



The Royal Society of New South Wales Bulletin and Proceedings 339

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September 2010

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 6 October 2010 at 7 pm

Dr Ziggy Switkowski

Is the climate right for nuclear power?

(see details at right)

Wednesday 3 November 2010 at 7 pm

Dr David Mills, Chief Scientific Officer and founder of Ausra, Inc.

Powering the US Grid from Solar and Wind

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 21 October 2010, at 6.30pm

Dr David Branagan

Geology & Geophysics of Antarctica: The Early Australian Story

(see details p. 4)

Friday 26 November 2010, at 5.30pm

Liversidge Lecture

Professor John White, ANU

Belief in Science

Merewether Theatre,
University of Sydney

Details in the next Bulletin

Bulletin Editor, Bruce Welch

Lecture 6 October 2010, Darlington Centre at 7pm

Dr Ziggy Switkowski

Chair, Australia Nuclear Science & Technology Organisation

Is the Climate Right for Nuclear Power?

The world is experiencing a strong warming trend believed to be driven by greenhouse gas emissions associated with the burning of fossil fuels for energy production. Australia's demand for electricity, and energy in general, is expected to double by 2050. The challenge is to moderate and meet this growing demand in an environmentally responsible way. Nuclear power is already widely used around the world and the debate for its deployment in Australia is well underway.

This presentation will review the nuclear fuel cycle in the context of low emission energy technology and point to the potential role of nuclear power in Australia's energy and climate change strategy.

Dr Ziggy Switkowski is the Chair of the Australian Nuclear Science and Technology Organization. He is also a nonexecutive director of Suncorp, Tabcorp and Healthscope and Chair of Opera Australia. He is a former chief executive of Telstra, Optus and Kodak (Australia).

In 2006 he chaired the Prime Minister's Review of Uranium Mining, Processing and Nuclear Energy which returned nuclear power to the country's strategic debate. He has a PhD in nuclear physics from the University of Melbourne and is a Fellow of the Australian Academy of Technological Sciences and Engineering.



Nemesis: The Search for Antimatter in the Universe

Professor Joss Bland-Hawthorn, Federation Fellow at the University of Sydney

Wednesday 6 October 2010 5:45pm - 6:45pm (immediately preceding the meeting above)

Venue: Eastern Avenue Auditorium, The University of Sydney

It's the ultimate battle of the universe: when normal matter and antimatter come together, they're annihilated, and all the mass is converted into energy. Fortunately, the Universe today is composed almost entirely of matter, with very little antimatter. However, the laws of physics require that the Universe began with equal amounts

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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

Lecture delivered for the Society's 1184th Ordinary General Meeting held on 1 September 2010

The Sun in Time

Ken McCracken, University of Maryland and Jellore Technologies

Over the past few years the sun has been behaving in a very unusual fashion. Dr Ken McCracken explained to a very interested audience at the September OGM that when the sunspot minimum approached in September 2006, a new solar cycle was widely expected to start in early 2007. NASA and others predicted it would be "the biggest ever". However, no one told the sun. Sunspots completely disappeared in late 2006, and very few sunspots were seen until December 2009. In fact, the new sunspot cycle is a weak shadow of any in living memory.

This is of considerable importance because work by Dr McCracken and his co-workers shows a very strong historical link between solar activity and global climate. Some kind of link has been suspected for over a century, but its statistical significance has always been marginal until now. The key advance is looking at the abundance of ^{10}Be in ice cores. This isotope is produced solely by high-energy galactic cosmic rays hitting the upper levels of the earth's atmosphere. When the sun's magnetic field is high (and the sunspot number is also high), these interstellar particles are deflected away from the solar system and so little ^{10}Be is produced on earth. Conversely, when the solar magnetic field (and sunspot number) is low, many galactic cosmic rays reach earth and so there is a relatively high abundance of ^{10}Be in the atmosphere. Snow falling in the polar regions records the beryllium abundance with a resolution of about a year. Dr McCracken and his co-workers have laboriously measured ice cores dating back over 20,000 years and have been able to construct high-resolution magnetic activity curves for the entire period. Their data has very good agreement with the 400 years of visual data and excellent agreement with the instrumental record (post 1935). There is also good agreement with the ^{14}C data (this isotope is produced by a different process and so serves as a confirmation of the ^{10}Be measurements, albeit at relatively low resolution because of the long residence time of CO_2 in the atmosphere).



There are several key conclusions. It is very clear that solar activity has varied strongly throughout the Holocene. Fourier spectra indicate strong, well-defined periodicities in solar activity of 2300, 970, 208, 87, 22 years and other weaker periods. In the past 10,000 yr there have been 22 "Grand Minima" similar to those that accompanied the 1650-1725 "Maunder Minimum" in sunspot activity and the "Little Ice Age" that so strongly shaped 17th Century European history.

There are also strong correlations between solar activity and the movements of European ice fields and glaciers over the past 10,000 years. Indeed, the change from the last glacial period to the Holocene appears to have coincided with maxima in the Halstatt cycle in solar activity.

Dr McCracken said that the mechanism for the link between solar magnetic activity and terrestrial climate is unclear. It may be due to changes in the solar irradiance, but he ventures no opinion. "This is the data" he said, "it is for others to explain it."

Dr McCracken indicated that the "space era" is definitely not representative of the sun's past behaviour. Instead, history suggests that the sun has entered a grand minimum similar to the 18th Century "Dalton minimum" and that this may last 2 solar cycles (>20 years). What this will do to global climate is unclear. It seems that we live in interesting times.

Jim Franklin,
Councillor, Activities Coordinator

Southern Highlands Branch Report of September Meeting Nuclear Energy Without Dangerous Radiation Professor Heinrich Hora



The Southern Highlands Branch meeting of 16 September 2010 was held at 6.30pm in the Drama Theatre, Frensham School, Mittagong. An audience of 55 began arriving early on a cold, windy night to hear the latest research on a new process of radiation-free nuclear fusion, which could in future lead to the development of clean and sustainable electricity production.

Professor Hora began his lecture by explaining the benefits of nuclear fusion, in particular its potential to provide vast quantities of electricity cleanly and sustainably. However, to date, the complications with nuclear energy are the serious and well-recognised adverse environmental and health issues due to side effect radiation. If fusion could be conducted so that the energy produced was free of radiation, then a whole new world of possibilities would be opened for generations to come.

Conventionally, deuterium and tritium are used as fuel in the fusion process. Laser irradiation is used to spherically compress the fuel which then ignites, producing helium atoms, energy, and neutrons which cause radiation. Hora described how fusion is also possible with a fuel of hydrogen and boron-11, a method which does not release neutrons. However, the disadvantage of this process is that the fuel requires much greater amounts of energy to

initiate, and for this reason, the process has remained unpopular.

A breakthrough has now been made by Hora's team who have demonstrated that new laser technology capable of producing short but high energy pulses could be used to ignite the hydrogen-boron11 fuel using side-on ignition. In this process, the fuel would not need to be compressed, with the result that the energy required would be less than previously thought. Hora said, "It was a surprise when we used hydrogen-boron instead of deuterium-tritium. It was not 100 000 times more difficult, it was only 10 times."

Professor Hora said that the hydrogen-boron11 process would produce less radiation than that emitted from current power stations that burn coal, which itself contains trace amounts of uranium. He added that hydrogen and boron are both plentiful and readily accessible, and that the waste product from their ignition would be clean helium gas.

Hora quoted Steve Haan, an expert in nuclear fusion at Lawrence Livermore National Laboratory in California, who stated recently that Hora's method has the potential to be the best route to fusion energy seen so far. However, both Haan and Hora are well aware that there is much work to be done before this technology is at hand. Hora concluded his lecture with the statement that the practical achievement of the new process will be heavily dependent on ongoing advances in laser optics, target physics and power conversion technology.

At the conclusion of the lecture, the audience showed their appreciation by asking Heinrich Hora as many questions as time allowed.

The vote of thanks was given by Anne Wood.

Anne Wood

New Members

Three new members were announced at the August meeting of the Society:

Leonard Mostaert - Full Member
Janette Hashemi - Full Member
William Gong - Associate Member

We welcome them into the Society.

From the President



On 13 August the Hon. Secretary (General) Bruce Welch and I met with Dr Chris Armstrong from the NSW government's Office of Science and Medical Research (OSMR) with the view to seeing whether there were possible funding sources available to the Society through OSMR. We also wanted to discuss Science House and see whether there was any further support for this initiative. The outcomes of the meeting were that OSMR saw possible avenues for funding relating to regional outreach (our Branches and the use of electronic media and the Internet to target regional centres of NSW) and science education. We will be following this up.

On 25 August I was pleased to take part in the Premier's Business University Government Forum, held at the MLC Centre in Sydney, on behalf of the Society. The invitation to attend resulted from our response to the government's request for input into the draft NSW Knowledge Statement and the draft NSW Tertiary Education Plan. The final versions of these documents were launched in conjunction with the Forum.

The Premier, Minister Firth and Minister McKay all spoke on the importance of these three sectors working more closely together to develop a cleverer and more responsive research community with a firm foundation in innovation. The Forum was chaired by the NSW Chief Scientist and Scientific Engineer, Professor Mary O'Kane. Many of the outcomes of the Forum align with our aims of cross-discipline awareness and the need to create greater awareness of the role and function of a scientist and so I feel we are well placed to further participate in some of these high level discussions. It was a 'feather in our cap' to be chosen to

participate in this high level event, which included Vice-Chancellors and Directors-General of government departments and so-called 'captains of industry'.

The creation of a NSW Science Centre at Science House would be one way to achieve some of the connections between industry, research and government, so we must move quickly to make these connections obvious for the powers that be in order to make the reality of Science House possible under the current government, otherwise we will need to wait until after the election. To that end, I have pointed this out to the Chief Scientist in correspondence and we have had further discussions with legal and other advisers to see how we might proceed.

On 15 September I attended the NSW Scientist of the Year Awards ceremony at Government House on behalf of the Society. This was also chaired by the NSW Chief Scientist, Mary O'Kane, with an introductory speech by Minister McKay. The Awards were presented by Her Excellency the Governor, Professor Marie Bashir. See elsewhere in this Bulletin for information about the winners. I would like to congratulate all winners for their incredible achievements.

On 23 August I was able to pay my respects at the Memorial Service in the Great Hall of the University of Sydney for Sir Bruce Williams, former Vice-Chancellor of the University, on behalf of the Society.

John Hardie

NEMESIS continued from page 1

of both. The origin of the asymmetry is not known, but a possible explanation relies on some bizarre events in the early Universe. Recently, however, the annihilation signature of antimatter has been observed emanating from the centre of the Galaxy, at a rate that corresponds to the annihilation of 16 billion tonnes of antimatter every second.

Find out what these observations are telling us about the creation of antimatter in violent processes at the centre of our Galaxy. Learn how research by the Astrophotonics group at Sydney is shedding new light on the origin and nature of these antimatter signals.

Southern Highlands Branch Lecture

Thursday 21 October 2010, at 6.30pm

Dr David Branagan

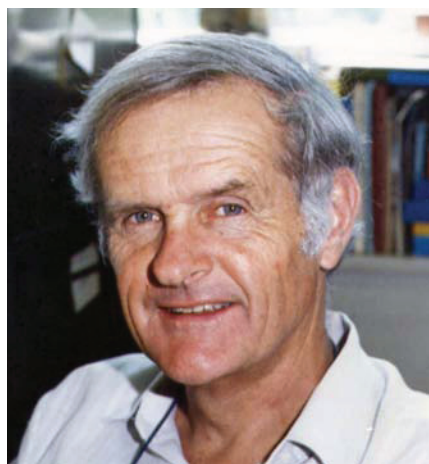
School of Geosciences, The University of Sydney

Geology & Geophysics of Antarctica: The Early Australian Story

There are two major themes in this presentation, (1) Search for the elusive South Magnetic Pole, and (2) the growth of knowledge of the Geology of Antarctica. A minor, but linked theme is the relationship between Australia, Scandinavia and Japan during the period under consideration, from about 1840 to 1914, and the key figure in the story is T.W. Edgeworth David.

Considerable Australian interest in Antarctic exploration and science dates from the 1880s, with the formation of an Exploration committee set up in Melbourne. Over the years numerous Australian residents and visitors played a part in stimulating interest in Antarctica. These included Franklin, Neumayer, von Mueller, Bull, Borchgrevink, Bernacchi, Gregory and David.

The Australian reaction to Amundsen on his return to Australia following his successful journey to the South Pole concludes the paper.



Dr David Branagan is an Honorary Research Associate in the School of Geosciences, the University of Sydney, where he taught for thirty years. A graduate of Sydney he earlier worked in Government and Industry and, through the years, as a consultant geologist in coal and metal mining, and particularly in engineering projects.

Author of a number of text books and many technical papers, in recent years he has concentrated particularly on the history of geology, ranging from geology in Renaissance art to studies of Pacific geology and mining. He was foundation Editor of *The Australian Geologist*. He has held an Harold White Fellowship at the National Library, Canberra; a C.H. Currey Fellowship at the State Library of New South Wales; and fellowships in New Zealand and the USA, and was an invited speaker at the Bicentenary Meeting of the Geological Society of London in 2007.

His biographical work includes contributions to the *Oxford Dictionary of National Biography* and the *Australian Dictionary of Biography*, and *TW Edgeworth David: A Life*, published by the National Library of Australia, which was one of four works short-listed for the first Prime Minister's History Award in 2007. He has been President of the International Commission for the History of the Geological Sciences, President of the Royal Society of New South Wales and is an Honorary Life Member of the Geological Society of Australia.

A double University Blue in Athletics (many years ago!), a major relaxation is in choral music.

He was awarded an honorary D.Sc. by the University of Sydney in 2008.

Central West Branch

Report of Lecture held on Friday 20 August 2010

Dr Alex Ritchie

An unexcavated fish fossil site near Canowindra in the state's Central West could be a scientific treasure trove, according to renowned palaeontologist Dr Alex Ritchie, the Australia Museum's palaeontologist from 1968–1995, who delivered the second public lecture held by the newly formed Central West Branch of the Society.

The site is located about 18 kilometres west of Canowindra and was the subject of a major dig, led by Dr Ritchie in 1993, which unearthed 70 tonnes of rock containing about 4000 fish fossils. These fossils, which scientists estimate are 360 million years old, are now housed in the Age of Fishes Museum in Canowindra. Most were remarkably well preserved. They included specimens up to 1.6 metres long—air-breathing, lobe-finned sarcopterygians,

which scientists believe include the ancestors of the first vertebrates to step onto dry land. Dr Ritchie told the meeting that the site would most likely contain species of fish that were new to science.

Dr Ritchie said it appeared the Devonian fossils unearthed in 1993 were trapped in a dried-out billabong where the fishes became more and more concentrated as the water evaporated. However, the original dig only touched the edge of the billabong and there are almost certainly many thousands more fossils waiting to be unearthed. Indeed, Canowindra could prove to be one of the world's great fish fossil sites.

Dr Ritchie has lobbied for many years for the expansion of the Age of Fishes Museum through the development of a complementary facility on the fossil site. The proposed development could include a range of interactive exhibits and an area allowing visitors to walk above part of the fossil site, as well as a working excavation area—this would be ideal for a group of postgraduate students to work on, he said. Such a facility could be a major tourist drawcard for the Central West. However, it would also require major government or corporate funding, which was proving difficult to obtain.

Mark Filmer



Dr Ritchie displays a cast of fish fossils found near Canowindra.



Dr Ritchie (left) chats with Professor David Kemp of Charles Sturt University following the lecture

LEADER OF THE ROBOT REVOLUTION IS THE 2010 NSW SCIENTIST OF THE YEAR

A University of Sydney based researcher leading a global robotics revolution has been named the NSW Scientist of the Year.

Minister for Science and Medical Research Jodi McKay said Professor Hugh Durrant-Whyte, who leads the Australian Research Council Centre of Excellence for Autonomous Systems and the Australian Centre for Field Robotics at The University of Sydney, has taken the world by storm, developing innovative robots for a wide range of applications.

"The NSW Scientist of the Year Award is our State's most prestigious science prize, recognising creative, high calibre research that brings benefits to the State's economy, environment and people," Ms McKay said.

"Professor Durrant-Whyte is a worthy winner of this year's award. He is a world-leader in robotics and has helped develop autonomous solutions for a range of industries including mining, marine, military, aeronautics and agriculture.

"He is literally leading a robotics revolution, not only for Australia but the world.

"Professor Durrant-Whyte is an outstanding example of the excellent research being carried out in NSW that positions us as Australia's leading clever State."

Ms McKay said Professor Durrant-Whyte wins \$55,000 for his achievement.

Professor Durrant-Whyte's team has spun out a number of companies, most recently Marathon Robotics, which has developed free-ranging robots protected by armour plating to train marksmen. The Marathon Robotics system recently attracted a \$57 million contract with the US Marines.

"He has also been involved in the development of underwater robots, flying weed-spraying drones and massive mining automation systems," Ms McKay said.

Professor Durrant-Whyte said he was proud to receive the NSW Scientist of the Year award and that NSW and Australia was the ideal place to develop robotics.

"Australia is the perfect place to develop and apply robotics. Robotics works for things that are big and expensive and things you don't want to put people into – from mining to underwater exploration.

"Autonomous systems represent the next great step in the fusion of machines, computing, sensing, and software to create intelligent systems capable of interacting with the complexities of the real world."

Professor Durrant-Whyte said the rise of robots was set to have a huge impact on all areas of society and especially in Australia.

"It's an exciting field and I liken it to the growth of the computer industry.

"Comparatively, we are currently developing the robotics equivalent of the mainframe computer of the 1960s. But one day, just like computers, there will be robots in every home."

NSW Scientist of the Year 2010 Category Winners

NSW Scientist of the Year

Professor Hugh Durrant-Whyte,
Australian Centre for Field Robotics, The University of Sydney.



Professor Durrant-Whyte completed his PhD in systems engineering at the University of Pennsylvania, and went on to hold positions at Oxford University. In 1995 he was appointed a professor at the University of Sydney, where he currently heads up the Australian Centre for Field Robotics. He is currently the Research Director of the Australian Research Council Centre of Excellence for Autonomous Systems, and was recently elected a fellow of the Royal Society, the world's oldest continuously running scientific academy.

Professor Bryan Gaensler – winner of the Physics, Earth Sciences, Chemistry and Astronomy Category

The University of Sydney



As an Associate Professor at Harvard, Professor Gaensler built the world's leading research group for studying neutron stars and supernova remnants, and also coordinated the astronomy major for undergraduate students. Now a Professor of Physics at the University of Sydney, his research group is focusing on the origin of magnetism in the universe and the demography of neutron stars and black holes in the Milky Way.

Professor Perminder Sachdev – winner of the Biomedical Sciences Category

The University of New South Wales



Professor Sachdev's research interests are in the areas of vascular dementia, Alzheimer's disease, dementia of Lewy body type and other dementias, Neuropsychiatric aspects of dementia and treatment of various neurological conditions.

Professor Christopher Dickman – winner of the Plant and Animal Sciences Category

The University of Sydney



Professor Andrew Pitman – winner of the Environment, Water and Climate Change Sciences Category

The University of New South Wales



Professor Pitman is a professor in atmospheric science and co-director of the Climate Change Research Centre at the University of New South Wales. He leads the new ARC Centre of Excellence for Climate System Science, which will provide detailed science essential for improved regional projections of changes in climate extremes across NSW.

spanned many issues of significance to NSW, including how climate change and human activity are altering sediment-dwelling organisms and the productive fisheries they support. She has been an invited participant at working groups identifying research priorities for Australia in the area of climate risk.

Mia Sharma – winner of Leadership in Teaching Secondary Science and/or Mathematics

International Grammar School



Ms Sharma is dedicated to advancing science careers with our young people. The numbers of students choosing science subjects in NSW high schools is declining. She has developed innovative, contextualized programs that emphasise how science is used in daily life, and leads students to develop a love of investigation and analysis. Consequently, more students enjoy science and choose elective science subjects. Ms Sharma promotes scientific thinking as an essential tool in life and encourages students to follow scientific careers.

The major focus of Professor Dickman’s research is the investigation of factors that influence the distribution and abundance of land animals. Research on communities of mammals and lizards contributes to debate shaping population and species dynamics, and achieving practical conservation goals.

Professor Aibing Yu – winner of the Engineering, Mathematics and Computer Sciences Category

The University of New South Wales



Professor Yu is a world-leading scientist in particle/powder technology and process engineering. He has made many significant contributions and is recognised as an authority in the areas of particle packing, particulate and multiphase processing, and simulation and modelling.

Dr Melanie Bishop –winner of the Environment, Water and Climate Change Sciences Category

Macquarie University



Dr Bishop’s research addresses coastal conservation from an ecosystem context. Over the past five years, her research has

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