SCHOOL OF PHYSICS

FACULTY OF SCIENCE

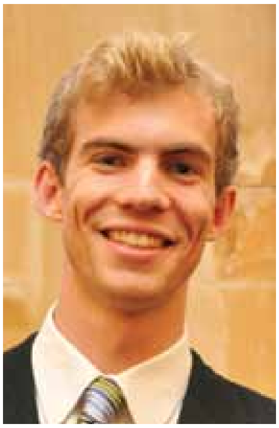
THE UNIVERSITY OF SYDNEY

Alumni News

SUMMER 2010/2011

SYDNEY TALENT

MICHAEL WEST, A STUDENT IN PHYSICS RECENTLY WON THE UNIVERSITY OF SYDNEY WRITING COMPETITION "ART VS SCIENCE". MICHAEL KINDLY GAVE *ALUMNI NEWS* PERMISSION TO REPRINT HIS AWARD-WINNING ESSAY, *WHY STUDY SCIENCE?*



Michael West

Artists are oddly insecure about science. John Keats lamented its ability to "unweave the rainbow", and Walt Whitman urged us to ignore "the learn'd astronomer" and instead just look at the stars. Implicit in these lines is the idea that science is dry and dusty, the province of charts and equations that strip the beauty from nature, to be dissected and locked away in glass cases. Given the steady decline in science enrolments around the world, this view seems to have caught on. But nothing could be further from the truth. Science offers a rare blend of intellectual elegance, civic contribution, and economic benefit. Far more than just dreary repetition, science "needs the free play of the mind in as great a degree as any other creative art", in the words of Nobel Prize-winning physicist Max Born. It is one of humanity's greatest academic achievements, and students should take the opportunity to be a part of it.

Importantly, this intellectual endeavour also leads to practical outcomes. Science takes the poetry of discovery and adds the prose of implementation. In fact, our lives depend on the fruits of research. From the fertilisers that nourish our crops, to the medicines that save us from polio and smallpox and countless other afflictions of bygone eras, no part of the modern world is untouched by science. But we are certainly not out of the woods yet, with overstretched resources, a potentially hostile climate, and a host of threatening diseases that still plague us. These immense challenges can only be met by the determined application of scientific knowledge. The work of artists might bring some temporary happiness to the impoverished, but it cannot fill their stomachs or cure their sick children. We need more bright young people to study science, so that their enthusiasm can be harnessed to its tools of genuine transformational ability.

Technology is also the engine powering our economy, and Australia's dwindling supply of scientists and engineers is a serious risk to our global competitiveness. Studies for the OECD show that scientific research and development accounts for about half of all GDP growth and two-thirds of productivity growth. Sometimes this has led to fear, the so-called Luddite view that science inevitably brings a bleak future of unemployment as artisans are replaced by soulless automation. But this is disappointing superstition; actually, net job growth occurs, as employers increase productivity with the same workforce instead of reducing staff numbers. Moreover, high-tech industries pay the highest wages. Even basic research, seemingly remote from the world

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Dr Cenk Kocer in the Applied Physics lab

VACUUM WINDOWS: SEEING THROUGH TO THE FUTURE

BY DR CENK KOCER

EVERYONE KNOWS THAT YOU'D BE CRAZY TO HEAT YOUR HOME IN WINTER WHILE YOUR WINDOWS ARE WIDE OPEN. CLOSING THE WINDOWS AND STOPPING AIR LEAKS AROUND DOORS ARE THE FIRST ESSENTIAL STEPS TO ACHIEVING ECONOMICAL HEATING. BUT EVEN IF YOUR WINDOWS ARE CLOSED, HEAT IS STILL LOST AS GLASS IS AN EXCELLENT CONDUCTOR OF HEAT.

In fact, heat loss through windows is the main contributor to building energy inefficiency. This is particularly important in severe climates – for example, in Sweden the energy lost through windows in dwellings amounts to 7% of the total energy consumed in that country.

The conventional method of reducing heat loss through windows is to use two panes of glass separated by about 12 mm – double glazing. Double glazing is effective because the trapped gas is a good insulator and so significantly reduces gaseous thermal conduction between the glass panes. Moreover the close proximity of these panes effectively eliminates heat flow by convection. In highly insulating designs of double glazing, radiative heat transfer between the glass sheets is reduced by incorporating special transparent low emissivity coatings on the inner glass surfaces.

We can put numbers on all of these quantities. The thermal performance of windows is characterized by a quantity called their

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THE PHYSICS OF FALLING

BY ASSOC. PROFESSOR ROD CROSS

ASSOC. PROFESSOR ROD CROSS GAVE EVIDENCE FOR THE PROSECUTION IN THE SUPREME COURT AT THE HIGH PROFILE CAROLINE BYRNE CASE, RESULTING IN THE CONVICTION OF GORDON WOOD. HE HAS SINCE GIVEN EVIDENCE IN ANOTHER CLIFF FALL CASE, THIS TIME INVOLVING DES CAMPBELL.

Campbell was found guilty in July 2010 of pushing his wife off a cliff, after the pair pitched their tent at the edge of a cliff in the Royal National Park. Physical evidence, including a shoe print and broken branches, indicated that Campbell's wife had been pushed, although a trip at a fast walking pace could not be entirely excluded.

The shoe print was found on a section of the cliff top sloping down at 26 degrees, described by detectives as "the point of no return". Immediately above the shoe print, detectives found a freshly broken tree branch, indicating that Janet Campbell was upright as she went over the edge and had not simply slipped or fallen onto the ground and then slid or rolled over the edge. Nevertheless, there were seven possible explanations, all physically possible but not all plausible. Janet Campbell might have stepped over the edge and jumped through the tree branch. She might have stepped past the edge to get a better view, holding onto the branch when it broke. She might have climbed the tree to get a better view and fell out of the tree.

Experiments established that it is indeed possible to stand on a 26 degree slope without slipping, but it would be similar to standing on a steep roof next to a 50 metre drop, and unlikely that anyone would do that to get a better view. Other experiments established that a person is more likely to step forward when pushed from behind, rather than to pivot and fall flat on their face.

That evidence, combined with other strong circumstantial evidence concerning Campbell's habit of extracting money from wealthy women and then dumping them, the fact that he kept his marriage a secret, he did not attend his wife's funeral, etc, convinced the jury that Campbell had pushed his wife off the cliff.

Rod also gave evidence in the coroner's court in August, concerning the suspicious death of a young woman who was found in Sydney Harbour, a week after her belongings were found at the top of a cliff at The Gap. Experiments established that she could have taken a short run, jumped off the cliff, cleared the rock shelf below and landed in 8 metre deep water. However, she had no injuries at all, either external or internal. A study of 92 falls off the Sydney Harbour Bridge since 1932 found that 14 people survived the fall and all had injuries, so the police are still investigating the case.

Police investigating the Campbell case; inset: Assoc. Prof. Cross at the scene

HEADLINE

PROFESSOR CLIVE BALDOCK

WELCOME TO THE SUMMER 2010/2011 ISSUE OF *ALUMNI NEWS*. I AM DELIGHTED TO ANNOUNCE THE SUCCESS OF THE SCHOOL OF PHYSICS IN SEVERAL KEY AREAS.

As I announced in the last Headline the School was awarded funding of $40million from the Federal Government's Education Investment Fund (EIF) for the new Australian Institute for Nanoscience (AIN). This is exciting news not only for the School but physics in general. The School of Physics Annexe (A29) is to be demolished and replaced by a purpose-built, state of the art building. Working with our physics researchers the AIN will provide national and international leadership in foundational, cross-disciplinary and translational research across three areas united by a common disciplinary core of nano-scale science and with shared requirements for world-leading, specialised nanofabrication research infrastructure.

Prof Clive Baldock welcomes Nobel Laureate Dr William D Phillips (see page 8)

The total investment of $110m for building and research infrastructure including the $40m from the EIF, additional funding from the University and co-investment by collaborators, will be pivotal in addressing the need in the university-sector for infrastructure development to keep pace with and support growth in human capacity in nano-science and the physical sciences more broadly in Australia.

It is planned that 120 postgraduate students are to be trained in the new Institute during its first three years of activity. The purpose-designed space will also accommodate a further 50 visiting researchers enabling deeper national and international collaborations.

The School has also been immensely successful with the recent announcement of our Centres of Excellence outcomes. Of the 13 Centres of Excellence funded nationally by the ARC, two will be housed in the School – All-sky Astrophysics Centre (CAASTRO) and Centre for Ultra-high bandwidth Device Optical Systems (CUDOS), with a further three nodes of other Centres of Excellence's also housed in the School.

A list of all the Centres of Excellence (and some articles on a few) can be found within this issue along with a list of awards received by our staff members. Congratulations to all School staff on their achievements.

I hope you enjoy reading *Alumni News*.

Professor Clive Baldock
Head, School of Physics
Director, Science Foundation for Physics
The University of Sydney

THE ARC CENTRE OF EXCELLENCE FOR ALL-SKY ASTROPHYSICS (CAASTRO)

BY PROFESSOR BRYAN GAENSLER

THE SCHOOL OF PHYSICS WILL UNDERTAKE A MAJOR NEW INITIATIVE IN 2011, IN THE FORM OF THE NEWLY ANNOUNCED ARC CENTRE OF EXCELLENCE FOR ALL-SKY ASTROPHYSICS, OR "CAASTRO". THERE IS A GROWING REALISATION THAT THE OUTSTANDING UNSOLVED QUESTIONS IN ASTRONOMY DEMAND ENTIRELY NEW APPROACHES, REQUIRING ENORMOUS DATA–SETS COVERING THOUSANDS OF SQUARE DEGREES OF SKY.

In the last few years Australia has invested more than $400 million both in new wide–field telescopes and in the high-performance computers needed to process the resulting torrents of data. These developments now present a window of opportunity for Australia to establish itself at the vanguard of the upcoming information revolution centred around all-sky astronomy.

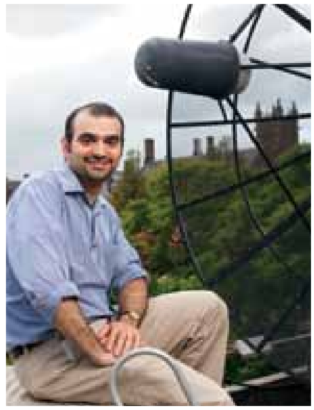
Through CAASTRO, we will assemble the world-class team needed to exploit the scientific potential of these exciting new wide-field facilities. CAASTRO will deliver transformational new science by bringing together unique expertise in radio astronomy, optical astronomy, theoretical astrophysics and computation, and by coupling all these capabilities to the powerful technology in which Australia has recently invested.

The CAASTRO team will pursue three interlinked scientific programmes, each of which can be addressed only with the all-sky perspective provided by wide-field telescopes:

- "The Evolving Universe": When did the first galaxies form, and how have they then evolved? CAASTRO will provide two crucial new views of how gas, stars and galaxies have evolved over cosmic time.

First, we will search for and study the faint radio signal from the "Epoch of Reionisation", the period when stars, galaxies and quasars ionised the entire Universe. Second, we will measure the stellar and neutral hydrogen content of 500,000 galaxies spanning the last eight billion years, thus allowing us to discriminate between competing theories of galaxy formation.

- "The Dynamic Universe": What is the high-energy physics that drives change in the Universe? In CAASTRO, we propose to carry out the first all-sky census of the variable and transient sky coordinated between both radio and optical wavelengths. These experiments will allow us to study the changing sky over a wider field of view, at higher sensitivity and over a wider range of time scales than has ever previously been possible. Our studies of the Dynamic Universe will provide crucial new probes of extreme conditions in the cosmos and, more broadly, will allow us to develop innovative approaches to finding weak signals in large data sets.



Professor Bryan Gaensler

- "The Dark Universe": What are the Dark Energy and Dark Matter that dominate the cosmos? In CAASTRO we plan to perform a set of innovative measurements that will probe the role of Dark Energy over most of cosmic time, and that will generate a map of Dark Matter on the largest scales ever performed. We will use our observations to test Einstein's theory of gravity in the weak field regime, to test whether Cold Dark Matter behaves as predicted, and to determine whether structure in the Universe is growing as expected for a Universe filled with Dark Energy in the form of a cosmological constant.

In CAASTRO we plan to perform a set of innovative measurements that will probe the role of Dark Energy over most of cosmic time, and that will generate a map of Dark Matter on the largest scales ever performed. We will use our observations to test Einstein's theory of gravity in the weak field regime, to test whether Cold Dark Matter behaves as predicted, and to determine whether structure in the Universe is growing as expected for a Universe filled with Dark Energy in the form of a cosmological constant. We plan to underpin all CAASTRO activities with a strong focus on training the next generation of scientists, thus providing a legacy extending well beyond the Centre's lifetime.

In CAASTRO, we aim to mentor and inspire the students who will lead the scientific discoveries made on future wide-field facilities, culminating in the ultimate all-sky telescope, the Square Kilometre Array. CAASTRO will also invest in the creation of documentaries for national television plus 2D/3D film content to be shown to the public at museums and planetaria. Through these activities, we will aim to highlight Australian innovation to the general public, and to inspire students to consider careers in science and engineering.

CAASTRO will receive more than $28M in funding over the next seven years to pursue these activities. CAASTRO will be led by The University of Sydney, in conjunction with Australian National University (ANU), University of Western Australia, University of Melbourne, Curtin University and Swinburne University, complemented by word-class institutions including CSIRO, Oxford, Caltech and the Max-Planck Society.

From the School of Physics, key members include Professor Bryan Gaensler (CAASTRO Director), Professor Elaine Sadler (CAASTRO Chief Investigator), Associate Professor Scott Croom (CAASTRO Chief Investigator) and Dr Tara Murphy (CAASTRO Associate Investigator).

CAASTRO will soon be advertising for a host of new administrative and research positions within the School of Physics and elsewhere around Australia, with a view to commencing CAASTRO operations in early 2011.

For more information visit: www.caastro.org.au.

ISS2011 LIGHT & MATTER

The Professor Harry Messel International Science School (ISS) is a biennial science educational program that honours excellence in outstanding Year 11 and 12 students and encourages them to pursue careers in science. One hundred and forty ISS scholars attend from over all Australia, China, Japan, India, Malaysia, New Zealand, Singapore, Thailand, UK and the USA.

Light & Matter is the theme of the ISS2011 and brings together work being carried out in physics, chemistry, biology and engineering. Sir John Pendry, the invisibility and cloaking pioneering scientist will be a keynote lecturer at this ISS. Dr Karl Kruszelnicki AM, our Julius Sumner Miller Fellow and media personality is also an ISS guest speaker.

All ISS scholars are chosen on their academic ability and, depending on their country, must compete for an ISS scholarship through either essay writing, an interview or sitting an exam. In the USA the ISS is awarded as a prize in the National Science Bowl run by the US Department of Energy. The ISS program reflects the different themes of each ISS and comprises lectures, hands on experiments and challenges as well as social activities.

The ISS2011 will run from 3–16 July 2011. ISS Applications will be available from the Science Foundation for Physics website from January 2011 (please note the Foundation does not select the ISS Scholars).

For more information visit sydney.edu.au/science/physics/foundation/education/iss.shtml

NOBEL PURPOSE

FROM 27 JUNE TO 2 JULY 2010, CHRISTOPHER HALES, PHD CANDIDATE (ASTROPHYSICS), THE UNIVERSITY OF SYDNEY & CSIRO ASTRONOMY AND SPACE SCIENCE, TRAVELED TO LINDAU AND THE ISLE OF MAINAU IN GERMANY FOR THE 60TH NOBEL LAUREATE MEETING AND 3RD INTERDISCIPLINARY MEETING. HERE CHRISTOPHER WRITES A REPORT ON HIS TRIP FOR *ALUMNI NEWS*.

Chris Hales in Lindau Harbour

I recently traveled to the idyllic island town of Lindau, located in southern Germany's Lake Constance, to attend the 60th Nobel Laureate Meeting. Since 1951 the meetings have brought together Nobel Prize winners and early career scientists with the broad ambition to Educate, Inspire, and Connect.

This year the meeting drew together 59 Nobel Laureates and 670 young scientists from around the world studying the interdisciplinary fields of physics, chemistry, and physiology/medicine. With seventy countries represented, the meeting was more than twice as international as the World Cup, affording participants the opportunity to learn not only about a wide range of science, but also about a wide range of cultures. On top of this, where else could you meet someone with a tattoo of the Taylor expansion of sin(x) on their arm?! (Personally I'd go for Euler's identity, or perhaps Einstein's field equations.)

The Australian delegation consisted of 14 young researchers and was led by then-President of the Australian Academy of Science, Kurt Lambeck. In order to become acquainted, our delegation met in Canberra for "Science at the Shine Dome" prior to heading to Germany. This was a wonderful opportunity to get to know the Australian "brain trust" whose specialties included cancer research and climate science, without having to take time to do so later in Lindau (unlike participants from other countries, who sometimes did not know any of their fellow compatriots). While in Canberra we heard from ABC TV's Catalyst Presenter, Dr Paul Willis, who mused over how many scientists have approached him to do a story on television without thinking about what that vision might be, and saw our own Professor Elaine Sadler, from the School of Physics, inducted as a Fellow of the Australian Academy of Science.

The week-long conference in Lindau was opened on 27 June by Countess Bettina Bernadotte, daughter of the late meeting founder Count Lennart Bernadotte, in an official ceremony consisting of speeches by German politicians and even HRH Princess Maha Chakri Sirindhorn of Thailand, musical interludes with harp and verrophone, along with the occasional score update for the concurrent World Cup Germany v. England match.

The daily meeting schedule was filled with events. There were wonderful talks by Nobel Laureates in the mornings, more intimate panel discussions in the afternoons, and many enjoyable social events throughout, including lunches, dinners, dancing and even a black tie night of chamber music at the opera house.

I was captivated by the breadth of knowledge being discussed, and fascinated by the inspiration and insights of some of the best minds in science. I enjoyed hearing Ada Yonath recall the exasperation she felt when she told people she worked on ribosomes only to have them mistake her speciality for risotto. John Mather reminded the females in the audience to do their cosmology in the morning when they do their cosmetic while Françoise Barré-Sinoussi recalled how she was working in the lab on her wedding day when she received a phone call at 11:30 in the morning asking if she was still coming (she lost track of time and had to say she'd be there "in half an hour"). Oliver Smithies pointed out the correlation between his most interesting results and working on Saturday mornings with Tim Hunt asking just how it is that parts of multi-celled organisms know when to stop growing (e.g. our noses). There were many other stories and technical details discussed throughout the meeting.

A few simple themes underlying successful science resonated throughout the week. These included capitalising on your interests and strengths to carve out a niche area, learning to explain your science in simple ways to non-scientists, recognising that collaboration works both ways and that it is often best to put the needs of your collaborators first, knowing when to stop working on a difficult problem that isn't getting anywhere, always being on the lookout for something unusual (where exception can lead to discovery which can lead to exception and so on), and investigating phenomena just for the sake of gaining understanding. Like Yogi Berra once said, "You can observe a lot by watching," and who knows what distant applications may be unleashed by present-day basic (non-translational) research.

I left Lindau with a great sense of excitement about science, its ability to seek truth amid complexity, and the myriad questions waiting to be explored. In a sentiment summed up by Oliver Smithies, at the end of his talk he made a reference to the logbooks he has been writing for over 50 years, asking "What's on the next page?" That's the beauty and captivation of science – we don't know…yet.

The island of Mainau

EXCELLENCE IN QUANTUM PHYSICS

QUANTUM SCIENCE CONSTITUTES A NEW FRONTIER IN PHYSICS THAT AIMS TO UNDERSTAND, CONTROL, AND EXPLOIT QUANTUM PHENOMENA TO CREATE REVOLUTIONARY NEW SCIENCE AND TECHNOLOGY. WITHIN THE UNIVERSITY OF SYDNEY, THE SCHOOL OF PHYSICS IS AT THE FOREFRONT OF THIS SCIENTIFIC ENDEAVOUR WITH THE ESTABLISHMENT OF THE QUANTUM SCIENCE RESEARCH GROUP. DR DAVID REILLY WRITES ABOUT THE GROUP'S RECENT GOALS AND ACHIEVEMENTS.

The Quantum Science Research Group is made up of Assoc.Professor Stephen Bartlett, Dr Michael J. Biercuk, Assoc. Professor Andrew Doherty, Dr Dane McCamey and myself. We are young, internationally recognized researchers with diverse backgrounds who have come together to start, from scratch, a new program in quantum science at Sydney.

The structure of our Group is fundamental to make the most of the opportunities present at Sydney. It centres around four continuing members of the academic staff, with expertise in both theory and experiment.

Our vision is to build a world-class research effort that leads both experimental and theoretical research in the field. This group will produce cutting-edge research and educate a generation of highly skilled students and researchers in this area of national significance.

This strategic vision has been recognised by the substantial level of international success we have achieved in 2010 and by the major funding awards for our researchers - including both domestic and international grants.

These successes include several major research grants from the US government, arising from programs run through the intelligence community and focused on quantum information science. These also include two efforts in quantum information: the Multi-Qubit Coherent Operations program and the Development of Quantum Computer Technology program. Both support the four Primary investigators within the Quantum Science group and fund major international collaborations with institutions such as Harvard, Tokyo, Delft, and Dartmouth.

More recently, the Australian Research Council (ARC) awarded a new Centre of Excellence for Engineered Quantum Systems (EQuS). The University of Sydney is a node of EQuS in collaboration with the University of Queensland, the University of Western Australia and Macquarie University. This new Centre will pursue groundbreaking research in the broad field of Quantum Science, aiming to develop new techniques for quantum control and measurement, produce revolutionary quantum-enabled sensors, and allow new studies of quantum simulation and synthetic quantum systems.

The awarding of this CoE represents a major vote of confidence in a new generation of young Australian researchers, and is another significant statement of commitment to the field on behalf of the Australian federal government.

Stable research funding and research infrastructure are key attractors for top experimental and theoretical faculty members. These major research awards will provide powerful new recruitment mechanisms for Sydney to attract the most talented junior and senior researchers worldwide. They have forcefully established Sydney as a major destination for students, academics, philanthropists, and commercial partners with interests in this nascent discipline.

Sydney has a strong history in pioneering research efforts that have truly transformed the field of physics: from quantum correlations in light to astronomy and astrophysics. Along with the announcement of funding for the Australian Institute of Nanoscience (AIN) we are certain that the Quantum Science Research Group at Sydney will be able to contribute to this rich history by embarking on a research program in one of the most far-reaching and dynamic fields in modern physics.

SUPPORT PHYSICS VISIT: **WWW.PHYSICS.USYD.EDU.AU/FOUNDATION/DONATIONS/DONATE.SHTML**

INVISIBLE THREADS ONE STEP CLOSER TO REALITY

INSTITUTE OF PHOTONICS AND OPTICAL SCIENCE (IPOS) STUDENT, ALESSANDRO TUNIZ, IS WORKING ON A CONCEPT TO MAKE ONE MICROMETRE INVISIBLE THREADS. HIS CONCEPT WORK COMBINES TECHNIQUES USED TO PRODUCE LIGHT-BENDING METAMATERIALS WITH THOSE USED TO MAKE OPTICAL FIBRES TO TRY AND CREATE REAL INVISIBLE THREADS.

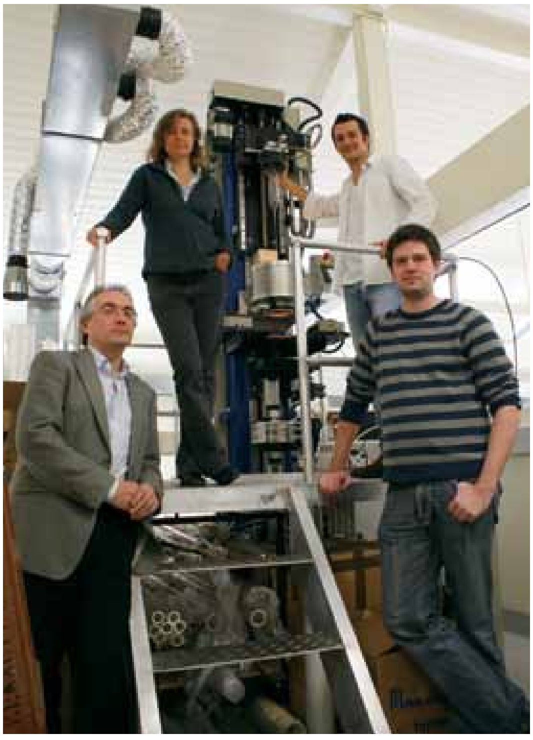
Alessandro Tuniz is interested in the optical metamaterials that are being formed into "invisibility cloaks" in labs across the world. Alessandro is working to create invisible material by shrinking metamaterials to a small enough size to make them disappear in certain light wavelengths.

His theory is based on "refractive index", which measures the speed at which light travels through a substance. Physicists are able to shrink fibres to nanoscale using a process called fibre drawing. For invisibility the fibres need to be small before the tiny wavelengths of light travelling through them can be controlled.

IPOS researchers Professor Simon Fleming, Dr Boris Kuhlmey and Dr Maryanne Large, have produced threads that are ten micrometre-thick threads. Alessandro Tuniz has used computer modeling to design the invisible one micron thread.

The project models calculations suggest that the thread would be invisible if seen from the side – rather than end on – in polarised light. The model shows that, like other optical metamaterials, the fibre's optical properties depend strongly on wavelength.

For more on IPOS visit: sydney.edu.au/ipos/



Dr Simon Fleming, Dr Maryanne Large, Alessandro Tuniz and Dr Boris Kuhlmey

IN BRIEF

AN EXCELLENT OUTCOME!

ARC Centres of Excellence to be housed in the School:

1. **Centre for All-sky Astrophysics** with Professor Bryan Gaensler as Centre Director. Income over the lifetime of the Centre will be $20,600,000. Professor Elaine Sadler and Assoc.Professor Scott Croom will also be Chief Investigators from the School of Physics.

2. **Centre for Ultrahigh Bandwidth Devices for Optical Systems** with Professor Ben Eggleton as Centre Director. Income over lifetime of the Centre will be $23,800,000. Dr Boris Kuhlmey, Professor Ross McPedran and Professor Martijn de Sterke will also be Chief Investigators from the School of Physics.

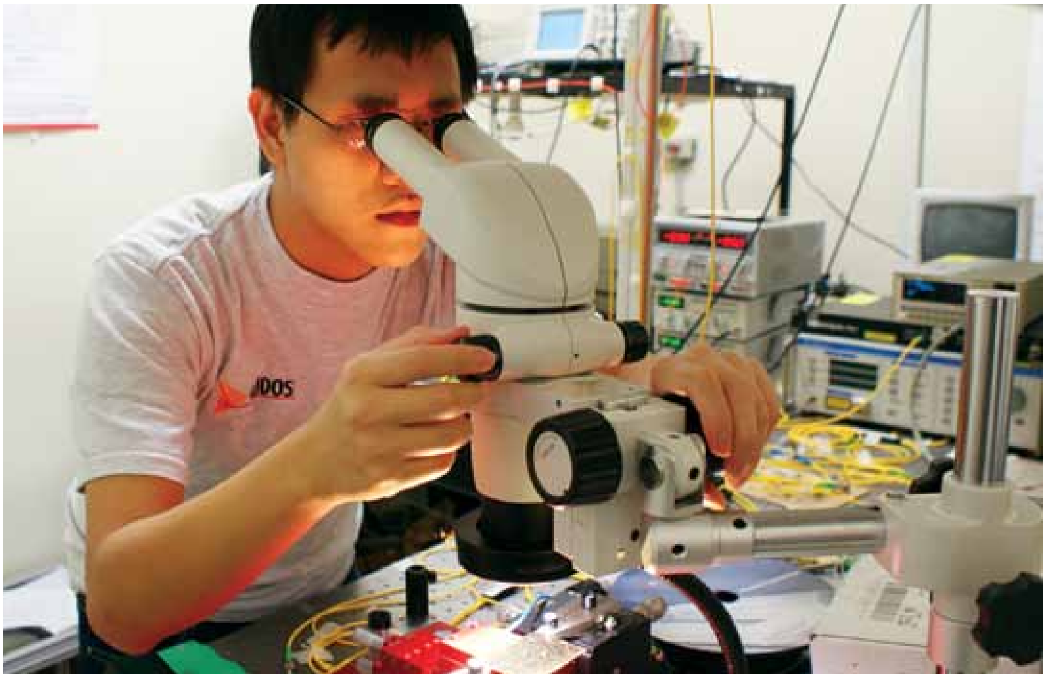
Nodes of ARC Centres to be housed in the School:

3. **Centre for Engineered Quantum Systems** housed at University of Queensland. Income over lifetime of the Centre will be $24,500,000. Assoc. Professor Stephen Bartlett, Dr Michael Biercuk, Assoc. Professor Andrew Doherty and Dr David Reilly will be Chief Investigators from the School of Physics.

4. **Particle Physics at the Tera-Scale Centre** housed at Melbourne University. Income over lifetime of the Centre will be $25,200,000. Assoc.Professor Kevin Varvell and Dr Bruce Yabsley will be Chief Investigators from the School of Physics.

5. **Quantum Computation and Communication Technology Centre** housed at UNSW. Income over lifetime of the Centre will be $24,500,000. Professor David McKenzie will be a Chief Investigator from the School of Physics.

All involved in these successful outcomes are to be congratulated. Such successes would be rare for any university School or department in Australia and this is certainly an unprecedented outcome for the School. This is an indication of future likely successes for the School, especially when combined with our recent success in obtained EIF funding for a new building, which will house the Australian Institute of Nanoscience (AIN).



PhD student, Trung Duc Vo, in the CUDOS Lab

EXCELLENCE IN PHOTONICS AND OPTICS

CUDOS – THE CENTRE OF EXCELLENCE FOR ULTRA-HIGH BANDWIDTH DEVICES FOR OPTICAL SYSTEMS – HAS SECURED MAJOR FUNDING FOR THE NEXT SEVEN YEARS. WITH A TOTAL OF $33 MILLION (AUS), INCLUDING $23.8 MILLION FROM THE AUSTRALIAN RESEARCH COUNCIL (ARC), CUDOS WILL BUILD ON ITS ALREADY SIGNIFICANT ACHIEVEMENTS AND TAKE INTEGRATED PHOTONICS TO THE NEXT LEVEL.

Headquartered in the School of Physics, CUDOS Director, Professor Ben Eggleton says, "CUDOS has a new vision with a strong foundation. With new Chief Investigators, new international links and end-user partnerships we have the capacity and drive to revolutionise information systems and create and develop Australian industry. Importantly we'll also be training and mentoring young researchers in the science and application of nanophotonics and photonic processing".

In the past two years CUDOS has published and presented prestigious papers while research developments have received international media attention. Some of the breakthrough technology includes unprecedented Tbaud processing speeds and demonstrations of slow light enhanced optical processing; these breakthroughs have the potential to reduce Internet information bottlenecks.

Eggleton says that the new CUDOS will take the next big step in optical systems by transforming photonic integrated circuits into a technology that will have a profound effect on economies and lifestyles around the world. This revolutionary research will allow the Internet to transfer vast amounts of data with significantly improved energy efficiency and securely using quantum photonics-based integrated devices.

The CUDOS photonic chips will also enable the detection of mid-infrared signatures of light from distant stars and complex molecules of environmental or biochemical importance. "We will achieve this by developing functional metamaterials with unprecedented optical properties to control light; engineering them into miniature photonic processors," explains Eggleton.

"The outcomes that can be expected from this second round of funding will fuel research and development programs for decades, harnessing links between fundamental research and commercial applications through industry partners and start-up companies, and developing strong linkages between Australian and overseas universities and companies."

The Chief Investigators include Professors Ben Eggleton, Yuri Kivshar, Martijn de Sterke, Barry Luther-Davies and Min Gu from the existing Centre and new expertise from Professor Arthur Lowery and other Australian researchers. CUDOS is Australia's Centre of Excellence in Photonics and is collaboration across seven Australian universities with major links with international partner organisations and industry. International partners include global leaders in the field, such as Sir John Pendry (Imperial College, UK), Professor Franz Kaertner (MIT, USA), Dr Shu Namiki (AIST, Japan), Professor Thomas Krauss (St Andrews, UK), Professor Zheludev (Southampton, UK), Professor Roel Baets (Ghent, Belgium) and others. Industry partners include local photonics companies (Finisar and Sapphicon Semiconductor).

Details on CUDOS are at: www.cudos.org.au

OUTSTANDING ASTRONOMER AWARDED

DR TARA MURPHY IS AN ASTRONOMER BASED IN THE SYDNEY INSTITUTE FOR ASTRONOMY (SIFA). A SCHOOL OF PHYSICS ALUMNA – BSC (ADV) (HONS) AND THE UNIVERSITY MEDAL IN 1999, DR MURPHY MAJORED IN PHYSICS AND MATHS, WITH HONOURS IN ASTROPHYSICS AND WAS RECENTLY AWARDED (JOINTLY WITH DR JAMES CURRAN IN THE SCHOOL OF IT) VICE-CHANCELLOR'S AWARDS FOR OUTSTANDING TEACHING, AND THE AUSTRALIAN LEARNING AND TEACHING COUNCIL (ALTC) CITATION FOR OUTSTANDING CONTRIBUTIONS TO STUDENT LEARNING.

Alumni News: When did you first discover your interest in astronomy?

Tara Murphy: When I was about six or seven years old my grandparents gave me five pounds as a Christmas present. I remember spending hours in the bookshop trying to decide how to spend it, and eventually settling on the "Universe Encyclopaedia" on the top shelf.

Mum said "Are you sure that's what you want?" I was sure, and that was the start of my interest in astronomy. (I still have the Encyclopaedia on my bookshelf, and some of the information in it is still correct :) !)

Around the same time we got our first computer – a BBC Micro – and that triggered a new interest in programming. So it was a real turning point in my career path towards my current position in Astroinformatics.

AN: As an astronomer is it very different from what you thought it would be like?

TM: Working in astronomy and IT as an academic is my dream job. I love thinking about big questions like "how did the universe evolve" but I also love practical problem solving like how to deal with the large datasets that our new telescopes produce. Getting to do this every day, and share my interest in astronomy and IT with students is ideal.

AN: You recently one an award for excellence in teaching – can you tell us a bit about that and what it meant to you?

TM: When I started my ARC Australian Postdoctoral Fellowship at the University of Sydney five years ago, I was lucky enough to get the opportunity to develop a new first year course teaching first year IT to advanced science and computer science students. The idea for this course was developed as I (and my partner James Curran, who is a computer scientist) thought about all the IT skills I needed to be an astronomer. The course encapsulates all of this in one semester, putting IT into a scientific, social, and historical context.

I have loved teaching the course over the last five years, and we have seen some great students go through. Trying to balance the demand to teach 'practical skills' with our belief that University students should consider the deeper philosophical implications of their discipline area is a challenge in the modern University context.

Winning the Vice-Chancellors Award for Teaching Excellence is an honour, and I am very excited about receiving my award in a graduation ceremony later this year, as some of my students graduate.

AN: How important is the new Centre of Excellence – the Centre for All-sky Astrophysics (CAASTRO) going to be important for Australian science?

TM: Astronomy (in particular radio and optical astronomy) is currently entering a new era in which the next generation telescopes will be able to scan the sky very rapidly, to great sensitivity. This opens up whole new areas of research that weren't previously possible, ultimately giving us insight into fundamental physics.

CAASTRO unites a large group of astronomers from around Australia who are working on large surveys with next generation telescopes.

AN: Do you think astronomy or space science has come along way since man walked on the moon?

TM: Astronomy has come a long way since man walked on the moon over 40 years ago. We have discovered the echo of the Big Bang – the Cosmic Microwave Background radiation, discovered that up to 98% of the matter in the universe is 'missing' – the famous 'dark matter and dark energy', and closer to home we have discovered over one hundred extra-solar planets (each of which may have their own moons).

Many of these amazing discoveries have been made due to new technological advances that have resulted in new telescopes. That is why the next generation of radio and optical telescopes hold so much promise as "discovery machines".

AN: Why do you think astronomy has such appeal?

TM: Since the dawn of time humans have always asked questions like "who are we?" and "what is our place in the universe?" This curiosity has driven much of art, religion and, of course, science. Astronomy lets us try to answer these questions within a rigorous scientific framework. The number one question I get asked by non-astronomers is, "do you believe there is other life in the universe?" What bigger question is there than that?

AN: Finally, do you have any advice for budding astronomers?

TM: If you are interested in astronomy as a career, I say follow your dreams! Right now is a great time to be an astronomer in Australia as we are world leaders in large survey astronomy. Obviously you have to love physics, but make sure you do IT and maths as well – they are critical for modern astronomy.

If you're interested in getting involved in astronomy, there is no better time for amateur astronomers to contribute to real science. In particular there are worldwide networks of amateur astronomers who are discovering new transient and variable objects.

Finally, you can even contribute from the comfort of your own home, by helping to classify galaxies and stars through projects such as Galaxy Zoo. [Editor – More than 250,000 people have taken part in Galaxy Zoo so far, producing a wealth of valuable data and sending telescopes on Earth and in space chasing after their discoveries.]

For more details visit: www.galaxyzoo.org/

Dr Murphy and Dr James Curran receiving the Vice-Chancellor's Award for Teaching Excellence from Professor John Hay, Chair of the Australian Learning & Teaching Council

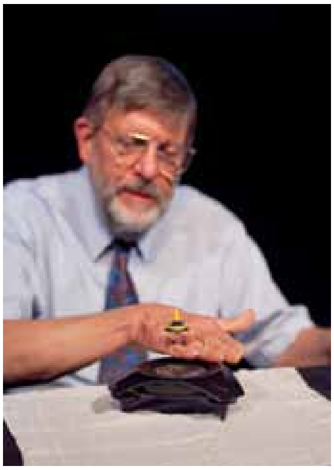
NOBEL LAUREATE

TIME, EINSTEIN AND THE COOLEST STUFF IN THE UNIVERSE

TIME, EINSTEIN AND THE COOLEST STUFF IN THE UNIVERSE WAS A SYDNEY IDEAS TALK PRESENTED BY US 1997 NOBEL LAUREATE FOR PHYSICS AND QUANTUM PHYSICIST DR WILLIAM D. PHILLIPS. THE TALK WAS ORGANISED BY THE SCHOOL OF PHYSICS WITH SUPPORT FROM THE SCIENCE FOUNDATION FOR PHYSICS.

Dr William D. Philips demonstrates how a spinning atom will levitate in a magnetic field

An audience of close to 500 were intrigued and appreciative of Dr Phillip's highly informative and lively lecture which had a focus on trapping atoms and the use of liquid nitrogen. Children (young and old alike) were delighted by the smashing of carnations and the emergence of dozens of balloons from the liquid nitrogen container when only four had been counted going in.



The demonstration of making an atom spin in order for it to have resistance to a magnetic force drew applause. The queue of people lining up to ask questions was long and had no sign of dissipating. However the talk (eventually) concluded with a final question and a thank you presentation to Dr Phillips.

The audience weren't the only ones who enjoyed themselves with Dr Phillips subsequently sending an email message to the School saying, "First I want to thank you for a great visit. The public lecture went very well, and I was really happy to have such good questions. I certainly hope that the next time I am in Sydney I will get a chance for a proper scientific visit to your labs and those of your colleagues."

Thanks to Dr Michael J. Biercuk, his former colleague from NIST, for having invited this Nobel Laureate physicist to Sydney. We certainly hope to see Dr William Phillips again before too long.

MAKING THE MOST OF SKAMP

THE SYDNEY INSTITUTE FOR ASTRONOMY (SIFA) BASED WITHIN THE UNIVERSITY OF SYDNEY'S SCHOOL OF PHYSICS, AND CSIRO HAVE COLLABORATED IN A PROJECT THAT WILL TRANSFORM AN EXISTING UNIVERSITY RADIO TELESCOPE INTO A WORLD-CLASS INSTRUMENT.

The University contracted CSIRO to assist in developing a signal-processing system to dramatically boost the performance of the existing Molonglo Observatory Synthesis Telescope (MOST) as part of its transformation to the Square Kilometre Array Molonglo Prototype (SKAMP).

CSIRO Director, Professor Brian Boyle, presents the complex digital system to Professor Anne Green

The heart of the new system is based on programmable logic chip technology which has taken SKAMP to an international level of functionality by making the telescope more flexible, three times more sensitive, with ten times more bandwidth, and able to make better-quality images of the sky.

Breakthrough technology for speed and efficiency of teraflop computational loads is an important part of the design of the Square Kilometre Array (SKA), an international project to build a radio telescope, which will be 100 times more sensitive than any existing radio telescope with one million square metres of collecting area.

SKAMP is part of the University and CSIRO program to develop and test new technology leading to the SKA. "This project has given our telescope a whole new capability," said SKAMP project leader, Professor Anne Green. "It looks the same, but under the bonnet it's been born again."

Duncan Campbell-Wilson, Molonglo Observatory's Site Manager, agrees, "It's been an interesting 50-year evolution here at Molonglo – from 1960 when the Mills Cross led the way in pioneering radio telescopes to its rebirth as MOST and now to SKAMP."

Mr Campbell-Wilson says that the observations with SKAMP are built on the back of innovative electronic engineering, which will allow us to look deeper into the Universe and provide spectral line capability for the first time on this telescope.

This very large University-operated radio telescope will look to the distant Universe to study evolving galaxies and will search for transient and variable radio sources, a research window wide open for new discoveries.

MOST has only 3MHz of bandwidth, centred on 843MHz. The new digital correlator and filterbank system has increased the bandwidth to 30MHz (around the same central frequency). As a result, the telescope's sensitivity has improved by a factor of three, producing deeper images with spectral information, which is something new for this telescope. The data-flow rate has increased by an astonishing factor of 10,000.

To transform MOST into SKAMP, the University has also upgraded the telescope's mechanical drive, changed the signal receivers, and replaced copper cables with fibre optics. The University plans to further enhance the telescope with a new dual polarization feed system, which will boost the bandwidth by another factor of three, up to100 MHz, and allow measurements of cosmic

CONGRATULATIONS TO ALL OUR SUCCESSFUL STAFF!

GRANTS, AWARDS AND ACHIEVEMENTS

ARC GRANT SUCCESS: ARC Federation Fellow Professor Bryan Gaensler has been awarded an **ARC Laureate Fellowship** to be taken up from 2011. He will use his fellowship to help demonstrate the viability of technologies that could be used in the Square Kilometre Array, the world's most powerful radio-telescope. This is an exceptional outcome for Bryan and the School of Physics.

Congratulations also to Dr Vasili Lobzin, Professor Iver Cairns and Professor Peter Robinson of the School's Complex Systems Research Group who, along with Australia's space weather agency IPS Radio and Space Services, have been awarded a **2010 ARC Linkage Grant** of approximately $360,000 to fund space weather prediction via automated data analysis systems over the next three years. The project will build world-recognised capabilities in forecasting space weather events at Earth ensuring protective measures can be taken for any forthcoming space exploration. It leverages the new Automated Radio Burst Identification System (ARBIS) developed by the successful investigators. As well the funding will help in identifying and analyzing solar drivers of space weather and modelling interplanetary space.

There have been two successful grants outcomes from the **Cancer Institute NSW Research Equipment Grant Scheme**.

1. Associate Professor Zdenka Kuncic as a sole Chief Investigator has been awarded $165,000 for "The NSW Advanced Computing Facility for Cancer Research".

2. Dr Phil Vial, Assoc. Professor Zdenka Kuncic and Professor Clive Baldock, as Chief Investigators, have been awarded $198,000 for "Making radiotherapy safer and more accurate: Developing detector technology for the next generation in treatment verification systems". Particular congratulations to Zdenka regarding this outcome. More information can be found on the Cancer Institute NSW website at www.cancerinstitute.org.au/cancer_inst/grants/successful.html

AWARDS AND PRIZES: **International BRAIN Net Challenge Award**: A 'six-minute' analysis of brainwaves that can detect Attention Deficit Hyperactivity Disorder (ADHD) has won Dr Jong-Won Kim and recent PhD graduate, Dr Cliff Kerr, both also of the Complex Systems Research Group, the international 2010 BRAINnet Challenge. The joint entry focused on demonstrating that several methods show potential use in diagnosing ADHD, including visual evoked potential mean voltage, de-trended fluctuation analysis, and heart rate auto-correlation. Based on a simple combination of these methods, a diagnostic measure was developed with a specificity and sensitivity of 75%, results that are comparable to existing quantitative EEG methods, which use far more parameters. BRAINnet is an international scientific network that enables its members to access data on a range of areas relating to the brain. Processed data is provided freely for research and for scientific publication thereby maximizing and sharing the benefits. Well done to Jong-Won and Cliff!

Selby Award: Quantum physicist Dr David Reilly has been awarded the 2010 Selby Research Award. The Selby Scientific Foundation makes the award available to assist an outstanding academic to establish their research career. The value of the award is $17,000 for one year.

Astronomical Society of Australia Poster Prizes: Sydney Institute for Astronomy (SIfA) staff were winners at the recent ASA meeting. Vanessa Moss won the prize for best poster with runner up for best poster won by fellow student, Holly Trowland.

The Bok Prize for Best Honours Thesis: was Madusha Gunawardhana (for work at AAO/Macquarie) and the Webster prize for best paper by an early career researcher was won by Dr Mike Ireland.

The NSW Scientist of the Year Awards were established in 2008 to recognise and reward the state's leading researchers for cutting edge work that generates economic, health, environmental or technological benefits for NSW.

Congratulations to Professor Bryan Gaensler for winning the Physics, Earth Sciences, Chemistry and Astronomy Category of the 2010 NSW Scientist of the Year Awards. The NSW Scientist of the Year awards were presented recently at Government House by Her Excellency Professor Marie Bashir AC, Governor of NSW.

Congratulations to Professor Joss Bland Hawthorn who was also a finalist in the Physics, Earth Sciences, Chemistry and Astronomy Category. Congratulations as well to the overall winner of **NSW Scientist of the Year** Professor Hugh Durrant-Whyte of the Australian Centre for Field Robotics at University of Sydney and a past guest lecturer at the Professor Harry Messel International Science School.

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magnetic fields. The frequency range has been broadened to cover from 650 MHz to 1200 MHz.

The formal handover of the complex digital system recently took place at the University of Sydney between CSIRO SKA Director, Professor Brian Boyle, SKAMP Project Leader, Professor Anne Green, and Mr Wayne Arcus of the Murchison Widefield Array (MWA) project.

Significant funding for the SKAMP project was provided by the Commonwealth Government, under the second round of the Major National Research Facilities program with additional substantial support from the Australian Research Council.

SYDNEY TALENT CONTINUED FROM PAGE 1

of business, often spawns new fields of enterprise. Quantum theory brought the transistor and thus the computer, while investigations of a particular tiny worm have been crucial to the development of genetic engineering. Science underpins prosperity, and will continue to do so; but a reliable supply of science students is vital.

Finally, science should be studied because it prioritises a search for truth over a proliferation of opinions. Scholars in the humanities construct theories and counter-theories, generating complex ecosystems of debate that may be entirely divorced from reality and supported only by intricate arguments, not facts. Sadly, they are often little more than rickety scaffolds of ink and ideology. Where science builds similar edifices of abstract thought, they are always anchored to the bedrock of reality by experiment. A theory that does not make testable predictions remains merely an intellectual curiosity, unable to claim any privilege over dozens of other equally valid hypotheses. Science may be complex and specific, and sometimes inaccessible to the public, but it represents our best representation of the truth about the world around us.

Despite science's clear strengths, few scientists would advocate its study, taking place to the utter exclusion of the arts. It is not a case of scientists looking down on artists in a sort of intellectual apartheid. Indeed, the plea of C.P. Snow in his famous 1959 "Two Cultures" speech at Cambridge was for a greater connection between the arts and science communities. Educated citizens, he thought, should understand as much of thermodynamics as they do of Shakespeare. But presently, that equality does not exist, and because they directly address the human condition, the arts are often seen as more relevant to our lives than science. In a world ever more dependent on technology, that is emphatically not true. There is room for both the dreaming spire and the gleaming laboratory, but in this century we will need more science more than ever, and that is why we should study it.

VACUUM WINDOWS CONTINUED FROM PAGE 1

thermal conductance, which has units of W m 2 K 1. The thermal conductance of a window is simply the amount of heat, in watts (W) that is transferred through a unit area (1 m2) of the window, when the temperature difference between the air in the inside and on the outside is 1 degree Celsius (which is the same as 1 degree Kelvin – K). The overall thermal conductance is affected by heat transport processes between the air and the surface of the glass. In fact, for a single piece of glass, these processes completely determine the thermal conductance because, in comparison, the glass is highly conducting. The heat transfer rate of such a single pane window is about 6 W m-2 K-1. In double glazed windows, this figure can be reduced by a factor of between two and six, depending on the design. There are even a few designs of "superwindows" that have heat transfer rates below 1 W m 2 K 1.

Clearly, significant energy savings can be achieved by using double glazed windows. Unfortunately, there are also disadvantages. First, the lowest heat transfer rates are only possible if very expensive gases such as Krypton, or Xenon are used. Second, the large space between the glass sheets makes the window unit quite thick, so a special window frame is needed to support properly the double glass panes and effectively seal in the gas – the frame is a significant added cost in new buildings and in some cases a greater cost when retrofitting to older buildings. Third, there are reliability issues with the sealing technology used in these devices which can lead to loss of the gas, and also result in condensation of water vapor on the internal surfaces.

In 1987, Dick Collins who was then Professor of Applied Physics at the University of Sydney went to a conference in Germany. Quite by chance, he attended a session on insulating glazings at which one of the speakers floated the possibility of addressing these shortcomings by removing the air from between the glass sheets. It was clearly argued that such a "vacuum glazing" could potentially achieve very high levels of thermal insulation. Also, in a vacuum glazing the separation of the glass sheets would only be about 0.2 mm, resulting in a total window thickness of about 6.2 mm. In new buildings a special window frame would not be needed, and in almost all existing buildings retrofitting with vacuum windows would not involve replacement of existing frames, which is a major cost saving.

Although Dick didn't know it at that time, this was not a new idea. Indeed, the first description of a vacuum glazing was in a 1913 German patent. Over the intervening years, many groups had tried to develop such a device, without success. The reason was that there were several quite difficult technological problems to overcome. Dick's early career had been in the electronics industry where he had seen some technology that he thought might be useful for making such a vacuum glazing. After returning to Australia, he talked about this amongst the prospective 1988 Honours students, and one of them, Stephen Robinson, chose to do his Honours research project on this topic. In 1989, Steve and Dick made the world's first vacuum glazing – a tiny sample less that 10cm across. Two months later they produced an A4 sized sample. Steve achieved First Class Honours, and subsequently completed a PhD on solar cells at the University of NSW. Sadly, only a few years later he was killed in an avalanche while mountaineering in New Zealand. One can only speculate on what he might have achieved over the rest of his career had it not been so tragically cut short.

As mentioned, the reason that vacuum glazing took so long to demonstrate was there were many daunting technological problems to overcome. For starters, you need to be able to form a completely leak-free, hermetic, seal between the two glass sheets. You also need to produce a high and stable vacuum, and demonstrate that this vacuum will be maintained over many decades. Another serious problem was that the vacuum creates large forces on the glass sheets – 10,000 Kg per square meter. So you need to balance the effects of the size of the support pillars, the separation between them, the total number of pillars, and their contribution to the total thermal conductivity of the glazing. The development of a reasonable design compromise between these constraints required an enormous amount of basic and applied work. Dick's group showed that it was indeed possible to make vacuum glazing with "superwindow" levels of thermal insulation, and even possible to improve further the insulating level of the glazing to lower than 1 W m 2 K 1.

Dick Collins was always passionate about applying the results of his research. Right from the beginning of the vacuum glazing project, he attempted to find an industry partner with whom to collaborate. In fact, it took over five years before, in late 1993, Nippon Sheet Glass Company of Japan (NSG) and the University entered into a licensing agreement to commercialize the technology. Only about three years later NSG launched their first commercial vacuum glazing product, SPACIA.

It would be foolish to pretend that this process has been all plain sailing. Indeed, over the years many unforeseen problems, and opportunities to improve the product, emerged which required great effort from both the University and NSG – including on several occasions the necessity to make major modifications to the existing production line! Dick retired from the University at the end of 2000, but his successor ARC Federation Fellow, Professor Marcela Bilek, now continues the project. The current research is aimed at understanding several effects which limit the performance of vacuum glazing. It is also possible that a whole new generation of vacuum glazings may emerge with even wider applications than are currently possible.

Two features of the entire vacuum glazing project are worth further mention. First, is the contribution of the many students that worked on the project over the years – nine higher degrees were awarded to students. Second, is the interplay between the very applied work directed at solving pressing production problems, with the very basic research aimed at understanding fundamental scientific issues in areas as diverse as surface science and fracture mechanics. The vacuum glazing project has been an outstanding example of how applied research can lead to advances in science, and also in technology, of direct practical relevance and benefit to society.

Acknowledgements

I would like to thank Emeritus Professor Richard (Dick) Collins for his help in writing this piece, and more importantly, I would like to acknowledge the continued support and work that Dick provides the vacuum glazing project. – CENK KOCER

EXCELLENCE IN PARTICLE PHYSICS

BY ASSOC. PROFESSOR KEVIN VARVELL

WITH THE STARTUP OF THE LARGE HADRON COLLIDER (LHC) THIS YEAR, CERN, THE EUROPEAN LABORATORY FOR PARTICLE PHYSICS STRADDLING THE SWISS/FRENCH BORDER NEAR GENEVA, IS THE PLACE TO BE FOR HIGH ENERGY PHYSICISTS YOUNG AND OLD. THE SCHOOL'S HIGH ENERGY PHYSICS GROUP HAS FOR MANY YEARS BEEN INVOLVED IN THE ATLAS EXPERIMENT, ONE OF SEVERAL LARGE EXPERIMENTS SITTING AT POINTS AROUND THE LHC WHERE THE PROTONS COLLIDE.

These experiments hope to improve our understanding of the fundamental building blocks of matter and the interactions between them. The group has recently become a node of the successful bid by four Australian universities and overseas partners for a $25.2M ARC Centre of Excellence for Particle Physics at the Tera-Scale, which will form the focus of Australia's efforts at the LHC, both experimental and theoretical, over the next seven years.

For an experimental PhD student's training, there is nothing like being at CERN to experience the buzz, help run the ATLAS detector and collect the data, whilst meeting and working with like-minded physicists from all over the world. First year Sydney PhD students Mark Scarcella, Ian Watson and Cameron Cuthbert travelled to CERN in September to commence this training, replacing second year PhD student Nik Patel who recently returned from a three-month visit.

Their adventures recently sparked the interest of the Sydney Morning Herald Science Editor and Journalist, Deborah Smith. To read the article in full visit: http://www.smh.com.au/world/science/setting-the-controls-for-the-heart-of-the-universe-20100913-159d0.html

THE BACKYARD OBSERVATORY

VELLO TABUR IS A PHD STUDENT IN ASTRONOMY AT THE SCHOOL OF PHYSICS. VELLO'S SO PASSIONATE ABOUT ASTRONOMY THAT HE BUILT AN OBSERVATORY IN HIS OWN BACKYARD IN CANBERRA. *ALUMNI NEWS* CAUGHT UP WITH HIM RECENTLY.

Alumni News: Your observatory was used for your highly successful PhD project. Which came first the observatory or the idea for the project?

Vello Tabur: I constructed the observatory prior to commencing post-graduate study, primarily to conduct a survey of the southern sky in search of comets. As a byproduct of the survey, I obtained photometric measurements of poorly studied variable stars, which led to a collaboration with my supervisor, Tim Bedding. The research project exploited my modest equipment by observing the brightest stars in the sky over a long period, which is technically difficult and prohibitively expensive with large aperture, professional-grade telescopes.

AN: What inspired you to build an observatory in your backyard?

VT: I required a permanent home for my instruments. More than just providing shelter from the elements, it allows the equipment to remain aligned, calibrated and ready for use at a moment's notice. Moreover, the observational phase of my research project lasted five and a half years, so nightly set-up and tear-down of equipment would have been impractical.

AN: How difficult is it to build such a structure? Aside from the materials did you need special planning approval?

VT: It was relatively easy to construct and approvals were unnecessary. A classic observatory conjures up images of a majestic white dome with a telescope within, peering at the sky through a slit. Not so, in my case. The observatory is little more than a tin shed with a roll-off roof, constructed from recycled timber and the cladding from an above-ground pool. What is lacks in elegance, it makes up for in photometric precision. With careful calibration, modelling and attention to detail, one can obtain profession quality results with amateur grade equipment.

AN: You are a qualified software engineer – why did you decide to study astronomy?

VT: Software engineering feeds my family; astronomy feeds my soul. I love exploring the night sky, discovering its secrets.

Vello Tabur in his backyard observatory

AN: Your supervisor, Professor Tim Bedding, says you're a very talented astronomer – do you think you'll ever take it up as a full time profession?

VT: I already have a successful career in software, so financial considerations would tend to preclude that possibility. However, I intend to continue collaborating with Tim on a part-time basis. There are many interesting avenues of investigation that are well suited to my equipment and, of course, I do not have to deal with time allocation committees (apart from my wife).

AN: Being a family man what do your wife and children think about the observatory? Any budding Gallileos yet?

VT: My wife irreverently refers to the observatory as my "tool shed". My children are more interested and, when younger, my daughter occasionally accompanied me outside. She enjoyed operating the telescope and just sitting back, gazing at the sky, devising her own constellations by "connecting the dots".

AN: Finally, any words of advice for anyone considering building their own observatory?

VT: Size does not matter! Serious research can be conducted with small optics and amateur-grade detectors. It simply requires one to be open minded, putting aside preconceived notions and finding a suitable area of study.

VALE

DR DON D MILLAR

DR DON D. MILLAR WAS DEPUTY HEAD OF SCHOOL AND EXECUTIVE OFFICER OF THE SCIENCE FOUNDATION FOR PHYSICS. HE WAS ALSO THE AUTHOR OF THE BOOK, THE MESSEL ERA, WHICH CHRONICLED PROFESSOR HARRY MESSEL'S TIME AS HEAD, SCHOOL OF PHYSICS. DR MILLAR PASSED AWAY IN MAY 2010. HE WILL BE GREATLY MISSED BY ALL WHO KNEW HIM AND WORKED WITH HIM DURING HIS TIME AT THE SCHOOL. HERE DR PETER KRUG, VISITING SCHOLAR, SCHOOL OF PHYSICS, RECOUNTS HIS FOND MEMORIES OF DON AS HIS TEACHER

I was saddened to learn of the passing of Don Millar. In February 1973 Don delivered my first ever university lecture (Electricity & Magnetism, I think), and thus marked the start of my continuing association with the School of Physics. With his wonderful clear British diction, his flair for clarity of presentation, coupled with his deep and intuitive grasp of Physics, Don delivered powerful lectures that remain a model of excellence in teaching of physics.

These days, as I deliver lectures myself, Don's masterful example remains with me. However, it was, perhaps, the seriousness with which he approached the task of supervising laboratory classes that I learned most from Don. For many academics, the job of supervising lab classes is a dull chore, to be avoided where possible, and tolerated where necessary. Don, on the other hand, would relish the opportunity to come by the lab bench and pose a seemingly simple question that drove to the very heart of the underlying physics. Almost every time Don posed such a question, the act of pondering and then attempting to answer the question led me to a deeper understanding of what I was doing.

While I know little of Don's private life, one non-physics-related anecdote has stayed with me. During a wide-ranging and often entertaining conversation one day, I mentioned to Don that in the archival photos of him I had seen he'd nearly always been smoking a pipe. As he clearly didn't smoke any longer, I asked whether he had found it difficult to quit. He replied that when he had realised how detrimental smoking was to one's health, he had immediately and permanently stopped smoking from that minute on. A simple and direct solution to a problem. No fuss, no second thoughts. Just what I would have expected from Don Millar!

FAR-REACHING VISION CAN'T CLAIM TELESCOPE'S INVENTION

DR KARL KRUSZELNICKI,
JULIUS SUMNER MILLER FELLOW

THE PHILOSOPHER AND MATHEMATICIAN, GALILEO, HAS A REPUTATION FOR MANY GREAT DISCOVERIES. BUT, AS DR KARL EXPLAINS, THE TELESCOPE IS NOT ONE OF THEM.

The astronomers have a special name for a telescope — 'light bucket'. You put out your light bucket at night, it catches a whole bunch of light from some distant object, and then you look at the light and see something wonderful.

Indeed, the 17th century astronomer, Johannes Kepler, said of the telescope: "O telescope, instrument of much knowledge, more precious than any sceptre! Is not he who holds thee in his hand made king and lord of the works of God?"

But most of us wrongly think that it was the famous Galileo who invented the telescope.

One of the most famous ancient lenses is a small piece of shaped rock crystal, thicker in the middle than at the edge, and dating to the seventh century BC.

Many other convex lenses (thicker in the middle than at the edges) have been uncovered in the ancient world — Rome, Cairo, Carthage, Troy, etc.

Practically all of them were steeply curved, and had a short focal length. They would bring their image to a focus only a few centimetres from the lens. They were perfect for seeing fine detail close-up, especially if you were a bit older, but totally useless for a telescope.

A basic modern telescope has two quite different lenses. The light goes into the telescope through a shallowly curved weak convex lens with a long focal length. The light comes out into your eyeball through a steeply curved strong concave lens (thicker at the edges than at the centre) with a short focal length.

There are many contenders for the title of 'Inventor of the Telescope'. Around 1000 AD, the brilliant Arabian astronomer and mathematician, Ibn Alhazen, wrote about concave lenses in his groundbreaking mathematical book on vision. The 13th century Oxford scholar and Franciscan monk, Roger Bacon, wrote about combining lenses to see at a distance, as did the 16th century Italian spectacle maker, Giovanbaptista Della Porta (1538-1615), and a host of others.

But the first documented actual working telescope was delivered by Hans Lippershey, a spectacle maker from Middelburg, in Zeeland (southern Holland) to Prince Maurice of Nassau in The Hague. This happened in the last week of September 1608. But the time was obviously ripe for the telescope to be invented, because within three weeks, two other spectacle makers turned up in The Hague to try to sell what they thought was their unique new invention of the telescope.

The word spread very rapidly across Europe about this new invention, and by May 1609, while Galileo was professor of mathematics at the University of Padua, he had heard of this new device. He was very smart, and very quickly worked out how to make his own telescope. He learnt how to grind lenses, and all the other necessary skills, and soon made an eight-power telescope (that would make the image eight times larger) and a 20-power telescope.

With this last telescope, he proved that Aristotle was wrong when he said that the Moon was perfectly smooth, as he could see mountains there "full of vast protuberances, deep chasms and sinuoisities".

Galileo also showed that the Sun was not perfect, when he saw sunspots on its surface. He proved that not everything in the universe orbited around the Earth, when he tracked the motions of the Jupiter's four largest moons and showed that they orbited Jupiter, not the Earth. (Galileo cleverly called them the Medicean Stars, and was rewarded by the de Medici family paying him to be their personal philosopher and mathematician. Today's rich elite have their own personal trainers and financial advisers, but how many of them have their own personal philosopher and mathematician?)

So how did Galileo get the reputation of inventing the telescope? We're not sure, but he was one of the first people to make great discoveries with the telescope, and he was a towering intellect, so perhaps people automatically assumed that he also invented the telescope.

After all, he had also done basic scientific research into falling bodies and parabolic trajectories, and as an engineer, he invented the thermometer, the compound microscope, an escapement mechanism for pendulum clocks, and even a machine for picking tomatoes.

But while he made many great discoveries with the telescope, and had actually built his own from first principles, this all happened only after he had heard that other people had previously made the breakthrough.

But Galileo was, nevertheless, a man of far-reaching vision.

To follow Dr Karl on Twitter visit: www.drkarl.com/home/

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