



The Bulletin 392

The Royal Society of New South Wales

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29 September 2015

PUBLIC LECTURE – Wednesday, 7 October 2015

Future Events

Thursday 15 Oct 2015

Southern Highlands Branch Meeting

Dr Lydia Guja

Seed Bank Canberra

**Importance of having a seed bank to conserve
the world's plant resources**

Performing Arts Centre, Chevalier College,
Bowral.

Starting Time: **6:30 pm**

Wednesday, 4 November 2015

1238th Ordinary General Meeting

Professor David Christian

Macquarie University

Big History

Union, University & Schools Club

25 Bent St, Sydney, 6.00 pm for 6:30 pm

Tuesday, 17 November 2015

Professor Michael Burton

UNSW

AIP Postgraduate Awards Day and

Jak Kelly Award Judging

Slade Lecture Theatre University of Sydney

6.00 pm for 6:30 pm

Thursday 19 November 2015

Southern Highlands Branch Meeting

Det Snr Sgt Craig Harris

Forensic Services Group, NSW Police

Forensic Science applied to Police

investigations

Performing Arts Centre, Chevalier College,
Bowral.

Starting Time: **6:30 pm**

Patron of The Royal Society of NSW

His Excellency General The Honourable

David Hurley AC DSC (Ret'd)

Governor of New South Wales

The Revolution in Radio Astronomy

Professor Elaine Sadler FAA

The University of Sydney

Union, Universities, & Schools Club, 25 Bent St, Sydney

6:00 for 6:30 pm, Welcome drink at 6:00 pm

Fellows & Members \$5; Guests, \$20

Please note dress code: jacket and tie

Please join us for dinner afterward, \$75 per person



Radio astronomy is currently entering a 'golden age', when new telescopes of unprecedented sensitivity will allow us to explore the Universe in ways that have never been possible before. Australia is at the forefront of these developments, as one of the two countries chosen to host the international Square Kilometre Array (SKA) radio telescope. I will show some of the first science results from two new Australian 'SKA precursor' radio telescopes which have recently started operations in a remote area of Western Australia, and describe some of the novel technologies which make these telescopes so powerful. I'll also discuss how the remoteness of the Western Australian site makes it possible for us to search for the faint signature of hydrogen gas in distant galaxies. (Go page 5.)



From the President

It is pleasing to report that the Royal Society of NSW and Four Academies Forum held on Tuesday 15 September at Government House, Sydney was an outstanding success. (See below and page 6.) The event was wait-listed and had strong representation from Fellows of the four Academies and Fellows and Members of the Society, together with a number of other invited guests. Feedback from attendees was extremely positive regarding both the topic explored (“The future of work”) and the extremely interesting speakers. There have been a large number of suggestions regarding further areas of collaboration and future events. The Governor was particularly complimentary and would like to be involved in future activities.

One purpose of the Forum was to return the Society to its place where people meet to discuss a broad range

of ideas across science, art, literature and philosophy – it could not have been more successful as the first major step to doing so. Planning has already started on how we take the material from the Forum forward to influence our programme for the next couple of years.

The Dirac Lecture was held in conjunction at the University of NSW on Tuesday 1 September, with the Society and the Australian Institute of Physics as co-hosts. This year’s lecturer and recipient of the Dirac Medal was Professor Subir Sachdev of Harvard University. Professor Sachdev’s area of research is quantum mechanics, in particular development of condensed matter theory. His lecture was entitled “Quantum entanglement and superconductivity” and explained how these two phenomena are interrelated. His lecture was extremely interesting and is a lot of discussion following it.

A reminder that the nominations for the Society’s 2015 awards close on 30 September. As you know, these are some of the most prestigious awards in Australian science and every year we have a very strong field of candidates nominated. If you are aware of worthy individuals, we encourage you to submit a nomination. Details are available on the website.

The new website is finished and is currently being tested – it is expected to go into production in the next week or so.

There are lots of things happening between now and the end of the year – I look forward to seeing you during the very busy for quarter of the year.

As always, I am easily contacted by email at president@royalsoc.all.au and would like to hear from you.

Donald Hector
September 2015



The Future of Work

His Excellency General The Honourable David Hurley AC DSC (Ret'd) Governor of New South Wales, and Patron of the Royal Society of New South Wales, opening the Royal Society of NSW and Four Academies Forum on the “Future of Work” held at Government House on Tuesday, 15 September 2015.

For the full report, please go to page 6



Richard Roberts

Human Evolution and Dispersal from Africa to Australia Professor Richard Roberts

Director of the Centre for Archaeological Science
University of Wollongong

Richard Roberts received his training in the Earth sciences, first in the UK, then in Canada. Australia was next. His interests centre on the interactions between prehistoric people and their environments, and in particular the timing, causes and consequences of modern human (*Homo Sapiens*) migrations around the planet.

The team which he heads is based at the Centre for Archaeological Science at the University of Wollongong, and is dedicated to archaeological dating and the reconstruction of past environments. Early work was concerned with the first evidence for the human colonization of Australia and the resulting mass extinction of the megafauna. Richard has since expanded these interests into Asia and Africa, and was involved in the discovery and dating of the “Hobbit”, a new species of tiny human (*Homo Floresiensis*) found in 2003 on the Indonesian island of Flores.

Many in the audience of 65 persons had come to hear Professor Roberts’ presentation and comments of his research experiences relating to the Hobbit. They were aware that twelve years ago in Australia and Indonesia, the scientific world had been turned on its head. By a very small head at that. The newly reported species of human was only one metre tall, with a brain the size of a chimp’s, leading some to theorise that the Hobbit was the unfortunate

consequence of one of our species, *Homo sapiens*, suffering from a severe medical condition called microencephaly, in which the head and brain are massively reduced in size. When the find of a partial skeleton was made in the Liang Bua cave, the archaeologists had been searching for the remains of the ancestors of the first Australians, early *Homo sapiens*, dispersing through the Indonesian archipelago to Australia. The skull was that of an adult human, but far too small to be one of our own species, and many other features of the skull, teeth and lower jaw didn’t fit the modern human mould. The same was also true of the rest of the body, with the Hobbit having very different limb proportions to us. Opinions were given by some in the field that a variety of different pathologies such as Down syndrome could explain the curious anatomy of the Hobbit. However as more bones have been excavated and described, expert opinion supports overwhelmingly the original diagnosis of the Hobbit as a new species.

Richard Roberts is the first to admit that there are huge gaps in our knowledge of the Hobbit. Two gaping holes are the early years of the Hobbit, including its evolutionary history and route of passage to Flores, and its final days. He also says that it is even possible that the Hobbits met and bred with the enigmatic Denisovans, a sister group to Neanderthals, who may have inhibited

parts of Southeast Asia at the same time as Hobbits and *Homo sapiens*. The cave deposits represent a snapshot in time, a mere glimpse of human activities over the last 100,000 years. We remain ignorant of the early evolutionary development of the Hobbit.

One thing about which there is no doubt however, is that we should expect the unexpected when excavating the lost worlds of Indonesia. Professor Richard Roberts feels that it is not beyond reason that another new species of human might be discovered in the years ahead. He cites advances in archaeological science techniques that are helping to illuminate the human past, from improvements in scientific dating techniques to the chemical analysis of residues attached to ancient artifacts, illustrated by examples from his current project funded by the Australian Research Council.

Anne Wood



**Report of 24 September 2015
Meeting of the Royal Society
Southern Highlands Branch**

**Role of the NSW Chief Scientist and Engineer,
as exemplified by the review into
Coal Seam Gas Activities in NSW
to provide advice to Government**



Mary O'Kane

Professor Mary O'Kane

The NSW Chief Scientist and Engineer

Professor Mary O'Kane was appointed NSW Chief Scientist & Engineer in October 2008. In her role, she consults widely with academia, industry and government to ensure that scientific knowledge and research can be adapted and used to benefit NSW. In 2013 the then Premier commissioned the Review into Coal Seam Gas Activities in NSW and asked the Chief Scientist & Engineer to undertake the review. In this lecture, Professor O'Kane covered the major processes and findings of the review as an example of how the Office operates in providing advice to Government.

The Southern Highlands audience of 45 was somewhat smaller than usual due largely to the school holidays, but those present were privileged to welcome NSW Royal Society President Dr Donald Hector and his wife, and Mr John Hardie, immediate past president.

In providing the context of NSW CSG development, Professor O'Kane pointed out firstly that gas from coal seams had been used during the war, when Balmain Colliery from 1935 to 1946 compressed gas and sold it as motor fuel. Later, climate change concerns drove the desire for lower emissions fuel such as gas. The NSW government encouraged prospecting in the 2000s, following the regulating of

CSG through the *Petroleum Onshore Act 1991*. Commercial extraction has been conducted at Camden for over 10 years.

The Terms of Reference for the review were far ranging. There had to be a comprehensive industry compliance study involving site visits and well inspections, this work being informed by compliance audits undertaken by regulatory officers, such as the Environment Protection Authority and other government agencies. The review had to also identify and assess any gaps in the identification and management of risk arising from coal seam gas exploration, assessment and production, particularly as they related to human health, the environment and water catchments.

The review also had to identify best practice in relation to the management of CSG or similar unconventional gas projects in close proximity to residential properties and urban areas, and consider appropriate ways to manage the interface between residences and CSG activity. It had to explain too how the characteristics of the NSW coal seam gas industry compared with the industry nationally and internationally. Inspection and monitoring of current drilling activities including water extraction, hydraulic fracturing and aquifer protection

techniques had also to be carried out. Finally, a series of information papers on specific elements of CSG operation and impact had to be produced, to inform policy development and to assist with public understanding.

Regarding the matter of public understanding, Professor O'Kane pointed out very early in her address that a big issue is that nobody trusts CSG companies or government. This was stated along with other conclusions of the report. She said too that although technologies to extract CSG and manage by-products are known, local hydrogeology is not well understood. However the situation should improve as the industry progresses. The distributed nature of the industry raises particular challenges too. She stated her belief that many of the troubling issues could be addressed, but that work was required on many fronts.

Anne Wood

(Continued from page 1.) **Elaine Sadler** is Professor of Astrophysics in the School of Physics at The University of Sydney, and Director of the Australian Research Council Centre of Excellence for All-sky Astrophysics (CAASTRO).

She started her career with an undergraduate physics degree at the University of Queensland, followed by a PhD in astronomy at the Australian National University. She held postdoctoral fellowships in Germany and the United States before returning to Australia to take up research positions at the Anglo-Australian Observatory and the University of Sydney.

Elaine's main research interest is galaxy evolution - using large observational data sets to study how galaxies form and change on timescales of billions of years. Much of her research involves the analysis of data from large-area optical and radio surveys of the sky. She has designed and undertaken several major astronomical surveys over the years, and currently leads the ASKAP-FLASH project. This project is using the new Australian SKA Pathfinder (ASKAP) telescope in Western Australia to learn more about the amount and distribution of neutral hydrogen gas in very distant galaxies.

Elaine was elected a Fellow of the Australian Academy of Science in 2010. She has served as President of Division VIII (Galaxies and the Universe) of the International Astronomical Union (2009-2012) and Chair of the National Committee for Astronomy (2010-2012). As CAASTRO Director, she oversees a 140-strong team of scientists and research students across seven Australian university nodes and 11 partner institutions here and overseas.



Crowdsourcing Appeal for Radio Astronomy

The Mopra radio telescope, which is located at Siding Spring Observatory near Coonabarabran, is facing closure at the end of this year in the face of funding cuts to the CSIRO. The telescope team is currently mapping the clouds of interstellar molecules that lie along the southern Milky Way. Professor Michael Burton FRSN says that for information about the research and donations to sustain it click <https://www.kickstarter.com/projects/astrocate/teammopra-save-a-telescope-and-map-the-milky-way>

Contacts for Your Officer Bearers and Council Members

Dr Donald Hector President: <president@royalsoc.org.au>
Em. Prof D. Brynn Hibbert Vice President: <b.hibbert@unsw.edu.au>
Mr John R Hardie Vice President: <john.hardie@royalsoc.org.au>
Ms Judith Wheeldon AM Vice President: <judith.wheeldon@mac.com>
Prof. Michael Burton Hon.Secretary (Editorial): <editor@royalsoc.org.au>
Prof. Neil Foster Hon. Secretary: <n.foster@unsw.edu.au>
Dr Ragbir Bhathal Hon. Librarian: <R.Bhathal@uws.edu.au>
Mr Hub Regtop (Southern Highlands Rep): <regtop@ozemail.com.au>
Dr Frederick Osman: <fosman@trinity.nsw.edu.au>

Prof Richard Banati: <rib@ansto.gov.au>
Em. Prof Roy MacLeod: <roy.macleod@sydney.edu.au>
Dr Erik Aslaksen <erik.aslaksen@bigpond.com>
Em. Prof Heinrich Hora: <h.hora@unsw.edu.au>
Dr. Desmond Griffin AM: <desgriffin@optusnet.com.au>
Prof. E. James Kehoe: <ejameskehoe@gmail.com>
Prof. Bruce Milthorpe: <Bruce.Milthorpe@uts.edu.au>
Prof. Ian Sloan AO: <i.sloan@unsw.edu.au>
Prof. Ian Wilkinson: <ian.wilkinson@sydney.edu.au>

The Bulletin is issued monthly by the Royal Society of New South Wales
Editor: Prof. E. James Kehoe; Managing Editor: Edward Hibbert
Contact: **Ms Zoe Ballarin** Phone: +61 2 9431 8691 Fax: +61 2 9431 8677 Email: info@royalsoc.org.au
Mailing Address: The Royal Society of NSW, PO Box 576, Crows Nest NSW 1585, Australia

For further information: <http://www.royalsoc.org.au/>

Royal Society of NSW and Four Academies Forum

“The Future of Work”

Tuesday, 15 September 2015

Government House, Sydney

The Royal Society of NSW and Four Academies Forum was the inaugural collaborative event between the Society and the NSW-chapters of the four national Academies. The Forum was hosted by the patron of the Society, His Excellency General David Hurley at Government House on Tuesday, 15 September 2015. (For a photo of the Governor, see p. 2.)

The speakers at the forum were Professor Mary O’Kane, Chief Scientist and Engineer of NSW (see p.4 for photo) who provided framing comments about the technological challenges that the working environment would face over the next 20 years or so and the need for NSW and the nation to embrace innovation and change and the introduction of new business models Professor Andrew Holmes of the Australian Academy of Science, Professor John Fitzgerald, President of the Australian Academy of the Humanities and Dr Alan Finkel, President of the Australian Academy of Technological Sciences and Engineering gave valuable insights from their various perspectives and a panel discussion responding to these issues was led by Professor Glenn Withers President-elect of the Academy of Social Sciences in Australia. In addition, there were five other speakers drawn from senior Fellows of the four Academies. They were Professor Thomas Maschmeyer, Professor Hugh Durrant Whyte, Professor Amarjit Kaur, Professor Bettina Cass, and Professor Julianne Schultz. The discussion panel, led by Professor Withers consisted of Dr Eric Knight, Professor Vera Mackie, Mr Anthony Roediger and Mr Jeremy Webster.

The issues covered were far-reaching: “techno-optimism” – humanity has a good track record for solving problems by the application of technology. We should not forget the enormous challenges of the changing environment that will take place over the next couple of decades but we should not forget the capacity of humans to adapt. One of the best ways that this adaptability presents itself is through (Continued p. 7)



Professor Andrew Holmes of the Australian Academy of Science.



Professor John Fitzgerald, President of the Australian Academy of the Humanities

Forum: “The Future of Work (Continued from p. 6)

innovation of entrepreneurship and examples of development of start-up technologies that have become very successful businesses. Yet many of the challenges that face the workforce will not be technological in their nature, even though they may have their origins there. The role of social policy, particularly around carers as the population ages and families with both parents participating in the workforce become the norm. Indeed, despite the fact we largely focus on the changes that face the workforce that originate in technology, many of the drivers are not technological in their nature – globalisation, climate change, resource conflicts, population movements and cultural change will be major influences in the coming decades. Although we tend to think of technological change as the driver of change, this is perhaps the wrong way to look at it – it suggests that we have no option. In fact, whether or not we choose to adopt particular technologies is a matter of policy and choice.

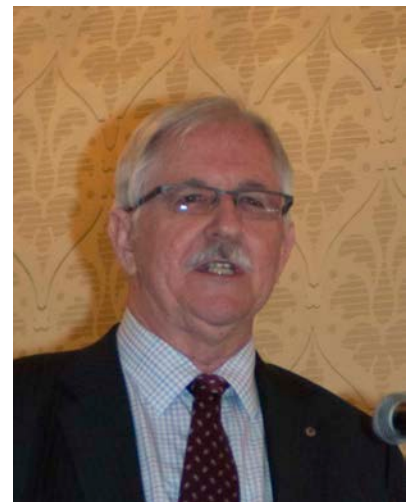
Education emerged as a major theme. A society cannot progress unless it educates its people. The challenge is to ensure that education is well directed and that we educate our people the right fields. We heard about the extraordinary advances in computing technology and how this would change the nature of work over the next 20 years – perhaps 40% of today’s jobs will disappear. But this need not be a looming social disaster because headlines about such projections tend to overlook the rate of job creation. If job creation is greater than job destruction, the technology will end up providing a net benefit. But such disruption itself causes problems and the workforce and the communities in which they work need to be resilient and to be able to embrace change. Historically, Australia has done well in this as evidenced in places like Newcastle and Wollongong, but there are always winners and losers – we need to be sure that communities in individuals are not destroyed in the process. It is also important that as a nation, we do not consider these issues in isolation. Workforces in Asia, for example, have very high migrant workforces – the movement of people and the cultural and social issues and challenges that these introduce will be an important factor as we plan for the future.

The Governor summed up, emphasising that our future might be defined in terms of volatility, uncertainty, complexity and ambiguity. Over the next 20 or 30 years, the rate of change will be great and the challenge for the nation is how we engage with these issues. Technology should not be the driver – it should be the tool to help us define what we want to be as a nation.

The Society thanks the speakers and the panellists for their extremely rich and diverse insights and, in particular, thanks the organising committee of the Forum, Dr Donald Hector, Dr David Cook, Professor Ian Dawes, Professor Max Crossley, Professor John Gascoigne, Professor Heather Goodall, Dr Des Griffin, Mr John Hardie, Dr Richard Sheldrake and Professor Ian Wilkinson for putting together such a stimulating programme.



Dr Alan Finkel, President of the Australian Academy of Technological Sciences and Engineering



Professor Glenn Withers, President-elect of the Academy of Social Sciences in Australia

“Trait-Based Ecology”

Distinguished Professor Mark Westoby

Macquarie University

1235th Ordinary General Meeting, Wednesday 2 September 2015



Distinguished Professor Mark Westoby

On average, species are around for about one million years. Each species is unique and, importantly, its genome represents a record or a heritage of solving problems – it is an embodied history and for this reason alone species should be respected and not casually discarded. Distinguished Professor Mark Westoby is a pioneer of 'trait-based ecology'. This approach arranges the world's 300,000 plant species into functional types on the basis of their traits. Traits summarise major trade-offs faced by plants. What emerges is a picture of the variety of different ways plant species make a living, sometimes adapting to different habitats but also via different approaches to shared habitat.

Until quite recently – no more than 40 years or so ago – ecology was rather like chemistry before the periodic table was conceived. There was little in the way of a system to organise our thinking. One attempt to establish such a system was Philip Grime's competitor/stress-tolerator/ruderal (CSR) triangle which characterised plant environment according to their stresses and disturbances. But Professor Westoby proposed setting this aside and simply using the traits directly as axes. For example, plants make dry matter and use this to deploy leaves, so the leaf-mass/leaf-area ratio is a useful measure to use to compare plant

populations. This poses interesting questions such as how can one species be competitive while deploying twentyfold less leaf area per unit of mass than another. The first world-wide collaboration using this methodology was the Global Plant Trait Network (GLOPNET). It examined leaf-traits using a “leaf economics” model using three axes: mean annual temperature; mean annual rainfall; and leaf-mass/area. Economic thinking in ecology is a novel approach utilising ideas developed in the field of micro-economics to structure problems in ecology.

Professor Westoby showed how plant traits have diverged through historical lineages and how traits influence competitiveness. He gave examples of analyses done in temperate zones and the tropics – for instance, looking at the growth of “focal plants” versus the basal area of competitors in the neighbourhood. The methodology correlated well across different forest types and demonstrated that the application of economic theory to a relatively simple model such as trait ecology enables worldwide collaboration and provides a simple, yet powerful approach to better understand a wide variety of ecological issues. for putting together such a stimulating programme.