The Royal Society of New South Wales

Bulletin and Proceedings 334

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Future Events 2010

Lectures in Sydney are held in Lecture Room 1, Darlington Centre, University of Sydney at 7 pm on the first Wednesday of the month with drinks available from 6 pm.

Wednesday 5 May 2010 at 7 pm

A/Prof Mike Cortie from UTS

The Weird World of Nanoscale Gold

(see details at right)

Wednesday 2 June 2010 at 7 pm

Dr Peter Tyler – Royal Society of NSW Historian

Science for Gentlemen – The Royal Society in the Nineteenth Century

Southern Highlands Branch

Meetings are held on the third Thursday of each month in the Drama Theatre at Frensham School, Mittagong (enter off Waverley Parade), at 6.30pm.

next talk

Thursday 20 May 2010, at 6.30pm

Membership Renewals

Thank you to the many members who have renewed their membership promptly. Many more members paid by direct debit this year than last. Only three members where unidentifiable by their direct debit payment reference – if you think this is you, please contact the office as soon as possible to rectify your membership status. Reminders will be mailed to un-financial members at the end of April. Your support is very much appreciated. Marian Haire, Hon. Treasurer

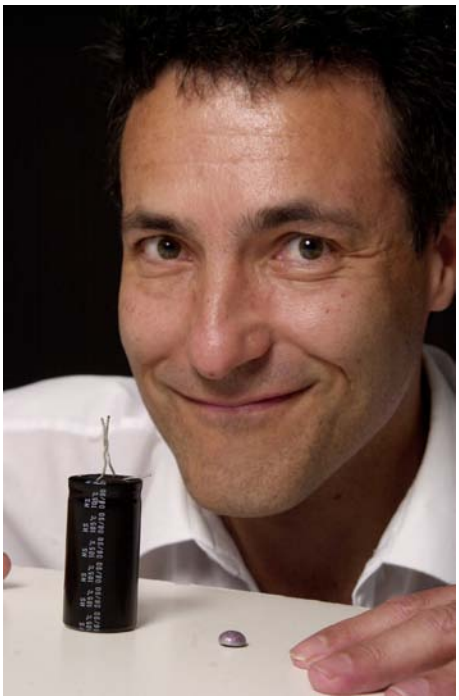
Bulletin Editor, Bruce Welch

Lecture 5 May 2010, Darlington Centre at 7pm

The Weird World of Nanoscale Gold

Michael Cortie, Director : Institute for Nanoscale Technology, University of Technology Sydney

The field of 'nanotechnology' has captured the imaginations of many. There are many new journals dedicated to the subject and the entertainment media have featured it in several recent movies and books. But what is 'nanotechnology', and is it actually a new thing? Some people have described much of current nanotechnology as just old things in new clothes. I will show that while the study and exploitation of matter at the nanoscale is old news, there really is something quite startlingly different about the new field of 'nanotechnology'. Real nanotechnology is the most reductionist form of science and technology imaginable. In the real thing, the basic paradigm is to define a desired technological functionality, and then to work backwards atom by atom to design a system to achieve that effect.



Mike Cortie shows two capacitors. The big one is made by conventional technology and the small one has the same capacitance but is made using mesoprous gold (a sponge made of gold nanoparticles)

Some materials, such as silicon, carbon, DNA, titanium dioxide and gold have become very prominent within the nanotech arena. This has not been the result of some arbitrary choices, rather these particular materials offer uniquely attractive engineering properties that specifically commend their selection for nanoscale systems and devices. Gold is particularly interesting to myself and my colleagues, and much of our research targets or uses this element. The reason gold is popular in nanoscale research and technology is that it offers an unrivalled combination of material properties for applications requiring a conductor. But what can you do with it? In my talk I will show first, how things become a bit weird with gold as the size scale is shrunk to nano-dimensions, and then I will describe some of the many useful devices that can be fabricated by exploiting these properties. Some of the interesting existing and prospective applications for gold at the nanoscale include bio-diagnostics, biosensors, solar filters, optical filters, colorants and pigments, single electron devices, new kinds of digital memory, and plasmonic circuitry. But it is a fast moving field and who knows what new ideas will pop up in the next couple of years.

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Patrons of The Royal Society of NSW

Her Excellency Ms Quentin Bryce AC
Governor-General of the Commonwealth of Australia

Her Excellency Professor Marie Bashir AC CVO Governor of NSW

From the President

On Saturday 27 March I attended the Royal Australian Chemical Institute's President's dinner at the North Ryde RSL as a guest of the President, Dr Adam Cawley. At this event the RACI's awards for the year were presented. The guest speaker was Dr Thomas Barlow, who has helped us with our work on Science House. It was pleasing to be able to be present at this event in order to further develop the already strong relationship between the two Societies and to make the work of our Society more widely known. It was also pleasing to see several other members of our Society present at this event.

The following Monday, 29 March, our Chief Patron, the Governor-General, hosted a splendid reception at Admiralty House for the Society. Her Excellency presented our seven Inaugural Fellows with their certificates before an invited audience of about 60. Following the investiture, many guests joined the Fellows and I for an informal dinner at Milsons Restaurant nearby to cap off a

very enjoyable and significant event for the Society.

This year's Annual General Meeting harked back to the Society's practice in the nineteenth century of having an Anniversary Address at this time. However, instead of the President delivering it I invited a distinguished academic, the Deputy Vice-Chancellor (Research) at Sydney University, Professor Jill Trewhella, to give her insights into what the future might hold for science education. It was pleasing to get a different perspective on how the Society might have a place in this new era and that we are already doing many of the things that align with this vision.

On 15 April I met with Shelley Peers from the Australian Academy of Science about the Academy's Primary Connections program, a significant educational initiative for the primary science curriculum operating in all states and territories. It is vital for the future of science that our children in primary school are given suitable and appropriate messages and positive experiences about science and the practice of science so that their attitudes toward science later in their lives will be based on reality and align with their own sense of curiosity and achievement. We also found time to discuss the possibility of working on joint projects with the Academy.

John Hardie

Inaugural Fellows Reception

As announced in the previous Bulletin, the Society was honoured by its Chief Patron, Her Excellency Ms Quentin Bryce AC, Governor-General of the Commonwealth of Australia, with a reception at Admiralty House Kirribilli at which the seven Inaugural Fellows of the Society were presented with their awards before an invited audience of about 60. Among the guests was the Australian of the Year, Professor Patrick McGorry, the NSW Chief Scientist and Scientific Engineer, Professor Mary O'Kane, the Deans of Science of Sydney, NSW, Macquarie and Charles Sturt universities, and the Chair of the Royal Institution of Australia, Mr Peter Yates. We have included Her Excellency's speech at the investiture in this issue of the Bulletin (see next page).

Inaugural Fellows (seated) are given a standing ovation by all present

The President reads a Fellow's citation under the watchful gaze of the Governor-General

Bob Clark, Irene Kelly (obscured), Bruce Ramage, Peter Tyler, Quentin Bryce, John Hardie, and Marian Haire

Address by Her Excellency Ms Quentin Bryce AC, Governor-General of the Commonwealth of Australia on the occasion of the inaugural Fellow awards by the Royal Society of New South Wales, Admiralty House, Sydney

29 March 2010

President, Royal Society of New South Wales, Mr John Hardie, Australian of the Year 2010, Professor Patrick McGorry, Inaugural Fellows, other distinguished scientists and scholars, ladies and gentlemen, I'm delighted that you could join us in this historic Australian house for an important occasion in the life of the Society, and of each of your Inaugural Fellows.

I am very proud to be your patron.

The Society has a long, rich and eminent history in this State: your keen and intense contribution to scientific enquiry and exposition since the early 1820s; your prescience in fostering scientific thought, not as an exclusive field, but as one, that naturally and sensibly sits alongside, and engages with, philosophy and the liberal arts.

Those early forays, and the public prominence and recognition that followed, helped to influence a culture and method of reasoning in this country that are now cross-disciplinary, lateral and creative, intellectually unencumbered, and thus, far-reaching in their possibilities, and also, rigorous and demanding in the high standards you consistently require of your members and your audiences.

Friends, I have to confess that I am absolutely fascinated and exhilarated by science – and always have been – though never brave enough to enter its scholarship.

I'm in awe of the discipline and exacting care with which you undertake its exploration and analysis, the ardour and deft control with which you write and talk about it.

I'm amazed, time and again, by the coalescence of conventional and unprecedented thinking; the simplicity and complexity of it; and its unfathomable opportunities.

As Einstein said, "I love the sense of mystery and beauty that underlies its endeavour."[1]

Last week I presented this year's Stellar Scholarships to twelve young women in public schools in New South Wales, mostly – I noted, from small country towns who have excelled in their secondary science studies.

Our Inaugural Fellows with Her Excellency: l to r Professors Bruce Warren, Robert Clark, Gavin Brown, Jak Kelly, Michael Archer, Richard Stanton (absent: David Craig)

The scholars do a week of work experience at the Sydney Observatory, receive a marvellous telescope and considerable funds over the coming two years, to spend wisely on developing their scientific interests.

I talked to them about cherishing these opportunities, as they represent new pathways, particularly for women, in science.

I mentioned our new Nobel Laureate, Professor Elizabeth Blackburn, whom I was privileged to invest recently with the Companion of the Order of Australia.

I recalled my girlhood memories of the first young woman from my little country town who went to The University of Queensland to study science in the 1940s – how we marvelled at the very idea.

In 1960, when I started there myself, there was one woman professor on the campus; Dr Dorothy Hill, a geologist. How we all admired her from afar.

And how we still admire you, women and men, at the forefront of your disciplines, at a time when the world is afflicted like never before.

Former Chief Scientist in Britain, and former President of the British Science Association, Sir David King, said this [2] in his 2008 address towards the end of his term: "We are faced with a series of enormous challenges in this century. They are quite different from anything our civilisation has had to face up to before, and, interestingly, they arise because of what science, engineering, medicine and agriculture have delivered in the 19th and 20th centuries. Notably, we have a lifespan of around 75 to 80 years, almost double that at the start of the last century; and, as a result, we're adding another billion people to the planet every twelve years, so by mid-century we'll be around the nine billion mark."

Sir David says we need to put these facts into all of the thinking we apply to governing and sustaining modern society, not just science.

As the Society has long appreciated and acted on, he talked about how vital it is for every field to be exposed to the 21st century challenges, philosophy, politics, economics, physics, engineering and the environmental sciences.

We need to keep reassessing our priorities – where we direct our research and teaching and funding – so that the urgent calls of the planet are responded to, growing and securing food for the nine billion of us, malaria, HIV/AIDS, better technologies to harness solar energy and there are many more of course.

I am reassured and inspired by the work the Society continues to support and encourage.

It is critical to how we live now, and how we aspire to live ten, twenty, thirty, forty years hence.

Inaugural Fellows, the awards you are to receive this evening are due recognition of your extraordinary contribution to the matters that are at the centre of our existence and wellbeing.

Friends, I salute you.

[1] Denis Brian, Einstein: a life, John Wiley & Sons, New York, 1996, p 234

[2] Refer interview by Robyn Williams, Science Show, Radio National, 20.9.08

Mary O'Kane and Gavin Brown

John Hardie reads citation for Mike Archer

Ted Smith, Clive Wilmot and Mike Archer

Marian Haire, Bill Sewell, Patrick McGorry and Michael Bryce

Richard Stanton with his daughter Marion and Peter Yates

Annual General meeting 2010

The Society held its Annual General Meeting on Wednesday 7 April 2010 at 7.15 pm at the Darlington Centre, University of Sydney. It was preceded by the 1179th Ordinary General Meeting at which a record 15 new members were admitted to the Society.

At the AGM the Society's Annual Report of Council for the year ended 31 March 2010 and the Audited Financial Statements for the year ended 31 December 2009 were accepted. They form part of this edition of the ***Bulletin and Proceedings***. Graeme Green Accountants was appointed as Auditor for the Society's 2010/11 year and the following members were elected to Council for the same period:

President: John Hardie,
Vice Presidents:
Prof Heinrich Hora
Clive Wilmot
Hon Secretary (General)
Bruce Welch
Hon Secretary (Editorial)
Prof Jak Kelly
Hon Treasurer: Marian Haire
Councillors:

- Alan Buttenshaw
- Jim Franklin
- Julie Haeusler
- Dr Donald Hector
- Prof. D Brynn Hibbert
- Michael Lake
- Fred Osman
- A/Prof Bill Sewell
- Prof. Bruce A Warren

Southern Highlands Rep.:
Clive Wilmot

Professor Jill Trewhella received the speaker's medal from John Hardie

The Deputy Vice-Chancellor (Research) at Sydney University, Professor Jill Trewhella, concluded the evening by delivering the Anniversary Address entitled ***Science and Scientists in the Modern World***. A vote of thanks was offered by the President.

Continued from page 1

Mike Cortie is the Director of the Institute for Nanoscale Technology at the University of Technology, Sydney (UTS), in Australia.

Mike Cortie was born and educated in South Africa. He has a BSc(Eng) degree in Physical Metallurgy, a Masters degree earned from research on the corrosion of zirconium and a PhD degree, which was focused on metal fatigue and awarded in 1987. After a stint at South Africa's Atomic Energy Corporation and at Pylon Engineering, a gear-cutting works, Mike joined Mintek, a minerals and metals research organisation. Mike headed the Physical Metallurgy Division of Mintek between 1997 and 2002. The Division consults widely to South African and international industry and now generates the major portion of its funds from foreign contract research. He relocated to Australia and joined UTS in July 2002.

Mike's current research interest is nanotechnology, and in particular the applications of precious metals in nanotechnology. Previous research activities included research on ferritic and nickel-substituted stainless steels, on intermetallic compounds with the C1 (CF12) and B2/L21 crystal structures, on X-ray diffraction and crystallographic texture of bcc and fcc alloys, on cellular automata and the simulation of metal solidification, cracking and solid state transformations, on explosive interactions between molten metal and water, on displacive transformations in Pt-containing alloys and compounds, on the phase relationships in the Al-Au-Cu ternary system, and on the crystal structures of the martensite phase formed by displacive phase transformation in the b Au-Al-Cu shape memory alloy. He has also been active outside of the materials arena, and has made contributions to the mathematical modelling and graphics rendering of mollusc shells, and the science education of children.

Southern Highlands Branch

Report of April Meeting

Weirdness in the Quantum World: When light and matter behave as both particles and waves.

Professor Kenneth Baldwin, Deputy Director: Research School of Physical Sciences and Engineering and the Australian Research Council Centre of Excellence for Quantum Atom-Optics, ANU

The Southern Highlands Branch meeting of 15 April was held at 6.30pm in the Drama Theatre, Frensham School, Mittagong. The lecture attracted a 48-strong audience.

Professor Baldwin is a laser physicist based at the Australian National University. He is a Past-President of the Australian Optical Society, and is the first Australian to be elected to the Board of Directors of the Optical Society of America. He is also Past-President of the Australian Scientific and Technological Societies (FASTS). In 2004 he won the Australian Government Eureka Prize for Promoting Understanding of Science for his role in initiating and championing "Science meets Parliament". He has 81 refereed publications, 183 conference papers and has given 17 invited/postdeadline conference talks.

Professor Baldwin introduced his audience to the dual behaviours of light as both particles and waves using practical demonstrations. He showed the wave behaviour of light using double-slit diffraction patterns from a laser beam, and the particle behaviour of the same beam with a photometer. He then used these basic experiments, along with numerous accompanying video presentations, as a platform to describe the type of research that he and his teams are conducting in order to develop new laser technologies.

According to the laws of quantum mechanics that govern conditions in the microcosmos, what we normally term a particle can sometimes behave like a wave. This is well known and is used in the electron microscope, for example. As early as 1924, de Broglie postulated the existence of matter waves and expressed their wavelength in terms of an inverse relationship with the momentum of the particles. The more slowly the particle moves, the less its momentum and the longer the de Broglie wavelength. According to the kinetic theory of gases, low particle velocities correspond to low temperatures. If a sufficiently dense gas of cold atoms can be produced, the matter wavelengths of the particles will be of the same order of magnitude as the distance between them. It is at that point that the different waves of matter can 'sense' one another and co-ordinate their state, and this is Bose-Einstein condensation. It is sometimes said that a "superatom" arises since the whole complex is described by one single wave function exactly as in a single atom.

Professor Baldwin described many aspects of his research interests. He talked of his research into atom optics, where lasers can be used to create nanostructures for better microchips, and showed how lasers can be used to cool atoms to the lowest temperatures in the universe, at which point they behave more like waves than particles. A large part of the presentation dealt with the physics of the wavelengths generated, many examples being chosen to demonstrate the relationship between the achieved wavelength and the momentum of the particle involved. One practical application of this wave behaviour is the generation of sensitive detectors of, for example, changes in the earth's gravitational field to enhance mineral exploration.

It was clear from Professor Baldwin's presentation that his field of quantum atom-optics is advancing at an unprecedented pace, one only has to consider the recent spate of Nobel prize winners in that field.

At the conclusion of this extraordinary lecture, Professor Baldwin answered as many audience questions as time allowed. The vote of thanks was given by Anne Wood.

Anne Wood

Photos from the launch of the Liversidge Book

John Hardie, Marie Bashir, Roy MacLeod and Professor Iqbal Ramzan, Dean of Pharmacy at Sydney University

Roy MacLeod with the portrait of Archibald Liversidge in the Great Hall

New Members

Fifteen new members were announced at the April meeting of the Society:

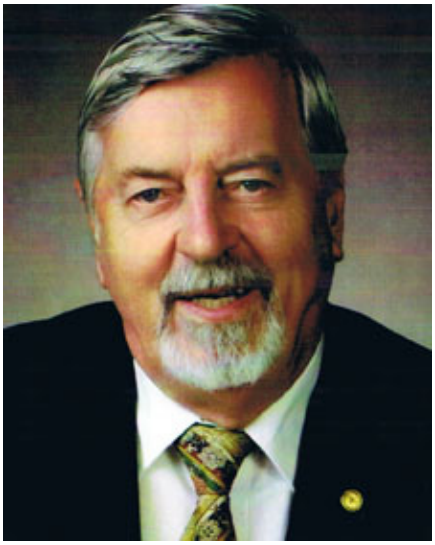
Maree Simpson - Full Member
Kevin Parton - Full Member
David McKenzie - Full Member
David Kemp - Full Member
David Goldney - Full Member
Murray Fletcher - Full Member
Scott Andrew - Full Member
Andrew Rawson - Full Member
Yahn Guisard - Full Member
Peter Anderson - Full Member
Anantanarayanan Raman - Full Member
Gregory Diven - Full Member
Dalibor Frtunik - Associate Member
Randolph Barnes - Full Member
Merlin Crossley - Full Member

We welcome them into the Society.

Nuclear power without radioactivity

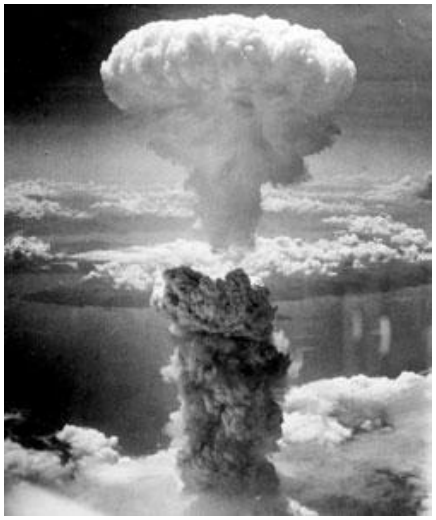
Radiation-free nuclear fusion could be possible in the future, claim a team of international scientists. This could lead to the development of clean and sustainable electricity production.

Despite the myriad of solutions to the energy crisis being developed, nuclear fusion remains the ultimate goal as it has the potential to provide vast quantities of sustainable and clean electricity. But nuclear energy currently comes with a serious environmental and health hazard side effect - radiation. For fusion to gain widespread acceptance, it must be able to produce radiation-free energy but the key to this has so far remained elusive, explains Heinrich Hora at the University of New South Wales in Sydney, Australia.



Heinrich Hora, Royal Society of New South Wales Vice President

Conventionally, the fusion process occurs with deuterium and tritium as fuel. The fuel is spherically compressed - meaning compression occurs from all directions - with laser irradiation to 1000 times its solid state density. This ignites the fuel, producing helium atoms, energy and neutrons which cause radiation. Fusion is also possible with hydrogen and boron-11, and this could produce cleaner energy as it does not release neutrons, explains Hora. But this fuel requires much greater amounts of energy to initiate and so has remained unpopular.



The power of nuclear fusion has yet to be tamed

Now, a team led by Hora has carried out computational studies to demonstrate that new laser technology capable of producing short but high energy pulses could be used to ignite hydrogen/boron-11 fuel using side-on ignition. The high energy laser pulses can be used to create a plasma block that generates a high density ion beam, which ignites the fuel without it needing to be compressed, explains Hora. Without compression, much lower energy demands than previously thought are needed. 'It was a surprise when we used hydrogen-boron instead of deuterium-tritium. It was not 100 000 times more difficult, it was only ten times,' says Hora.

'This has the potential to be the best route to fusion energy,' says Steve Haan, an expert in nuclear fusion at Lawrence Livermore National Laboratory in California. However, he also points out that it is still only potential at this point, 'there's a fair amount of work to do before this technology is at hand'.

Hora agrees that much more work is needed to fully understand this radical new approach. Its achievement will depend on continued advances in laser optics, target physics and power conversion technology, he concludes.

Yuandi Li

Editor, Royal Society of Chemistry, London. 24 March 2010

Energy Environ. Sci. 2010, 3, 479-486

Australian Institute of Physics NSW Branch

3rd General Meeting 2010
Monday 24 May 2010

Professor Heinrich Hora, University of NSW; "Nuclear Energy without Radioactive Radiations". Talk commences at 6:30pm

Location of talks: Slade Lecture Theatre, School of Physics, University of Sydney. Refreshments will be available before each talk. Entrance to all events is free.

Dinner to follow at Buon Gusto Restaurant, Abercrombie St.
Please contact Dr Fred Osman on 0418 444 477 to book.

Contact your office bearers

John Hardie President	02 9363 9360	Prof Heinrich Hora Vice President	02 4627 7769
Clive Wilmot Vice President	02 4886 4199	Bruce Welch Hon. Secretary (General)	02 9569 9928
Prof Jak Kelly Hon. Secretary (Editorial)	02 9419 6877	Marian Haire Hon Treasurer	02 8467 3575
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Prof. D Brynn Hibbert	0411 286 480	Michael Lake	02 9514 2238
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