best Paper Award presented by the Institute of Physics, the 1999 European Frequency and Time Forum Young Scientist Award and the 1997 Australian Telecommunications and Electronics Research Board Medal. During 2007 he became a Fellow of the Institute of Electrical and Electronics Engineers and during 2008 of the Australian Academy of Technological Sciences and Engineering.

### *Precision electromagnetic measurements with application to terrestrial and space clocks and the quest for a physical theory of everything*

The Frequency Standards and Metrology research group at the University of Western Australia and international collaborators are world leaders in precision measurement technology and its application to tests of fundamental physics, such as precision tests of Einstein's Equivalence Principle, including Lorentz Invariance, Local Position Invariance and variations in fundamental constants. This includes the necessary development of some of the world's best clocks and devices, including the ultra-precise sapphire clock and interferometer noise measurement systems.

The European Space Agency's Atomic Clock Ensemble in Space (ACES) mission on board the International Space Station is a mission in fundamental physics and technology based on the operation of atomic clocks on the International Space Station. Time scales will be delivered to Earth ground stations by a high performance link, allowing the most accurate world synchronisation of clocks ever achieved. Australia was nominated as a crucial site to maintain data collection on southern transits to offset northern bias. This project will send the first ever laser-cooled atomic clock into space and will usher in a new era of precision timing in space. ACES has the potential to revolutionise global positioning systems, navigation, geodesy and precision tests of physics.

## Professor Jane Visvader FAA

**Stem Cells and Cancer Division, Walter and Eliza Hall Institute of Medicine**

Jane Visvader is Joint Head of the Division of Stem Cells and Cancer and the Breast Cancer Laboratory at The Walter and Eliza Hall Institute of Medical Research. She carried out PhD studies in the Department of Biochemistry at the University of Adelaide, and held subsequent positions as a postdoctoral fellow at the Salk Institute, San Diego, and Research Associate and Instructor at the Children's Hospital/Harvard Medical School, Boston. She was awarded an NHMRC Australia Fellowship in 2011. Visvader serves on the Medical and Scientific Advisory Committee of the Cancer Council Victoria and the Scientific Advisory Council of the National Breast Cancer Foundation. She is a Senior Editor for *Cancer Research* and a member of the Editorial Boards of *Cell Stem Cell*, *Cancer Cell* and *Breast Cancer Research*. Her laboratory focuses on understanding the epithelial hierarchy in normal and cancerous breast tissue, as well as identifying genes important for regulating mammary development.

### *Identification of the breast stem cell hierarchy and its implications for cancer*

Breast cancer is the most common malignancy to affect Australian women and a leading contributor to cancer-related morbidity. Our laboratory is interested in elucidating the normal epithelial cell types within breast tissue in order to identify the 'cells of origin' that give rise to the different subtypes of breast cancer. We have identified and isolated the ancestral breast stem cell, which lies at the apex of the normal tissue hierarchy and can give rise to all breast epithelia. Even a single stem cell was shown to fully reconstitute the breast ductal tree using mouse models. Further studies led to the discovery of daughter cells of stem cells, the so-called luminal progenitors, in both human and mouse breast tissue. Given the decades of evidence linking female hormones to breast cancer risk, we studied the influence of ovarian hormones on stem cells. These cells were found to be exquisitely sensitive to female hormones via signals emitted by adjacent hormone sensor cells. Molecular analyses have indicated novel strategies to switch off stem cells in individuals at high risk of developing breast cancer. Our research has also highlighted molecular signatures that are shared between normal breast epithelial cells and distinct types of breast cancer cells, providing clues on the 'cell of origin' in breast cancer. The luminal progenitor cell was discovered to be the culprit that gives rise to breast cancer arising in *BRCA1* mutation carriers who are prone to developing clinically aggressive breast cancer. This work has led to the identification of new therapeutic targets, currently being tested in pre-clinical models.

## Professor Robert Charles Williamson FAA

**National ICT Australia and Australian National University**

Robert C Williamson is a professor in the Research School of Computer Science at the Australian National University and leader of the Machine Learning Group at National ICT Australia (NICTA). He received a Bachelor of Engineering (Electrical) from Queensland Institute of Technology and a Master of Engineering Science and PhD from the University of Queensland. He played a substantial role in the creation of NICTA, contributing to the original proposal, and serving as founding Canberra Laboratory Director and subsequently Scientific Director. His initial interest in signal processing was sparked by amateur radio in high school and he has done work on frequency estimation and microphone arrays. His primary scientific interest is machine learning where he focuses on the development of improved theoretical understanding of machine learning problems.

### *The scientific study of machine learning*

It is now a commonplace observation that data is pervasive and ever growing, and there are consequently increasing demands to make sense of it. Machine learning is technology designed to make sense of data. I will introduce the idea of machine learning and explain what is actually meant by a machine that learns. I will then discuss three core scientific questions that arise in the study of machine learning: data representation, capacity control, and problem categorisation. Data representation involves the development of new methods of representing complex data in a manner that allows the application of powerful mathematical techniques to extract meaning from data. The more powerful a representation, the more likely a machine will be misled by random disturbances. This problem is as old as classical mathematical statistics, but is more complex in the field of machine learning simply because of the complexity of the problems considered. I will explain how researchers address capacity control and give some intuition concerning how it is related to the representation by analogy with the information theory (which considers analogous questions in the design of telecommunication systems). Finally I will outline my current research agenda on problem categorisation which aims to modularise the field of machine learning more effectively in order to enhance its applicability. This entails relating different machine learning problems in a manner analogous to how functional analysis in mathematics studies transformations and relations between functions, rather than just the functions themselves.

## Dr John Church FAA FTSE

**Marine and Atmospheric Research, CSIRO**

John Church is a CSIRO Fellow with the Centre for Australian Weather and Climate Research. His area of expertise is the role of the ocean in climate. He has been a Principal Investigator on NASA/ Centre National d'Etudes Spatiales (CNES) Science Working Teams since 1987. He was co-convening lead author for the Chapter on Sea Level in the Intergovernmental Panel on Climate Change's Third Assessment Report and (currently) the Fifth Assessment Report. He co-chaired the international Scientific Steering Group for the World Ocean Circulation Experiment from 1994 to 1998 and chaired the Joint Scientific Committee of the World Climate Research Program from 2006 to 2008. He was awarded the 2006 Roger Revelle Medal by the Intergovernmental Oceanographic Commission, was a winner of a CSIRO Medal for Research Achievement in 2006, won the 2007 Eureka Prize for Scientific Research and presented the 2008 Australian Meteorological and Oceanographic Society's RH Clarke Lecture. He is a Fellow of the Australian Academy of Technological Sciences and Engineering.

### *Understanding sea level rise*

Sea level is a high profile issue that is an integral component of anthropogenic climate change. Improving projections of sea-level variability and change requires engagement from many disciplines and from the observational, theoretical and modelling communities.

Palaeodata indicates that at the time of the last interglacial, sea level was more than six metres higher than current data sea level. Both palaeo and instrumental data indicate the rate of sea-level rise has increased significantly since the mid-19th century. In situ and satellite data indicate the rate of rise since 1993 is not significantly larger than rates over comparable length periods since 1880. An adequate quantitative explanation for the observed 20th century rise has been elusive. Recent progress indicates that ocean thermal expansion and the contribution from glaciers explain about 80 per cent of the observed rise since the early 1970s. While still controversial, observations indicate contributions from the Greenland and Antarctic ice sheets have increased over the last two decades.

Projections of the regional distribution of sea-level change need to include changes in ocean steric sea levels, changes in vertical land motion resulting from changes in historical ice sheet distributions and modern day changes in the Earth's gravitational field land motion from the changing mass distribution of water. On millennial time scales, there are potentially irreversible commitments to sea-level rise and thresholds for the future viability of the ice sheets.

## Professor Francis Robert Carbone FAA

**Department of Microbiology and Immunology, University of Melbourne**

Frances Carbone received his PhD in Biochemistry from the University of Melbourne, and took up a postdoctoral appointment in the laboratory of Professor Michael Bevan at the Scripps Research Institute in California. There he worked on the mechanism by which the immune system recognises virus-infected cells and was ultimately appointed to the Faculty as an Assistant Professor. He returned to Australia to take up a position as a Senior Lecturer at Monash University and began a long-standing collaboration with Professor William Heath identifying cells involved in immune initiation. He is now an NHMRC Australia Fellow in the Department of Microbiology and Immunology at the University of Melbourne involved in research on infection and immunity, specifically the mechanisms that can provide protective immunity at the body surfaces such as skin.

### *The generation of immune protection at body surfaces*

Once exposed to a pathogen, the body develops immunity to subsequent exposure to the same infectious agent. Much of this immunity relies on the production of antibodies specific for the pathogen, which can neutralise its infectivity. Most vaccines operate by successfully inducing neutralising antibodies against the pathogen, and most infections where there is no effective vaccine are those where antibodies are poorly protective. Separate to the antibody response, the immune system has a series of white blood cells that recognise and kill infected cells and in so doing, eliminate pathogens from the infected individual. These are known as killer T lymphocytes and they represent a potential means of providing effective immunity in situations where antibodies fail or afford only suboptimal protection against infection. Our laboratory has been developing approaches by which killer T lymphocytes can be embedded within the outer layers of the skin and other organs. By doing this, we can generate a barrier against infection at the very surfaces that form the most common entry points of infection.

# **Program** Thursday 3 May

8.00 – 9.00am Tea and coffee available in the Jaeger room

## Awards

9.00am **President's address**
Professor Suzanne Cory AC PresAA FRS
President, Australian Academy of Science

9.30am – 5.00pm **Engaging students in science**
*Interactive workshop for teachers*
Meeting room, Ian Potter House

## Macfarlane Burnet Medal and Lecture

9.20am **Macfarlane Burnet Medal Lecture**
Professor Ruth Hall FAA
University of Sydney
*Acquired antibiotic resistance in bacteria*

## Honorific awards

9.40am **Career honorific awards**

2012 DAVID CRAIG MEDAL
Professor Maxwell Crossley FAA
University of Sydney
*Application of porphyrin-based research to construct artificial photosynthetic reaction centres*

2012 MAWSON MEDAL
Professor Gordon Lister
Australian National University
*Killer megathrusts and great earthquakes*

2011 THOMAS RANKEN LYLE MEDAL
Professor James Williams FAA
Australian National University
*Applying a little pressure can have unforeseen consequences*

10.50am **MORNING TEA**

11.20am **Early career honorific awards**

2012 FENNER MEDAL
Professor Harvey Millar
University of Western Australia
*The leaves are breathing: what plant respiration can teach us about ourselves and tomorrow*

2012 RUTH STEPHENS GANI MEDAL
Dr Manuel Ferreira
Queensland Institution of Medical Research
*Back to humans: how genetic research can point to new drug targets for asthma*

2012 GOTTSCHALK MEDAL
Professor Katharina Gaus
University of New South Wales
*Molecular microscopy: shedding light on the regulatory mechanisms of T cell signalling*

2012 ANTON HALES MEDAL
Dr Todd Lane
The University of Melbourne
*Thunderstorms, waves and turbulence*

2010 ANTON HALES MEDAL
Professor David White
University of Western Australia
*The geotechnical design of safe seabed pipelines*

2012 CHRISTOPHER HEYDE MEDAL
Dr Josef Dick
University of New South Wales
*Numerical simulation and computation*

2012 DOROTHY HILL AWARD
Dr Karen Black
University of New South Wales
*Herds overhead: heavyweight marsupial herbivores in the Miocene forests of Australia*

2012 FREDERICK WHITE PRIZE
Dr Andrew Hogg
Australian National University
*Surprises in the Southern Ocean*

2012 PAWSEY MEDAL
Professor Tanya Monro FAA
University of Adelaide
*Interacting light with matter: new tools for sensing*

1.30pm **LUNCH**

2.00pm – 5.00pm **Early career researcher workshops**

- *Media and communicating science*
  Becker Room, Shine Dome
- *Successful scientific collaborations*
  Upstairs board room, Ian Potter House
- *Grant writing – Getting your research ideas funded*
  Meeting room, Ian Potter House

2.15pm – 5.00pm **Social program**
*Traversing Antarctica: the Australian experience*
National Archives of Australia

2.30pm – 5.00pm **Annual General Meeting**
(closed session for Fellows of the Academy)

6.40pm **Buses leave** from University House and Diamant Hotel for Australian National Gallery

7.00pm **Annual dinner**
(Pre-dinner drinks at 7.00pm, dinner at 7.30pm)
Venue: Gandel Hall, National Gallery of Australia
Presentation of Career Award Medals
Dress code: Black tie/cocktail
Guest speaker: Professor Tom Griffiths FAHA

# 2012 Macfarlane Burnet Medal and Lecture for research in the biological sciences

***Recognises scientific research of the highest standing in the biological science and commemorates the contributions to science by Sir Macfarlane Burnet* OM KBE MD FAA FRS Nobel Laureate.**

## Professor Ruth Hall FAA

**School of Molecular Bioscience, University of Sydney**

Ruth Hall is internationally known for her work on the dissemination of antibiotic resistance genes in Gram negative bacteria. Her research has provided significant insights into the ways in which bacteria acquire new genetic information. Her best known work predicted and proved the mechanism used by the novel integron-gene cassette system for gene dissemination that was discovered in her laboratory.

She has received awards in Australia and in the USA for this work. She graduated from the University of Sydney, then undertook a PhD in bacterial genetics at the University of Edinburgh in a department that was the first in the world to be named Molecular Biology. Her work on the integron-gene cassette system was undertaken at the CSIRO. She currently continues her work on antibiotic resistance at the University of Sydney.

### *Acquired antibiotic resistance in bacteria*

The use of antibiotics to treat bacterial infections has resulted in a bacterial evolution experiment that has already run for more than 50 years. Under this selective pressure both commensal and disease-causing bacteria have become resistant to one antibiotic after another, rendering antibiotics less useful. However, this experiment has also provided many insights into how bacteria evolve.

In contrast to eukaryotes, including humans, bacteria don't just change via mutation but also readily increase the genetic information they carry by acquiring additional DNA, hence acquiring the ability to do new things. This is facilitated by specialised mobile genetic elements including plasmids and integrating elements which can move between cells, transposons, integrons and gene cassettes, and CR elements, which can move resistance genes from one DNA location to another. My lab uncovered two of these mechanisms for moving antibiotic resistance genes. We have studied how integrons capture antibiotic resistance genes in small gene cassettes using site-specific recombination machinery. We have also identified and studied CR elements which mobilise resistance genes that are adjacent to them.

Acquisition of new genes via these mechanisms can also contribute to adaptation to other pressures such as the presence of toxic chemicals. Consequently, the study of mobile elements has greatly enhanced our understanding of how bacteria adapt to changing circumstances and generate the enormous diversity that can be found in a single bacterial species like *Escherichia coli*.

# Honorific awards

## 2012 David Craig Medal for research in chemistry

Recognises the outstanding contribution to chemical research of Emeritus Professor David Craig AC FAA FRS. Its purpose is to recognise contributions of a high order to any branch of chemistry by active researchers. The awardee will present public lectures in cities across Australia.

### Professor Maxwell Crossley FAA

**University of Sydney**

Max Crossley is Professor of Chemistry (Organic Chemistry) and University Professorial Fellow in the School of Chemistry, at the University of Sydney. He graduated from the University of Melbourne with a BSc and PhD (1976). He held postdoctoral appointments at the Research Institute for Medicine and Chemistry in Cambridge Massachusetts and Oxford University, and a research associate position at MIT. He joined the University of Sydney in 1980. Over the years he has received a number of honours and awards – these include the 1998 Birch Medal and 2001 HG Smith Memorial Medal of the Royal Australian Chemical Institute and, most recently, the 2012 Robert Burns Woodward Award, the senior award of the International Society for Porphyrins and Phthalocyanines. He has been very active in establishing international research links, especially with Chinese and Japanese scientists. His primary research interests lie in the area of porphyrin chemistry and functional organic materials.

#### *Application of porphyrin-based research to construct artificial photosynthetic reaction centres*

Porphyrins are a class of compounds of great importance to life and for which many new uses are emerging in nanosciences. Haem, the red coloured oxygen-carrier in blood, and chlorophylls, green pigments responsible for photosynthesis in plants, are important porphyrins. In our research we design and construct new functional porphyrin systems for use in solar energy devices, in mimicry of photosynthesis, in the burgeoning field of molecular-scale electronics, and in development of porphyrin-based antibiotics.

Over the past 30 years, a number of advances that allow efficient functionalisation of the porphyrin outer periphery have been developed in our laboratory. These advances enable modulation of properties and control of frontier orbital ordering of porphyrins, expansion of the porphyrin pi-system, and allow porphyrin arrays to be assembled by selective linkage reactions. As a result, the chromophore, redox and photophysical properties of the porphyrins can be modified in useful ways.

In this Award Lecture some of these contributions to porphyrin-based research are illustrated by the synthesis of the closest distance, orientation, redox gradient, and photophysical model compound yet prepared to mimic the charge-separation apparatus of natural photosynthetic reaction centres.

## 2012 Mawson Medal for research into geology

Recognises outstanding contributions to Earth science in Australia and commemorates the work of the late Sir Douglas Mawson FAA FRS, geologist and Antarctic explorer. The Mawson Lecture will be delivered at the Congress of the Geological Society of Australia.

### Professor Gordon Lister

**Australian National University**

Gordon Stuart Lister was born in Brisbane on 21 September 1948. Some months later he escaped north to the tropical rainforests around Cairns where he learned essential skills denied most other Australians. He was one of the first two Honours students at James Cook University, in 1969. He then migrated south to do a PhD in Geophysics at ANU, and was awarded the Crawford Medal in 1975. His time at ANU served to develop a rigour and a physical science based approach to geology that shaped his future career. His career has spanned three continents. Professor Lister is a Carey Medallist, a Fellow of the Geological Society of America, a Life Member of the American Geophysical Union, an ISI Highly Cited Author, and an Associate Editor for the *Journal of Geophysical Research*.

### *Killer megathrusts and great earthquakes*

An enormous amount of energy is released in a 'killer megathrust' earthquake such as the Mw 9.1 2011 Tohoku-Oki Earthquake. Yet megathrusts are rarely mentioned when disaster strikes. Strangely it is the 'ring of fire' that routinely attracts media attention. Nevertheless, geoscience continues to improve its ability to forecast which megathrust segments are frictionally locked and tectonically loaded to the point of imminent failure. The problem with monitoring the vast areal extent of killer megathrusts is whether instruments are capable and if they are in the right location. This is where a detailed understanding of the nature of the structures deep in the lithosphere surrounding a megathrust is vitally important. The ideal locations for instruments can be determined through understanding the dynamics of loading, and how load-bearing structures interact. Earthquakes result from catastrophic reduction in the load-bearing capacity of stressed mechanical structures. Post-mortem they can be examined in the same way as an engineer would analyse failure and collapse of a major bridge, dam, or even a large building. Key to such forensic analysis is knowledge as to the details of the 3D geometry, and how load would be distributed and/or redistributed as a consequence of partial or complete failure of individual load-bearing components. Here we show that thick slices of the surface layers of the lithosphere may slump and detach during subduction. Accelerating subsidence on the outer rise has thus the potential to forecast catastrophe, if only instruments were located in such zones.

# 2011 Thomas Ranken Lyle Medal for research into mathematics or physics

Commemorates the contribution of Sir Thomas Ranken Lyle FRS to Australian science and industry generally and in particular to his own fields of physics and mathematics. The medal recognises outstanding achievement by a scientist in Australia for research in mathematics or physics.

## Professor James Williams FAA

**Australian National University**

James Williams obtained his PhD from the University of NSW in 1973 and spent several years in Europe and the US (including Bell Telephone Laboratories) before returning to Australia in the late 1970s. He was Director of a Centre of Excellence at RMIT from 1982 before joining ANU as the Founding Professor of the Department of Electronic Materials in 1988. He is currently the Director of the Research School of Physics and Engineering at ANU. His research is in the broad field of condensed matter physics with a focus on semiconductors and applications. He has published more than 450 journal papers, has served on the editorial board of more than 10 international journals, delivered more than 90 plenary presentations at international meetings, is an elected Fellow of 7 national academies or professional societies, has trained more than 80 graduate students and young research staff, and has founded two spin-off companies.

### *Applying a little pressure can have unforeseen consequences*

It is well known that carbon possesses a number of allotropes such as diamond and graphite that have distinctly different structures and properties. The fact that silicon also has up to 13 allotropes with distinctly different structures is not as well known, probably since they are only accessible by the application of considerable pressure. It is the diamond cubic form of silicon, the only truly stable phase, that exhibits the attractive suite of properties that have driven the current functionality of the silicon chip. However, it has recently been shown that at ambient temperatures and pressure there are up to four other phases of silicon that are metastable. This presentation outlines research from the ANU group over the past 15 years that has provided the basis for understanding the transformation processes that lead to these phases, their stability and in some cases their unusual properties. For example, we have shown that one of these metastable phases, so called Si-XII, is a semiconductor with properties that are totally different to those of conventional diamond cubic silicon, but no less attractive for applications.

## 2012 Fenner medal for research in biology

Commemorates outstanding contributions to science by the late Professor Frank Fenner AC CMG MBE MD FAA FRS. It recognises distinguished research in biology, excluding the biomedical sciences.

### Professor Harvey Millar

**University of Western Australia**

Harvey Millar completed his PhD at the Australian National University in plant biochemistry, before taking up a Human Frontier Science Program fellowship at the University of Oxford. In 1999 he moved to the University of Western Australia where he has been supported by a series of ARC Fellowships to establish research on energy production in plants and how the process of respiration is affected by harsh climates. His laboratory's work has showcased the value of proteomics in studying plant mitochondria, the organelles that perform respiration in cells. He has shown how respiration can be protected during environmental stress, how production of vitamin C is controlled by respiration in plants, how mitochondria signal the nucleus about energy status and pathogen attack, and how the links between respiration and plant growth can alter plant performance. His laboratory's discoveries contribute to our understanding of respiratory damage in cell ageing and disease, a topic that bridges the divide between kingdoms and is relevant to both plants and animals.

#### *The leaves are breathing: what plant respiration can teach us about ourselves and tomorrow*

Respiration is a fundamental process in living tissues to efficiently extract energy from sugar by combustion using $O_2$ to make $CO_2$ and water. Respiration transfers much of the energy to the cellular currency of ATP rather than just releasing the energy as heat. We inhale $O_2$ and exhale $CO_2$, however the chemistry does not happen in our lungs but in cellular organelles called mitochondria throughout our bodies. At the same time as James Cook was discovering Botany Bay, researchers were discovering the chemistry of this process in animal cells. Remarkably, at the same time the very same researchers reported a similar process was happening in plants. Leaves were breathing. It has taken nearly 250 years of research (including several periods when the whole topic was refuted by the leading scientists of the day) to unravel that this plant respiration is one of the largest biochemical processes on the planet. Plant respiration dwarfs our daily release of $CO_2$ from fossil fuels. Studying respiration in plants tells us about mitochondria that are more complex than our own, that have ingenious methods to adapt to the environment, but that share many of the same frailties of our own cells during stress and disease. Mastering respiration in plants could help us in our quest to build the tomorrow we would prefer as we seek to better harness the plant energy economy for all it's worth. We now know money does not grow in banks, so it is probably time to accept that it might just grow on trees after all.

## 2012 Ruth Stephens Gani Medal for research in human genetics

Recognises distinguished research in human genetics, including clinical, molecular, population and epidemiological genetics and cytogenetics. It honours the contributions to science in human cytogenetics by the late Ruth Stephens Gani.

### Dr Manuel Ferreira

**Queensland Institute of Medical Research**

Manuel Ferreira graduated in Biology from the University of Lisbon (Portugal) and University of Oxford (UK) in 2001. He then moved to the Queensland Institute of Medical Research (QIMR, Brisbane) where he completed a PhD in Human Genetics. This was followed by a postdoc at Harvard University (2006–08) funded by an NHMRC Sidney Sax Fellowship. After returning to QIMR in 2008, Dr Ferreira established the Australian Asthma Genetics Consortium, a collaborative project that aims to improve asthma management through breakthrough genetic research. In the last five years he published 38 papers, of which 18 were in influential journals including *Lancet*, *New England Journal of Medicine*, *Nature*, *Nature Genetics* and *American Journal of Human Genetics*. Dr Ferreira is currently a Senior Research Fellow at QIMR and holds a Career Development Fellowship from the NHMRC.

#### *Back to humans: how genetic research can point to new drug targets for asthma*

Despite many decades of research, no major effective new treatments for asthma have emerged recently.

This may be a testament to the complex pathophysiology of the disease, but also reflects the nature of the studies conducted to dissect its aetiology. The majority of these have been hypothesis-driven, in that they have focused on particular cellular and molecular aspects of the immune and inflammatory mechanisms thought to underpin the disease. These have led to a substantial increase in our understanding of such mechanisms but, we would argue, have not led to major paradigm shifts in asthma aetiology since the implication of Th2 immunity in allergic disease in 1992. In 2006, after substantial technological and analytical progress, large-scale hypothesis-free genetic studies became feasible in humans. If conducted in large samples, these were expected to provide the most powerful approach to identify genes whose expression contributes to disease risk. This expectation has already been met, with 15 genes with strong and replicated associations with asthma identified in the last five years. These include the interleukin-6 receptor gene, which we identified recently through the Australian Asthma Genetics Consortium. This gene has a more active version and a less active version. The more active version is more commonly found in asthmatics and contributes to inflammation. These findings suggest that a drug that reduces the activity of this gene – currently used to treat rheumatoid arthritis – may be effective in asthma. This hypothesis will now be tested in a phase 2 clinical trial.

## 2012 Gottschalk Medal for research in the medical sciences

The Gottschalk medal honours the contributions to science by the late Dr A Gottschalk FAA. It recognises outstanding research in the medical sciences by scientists who are no more than 40 years of age.

### Professor Katharina Gaus

**University of New South Wales**

Katharina Gaus is an NHMRC Senior Research Fellow and leads the Cell Membrane Biology group at the Centre for Vascular Research, University of New South Wales. The main objective of her research is to identify the organisation of the cell membrane in T lymphocyte signalling and other signal transduction processes. Her team uses novel fluorescence microscopy approaches to define the molecular mechanisms that regulate the temporal and spatial organisation of cell signalling, with a special focus on lipids and the contribution of membrane lipids in regulating signalling proteins. Born in Germany, Katharina studied physics at the Ruprecht-Karls-University of Heidelberg and received her PhD in biology in 1999 from the University of Cambridge. After postdoctoral fellowships from Germany and the ARC, she was awarded a Career Development Award from the NHMRC and established the Cell Membrane Biology group in 2005.

#### *Molecular microscopy: shedding light on the regulatory mechanisms of T cell signalling*

An essential step in the adaptive immune response is the activation of T lymphocytes by antigenic peptide. T cell activation begins with the formation of signalling complexes at the cell surface involving the T cell antigen receptor (TCR) and other signalling proteins, triggering a complex signalling cascade that involves tens, if not hundreds of different proteins. Most signalling proteins participate in many signal transduction processes and are not specific to a single receptor. It is therefore thought that it is the organisation of signalling molecules in time and space that determines signalling outcome in health and disease. But how do signalling molecules 'know' how to organise themselves?

Light microscopy has been a wonderful tool for studying cell signalling but its resolution is limited due to the diffraction of light. Recently, this limitation was overcome and we have now established so-called super-resolution fluorescence microscopy that allows us to image individual proteins in intact and live cells. We can therefore precisely map the localisation of each signalling protein in time and space. In particular, it allows us to see what effect lipids have on signalling proteins, providing new insights about how proteins and lipids must cooperate so that signalling molecules are at the right place at the right time. We are currently extending our work on dietary lipids to find an explanation of why immune function is compromised in obese people.

## 2012 Anton Hales Medal for research in Earth sciences

Recognises research in the Earth sciences and honours contributions to Earth sciences by the late Professor Anton L Hales FAA. Professor Hales was the founding director of the Research School of Earth Sciences at the Australian National University.

## Dr Todd Lane

**University of Melbourne**

Todd Lane received his PhD in Applied Mathematics and Meteorology from Monash University in 2000. Shortly thereafter he joined the National Center for Atmospheric Research in Colorado, USA, first as a postdoctoral fellow and then as a tenure-track research scientist. Dr Lane has been a member of academic staff in the School of Earth Sciences at the University of Melbourne since 2005, where he leads a research group focused on mesoscale meteorology and high-resolution atmospheric modelling. His current projects are examining thunderstorm dynamics, atmospheric waves, turbulence, precipitation processes, tropical convective clouds, and fire weather. Dr Lane is currently an ARC Future Fellow and a Chief Investigator of the ARC's Centre of Excellence for Climate System Science.

### *Thunderstorms, waves and turbulence*

Thunderstorms are prevalent around the globe and contribute to many forms of severe weather. Although their size and intensity vary with geographic location, all thunderstorms feature similar characteristics including strong upward and downward motions driven by microphysical processes within the cloudy air. As well as their local weather effects, thunderstorms drive atmospheric circulations on a variety of scales and are crucial contributors to the heat, momentum, and radiation budgets of the climate system. Unfortunately, the spatial and temporal scales of thunderstorms make them difficult to represent in current computer models of weather prediction and climate. Nonetheless, recent advances in computing power have meant that research models can provide incredibly realistic simulation of cloud processes, which has facilitated important improvements in our understanding of the way thunderstorms behave.

One important aspect of thunderstorm dynamics is the role of atmospheric waves, which communicate the effects of thunderstorms to the surrounding atmosphere. The waves propagate horizontally and vertically away from the clouds and can influence the atmosphere hundreds of kilometres away from their original source. Similar to water waves, these waves can break and recent research has demonstrated that this wave breaking contributes to the formation of turbulence in the upper atmosphere. Among other things, turbulence is a hazard to aviation. In this presentation I will outline recent advances in our understanding of wave generation by thunderstorms and provide examples of the importance of these waves for aircraft turbulence.

# 2010 Anton Hales Medal for research in Earth sciences

## Professor David White

**University of Western Australia**

David White is a geotechnical engineer, and an ARC Future Fellow at the Centre for Offshore Foundation Systems in the University of Western Australia. His research is concerned with the behaviour of the seabed, and its interaction with the ocean and infrastructure such as pipelines, foundations and anchors. He has pioneered new techniques of physical modelling at UWA's National Geotechnical Centrifuge Facility and the new Large O-tube flume at UWA. He was awarded his PhD in 2002 from Cambridge University where he held a Lectureship until 2007 before moving to UWA. He has authored more than 160 technical papers, five of which have won awards. He was Western Australia's 2011 Early Career Scientist of the Year and won the 2011 WA Tall Poppy Science Award. His solutions for assessing pipeline-seabed interaction are widely used in practice and he acts as a consultant to industry through the Perth-based firm, Advanced Geomechanics.

### *The geotechnical design of safe seabed pipelines*

Australia's network of seabed pipelines is a vital lifeline for our oil and gas industry. This network is rapidly expanding into deeper waters located further from shore, as new fields are developed. Pipelines are subjected to various unwanted loads during their operating life, as they heat up and cool down and as cyclones pass over them. In this presentation, two critical design issues are highlighted, and new solutions emerging from recent research are described.

The first design issue is thermal loading, which tends to cause buckling. Efficient designs work with the pipeline, rather than against it, allowing gentle buckling at controlled intervals. Reliable buckle modelling relies on accurate estimates of the pipeline-seabed resistance. New techniques for assessing this resistance account for the changing topography and strength of the disturbed sediment. Physical modelling using a geotechnical centrifuge has inspired these new techniques, supported by complementary numerical simulations.

A second critical design situation is the stability of a pipeline during a cyclone. Historically, designers consider separately the ocean-pipeline and pipeline-seabed interactions, ensuring that the resistance from the latter exceeds the loading from the former. However, the seabed itself can become unstable before the cyclone can dislodge the pipeline. Observations from UWA's new Large O-tube flume – a recirculating tunnel filled with 50 tonnes of water — are being used to validate new models for the tripartite ocean-pipeline-seabed interaction. In some cases, pipelines 'self-bury' beneath a protective layer of sediment. By accounting for this benefit, expensive stabilisation measures can be avoided.

## 2012 Christopher Heyde Medal for research in mathematics

Honours the contributions to mathematics by Professor Christopher Charles Heyde AM FAA FASSA. In recognition of Professor Heyde's broad interest in the mathematical sciences the award is offered in one of three fields on a rotating basis – pure mathematics; applied, computational and financial mathematics; and probability theory, statistical methodology and their applications. The 2012 Christopher Heyde Medal is for research in applied, computational and financial mathematics.

### Dr Josef Dick

**University of New South Wales**

Josef Dick is a Queen Elizabeth II Fellow of the ARC and a Senior Lecturer at the University of New South Wales. He received his PhD from the University of New South Wales in 2004 under the supervision of Professor Ian Sloan and has held various postdoctoral positions in Australia and overseas. In 2004 he was co-winner of the Information-based-complexity Young Research Award, was co-winner of the Journal of Complexity Best Paper Award in 2005 and was plenary speaker at the main conference in his research area in 2008. His main scientific contributions are in the area of numerical analysis and computational mathematics. In particular he worked on quasi-Monte Carlo methods, information-based-complexity and discrepancy theory. Jointly with Professor Friedrich Pillichshammer he wrote a book on this topic published by Cambridge University Press in 2010.

#### *Numerical simulation and computation*

Computational methods play an increasingly important role in the applied sciences, for instance, for analysing data, numerical simulation and numerical solutions to complex problems. A staple tool for computational problems is the Monte Carlo method, which simulates complex systems using random inputs. This method, however, has limitations, in terms of the scope of problems to which it can be applied and the time it requires to obtain the desired results. Hence to achieve progress one often needs sophisticated algorithms. In this talk I shall outline some of my work on numerical methods using quasi-Monte Carlo methods (a deterministic version of the Monte Carlo method), some of the scientific challenges one faces in this context and how mathematics can help to solve them.

## 2012 Dorothy Hill Award for research in the Earth sciences

Recognises research by women in the Earth sciences including reef science, ocean drilling, marine science and taxonomy, and honours the contribution to the field of Earth science by the late Professor Dorothy Hill FAA as well as her work in opening up tertiary science education to women.

### Dr Karen Black

**University of New South Wales**

Karen Black is a vertebrate palaeontologist in the School of Biological, Earth and Environmental Sciences at the University of New South Wales. She has developed an international research profile in marsupial evolution, taxonomy, morphology, phylogeny, ontogeny and biocorrelation, and has named many new fossil species including koalas, possums, marsupial moles, wombat-like diprotodontids and trunked palorchestids. Karen has 10 years' experience in extracting, curating and analysing the rich fossil vertebrate faunas of the limestone deposits of the Riversleigh World Heritage Area in north-western Queensland, and has supervised the dig at the extraordinary fossil cave known as AL90 since major excavation of this remote site commenced in 1993. Karen is an ARC Postdoctoral Fellow at UNSW

and lead investigator on a Discovery Grant focused on correlating faunal change with global palaeoclimatic events to provide new evidence-based understanding about current and probable future climate-driven changes in biodiversity.

### *Herds overhead: heavyweight marsupial herbivores in the Miocene forests of Australia*

Diprotodontoid marsupials are a taxonomically diverse, widespread group of browsing herbivores that were once common in the ancient environments of Australia and New Guinea. They ranged in size from, at the small end, sheep to calf-sized types about 24 million years ago, to the two tonne Pleistocene giant *Diprotodon optatum*, the largest marsupial that ever lived. Throughout their known history, they were always the biggest mammalian herbivores in our ecosystems until the last ones died out around 50,000 years ago. At about 70 kg, *Nimbadon lavarackorum* is among the smallest, most primitive and best represented diprotodontoid. A remarkable collection of well-preserved skulls and articulated skeletons of *Nimbadon*, ranging in developmental stages from pouch young to mature adults, has been recovered from a 15 million year old fossil cave known as AL90 Site, in the Riversleigh World Heritage Area of north-western Queensland. Uncrushed skulls and skeletons of this kind, including youngsters that were still in the pouch, are extremely rare anywhere in the world. These have allowed the first detailed study of cranial development in a fossil marsupial, and analysis of the skeleton has revealed a unique and most unexpected ecological niche for this ancient herbivore – one that is no longer filled in any Australian ecosystem. The balance of evidence suggests that these remarkable, large marsupials were actually moving in herds within the crowns of trees rather than on the ground.

## 2012 Frederick White Prize for research in physical, terrestrial and planetary science

The Frederick White Prize recognises the achievements of scientists in Australia who are engaged in research of intrinsic scientific merit which has an actual or potential contribution to community interests, to rural or industrial progress or to the understanding of natural phenomena. Relevant areas of research are mathematics, physics, astronomy, chemistry, the terrestrial and planetary sciences.

### Dr Andrew Hogg

**Australian National University**

Andrew Hogg is a physical oceanographer who has made outstanding contributions to understanding of the dynamics of global scale ocean circulation, particularly in the Southern Ocean. He comes from a physics and fluid dynamics background, and undertook postgraduate studies at the University of Western Australia. His postdoctoral years were spent at the National Oceanography Centre in UK, where he developed his work on the effect of small-scale ocean eddies upon climate. He returned to the Australian National University in 2004, and has since focused on the use of numerical models to understand the ocean circulation, with a particular emphasis on the Southern Ocean.

### *Surprises in the Southern Ocean*

The Southern Ocean is unique amongst the world's oceans. It incorporates the ocean waters surrounding Antarctica, including a band of latitudes that are uninterrupted by continental land masses. These latitudes are home to the world's strongest ocean current, the Antarctic Circumpolar Current, with the sea ice zone to the south and sub-tropical oceans to the north. This region also plays host to the 'furious fifties' — the highest average wind speeds anywhere on the planet.

The geometry of the Southern Ocean gives rise to some surprising phenomena, which opposes the conventional wisdom obtained from studying the circulation of the North Atlantic and Pacific Oceans. In this talk I will outline three such phenomena — that the strength of the Antarctic Circumpolar Current is almost independent of the strength of the wind; that small-scale (less than 10 km) flow features are critical in governing the large-scale circulation; and that the magnitude of circumpolar flow is partially controlled by the buoyancy forcing (cooling of the ocean surface) in the Antarctic zone. These factors combine to compromise our ability to accurately model the response of the Southern Ocean to future changes in climate.

# 2012 Pawsey Medal for research in physics

Recognises outstanding research in physics and honours the contributions to science in Australia by the late Dr JL Pawsey FAA.

## Professor Tanya Monro FAA

**University of Adelaide**

Tanya Monro is an Australian Research Council Federation Fellow and Director of the Institute for Photonics and Advanced Sensing, a transdisciplinary research institute at the University of Adelaide. She is a Fellow of the Australian Academy of Technological Sciences and Engineering and a member of the National Committee for Physics. Tanya has been recognised with awards including South Australia's Australian of the Year for 2011 and the Prime Minister's Malcolm McIntosh Prize for Physical Scientist of the Year in 2008. Tanya obtained her PhD at the University of Sydney and was awarded the Bragg Gold Medal for the best Physics PhD in Australia in 1998. In 2000 she received a Royal Society University Research Fellowship at the University of Southampton in the United Kingdom. She came to Adelaide in 2005 as inaugural Chair of Photonics. She has published more than 400 papers and raised more than $70 million for research. Her research focuses on creating disruptive photonic sensing technologies.

### *Interacting light with matter: new tools for sensing*

The capacity to structure glass on the scale of the wavelength of light opens up new opportunities for controlling and guiding light while also getting it 'out' of the glass, making it available to interact with materials. Recent physics-led developments will be described, including the first embedding of nanoparticles in optical glass and new approaches to controlling light at the nanoscale. Harnessing these, and other recent advances in photonic materials and device platforms, along with the capacity to functionalise the glass surfaces in novel ways, opens up the possibility of creating disruptive new tools for sensing that are capable of making measurements in previously inaccessible situations, whether that be in the vicinity of a cell or within the structure of an aeroplane. A range of new platform technologies enabled by the interface of nanofabrication and biotechnology will be presented, as well as recent developments in ultra-compact lasers and optical processing devices.

The presentation will also paint a picture of opportunities to harness physics in Australia to enable new science in a broad range of disciplines, empower the creation of new technologies, support industry and drive economic development.

# Early Career Researcher Workshops

## Media and communicating science

What makes a good media story? Can any piece of science research be shaped for presentation in the media? What does it actually take to get your science message out through the media? This session will explore the theory and practice of effectively communicating science.

**Facilitator: Dr Paul Willis**, RiAus

RiAus Director Dr Paul Willis is well-known as a science broadcaster with the Australian Broadcasting Corporation, presenting and producing on ABC television science shows including *Quantum* and *Catalyst*.

Paul is passionate about informing, educating and amusing people of all ages and backgrounds about science and is keen to seize the opportunity to talk about science in a variety of public forums. He was rewarded for his passion in 2000 when he was joint recipient of the Eureka Prize for Science Communication.

Dr Willis brings a solid research career in vertebrate palaeontology to his work as a science communicator and now as Director of RiAus. He has produced many academic reports and papers, has authored or co-authored seven books on dinosaurs, rocks and fossils, and has written many popular science articles for a variety of publications.

Paul was the resident palaeontologist on seven Antarctic expeditions and brings this enthusiasm and keen sense of adventure to his role as Director of RiAus. He is ready and willing to engage with non-scientists and to stimulate community conversations about science, life, and everything.

## Successful scientific collaborations

Sharing expertise, results or data has become a key component of a successful career in science. However, initiating and maintaining productive collaborations is not always easy. In this workshop, we will identify and discuss issues that often determine the success of collaborations.

**Facilitators:**

**Dr Manuel Ferreira**, Queensland Institute of Medical Research

Manuel Ferreira graduated in Biology from the University of Lisbon (Portugal) and University of Oxford (UK) in 2001. He then moved to the Queensland Institute of Medical Research (QIMR, Brisbane) where he completed a PhD in Human Genetics. This was followed by a postdoc at Harvard University (2006–08) funded by an NHMRC Sidney Sax Fellowship. After returning to QIMR in 2008, Dr Ferreira established the Australian Asthma Genetics Consortium, a collaborative project that aims to improve asthma management through breakthrough genetic research. In the last five years he published 38 papers, of which 18 were in influential journals including *Lancet*, *New England Journal of Medicine*, *Nature*, *Nature Genetics* and *American Journal of Human Genetics*. Dr Ferreira is currently a Senior Research Fellow at QIMR and holds a Career Development Fellowship from the NHMRC.

**Dr Andrew Hogg**, Australian National University

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## Grant writing – getting your research ideas funded

The aim of this workshop is to develop more effective approaches to getting your research funded. We will explore effective strategies for pitching your research ideas, and provide insight into what happens when grants are assessed.

## Facilitators:

**Professor Tanya Monro**, University of Adelaide

Tanya Monro is an Australian Research Council Federation Fellow and Director of the Institute for Photonics and Advanced Sensing, a transdisciplinary research institute at the University of Adelaide. She is a Fellow of the Australian Academy of Technological Sciences and Engineering and a member of the National Committee for Physics. Tanya has been recognised with awards including South Australia's Australian of the Year for 2011 and the Prime Minister's Malcolm McIntosh Prize for Physical Scientist of the Year in 2008. Tanya obtained her PhD at the University of Sydney and was awarded the Bragg Gold Medal for the best Physics PhD in Australia in 1998. In 2000 she received a Royal Society University Research Fellowship at the University of Southampton in the United Kingdom. She came to Adelaide in 2005 as inaugural Chair of Photonics. She has published more than 400 papers and raised more than $70 million for research. Her research focuses on creating disruptive photonic sensing technologies.

**Professor Katharina Gaus**, University of New South Wales

Katharina Gaus is an NHMRC Senior Research Fellow and leads the Cell Membrane Biology group at the Centre for Vascular Research, University of New South Wales. The main objective of her research is to identify the organisation of the cell membrane in T lymphocyte signalling and other signal transduction processes. Her team uses novel fluorescence microscopy approaches to define the molecular mechanisms that regulate the temporal and spatial organisation of cell signalling, with a special focus on lipids and the contribution of membrane lipids in regulating signalling proteins. Born in Germany, Katharina studied physics at the Ruprecht-Karls-University of Heidelberg and received her PhD in biology in 1999 from the University of Cambridge. After postdoctoral fellowships from Germany and the ARC, she was awarded a Career Development Award from the NHMRC and established the Cell Membrane Biology group in 2005.

## *Still no Mawson: Frank Stillwell's 1911–13 Antarctic diaries*

As part of our celebration of 100 years of Antarctic science, the Academy is publishing the 1912 diaries of geologist Frank Stillwell. At the age of 23 Stillwell wintered at Cape Denison with Douglas Mawson's Australasian Antarctic Expedition. This book is the first to deal with Stillwell's time in Antarctica and it gives a fresh perspective on the 1911–14 expedition.

Stillwell was elected as a Fellow of the Academy in its founding year. His diaries, edited by Bernadette Hince, are being published with generous assistance from Geoscience Australia, the Geological Society of Australia and the National Library of Australia.

$24.95 plus p&h

Special pre-publication offer of $19.95 (collection only) for those attending the Academy symposium *100 years of Antarctic science*.

'Still no Mawson' is available for sale in the foyer of the Shine Dome.

Photo: State Library of NSW Home and Away collection, item 37175

Frank Stillwell at his plane table in Antarctica

# **Program** Friday 4 May

8.00 – 9.00am Tea and coffee available in the Jaeger room

## Annual symposium
## *100 years of Antarctic Science*

### MORNING SESSION

**Chair:** **Dr Ian Allison**

8.45am *Opening remarks*
**Professor Suzanne Cory AC PresAA FRS**

8.50am *Welcome*
**Professor Mike Coffin** (Gold Sponsor)
Institute for Marine and Antarctic Sciences, University of Tasmania

8.55am OFFICIAL OPENING OF THE SYMPOSIUM
***100 years of Antarctic science***
**Dr Tony Fleming**
Australian Antarctic Division

9.00am *The South Magnetic Pole*
**Dr Charles Barton**
Australian National University

9.30am *Terrestrial vegetation of East Antarctica in a changing climate*
**Professor Sharon Robinson**
University of Wollongong

10.00am *Marine biodiversity in the Southern Ocean: new paradigms of speciation and connectivity*
**Dr Jan Strugnell**
La Trobe University

10.30am **MORNING TEA**

11.00am *Changing southern ocean biogeochemistry: the influence of iron and $CO_2$*
**Professor Thomas Trull**
University of Tasmania

11.30am *Links between the geology of Antarctica and Australia*
**Dr Kate Selway**
University of Adelaide

12.00pm *Looking through the ice: the landscape of subglacial Antarctica*
**Professor Martin J Siegert**
University of Edinburgh, United Kingdom

12.30pm *Launch of Frank Stillwell's 1911–13 Antarctic diaries*
**Dr Tony Fleming**
Australian Antarctic Division

12.40pm **LUNCH**

### AFTERNOON SESSION

**Chair:** **Professor Trevor McDougall FAA**

1.45pm Climate and meteorology of the Antarctic region
**Dr Phillip Reid**
Bureau of Meteorology

2.15pm *The Southern Ocean and climate*
**Dr Stephen Rintoul FAA**
CSIRO Marine & Atmospheric Research

2.45pm *The Antarctic ice sheet, ice cores and climate*
**Dr Tas van Ommen**
Department of Sustainability, Environment, Water, Population and Communities

3.15pm **AFTERNOON TEA**

3.45pm *Palaeoenvironmental records from Antarctica*
**Professor Tim Naish**
Victoria University of Wellington, New Zealand

4.15pm – 4.35pm CONCLUSION AND CLOSE OF MEETING
**Dr Ian Allison**
Antarctic Climate and Ecosystems Cooperative Research Centre

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A partnership between CSIRO and the Bureau of Meteorology

CSIRO

The Centre for Australian Weather and Climate Research is a partnership between Australia's leading atmosphere and ocean research agencies: the Bureau of Meteorology and CSIRO. The Centre's more than 300 staff operate in integrated teams at a number of locations across Australia, with the main sites in Melbourne and Hobart. Our research is delivered in a number of ways: directly from the Bureau of Meteorology, indirectly through support for Bureau services, and through various CSIRO portfolios including the Wealth from Oceans, Climate Adaptation, Water for a Healthy Country, and Energy Transformed Flagships, and the Climate and Atmosphere Theme in CSIRO Marine and Atmospheric Research. For more information, see www.cawcr.gov.au.

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Australian Antarctic Division

Tasmania
Explore the possibilities

# 100 years of Antarctic science

## Official opening of the symposium

### Dr Tony Fleming

**Australian Antarctic Division**

Tony Fleming has recently been appointed the Director of the Australian Government's Antarctic Division, with responsibility for Australia's Antarctic program.

He was formerly National Operations Manager for the Australian Wildlife Conservancy, a nongovernment organisation that acquires land and works with other landholders to establish sanctuaries for the conservation of threatened wildlife and ecosystems. The Conservancy has 22 sanctuaries covering more than 2.5 million hectares throughout Australia.

Before joining the Conservancy, he spent nine years with the NSW National Parks and Wildlife Service, for the first five years as Director of the Southern Branch, and then as Head of the Service. In that role he was also a member of the NSW Marine Parks Authority and Chair of the Lord Howe Island Board.

He has previously worked in the Federal Environment Department, where he led the development of the Environment Protection and Biodiversity Conservation Act. He has also worked as a senior policy adviser to three Federal environment ministers — Graham Richardson, Ros Kelly and John Faulkner.

#### *100 years of Antarctic science*

On 29 March 2012 the Antarctic community, and indeed many parts of the world, commemorated the centenary of the death of Robert Falcon Scott. In this centenary year much has been written about the 'race to the pole' between Scott and Amundsen. But the largely untold story remains the science that the 'heroic era' expeditions accomplished during those first few years of the twentieth century. The Australasian Antarctic Expedition that set out from Hobart late in 1911 is more remembered for Douglas Mawson's incredible survival story, than for the fact that it was the largest scientific expedition in Antarctica. Douglas Mawson was first and foremost a scientist and the gathering of scientific knowledge was his primary aim. A continuous thread runs from those early expeditions through the decisions to create the Antarctic Treaty and the Madrid Protocol, to the scientific programs of today. Those early expeditions of a century ago laid the foundations for what we have today — an entire continent and its surrounding ocean dedicated to peace and science.

## Symposium speakers

### Dr Charles Barton

**Australian National University**

Charles Barton's research interests cover the nature, origin, and applications of the Earth's magnetic field. He is currently a visiting Fellow at the Research School of Earth Sciences, Australian National University. After graduating in Physics from Bristol University, United Kingdom, Charles spent 10 years teaching and exploring for oil in Africa, then completed a PhD in palaeomagnetism at ANU. After working at the Universities of Edinburgh and Rhode Island, he joined Geoscience Australia to run Australia's magnetic observatory program. In 1994, with Canadian colleagues, he made the closest approach to the North Magnetic Pole, and in the year 2000 got within a mile (1.6 km) of the South Magnetic Pole — thus becoming the first and to date the only person to fulfil James Clark Ross's dream of reaching both of the planet's magnetic poles. He is a Past President of the International Association of Geomagnetism and Aeronomy and runs an International Council for Science project to reduce the digital divide in Africa.

#### *The South Magnetic Pole*

Our knowledge about the Earth's magnetic field and its magnetic poles is traced from the earliest form of magnetic compass invented by the Chinese 2000 years ago, through to modern-day computer simulations of fluid motions in the Earth's core and magnetic polarity reversals. The South Magnetic Pole is the principal point where the Earth's field is exactly vertical and downward; it moves constantly in response to natural variations in source fields. The main focus is on the quest to find the South Magnetic Pole. After his successful discovery of the North Magnetic Pole in 1831, the famous polar explorer, James Clark Ross, attempted but failed to reach the South Magnetic Pole. That honour went officially to Mawson, David, and MacKay in 1909. The approach of 1.6 km was recorded in 2000 when the Pole had drifted off the Antarctic continent and out to sea at about 5 km per year, heading towards Adelaide.

## Professor Sharon Robinson

**University of Wollongong**

Sharon Robinson is a plant ecophysiologist and climate change biologist. Her research examines how plants respond to climate change with an integrated systems approach using molecular to ecological techniques. After completing her PhD at University College London in 1990, she held postdoctoral positions at Duke University (USA) and the Australian National University before her appointment as a Lecturer at the University of Wollongong in 1996. She is currently a member of the United Nations Environment Program Environmental Effects Assessment Panel and the Antarctic Science Advisory Committee, and an Editor for the journal *Global Change Biology*. She first visited Antarctica in 1996 and has been on nine ANARE expeditions to Casey, Davis and Macquarie Island. She is a custodian for the only Antarctic State of the Environment Indicator concerned with Antarctic vegetation and her research group has provided the first evidence that climate change is affecting East Antarctic terrestrial communities.

### *Terrestrial vegetation of East Antarctica in a changing climate*

The flora of continental Antarctica is limited to ice free areas, which occupy less than two per cent of the continent, with the Australian Antarctic Territory home to some of the best developed vegetation. The summer growing season lasts only a few months and is characterised by long days and temperatures ranging from -20 to +10˚ C. In winter, vegetation has to withstand freezing conditions and darkness. Organisms that can withstand these harsh conditions include lichens, bryophytes, algae and cyanobacteria but no flowering plants are present. To survive the harsh winters the vegetation must be able to freeze dry, and it is this ability to dry to a crisp and then rehydrate that makes the Antarctic flora so special. Once dry it can tolerate extremely cold conditions. Even though these plants are incredibly tough, they are living on the edge, and are increasingly being affected by climate change.

## Dr Jan Strugnell

**La Trobe University**

Jan Strugnell completed her BSc (Hons) at James Cook University. She then obtained her PhD at Oxford University where she published the first study to use molecular and fossil evidence to estimate divergence times within cephalopods (octopus, squids and cuttlefish). She then worked as a postdoctoral research fellow at Queen's University Belfast, the British Antarctic Survey and then Cambridge University where she investigated evolutionary relationships within and between Antarctic and deep-sea octopods. She reported the first dated molecular evidence that deep-sea fauna from other ocean basins originated from Southern Ocean taxa. Jan is currently based in the Genetics Department at La Trobe University, where she is working on an ARC funded project to use transcriptomics to investigate the molecular basis of stress and disease in abalone, a commercially important shellfish. She also continues her research investigating population and species level molecular evolution in Antarctic and deep-sea taxa in the context of past climatic and geological change.

### *Marine biodiversity in the Southern Ocean: new paradigms of speciation and connectivity*

Whales, seals and penguins jump to mind for many when we picture marine biodiversity in the Southern Ocean. However, beneath the water's surface a fascinating array of biodiversity abounds, including fish with antifreeze in their blood and sea spiders the size of dinner plates. Southern Ocean biodiversity has been shaped by marked shifts in the climatic, oceanographic and tectonic history of the region; molecular data carries signatures of these processes. The inherent difficulty of collecting samples in the Southern Ocean has meant that until recently our knowledge of its marine biodiversity was limited by small sample sizes and limited spatial coverage. Recent findings will be outlined which demonstrates a paradigm shift in our understanding of Southern Ocean biodiversity. Notably, evidence for glacial refugia during the last glacial maxima is now strong and cryptic speciation is considered common, challenging theories of circumpolar and eurybathic distributions. Evidence is also emerging for the existence of historical trans-Antarctic seaways as past dispersal routes.

## Professor Thomas Trull

**University of Tasmania**

Raised in a small farming and manufacturing town in Michigan, USA, Tom Trull first saw the sea as a teenager at Barwon Heads, Victoria. After completing a PhD in Oceanography in the Massachusetts Institute of Technology-Woods Hole Oceanographic Institution Joint Program, he joined the Antarctic Cooperative Research Centre in Hobart in 1993. He holds a joint CSIRO-University of Tasmania appointment as Professor of Marine Biogeochemistry, and leads Antarctic Climate and Ecosystems Cooperative Research Centre programs investigating ocean absorption of CO2, and impacts of ocean acidification on ocean ecosystems. He participated in the first Southern Ocean artificial and natural iron fertilisation experiments and serves as a science advisor to Australia's delegation to the International Maritime Organisation for regulation of ocean fertilisation. He leads the Integrated Marine Observing System Southern Ocean Time Series Facility — a program which deploys automated moorings and autonomous floats and gliders to quantify ocean biogeochemistry and carbon uptake.

### *Changing Southern Ocean biogeochemistry: the influence of iron and $CO_2$*

The Southern Ocean is a strange and special place. Biological productivity is severely limited by the lack of one of the most abundant elements on Earth — iron. The deficiency was suspected in the 1930s, but it was not until the 1980s that sub-parts per billion levels could be determined. In 1999, an iron addition experiment produced a phytoplankton bloom that became the first human-made marine object visible from space — showing that even in the low light and cold, phytoplankton respond to iron supply and take up $CO_2$. This response contributes to the magnitude of glacial-interglacial climate variations and will influence future ocean $CO_2$ uptake. That uptake increases acidity, which appears to be already altering ocean ecosystems. Quantifying the coupling of iron and $CO_2$ and the impacts of acidity is proving to be complex and regionally variable.

## Dr Kate Selway

**University of Adelaide**

Kate Selway is an Australian Research Council Postdoctoral Fellow at the Centre for Tectonics, Resources and Exploration at the University of Adelaide. After completing a Bachelor of Science with Honours majoring in geology and geophysics, she completed a PhD at the University of Adelaide in 2007, using a geophysical technique called magnetotellurics, or MT, to research the geological evolution of central Australia. Kate has since worked on a number of post-doctoral research projects in which she has used MT to investigate Earth history and processes. These have included investigating large-scale tectonic features in both East and West Antarctica as well as research into mineralising systems in Australia and into the East Africa Rift in Tanzania. In 2008 Kate was named the South Australian Young Achiever of the Year for her research and science promotion.

### *Links between the geology of Antarctica and Australia*

Beneath the Antarctic ice sheet lies a remarkable landscape, sculptured by ancient tectonic, river and glacial processes, that has a fundamental control on the modern flow of ice. To understand how the ice sheet may change in the future requires knowledge of the subglacial bed. Fifty years ago, our appreciation of subglacial Antarctica was extremely limited. It took an Australian, Gordon Robin, to establish radio-echo sounding as a scientific method to gain information from beneath the ice. Mounted on an aircraft, this efficient method of data collection allowed his team to survey approximately 40 per cent of the continent during the 1970s. Several significant recent surveys have added to our knowledge of this hidden environment, revealing mountains, lowlands, lakes and rivers beneath ice up to 5 km thick. Despite recent advances, significant data gaps remain today, limiting our ability to understand the response of Antarctica to climate change. Future international collaborative efforts are therefore focused on filling these gaps within the next decade, extending the impact of Robin's pioneering research 50 years after it began.

## Professor Martin J Siegert

**University of Edinburgh, United Kingdom**

Martin Siegert is Professor of Geosciences at the University of Edinburgh. He is the Principal Investigator of the Subglacial Lake Ellsworth Exploration program that aims to undertake the direct measurement and sampling of this unique environment in December 2012. He is also the UK lead scientist on the UK-Australia-USA program Investigating the Cryospheric Evolution of the Central Antarctic Plate (ICECAP), which has successfully acquired more than 150,000 km of airborne geophysical data from East Antarctica over the last four seasons. He has investigated subglacial environments in Antarctica for more than 20 years. He has served on several programs of the Scientific Committee on Antarctic Research (SCAR), including Antarctic Climate Evolution, which he co-chaired for six years, and Subglacial Antarctic Lake Environments. For the past five years he has been the UK delegate to SCAR. In August 2012, he will take up a Chair at the University of Bristol.

### *Looking through the ice: the landscape of subglacial Antarctica*

Beneath the Antarctic ice sheet lies a remarkable landscape, sculptured by ancient tectonic, river and glacial processes, that has a fundamental control on the modern flow of ice. To understand how the ice sheet may change in the future requires knowledge of the subglacial bed. Fifty years ago, our appreciation of subglacial Antarctica was extremely limited. It took an Australian, Gordon Robin, to establish radio-echo sounding as a scientific method to gain information from beneath the ice. Mounted on an aircraft, this efficient method of data collection allowed his team to survey approximately 40 per cent of the continent during the 1970s. Several significant recent surveys have added to our knowledge of this hidden environment, revealing mountains, lowlands, lakes and rivers beneath ice up to 5 km thick. Despite recent advances, significant data gaps remain today, limiting our ability to understand the response of Antarctica to climate change. Future international collaborative efforts are therefore focused on filling these gaps within the next decade, extending the impact of Robin's pioneering research 50 years after it began.

## Dr Phillip Reid

**Bureau of Meteorology**

Phillip Reid is acting Regional Manager of the Antarctic Meteorological Section within the Tasmanian/Antarctic Regional Office of the Bureau of Meteorology. He grew up in Tasmania and completed his science undergraduate degree and PhD at the University of Tasmania in Hobart. Since completing his PhD he has undertaken research on European rainfall, the El Niño/La Niña-Southern Oscillation (ENSO), Antarctic meteorological observations and Southern Hemisphere sea ice. For the last five years he has been an invited author on the Bulletin of the American Meteorological Society's State of the Climate Report. He has served as a member on two World Meteorological Organization Expert Teams as well as presenting workshops on the development of climate watches and seasonal outlooks in a number of overseas countries with AusAID and the World Meteorological Organization. Currently he is leading the development of the Polar version of the atmospheric forecasting model to be used by forecasters on Australian Antarctic bases.

### *Climate and meteorology of the Antarctic region*

One hundred years ago Douglas Mawson set out on his famous expedition to Antarctica. Science was the principle underpinning the expedition and a component of that was the study of meteorology. It was somewhat ironic that Mawson chose as his main base Commonwealth Bay, a location now indelibly marked as the windiest location on the surface of the Earth. The 1929 report by Madigan on the meteorology over the period of Mawson's expedition was questioned at the time for the severity of the surface winds but the analysis has stood the test of time. The expedition was also notable as being the first to use high frequency (HF) radio to routinely transfer meteorological observations out of Antarctica to Melbourne. A century on, we still rely on the routine transfer of data from the continent to assist in weather forecasting and climate studies. Our abilities to provide useful and accurate weather forecasts to personnel working in Antarctica have improved steadily over the subsequent decades. However, much still remains unknown of the Antarctic atmosphere today, and which requires an ongoing commitment to the Antarctic atmospheric sciences begun by Mawson.

## Dr Stephen Rintoul FAA

**CSIRO Marine and Atmospheric Research**

Stephen Rintoul is a physical oceanographer and climate scientist with a long-standing interest in the Southern Ocean and its role in the Earth system. His research has contributed to a deeper appreciation of the influence of the Southern Ocean on global climate, biogeochemical cycles and biological productivity. He uses a variety of tools to study the Southern Ocean, including ships, satellites, floats, moorings and instrumented seals. He has led 14 oceanographic expeditions to the Southern, Indian and Pacific Oceans. Dr Rintoul is a Coordinating Lead Author of the Oceans chapter in the 5th Assessment Report of the Intergovernmental Panel on Climate Change. His scientific achievements have been recognised by many national and international awards, including the Georg Wüst Prize of the German Society for Marine Research and appointment as a CSIRO Fellow, the organisation's highest honour for science.

### *The Southern Ocean and climate*

The Southern Ocean is the only region in which an unbroken channel of ocean circles the globe. This accident of geography has profound implications for ocean circulation and climate. The Southern Ocean connects the ocean basins and links the shallow and deep layers of the ocean, resulting in a global-scale overturning circulation that determines how much heat and carbon the ocean can store (and therefore the pace of climate change). Given the global influence of the Southern Ocean, any change in the region would have widespread impacts. Recent studies suggest change is under way, in response to both natural and human drivers, and with implications for climate, biogeochemical cycles, and sea-level rise. Present efforts to unravel the nature, causes and consequences of Southern Ocean change continue the legacy of Sir Douglas Mawson, who in 1912 collected some of the first oceanographic measurements ever made in the Southern Ocean.

## Dr Tas van Ommen

**Department of Sustainability, Environment, Water, Population and Communities**

Tas van Ommen is a Principal Research Scientist with the Australian Antarctic Division's Climate Processes and Change Program. Tas is also Leader of the Cryosphere Program at the Antarctic Climate and Ecosystems Cooperative Research Centre. His research interests centre on climate and glaciology, and particularly ice core records of past climate. He is also involved in international airborne glaciology to map the bedrock of the East Antarctic ice sheet. Tas has published more than 60 peer-reviewed papers and has been a contributing author and reviewer for the Intergovernmental Panel on Climate Change. He leads the International Geosphere-Biosphere Program's PAGES (past global changes) project working group for reconstructing Antarctic climate from proxy records over the last 2000 years. Tas has a strong interest in public communication of climate science. His recent research includes work revealing a link between drought in southwest Western Australia and Antarctic snowfall changes. This finding suggests that human-driven climate change is playing a role in the drought.

### *The Antarctic ice sheet, ice cores and climate*

Antarctica is defined by ice. The ice sheet reaches an altitude of just over 4 km and depths of more than 2 km below sea-level. At its extreme the ice sheet is more than 4.5 km thick and holds sufficient fresh water to raise sea level by more than 60 metres. The Antarctic ice sheet has been a dynamic planetary force through the last 34 million years, ebbing and flowing with the beat of global climate changes. It also holds in its frozen interior a record of global change that has shaped our understanding, providing ice core records of climate forcing and responses over the past 800,000 years. Now, the Antarctic ice sheet is responding also to human influence, and in turn has potential to significantly shape future human enterprise as it influences sea levels for centuries to come. This talk will give an overview of the lessons we have learned from ice core records and review the state of knowledge around the response of the ice to a warming climate.

## Professor Tim Naish

**Victoria University of Wellington, New Zealand**

Tim Naish is Director of the Antarctic Research Centre at Victoria University of Wellington and Principal Scientist at the New Zealand Crown Research Institute, GNS Science. He is a palaeoclimatologist focused on reconstructing past ice sheet and global sea-level changes from continental margin geological records. He has participated in nine expeditions to Antarctica and helped found ANDRILL, an international Antarctic Geological DRILLing Program. He was co-chief scientist of ANDRILL's McMurdo Ice Shelf Project which recovered sediment cores documenting the first direct evidence that the West Antarctic Ice Sheet had collapsed the last time the world was 2–3°C warmer, 3–5 million years ago. He is currently a Lead Author on the Intergovernmental Panel on Climate Change's 5th Assessment Report.

### *Palaeoenvironmental records from Antarctica*

Geological reconstructions and model simulations depict a close relationship between atmospheric $CO_2$ levels and global climate, including thresholds for Antarctic and northern hemisphere ice sheet inceptions. They clearly indicate that past changes in Earth's surface temperature were correlated with substantial changes in ice volume and global sea-level. This presentation will review our current understanding of the evolution of Antarctica's ice sheets as a consequence of Earth's changing climatic boundary conditions through the Cainozoic Era. New ice sheet proximal palaeoenvironmental records will be discussed in the context of the latest far-field proxy records from ocean drilling and continental margin sequences. Emphasis will be placed on past times when atmospheric $CO_2$ concentrations and surface temperatures were comparable with or higher than the industrial era. Such intervals are of special interest for understanding recent climate change and providing perspectives on future projections.

## Dr Ian Allison

**Antarctic Climate and Ecosystems Cooperative Research Centre**

Ian Allison is an Honorary Research Professor with the Antarctic Climate and Ecosystems Cooperative Research Centre in Hobart, and former leader of the Ice Ocean Atmosphere and Climate program at the Australian Antarctic Division. He has studied ice and climate in Antarctica for more than 40 years, participated in or led 25 research expeditions to the Antarctic, and published over 100 peer-reviewed papers on Antarctic science. His research interests include ice shelf ocean interaction, Antarctic weather and climate, sea ice, and the mass budget of the Antarctic ice sheet. He was co-chair of the International Council for Science / World Meteorological Organization Joint Committee for the International Polar Year 2007–2008, a lead author of the Intergovernmental Panel on Climate Change Fourth Assessment Report. He is currently President of the International Association of Cryospheric Science of the International Union of Geodesy and Geophysics, and a lead author of the Intergovernmental Panel on Climate Change Fifth Assessment Report.

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