

Australian Research Council Federation Fellowships 2005

PROFESSOR GEREMIE BARME

Project: *Beijing: China's Heritage and the City as spectacle*

Current institution: The Australian National University

Host institution: The Australian National University

Primary research field: Asian History

Professor Barme will investigate the historical context and looming significance of how the Chinese state and the public and semi-private media project the city and culture of Beijing as being a core of Chinese national identity in the post-socialist era (1978-) and in the years surrounding the 2008 Beijing Olympics. He will use the concepts of heritage and spectacle to study the city and the evocation of history, from imperial times to the present, to construct a global Chinese identity. The project will provide the major national focus for trans-historical research on China, research that is grounded in traditional Sinological skills and addresses some of the important and long-term issues of Chinese history, culture and society and their contemporary relevance in North-east Asia and the Asia Pacific. It will provide a national hub for the study of late-traditional China and its relevance to Australia today and create an opportunity for a multifaceted understanding of the underpinnings of the cultural influence of China in the future.

PROFESSOR ALAN BOND

Project: *Integration of Electrochemistry and Green*

Chemistry: A Roadmap for Scientific Innovation

Current institution: Monash University

Host institution: Monash University

Primary research field: Electrochemistry

Professor Bond will focus on nuclear magnetic resonance spectra applications revolutionised by integration of instrumental and mathematical advances that transform seemingly incomprehensible data into instantly recognisable images. An analogous electrochemical roadmap for attainment of broad-ranging innovation will be established in this research program. When set in a green chemistry context and specifically interfaced with problems associated with nanochemistry, catalysis, materials science, biologically important reactions and chemical processes of industrial significance, the anticipated outcome is extensive access to exploitable insights of fundamental and applied importance.

PROFESSOR JOHN BOWMAN

Project: *Role of an ancient genetic program in the elaboration of plant architecture*

Current institution: University of California, Davis

Host institution: Monash University

Primary research field: Genetic Development

Professor Bowman's research program will focus on meristems (organised groups of stem cells found at the tips of plant organ shoots and roots). How leaves and other organs grow depends on positional information provided by meristems. The aims this research are to deduce the role of three inter-related gene programs in regulating growth patterns of leaves and other plant organs and to investigate the evolutionary origins of meristems in all land plants. The ability to manipulate the size and shape of plant organs has broad implications for horticulture, agriculture and forestry. This research will reveal how plant architecture is controlled by genes and, ultimately, help us manipulate plant forms tailored for Australia's crops, pastures and plantations. Potential benefits include larger leaves, more fruits and seeds and timbers with new properties.

PROFESSOR HILARY CHARLESWORTH

Project: *Building Democracy and Justice after Conflict*

Current institution: The Australian National University

Host institution: The Australian National University

Primary research field: International Law

Professor Charlesworth will investigate how war weakens democratic governance and the capacity to deal with crimes committed during the conflict. Her project will advance new ways of thinking about building the structures for democracy and justice after conflict. The focus will be the potential contribution of international law to this enterprise. Through national and international collaboration, she will develop innovative theoretical models to ground international norms about governance and justice after conflict, but also practical proposals to implement them. This project is highly significant to engagement by Australia in nation-building projects, both in its region and further afield. It will build Australia's expertise in the ways that international law can promote democracy and justice, and develop guidelines for states and organisations involved in peace and nation-building. It will thus contribute to safeguarding Australia by increasing Australia's capacity to engage with, and interpret itself to, its neighbours and the broader international community.

PROFESSOR TOM DAVIS

Project: *Constructing the Building Blocks for Future Nanomaterial Design: Self-assembly and Information Storage in Synthetic Macromolecules*

Current institution: The University of New South Wales

Host institution: The University of New South Wales

Primary research field: Synthesis of Macromolecules

Professor Davis will create a team with the capability to tailor-make synthetic macromolecules that can be used to store and convey information. To do this, he will incorporate functionality that can be used to affect information storage by using nucleotides, peptides and saccharides in synthetic macromolecules. To achieve this, the project will need to create high-quality expertise in two areas currently outside the scope of his existing research group, namely, saccharide and peptide synthesis. The outcome will be a unique research team within Australia possessing world-class strength in hybrid macromolecular design and construction. This will be of benefit to the Australian research community in the development of new materials and also support the creation of a vibrant high-tech industry using synthetic materials for applications such as responsive membranes and 'clever' drug delivery.

ASSOCIATE PROFESSOR MATTHEW ENGLAND

Project: *Genesis of Australian Climate Extremes in the Southern Hemisphere Extra-tropical Ocean-Atmosphere*

Current institution: The University of New South Wales

Host institution: The University of New South Wales

Primary research field: Climatology

Professor England will focus on Australia's vulnerability to climate extremes in order to better understand extra-tropical variability and its unique role in extremes and predictability of climate and climate change. In the context of limited knowledge of extra-tropical variability and climate change, the project will use innovative applications of climate system models in conjunction with available observations to quantify extra-tropical ocean-atmosphere variability and change, discover how this impacts on Australian climate and weather and calculate the associated predictability of extreme climate. Harsh droughts, severe bushfire seasons, climate change, soil loss and salinity all pose enormous socio-economic challenges for Australia over the next 50 years. Research into climate variability, extremes and predictability will underpin efforts to protect our biodiversity and ensure environmental sustainability. This project will have significant benefits for many sectors of society reliant on inter-seasonal and inter-annual climate prediction

such as agriculture, energy, freshwater supply, bushfire control, air quality, health and tourism.

PROFESSOR SHEILA FITZPATRICK

Project: *Russia (The Soviet Union) and Australia in the 20th and 21st centuries*

Current institution: University of Chicago

Host institution: The University of Melbourne

Primary research field: European History

Professor Fitzpatrick will investigate the social and cultural roots of the Soviet collapse of 1991, with particular reference to the growth of the "shadow economy" and problems handling the challenge of western culture in the Khrushchev period. The research will cover institution-building and the development of international ties to provide leadership in the field of Russian studies in Australia and raise the visibility and reputation of Australian Russian studies worldwide. Her program will contribute to re-establishing Australia as a significant player in Russian studies by bringing in internationally recognised leadership.

PROFESSOR BRYAN GAENSLER

Project: *The Origin and Evolution of Cosmic Magnetism*

Current institution: Harvard University

Host institution: The University of Sydney

Primary research field: Astronomy and Astrophysics

Professor Gaensler will seek to advance our knowledge of the universe studying the magnetism that threads interstellar and intergalactic space. His work will entail a suite of innovative experiments, using both radio telescopes in Australia and X-ray telescopes in orbit, which will cast new light on the essential role that magnetic fields play in the generation of turbulence and large-scale structure, the production of high-energy cosmic ray particles and the formation of the first stars and galaxies. The work will significantly advance our understanding of structure and evolution in the universe, in keeping with Australia's outstanding track record of astronomical discovery. The instrumentation and techniques to be developed are expected to lead to innovative transfers of technology to fields such as telecommunications and medical imaging.

PROFESSOR JOHN HARTLEY

Project: *Uses of Multimedia: Citizen Consumers, Creative Participation and Innovation in Australian Digital Content*

Current institution: Queensland University of Technology

Host institution: Queensland University of Technology

Primary research field: Screen and Media Culture

Professor Hartley will focus on innovation in digital content and creative industries. New multimedia technologies require new capabilities (literacy). Cultural acceptance and social uptake are more decisive determinants of market success than is technology, but public policy and academic research both focus overly on the production end of the value chain. This project promotes consumer-led innovation in Australian digital content. It will analyse and offer practical solutions for extending the social reach of multimedia literacy. Outcomes include the development of low-cost multi-platform distribution of Australian content for next-generation national networks. Linking professional production and consumer-led innovation will significantly strengthen the service economy.

PROFESSOR JOHN HODGES

Project: *Human long-term memory and social cognition: An integrated cognitive neuroscience approach*

Current institution: Medical Research Council (UK)

Host institution: The University of New South Wales

Primary research field: Neuropsychology

Professor Hodges will investigate how the brain represents long-term memory and the processes involved in social cognition. His project will test the hypothesis that temporal regions play a key role in the formation and storage of knowledge, while frontal regions are critical for normal social behaviour such as interpreting the thoughts and emotions of others. The project combines neuropsychological, structural and functional brain imaging and involves patients with and without brain disorders. A long-term goal is to develop widely applicable tasks that can be translated into effective tools for the assessment of patients with disorders affecting these fundamental aspects of human cognition. Impairment of memory is a ubiquitous feature of the dementias. A better understanding of memory processing in the brain is central to developing better tests for early detection and monitoring of disease progression. The study of social cognition is relevant to a range of developmental, psychiatric and neurological disorders. This project will provide the catalyst for the development of a National Memory and Cognitive Disorders Centre for multidisciplinary cognitive neuroscience research. The ultimate aim will be the translation of basic neuroscience into effective tools

that will have an impact on the health outcomes of the ageing population.

PROFESSOR MICHAEL KEANE

Project: *Understanding and Modelling Individual Choices in Applied Economics*

Current institution: Yale University

Host institution: The University of Technology, Sydney

Primary research field: Microeconomic theory

Professor Keane will investigate how individuals and organisations make uncertain or risky choices that impact on current and future costs and returns. His work will significantly advance knowledge in such areas as the design of health insurance markets, tests for adverse selection in insurance markets, the ability of people to plan for retirement (superannuation choices), the ability of people to plan and choose in dynamic environments, and decisions to adopt new technologies and products in evolving markets. The outcome will be new ways to understand and predict choices that can significantly improve practices in business and other organisations.

DR CAMERON KEPERT

Project: *Advanced Molecular Nanomaterials*

Current institution: The University of Sydney

Host institution: The University of Sydney

Primary research field: Structural Chemistry

Dr Kepert will focus on the strategic design of advanced nanomaterials. This requires both the control of nanoscale structure and the incorporation of specific function into that structure. He will develop sophisticated molecular design principles to generate materials that display an array of unusual and highly useful properties: anomalous thermal expansion, electronic and magnetic response to guest-exchange, chiral selectivity, hydrogen storage and controlled release. His approach addresses key questions in the science of nanoscale systems and will lead to fundamental breakthroughs in understanding. Commercialisation of the materials is expected to lead directly to the generation of innovative high-level technologies over a broad range of applications in electronics, photonics, molecular sensing, drug synthesis and purification, clean energy and the controlled release of agrochemicals and pharmaceuticals.

ASSOCIATE PROFESSOR BOSTJAN KOBE

Project: *New approaches to functional and structural genomics*

Current institution: The University of Queensland

Host institution: The University of Queensland

Primary research field: Functional Genomics

Professor Kobe's program will contribute to the worldwide effort in sequencing the genomes of humans and other organisms. This work has identified a large number of proteins with unknown functions. Determining the functions of these proteins is one of the next great challenges in biology. This program of research will pursue novel approaches for determining protein function, using three-dimensional structural information of proteins as the basis. In the first approach, the available structural information will be explored to develop bioinformatic tools that will enable functional annotation of proteins computationally. In the second approach, new ways of identifying and structurally characterising cellular protein complexes will be pursued. The proposed research will lead to the discovery of new biological molecules, interactions and processes essential for the function of cells, identify new therapeutic targets and strategies to combat disease and identify new concepts in bio- and nanotechnology.

PROFESSOR PHILIP MAINI

Project: *Multiscale modelling: Applications to the Biomedical Sciences*

Current institution: University of Oxford

Host institution: The University of Sydney

Primary research field: Biological Mathematics

Professor Maini will use a multidisciplinary multi-scale approach to investigate tumour growth and analyse dermal wound healing. Outcomes are expected to include development of a virtual tumour which will allow different clinical and surgical procedures to be simulated and tested, and new treatments for wound healing and chronic disease. The expected benefits of this research include significant reductions in the costs of developing pharmaceutical treatments, substantial reduction in hospitalisation costs and improved treatment of wounds, a significant cause of chronic ill-health and high health care costs.

DR LARRY MARSHALL

Project: *Optical Semiconductors for next-generation lasers, optical processors and integrated optical chips*

Current institution: Arasor Corporation

Host institution: Macquarie University

Primary research field: Optics and Opto-electronic Physics

Dr Marshall will create a generic optical source and processor technology, integrating semiconductor and non-linear elements in chip-scale optoelectronic devices. He will address scientific and technical challenges in resonator design, nonlinear processes, waveguides, understanding fundamental processes affecting performance and lifetime, and integration of semiconductor and non-linear optical elements. This technology, exploiting the scale and economic advantages of microelectronics fabrication, is expected to open the way to a vast array of low-cost applications in biomedicine, industry and defence, and place Australia in a leading position to benefit from key skills and intellectual property.

PROFESSOR JOHN MATTICK

Project: *The genomic programming of complex organisms*

Current institution: The University of Queensland

Host institution: The University of Queensland

Primary research field: Genetics

Professor Mattick will investigate ribonucleic acids, which comprise 98 per cent of the output of the human genome. He will use a combination of genetic, biochemical, bioinformatic and mathematical approaches to explore the hypothesis that higher organisms have evolved an advanced genetic operating system based on a network of digital RNA signals the function of which is to integrate complex suites of gene activity. The project may transform our understanding of genetic programming of higher organisms, their evolutionary history and the basis of the phenotypic diversity of individuals and species, including quantitative trait variation and disease susceptibility. It is expected to have far-reaching consequences in medicine, agriculture, engineering, biotechnology, information science and associated industries. It should provide a platform for the rationalisation of genetic epidemiology and improvement programs, development of new diagnostics and therapies, new core technologies and practical approaches in genetics and genetic diversity, a framework for advanced genetic engineering, development of new principles and systems for information storage and transmission, and design of artificial systems capable of self-referential assembly in other environments.

PROFESSOR BARRY MUDDLE

Project: *Design in Nanostructured Materials - Formation and Stability of Nanostructure in Light Alloys and Light Metal Hybrids*

Current institution: Monash University

Host institution: Monash University

Primary research field: Physical Metallurgy

Professor Muddle will investigate the emerging potential for manipulation of the structure of materials at the nanoscale. His program is at the forefront of international research to determine the factors that control formation and stability of nanostructure in advanced light alloys. It also foreshadows a major initiative in the development of light metal hybrid structures with critical dimensions on the micro- and nanoscale. Coupled with innovations in processing, the advances anticipated will revolutionise current approaches to design in light metal systems, substantially improving properties of existing alloys and creating novel hybrid materials to meet design targets aligned with emerging national and global market priorities. The program will advance international leadership in the design and downstream processing of light alloys. It will also provide leadership in a new national research activity in light metal hybrid structures, targeted at innovation in materials design and the expansion of markets for light metals, underpinning major developments in the light metals industry nationally and globally.

ASSOCIATE PROFESSOR PAUL MULVANEY

Project: *Energy Conversion and Signal Transduction in Nanomechanical Systems*

Current institution: The University of Melbourne

Host institution: The University of Melbourne

Primary research field: Nanotechnology

Professor Mulvaney will focus on one of the great challenges in nanoscience, namely how to build mechanical devices such as valves, switches, pumps and motors with sizes approaching molecular dimensions. To create such miniature structures, scientists must learn how to harness energy on nanoscale levels and how to assemble molecules so that they may perform mechanical actions. This Fellowship will explore the possibilities for creating such structures using state-of-the-art microscopy and nanofabrication techniques. The aim will be to open up the new field of molecular mechanics. This Fellowship will explore ways to make smaller, portable devices that can be used for personal health monitoring, environmental sensing and detecting disease and pathogens.

DR ANDREW PARKER

Project: *The diversity and assembly of optics in nature*

Current institution: University of Oxford

Host institution: The University of Sydney

Primary research field: Biochemistry and Cell Biology

Dr Parker will investigate the broad diversity and finer variations of optical reflectors in animals and exploit new designs within the optics industry. It is expected that novel designs for anti-counterfeiting devices will emerge, creating opportunities for commercialisation. Dr Parker will also steer this field in a new direction and culture cells that produce optical devices and farm those devices in the laboratory. This would provide a breakthrough technology within the optics industry, where the types of optical devices found in nature are highly desirable. Following extensive preliminary planning, it is expected that at least one reflective scale of a butterfly will be cultured, revealing potential for a new optics industry. Optical devices exist far and wide in our everyday lives, from security devices on banknotes (holograms) to computer monitors. An interesting parallel exists in nature – animals possess similar optical devices to those we use. It therefore makes sense to examine the animals' devices in a search for new reflectors. Since reflectors are often difficult to make, why not let animals make reflectors for us? Soon we may have genetically-altered butterfly scales embedded in our credit cards that cannot be counterfeited.

PROFESSOR MARK RANDOLPH

Project: *Geotechnical engineering solutions for deep-water oil and gas developments*

Current institution: The University of Western Australia

Host institution: The University of Western Australia

Primary research field: Geotechnical Engineering

Professor Randolph will develop new paradigms for characterising seabed sediments and design of foundation, anchoring, pipeline and riser systems for the next generation of offshore facilities. Offshore oil and gas extraction is a multi-billion dollar industry facing increasing challenges as it moves to water depths of three kilometres. The project is expected to lead to substantially improved assessment and analysis methods for deep-water developments, with potential multi-million dollar cost-savings on individual projects through improved reliability in design. The project will provide international leadership in geotechnical engineering solutions for deep-water offshore facilities with significant benefits to our economy and in minimising impact on the marine environment.

PROFESSOR BRIAN SCHMIDT

Project: *Understanding the Evolution of the Universe*

Current institution: The Australian National University

Host institution: The Australian National University

Primary research field: Astronomy and Astrophysics

Professor Schmidt's program seeks to understand the basic evolution of the universe since the time that the first stars and galaxies formed 13 billion years ago. This includes understanding a form of matter called Dark Energy which is pushing the universe apart, discovering when the first stars formed in the universe and untangling how galaxies, including our own Milky Way, were assembled. This program will use the whole range of Australian telescope facilities including the new SkyMapper telescope, the construction and operation of which this proposal will spearhead.

PROFESSOR RICHARD SHINE

Project: *Ecology and evolution in dynamic systems: a new approach to conserving Australian biodiversity*

Current institution: The University of Sydney

Host institution: The University of Sydney

Primary research field: Conservation and Wildlife and Habitat Management

Professor Shine will develop a new approach to conservation biology, centred on the distinctive ecological characteristics of Australian habitats and the organisms that live in them. He will enrich the conceptual and methodological base of conservation research by incorporating ideas and approaches from other fields, particularly developmental plasticity, thermal biology and microevolution. He will be seeking to find solutions to such practical problems in Australian conservation as the ecological impacts of invasion by cane toads, increased vegetation density in some forested areas of Australia since the cessation of indigenous 'firestick farming' and global climate change. The focus of his Federation Fellowship on key aspects of biodiversity has profound implications for our economy, which is reliant on the harvesting of natural resources in a sustainable manner. It is expected also to provide novel solutions for the conservation of our unique fauna.

PROFESSOR JEREMY SMITH

Project: *Neutron Scattering in Biology*

Current institution: University of Heidelberg

Host institution: Australian Nuclear Science and Technology Organisation

Primary research field: Biophysics

Professor Smith will study protein structure, dynamics and function using advanced neutron and X-ray scattering techniques and molecular simulations. He will investigate proteins and protein-based complexes under different environmental and functional states. He will also obtain information to improve simulation methods, increase the understanding of the dynamic origin of experimentally-measured scattering intensities and, in certain cases, determine relationships between protein dynamics and function. Scattering experiments will be conducted at Australia's Opal Reactor as well as international facilities, with these activities providing leadership for biological neutron scattering in this country. Opal represents the country's largest single investment in scientific research infrastructure. This program will stimulate its production of high-quality research in materials science, chemistry and biology.

PROFESSOR DAVID VAUX

Project: *Molecular control of apoptosis and protein homeostasis*

Current institution: Walter and Eliza Hall Institute of Medical Research

Host institution: La Trobe University

Primary research field: Cell Development and Apoptosis

Professor Vaux will focus on apoptosis, the process by which most animal cells kill themselves. Apoptosis of the wrong cells, or failure of cells to die when they should, has been observed in practically every disease. The health of a cell depends on its ability to control the intracellular environment. Study of the Inhibitor of Apoptosis protein family has led to the discovery of a mechanism that controls protein abundance within cells. Analysis of the mechanisms of apoptosis and protein homeostasis will increase our understanding of these fundamental biological processes and provide novel avenues for the treatment of disease such as cancer and heart attacks. Understanding the molecular mechanisms of cell death is the first step towards developing drugs that can cause cancer cells to kill themselves or prevent cells dying when they shouldn't.

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