The University of Sydney

The University of Sydney
School of Physics & International Science School

Alumni News

SUMMER 2009/2010

Evidence for Murder

How physics convicted a killer

Professor Rod Cross is a well-known physicist based within the School of Physics who helped police crack one of Australia's most infamous murder cases ensuring the culprit, Gordon Wood, got his just desserts. *Alumni News* spoke with Rod Cross about the Caroline Byrne case and his new book, *Evidence for Murder*, released in October.

Alumni News: Congratulations on helping to bring a murderer to justice. How long were you involved in the case?
Rod Cross: The police first contacted me in 1997, just before the coroner's inquest. I told them that Caroline probably jumped. They asked me for a second opinion six years later, and I told them it still looked liked she jumped.

AN: Initially the police thought the case was a suicide – what changed that way of thinking?
RC: Her father alerted the police to many inconsistencies in Wood's story.

AN: Why were you brought in to help with the investigations?
RC: In 1997 it was simply a phone call to see if I could distinguish between a push and a jump. In 2003, they wanted a full report.

AN: What was the attitude of the police to working with a physicist?
RC: They were very keen. They often work with experts like this.

AN: What was the attitude of the lawyers and barristers?
RC: They were not very interested in the physics of the case. The prosecution wanted to know just the bottom line, and the defence tried to establish that I didn't know what I was talking about.

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Professor Cross with lawyers from the Gordon Wood murder trial

Dr Boris Kuhlmey – Future Fellow

Dr Boris Kuhlmey is a Senior Lecturer in optics and photonics within the Institute of Photonics and Optics (IPOS). Kuhlmey was recently awarded an ARC Future Fellowship for his research into photonic crystal fibres.

Boris Kuhlmey first visited The University of Sydney in 1999 as part of a three-month undergraduate research project in theoretical physics with supervisor, Professor Ross McPhedran. Boris commented that, when he returned to France, "I didn't realise I'd be returning so soon to Australia."

Upon finishing his Masters he spent the next three years studying for his PhD in both Marseilles and Sydney. Serendipitously in 2003, just as Boris completed his PhD, CUDOS started so it was a natural progression to continue into a postdoctoral position through the new Centre of Excellence.

"I loved being in Sydney and CUDOS contained some big names in photonics and optics plus it had massive funding, so it wasn't a hard decision to make," explains Boris whose research centres on a particular

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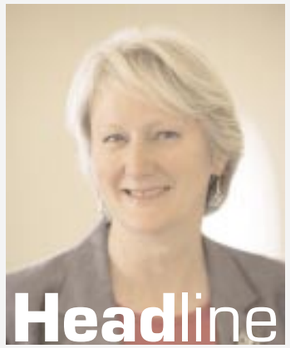

Professor Anne Green
Head of School &
Director, Science
Foundation for Physics

The 35th *Professor Harry Messel International Science School (ISS) — Genes to Galaxies* was an exhilarating two weeks to be sure. One hundred and forty five Year 11 and 12 students arrived from all states and territories in Australia, including five enthusiastic girls each of who had won a place through the ISS Indigenous Science Scholars program.

As well we welcomed students from China, India, Japan, New Zealand, Thailand, the UK and the USA. Due to swine flu concerns Malaysia and Singapore were not part of the 2009 cohort but we hope to see them again in 2011. Two Canadian students joined us for the first time attending to honour Emeritus Professor Harry Messel AC CBE in the 55th Year of the Science Foundation for Physics.

After the ISS was officially declared opened by its Patron, HE Professor Marie Bashir AC CVO, 1964 ISS Alumnus, Chief Justice Robert French, gave an exceptional opening lecture to the eager young audience. Their science appetite whetted, the scholars embarked on a two-week journey that left them wanting more. Matt Dunstan, Senior Staffie and ISS alumnus writes more about *Genes to Galaxies* in this issue.

I must extend a warm thankyou to all our alumni, friends and supporters who attended the ISS Gala Reception in July. The Great Hall was packed and it was terrific to see so many familiar and new faces enjoying themselves. As Director of the Science Foundation for Physics it was heartening to see people having their photos taken with Professor Messel and Dr Karl, students and younger children enjoying the now famous ISS Chocolate Fountain and especially seeing the ISS scholars personally thanking donors and supporters for making the ISS happen. We hope to see you again at our next alumni event.

The School of Physics held its Postgraduate Information Day in September. There are many fascinating and diverse areas of research happening here in Physics. From astronomy to medical and biological physics to photonics and optics postgraduate students here have told us how much they enjoyed their study at Sydney. David Wang recently gained some amazing media due to his research into using optics for dentistry. His pioneering Ultrasonic Evaluation Technique had journalists as far afield as Germany and the USA clamouring to talk to him. Make sure you read about David's research inside.

We always welcome stories from our alumni and when Dr Bob Ashcroft, formally known as Brother Robert Geoffrey, sent us his story highlighting his career in science we couldn't resist publishing it in *Alumni News*. I'm sure it will bring back many memories for those who knew Bob and for those who were at Physics during the 1960s.

I hope you enjoy this packed issue of *Alumni News*.

Dr Boris Kuhlmey – Future Fellow

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class of optical fibres known as photonic crystal fibres (PCFs). These fibres incorporate microscopic holes running along their length, which fundamentally modify the way light propagates in them. In particular, PCFs can be used for innovative devices in telecommunications, in sensing, in biology and for experiments in fundamental physics — work on new atomic clocks using such fibres won the 2005 Nobel Prize for Physics.

Future fellowships are attributed to researchers with outstanding track record; for Boris this comes in large parts in recognition of his authorship of two outstanding papers and for his publicly released software, which accurately calculates the propagation of light in PCFs. This software is now unanimously accepted as the benchmark for verifying the accuracy of other models and has been downloaded several thousand times from over 42 countries. "Virtually all research groups working on photonic crystal fibres worldwide have made use of the software and dozens of publications are based on it. This software is based on two seminal papers which have accumulated over 213 and 135 citations in less than six years," says Boris who is also a co-author of "Foundations of Photonics Crystal Fibres" (Imperial College Press).

Boris' future work will be based on a discovery made on a particular type of photonics crystal fibres containing rings instead of holes. Along with former student, Tom Grujic, and fellow researcher, Professor Martijn de Sterke, their research has shown that this photonic crystal fibre contains two properties not normally found together i.e. interesting dispersion properties and nonlinear behaviour, which can be used to convert light from one wavelength to another. Boris says his ultimate aim is to make efficient, cheap and compact tuneable light sources over wide wavelength ranges.

For more information on Dr Boris Kuhlmey's research visit: www.usyd.edu.au/ipos/

Dr Boris Kuhlmey

Open Wide and Say 'Zap'

A group of researchers in Australia and Taiwan has developed a new way to analyze the health of human teeth using lasers. As described in the latest issue of *Optics Express*, the Optical Society's (OSA) open-access journal, by measuring how the surface of a tooth responds to laser-generated ultrasound, they can evaluate the mineral content of tooth enamel —the semi-translucent outer layer of a tooth that protects the underlying dentin.

This is the first time anyone has been able to non-destructively measure the elasticity of human teeth, creating a method that can be used to assess oral health and predict emerging dental problems, such as tooth decay and cavities.

"The ultimate goal is to come up with a quick, efficient, cost-effective, and non-destructive way to evaluate the mineralization of human dental enamel," says David Hsiao-Chuan Wang, a PhD student at the University of Sydney's School of Physics and first author on the paper in *Optics Express*. Wang and his advisor Simon Fleming, a physics professor at the University of Sydney's Institute of Photonics and Optical Science, collaborated on the study with dental researchers at the University of Sydney and ultrasonic evaluation researchers at National Cheng Kung University in Tainan City, Taiwan.

Stronger than bone, enamel is the hardest and the most mineralized substance of the human body —one of the reasons why human teeth can survive for centuries after a person has died. It envelops teeth in a protective layer that shields the underlying dentin from decay.

Throughout a person's lifetime, enamel constantly undergoes a cycle of mineral loss and restoration, in which healthy teeth maintain a high mineral content. If the balance between mineral loss and gain is lost, however, teeth can develop areas of softened enamel — known as carious lesions — which are precursors to cavities and permanently damaged teeth.

Enamel demineralization is caused by bad oral hygiene. Not brushing, for instance, can lead to the build-up of dental plaques, and bacteria in these plaques will absorb sugars and other carbohydrates a person chews and produce acids that will dissolve the minerals in tooth enamel.

Quantifying the mineral content of tooth enamel can help dentists determine the location and the severity of developing dental lesions. Existing methods for evaluating enamel are limited, however. Dentists can visually assess the teeth, but dental lesions can be hard to spot in certain parts of the mouth because they are obscured by dental plaque, saliva, or the structure of a tooth itself. Dentists can use sharp instruments to probe the enamel, but this can be destructive to the teeth and gums. X-ray scans can reveal dental lesions, but they give no information on the level of mineralization.

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Evidence for murder

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AN: Are there any memorable 'court moments'?
RC: Many, mostly concerning 'dumb lawyer' questions. Most are in the book chapter on my evidence.

AN: This is a murder case that gained international attention – why do you think it was so interesting to the general public?
RC: The press concentrated on the possible connection to Rene Rivkin *[Editor – Australian millionaire investment broker who was gaoled for insider trading and subsequently committed suicide.]* and his flamboyant lifestyle and the $53 million insurance payment after a suspicious fire at his printing plant. The story was like a soap opera with many twists and turns.

AN: Many people thought Gordon Wood was guilty before the evidence was conclusive – what did you think?
RC: His story sounded very suspicious but I treated the evidence regarding the cliff fall itself as a totally separate issue and made judgements based only on that evidence.

AN: As a physicist did you break any new ground in the area of forensic investigation?
RC: I wrote a paper on the physics and biomechanics of the case a few years before the trial. There were many new results. Biomechanists focus mostly on elite athletes. I needed to gather a whole lot of data on the athletic abilities of average people after a short run-up (to the edge of the cliff).

AN: What was the reaction of Caroline Byrne's family once Wood was pronounced guilty?
RC: They were very pleased with the result. Tony Byrne (Caroline's father) said, "You don't know the meaning of the word 'justice' until you have sought it."

AN: How did that make you feel?
RC: I was very pleased for them, but the conviction of Wood was never going to make up for the loss of Caroline. It simply brought a small measure of closure.

AN: Did the writing the book give you a sense of closure about the case?
RC: Not really. I wanted to record the forensics of the case, given that falling accidents and fatalities are quite common and not widely studied. The publisher now wants me to go on radio to talk about the case and the book, so there is still some work to do.

AN: Finally, any advice for budding forensic physicists or perhaps budding true crime writers?
RC: Working with the police and with lawyers was a very rewarding experience. True crime writers should read the *Journal of Forensic Sciences*. It is full of amazing stories every issue.

Evidence for Murder, by Professor Rod Cross, is published by UNSW Press and retails for approximately $A35.00. A special 20% discount applies if you order the book by downloading an order form from www.physics.usyd.edu.au/

ISS 2009 – Third time lucky!

By Matt Dunstan

For those familiar with the Professor Harry Messel International Science School (ISS), you would know that those fortunate enough to be selected as scholars get a truly unique chance to pick the brains of both discipline-leading academics and their fellow talented peers. Being able to attend one ISS is a truly life-changing experience and for *ISS 2009: Genes to Galaxies*, I was lucky enough to come back for my third dose of science at its very best. After being a student in 2005, and a staffie in 2007, I still had the ISS bug (the good one) so when I was offered the chance to attend as a senior staffie it was an easy decision to pack my bags for the Women's College once more.

There, 140 scholars from all corners of the world, including for the first time two students from Rivers College, in Professor Messel's hometown of Rivers, Manitoba, Canada, joined me and along with 13 staffies and the Science Foundation for Physics' (SFP) 'A-team' (Anne Green, Adam Selinger, Alex Viglienzone and Alison Muir) we were all ready for two weeks of lectures and activities ranging from the miniature — exemplified by Professor Peter Waterhouse's lectures on gene silencing, to the massive, such as Professor Geraint Lewis leading us through the evolution of our very own galaxy. A personal highlight were lectures from Professor Jill Tarter, Director of the Centre for the Search of Extraterrestrial Intelligence (SETI), who spoke of SETI's plans for the future to truly involve the whole world in search for alien communications; and from Mr Wayne Lee, Chief Engineer at NASA, who spoke of NASA's plans to send man back to the moon in the near future and the behemoth task that faces him and his team as they try and emulate the success of that mission 40 years ago.

It isn't all work and no play however, and with the help of the Young Scientists of Australia there was an equally full social programme for scholars. Some events showed our visitors a bit of Australia and its culture such as a bush dance and the amazing floating seafood buffet, disco and observation platform aka the Harbour Cruise; while other activities were perhaps a newer addition to the Australian cultural milieu such as the (cough) sixth Harry Potter film (cough). In the midst of all of this was the miscellany that can only be found at ISS including Houseparent John Bright's jokes, Rubik's cubes at the dinner table, confounding logical riddles and the surprise at finding other people who are just as crazy about science as you…and the happiness at now being able to count them amongst your close friends.

Looking back now I can say with all certainty that ISS has had such a profound influence on the trajectory of my life both academically and personally, a feeling that I am sure is now shared by the newest members of the Foundation's Alumni. To this end, I would like to thank Adam, Alex, Alison and Anne of the SFP, the houseparents and the other staffies for making ISS 2009 such an unforgettable experience. But most of all, thankyou to Professor Harry Messel, whose passion, vigour and intelligence has reminded generations of young people of the importance of an inquisitive mind, a sharp intellect and a love for science. Onwards to ISS 2011!

ISS 2009: Genes to Galaxies students, and (below) Emeritus Professor Harry Messell

Frontiers of Science

In 1961, a brand new kind of comic was launched in the pages of *The Sydney Morning Herald*. More science fact than science fiction, presented in dramatic black and white imagery, *Frontiers of Science* was a true-life adventure of the story behind the amazing scientific breakthroughs of the day.

The brainchild of School of Physics theoretical physicist Professor Stuart Butler who worked with journalist and television producer Robert Raymond, *Frontiers of Science* was a factually correct scientific portrayal of scientific discovery, history and facts all delivered in comic strip form. It was produced on a weekly basis and beautifully drawn by artists, first Andre Bresciani then, after Andre's death, by David Emerson. Today it is finding new fans in the aficionados of graphic novels.

The comic strip format covered a complete topic over five days with one-day strips for each weekday. This format could be blocked into a one-day format as some Sunday papers did.

Each week covered a complete subject although occasionally the topic went over two or ever three weeks. Topics included climate change, the atom, and artificial hearts just to name a few.

In its heyday the strip ran in papers in the U.K., Canada, South America, New Zealand, Hong Kong, India, Israel and the main daily papers in all states in Australia with the exception of South Australia.

Frontier of Science ran in over 600 papers worldwide and was translated into Spanish and Japanese. In fact, it still holds the world record for the longest running factual scientific strip as well as for being the first in this type of presentation.

Frontiers of Science was unique and well before its time in bringing real scientific facts and features to the general public.

With support from the Science Foundation for Physics the Rare Books Section of the Fisher Library has now digitised many of the *Frontiers of Science* strips and they are available for viewing by visiting: http://frontiers.library.usyd.edu.au/

Open Wide and Say 'Zap'

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For research purposes, 'nano-indentation' is commonly used for gaining information on the elasticity of tooth enamel — a measure of its mineral content — but nano-indentation destroys the measured regions of the enamel in the process and is only used to look at extracted teeth.

What Wang, Fleming, and their colleagues wanted to do was to develop a clinical method that would give as much information as nano-indentation and could be used to assess tooth enamel in actual patients while being completely non-destructive. So they developed a way to measure the elasticity of tooth enamel by adapting laser ultrasonic surface wave velocity dispersion, a method similar to what industrial engineers use to evaluate the integrity of thin films and metals.

The method uses short duration laser pulses to excite ultrasonic waves that propagate along the surface and penetrate only a small distance into a tooth. The velocity of these waves is influenced by the elastic properties of the enamel on a tooth, and by detecting the ultrasonic waves with fiber optics at various points, they can determine the enamel's elasticity, which is directly related to its mineralization.

In their Optics Express article, Wang, Fleming, and their colleagues showed that they could use this technique on extracted human teeth. They have not yet tested the technique on a living person's teeth, and it will likely take several years before any eventual device is ready for use in the dentist's office.

This work was funded by the Australian Government and Bio-Dental Technology Pty. Ltd. Paper: "Laser Ultrasonic Surface Wave Dispersion Technique for Non-destructive Evaluation of Human Dental Enamel," Hsiao-Chuan Wang et al., *Optics Express*.

This report is reprinted from the original story published in OSA. For more information, visit www.osa.org.

ALUMNI PROFILE
DR BOB ASHCROFT

From 'Penguin' to Physicist — Physics Alumnus Dr Bob Ashcroft tells about his career in science

Students at Sydney University during the 1960s may remember the Penguin Brigade, serious men in black suits, who wore the reversed 'roman' collar and arrived on campus each morning in their combi-buses. I was one of them and, from 1962, studied Science with Majors in Physics and Maths, before going onto Honours Physics in 1965. Then known as Brother Robert Geoffrey, I was colleague and confrère to some twenty such 'Penguins' doing First Year in 1962, the largest single year the Marist Brothers ever put through The University of Sydney.

I recall my fellow student Marist Brothers included Geoff Colvin, Tony Craven, Martin Kelly, Marshall McMahon, Roger Riordan, Colin Marstin, Jimmy Butler, Terry Linsell, Eugene Dwyer and Terry Curley in Science, with (Dr) Paul Brock (a brave and dignified man now sadly struck down by that most heinous of afflictions, Motor Neurone Disease), Brian Hannigan, Ray Mulvogue, Bryan Leake, Leonard Spillane and Frank McMahon. As well I still remember Don Hall and Richard Smith (who went into Medicine).

My Honours Physics project supervisor in 1965 was Dr Murray Winn, who was running the SUGAR experimental program assisting Professor Mills' work. My lecturers included Professor Harry Messel, Drs Paul George, Murray Winn, Bob May (now Lord Robert May of Oxford), Michael Large and Professor Makinson. Dr Guest and Dr Phyllis Nicol ran the lab classes I attended and they were ably supported by demonstrator/tutors like Robert Hewitt, Peggy Adamson and Bruce MacKellar, then graduate students of Professor Stuart Butler. Hank Benis and Dr Henry Rathgeber (along with his son, Michael) supported the technical side of the Practicals.

Marist life was one of intense religious commitment, the initiated being required to take vows of Poverty, Chastity and Obedience, which were renewed annually for the first five years, then taken as 'perpetual'. We Penguins proved to be pretty good students, living a communal monastic life at Dundas. Thus 'avowed' none fell prey to the distractions of housing, feeding and clothing ourselves, nor of pursuing any personal attachments, male or female.

I surprised myself somewhat with my Distinctions and Credits over those years, and came out with a solid HII Div I in my Honours Physics year. Brother Ronald Fogarty led the Teacher Training program during uni holidays that saw us finish our four years at Sydney ready to start teaching in Marist secondary schools across Australia.

I taught at two Marist school teaching posts. First at Kogarah (1966) then at St Joseph's at Hunters Hill (1967). In January 1970 my vows were annulled and I then took up a (very short) contract as a jackeroo on a farm at Hall, near Canberra. Within three months I was back in the big smoke, teaching briefly at Waverley College, before taking up a Commonwealth Post-Graduate PhD scholarship at the University of NSW. I was jointly enrolled in Physics and Chemistry and spent a long time on my PhD project, but it was a good time. I switched to Biophysics, where my final supervisor, Dr Hans Coster, was a USyd Physics/ CSIRO Graduate, and submitted my Thesis in 1979.

Looking back now I think of those years as tumultuous although I had managed to find and marry my beautiful wife, Wendy. During that time though I had a very serious car accident, which I was lucky to survive. After recovering Professor Nairn in Immunology at Monash Medical School in Melbourne offered me a Post-Doc, which I accepted.

There I was introduced to the science/art of cell sorting using a fluorescence-activated cell sorter (FACS). Working with FACS became the basis of my future professional life, leading me from Monash to the Melbourne University affiliate, the Ludwig Institute for Cancer Research. From there I launched into private commercial practice. Cell-sorters fascinated me, and I saw that major advances in performance could be achieved via effective use of laboratory computers of the type then sold by Digital Equipment Corporation, DEC, in their PDP11 series, which Hans Coster and John Smith had introduced me to during my Doctorate days. With the help of two fine Engineer-Physicist graduates from Melbourne University, and the benevolent patronage of my director, Dr Tony Burgess, I set about devising an add-on PDP11-based controller for the LICR's Cell-Sorter, to replace the ineffectual system provided by its manufacturer, Ortho, powered by Data General lab computers.

George Malachowski and Brian Hall [the MU Graduates] provided the programming and electronics know-how that led to our devising and building a Universal controller for cell sorters, CICERO, whose heart was a PDP11. Before long we had pushed the sort-rate capabilities from 3,000 cells/s to 15,000 cells/s, which opened the way to biological experiments not previously possible. The LICR agreed to transfer the IP of CICERO to us and, in 1988, we set up a US company, Cytomation Inc., in Inglewood Colorado, USA. This company attracted the interest of a Melbourne and Loveland (CO, USA)-based medico, venture capitalist and businessman, Dr Merv Jacobson, who invested several million dollars in Cytomation, in return for majority ownership of the company.

I drifted away from Cytomation from 1988 (when I left LICR) to 1995, and was involved in two more start-up companies, one with my wife, called Certain Cell Sorting P/L. This was a family vehicle by which we sold our services, and one with Professor Hans Coster at UNSW, and Dr Tohsak Mahaworasilpa, then a PhD student, called FuCell Pty Ltd; Unisearch was also a partner in FuCell.

FuCell exploited aspects of dielectrophoretic techniques invented by Hans and characterised by him and Tohsak, whereby it was possible to select and transport, in a supporting saline fluid, single cells of different varieties. One could bring them into close apposition, such that while in this state of intimate appressed contact, a binary pair could be fused to form a sometimes viable binary hybrid cell, which shared the expressed DNA of the 2 original cells. Such hybrids could then be grown in culture until they reached a state of nuclear stability and DNA expression. The successful development of this technique positioned us to be able to make binaries almost to order, to fuse cell pairs from the immune system that mimicked the behaviour of 'hybridoma' cells, usually originated from mice or similar small mammal, cells which secrete highly monoclonal forms of antibodies. Such monoclonal antibodies showed exquisite selectivity in binding to target features (epitopes) of cells or other tissue structures.

Monoclonal antibodies formed the basis for a multibillion dollar diagnostics industry, being widely used in the detection and classification of leukaemias and lymphomas; they were particularly useful in following and classifying the progression of HIV infection onto AIDS, an immunodeficiency disease that arose during the 1980s, and remains a problem today. The company goal was production of human monoclonal antibodies for commercial therapeutic deployment.

FuCell did not meet its objective of commercial human hybridoma production but after 10 years it was taken over by a key shareholder who led its science and business along other pathways, including a name change and then a public offering. I had completely separated myself from FuCell by 1998, to focus once again on working as the Australian agent for Cytomation Inc, CI, then based in Fort Collins CO, with CICERO installations all over the developed world. We at CI had sold approx 250 CICERO instrument controllers in that decade, and in 1995, won the manufacturing and selling rights to a high-speed sorter, MoFlo, developed at the Lawrence Labs in Livermore CA. The prototype MoFlo was much adapted, supplemented [especially in computer contro and interfacingl] and augmented to enable the customised mass-production of MoFlos in Cytomation's facilities in Fort Collins.

Bob Ashcroft circa 1962

We sold our first MoFlo machine in 1995, and the third MoFlo sold was into Australia — bought in December 1995 by UNSW immunologist Dr Andrew Collins. Australia was at the forefront of the uptake of these 'Porsches' of the industry. Our high speed sorters could measure 200 million cells in an hour, and isolate the target cells within the sample, whether they were abundant or rare. Purities of over 99.5% were routinely achievable even at these sort-rates. Isolation of 50 million cells from a starting incidence of 25% could be achieved in just an hour, and cells were viable enough to be re-implanted or to perform in vitro functional analyses. The MoFlo SX sperm cell sorter used by XY Inc posted case after case of gender selected offspring in horses, sheep, pigs to name a few. By 2002, we had sold over 300 MoFlos and had annual sales figures of round US$30 million.

In 2002, Dako AS [a Danish pathology company] and CI merged to form a new company of 1200 employees worldwide selling sorters and analysers plus their monoclonal antibody[consumable] reagents. The merger did not deliver the sales synergies expected of it, and after an internal demerger, the company was sold in 2007 to a European Venture Capital company, EQTV, which sold off the part equating to the original Cytomation, at the end of 2007. The purchaser was Beckman Coulter Industries, a US multinational, and my association with the company ceased at the end of March, 2008.

My semi-retirement sees me cultivating my interests in languages and culture, in local food and wines, and a small amount of consulting work as well as helping out my older son in his internet-based business. All in all not a bad life for an ex 'Penguin'!

UNDER THE RADAR
THE SECRET LIFE OF RUBY PAYNE-SCOTT

The world's first female radiophysicist, Ruby Payne-Scott (1912–1981), had such a brilliant mind that, if she had been born a man, she surely would have received due recognition. Instead she was subject to ASIO scrutiny, had to keep her marriage a secret for six years and had her extraordinary career cut short by pregnancy before ultimately being forced into retirement.

Her biography, *Under the Radar: Ruby Payne-Scott, the First Woman Radio Astronomer*, is written by Professor Miller Goss and Dr Richard McGee and will be launched on Wednesday 25 November from 6pm to 8pm in The Great Hall. Professor Miller Goss, and Payne-Scott's children, contemporary artist, Fiona Hall and mathematician, Professor Peter Hall, will be at the launch which is a free event. Copies of the book will be available for sale.

For more information about the book launch contact Alison Muir on +61 2 9036 5914 or email: a.muir@physics.usyd.edu.au To order a copy of *Under the Radar* visit: www.physics.usyd.edu.au and follow the link.

This is a free event supported by the School of Physics, The Faculty of Science's Women in Science Project and CSIRO.

AWARDS & GRANTS

Congratulations to Professor Robert Fulton and his team for being awarded the Siemens High Performance Preclinical Image of the Year at the 2009 World Molecular Imaging Congress in Montreal. This award is for a 'cutting edge' development in small animal imaging technology. The School of Physics-administered ARC Discovery Grant for the PET imaging of 'awake' rats (as recently described at a Research Bite).

Fulton reports, "We have nice trophy to put on display in our lab". Team members include: Victor Zhou, Andre Kyme (Physics) Steve Meikle, Kata Popovic, Ingallil Karlsson, Mahmood Akhtar, Wencke Lehnert, Michael Kassiou (BMRI).

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Funding for the International Program Development Fund (IPDF) – 2010 Round, resulted in successful applications by Members of Staff from the School of Physics:

Professor Geraint Lewis: The Pan-Andromeda Archaeological Survey (PAndAS) – $9,250

Dr Greg Madsen & **Professor Bryan Gaensler**: Understanding the Physics of the Magellanic Clouds – $10,000

Dr Tara Murphy & **Professor Bryan Gaensler**: Building a Collaboration for Transient – Detection with SKA Pathfinders $14,000

Congratulations to all recipients.

Zero Gravity

by Dr Karl S. Kruszelnicki

We've had the 40th anniversary of the first moon landing. Quite a lot of the footage showed astronauts floating inside their spacecraft, seemingly unaffected by gravity. Because of that awe-inspiring image, many of us wrongly believe that there is no gravity in space. But that belief is 100 per cent wrong.

The gravity of every object (no matter how little mass it has) reaches to the very edges of the universe. As a result, every part of the universe is filled with squillions of individual gravitational fields, each generated by the squillions of individual objects.

Newton told us — and he was right — that there is a gravitational attraction between any two bodies. So think of you standing on the surface of the earth. The mathematicians tell us that you can think of all of the mass of the earth as being concentrated at the centre.

So you are standing on the surface, about 6000 kilometres away from the centre. Your weight is (let's say) 80 kilograms, if you plug the numbers into Newton's equation of gravity.

Now, let's put you on the very top of a giant pin, about 300 kilometres high. This is a great height, but it's only a pimple on the earth, about five per cent of its radius. And I've chosen 300 kilometres, because this is the height at which the Space Shuttle orbits.

Gravity gets weaker as you get further away from its source. Plug this extra distance into Newton's equation of gravity, and you find that you weigh only 72 kilograms, about 10 per cent less. Please note: that's not 100 per cent less, only 10 per cent less.

So how come do the astronauts in the Space Shuttle float, if they weigh 90 per cent of normal? Simple: first, they are falling because they have weight; but second, they are moving forward really, really quickly; and third, the earth is curved, not flat. Let me explain this to you.

First, at their altitude of 300 kilometres, they are moving forward about seven kilometres in each second. The earth is curved, not flat. At their altitude, the curve of the earth drops away by roughly 4.5 metres for every seven kilometres they fly forward. So in that second when they move forward seven kilometres, gravity pulls them 4.5 metres vertically downwards towards the earth.

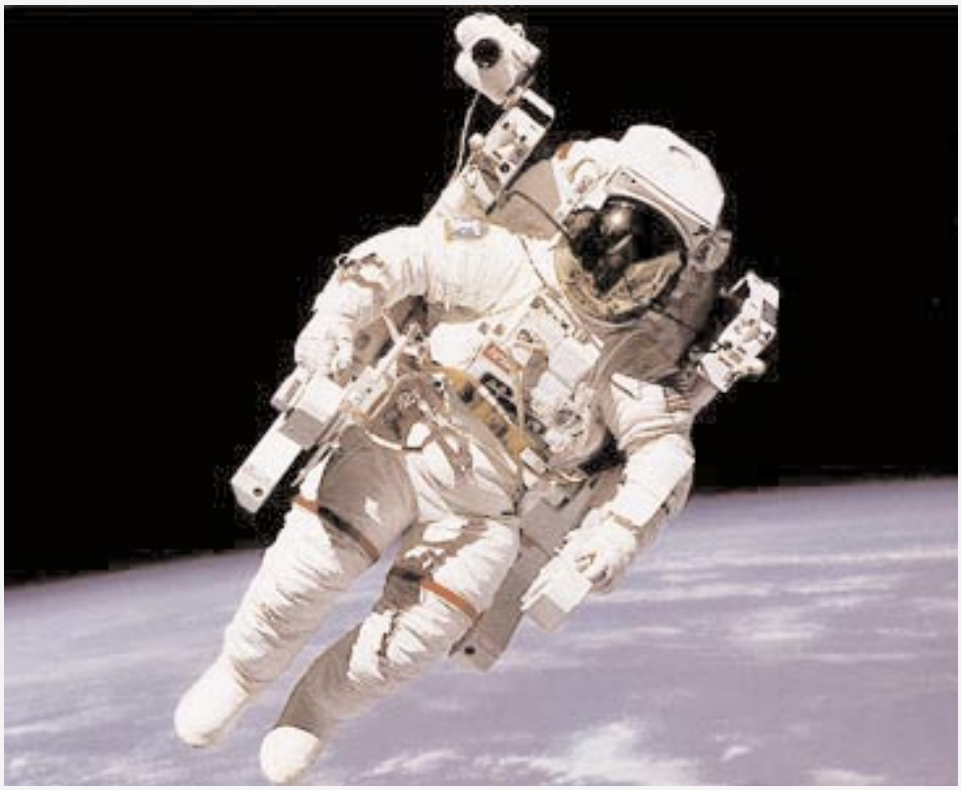
But (as I said earlier) in the seven kilometres that they cover in that second, the curve of the earth is such that the surface of our planet has 'fallen' away by 4.5 metres.

So there you have it. The astronauts have both horizontal motion across the surface of the earth, and vertical motion towards the surface of the earth. But the gravity of the earth pulls on them vertically.

The net result is simple. After one second, they are still the same distance from the surface of the earth. After the next second, they are still the same distance from the surface of the earth. And so it goes. After 90 minutes, they have made a complete loop of the earth, and are still the same distance from the surface.

They are in 'free fall'. They are always falling freely, but thanks to the perfect matching of their speed and the curve of the earth, they are always the same distance from the surface of the earth so they appear to float.

A few centuries ago, Isaac Newton solved this problem of 'free fall' by thinking about a cannon mounted one metre above the ground. If it had a small charge of gunpowder, the ball would fly 100 metres before hitting the ground.



A bigger charge would make it fly 100 kilometres before it hit the ground. An absolutely huge charge would make it fly one metre above the ground all the way around the earth (assuming there's no wind resistance). If there were no wind resistance, that cannonball would orbit the earth forever.

So, like the astronauts, the cannonball would always be falling. But there's also the perfect match of its speed and the curve of the earth. So it's always falling toward the earth, and the surface of the earth is always dipping away from it.

NASA used to talk of 'zero gravity'. Today, they talk of microgravity. Maybe the correct approach is to realise that there is no such thing as gravity, and though the earth may be a beautiful place, it really sucks.

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Image courtesy of NASA