



EUREKA GOLD



Left to right) Dean of Science, Prof. Trevor Hambley, Dr Chris Dey, A/Prof. David Moss, Prof. Ben Eggleton and Dr Joy Murray and Vice Chancellor, Dr Michael Spence.

FIVE SCHOOL OF PHYSICS RESEARCHERS HAVE STRUCK EUREKA GOLD. Professor Ben Eggleton, Associate Professor David Moss, Professor Manfred Lenzen, Dr Joy Murray and Dr Chris Dey - took out three prestigious Eureka Prizes at a special black tie event held on Tuesday 6 September.

The Eureka Prize for Leadership in Science was presented to Professor Ben Eggleton, Director of the ARC Centre of Excellence, CUDOS, headquartered in the School of Physics. The prize recognises Professor Eggleton's outstanding record of multidisciplinary research leadership in Australia and the US, and his ability to develop and lead breakthrough science and technology in the field of optics and photonics and to translate discoveries into commercial realities.

Professor David Moss from the Institute of Photonics and Optical Science in the School was named winner of the Eureka Prize for Innovation in Computer Science. Professor Moss was recognised for his breakthrough work incorporating light onto silicon computer chips. His research will be critical to overcoming many of the energy and bandwidth bottlenecks for on-chip and chip-to-chip communications, and will play a key role in enabling silicon photonic chips.

Professor Manfred Lenzen, Dr Christopher Dey and Dr Joy Murray from the Integrated Sustainability Analysis Research Group (ISA) in the School won the Eureka Prize for Innovative Solutions to Climate Change with their model designed to calculate the environmental cost of what we produce, buy and eat. The ISA team develops leading-edge research and applications for environmental and broader sustainability issues, bringing together expertise in environmental science, economics, technology, and social science.

Vice-Chancellor Dr Michael Spence congratulated all the winners saying he was delighted the University had been so widely represented in the 2011 awards. "These awards are wonderful recognition for their work over many years. The University of Sydney takes great pride in their achievements. They epitomise our commitment to undertake research that makes an original contribution to knowledge and understanding."

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A RADICAL WAY OF HARNESSING NATURE'S NANOMACHINES

The science world is abuzz with news of a new platform technology developed by Professors Marcela Bilek and David McKenzie in the School - technology that can be used in areas as diverse as disease detection through to biofuel production.

Details of the breakthrough technology were published recently in the international journal *Proceedings of the National Academy of Sciences*. *The paper: Free radical functionalization of surfaces to prevent adverse responses to biomedical devices*, says the technology uses a layer of carbon and nitrogen, rich in free radicals to anchor proteins to a surface.

The simplicity of the method and the strong adherence of the biomolecules, while still preserving their biological function, has the science community talking. Professor David McKenzie of the School of Physics says, "Free radicals are often thought of as 'bad guys' who, if allowed to run free in the body, are understood to be involved in degenerative diseases, biological aging and cancer. In our technology we're putting these radicals to good use."

The new technology will be of benefit to implantable medical devices such as stents. The breakthrough allows the surface to cloak itself in the patient's own protein, reducing the chance of medical complications such as inflammation and rejection.

The patient's protein retains its "native" structure and will not trigger adverse reactions such as blood clots or the foreign body response. "When proteins land on surfaces currently



Professor Marcela Bilek

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**STOP
PRESS**

The 2011 Nobel Prize in Physics has been awarded to Professor Brian Schmidt who leads the Dark Universe theme within CAASTRO, the ARC Centre of Excellence headquartered in the School of Physics. Read more on page 9,

HEADLINE

PROFESSOR CLIVE BALDOCK



Welcome to the Spring 2011 & Summer 2012 issue of Alumni News.

I am pleased to inform our alumni and friends of the wonderful philanthropy of Mr John Hooke CBE to the new Australian Institute of Nanoscience (AIN), which is scheduled to commence building in 2012.

Mr Hooke, a Physics Alumnus, has been a great supporter of the School of Physics for several years and it is with great pleasure that the Chair of Nanosciences that he has generously endowed with a gift of \$5 million will be named in his honour. You can read an interview with him in this issue of Alumni News.

The Eureka Prizes, held in early September, were a great success for the School of Physics with each of our five physicists winning in their three categories. Many congratulations to Professor Ben Eggleton, Assoc. Professor David Moss and Professor Manfred Lenzen, Dr Chris Dey and Dr Joy Murray of the Integrated Sustainability Analysis Research Group (ISA). Many congratulations to them all.



Dr Paul Willis
Director RIAus

It was very good to meet so many of our alumni and friends in person at the ISS2011 Gala Reception that was held in The Great Hall in July. Warm thanks to Dr Paul Willis, Director, Royal Institution of Australia and former presenter, Catalyst (ABC TV), who was our guest MC at this special event.

Thank you as well to the Chief Scientist of Australia, Professor Ian Chubb AC, and Mulpha Australia's Chief Operating Officer, Mr Greg Dyer, who both presented the prestigious ISS science prizes. There is a special ISS section in this issue, in which you can read more about the ISS2011.

I hope you enjoy this issue of Alumni News.

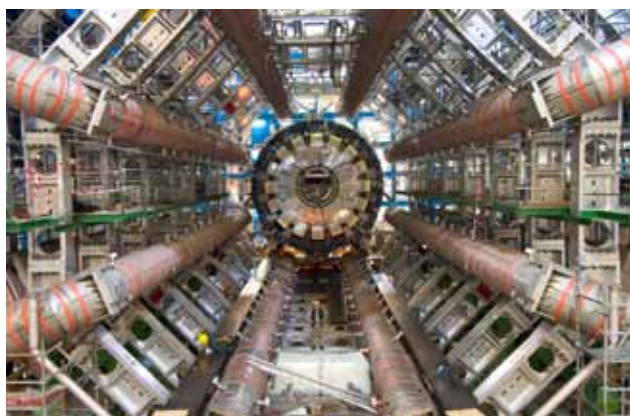
Professor Clive Baldock
Head, School of Physics, The University of Sydney

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NEW ARC CENTRE JOINS IN A ONCE-IN-A-LIFETIME OPPORTUNITY FOR DISCOVERY

BY CAROLINE HAMILTON

In the world of particle physics, the next twelve months promises to be the most exciting to date as researchers close in on solving mysteries that have been eluding physicists for a number of years. These discoveries are bound to do either one of two things: confirm the 'Standard Model' of particle physics, bringing us closer to a unified theory of everything or pave the way for something



Large Hadron Collider, CERN

new to fill the space. Joining the quest will be School of Physics researchers from the newly formed ARC Centre of Excellence for Particle Physics at the Terascale (CoEPP).

The Centre has been awarded a colossal \$25million to cover operations for the next seven years, a funding injection that is sure to put Australia's contribution to particle physics on to the global stage. Leading the charge at the Centre's Sydney Node in the School of Physics is Associate Professor Kevin Varvell.

"The timing of the startup of the Centre is perfect, capturing as it does the first serious data to flow from the LHC and the mood of excitement of the scientific community, that we now have a tool which will allow us to take the next important steps in revealing how the Universe works at a fundamental level," says Professor Varvell.

CoEPP brings together experimental and theoretical particle physicists from across Australia and internationally to work on the ATLAS particle physics experiment at the Large Hadron Collider (LHC) in CERN, Geneva. With a circumference of 27 kilometres, the LHC is the largest particle accelerator in the world. The acronym ATLAS takes its name from the particle detector situated at the LHC and stands for A Toroidal LHC Apparatus.

For the first time in Australia, terascale particle physics will be coordinated, allowing for a cross-pollination of ideas and formation of professional collaboration never before seen in the Australian particle physics community.

One of the major hoped-for discoveries is to find the Higgs particle. The Higgs explains how sub-atomic particles acquire mass and is the one remaining element of the Standard Model that is yet to be discovered. Every day sees scientists involved in the ATLAS experiment refining the Higgs search area and physicists are becoming very, very excited. CERN's Director for Research and Scientific Computing, Sergio Bertolucci, says, "Discoveries are almost assured within the next twelve months. If the Higgs exists, the LHC experiments will soon find it. If it does not, its absence will point the way to new physics." Professor Varvell shares this excitement.

"Something in Nature is responsible for giving fundamental particles the masses that they have, and I believe that we will soon know whether a Standard Model Higgs boson does that job for us or whether the story is more complicated, and richer, than that", he says.

Professor Varvell is no stranger to the ATLAS collaboration at CERN. Varvell and his team along with experimental physicists from Melbourne were heavily involved in the research leading to the development of the ATLAS detector.

The Centre differs from previous collaborations in that it consolidates the theoretical with the experimental side of particle physics and formalizes the Australian contribution to ATLAS.

Professor Varvell says, "Physics is an experimentally based discipline, with experimental results constraining theoretical ideas and theory providing predictions that motivate experiments. The Standard Model, whilst we know that it cannot be the whole story, has worked so well that for a long time now experiment has been having a hard time constraining theory.

Theorists have themselves yearned for experimental results that might confirm or refute their extensions to the Standard Model, and allow them to refine their thinking. With the LHC results starting to flow, hopefully the meaningful to-and-fro between theory and experiment will resume afresh, and within the Centre we want the lines of communication between the two to be as seamless as we can make it."

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“Our commitment to sustainability research is clear: it is fantastic to see the multi-disciplinary team led by Manfred Lenzen, Christopher Dey and Joy Murray recognised for their work in this area.

“It is also pleasing to see our researchers recognised for leadership and communication. We are determined to see our research go beyond the boundaries of our campus and have a real affect on broader society; we want to solve problems and innovate. Ben Eggleton has shown exemplary leadership in this area.”

All of the University of Sydney finalists at the Eureka Prizes took out the top prize in their category. Presented annually by the Australian Museum, the Eureka Prizes reward excellence in the fields of scientific research and innovation, science leadership, school science and science journalism and communication

A RADICAL WAY OF HARNESSING NATURES NANOMACHINES CONTINUED FROM PAGE 1

used in implants they unfold and distort, losing their biological function,” explains Professor Marcela Bilek.

“When our surface is immersed in a fluid containing protein, the protein is bound by reacting with free radicals that are trapped in the surface’s under-layer. The radicals do not harm the protein but tether them gently to the surface”.

The patented, breakthrough technology can also be used for the early detection of diseases. “Antibodies can be anchored on the new surface in an array of spots. Diseased cells attach to the antibodies in characteristic patterns that enable the disease to be detected long before the symptoms emerge.

“This will allow early intervention and higher cure rates,” says Professor Bilek. “We have recently demonstrated diagnostic arrays which can detect diseased cells at levels lower than previously possible.”

As well the platform technology will have an impact on biotechnology. “Ethanol is a valuable fuel that could be produced from waste cellulose (cardboard and agricultural waste) with special enzymes. These enzymes will be tethered to the new surface and continue to function, enabling new industrial production methods based on continuous flow rather than batch operation,” says Professor McKenzie.

The multi-disciplinary team, including Professors Weiss and dos Remedios from the Schools of Molecular Biosciences and Medical Sciences, respectively, is keen to attract sponsorship and establish partnerships to develop the technology for applications in biosensing, immunoassays and enzymatic processing.



Professor David McKenzie

THE PHYSICS OF PHILANTHROPY

John Hooke CBE, former Chairman and CEO of Amalgamated Wireless Australasia (AWA) and a member of the Science Foundation for Physics since 2003 has generously donated \$5 million that will enable the University of Sydney to make major advances in the exciting new field of nanoscience.



Mr John Hooke CBE and Prof. Clive Baldock

The gift will endow a new academic chair, the John Hooke Chair of Nanosciences,

in the School of Physics and the Australian Institute of Nanoscience (AIN), which is to be built at the University of Sydney. Alumni News spoke to John Hooke about his extraordinary gift.

Alumni News: Firstly, thank you and congratulations on your gift to science. It shows an extraordinary foresight. Why did you decide to give so generously?

John Hooke: It was the easiest decision of my life. I wanted to create something new and worthwhile, something that would build on the extraordinary advances of the last half-century, and open new horizons. I wanted a broad field with a big future. Nanoscience fits my aims perfectly, and my mind was made up when I learned that the School of Physics, which I value so much, is heading in this direction.

AN: What do you hope the John Hooke Chair of Nanosciences will enable scientists to achieve?

JH: Nanoscience is an all-pervasive thing that touches just about every branch of science and engineering. It is at an exciting stage, a bit like the early days of transistors: no one could forecast precisely where they would be applied, but we just knew it would be everywhere. Within this vast spectrum, I believe that, rather than competing head-on with the rest of the world, we can create areas in which we are world leaders.

AN: You have been a Council Member of the Science Foundation for Physics for eight years. Do you think this time spent in the School helped you gain a better understanding of the work of the researchers and their goals?

JH: Yes, we on the Council felt we were part of the School, and enjoyed many discussions with the researchers.

AN: You were also the Chairman of the Messel Endowment Capital Campaign Committee raising major gifts for the Professor Harry Messel International Science School (ISS) for a three-year period. Did this first-hand experience of fundraising make you think of philanthropy as being important? In what way?

JH: I have always believed philanthropy to be hugely important. It facilitates support for ideas not yet in the mainstream, which can be difficult to achieve under bureaucratic procedures. What I did learn from the Campaign is that the vision possessed by some large organisations is surprisingly lacking in others.

AN: The reasons often cited for giving are often an emotional affiliation to an area or organisation or to make a change to people’s lives. What were your reasons for making such a significant gift?

JH: In the post-industrial world, our future depends on creativity, research and innovation. Education underpins all these, and the University of Sydney has a proud record in research and education. It merits all possible support. Emotional support helps, but is not the main driver.

AN: Finally, any advice for someone who might be considering making a major gift or leaving a bequest to Physics?

JH: Don’t hesitate – do it! Physics is fundamental.

AN: Thank you John.

HOME AND AWAY

BY DR CHRISTINE LINDSTRØM



After eight years of 'hanging around' in the School of Physics, I left its safe walls and Sydney for the world; alternatively, after eight years of experiencing the world (i.e. Australia), I returned home to my native Norway. (With two home frames of reference, home and away become harder terms to apply.)

In the space between home and away was adventure: backpacking to remote crater lakes in Cambodia and learning to ride elephants in Laos. After a familiar Christmas, the subsequent unfamiliar experience of not returning to Sydney after welcoming the New Year marked the beginning of a new chapter – one written in a language I had not used much for ten years.

However, a lucky star – probably one that died thousands of years ago – shone upon me, when I discovered an ad for the dream job the day after I started looking: a post doc in science education at Oslo and Akershus University College. I applied and waited for about four months for an answer.

In the meantime, I got restless, found an ad for a temporary job at the Norwegian University of Science and Technology in Trondheim, sent off an email, was flown up for a meeting, and was asked to start yesterday. Obeying the law of causality, I moved to this 1000-year-old town with a strong academic position 600 km north of my hometown, Sandefjord.



Moving into a house in a national park two kilometres from the nearest bus stop in the middle of a snowy winter, it was hard to imagine living somewhere less reminiscent of Sydney. For half a year I worked as an Associate Professor of University Pedagogy teaching three-day crash courses to international PhD students and post docs about how to teach at university, as well as writing up papers from my thesis.

What I learnt about Norwegian academia is that being a PhD student is considered a job – a handsomely paid one at that – and that there are only two academic levels above PhD student: Associate Professor and Professor. A strange place indeed!

In mid-May I was offered the post doc I had applied for in Oslo, and three days later I had bought the dream apartment in Oslo, by which time I was sure I had spent my decadal allocation of luck. That was until I was offered a position as Adjunct Associate Professor in Trondheim to hold in parallel with my post doc in Oslo. Such a position is quite common in Norway: in addition to a full-time position, academics can have a 20% position at a different institution to ensure that the limited specialised academic resources are utilised as well as possible in this small country of five million people. In my case it means spending a couple of weeks in Trondheim each semester

to teach the crash course, in addition to helping out with proof reading English papers and documents – and with whatever else they may feel like challenging me.

My last working day in Trondheim coincided with the tragic terrorist attack that put the whole country on hold for a few days. When I moved south three days later, I therefore decided to spend a week with my family in my home town 100 km south of Oslo before relocating to the Tiger City.

After seven weeks in my new job, I am, finally again, my old busy self. I still write up papers from my thesis, and in my new project I will continue to integrate knowledge of human learning from neuroscience and cognitive psychology with the theoretical foundations of Physics Education Research. My specific focus will be on how young children implicitly construct their knowledge about the physical world around them, and try to understand in more detail how this interferes with the explicit instruction of classical mechanics when they become novice physics students.

One of the most enjoyable aspects of returning to Norway has been the networking, with the absolute highlight occurring very recently. My new mentor, Professor Svein Sjøberg, hosted Professor Lawrence Krauss for three days packed with public lectures, academic mingling and fancy dinners. Being invited along to everything, I thoroughly enjoyed inspirational lectures and stimulating conversations with Professor Krauss. It was then that I fully realised how satisfied I was with my choice of returning to little Norway. It's not such a bad thing being a relatively bigger fish in a small pond, when that pond is connected to vast oceans.

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NEW ARC CENTRE JOINS IN A ONCE-IN-A-LIFETIME OPPORTUNITY FOR DISCOVERY
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The ARC funding also allows for an increase in the number of Research Higher Degree students able to directly participate in the high profile and significant work currently being done in high-energy physics.

The work of Varvell and the Sydney node team presently includes searches for new particles decaying to tau leptons (a heavy cousin of the electron). Not only is this one of the possible ways in which the Standard Model Higgs boson might be detected, but it may also be the way that charged Higgs bosons, supersymmetric particles and other heavy particles predicted by theories that extend the Standard Model turn up in the data collected by the ATLAS experiment.

The potential of CoEPP to be a part of the most amazing periods in physics history will mark Australia as a leading contributor. It is becoming more and more likely that the timing of the Higgs discovery (or refutation) is likely to be announced in Australia at the 2012 International Conference on High-Energy Physics (ICHEP2012) to be held in Melbourne at the beginning of July, marking Australia's place in the annals of physics history.

Caroline Hamilton is the Communications and Outreach Coordinator at the ARC Centre for Excellence for Particle Physics at the Terascale.



Associate Professor Kevin Varvell

[LEARN MORE: COEPP.ORG.AU](http://LEARN.MORE:COEPP.ORG.AU)

ISS2011



LIGHT & MATTER

HOUSEPARENTS RULE!

BY JOHN BRIGHT

Once again, it was with a mixture of excitement and trepidation that I boarded the plane for Sydney to take up my position as houseparent (house-dad, obviously) for the Professor Harry Messel International Science School (ISS) 2011. Karen (my wife and house-mum) and I met on youth camps quite a few years ago, and have shared many school and youth camping experiences. However, I have to count my four opportunities to be part of the ISS as probably the most stimulating and rewarding "camps" I have ever enjoyed. It doesn't hurt that I am house-dad to 150 of the brightest and most enthusiastic young adults you are likely to encounter in one place at one time, though it doesn't always help knowing just how "creative" they can be, either.

At the ISS we are lucky to enjoy the hospitality of the Women's College. Their commitment to ensuring that our scholars have the best possible experience goes a long way to making my job easier. Karen and I are also supported in our role by the amazing Alex Green and Alison Muir, the highly valued Foundation staffers who do all the organisation before and during ISS, and a team of "staffies" who were scholars at a previous ISS, and who have volunteered to return to ensure the latest scholars have a wonderful experience. Dr Chris Stewart, who has been the ISS Manager for three of my visits, pulls the whole thing together with his energy, enthusiasm and great leadership.

The job description for the role of houseparent is rather vague – be "on deck" or "on call" for a continuous period of 336 hours to look after 150 Australian and International scholars, help them to stay happy and healthy, try not to lose any of them and try to ensure that they are able to get the maximum enjoyment from the wonderful opportunity they have been offered.

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PROFESSOR HARRY MESSEL INTERNATIONAL SCIENCE SCHOOL (ISS)



Created by Professor Harry Messel in 1962 the Professor Harry Messel International Science School (ISS) is a free science education program for Year 11 and 12 students funded by the Science Foundation for Physics and held in the School of Physics and the University of Sydney. Over the past 49 years the ISS has developed from a national program to one that attracts students from China, India, Japan, Malaysia, New Zealand, Singapore, Thailand, the UK and the USA.

The ISS2011 team would like to take this opportunity to warmly thank all ISS and Messel Endowment donors, volunteers, alumni and friends as well as our ISS Patron - HE Professor Marie Bashir AC CVO, Governor of NSW, and the high profile scientists who donate their time to help lecture or take part in ISS events. As well the enormous undertaking of the state, national and International selection committees is greatly appreciated.

ISS2011 LECTURERS

BY DR CHRIS STEWART

The Professor Harry Messel International Science School (ISS) has, for almost 50 years, given secondary school students a life-changing experience. While the students experience a range of science challenges and activities, the backbone of the ISS is the lecture series.

Every two years leading scientists from across Australia and around the world are invited to talk about their work and its impact on society. In fact, the ISS has a long list of great speakers over the decades - James Watson, who won a Nobel Prize for discovering the structure of DNA, Jerome Friedman, also a Nobel Laureate his for work on particle physics, Sir Hermann Bondi (physicist and astronomer at Cambridge University), Margaret Burbidge (astronomer with the Hubble Space Telescope), Carl Sagan (famous astronomer and science communicator) and Lord Robert May of Oxford (President of the Royal Society) have all given talks at the ISS.



Pioneering Physicist, Professor Sir John Pendry

The ISS also started the media career of Professor Julius Sumner Miller, who entertained television audiences with his science antics through the late 60s and 70s, and whose legacy lives on in the position of the Julius Sumner Miller Fellow in the School of Physics, held by the incomparable Dr Karl Kruszelnicki.

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HOUSEPARENTS RULE! CONTINUED FROM PAGE 1

This can be more challenging than it might appear, because we always seem to have a few budding “absent-minded professors” and a few who clearly are in the teenage mode of staying in bed until a real Mum or Dad pushes them out the door to go to school. Fortunately the fantastic program prepared for the scholars presents them with a lure to overcome any natural inertia or vagueness.

Happily we manage to keep most of the students healthy most of the time and I am often able, during the days, to get to enjoy the lectures and activities that are scheduled for the scholars. In my real life I am a Physics teacher in Brisbane, and I never cease to be impressed at the level of the questions that the ISS scholars raise with the lecturers (as I believe many of the lecturers are, as well).

Early evenings are usually the most relaxing time for a houseparent at ISS as volunteers from YSA (Young Scientists of Australia) provide a wide range of social activities and tutorials for the scholars to allow them to relax and socialize with their new found friends, to see many of the most interesting attractions that Sydney has to offer. Personally, my favourite social events are the Bush Dance and “Talent” night, though the Harbour cruise is also wonderful. The Bush Dance is most notable because it is



Houseparents John Bright, left, and Karen Palmer, fifth from left, with ISS2011 staffies.

the event that many Australian scholars are rather doubtful about as possibly being rather corny and old-fashioned, but which is greatly enjoyed by both the Aussies and their overseas counterparts.

It's amazing how quickly two weeks can pass and just as you really settle into a routine, the program is heading for its conclusion. Scholars who were recently strangers from different cities or states or countries have formed friendships that will, for many, last a lifetime.

I think the greatest pleasure for me as a house-dad is seeing the wonderful changes that can occur in those scholars whose eyes are opened to a wonderful new world of promise and potential, and whose future is redefined by a single fortnight in July in Sydney. We do know of scholars for whom this redefinition has been genuine and powerful in their post-ISS lives. Emeritus Professor Harry Messel tells us we should “honour excellence”, and I think we should all honour the excellent ISS experience and its wonderful scholars.

FROM ISS TO PHYSICS

BY GABRIEL NGUYEN

Three Professor Harry Messel International Science Schools (ISS) with a total of 417 students from 10 different countries, 33 esteemed lecturers drawn from the School of Physics as well as from all around the world and two weeks living at the Women's College at the University of Sydney. But what does this all mean? The numbers are only a fraction of the experience that has taken me from my final year of high school in 2007 to the brink of finishing my Honours in Physics at the University of Sydney, there is much more behind them.

In the final year of high school, I was studying Physics and the HSC Cosmology Distinction course, but I was not really feeling that science was a viable university option. At that point, I was weighing up what course to combine with a desired law degree, and science did not appear on the horizon. Then, as if by chance, a friend linked me the application form for ISS2007. With little more than the ‘ecoscience’ theme as guidance, I decided to apply, as I still thought science was an interesting topic.

To my amazement I was accepted into the ISS 2007. That Science School was a life-changing experience. Surrounded by 132 highly talented people like myself from nine different

countries and exposed to some of the best and brightest scientific minds in the world over the two weeks, I could not help but get caught up with ISS.

Lecturers such as Professor Michael Oppenheimer and Professor Lord Robert Winston were inspiring, and a personal highlight was being able to quiz Professor Fred Watson about dark matter. The two weeks however provided more than just invigorating scientific activities; the social programme offered with the help of the Young Scientists of Australia (YSA), including the Harbour Cruise and the Bush Dance, provided a multitude of social opportunities that brought us out of our shell.

I came out of ISS2007 with many new friends and a new appreciation for science, changing my academic trajectory. From languishing beyond the horizon science rose up, and in 2008 I started a Combined Science/Law degree at the University of Sydney. Almost immediately I decided to major in physics, and the Talented Students Program within the School of Physics allowed me to argue the future direction of Australia's renewable energy target, explore the telescopes and understand the effects of active galactic nuclei on the surrounding interstellar medium, all within the first year of my degree.

If ISS2007 brought me closer to science, then ISS2009 helped me discover my passion. I applied to be a volunteer staffie for ISS2009 because I wanted to provide each student the same opportunity to experience the ISS to its fullest, as my staffies had given me in



Dr Karl and Gabriel Nguyen

2007. I was lucky enough to be invited back, and the second ISS, if anything, only got better. Personal highlights were seeing my own lecturers from the School of Physics in Professor Geraint Lewis and Dr Helen Johnston loved by the scholars, and the lecture by Chief Justice Robert French combined the best of my degrees, amongst the numerous other wonderful memories of ISS2009.

Mentoring 24 bright and talented scholars in the group of 138 scholars brought a sense of purpose that stays with me to this day. The energy and excitement I felt during the two weeks with such a wonderful group stayed with me long after ISS2009 came to a formal close. This changed my personal trajectory, leading

START SMALL – ACHIEVE BIG

Joelene Puntoriero was one of the eight Indigenous Science Scholars who attended the ISS2011 – Light and Matter. Joelene was awarded the Mulpha ISS Leadership Award for her academic and leadership skills. Joelene tells of her experience at the ISS.

My name is Joelene Puntoriero and I am an indigenous student at Taminmin College in the Northern Territory. I was encouraged by my Biology teacher to apply for the Professor Harry Messel International Science School (ISS) 2011 at the University of Sydney. After being accepted I excitedly flew to Sydney with fellow classmate; David Ung, Year 11 student; Leon Mills and a Darwin high school student; Nerida Liddle to attend the ISS2011 Light and Matter held in the School of Physics at the University of Sydney.

During the two-week science program I was blown away by the concepts that were presented by Sir John Pendry and his presentation on invisibility and Professor Alan Clark's presentation on the Large Hadron Collider. We scholars were also privileged enough to experience a myriad of other profound scientists' lectures in the very limited time of two weeks.

Every day was unique in its own way, either being whisked off to lectures in theatre rooms or dissecting sea urchins, I thoroughly enjoyed each given opportunity. The ISS has opened my eyes to concepts, which are only imagined about let alone put into practice; for example bending spoons with matter. Not only did the ISS provide me with the opportunity to explore

the science world in ways I could never have imagined but it also allowed me to be fortunate enough to meet some of the world's best young science scholars.

The ISS opened my eyes to a world full of opportunities and shown me that the only person that is holding you back is yourself. Being an indigenous student has only made me yet more determined to succeed in anything I throw myself into. Although it has assisted me in being accepted into numerous camps, I am sincerely grateful for every opportunity my ethnic background has afforded me, honestly I wouldn't have it any other way.

My motivation comes from my dream to become a member of Australia's Science Society; my motto is 'start out small in order to achieve big'. Everybody must always begin somewhere even if it's volunteering at a farm or helping out at charities but if you are determined enough anyone can achieve anything.

My main support comes from my family, friends and mentors; I couldn't imagine where I would be without them. With the support of aspiring individuals and the opportunity to attend numerous camps I have come to realise that my dream is to become agricultural scientist.

To students who want to succeed, never give up. Emeritus Professor Harry Messel says never stop asking questions. "As a scientist an inquisitive nature will be the most valuable attribute to their formula for success."

I couldn't agree more!



Joelene Puntorelero Mulpha ISS Leadership Award winner with Greg Dyer, CFO, Mulpha Aust.



Professor Alan Clark, Particle Physicist, University of Geneva.

me to join YSA; there I staffed and helped to organise other science camps held around NSW. I also started communicating science to groups of young students in the hope of persuading them to undertake future science studies.

ISS2009 altered my academic life as well. While undertaking a research project looking at dark matter distribution in galactic haloes, I talked to the Sydney University Physics Education Research group (SUPER) about projects involving physics and science education. At the beginning of this year, my Honours project was settled: looking at the attitudes of university students with regards to the scientific process in the School of Physics. I also got involved with the Kickstart program, helping to teach HSC Physics.

Third time's the charm, and ISS2011 was the culmination of my ISS experiences. Some familiar faces returned, but the event provided so many beautiful and wonderful memories. Personal highlights included Sir John Pendry on metamaterials, looking over Sydney Harbour at the British Consulate on a beautiful Monday evening and the Harry Potter-themed Gala Reception. ISS 2011 allowed me to again experience the beauty of science, but also a deeper appreciation of the effort and energy that it takes to put on the ISS.

I have had the privilege of three life-changing experiences at ISS, and I can definitely say that without it, I would not have ended up part of the wonderful community within the School of Physics. To the organising committees of each ISS, in particular Chris Stewart (ISS2005, 2007, 2011), Adam Selinger (ISS2009), Alex Green (ISS2005, 2007, 2009, 2011) and Alison Muir (ISS2003, 2005, 2007, 2009, 2011), thank you for all the effort you have put into each ISS, it is truly inspiring. I would also like to thank all the lecturers and activity leaders. I've learnt so much from what you have contributed.

To the ISS 07/09/11 staffies and the houseparents John and Karen, it has been an absolute pleasure working with all of you. To all the ISS scholars that have been there for each ISS I've been to, I hope you have taken on board your experiences at ISS and carry the inspiration in your future endeavours.

Finally, as I continue with my education at the School of Physics, to Emeritus Professor Harry Messel, for without his intelligence and passion for science education the ISS could not exist, I offer my deepest thanks for reminding generations of students that science is rewarding and that no matter what you do in the future, the one thing that matters is to take each step of life 'honouring excellence'.



Gabriel in action



ISS2011 Opening Ceremony, (Left to right) Prof. Stephen Garton, Mr Jim O'Connor, Em. Prof. Harry Messel, Mr Albert Wong, HE Governor of NSW, Mr Trevor Danos, The Hon. Neville Wran, Prof. Clive Baldock



A packed Slade Lecture Theatre during the Science & Engineering Challenge



ISS2011 Chinese Scholars



Prof. Ian Chubb, Chief Scientist of Australia, with Hadleigh Frost, NZ ISS Scholar & Len Baser Science Prize winner and Mr Martin Welsh NZ Consul General

ISS2011 LECTURERS CONTINUED FROM PAGE 5

The ISS2011 lecturer series featured once again some inspiring scientists. The program was officially kicked off by Prof. Allan Clark, Director of the Department of Nuclear and Particle Physics at the University of Geneva, and member of the Atlas experiment at CERN's Large Hadron Collider. Prof. Clark enthralled the students with two talks on the most fundamental layers of matter and the LHC's search for the elusive Higgs boson, theorised to be responsible for giving all other particles in the universe their mass.

Our other international guest speaker was Prof. Sir John Pendry, Chair in Theoretical Solid State Physics at Imperial College, London. Prof. Pendry is a world leader in the subject of metamaterials — strange materials engineered to have properties not found in nature. His is best known as the scientist behind a discovery straight out of science fiction and fantasy stories: an "invisibility cloak", a device that can hide objects from view, just like something out of Harry Potter.

Our homegrown scientists were equally inspirational. ISS Scholars learned about plasmas, the fourth state of matter, from Professor Christine Charles from Australian National University, and whose team is working on plasma thrusters for future space travel. The highlight (literally!) of Professor Charles's talk was lighting a fluorescent tube via a human electric cable. Fifteen students hand-in-hand, the last clutching the lit fluoro tube as an electromagnetic field was applied to the first student at the start of the chain.

Professor Martin Green, Scientia Professor with the UNSW Photovoltaics Centre of Excellence, spoke about designing world-leading solar cells and the future of solar power. And renowned ABC science journalist Robyn Williams regaled the students with stories from a lifetime of reporting science on radio — including some hair-raising tales of scientists behaving badly!

The ISS2011 program also featured a lot of University of Sydney talent. Dr Jo Whittaker from the School of Geosciences took the students on a tour of the sea floor, and her research that reconstructs the shape of the continents over millions of years. Dr Deanna D'Alessandro and Professor Thomas Maschmeyer, both from the School of Chemistry, described research to boost our chances of tackling climate change.

Dr D'Alessandro's research into carbon capture offers hope for reducing our greenhouse emissions, and Professor Maschmeyer's research into future energy sources promises greener, more sustainable fuels.

From the School of Biological Sciences, Professor Stephen Simpson told a fascinating story that began with tickling locusts, expanded into a theory of locust swarming behaviour and ended with insights into human obesity and the modern western diet.

From the School of Physics, Professor Stephen Bartlett outlined exciting developments in quantum science, where the quantum theories of the last century are used to develop new technologies, such as quantum computing and cryptography. Also from the School, ARC Federation Fellow and Director of CUDOS, Professor Ben Eggleton, showed the future of optical communications technology, tackling the problems faced by the current electronics technologies in dealing with our ever-increasing demands for Internet traffic.

The ISS was officially closed with a talk by Professor Fred Watson from the Australian Astronomical Telescope, returning to the program after speaking at ISS2007. Professor Watson, well known for communicating the fascination of astronomy on Australian TV and radio, took the students on an animated fly-through of the universe, and described the mysterious dark matter and dark energy that dominates the structure of the cosmos.

The ISS2011 Book of Lectures, which provides a snapshot of the forefront of science at this point in time, was given to each student, with an electronic (PDF) version available for download from our website.

Thank you to all ISS2011 lecturers and guest speakers. Your support for our future scientists is truly valued and inspirational.

DOWNLOAD THE ISS2011 BOOK OF LECTURES
PHYSICS.USYD.EDU.AU/FOUNDATION/ISS/ISS.SHTML

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VIMEO.COM/ISS2011/VIDEOS

CAASTRO AIMS FOR THE STARS & BEYOND



The CAASTRO logo lights up Sydney Observatory at the launch

The sky is no longer the limit, with CAASTRO, the new ARC Centre of Excellence for All-sky Astrophysics, headquartered in the School of Physics, launched by University of Sydney Chancellor, Professor Marie Bashir AC CVO, in front of an A-list of astronomers at the Sydney Observatory on 12 September 2011.

CAASTRO is taking a revolutionary new approach to astronomy by using an all-sky perspective to answer the big questions about our universe. CAASTRO brings together unique Australian expertise across six Australian universities, along with local and international partners.

The new centre, in collaboration with the Australian National University, the University of Melbourne, the University of Western Australia, Curtin University and Swinburne University of Technology.

CAASTRO brings together expertise in radio astronomy, optical astronomy, theoretical

astrophysics and computation to investigate three interlinked themes: the Evolving Universe, the Dynamic Universe, and the Dark Universe.

“CAASTRO is a major new initiative that is revolutionising the way we see the universe,” says Professor Bryan Gaensler, Director, CAASTRO. “The traditional approach to astronomy has had a lot of success, but we’re now running up against a whole range of questions these old approaches can’t answer.”

“The big unsolved questions in astronomy demand entirely new approaches, requiring us to look at the whole sky at once, rather than studying single objects in the sky in isolation.”

“You really need to look at how everything works together to truly understand what is going on out there and that’s what CAASTRO will do with our all-sky approach to astronomy. CAASTRO research will use wider fields of view, with bigger data sets, processed more deeply and more subtly, than anyone has attempted before,” says Professor Gaensler.

He adds, “In the last few years, Australia has invested more than \$400million in new wide-field telescopes and the high-performance computers needed to process the resulting torrents of data. Using these new tools, Australia now has the chance to be at the vanguard of the upcoming information revolution in all-sky astronomy.”

CAASTRO’s three interlinked research themes are:

1. The Evolving Universe: When did the first galaxies form, and how have they evolved?
2. The Dynamic Universe: What is the high-energy physics that drives rapid change in the Universe?

3. The Dark Universe: What are the Dark Energy and Dark Matter that dominate the cosmos?

Professor Gaensler says CAASTRO’s strength is that it will be a collaborative structure that for the first time combines the relevant expertise and resources into a single coherent unit.

“In addition to our revolutionary science, we’ve decided right from the outset that CAASTRO should also put a high priority on training the next generation of scientists, on providing a family friendly environment for all our staff, and engaging with schools and the public with outreach activities.”



CONGRATULATIONS TO 'CAASTRO'S' 2011 NOBEL PRIZE IN PHYSICS WINNER PROFESSOR BRIAN SCHMIDT



For research on the Acceleration of the Universe the 2011 Nobel Prize in Physics has been jointly awarded to Professors Brian Schmidt, Saul Perlmutter and Adam Riess.

Professor Schmidt, an Australian Laureate Fellow and Professor of Astronomy at The Australian National University’s Mount Stromlo Observatory, leads the Dark Universe theme within CAASTRO.

His unique roles as SkyMapper lead scientist and leader of the High-Redshift Supernova Search team give him an international profile in this area second to none.

Many congratulations to the 2011 Nobel Prize in Physics winners on their extraordinary achievement!



Prof. Trevor Hambley, Dean of Science, Prof. Bryan Gaensler, Director, CAASTRO, HE Prof. Marie Bashir AC CVO, Prof. Margaret Shiel, Director, ARC, Dr Alan Finkel AM, CAASTRO Advisory Board and Prof. Lister Staveley-Smith, CAASTRO Board at the CAASTRO Launch

COSMIC MICROWAVES

BY DR JAMES ALLISON

The Cosmic Microwave Background (CMB) is a relic radiation generated in the origins of the Universe, almost completely smooth across the whole sky and thought to originate 100,000 years after the Big Bang with a temperature of 3000 K. This background radiation has since cooled to 2.728 K as the Universe has expanded, and is an almost perfect example of naturally occurring black body radiation.

The characteristic temperature of the CMB produces a peak in its brightness spectrum that is suitable for observation at microwave wavelengths. Arno Penzias and Robert Wilson, reporting an excess antenna temperature equal to 3.5 K at a frequency of 4.08 GHz, discovered the CMB in 1965. Other groups, including Peebles, Dicke and Wilkinson at Princeton, had been looking for a universal microwave background after its predicted existence by Ralph Alpher and Robert Herman.

The discovery of the CMB provided the 'smoking gun' evidence for the Big Bang model of the Universe proposed by George Gamow. The Big Bang model states that the early Universe was very dense and hot, which then expanded and cooled to form the structure seen at the present day. Gamow used this model to explain the relative abundances of the chemical elements seen today, created in a process known as nucleosynthesis.

In nucleosynthesis the rates at which reactions occur between the nuclear particles are eventually dominated by the expansion rate of the Universe, causing the abundances of different nuclei to freeze-out at fixed values. Most of the Universe observed at the present day consists of Hydrogen and Helium, with trace amounts of Lithium and various isotopes thereof; the heavier elements are generally believed to have formed much later during the supernova deaths of stars.

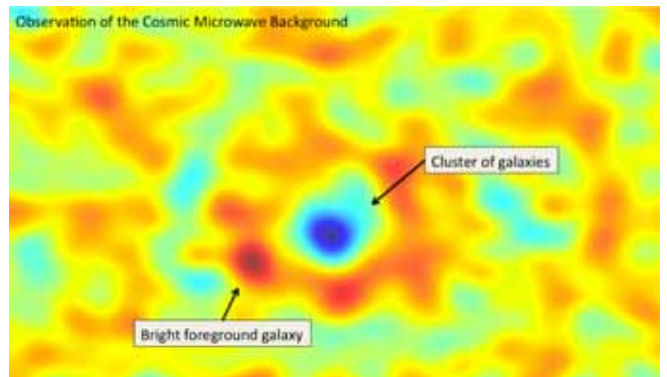
For the first 100,000 years following the Big Bang, radiation and matter formed an opaque primordial plasma, within which photons and unbound electrons interacted via Compton Scattering. As this plasma expanded and cooled below the binding energy of the lightest atoms, the number of unbound electrons reduced considerably, causing the radiation and matter in the universal plasma to de-couple and evolve separately.

The CMB that is observed today is an image of the Universe during this period of re-combination, propagating through the now transparent Universe. The spherical shell surrounding the observer, from which the CMB radiation originated, is known as the surface of last scattering.

Following the discovery of the CMB in 1965, a range of complimentary experiments were carried out in the 1970s and 1980s to determine both the spectral and spatial properties of the radiation. They showed that the background radiation behaves very similarly to the expected black body curve and measured the average temperature to be approximately 3K. The high degree of smoothness in the CMB was consistent with the cosmological principle that the Universe is both isotropic and homogeneous on the largest scales. However it was also expected that the CMB should be anisotropic to at least a small degree, since the radiation had once been tightly coupled to matter, which has now formed distinctly anisotropic complex structures under the action of gravity.

The primordial CMB anisotropies were not detected until the advent of the Cosmic Background Explorer (COBE), a satellite that was launched in 1989 and designed specifically to measure the CMB spectrum and anisotropy to unprecedented accuracy. COBE observations showed that the temperature anisotropy is at the level of one part in 100,000 and that the spectrum is almost identical to that of a black body source. For this work the 2006 Nobel Prize in Physics was awarded to John Mather and George Smoot.

Subsequent experiments observed the anisotropy on different angular scales so as to constrain the physical properties of the Universe including its geometry, normal and dark matter content. These include the Wilkinson Microwave Anisotropy Probe (WMAP) satellite, which provided strong constraints on these cosmological parameters, and Earth-based experiments that mapped small-scale variations in temperature. These cosmological parameters are used regularly in the work of Astronomers to convert the angular sizes of astronomical objects to physical distances.



Present day observations focus on the smallest scale variations in temperature. On these scales foreground objects give rise to secondary fluctuations that can be difficult to disentangle from the background radiation. Some galaxies generate emission that can be seen at microwave wavelengths and which will generate anisotropies at relatively small angular scales. In order to separate the intrinsic CMB and galaxy anisotropies we require a study of the galaxy population at microwave wavelengths.

A recent survey led by members of the School of Physics observed 6,000 galaxies at short radio wavelengths providing valuable information for CMB astronomers. My research in collaboration with the Experimental Cosmology group at the University of Oxford uses the Cosmic Background Imager, Chile to observe a further secondary effect that arises in the hot gas of massive clusters of galaxies. The electrons contained within the cluster gas interact with the background radiation and scatter it to shorter wavelengths.

We observe this as a decrease in CMB temperature, providing a valuable distance-independent measure of the total thermal energy contained in the galaxy cluster. In addition to other experiments around the world, Indian and Australian astronomers at the Compact Array, Narrabri, have achieved observations of this effect where they obtained images of the violent merger of two galaxy clusters three billion light years away.

The European Space Agency's Planck satellite mission (www.esa.int/SPECIALS/Planck/index.html) is now using this technique to detect distant clusters of galaxies and map the distribution of matter throughout the observable Universe.

With the continuation of both ground based and satellite experiments, experimental cosmology is currently a very active field which continues to answer the most fundamental questions we have about the Universe.

IPOS SYMPOSIUM

The Institute of Photonics and Optical Science (IPOS) of the University of Sydney is holding its third Annual Symposium. To be held on Tuesday 6 & Wednesday 7 December 2011, the topic for this year is "Energy and the Environment: Photonics Solutions for the 21st Century."

This Symposium will focus on the role of optics and photonics in clean energy generation, energy conservation and monitoring and environmental sensing. Topics will include energy generation through photovoltaics and photothermal technologies, energy consumption of the Internet, energy conservation through more efficient photonics-based technology and monitoring, and environmental sensing.

The venue for this exciting event is the Lecture Theatre 101, New Law Building, the University of Sydney. Attendance is free, but registration is essential. Register now at: sydney.edu.au/science/ipos_symposium_rsvp_2011.php

REACH OUT

BY TOM GORDON



I'm Tom Gordon and it is with great pleasure that I introduce myself to you as the new Science Communicator in the School of Physics.

With a degree in Astrophysics at the Australian National University (ANU) I then achieved a Graduate Diploma in Science Communication with Questacon in Canberra. From there I travelled overseas to Strasbourg, France where I gained a Masters in Space Science. I also spent a year in the National Measurement Institute (NMI) in the legal metrology and policy area. A highlight of my career has been my participation in a European Space Agency Student Parabolic Flight Campaign.

During this time I returned to Sydney and worked as a secondary school physics teacher for four years. I remember bringing my physics students to several HSC Kickstart Physics workshops as well as attending a Science Teachers Workshop. On each occasion I coveted the position of School of Physics' Science Communicator. Luckily for me this is now my role and I couldn't be happier.

As a teacher, I have a unique perspective on the role of Kickstart and its future directions, as well as the other programs that I now manage. In the process of updating the Kickstart workshops and there are a number of places where I see development opportunities, from the worksheets themselves, to further the interactive demonstrations and experiment, to new workshops altogether.

An important area that the workshops will be developed is in the alignment with the Higher School Certificate (HSC) syllabus itself. This includes connections with HSC assessments, textbooks, syntax and Key Learning Areas. As the Australian National Curriculum is rolled out, this will make the sessions even more relevant to the teachers and students.

By renewing some of the other workshops, such as the Gifted and Talented program and including a new G&T workshop called, "How to be a Physicist" the focus will not only be on the content of science but will also concentrate on developing scientific skills. As a teacher, I have identified a lack of knowledge and skills for some simple things like drawing a graph, identifying variables, collaborating and recognising risks.

As a physicist I now have the opportunity to communicate the core business of science. So, from now, all Science programs from the School of Physics Science Communication office will have a strong focus towards scientific skills, as well as proper and expert content. To me this is both very exciting and important.

I have also been given the green light to conduct some of my own research into Science Communication to make my job better, more effective, and also to contribute to the international discussion on science communication. This research will initially be designed to answer questions like how effective are Kickstart and other science programs from the School of Physics at getting students to study Physics?

A very open ended and challenging questions to pose for sure, but it wouldn't be research if it weren't challenging. I am looking forward to this aspect of my role, as I believe science communication is extremely important, and in some ways, not well understood.

I am so excited to be here, and I have many ideas for development of the programs and my role that are not necessarily confined to the Second Year Lab!

YOUNG PHYSICIST AWARDED PRESTIGIOUS NMI PRIZE

Research into the most sensitive measurement of force yet recorded has earned University of Sydney physicist Dr Michael Biercuk, from the School of Physics' Quantum Science Group, the National Measurement Institute Prize for Excellence in Measurement Techniques by a scientist under 35.



Dr Mike Biercuk being awarded the NMI prize

In collaboration with the Ion Storage Group at the US National Institute of Standards and Technology, Dr Biercuk demonstrated it is possible to use trapped atomic ions as extremely sensitive detectors of applied forces and electromagnetic fields. In so doing, the researchers were able to measure forces with extraordinary sensitivity - down to the yoctonewton (yN) level. The yoctonewton represents one septillionth of a newton, the unit of force named after physicist Sir Isaac Newton.

"This award recognises Dr Biercuk's contribution to research in the most sensitive measurement of force to date - the yoctonewton," said Innovation Minister Senator Kim Carr, who announced the award. "This is an incredibly small force - about a million million billion times smaller than the force exerted by a feather lying on a table. And the measurement is a thousand times more sensitive than anything previously possible," he said.

The discovery provides an opportunity to address new challenges in materials science, nanotechnology and industrial sensing. For example, forces at the yoctoscale correspond to the weight of tiny nanoparticles consisting of just a few dozen atoms, or the effects of tiny electric fields on charges in nanoscale materials.

To detect the force, Dr Biercuk and colleagues used a device consisting of about 60 beryllium ions confined in a Penning Trap, which stores charged particles using electric and magnetic fields. Any movement caused by an applied force was measured with a laser. The resulting measurement of forces with sensitivity at the level of 390 yoctonewtons with just one second of measurement eclipsed the previous record by three orders of magnitude.

"I am extremely grateful and humbled that this work was deemed significant enough to warrant this distinction, and I'm very pleased that the exciting new field of quantum science is having impacts on a variety of disciplines, including measurement science," said Dr Biercuk.

SYDNEY SET FOR NUCLEAR CONFERENCE IN 2012

Assoc. Professor Reza Hashemi-Nezhad from the School of Physics, attended the 25th International Conference on Nuclear Tracks in Solids (ICNTS) held in Mexico where he presented two very well received papers. During the Conference Professor Hashemi-Nezhad was delighted to learn that the International Nuclear Track Society (INTS) general assembly had unanimously approved Sydney as the destination for the 2012 Conference.

At its closing ceremony, the flag of the INTS officially was handed to Professor Hashemi-Nezhad. Planning is now underway for the 26th ICNTS. As well the general assembly of the International Nuclear Track Society the executive committee members of the INTS for next three years were elected with Professor Hashemi-Nezhad elected as President.

Congratulations to Professor Reza Hashemi-Nezhad on all his achievements. *Alumni News* is sure the 2012 Conference will have a great international reaction.

LEARN MORE
WWW.PHYSICS.USYD.EDU.AU/SCHOOLS_COMMUNITY/INDEX.SHTML

Dr Karl has been out in the moonlight – read more: MOON'S ROTATION A PASSING PHASE

The Moon is a major part of our lives. It is responsible for two-thirds of the height of the tides that wash across our beaches twice every day. It also stabilises the tilt of the Earth, thus making life possible. In pre-industrial times, it gave us that very important light at night, and of course it's related strongly to the female menstrual cycle. So if the Moon features so prominently in our lives, why do so many people wrongly believe that the Moon doesn't rotate? That is 100 per cent wrong. But if you believe that you always see exactly the same face of the Moon, you're only nine per cent wrong.

The Moon takes about 27.3 days to perform one complete orbit around the Earth. And that's the same time that it takes for the Moon to perform one rotation on its spin axis. (Yes, that's right, the Moon does spin.) It's easy to see why this myth-conception of the Moon not spinning appears perfectly reasonable. Do a simple experiment and plonk yourself in a rotating chair. (Think of yourself as the Earth.) Get a friend to walk around you in a circle, always keeping their face pointing at you while you spin around, following their path.

Your friend is the Moon. To you, it's all quite straightforward. As they (the Moon) walk around you (the Earth sitting in the spinning chair), you can always see the face of the person. Therefore, as far as planet Earth is concerned, the Moon doesn't appear to be rotating.

But then get someone else to take your place in the spinning chair. Stand yourself outside the circle that your friend, the Moon, makes around the Earth.

As the Moon walks around the Earth, carefully always pointing their face at the Earth, you'll notice that you, the external observer, will first see their face, then one side of their head, then the back of their head, the other side of their head, and then finally the face. You are standing still, so they have to be rotating. So the Moon does in fact rotate, and it does so in the same time that it takes to do one complete orbit around the Earth.

Physicists call this 'synchronous rotation'. It's caused by two separate factors — a thing called 'tidal force' and the fact that the denser parts of the Moon are on the side of the Moon facing the Earth. But the synchronous rotation is not perfect, so the Moon does not always show exactly the same face to the Earth. We can actually see slightly over half of the Moon's surface, about 59 per cent, if you observe it over a month. This wobbling effect is called 'libration', and comes from the Latin word, *libra*, meaning 'a balance'.

There are three separate librations. Each one lets us see slightly more than 50 per cent of the Moon. Together, they add up to let us see an extra nine per cent of the Moon's surface.

First, diurnal means 'relating to the day'. You can see slightly different view of the Moon at moonrise and moonset. At moonrise, we can see slightly more of the east side of the Moon. But at moonset (I bet you've never said that word before), you can see slightly more of the

west side of the Moon. The second factor is that the Moon travels in an elliptical, or sort of a rugby ball-shaped, orbit around the Earth, rather than a perfect circular orbit.

This means that when it is close to the Earth it moves faster, and when it is further away it moves more slowly.

But the Moon always spins at the same rotational speed. So there is a mismatch. So sometimes we can see a little around the leading edge of the Moon, and later we can see a little around the trailing edge of the Moon. Finally, the Moon does not orbit around the Earth directly above our equator. No, the Moon's orbit is tilted by 6.7 degrees to the Earth's equator. So sometimes we can see more of the Moon's south pole, and at other times, more of its north pole.

So we know that the Moon does rotate, and that it does not show exactly the same face to the Earth at all times. But we still don't know why the full Moon looks so huge as it rises just above the horizon, even though you can measure it and see that it's not really bigger.

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THE UNIVERSITY OF
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Alumni News

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