The Bulletin 372

The Royal Society of New South Wales

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Future Events

Wednesday 18 December 2013
Special meeting to consider rule changes
Union, University & Schools Club
25 Bent St, Sydney
6:15 pm

Wednesday 18 December 2013
1217th OGM, Jak Kelly Award Presentation
Delivered by:
Xavier Zambrana-Puyalto
6:00 pm for 6:30 pm
Union, University & Schools Club
25 Bent St, Sydney
Followed by the Society's Christmas Party
$35.00 for members & Guests
RSVP to royalsoc@royalsoc.org.au

Wednesday 5 February 2014
1218th OGM, Scholarship Award Presentations
Union, University & Schools Club
25 Bent St, Sydney
6:00 pm for 6:30 pm

Wednesday 19 February 2014
Joint meeting with the Australian Institute of Forensic Sciences
Delivered by:
Associate Professor Robyn Sloggett
Union, University & Schools Club
25 Bent St, Sydney
6:00 pm

Thursday 27 February 2014
5:30 pm for 6:00 pm
Meeting of the Four Societies
Future of Power Generation for NSW
Professor Mary O'Kane
NSW Chief Scientist & Engineer
Hamilton Room, Level 47,
MLC Centre,
Martin Place, Sydney

[redacted]

Wednesday 18 December 2013

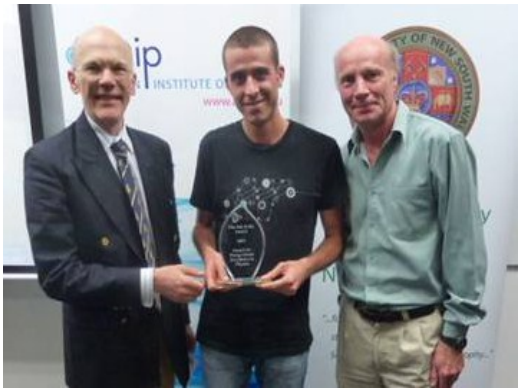
Special meeting to consider rule changes

Jak Kelly Award Presentation & Christmas Party

Probing the Nano-World with the Symmetries of Light

Delivered by Xavier Zambrana-Puyalto
Union, University & Schools Club, 25 Bent St, Sydney City
6:00 for 6:15 and 6:30 pm

Note revised date for this meeting. The 2013 **Jak Kelly Award** Winner Xavier Zambrana-Puyalto, Department of Physics and Astronomy, ARC Center of Excellence for Engineered Quantum Systems, Macquarie University, will deliver his talk **"Probing the Nano-World with Symmetires of Light"** at the Society's 1217th OGM.



Dr Donald Hector, Xavier Zambrana-Puyalto, Prof. Michael Burton

Abstract

In 1959, Richard Feynman gave a seminal lecture entitled "There's Plenty of Room at the Bottom" which pushed scientists to set out on the journey of controlling light-matter interactions at the nano-scale. Since then, nanotechnology has rapidly developed. Nowadays it is inconceivable to think of any new information devices whose circuits are not in the nano-scale. Whereas nanoelectronics is a well consolidated technology producing transistors of less than 50 nm, nanophotonics has yet to overcome some drawbacks. So far, probably the most successful way of pushing light-technology to the nano-scale has been plasmonics. In plasmonics, plane waves are used to excite smartly designed nano-structures to couple light with free electrons oscillations on a metallic surface and transmit information. I will show that if symmetry considerations are taken into account and more elaborate beams of light are used, extra information can be retrieved from the same samples. To prove this, I will present a recent experiment carried out in my group where the complex behavior of a circular nano-metric aperture is easily predicted using symmetry considerations. The experiment deals with an old problem – the circular dichroism (CD) of a sample. CD is a widely used technique in science, and its uses range from DNA studies to protein spectroscopy. It is defined as the differential absorption of left and right circular polarization. Typically, it is established that CD can only be found in interactions with chiral structures, i.e. structures whose mirror image cannot be superimposed with them. I will show that non-chiral structures, such as a circular nano-aperture, can also produce CD when light beams with cylindrical symmetry are used. We will be able to reconcile the experimental results and extend the current understanding of this phenomenon using symmetry considerations.

This will be followed by the Society's Christmas Party. For booking and further details see separate flyer.

Dress code: Jacket and tie.

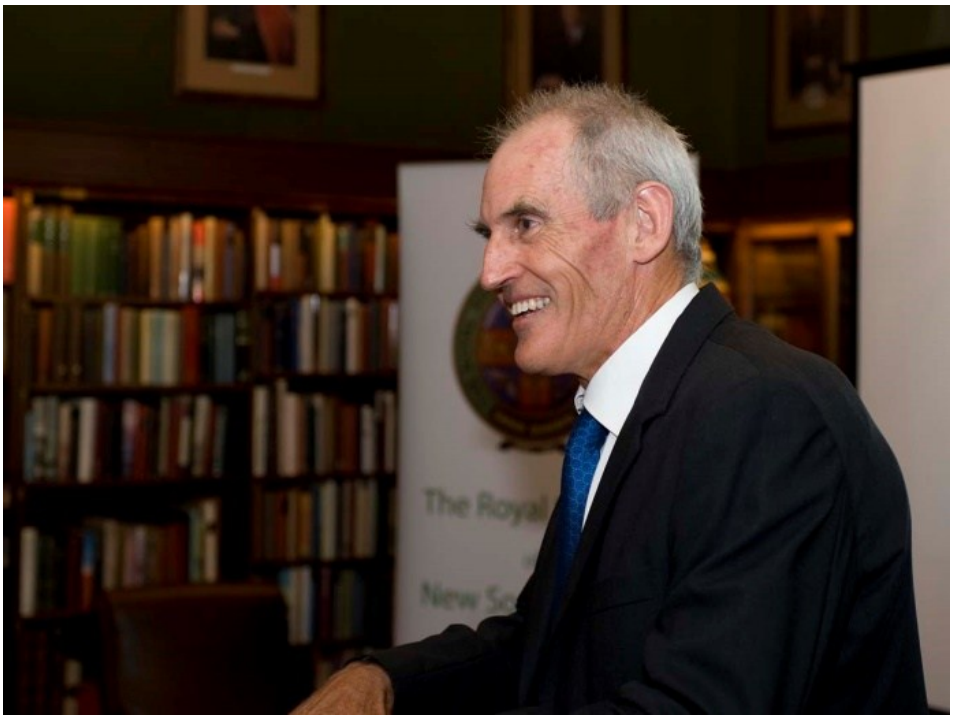
1216th Ordinary General Meeting

Held on Wednesday 6 November 2013

The Senior Science National Curriculum

Dr Mark Butler

An issue of particular interest to the Society over recent years has been the importance of the teaching of maths and science to schoolchildren. This issue was a subject of the 2013 Royal Society of NSW Forum, so at our November meeting, the Society was delighted to have the opportunity to hear directly from one of the key people in developing the senior secondary science curriculum, Dr Mark Butler.



Dr Mark Butler

The background to the current curriculum dates from 1989 when the Education Ministers of all the states issued "common goals for schooling". In 2004, the Federal Government started to explore the notion of an Australian Certificate of Education that would harmonise the approaches of each of the States. This led to the Melbourne Declaration on Educational Goals for Young Australians and resulted in the creation of the National Curriculum Board, now known as the Australian Curriculum Assessment and Reporting Authority (ACARA).

The role of ACARA is to develop the K -12 national curriculum in specific learning areas, to coordinate the National Student Assessment Programme (NAPLAN) and to administer a public data collection and reporting system (the "My School" website). This was implemented in a number of phases, commencing with the development of the K-12 national curricula in English, Mathematics, Sciences and History. The second phase was the development of curricula for Languages, Geography and the Arts, and the third phase was curricula for Design and Technology, Health and Physical Education, ICT, Economics and Business, Civics and Citizenship, Work Studies, and National Trade Cadetship.

Developing the national curriculum involved an extensive process of consultation between education authorities in each of the States. It was agreed that State and Territory curricula, assessment and certification authorities would integrate the Australian Curriculum subject matter into courses, adding assessment and certification specifications as required. That is, States have responsibility for preparing the courses and, as far as possible, will incorporate the Australian Curriculum requirements. The aim is to have the senior secondary Australian curriculum for each subject as accessible to as many students as possible within the context of the nature of the subject and its specified rationale. The curriculum is designed around a 4-unit structure with each unit able to be taught in about half a school year (about 50-60 hours including assessment and examinations). The States are responsible for assessment and certification and will determine the permitted entry and exit points in line with their requirements.

The framework of the Australian Curriculum revolves around two important concepts: first, is an underlying foundation of "systems", teaching systems thinking as a means to unify scientific knowledge and understanding and as a way to relate and describe phenomena. Models and theories are taught as being a means of representing systems in order to explain, analyse and predict system behaviour. This approach is taught through three integrated strands – Science Understanding,

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Science As a Human Endeavour, and Science Enquiry Skills. Each of these are intended to teach fundamental core content expressed as concepts rather than facts and to encourage representation using theories and models to represent the phenomena being investigated. This core content then is extended into science enquiry skills on how to conduct research, design and conduct investigations, represent and analyse data, evaluate processes, claims and conclusions, select and use appropriate representations and then to communicate information to specific audiences. Of particular importance is teaching students the unique nature of scientific enquiry and scientific knowledge. Scientific knowledge and its application affects people's lives, how it is influenced by society and how it informs decision-making.

Dr Butler's talk stimulated an extensive discussion session, reflecting his passion and enthusiasm for the subject.

Donald Hector

Paperless Bulletin?

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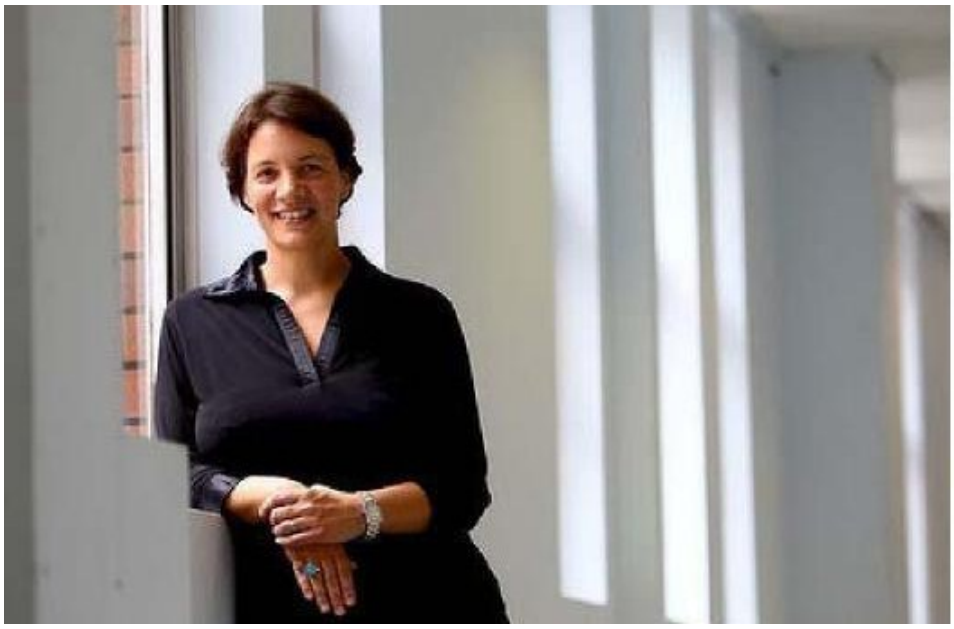
The Pollock Memorial Lecture 2013

The Royal Society of NSW and the Univeristy of Sydney
In Conjunction with the
Australian Insitute of Physics



Professor Michelle Simmons

A crowd of diverse attendees gathered at the University of Sydney to experience the 2013 Pollock Memorial Lecture in October. The event occurs only once every four years in the memory of Professor J.A. Pollock, Professor of Physics at the University of Sydney (1899-1922) and a 25-year member of the Royal Society of NSW, which has sponsored this event since 1949.

The recipients of this accolade include some very eminent scientists such as Fred Hoyle (1962), Brian Josephson (2006) and, most recently, Brian Schmidt (2009). Tonight the lecture was delivered by Professor Michelle Simmons of the University of New South Wales (UNSW).

Professor Simmons is the Director of the Australian Research Council Centre of Excellence for Quantum Computation and Communication Technology, a Federation Fellow and a Scientia Professor of Physics at the University of New South Wales. Following her PhD in solar engineering at the University of Durham in the UK she became a Research Fellow at the Cavendish Laboratory in Cambridge, UK, working with Professor Sir Michael Pepper FRS in quantum electronics. In 1999, she was awarded a QEII Fellowship and came to Australia where she was a founding member, and now the Director of the Centre of Excellence. The lecture was entitled "Quantum computing in silicon and the limits of silicon miniaturisation".

Professor Simmons' commenced her address by overviewing the advances of the now conventional semiconductor industry. From the first, famously crude, transistor, through discrete silicon devices in "transistor radios" through to modern day integrated circuits composed of billions of devices. A point, well made, was that there were a full ten years between the laboratory transistor and the first integrated device and yet another 15 years before mass products flooded into the market. It has been a technology that has revolutionsied the way we live, but remarkably still has not deviated from Moore's Law. Prof Simmons described the basics of what the term "quantum computer" means and the various characteristics a device must exhibit to comprehensively qualify as such. Although scientifically advanced, the area is in its infancy

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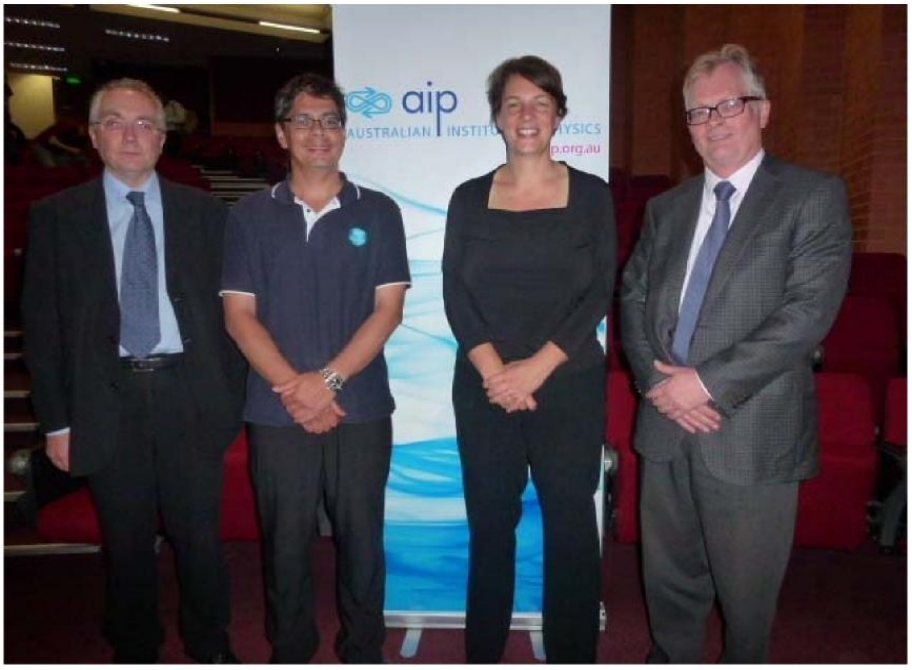
analogous to the time of the first transistor, when the plethora of future applications could not have been conceived – and that is just how it is now with quantum computers – we cannot begin to estimate their future impact.

Some problems scale exponentially – like the Travelling Salesman problem where the task is to calculate all possible alternative routes of a salesman visiting N cities in any order. As N is increased the number of options explodes, quickly outstripping the capacity of even a supercomputer. Other such problems are many-body models for simulating molecules and materials. Whereas conventional "serial" computers become overwhelmed, quantum computers mirror the exponential character of these problems with the exponential number of possible quantum states held in superposition across the qubits of the quantum computer. Indeed, with only 300 qubits, a quantum computer would possess more processing power than all of the computers currently in the world.

They are known to be suited to particular niche problems such as decryption, but they may be combined in many architectures to perform different logical operations, some of which Prof Simmons described using truth tables and quantum mechanical notation. The latter may have left behind anyone without degree level physics, but it was fascinating to many that do.

Finally, Prof Simmons gave an overview of the different research approaches being applied around the globe towards realizing the first true quantum computer – elucidating the strengths and potential issues with each of the categories. The work at UNSW involves excavating a surface of silicon atom by atom and then placing and burying a single dopant atom to form a qubit, before covering it over with silicon and attaching electrodes. Her group is the only group world-wide that can make such atomically precise devices in silicon: they have developed the world's thinnest conducting doped wires in silicon, and the ability to manipulate and electronically measure devices with atomically precise dopant placement.

Prof Simmons address was followed by 20 minutes of insightful and imaginative questions from the audience. Dr Scott Martin, NSW Chair of the Australian Institute of Physics made the vote of thanks and presented an AIP scarf and a bottle of wine as tokens of appreciation. Members of the Royal Society of NSW and the AIP were honoured to further engage with Prof Simmons at dinner afterwards.



Professor Simon Fleming, Dr Scott Martin, Professor Michelle Simmons and John Hardie

New Members of the Society

We welcome the following new members to the Society:

· Ian Hugh Sloan

· Judith Wheeldon

· Kenneth Henry Dawson

· Margaret Sybil Cameron

· Michael Kelly

· Richard Payne

· Robert Spanswick

· Thomas Maschmeyer

For information about membership please contact the Society's office or visit the Society's website or contact Emma at royalsoc@royalsoc.org.au

We encourage members to introduce new members to the Society.

Southern Highlands Branch

Report of November Meeting 2013

Outsmarting Superbugs?

Prof Elizabeth Harry

Professor of Biology and Deputy Director of the ithree institute, University of Technology Sydney

The 77 attendees waiting to greet Professor Liz Harry for her Southern Highlands lecture at 6.30pm on November 21 were quite disappointed when told of her unavoidable delay in Sydney.

Fortunately the wait was made enjoyable and enriching by the ingenuity of some in the audience. Committee member Andrea Talbot outlined the speaker program for 2014. Then Royal Society member Douglas Mackinlay delivered an impromptu address on his current research into ancient Egyptian timelines. It was a fascinating presentation.

Professor Harry began her lecture with an overview of bacteria, emphasizing their prevalence and the fact that we cannot live without them. They make about half of the oxygen we breathe, and 80% of the nitrogen we use. There are more bacteria on a person's hand then there are people on the entire planet, and bacterial cells produce 100 times more protein in our bodies than human cells do. The global number of bacteria is of the order of 6 x 10^30, 90% of all bacteria occurring at the subsurface (sediment depth approx 500m). The biomass of subsurface microorganisms corresponds to one third of the total living biomass on Earth. Despite this huge prevalence of bacteria, only very few cause disease. Tuberculosis and meningitis are caused by airborne bacteria. Lyme disease, anthrax, leprosy, cholera and typhoid are all bacterial in origin. So too are infected wounds on our skin.

The emergence of antibiotic resistance was first noted in 1947, nineteen years after the discovery of penicillin, when *S. aureus* was found to be resistant to it. By 1955 it was resistant to erythromycin and tetracycline, by 1958 resistant to sulphonamide, then in 1961 resistant to methicillin. The pattern of resistance continues to this day. In USA, the number of *S. aureus* (MRSA) infections in intensive care unit patients was less than 2000 in 1993. By 2005, there were 368000, an alarming increase.

Liz Harry spent quite some time in her lecture describing how bacteria are able to generate resistance to antibiotics. She has pioneered the development of microscopy techniques for 'seeing' where proteins are in a bacterial cell. These techniques have revolutionized our view of the internal organization of bacterial cells. Her research on bacterial cell division has had a significant impact on our understanding of how bacterial cells multiply, and how they control this process to ensure equal partitioning of chromosomes vital for survival. She has worked with industry to develop novel antibiotics that target this process in pathogens, and to examine how natural products, such as honey, function as effective therapeutics for infectious diseases.

One of her areas of research has been the experimental testing of honey as a topical antibiotic. She showed photographs of a case where honey-impregnated dressings were effective in healing infected skin ulcerations that had resisted other antibiotic treatments. Honey appears to have a general antibiotic property that allows it to be safely stored by bees and in our pantries and refrigerators for extended periods. The honey that Professor Harry and her colleagues have chosen for research is Manuka honey.

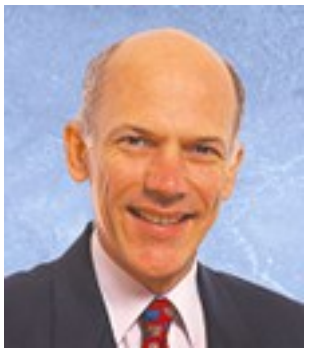
Professor Harry lamented the fact that research on antibacterial agents of all varieties has languished mainly due to commercial considerations. Drug companies clearly stand to make larger profits from drugs designed for chronic conditions, such as hypertension, than from the design of more effective antibiotics which are used for shorter periods of time in addressing acute conditions.

Her research so far has resulted in her awards of the Australian Eureka Prize for Scientific Research in 2002 and the Australian Society of Microbiology Frank Fenner Prize in 2008 in recognition of her distinguished contributions to Australian research in microbiology.

At the end of the lecture, Professor Harry very kindly offered access to her PowerPoint presentation to those further interested. It can be requested at elizabeth.harry@uts.edu.au and at wood.anne@gmail.com

Anne Wood

From the President



There were a number of important activities in November.

In addition to the monthly meeting, and excellent presentation on the preparation of the Australian science curriculum by Dr Mark Butler, the winner of the Jak Kelly Award was determined and the 2013 Dirac lecture was presented by Sir Michael Pepper, an internationally-renowned physicist.

On Tuesday 19 November, in conjunction with the Australian Institute of Physics, the Jak Kelly Award was determined. The winner was Xavier Zambrana-Puyalto, from Macquarie University for his outstanding presentation "Probing the nano-world with symmetries of light". Xavier will present to the Society at the next meeting to be held on Wednesday 18 December.

The 2013 Dirac Lecture was delivered at the University of NSW on the evening of Thursday 21 November by Sir Michael Pepper. This took place in conjunction with conferring of honorary degrees at the University of New South Wales and was an outstanding success.

We have been doing quite a lot of work regarding our Journal exchange programme and this has slightly delayed printing of the edition published in June. If you have subscribed to the hardcopy of the Journal, you should receive it in the next couple of weeks – some good Christmas reading! Our editor, Professor Michael Burton is putting the finishing touches to the second edition for the year and this is expected to be published electronically before the end of December, with hardcopy being printed early in the New Year.

As mentioned in recent Bulletins, the Council has recently conducted a major review of the Rules and By-Laws in order to modernise them, particularly making them consistent with current corporations law. This is now complete and a special meeting to consider them will take place immediately prior to the meeting to be held on Wednesday 18 December. Most of the changes are procedural but there are is a significant change regarding fellowship of the Society that we expect to have a very positive impact on our membership. Members will receive a notice of meeting shortly that will include an Explanatory Memorandum regarding each of the Rule changes. It is most important that members participate in this process – if you are not able to attend the meeting in person would you please lodge a proxy.

Immediately following the special meeting and the presentation by the Jak Kelly award winner, we will have the Society's Christmas party. I do hope you can attend and look forward to seeing you there.

Donald Hector

For information about membership please contact the Society's office or visit the Society's website or contact Emma at royalsoc@royalsoc.org.au

We encourage members to introduce new members to the Society.

Contact your office bearers

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