



Alumni News



Eureka! moment for Sydney Astronomer

Discovering whirling nebulae using a "dustbin lid" has earned University of Sydney Astrophysicist Dr Peter Tuthill the 2005 Eureka Prize for Scientific Research. His technique, which involves placing a mask with strategically positioned holes over a telescope mirror, has allowed him to improve the resolution to an unprecedented level – five times better than that of the Hubble telescope.



The pinwheel nebula around Wolf-Rayet 104



Peter Tuthill receives his Eureka Prize from the UNSW DVC for Research. Photo: Stuart Humphreys, copyright Australian Museum.

Yet the technique, which has achieved some far better results than those of large teams of scientists and engineers using the high-budget modern techniques of Adaptive Optics (AO), was pioneered and brought to fruition almost single-handedly by Dr Tuthill – at a tiny fraction of the billions of dollars required to use space telescopes such as the Hubble.

Dr Tuthill shared the \$10,000 award with Professor Veena Sahajwalla, Director of Sustainable Materials Processing Research at the University of New South Wales. He was also a finalist in the people's choice award. "It's been a kick; yeah, it's been huge", he said modestly.

The increase in resolution from Dr Tuthill's masking technique has revealed some fascinating structures in our galaxy, such as the rare whirling nebulae surrounding some Wolf-Rayet stars – stars

100,000 times brighter than our sun. Christened "Pinwheels" by Dr Tuthill, the rotating spiral plumes such as WR104 (pictured) come from binary star systems which rotate every eight months, throwing off a spiral of glowing dust, just as a garden sprinkler sends out a spiral of water droplets.

Dr Tuthill's observations, using the near infra-red Keck telescope in Hawaii, have also yielded spectacular images of the birth and deaths of stars, which have led to significant advances in our understanding of stellar evolution. But, he warns, the technique is only good for bright objects: "if you're short of photons, you have no business putting a mask over your telescope!"

The paradoxical idea to improve a telescope by putting a mask over it dates back more than a hundred years to Fizeau, a French optician. Fizeau's

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Yet Another Jolly Good Fellow

It has to be some kind of record... Physics alumnus and former Young Australian of the Year Bryan Gaensler has been offered a prestigious Federation Fellowship to return to the School of Physics in 2006.

If the astronomer takes up the offer to return to Australia, he will become the fifth in the School's growing list of Federation Fellows, along with Professors Cathy Stampfl, Peter Robinson, Ben Eggleton and Marcela Bilek.

To put that in perspective, the University of Sydney has just fifteen Federation Fellows. The Federal Government has awarded up to 25 Fellowships each year since 2001 – so for an individual School to host five of them is either a strong signal of research excellence... or an astounding statistical anomaly.

Bryan Gaensler is currently an Assistant Professor at the Department of Astronomy at Harvard University. His research focuses on radio, X-ray and optical observations of neutron stars and supernova remnants, and the effect of magnetic fields on turbulence in the interstellar medium and the formation of large-scale structures. Bryan was in Sydney in July and gave the 2005 Harley Wood Lecture at the annual meeting of the Astronomical Society of Australia.

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Headline



Assoc Prof Brian James

As you saw on the front page, the School of Physics will gain a fifth Federation Fellow – Professor Bryan Gaensler is due to take up his position in mid-2006. Bryan will provide strong leadership in the area of astronomy and astrophysics at a time when Australia is in the running to host the Square Kilometre Array, the planned big international radio telescope project. One of the proposed antenna designs – parabolic cylinders – is being developed at the School’s Molonglo Observatory, which celebrates its 40th anniversary in November. That occasion will be marked by a symposium on 17 November, followed the next day by a BBQ on site at Molonglo. Many staff and students who used the telescope are expected to join the celebrations.

Next year will mark another significant event for the School: the 50th anniversary of SILLIAC, the first computer to be constructed in an Australian university. Celebrations are being planned to coincide with the 50th anniversary of the official opening, which occurred in September 1956. SILLIAC not only introduced University staff and students to the use of computers for calculations, but also allowed many companies and government departments to do likewise. Out of the SILLIAC program grew the first computer science department in an Australian university, the Basser Computer Science Department, which split from the School in 1972 and continues today as the University’s School of Information Technologies.

As part of the continuing celebration of the International Year of Physics, the School hosted a series of public lectures on Einstein’s achievements,

which is touring the country under the auspices of the Australian Institute of Physics. The attendance at each talk – about 120 – was so pleasing that the School is planning public lectures on Physics topics on a more regular basis.

The higher education environment is far from quiescent, being subject to many external influences, not least of which are those originating with government. Recently a ranking of teaching quality in Australian universities received wide publicity. Although the University of Sydney did well, many are unhappy with the procedures used and doubtful about the significance of the results. The government is preparing an assessment of research quality in universities and research institutes, which could have a major effect on the distribution of government research funds. In this environment the School is in the process of establishing an external advisory board, is about to review its relationship with the Science Foundation for Physics, and is preparing a 5-year strategic plan – more on these matters at a later date.

I hope we will see many alumni at the various celebrations mentioned above. Best wishes for the holiday season and for 2006.

Head, School of Physics
The University of Sydney

Tell us what you think!

We really would like to know what our Alumni think about activities such as mentoring and getting involved in our Alumni Association – so we have enclosed a survey for you to complete and return to us. You can fax it to Alison Thorn on + 61 2 9351 7726, you can request an electronic version by emailing a.thorn@physics.usyd.edu.au, or you can post your completed survey to School of Physics A28, The University of Sydney NSW 2006. Every bit of feedback helps, so thanks in advance!

Eureka! moment for Sydney Astronomer

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idea was to overcome the image distortion caused by turbulence in the atmosphere (the same effect that causes the twinkling of stars) by comparing light collected from a pair of holes in the mask. Dr Tuthill developed the idea into a two dimensional pattern of 21 holes arranged in threefold symmetry around the mask, effectively turning a single telescope into an interferometer consisting of 21 telescopes working in concert.

The pay-offs have been extraordinary. In just 8 years since devising the idea, Dr Tuthill has perfected the technique and has built masks for the world’s largest telescopes: Keck I and II in Hawaii, Gemini South in Chile, Mt Palomar in California, and soon the Very Large Telescope, also in Chile – all this before anyone else in the world could think to try to compete with him.

Stars, skin cancer and silicon under the microscope

A revolutionary new microscope with applications from biological systems to electronics to astronomy is set to make the leap from academia to the commercial world.



Image of the surface profile of an integrated circuit using Roy's technique

The School of Physics's Dr Maitreyee Roy has been approached by Arizona-based Veeco Instruments, a company specialising in nanoscale measurement and manufacturing – they're interested in commercialising her geometrical phase-shift microscopic technique developed from her PhD work with the Physical Optics group in the late nineties.

The new technique is not only more sensitive than traditional microscopy imaging methods, but is also faster, allowing images to be taken in less than a millisecond. These qualities make for wide-ranging applications. At the largest scale, the technique is set to be used at the Sydney University Stellar Interferometer (SUSI) where the short image time avoids distortions caused by the turbulence of the atmosphere. And at the tiniest scales there are applications characterising proteins and DNA in dynamic biological systems.

“As electronic devices get smaller, characterising them for quality control purposes – simply looking at what you have created – has become a real challenge.”

In another direction, Dr Roy has established links with Royal Prince Alfred Hospital, to apply her technique to diagnosing melanomas. However, the application to micro-electromechanical systems (MEMS) is what has attracted Veeco to Dr Roy's technique.

As electronic devices get smaller, characterising them for quality control purposes – simply looking at what you have created – has become a real challenge. Current methods typically tackle the problem by placing the sample in an interferometer. This device splits a laser into two beams and sends each beam out to a mirror; as they return from the mirror the beams are recombined. When the two path lengths differ, interference results in a pattern of light and dark fringes.

But by replacing the mirror in one arm of the interferometer with a sample – say, a silicon chip – a very sensitive interference pattern is formed which shows the height variations on the surface of the chip.

The problem is that by using lasers, which consist of light of a single wavelength, the pattern of light and dark can be ambiguous. A fringe in the pattern might mean a path length difference of one wavelength, or two wavelengths... or any number of wavelengths.

“The problem is that by using lasers, which consist of light of a single wavelength, the pattern of light and dark can be ambiguous.”

Dr Roy's technique solves this problem by using white light instead of a laser. Because white light consists of many wavelengths, it is a lot harder to get a fringe pattern – all the different wavelengths must be in step at once, which only occurs if the two beams have travelled exactly the same distance, making this microscope much more sensitive.

In order to measure the surface variations of the sample, traditional methods use a piezo-electric crystal to move it back and forth. The second innovation in Dr Roy's technique, which allows the fast timescale of measurements, is the replacement of moving parts with a ferroelectric liquid crystal. Instead of changing the length of the reference arm, the ferroelectric crystal in Dr Roy's system modulates the geometric phase of the beam, achieving the same end by varying a voltage instead of moving the sample. The result: a more stable, short timescale system.

As more and more interested parties knock on the door of Dr Roy's unassuming lab tucked in a corner of the Physics Building, her next challenge is going to be keeping up with the demand for her skills.

WAVES OF THE FUTURE



The 33rd Professor Harry Messel International Science School

"It will be the best two weeks of your lives... " To the uninitiated the traditional welcome to the International Science School could be dismissed as hyperbole, just our way of getting the students' attention and breaking the ice on that first day.

But the letters, emails, cards and text-messages we received from the latest cohort of ISS scholars show that it isn't an exaggeration: for many of the 140 scholars, those two weeks in July 2005 rank up there with their most exciting, challenging and inspiring experiences so far.

Each International Science School gathers top high school students from every state and territory of Australia, and from eight other countries – Singapore, Thailand, Malaysia, New Zealand, Japan, China, the United States and the United Kingdom. They live on campus in the Women's College, attend lectures and activities by day and social activities by night. It's an intense couple of weeks of scientific challenges and new friendships.

This year, the 33rd International Science School, Waves of the Future, featured another great line-up of guest lecturers. Professor David Cockayne from Oxford University took the scholars on a tour of the nanoworld, home of buckyballs and nanotubes. Dr Joe Hope from the Australian National University introduced the students to the wild world of the quantum, and Dr Frank Seebacher showed them the best ways to track crocodiles in the far North of Australia.

In a sad twist, Professor Raffaella Morganti from the Netherlands Institute for Research in Astronomy became ill and could not present her talks on the black holes that lurk in the cores of galaxies – but at the last minute her friend and colleague here in the School of Physics, Professor Elaine Sadler, stepped in to fill her shoes.

Outside of the lecture hall, the ISS scholars were shown through the many research labs of the School of Physics, and had a guided tour of the Electron Microscope Unit. They participated in a live psychology experiment in a talk by Dr Caleb Owens, competed for prizes and glory in the University of Newcastle's Science and Engineering Challenge, and cheered through the incomparable Dr Karl Kruszelnicki's *Great Moments in Science*.

Add in the harbour cruise, the quiz night, the bush dance and the antics of the talent competition... well, in the words of one of the scholars, "I'm still carrying the memories of the science school, it was totally an awesome experience!"

Webcasts

The two weeks may be over, but the ISS lives on – anyone, anywhere in the world, can view the entire lecture series on-line through the International Science School Webcasts.

In the 60s and 70s, the Science School lectures were telecast on Channel 9 and the ABC, taking the ISS experience out of the Slade Lecture Theatre and into people's living rooms. Today, internet technologies allow interested people around the globe to tune in to watch talks by leading researchers about cutting edge science: just point your browser of choice to www.scienceschool.usyd.edu.au

Supporters of the ISS2005

We couldn't run even a single day of the International Science Schools without the generosity of our supporters, including the many people who have given to the Messel Endowment. To everyone who gave their time, money and effort to the 33rd ISS, our warmest thanks:

The Messel Endowment

(a full list of donors can be found at www.physics.usyd.edu.au/messel/index.htm)

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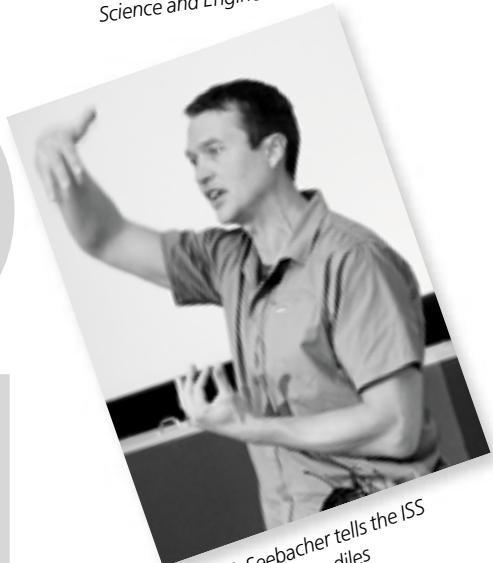
Dr Jenny Nicholls

ISS 2005



Scholars competing in the University of Newcastle's Science and Engineering Challenge

“ What sweet memories! They were brightest pages of my life! I want to say thank you very much for organizing so wonderful program, I really enjoyed it very much! I LOVE ISS!! ”
(Japanese ISS Scholar)



Dr Frank Seebacher tells the ISS how to track crocodiles

“ From the reaction of the students, there can be no doubt about the enormous value of this endeavour... it is extremely rewarding to feel the enthusiasm from the audience, and to have the chance to interact with such keen young people. ”
(Prof. David Cockayne, Oxford University, ISS lecturer)

“ The ISS of 2005 was one of the best experiences I've had in my life. The activities were great and the lectures were even better, I've taken a lot away from the school and I just hope that I can repay a fraction of what I have learnt back to it someday. ”
(Qld ISS Scholar)



Prof. Harry Messel addresses the crowd at the ISS opening ceremony



The 139 Scholars of Waves of the Future



Profile: Nancy Shoemaker

All The Way (to Sydney) with LBJ

Alumni News spoke with Nancy Shoemaker, Messel Ednowment supporter and one of the first American 'Lyndon B. Johnson Australian Science Scholars' to attend the International Science School in 1967. Nancy is once again supporting the Science Schools by attending a special reception for US based ISS Alumni, to be held in the Australian Consulate in New York on 10 November 2005.*



Nancy Shoemaker

Nancy, how did you feel about being named as one of the top science scholars in the USA in 1967?

I was honored to be part of such a remarkable group. I'll admit to having slipped in with an "aptitude" rather than the "achievements" of some of the others. I applaud the vision of Professor Messel and others involved with the school to realise the benefits of challenging high school students with such high level programs!

The ISS runs for two weeks every two years – given it's really a very short period of time to be involved with something, why do you think people who attend are so attached to the ISS?

For me, the whole trip was layer upon layer of new experiences and new friends. I don't think I'd met anyone with a PhD before, and here I was sitting in lectures and having informal chats with world class scholars. My wonderful host family introduced me to passionfruit, surfing, and a culture that seemed the same on the surface, but was in many ways so different from the suburbs of western Massachusetts. I look back on the ISS as a bridge to adulthood that had a profound effect on my confidence in many areas, not all of them academic.

Is there a particular memory of the ISS that has stuck with you over the years?

When I think of the Science School, I remember the energy of the lecture hall – the intense concentration that came from every corner. There was a particular point when a student caught Glenn Seaborg [Nobel Prize for Chemistry, 1951] in a small error at the blackboard, and that seemed to crystallize the "community of scholars" sense of the group. Though we were young, we'd been told our reasoning was sound, and we were ready to build on our potential and join the scientific conversation.

You obviously had a great ability and interest in science – where did this lead you, in your professional and personal life?

Well ... I majored in mathematics and went on to a PhD and a few years of the college teaching that I had planned. But in my early 30s, I revisited what I wanted from my work, and took a turn away from academia to work in computer support. I've found that challenging and rewarding, and now have my own consulting business, primarily helping small nonprofit organizations make better use of the Internet and related technologies. I've never regretted the time spent in mathematics, and the lessons I learned on how to tackle problems have served me well. I do, however, spend a great deal of time supporting the American Association of University Women and their efforts to ensure that girls and women have full access to opportunities in science and math. While I finally did "drop out" of math at 31, I work to ensure that no girl is tempted to quit at 13!

You'll be attending a special reception for US based ISS Alumni in the Australian Consulate on Thursday 10 November 2005. Are you looking forward to catching up with Prof. Harry Messel and fellow ISS Alumni after all this time?

It will be wonderful to thank Professor Messel in person – after all these years – for what was such a life-changing experience. The generosity of the program was truly humbling. I'm also looking forward to catching up with Ellen Gesmer, my roommate during the US contingent's travels – it's been years since we've seen each other. I do hope this event can help to rebuild connections. If anyone knows Laurelle Morris or Helen Perry, Cremorne Girls' High, please give them my love and my e-mail address: shoemaker@acm.org.

Finally, any words of wisdom you can offer to younger ISS Alumni?

Just to expect the unexpected and enjoy the journey! And keep those e-mail address books up to date so you can find each other in 30 years!



The book cover from the 1967 Science Summer School

*See Page 7 for more information on the Messel Endowment.

Gala Reception Delights ISS Scholars and Supporters

When you're announcing the inaugural winners of two major new awards, you should do it in style – which is why friends, supporters and scholars past and present of the International Science Schools donned their best evening wear for the Waves of the Future Gala Reception, in the University's beautiful Great Hall on 13 July.



The Hon Dr Brendan Nelson with the two award winners, Mathew Dunstan (left) and Chang Lian (right)

As major sponsors of the Messel Endowment to fund the Science Schools in perpetuity, Mulpha Australia and the Department of Education, Science and Training each established an award to honour leadership amongst the ISS Scholars.

The Hon Dr Brendan Nelson, Minister for Education, Science and Training presented The Len Basser Prize for Scientific Leadership, named in honour of the late Len Basser, a high school science teacher who encouraged and inspired several prominent Australian scientists with his teaching methods, including Lord Robert May.

Chinese student Chang Lian was awarded the Len Basser Prize for his combination of originality of thought and willingness to assist others in participating in the ISS. In presenting the prize, Dr Nelson observed, "This [prize] is a self-discovery of qualities which Len Basser nurtured. The Len Basser Prize for Leadership in Science is a unique award, and a new and important element of the International Science School."

Mr Seng Huang Lee, Executive Chairman of Mulpha Australia Ltd, presented the Mulpha International Science School Award for Leadership to Matthew Dunstan from NSW. This award recognises the international kinship fostered through the ISS and is awarded to a student who displays diplomacy, friendship, encouragement and understanding of ISS students from all cultures.

The reception was a wonderful opportunity for supporters and alumni of the ISS to meet the 2005 scholars and hear first hand about the influence the ISS has on these outstanding students.

The ISS Scholars enjoyed talking to many of the generous benefactors whose support of the Messel Endowment has made the goal of continuing the ISS in perpetuity a little more tangible.

The Messel Endowment Capital Campaign was launched in 2004 to fund the ISS in perpetuity. The Endowment's target is to raise \$4.5 million by June 2006; to date approximately \$2.8 million in gifts and pledges has been raised.

Ongoing support for the **Messel Endowment** is crucial. For more information on how you can contribute please contact **Alison Thorn** of + 61 2 9036 5194 or **email** a.thorn@physics.usyd.edu.au

US Alumni – New York Calling!

The Australian Consul-General in New York, The Hon Kenneth Allen AM, is once again playing host in support of the International Science Schools and the Messel Endowment. With the assistance of 1962 ISS alumnus and MIT Professor Greg McRae, a special reception for US based alumni is being held on Thursday 10 November at the Australian Consulate. All ISS alumni based in the USA are invited to attend what is sure to be a prestigious event. Guest of honour Professor Harry Messel CBE is looking forward to catching up with as many alumni as possible.

For more information please contact **Alison Thorn** on +61 2 9036 5194 or, if based in the USA, please **email** Fiona.Gosschalk@dfat.gov.au. Please note that it is essential to RSVP so if you have not received an invitation to this free event, please contact us as soon as possible.

Science Fair Goes Off at Sydney Uni Live



The crowds at the hands-on physics area at Sydney Uni Live

Amidst leaping metal rings, levitating superconductors and hair-raising static electricity, the winners of the first School of Physics Science Fair were announced at *Sydney Uni Live* in August.

School students in and around Sydney were invited to submit an entry to the Fair – an invention, and experiment or a scientific model – and the finalists were asked to present their entries to a panel of judges at the University open day. Then, in front of a packed auditorium,

Dr Karl Kruszelnicki presented the grand prize pack, including an Apple iPod, to Barker College's Tristan Howes for his wind-tunnel project. Runners-up Thomas Jackson, also from Barker College, and Saeed Barwar from Birrong Boys High also received prize packs from Dr Karl.

Given the quality of entries in this first-ever Science Fair, we're confident the contest will be back bigger and better in 2006!



Where are you now?

Alumni report on themselves

Melanie Fitzpatrick

(Bsc 1989)

Melanie Fitzpatrick is currently teaching survival skills to scientists and wintering station personnel at Australia's Antarctic bases. Melanie followed her BSc in Physics and Chemistry at Sydney with an Honours degree in Geophysics at ANU, then spent much of the

next ten years as a field Glaciologist with the Australian Antarctic Division. As well as regularly instructing in Antarctica, Melanie is completing a PhD in Glaciology at the University of Washington in Seattle. She was awarded a NASA Global Change Fellowship for this work and plans to defend her thesis in June 2005.

We welcome contributions to this column

Dr Karl at large

Not by a long sight

"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?" said astronomer Johannes Kepler (1571-1630) of the mighty "light bucket". Most of us have been led to believe we've got Galileo to thank for its invention, but there are many contenders for the title of "Inventor of the Telescope".

A basic telescope has two quite different lenses. The light goes in through a shallow, weak convex lens (thicker in the centre than at the edges) with a long focal length. The light comes out into your eye through a steeply curved, strong concave lens (thicker at the edges) with a short focal length. About AD1000, the brilliant Arabian astronomer and mathematician, Ibn al-Haytham (or Alhazen) wrote about concave lenses in his ground-breaking mathematical book on vision. The Oxford scholar and Franciscan monk Roger Bacon (1214-1294) wrote about combining lenses to see at a distance, as did the Italian spectacle-maker Giovanni Battista Della Porta (1538-1615) and a host of others.

But the first documented working telescope was delivered by Hans Lippershey, a spectacle-maker from Middelburg, in the southwest of Holland, to Prince Maurice of Nassau in The Hague in the last week of September 1608. Within three weeks, two other spectacle-makers turned up in The Hague to try to sell what they thought was their unique invention. Word spread rapidly across Europe and by May 1609, while Galileo was professor of mathematics at the University of Padua, he heard of the new device and quickly worked

out how to make his own. Soon he had made an 8-power telescope (that would magnify an image eight times) and a 20-power telescope. With this last telescope, he proved that Aristotle was wrong in saying the Moon was perfectly smooth, as he could see mountains there "full of vast protuberances, deep chasms and sinuosities". He also showed that the Sun had sunspots on its surface, and proved that not everything in the Universe orbited Earth, when he tracked the motions of Jupiter's four largest moons – and showed that they orbited Jupiter. He then discovered that Venus went around the Sun (not the Earth) by observing the Sun's shadow on Venus's surface.

So how did Galileo get the reputation of inventing the telescope? I'm not sure, but he was one of the first people to make great discoveries with it, and he was a towering intellect, so perhaps people automatically assumed he invented it. 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, and even a "geometric and military compass" that helped cannon gunners work out how much gunpowder to load, and at what angle to elevate their weapon.

But while Galileo used the telescopes he built to cement his reputation as a great astronomer, this was only after he'd heard of other people's breakthroughs.

This story appears in Dr Karl's 24th book 'Dis Information and other wikkid myths', due out in early November 2005.



Dr Karl presents the Science Fair grand prize to Tristan Howes – see page 3.

Alumni News



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