The Bulletin 384

The Royal Society of New South Wales

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Future Events

Wednesday 4 February 2015
Royal Society of NSW Scholarship Presentations & 1229th OGM
Union, University & Schools Club
25 Bent St, Sydney
Dress code: Jacket and tie
6:00 for 6:30 pm

Monday 16 February 2015
Meeting of the Four Societies
(see separate flyer)
Latest Developments in Small Modular Reactors
Delivered by:
Dr. Adi Paterson
CEO, Australian Nuclear Science and Technology Organisation
Clayton Utz
Level 15
1 Bligh Street, Sydney
5:30 for 6:00 pm

SOUTHERN HIGHLANDS BRANCH
Thursday 19 February 2015
Topic: To be announced
The Performing Arts Centre,
Chevalier College, Bowral
6:30pm

For more upcoming events see website www.royalsoc.org.au

Patron of The Royal Society of NSW
His Excellency General The Honourable David Hurley AC DSC (Ret'd)
Governor of NSW

Wednesday 4 February 2015

Royal Society of New South Wales Scholarship Presentations and 1229th Ordinary General Meeting
Union, University &Schools Club
25 Bent St, Sydney
6:00 for 6:30 pm
Enjoy a welcome drink from 6:00 pm

Join us for the annual presentation of our Scholarship Awards which acknowledge and support outstanding achievements by early-career individuals working towards a higher research degree in a science related field.

The 2014 recipients are **Melanie Laird** from the School of Biological Sciences, University of Sydney; **Stephen Parker** from the School of Chemistry, University of New South Wales; and **Ruth Wells** from the School of Psychology , University of Sydney.

Each recipient will deliver a brief talk outlining their current work.



Dress code: Jacket and tie
Members and Fellows: $5; non-members: $20
Book for the dinner after the meeting: $75 per head

OUR WEB ADDRESS

The Society's legacy web address "http://nsw.royalsoc.org.au" has been discontinued. Members should use "www.royalsoc.org.au" or simply "royalsoc.org.au"

From the President

First, on behalf the Council, I wish all our members a very prosperous 2015.

There was a very strong finish to our programme of events in the last month or so of 2014. Professor Martin Banwell of ANU presented the Liversidge Research Lecture; Nobel laureate, Professor Serge Haroche, of the Collège de France presented the Dirac lecture and we finished the year with a most interesting presentation from the Jak Kelly award winner, Linh Tran.

We are pleased that the last stage of the substantial improvement to our back-office systems has been successfully completed, with introduction of our on-line booking and payment facility, with members being able to update their personal information online. The Society also migrated its internet system to a new cloud-based server and at the same time has made substantial change to the website.

But much more important is what we intend to achieve in the coming year or two.

For some time, the Society has been in discussion with the NSW chapters of Australia's four learned Academies (the Australian Academy of Science, the Academy of Social Sciences in Australia, the Australian Academy of the Humanities and the Australian Academy of Technological Sciences and Engineering). The intention is for the Royal Society of NSW provide a meeting place for discussion of matters of national importance, with particular emphasis on long-term future of NSW and, more broadly, Australia. In-principle agreement has been reached to hold a one-day conference in Sydney in September 2015 with the subject "The future of work". The intention is to take a futuristic look at the enormous changes expected in the workplace over the next 20-30 years and the impact and opportunities that this will present. The Council believes that this type of intellectual leadership is the role that the Society must create for itself to maintain its relevance and to make a valuable contribution to the future of NSW.

The Society's origin dates from 1821, making it the oldest such institution in the Southern Hemisphere – but it's important that we look to the future rather than reflect on our history. In the last year, we have had our biggest growth in membership for decades, with many of the new members joining as Fellows of the Society. The Council is about to embark upon a process of consultation to engage with as many of our members as we possibly can so that we can create a future for the Society that maximises opportunities for engagement and to make a substantial contribution to Australia's intellectual life. We expect to have this work ready for discussion at the AGM in April.

There have been a lot of changes in the last year and some of these have been quite disruptive but we are entering 2015 on an entirely new platform. We believe that this is just the beginning and that the society is on course to re-establish itself as being a major influence in the intellectual life of the State. We would like to hear from any member of the Society who would like to contribute to this discourse. As always, I am easily contacted by email at president@royalsoc.all.au and would like to hear from you.

Donald Hector

Dirac Lecture—Photo Gallery (cont. from p.3)

L to R: Michelle Simmons, Serge Haroche, Graeme Melville, Merlin Crossley, John Hardie, Sven Rogge, Heinrich Hora, Donald Hector, and Frederick Osman

Professor Merlin Crossley congratulating and awarding the 2014 Dirac Medal to Nobel Laureate Professor Serge Haroche

Report of the Dirac Lecture held on Tuesday 9 December 2014

The Beauty and Serendipity of Blue Sky Research

Professor Serge Haroche

Head of the Collège de France, Paris

Nobel Laureate Professor Serge Haroche, Collège de France in Paris, was awarded the Dirac Medal and presented the 2014 Dirac Public Lecture at the recent University of New South Wales event.

The 2014 Dirac Lecture was held at the University of New South Wales in December last year. It was a great success, with an audience of more that three hundred people. It was delivered by by Professor Serge Haroche, the French physicist who was awarded the 2012 Nobel Prize for Physics jointly with David J. Wineland for "groundbreaking experimental methods that enable measuring and manipulation of individual quantum systems", a study of the particle of light, the photon. Both Haroche and Wineland made tremendous advances in the understanding of quantum entanglement with Haroche working with cavity quantum electrodynamics and Wineland with trapped ions.Haroche and Wineland have made tremendous advances in our understanding of quantum entanglement, with beautiful experiments to show how atomic systems can be manipulated to exhibit the most extraordinary coherence properties; Haroche working with cavity quantum electrodynamics and Wineland with trapped ions.Haroche and Wineland have made tremendous advances in our understanding of quantum entanglement, with beautiful experiments to show how atomic systems can be manipulated to exhibit the most extraordinary coherence properties; Haroche working with cavity quantum electrodynamics and Wineland with trapped ions. Haroche and Wineland have made tremendous advances in our understanding of quantum entanglement, with beautiful experiments to show how atomic systems can be manipulated to exhibit the most extraordinary coherence properties; Haroche working with cavity quantum electrodynamics and Wineland with trapped ions.

Mankind has always been fascinated by fundamental questions about the universe and our place in it. This has led to the development of blue sky research – research driven by mere curiosity with successes that are among the jewels of our civilized world. There is indeed an aesthetic truth in a scientific theory, comparable to the gratuitous beauty of a piece of art. In addition, basic science is essential to the development of new technologies. The knowledge accumulated by the fundamental approach to science has led, often in unpredictable ways, to practical applications which have revolutionized our daily lives. Nobel Laureate Professor Haroche illustrated in his presentation the long road from fundamental discoveries to technological innovations by a few examples taken from his own field of research – atomic and optical physics. He reflected on the dangers that blue sky research faces in our uncertain global world and explain why it is essential to protect it and to make it thrive, in spite of the present economic difficulties.

The Dirac Medal for the Advancement of Theoretical Physics is awarded by the UNSW and the Australian Institute of Physics. The Lecture and the Medal commemorate the visit to the university in 1975 of Professor Dirac, who gave five lectures. The lectures were subsequently published as a book *Directions of Physics*. Professor Dirac donated the royalties from this book to the University for the Establishment of the Dirac Lecture and Prize. The prize includes a silver medal and honorarium. It was first awarded in 1979.

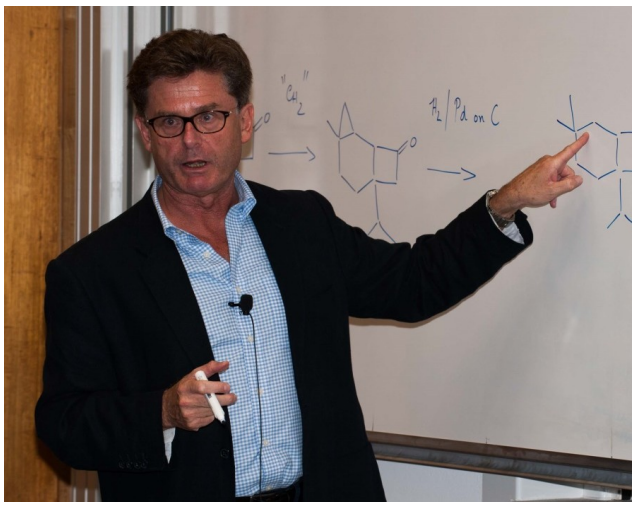
At the end of the lecture and the questions that followed, Serge Haroche was kind enough to answer further questions from the public. The talk was very well received and geared to scientists and members of the public alike with many discussions continuing later after the lecture. The NSW Branch of the Australian Institute of Physics and the Royal Society of New South Wales thoroughly thanks the University of New South Wales for their support and use of facilities on hosting the event and Nobel Laureate Professor Haroche for delivering an outstanding and stimulating 2014 Dirac Lecture!

The Liversidge Research Lecture 2014

Recent studies on the total synthesis of natural products and related systems

Professor Martin Banwell

The Liversidge Research Lecture 2014 was delivered by Professor Martin Banwell at the University of Sydney on Thursday, 20 November 2014. Professor Banwell is an organic chemist and is one of Australia's most accomplished researchers into the synthesis of complex organic compounds. In this year's Liversidge Research Lecture, he described work that has been done in his group over a number of years to synthesise materials that have wide-ranging applications, especially as pharmaceuticals.



The starting point for his work is a family organic chemicals called arenes. These are substances based on a structure of six carbon atoms arranged in a ring, with each carbon atom having a hydrogen atom attached – this substance is known as benzene. Some of the hydrogen atoms can be replaced by other substituents, for example, instead of one of the hydrogen atoms, methyl, bromine, chlorine, trifluorocarbon, hydroxyl, carboxyl etc groups can be substituted. These can then be used as building blocks, using a variety of synthetic pathways, to make much more complex substances.

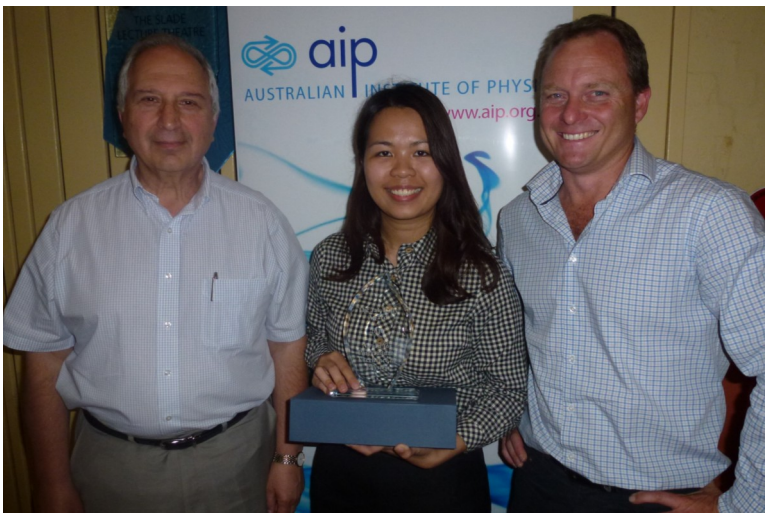
Until quite recently, many of these syntheses were done using a variety of chemical reactions that have been developed by organic chemists over the last 150 years. One of the problems that arises with this approach is that substances with the same chemical formula can have different shapes. For example, substances that have the same chemical formula can be mirror images of each another, in much the same way as the right-hand is the mirror image of the left-hand – these are called enantiomers. Often, one enantiomer will have little physiological effect in comparison to the other. In the last 15 years or so, genetically-modified organisms have been developed that allows synthesis of these substances, favouring production of the biologically-active enantiomer.

Professor Banwell described his work to develop synthetic pathways, starting with the simple substances described above and reacting these with genetically modified *e. coli* to produce an arene with two adjacent hydroxyl groups, in addition to the other reactive site. This results in an intermediate that allows a great variety of subsequent synthetic pathways, allowing synthesis of a very large number of biologically active substances. Two examples of these are vitamin C and the influenza drug, Tamiflu.

Professor Banwell went on to describe a complex sequence of reactions that has enabled his group to synthesise a substance called Ribisin C, a substance that, at very low concentrations, appears to have a marked effect on the stimulating neurite growth in PC12 cells. (Neurites are projections that growth from neurons (nerve cells) as they develop and PC12 cells are particular type of rat neuron that is used in medical research.) It is hoped that this research work may lead to new treatments for neurological diseases and damage to the nervous system.

Professor Banwell's group is also working on novel pathways for making codeine, an opioid that is currently derived from opium poppy production. A synthetic pathway could, potentially, lead to a much less expensive production process for opiates.

AIP Awards Day—Photo Gallery (cont. from p.5)



Professor Anatoly Rozenfield and Dr Michael Lerch with Ms Linh Tran (UOW) - 2014 Royal Society of NSW Jak Kelly Award winner

Dr Frederick Osman with Mr. Michael Seo (USYD) - 2014 AIP Postgraduate Awards winner

Australian Institute of Physics and the Royal Society of NSW

Postgraduate Awards Day— Tuesday 18 November 2014

Report by Dr. Frederick Osman, AIP NSW Branch Postgraduate Awards Coordinator

The NSW Branch of the AIP in conjunction with the Royal Society of NSW held its annual Postgraduate Awards Day on Tuesday 18 November 2014 in the Slade Lecture Theatre, University of Sydney. Each New South Wales University was invited to nominate one student to compete for the $500 prize and Postgraduate medal on that day.

This year we would like thank the generous support of The Royal Society of NSW as the co-sponsor to award the Jak Kelly Scholarship prize of $500 as a separate award category for this event.

Students were asked to make a 20-minute presentation on their postgraduate research in Physics, and the presentation was judged on the criteria (1) content and scientific quality, (2) clarity and (3) presentation skills. *The nominated speakers for 2014 were:*

Donghan Seo, University of Sydney, School of Physics -*Single Step, Plasma Enabled Transformation of Natural Precursors into Graphenes and their Applications in Energy Storage Devices*

Romana Lester, Australian National University, Research School of Physics and Engineering - *Snapshot imaging of a cool, flowing plasma*

Margaret Sharpe, University of New England, School of Science and Technology - Coal Sack and Sky Emu – *Towards a survey of magnetic fields in southern Milky Way dust clouds*

Noel Hanna, University of New South Wales, School of Physics - *Direct measurements of the source-filter model for voice production*

Keith Motes, Macquarie University, Department of Physics and Astronomy - *How to Build the World's First Quantum Computer*

Linh Tran, University of Wollongong, School of Physics - *Development of 3D semiconductor microdosimetric sensors for RBE determination in 12C heavy ion therapy*

The winner of the AIP Postgraduate Presentation for 2014 was awarded to **Michael Seo**, University of Sydney for his talk on *Single Step, Plasma Enabled Transformation of Natural Precursors into Graphenes and their Applications in Energy Storage Devices*. Michael received the 2014 Crystal Postgraduate figurine, and a $500 cheque from the AIP.

The AIP congratulates Michael on this excellent achievement. The runners' up all received a small AIP medal and a special certificate recognising their high standing.

The winner of the **Royal Society of NSW Jak Kelly Award for 2014** was awarded to **Linh Tran, University of Wollongong, School of Physics** - *Development of 3D semiconductor microdosimetric sensors for RBE determination in 12C heavy ion therapy.* Linh received the 2014 Crystal Jak Kelly Award and a Scholarship prize of $500 from the Royal Society of NSW.

The Royal Society of New South Wales congratulates Linh on this excellent achievement.

2014 Postgraduate Group Photo:

Romana Lester, Dr Graeme Melville (AIP Chair), Margaret Sharpe, Linh Tran (2014 RSNSW Jak Kelly Winner), Keith Motes, Noel Hanna and Michael Seo (2014 AIP Post Grad Winner)

(Continued on page 4)

Southern Highlands Branch

Report of 20 November 2014 Meeting

Epigenetics and the Consequences of Epigenetic Changes

Professor Catherine Suter, Head, Epigenetics Laboratory, Victor Chang Cardiac Research Institute

An audience of 71 greeted Professor Catherine Suter to hear her deliver the last lecture of the year for the Royal Society Southern Highlands Branch. Having received her PhD in 2001 from the University of NSW for her work on breast cancer metastasis, she moved into the field of epigenetics during her post graduate studies. There she reported the first cases of germline epimutation in humans. Her lecture to the Southern Highlands Branch largely concerned her team's work on epigenetic changes over many generations of the viable yellow agouti mouse, AVY.

Epigenetics literally means *above* genetics, that is, it refers to the beacons that are on top of the DNA. In 2000 the human genome was finally mapped, but at that stage, scientists did not know of the hidden array of switches on the DNA that can be turned on or off, not only by what our bodies experience but also by the behaviour of our predecessors. Molecular modifications sitting on top of the DNA cause individual genes to be switched on or off without changing the genetic code. Our predecessors are now known to affect us not only by the passing on of their genes, but also by the passing on of epigenetic changes to their DNA.

Dr Suter demonstrated this by showing surprising pictures of five AVY mice which were essentially identical quintuplets. One mouse was very large, fat and golden-furred, her sisters appearing as small, brown, normal-looking mice.

In the brown mice, the AVY gene had functioned normally. In the large yellow mouse however, some factor had caused the AVY gene to be switched on all the time, transforming the coat to yellow, and blocking the normal signals that tell the mouse it has eaten enough, thus pushing it toward diabetes. There had been no change at all in the DNA sequencing.

Other experiments by Suter's team have shown that feeding a pregnant agouti mouse with supplements such as folate and vitamin 12 not only made her offspring more likely to be brown, slim and healthy, but also had the same effect on her grandchildren. Even though the grandchildren mice were not fed the supplement, they were affected because they came from eggs that were growing inside the embryo while it was being affected by what the mother was eating. When the team continued feeding the modified diet to several generations of mice, the effects were magnified. This raises possible answers as to why some human populations have a greater risk of developing certain diseases.

Another interesting outcome of these experiments to date is the realization that the same gene that caused the large mouse to turn a beautiful yellow colour also caused it to overeat, thus causing obesity and type 2 diabetes. Of even more interest is that the mother's diet can determine whether the gene is switched on or off. The affected mouse will then pass on this epigenetic tag to the next generation. In essence, the diet of the grandmother can actually affect her grandchildren.

The question now to be investigated is to what extent epigenetic changes can be inherited in humans, and what effect this discovery would have on modern medicine as we know it. Professor Suter has in fact already found an epigenetic change involved in cancer which has been passed on the next generation, an incredible breakthrough in medical research.

Anne Wood

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Contact: Mr Ben Williams 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