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Cover: The Turbulence Energy and Combustion Group at the University of Adelaide has built a state of the art laser laboratory with custom designed lasers (a Quantel YG series Nd:YAG pumped TDL90 tuneable dye laser system with dual wavelength output) and camera systems (three Princeton Instruments PI-MAX intensified CCD camera systems). For more information see page 16.

Contributions should be sent to
Corinna Horrigan, Editor
The Physicist
PO Box 3497
Parramatta NSW 2124
Tel: 0417 775 109
thephysicist@aip.org.au

Design, Artwork & Printing
Scott Williams
Cliff Lewis Crompton Printing
91-93 Parrawane Road
Caringbah NSW 2229 Australia
Tel: 02 9525 6588
Fax: 02 9524 8712
scott@clp.com.au

Advertising Enquiries
Mrs Leigh Wallbank
PO Box 70,
Oyster Bay 2225
NSW Australia
Tel: 02 9528 4362
Fax: 02 9523 9637

Published 6 times a year, on behalf of the Australian Institute of Physics by Cliff Lewis Crompton Printing Co. Pty. Ltd., Copyright 2003 Pub. No. PP 224960 / 00008 ISSN 1036-3831

The statements made and the opinions expressed in The Physicist do not necessarily reflect the views of the Australian Institute of Physics or its Councils or Committees.
PRESIDENT’S COLUMN

It is a great honour to take over as President of the Australian Institute of Physics in this the Einstein International Year of Physics 2005 (EYYP). I appreciate the work of Rob Elliott, the outgoing president, and look forward to working with him and the rest of the executive during the term over the next two years. As the Einstein International Year of Physics gets under way, I will be working with our new Vice President, Cathy Foley, to make sure that 2005 is a memorable year. Thanks to financial support from DEST, the AIP has engaged the services of Niall Byrne and his team at “Science in Public” to manage media relations. This has already resulted high profile media appearances and we hope to link up with many existing activities to give them an Einstein International Year flavour.

Working with the AIP, Niall and his team have already set up a stakeholder list for bulletins of forthcoming EYYP activities, including the announcement of a scheme to fund initiatives for the year. Activities the AIP has funded in the first round, announced in October 2004, include support for the Science film competition, funding for travelling physics shows targeting schools in South Australia and Queensland and the Flowvis art exhibition. If you did not see Flowvis at the Congress, look out for it when it comes to your state. Melanie O’Byrne has done a terrific job putting together an exhibition of spectacular images portraying everything from magnetohydrodynamic flows in interstellar space, tidal bores in rivers and convoluted sub-nuclear fluids forming skyrmions. We have also provided funding for Craig Savage and his team at the ANU to produce a DVD resource pack showing computer simulations of relativistic phenomena. Those of you who have seen examples of Craig’s work will know there will be spectacular material on this DVD. An advertisement for a second round of EYYP activities appears elsewhere in this issue. As a result of these activities, throughout 2005 and beyond, we hope to make the AIP the most highly visible champion of Physics in Australia.

And just what is the state of Physics in Australia? Having just been at the Congress, where nearly 1000 delegates gathered in close to the largest Congress ever, I would have to say Physics is looking strong! Congratulations to Ken Baldwin and his team for running such an excellent Congress. It was good to see the high level of interest in the Physics Education Group sessions - there was standing room only in the theatre for Mario Zadnik’s lecture on “Changing times – changing teaching”. Cathy Foley’s interesting review of the status of women in physics in Australia and overseas was also delivered to an overflow theatre. On this topic, I would like to congratulate the three physics Federation Fellows who have recently given birth. My best wishes for combining the demanding tasks of raising children with a career in Physics!

Participation at the Congress is not the only sign Physics is doing well in Australia. Dan O’Keefe presented a very interesting Annual Education Report to the AIP Council meeting showing the participation in Secondary School Physics over the period 1975-2003. Keep it in mind that in 1975 (I admit, this was when I was studying Y12 Physics at secondary school!), about 70% of 17 year olds were enrolled in “workforce 101” and were not actually present in the School cohort. When the workforce 101 cohort, which is below 25% and falling, is included in the analysis, the data reveals a picture of the enduring popularity of Physics. Dan shows that over the period 1975-2003, when calculated as a fraction of all individuals in the age group 16-18 years of age, the fraction studying Physics has held up remarkably well. In fact the fractions in NSW and Victoria show an overall upward trend. This is a very encouraging sign.

During 2003 and 2004 I had the opportunity to visit many University Physics Departments in Australia as part of the AIP course accreditation team. I always found these visits interesting and it was a pleasure meeting fellow professionals with a passion for Physics. With Cathy Foley from the CSIRO serving as our Vice President, I look forward to greater involvement of the AIP in government and Industrial laboratories.

David Jamieson

More information:
EDITORIAL

A change is not always as good as a rest...

As I have mentioned before, I worked at CSIRO for many years – 21 in all. It was pleasant to catch up with many of my CSIRO colleagues at the Physics Congress. Of course we chatted about the way it used to be and about the way it is now. So I learned that CSIRO Telecommunications and Industrial Technology is about to undergo a major review.

I wasn’t at all surprised. When I began working at the Lindfield site, it was the National Measurement Laboratory. Since then it has gone through many name changes, mergers, demergers, chiefs and organisational styles. Each change seemed to be accompanied by a review. This was in addition to any internal reviews that the Division carried out. During my time working there, it felt as if we were always either undergoing a review, about to be reviewed or had just finished being reviewed.

Now, I agree that every organisation needs to be reviewed with some regularity, but this is not the same as continuously. Surely when it begins to feel like that, it has become detrimental to both productivity and morale. And perhaps this leads into a spiral of more reviews and more changes.

Doubtless this rage to review isn’t peculiar to TIP or even to CSIRO – it appears to be a favourite pastime for some organisations and government agencies. It is certainly a good way of giving the appearance of doing something. To quote Petronius: “I was to learn later in life that we tend to meet any new situation by reorganising; and a wonderful method it can be for creating the illusion of progress while producing confusion, inefficiency, and demoralisation.”

Perhaps it’s time to let CSIRO have a period of stability.

... but does have a place.

At least I hope so. There will be changes to The Physicist this year. Not only are we going to get a new look (not this issue, but soon), but I’m going to start semi-regular sections on Physics Education and possibly some of the other groups within the AIP, such as Women in Physics.

Some years ago, the Physicist had a regular Education supplement and I think that a revival is timely. The Education stream at the Congress was always well attended, so there is certainly interest and, judging by the presentations I attended, there is plenty of material. Hopefully, some of it will find its way into this publication.

In this issue: Brian Sowerby and James Tickner were awarded the Alan Walsh medal for their work on a scanner that uses fast neutron and gamma-ray radiography to detect contraband in air cargo containers. As well as presenting a talk at the Congress, they have written about it for The Physicist. As I attended the Congress, I thought I would give my view of it and include some of the photos that I took.

There are also calls for nominations for a number of prizes, including the Boas and Bragg medals.

Deadline for next issue: 8th April
Dear Editor,

May I pass on my congratulations to the AIP executive on its revision of the fee structure, which had the aims of “reducing costs” and “minimizing the burden on retirees”, but which then increased the fee for retired fellows by 66%. Even though my research area is ‘spin’ resonance I remain unconvinced.

Yours Sincerely,
Don Hutton, Retired Fellow.
This issue was mentioned by many people and was addressed at the AIP Council meeting held at the Congress and that the cost to retirees has been reduced considerably. The retired member’s fee was set at 50% of the actual fee up to a maximum equivalent to the Associate rate, which is currently $80. A retired member therefore pays $70 and a retired Fellow pays $80.

EDUCATION

The Society of Physics, Astronomy, Cosmology and Experimental Deeds - SPACEC - is the official student organisation for physics and astronomy at the University of Adelaide. Formed in 2000, it embraces students from all backgrounds and aims to involve its members in every kind of social and discipline-related activity. Past events that have been organised by SPACEC include:

- BBQs
- Lectures
- Observatory and Planetarium Visits
- Dinners and Functions
- Quizzes

In addition, SPACEC hosted an afternoon where members of the university community were able to observe the 2004 transit of Venus. As nearly 150 people attended, one was left wishing such a phenomenon occurred more often!

With the support of the South Australian branch of the Australian Institute of Physics and the Adelaide University Physics Department, SPACEC has, for the past five years, ensured that there is an ongoing student presence in the local physics community. As the 2005 International Year of Physics begins, SPACEC is busily planning for the next twelve months. As well as increasing the frequency and variety of events already in place, we plan to do more to involve other universities and the general public in physics. We plan to host a series of public lectures aimed at informing people about the history of physics, both locally and internationally and to forge stronger ties with established physics related bodies such as the AIP. Most importantly, we hope to dramatically increase the level of interest and passion with which students approach physics.

Currently, SPACEC is the only student-run physics or astronomy body in South Australia. No similar organisation currently exists at any of our other universities. While student involvement in physics is by no means heading towards extinction, it could certainly benefit from a shot in the arm. With this in mind, I would like to ask the physics community of Australia to do what it can in 2005 to help local student physics clubs and societies. Help to organise events aimed at increasing the wonder and joy that students find in the most fundamental of the sciences; answer more questions and challenge students to seek even more answers themselves. Above all, do what you can to encourage and foster a fascination and love for physics in every student you meet. The students of today will be the physicists of tomorrow. Help them ensure that the 2005 celebration of physics won’t be lost the world sees.

Wade Shiel.
President, SPACEC

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The Einstein Year presents an opportunity to raise awareness of physics and the fundamental role it plays in society. It is a chance to celebrate all that is known about the world around us, and all that is yet to be known.

The Australian Institute of Physics is inviting applications for seed funding from individuals and organisations who are planning outreach activities on the theme of the Einstein International Year of Physics 2005.

Grants of up to $3,000 are available.

To apply, send a one page proposal outlining:

- what your event is,
- who the audience is,
- what other support you have (in-kind or financial),
- when you are expecting to hold the event, and
- your contact details.

Priority will be given to events aimed at taking physics into the wider community and events that have a wide reach (this includes potential for media coverage).

The AIP recommends applicants consult with their state AIP branch before applying. Contact details online at www.einstein2005.org.au.

Proposals to be emailed to: einstein@aip.org.au

Closing date is Friday 18 March and we anticipate finalising winners by the end of March.
**SAMPLINGS**

PhysicsWeb - Highlights of the year

As the physics community gets ready to celebrate the centenary of Einstein's papers on relativity, the quantum theory of light and Brownian motion, many of PhysicsWeb's highlights of 2004 can be traced back to what Einstein did in 1905. Other highlights include evidence for ancient water on Mars, advances in low-temperature physics and the world's smallest atomic clock.

1. **Pure and applied quantum physics**

2004 was the year in which quantum cryptography was used in a commercial transaction for the first time. On 21 April the Mayor of Vienna transferred money from the City Hall to Bank Austria Creditanstalt over a fibre-optic cable using a quantum "key" made of single photons to ensure that the transfer was completely secure. At present classical keys - essentially random numbers that must be kept secret by the two parties involved - are used to keep such transactions secure.

The quantum key was generated at the bank by using a crystal to convert photons from a laser into "entangled" pairs of photons: one photon in every pair remained at the bank while the other was sent to the City Hall. By measuring the polarizations of the photons, the two parties were able to generate identical strings of ones and zeros that could be used as the key.

In addition to relying on quantum mechanics rather than computer algorithms to generate the keys in the first place, quantum cryptography has the added advantage that eavesdroppers can be easily detected. In December several of the groups involved in the Vienna experiment shared the European Union's Descartes prize for their work on quantum cryptography.

Elsewhere quantum physicists notched up a series of experimental breakthroughs in fundamental research with entangled states containing up to five photons being produced, atoms being teleported for the first time, and the boundary between the quantum and classical worlds being explored with carbon-70 molecules.

2. **Putting general relativity to the test**

In January, radio astronomers in Australia and in the UK reported that they had discovered the first double pulsar system. Pulsars are extremely dense, rapidly rotating neutron stars that are a million times more massive than the Earth, but measure just tens of kilometres across. The discovery will allow physicists to perform the most stringent tests of Einstein's general theory of relativity to date.

April saw the launch of Gravity Probe B, which has been designed to test two predictions of general relativity: the Lense-Thirring effect and the geodetic effect. The former is caused by massive bodies such as stars and planets "dragging" space-time with them as they rotate, while the latter is due to the distortion of space-time caused by the body. The first results from the mission are expected in 2006.

In October, however, physicists in Italy and the US reported that they had used existing satellite data to measure the Lense-Thirring effect with an accuracy of 10% and that their results agreed with the predictions of general relativity.

3. **Good year for planets**

2004 was a busy year on Mars with two rovers, Opportunity and Spirit, landing on the red planet and Mars Express going into orbit around our near neighbour. All three missions found evidence for ancient water on Mars - a feat that was selected as the breakthrough of the year by Science magazine.

Images from Opportunity revealed numerous layered outcrops, similar to sedimentary rocks on Earth, suggesting that liquid water had once flowed through the rocks, while Spirit found that water may have altered volcanic rocks at Gusev crater. Meanwhile the OMEGA instrument on board Mars Express obtained the first direct evidence for frozen water on the surface of Mars by analysing the spectrum of sunlight reflected from the planet.

Elsewhere astronomers discovered Sedna, the most distant object ever seen observed in the solar system - a fact that was selected as the top story of the year by Astronomy magazine. And still further away, three separate teams discovered three planets that are between 10 and 20 times as big as the Earth. These "super-Earths" are the smallest of the 140 or so extrasolar planets detected so far.

4. **Supersolid helium**

Physicists at Pennsylvania State University in the US created a new "supersolid" phase of matter by cooling helium-4 to ultracold temperatures. Supersolid helium-4 behaves like a superfluid -- a liquid that flows without resistance -- but has all the characteristics of a crystalline solid. Liquid helium-4 displays superfluidity when it is cooled to below about 2 Kelvin. The Penn State experiments, which were carried out at a range of pressures between 26 and 66 bars, show that solid helium-4 becomes a superfluid at temperatures below 230 millikelvin. Superfluid behaviour has now been observed in all three phases of matter - gas, liquid and solid.

5. **Ultracold Fermi gases**

In July physicists at Innsbruck in Austria reported the strongest evidence to date for superfluidity in an ultracold gas of fermionic atoms when they observed the "pairing gap" in an ultracold Fermi gas for the first time. The observation of a similar gap in low-temperature superconductors in the late 1950s was a major milestone in the quest to understand these materials.

The new results, which agree with theoretical calculations by a second group in Finland, could help us understand more about high-temperature superconductivity and systems as diverse as exotic neutron stars, atomic nuclei and quark-gluon plasmas. The gap was observed in experiments on "fermionic condensates", a new state of matter that was reported for the first time by a group in the US in January.

6. **Physicists target viruses**

Most physicists are used to detecting inanimate objects such as photons and electrons, but this year saw increased interest in the detection of living objects such as viruses. Different teams in the US modified a range of existing devices -- including field-effect transistors, atomic force microscopes and both nanoelectromechanical systems and magnetic sensors -- so that they could detect single viruses.

Meanwhile a team in France demonstrated the first purely electronic technique for detecting DNA by measuring the intrinsic charge of the molecule with an array of silicon transistors.

7. **Electrons in a spin**

The spin Hall effect, which causes "spin-up" and "spin-down" electrons to build up on opposite sides of a sample in the presence of an electric field, was observed for the first time this year. The ability to manipulate electron spins with an electric field rather than a magnetic field could prove useful for making "spintronic" devices that manipulate spin rather than charge.

Meanwhile physicists imaged the spin of an individual electron for the first time by combining magnetic resonance imaging with atomic force microscopy. This breakthrough was selected as the top physics story of the year by Physics NewsUpdate.

Finally, researchers in Switzerland and Sweden used a scanning tunnelling microscope to add and remove single electrons from individual gold atoms on a surface. The technique could ultimately lead to memory devices that store each bit on just one atom.

8. **Liquids go against the flow**

Solids usually melt when they are heated but in September French physicists reported that a simple solution composed of two organic compounds becomes a solid when it is heated...
and a liquid again when cooled. The team says that hydrogen bonds are responsible for this novel behaviour.

Meanwhile physicists in Japan confirmed that liquids can exist in more than two different states at the same time -- contrary to what is commonly believed. The results suggest that liquid-liquid transitions can occur in any liquid.

Finally, another Japanese group found that strong magnetic fields can slightly increase the melting point of water. This result was unexpected because water is diamagnetic and therefore should not be affected by a magnetic field. Again, hydrogen bonds are thought to be responsible.

9. Smallest atomic clock

For more than 50 years, atomic clocks have set the gold standard for time and frequency measurement but their applications have been limited by their complexity, size and expense. Now physicists in the US have built a "atomic package" -- the components that lie at the heart of an atomic clock -- that is 100 times smaller than those in existing atomic clocks and several orders of magnitude more stable than conventional devices such as quartz crystal oscillators. The new clock opens the way for atomic-level timekeeping in portable, battery-operated systems such as global positioning receivers and wireless communications.

10. Particles and prizes

In 2004 particle physicists continued to report results that agreed with the Standard Model, such as the first observation of parity violation in collisions between electrons at Stanford, as well as results that required new physics beyond the model. The latter included the most precise measurement to date of the anomalous magnetic moment of the muon at Brookhaven and evidence for antineutrino oscillations from the KamiLAND experiment in Japan.

However, the particle physics community was split over the existence of exotic particles that contain four quarks and an antiquark. First reported in 2003, roughly half of the experiments that have looked for "pentaquarks" to date have seen them, but the rest have not.

Elsewhere the particle physics community decided to design the international linear collider using cold or superconducting technology, although a decision on whether to go ahead and build the collider is not expected before 2010. Meanwhile three particle theorists -- David Gross, Hugh Politzer and Frank Wilczek -- shared the Nobel Prize in 2004 "for the discovery of asymptotic freedom in the theory of the strong interaction".

And finally: The physics of everything

As always, physicists did not restrict themselves to physics during 2004. Spiders, archaeology, Brazilian football and the EU constitution were just some of the topics to attract the attention of the physics community during the year, while in August a bookmaker in the UK turned the tables and offered odds on various breakthroughs happening by 2010.

List compiled by Peter Rodgers, Editor of Physics World and Belle Dumé, Science Writer at PhysicsWeb

Devices controlled by thought move closer

Scientists in the US have shown that "electroocorticographic" signals from the brain can be used to manipulate an external device. The techniques developed by Daniel Moran of Washington University in St Louis, Eric Leuthardt from the Barnes-Jewish Hospital, also in St Louis, and colleagues could ultimately lead to artificial limbs that can be controlled by thought alone (E C Leuthardt et al. 2004 J. Neural Eng. 1 63).

Studies on animals have shown that specific nerve cells become active just before the animal makes a certain movement. By processing the electric signals from these cells it is possible to predict the movement before it is actually made. The same information could also be used to make an artificial limb perform the same movement.

Moran and colleagues measure the neuronal signals by placing a grid of electrodes directly on the surface of the brain. This method, known as electrocorticography (ECoG), is routinely used to monitor and control seizures in patients with epilepsy. It provides much better signals than electroencephalography, in which the electrodes are placed on the scalp, and is much less traumatic than procedures in which the electrodes actually penetrate the brain.

Leuthardt, Moran and co-workers asked four volunteers -- who were already wearing the electrodes -- to perform certain movements that included opening and closing their hands and sticking out their tongue. During this time, the scientists identified which brain signals were associated with each of the different movements.

Next, the patients were asked to attempt to control a cursor on a computer screen by imagining it to make these movements. This relied on a computer program called BC12000 that had been developed by team member Gerwin Schalk at the Wadsworth Center in New York. After just a few minutes of training, the patients were able to control the cursor using their thoughts with an accuracy of over 70%.

Leuthardt said that the ability to operate a prosthetic device using the electric signal of the brain was rapidly leaving the realm of science fiction and becoming a realistic goal of the scientific community.

PhysicsWeb

Winters warm up

The heat wave that hit Europe in the summer of 2003 resulted in thousands of deaths in France, Italy and several other European countries. However, a new analysis by a Swiss climate scientist has shown that the temperature changes that occur at high altitudes during the "warm winter spells" are even larger than those that happen during the summer (Geophys. Res. Lett. 32 L01812).

Martin Beniston of the University of Fribourg analysed data from 11 climate recording stations in Switzerland and found that the incidence of warm winter spells has increased since 1970. In 2003, for instance, the average temperature recorded at Saanits, a town in the northwest of Switzerland, was 15°C above the seasonal average during the winter, compared with 11.5°C for the summer. A similar pattern was observed in data from other stations. Moreover, climate simulations for the period 2071–2100 suggest warm winter spells are going to become more common.

Beniston says that these anomalies could be caused by the North Atlantic Oscillation or Atlantic El Niño -- a cyclic pattern of atmospheric pressure variability that affects the weather of North America and Europe.

PhysicsWeb

Astronomers find smallest exoplanet

Alex Wolszczan of Pennsylvania State University and Maciej Kozaci of the California Institute of Technology have announced the discovery of the smallest extrasolar planet to date. The new planet, which is about one fifth the size of Pluto, is the fourth planet to be discovered orbiting around a pulsar called PSR B1257+12. The orbits of the planets around the pulsar are like a scaled-down version of the Solar System, even though the central stars in the two systems are completely different.

The existence of the pulsar planets provides strong evidence that Earth-mass planets can form just as easily as the much larger gas giants which are known to orbit around more than 5% of nearby Sun-like stars. However, the formation of Earth-like planets requires special conditions, making such planets a rarity, says Wolszczan.

Pulsars are rapidly rotating neutron stars that are formed from the collapsed cores of supergiant stars that have exploded as supernovae. Typically they measure just 20
kilometres across, but are extremely dense and send out highly regular beams of radio waves that are detected as a series of pulses on Earth.

The presence of an object like a planet will cause small changes in the arrival times of the pulses. The new planet was discovered with the Arecibo radio telescope in Puerto Rico.

**Novel molecule makes its debut**

Physicists in Switzerland have observed a novel type of molecule known as an exciplex - short for excited complex - for the first time. Antoine Weis, Daniel Nettels, Peter Morokhin and colleagues at the University of Fribourg have seen evidence for an exciplex that contains one caesium atom and seven helium atoms, as well as a simpler version that contains just two helium atoms (D. Nettles et al. 2005 Phys. Rev. Lett. 94 063001).

Until recently it was thought that exciplexes containing more than two helium atoms could not exist.

Exciplexes are molecules that can only exist if one of the atoms in the molecule is in an excited state. If this atom returns to its ground state the exciplex falls apart. For example, alkali atoms and helium atoms strongly repel each other in their ground state at short distances because of the Pauli exclusion principle. However, if the alkali atom is excited by a laser, for example, the force between the atoms becomes attractive and an exciplex molecule can form.

The first alkali-helium exciplexes were observed in 1995, and since then they have been seen in liquid helium, cold helium gas and on the surface of helium nanodroplets. Now, the Fribourg team has detected exciplexes in solid helium for the first time.

**The biggest bang**

Astronomers have detected the brightest ever event from outside our Solar System. The event occurred on 27 December last year and was so powerful that it was seen over a wide range of wavelengths by a number of space-based and ground-based telescopes. The event was brightest at gamma-ray wavelengths and has been linked to a magnetar - a spinning neutron star with a strong magnetic field - called SGR 1806-20 in the constellation Sagittarius about 50,000 light years away.

The blast was detected by several spacecraft, including NASA's Swift (which was launched last November to study gamma-ray bursts), Wind and RHESSI, as well as ESA's INTEGRAL. The afterglow was observed by ground-based radio telescopes, including the Very Large Array in New Mexico and the Australian Compact Array.

Neutron stars are extremely dense stars that are heavier than the Sun but measure just tens of kilometres across. Magnetars are a special type of neutron star that have extremely strong magnetic fields - 1,000 times stronger than ordinary neutron stars, and 1012 times stronger than the Earth's magnetic field.

Of the 13 magnetars discovered to date, four are known as "soft-gamma-ray repeaters" because they occasionally flare up and emit gamma-ray flashes. The event observed in December, which might have been caused by a quake in the star's crust or an eruption on its surface, was one such event. It released more energy in a tenth of a second than the Sun emits in 150,000 years.

The explosion could solve the mystery of short-duration gamma-ray bursts, which last for less than two seconds, as opposed to the "long" events that can last for minutes. Hundreds of brief, high-energy flashes of radiation from far beyond our galaxy have been detected in recent years but astronomers are unsure of their exact origins.

**Have we seen the first "dark galaxy"?**

Radio astronomers may have found the first ever galaxy that is made almost entirely of dark matter. The 'dark galaxy', which lies in the Virgo cluster about 50 million light years away, rotates in the same way as an ordinary galaxy but does not contain any stars (R. Minchin et al. Astrophysical Journal at press).

Dark matter was originally proposed to explain why galaxies rotate much faster than can be explained by the amount of visible matter they contain. This mysterious form of matter does not emit or absorb electromagnetic radiation - hence the name "dark" - and can only be detected by its gravitational influence on ordinary matter. Overall the universe is thought to contain about 5% of ordinary matter, 25% of dark energy and 70% of dark energy. Although various types of new particle have been proposed to explain the dark matter, the nature of the dark energy remains a complete mystery.

Recent advances in radio astronomy have allowed researchers to carry out large surveys of the amount of hydrogen in various parts of the universe. This allows them to detect astrophysical structures by their gas content alone, rather than by the light emitted by the stars they contain. This has opened up the possibility of finding isolated clouds of intergalactic gas with no stars.

The galaxy, called VIRGOH21, was detected last year during a survey of the Virgo cluster of galaxies using the Lovell telescope at Jodrell Bank Observatory. Now, Robert Minchin and colleagues at Cardiff, together with co-workers in Italy, France and Australia, have studied this galaxy in more detail.

Based on the speed at which it is rotating, Minchin and co-workers calculate that VIRGOH21 is a thousand times more massive than can be accounted for by the amount of hydrogen it contains. Moreover, if it was an ordinary galaxy it should be bright enough to detect at optical wavelengths.

Although similar dark objects have been detected before, they were later found to contain stars or debris from nearby visible galaxies. In contrast, VIRGOH21 contains no stars, as confirmed by observations with the Isaac Newton optical telescope in La Palma.

**Complex Hybrid Structures**

Complex hybrid structures, part vortex ring and part soliton, have been observed in a Bose-Einstein condensate (BEC) at the Harvard lab of Lea Vestergaard Hau. Hau previously pioneered the technique of slowing and then stopping a light pulse in a BEC consisting of a few million atoms chilled into a cigar shape about 100 microns long.

In the new experiment, for the first time, two such light pulses are sent into the BEC and stopped. The entry of these pulses into the BEC set in motion toroidal-like vortices. These vortices are further modulated by solitons, waves that can propagate in the condensate without losing their shape. The resultant envelope can act to isolate a tiny island of superfluid BEC from the rest of the sample.

The dynamic behavior of the structures can be imaged with a CCD camera by shining a laser beam at the sample. Never seen before, these bizarre BEC excitations sometimes open up like an umbrella. Two of the excitations can collide and form a spherical shell (the vortex rings taking up the position of constant latitude). Two such rings, circulating in opposite directions, will co-exist for a while, but after some period of pushing and pulling, they can annihilate each other as if they had been a particle-antiparticle pair.

Hau (hau@physics.harvard.edu) and her colleagues have devised a theory to explain the strange BEC excitations and believe their new work will help physicists gain new insights into the superfluid phenomenon and into the breakdown of superconductivity.

(Phys. Rev. Lett. 93 64101 (2004))

**Physics News Update**
THE 2005 BRAGG GOLD MEDAL FOR EXCELLENCE IN PHYSICS

AIP STATE BRANCHES AND PHYSICS DEPARTMENTS ARE NOW INVITED TO NOMINATE CANDIDATES FOR THE AWARD OF THE BRAGG MEDAL

Aim
The purpose of the prize is to recognize the work done by a Ph. D. student in Australia that is considered to be of outstanding quality.

Background to the Award
The Bragg gold medal for the best Ph. D. thesis by a student from an Australian University was established in 1992 as an initiative of the South Australian Branch, to commemorate Sir Lawrence Bragg (whose picture is inscribed on the medal) and his father Sir William Bragg.

Conditions of the Award
The medal is awarded annually to the student who is judged to have completed the most outstanding Ph. D. thesis under the auspices of an Australian university, whose degree has been approved, but not necessarily conferred, in the thirteen months prior to the closing date for applications to the State Branch (i.e., from the beginning of July 2004 to the end of July 2005). No candidate may be nominated more than once.

Only one medal shall be awarded; there is no possibility of a dual award. If the selection committee considers that none of the theses submitted reaches an appropriate standard, no award will be made.

Nominations
Each Australian university may nominate one candidate. These nominations are submitted to the State Branch committee. The committee selects the best thesis from their State (two for NSW and Vic), and three copies of the selected thesis are then forwarded to the honorary secretary.

Time Line:
Nominations from the universities should reach the secretary of the local State Branch by Friday 16th July 2005.

The selected nominations from the State Branches, accompanied by three copies of the thesis, the citation and referees’ reports, should reach the Honorary Secretary at P. O. Box 16, Willetton, WA 6955 by Friday 19th September 2005.

The announcement of the winner of the 2005 Bragg Medal shall be made by the end of January 2006.

Presentation of the Award
The medal will be presented to the chosen candidate at the Congress in even numbered years, and in odd numbered years at a function to be arranged by the AIP Branch of the State of the candidate’s university. The medal will not be awarded in absentia; the candidate must be available for the presentation at a time which is mutually convenient. Reasonable expenses in attending the presentation will be met by the Council of the AIP.

Previous Winners
2002 Dr. Annette Berriman,
Australian National University.

2003 Dr. Michael Bromley,
Northern Territory University.

2004 Dr. Warrick Bowen
Australian National University.

Further information about any of these awards can be obtained by email from secretary@aip.org.au or by phone to (08) 9332 1513.

Ian Bailey
Hon. Secretary
SCANNER FOR THE DETECTION OF CONTRABAND IN AIR CARGO CONTAINERS

BRIAN SOWERBY AND JAMES TICKNER
CSIRO Minerals, Private Mail Bag 5, Menai NSW 2234 Australia

Introduction

There is a worldwide need for efficient inspection of cargo containers at airports, seaports and road border crossings. The main objectives are the detection of contraband such as illicit drugs, explosives and weapons and the verification of declared manifests. Due to the large number of cargo containers passing through Australia’s ports and airports every day, it is critical that any scanning system be capable of working on unpacked or consolidated cargo, taking at most a few minutes per container.

Two important parameters for a cargo inspection system are the width of the cargo across its narrowest dimension and its average density. These parameters dictate the penetration required to enable the entire contents of the container to be imaged. Only fast (high-energy) neutrons and high-energy X-rays or gamma rays have the required penetration for imaging the contents of cargo containers. Air cargo is usually packaged into lightweight aluminium containers called Unit Load Devices (ULDs). The most common ULDs have a width of about 1.6 m and a maximum weight of 1.6 tonnes. However pallet ULDs are significantly larger, with widths up to 2.4 m and maximum weights up to 6.8 tonnes. Approximately 300,000 tonnes of air cargo passes through Sydney airport each year.

The majority of inspection systems installed today use high energy X-ray or gamma-ray radiography to form a 2D transmission image of the container’s contents. The image is analysed by a human operator, who is required to make a decision in a few minutes as to whether the container should be opened for manual inspection. Image quality is crucial and recent developments have focussed on improving the resolution and contrast of the collected images. High-energy X-ray and gamma-ray radiography is primarily sensitive to density and is particularly effective in detecting metallic objects with readily identifiable shapes such as firearms and other weapons. However, low density, indistinctly shaped organic materials such as drugs can be concealed.

Dual-energy X-ray radiography is an important enhancement to X-ray radiography systems. It provides additional, if limited, information on the composition of the object being imaged. By comparing the attenuations of transmitted high and low-energy X-ray beams, it is possible to build a 2D image, colour coded to indicate metal and organic materials. In applications such as examining passenger luggage, dual-energy X-ray radiography has become the standard screening method. However, the limited penetration of the low energy X-rays used to provide composition information prevents the method being used on unconsolidated air or sea freight.

The limitations of X-ray systems for the detection of explosives and drugs have stimulated a need to develop alternative methods for cargo inspection including those based on neutrons. Fast neutron techniques are attractive for these applications as they have the required penetration and they interact with matter in...
a manner complementary to X-rays. X-rays and gamma rays scatter primarily from electrons whereas neutrons interact via the strong interaction – that is, they scatter from the protons and neutrons in the nucleus. As a result, neutrons are scattered and slowed down more by the light elements than by the heavy elements. For example, high Z metals such as lead are fairly transparent to neutrons but opaque to X-rays and gamma rays. Neutron interrogation techniques usually involve bombarding an object with neutrons, causing neutron scattering, neutron flux attenuation and the emission of characteristic gamma rays. Neutron techniques are widely used in industry, particularly for on-line elemental analysis of cement and coal. However, the application of neutron techniques to explosive detection in cargo has not lived up to the early promise, primarily because of low detection sensitivity and/or high false positive rates, equipment complexity and high cost.

This paper describes a new fast neutron and gamma radiography technique developed by CSIRO, including the development and application of a full-scale prototype scanner at Lucas Heights and a commercial prototype scanner for Brisbane airport.

**Fast Neutron and Gamma Radiography**

The CSIRO Fast Neutron and Gamma Radiography (FNGR) technique forms 2-dimensional projection images showing both density (strictly, mass per unit area) and composition. It works by measuring the attenuation of beams of fast neutrons and gamma rays as they pass from the radiation sources, through the object to be imaged, to an array of detectors. FNGR is a direct measurement as it does not involve measuring secondary radiation such as neutron-induced gamma rays.

Assuming a narrow beam geometry in which scattered radiation does not reach the detector, the transmission of fast neutrons through an object of density $\rho$ and thickness $x$ can be calculated using the equation:

$$I_n / I_n^0 = \exp(-\mu_n \rho x)$$  \hspace{1cm} (1)

where $I_n$ is the measured neutron intensity through the object, $I_n^0$ is the measured neutron intensity with the object removed and $\mu_n$ is the neutron mass attenuation coefficient. Similarly, gamma-ray transmission can be written as:

$$I_g / I_g^0 = \exp(-\mu_g \rho x)$$  \hspace{1cm} (2)

where $I_g$ is the measured gamma-ray intensity through the object, $I_g^0$ is the measured gamma-ray intensity with the object removed and $\mu_g$ is the gamma mass attenuation coefficient.

The ratio, $R$, of the neutron and gamma-ray attenuation coefficients is:

$$R = \frac{\mu_n}{\mu_g} = \frac{\ln(I_n / I_n^0)}{\ln(I_g / I_g^0)}$$  \hspace{1cm} (3)

$R$ can therefore be determined directly from the measured neutron and gamma-ray transmissions without knowing the mass of material in the radiation beams. This ratio provides a powerful discriminator between different classes of material, depending on the energies chosen for the neutron and gamma-ray beams. For 14 MeV fast neutrons and for $^{60}$Co gamma-rays (energies 1.17 and 1.33 MeV), Figure 1 illustrates the dependence of $R$ on composition. High atomic number metals have the lowest $R$ values, with hydrogen having the highest value.

Whilst the accurate measurement of $R$ would in principle allow a wide variety of material classes to be directly identified, there is a major complicating factor. Because the neutron and gamma-ray beam transmissions are measured along a line between the radiation source and detector, the mass attenuation coefficients appearing in equations (1) and (2) need to be averaged over all the materials that the beams pass through. Strictly, the $\mu x \rho$ term appearing in these equations should be replaced by $\int \mu(x) \rho(x) dx$ where both $\mu$ and $\rho$ (mass attenuation coefficient and density) are now functions of the distance $x$ from the source on a straight line towards the detector. Consequently, the measured $R$ value is an average for the materials in front of each detector element. In simple cases, correction can be made for overlying or underlying materials to allow the $R$ value of an individual object to be determined. However, this correction is difficult for very cluttered images.
Laboratory Prototype Scanner

Preferably, the scanner needs to be capable of forming transmission radiography neutron and gamma-ray images through ULDs of thickness up to 2.4m. To facilitate the work of the cargo inspectors, the images need to have high-resolution, be low-noise and have a high-contrast. These requirements place significant design constraints on the overall geometry of the scanner, the radiation sources and collimators used to provide the neutron and gamma-ray beams, and the detector arrays used to form the final image.

Source/Detector geometry

Figure 2 shows a schematic cross-section through the prototype scanner and Figure 3 shows a photograph of the scanner. The radiation sources are situated on one side of a shielding tunnel with the detector array on the opposite side. The cargo to be scanned is passed through the tunnel on a moveable platform mounted on rails.

Two critical design parameters are the length of the detector array and its distance from the source. Ideally, the radiation beams passing through the cargo should be essentially horizontal as this minimizes distortion due to projection effects and means that the detector array only needs to be the height of the largest cargo item to be scanned. However, this implies that the sources are situated a long way from the detectors which reduces the intensity of the transmitted radiation. As the sources are moved closer to the detector array, the array needs to increase in length to image the complete container and projection effects become more severe. In the prototype scanner, the source was approximately 4.5 m from the detector array and the array itself matched the height of the tunnel, approximately 1.8 m. This led to a significant “dead-region” which could not be imaged, as shown in Figure 2.

The radiation sources were mounted inside a shielding block that, in addition to providing radiological protection for operators of the scanner, served to define the radiation beams passing through the tunnel. The primary function of the shielded tunnel was to prevent personnel passing through the radiation beams when the scanner was operating; the tunnel also reduced the external dose from the low-level of radiation scattered by the cargo. Finally, a shielded tower served to house the detector arrays and provide a backstop for radiation transmitted through the cargo. Regular construction concrete was used throughout.

Raditions Sources and Collimators

The main requirements on both the neutron and gamma-ray sources were: intense output to allow rapid scanning, high energy to penetrate thick cargos, small active volume to preserve image resolution, reasonable capital and running costs and safety considerations.

The choice of neutron source was a commercially available 14 MeV neutron generator in which neutrons are produced from the interaction of accelerated deuterium ions on a tritium target. The laboratory prototype scanner used a Thermo MF Physics A-325 neutron generator that could produce up to $10^8$ neutrons/second. The key parameters for successful industrial applications using neutron generators are reliability, neutron tube lifetime and replacement costs. A key advantage of a sealed tube generator over radioisotope neutron sources is that when turned off, the source emits essentially no radiation.

Cobalt-60 (gamma-ray energies 1.17 and 1.33 MeV) was selected as the gamma ray source. The advantages of $^{60}\text{Co}$ include its long half-life (5.3 years), the availability of high source strengths and high specific activities and their relatively low cost. In the laboratory prototype scanner, a 0.8 Gbq source was used. Alternative sources include electron linear accelerators (available from 2 to 9 MeV) that are used in a number of commercial X-ray cargo scanners.

Steel collimators were used to accurately define the radiation beams emerging from the source shield block. Careful design of these collimators serves to minimize radiation scattering that reduces both the resolution and contrast of the transmission images.

Detector arrays

The detector array governs the spatial resolution of the transmission images. A small detector element size is desirable to provide sharper images. However, reducing the size reduces the fraction of transmitted radiation detected by each pixel, leading to a noisier image. The cost and complexity of the system also increases as the use of smaller pixels implies a need for a larger number of detectors to maintain the size of the detector array. High detection efficiency was also important, particularly for neutrons, as the brightness of conveniently available neutron sources is low.

Thus a key aspect of the current scanner was the development of high efficiency, low cost detector arrays capable of measuring fast neutrons and gamma rays. The most efficient fast neutron detectors were those based on proton recoil in plastic (or liquid) scintillators. Readout of the light from the plastic scintillators was performed using silicon photodiodes. Compared to photomultiplier tubes, silicon photodiodes are inexpensive, compact and rugged. In addition, they only require low voltage (~50 volts) and they do not require gain stabilisation. However, the spectral response of silicon photodiodes is not well matched to standard plastic scintillators, requiring the use of special orange-shifted plastic scintillators whose light output is better matched to the photodiode response. These scintillators were available from a number of manufacturers. Each plastic scintillator pixel was 20×20×75 mm. The wrapping of the scintillators was optimised to maximise light collection at the photodiode. Conventional photodiodes have no internal gain and produce a very small signal for both neutrons and gamma rays. Therefore, a significant technical challenge in the current project was to develop low noise/high gain amplifiers at a relatively low cost. In the prototype scanner one column of 80 pixels was used for the simultaneous detection of both fast neutrons and gamma rays.

A photograph of one of the 32 pixel arrays used in the prototype scanner is shown in Figure 4. Figure 5 shows the pulse height spectra obtained from one 20×20×75 mm pixel for 14 MeV
neutrons, $^{60}$Co gamma-rays and with no source. Both neutrons and gamma-rays were clearly separated from the electronic noise of the readout system and could be distinguished from one another on the basis of the energy deposited in the scintillator. The high-energy gamma-ray events above channel 40 were caused by $^{60}$Co gamma-rays interacting directly in the photodiode rather than in the scintillator. These unwanted interactions generated a background to the neutron signal, which had to be corrected.

**Scanning process and detector readout**

In the prototype scanner, objects that were to be scanned were passed through the tunnel on a moving platform. The trolley was typically operated at a speed of 0.25 mm/sec and consequently, over 2 hours were required to collect the image of a 2 m long ULD. The slow speed was entirely governed by the low strength of the sources used, particularly that of the neutron generator.

The detector array comprised modules of either 16 or 32 pixels each. Scintillation events from each module were multiplexed and read out using a commercial multichannel analyser card. A separate 256 channel spectrum was collected for each pixel. These spectra were read out and reset every time the trolley traversed 10 mm.

**Image processing and results**

For the prototype scanner, the neutron and gamma-ray count rates with no intervening material were approximately 7.5 and 250 counts per second respectively. Whilst the array was designed to have similar sensitivity for neutrons and gamma-rays, the significantly greater brightness of the gamma-ray source led to much higher gamma-ray count rates. Due to the higher count-rates and lower background scattering of the gamma rays, the gamma-ray image carries most of the information about shape and density. For each pixel in the image, the quantity $-\ln(I_p / I_0)$ unit area of material along the line from the radiation source to the pixel in question. The $R$ value for each pixel was calculated using equation (3).

![Figure 4. Photograph of an assembled 32-element detector array for the prototype scanner. The 32 plastic scintillators with wrapping are at the top of the picture.](image)

![Figure 5. Neutron, gamma-ray and background spectra measured in a plastic scintillator pixel in the prototype scanner. The counting time was 200 sec.](image)

![Figure 6. Colour scheme used to identify the composition of pixels in the combined density and $R$ images.](image)

Spatial filters were applied to both the density and $R$ value images. A sharpening filter was applied to the density image to enhance edges and boundaries between objects. A smoothing filter was applied to $R$ value to reduce the noise that was due to the relatively low neutron count rates. Straightforward linear sharpening and smoothing filters had the undesirable effect of increasing image noise and blurring edges respectively. Nonlinear filtering algorithms were developed that minimised these unwanted artefacts.

Finally, the density and $R$ value images were combined as follows. The ratio $R$ was mapped to the hue or colour of the pixel. In the images, low $R$ values (inorganic materials) were coloured purple or blue, intermediate $R$ values were coloured green and high $R$ values (organic materials) were coloured yellow and orange (Figure 6). This colour scheme is similar to that widely used in dual-energy X-ray scanners for luggage and parcels. The density value was used to determine the brightness of the colour. When no intervening material
is present, a pixel was coloured white. If the density was higher, the colour was darkened towards the saturated colour determined by the R value. For very high densities, the colour was darkened towards black. This mapping has the advantage that when the R value is poorly determined due to either too little or too much intervening material being present, the pixel was coloured white or black and the uncertainty in R did not lead to a noisy image.

**Results**

Two typical scans are shown in Figures 7 and 8. Figure 7 shows the scan of a motorbike obtained using the prototype scanner. The upper monochrome image shows only density information, such as would be obtained with an X-ray scanner. The lower image includes the composition information provided by the neutron measurement. This image provides a good indication of the overall imaging capabilities of the scanner. In particular, fine details such as the front brake cables show quite clearly, even though they are considerably smaller than the 20 mm pixel size. The metal frame and engine of the bike show up blue in the composition image whereas the fuel in the petrol tank, rubber tyres, plastic seat, lights etc show up orange. The oil in the sump (immediately above the kickstand), when averaged together with the metal in the same path, shows as a green patch.

Figure 8 shows a ULD filled with a variety of goods, including a refrigerator, several computers, metal parts, hollow concrete blocks, a propane gas cylinder and tools. Two packets of organic material substituting for drugs (weighing about 1 Kg each) were concealed in the ULD - one within one of the computers and one inside one of the concrete blocks. The top image shows a photograph of the container and indicates the positions of some concealed items. The middle monochrome figure shows the density image in which neither of the packets of surrogate drugs is particularly obvious. The propane gas cylinder could be identified based on its shape, although the organic nature of its contents was not clear. In contrast, when the additional information from the neutron scan is used to colour the image, both packets of concealed drugs could be identified and the organic contents of the gas cylinder are clearly displayed.

**Contraband identification and detection limits**

The contraband scanner can be used in at least three ways for detecting and identifying contraband materials:

1. The gamma-ray images provide considerable information about the shapes, sizes and densities of objects inside a ULD. In this respect, the CSIRO scanner functions as a conventional X-ray scanner, tailored to objects with ULD dimensions.

2. The colouring of the gamma-ray image based on composition information derived from the neutron measurements provides powerful extra information for the interpretation of scan images and identification of suspicious materials. In particular, the detection of organic materials inside predominantly inorganic objects is greatly facilitated. The detection of small quantities of drugs and

drug simulants has been demonstrated when the suspicious materials are concealed inside a packed ULD.

3. Finally, under certain circumstances, the scanner can be used to measure the neutron/gamma ratio (R values) of suspicious materials to assist in their identification. When the over- and under-lying material is reasonably uniform in the immediate vicinity of the suspicious material, it is possible to make an accurate correction for the absorption of neutrons and gamma rays in the over- and under-lying material to obtain the R value of just the substance of interest.

**Commercial Prototype Scanner at Brisbane Airport**

The prototype scanner at Lucas Heights has been used to successfully image a range of objects including readily identifiable items such as a motorbike and simulated air cargo containing concealed surrogate contraband materials. Following the successful demonstration of the technique on full-scale air cargo the Deputy Prime Minister announced on 4 December 2003 of the granting of $8.4 million dollars to the Australian Customs Service to construct a commercial-scale scanner at Brisbane airport based on the CSIRO technology. The commercial prototype scanner will be installed in Brisbane in 2005.

The commercial prototype scanner for airport applications is based on the laboratory prototype scanner discussed above, but upgraded in a number of significant ways, namely:

- An intense D-T neutron generator, capable of producing up to 10¹⁰ neutrons/second and a higher intensity (~185 GBq) ⁶⁰Co gamma ray source.
- Increased source-to-detector distance, increased height of the tunnel and increased length of the detector array. The longer detector arrays allow complete ULDs of height up to 2.7 m to be scanned.
- Separate neutron and gamma ray detector arrays. The advantages of using separate arrays are that smaller gamma pixels can be used (resulting in improved spatial resolution) and that the gamma-induced background in the neutron pixels is reduced.
- The neutron detector array comprises individual detectors similar to the 20×20×75 mm plastic scintillators in the laboratory prototype scanner. The gamma detector array comprises individual 10×10×50 mm CsI(Tl) scintillators with photodiode readout.
- Pixels in the Brisbane airport scanner are arranged into modules of 16 or 32, with the results from each module multiplexed and stored by a custom digital circuit. The entire detector array is controlled and read-out using a proprietary high-speed serial network.
- Temperature control of the detector array to improve stability and reduce noise.
- Enhanced analogue and digital electronics to handle the increased count rates and larger number of pixels.
- Improved imaging software.
An industrial system for smoothly moving the ULDs through the scanner at a uniform rate of about 1-2 m/min to achieve scanning times of approximately 1-2 minutes per ULD.

The scanner has good radiation safety because of (a) the relatively low-intensity sources compared to other scanners, and (b) the highly collimated fan-beams of radiation used. The concrete shielding around the scanner has been designed to minimize the radiation exposure of workers in the vicinity. In addition, the Brisbane airport scanner will be enclosed in a building to prevent access to the scanner by unauthorized personnel. Multiple fail-safe interlock mechanisms will be used to prevent people entering the scanner during its operation.

In the Brisbane airport scanner, cargo passing through the tunnel will be briefly exposed to gamma-ray and neutron beams. The total radiation dose received by the cargo during scanning is calculated to be approximately 5 mSv. This is approximately the natural background radiation dose that would be received at sea level in one day, or the cosmic ray-induced natural background that would be received during about 3/4 hour in an aircraft at 10,000 m altitude.

**Summary**

Key advantages of the fast neutron and gamma radiography (FNGR) scanner compared to other cargo scanners include:

- The FNGR method provides composition as well as shape and density information with both good image resolution and good composition sensitivity. The scanner can distinguish classes of compounds such as organics (drugs, alcohol and explosives), glass/ceramics, and metals in air cargo;
- Use of commercially available, sealed-tube 14 MeV neutron generator and $^{90}$Co gamma ray source;
- The detection of fast neutrons and gamma-rays using unique, high-efficiency detector arrays and associated electronics, allowing images to be collected more quickly.
using lower intensity neutron and gamma ray sources;
- Rapid imaging (approximately 1-2 minutes per ULD). The scanner will allow faster clearance rates from effective non-intrusive inspection of consolidated ULDs without unpacking; and
- Good radiation safety and acceptable cost for wide scale deployment.

The scanner has significant market potential and patent applications have been lodged.\textsuperscript{10}

Acknowledgments

The authors gratefully acknowledge the financial support of the Australian Customs Service throughout this project and the assistance and encouragement of Customs staff, particularly Melanie Challis, Fiona Fraser and Kristin Williams. The authors wish to thank the staff of the On-Line Analysis and Control Program and the Lucas Heights Mechanical Engineering and Electronics Groups of CSIRO Minerals for their invaluable contribution to the project.

References

THE CONGRESS DIARIES

CORINNA HORRIGAN

It’s been at least six years since I’ve been to a physics conference of any kind. Since then, my career has veered in a different direction and perhaps this gives me a slightly different perspective. So here’s my view of the 2005 Congress. It’s a personal view put together from memory and from some of the notes that I made. Memory is both malleable and individual, so I expect that others will have seen the Congress quite differently. There were about 950 registrants at the Congress - no doubt each has their own story.

Generally, I found myself looking forward to the AIP Biennial Physics Congress with more excitement than I had anticipated. While I had no special focus as far as the subjects were concerned - there were no areas that I had to attend - I did have a mission: to find as many possible future contributors to The Physicist as possible! I went to a lot of presentations in furtherance of this aim but I’m not going to try and summarise them all here - I doubt that it would be fair either to the presenters or to the readers.

Of course, the other reason for this ‘diary’ is to provide a framework for the photos that I took at the Congress so if you like, you can just look at the photos and their captions to get some idea of the event.

Day 1 – The Welcome

I often drive from Sydney to Canberra, but not usually on a Sunday afternoon. It was certainly more pleasant than the mad dash I often do on a Friday evening! Trucks were few and traffic was not too heavy and I arrived at the ANU in plenty of time for Registration. Fortunately, I knew this part of ANU fairly well and had no trouble finding the registration desk. The process was efficient and friendly and I ended up with a new backpack full of the usual conference goodies.

From there I went to the Welcome Reception in Melville Hall. Even though not all registrants made it to the Welcome, the room was still pleasantly crowded and I’m sure that a lot of networking happened. I spent some time catching up with friends and acquaintances not seen for some time and putting faces to the names of people whom I had corresponded with, but never met before. The social wheels turned smoothly thanks to the food and drink provided.

As the time came to leave and search for somewhat more substantial food, I realised that I had left my camera with my bags, so there are no photos of this part of the congress. You’ll just have to imagine it.

Note that Melville Hall was also where the Exhibitors were set up and the posters would be displayed over the next few days. To encourage delegates to check these out, it was also where morning and afternoon teas were served for the whole Congress. A cunning plan on the part of the organisers.

Day 2 – The Opening

I am most definitely not a lark, so I had noted with some dismay that every day began with a plenary session at 8.30 am!
However, on this day I made it to the Opening Ceremony with time enough to actually get a seat in the main lecture theatre. As none of the theatres was big enough to take all delegates, a video feed was set up for each plenary so that no-one need miss the talk. This was an excellent idea and one that I did take advantage of later in the week.

The Congress was opened by Hon. Gary Nairn MP, Federal Liberal Member for Eden-Monaro and Parliamentary Secretary to the Prime Minister. And just because I had to get there so early, I have included the photo I took then.

After the official opening there was the first plenary lecture by Professor Tony Leggett, winner of the 2003 Nobel Prize for Physics for his pioneering contributions to the theory of high temperature superconductors. Prof. Leggett gave a talk on Bose-Einstein Condensation and Cooper Pairing. Prof. Leggett is a good speaker and enthused about his subject but, as they say, it wasn’t my field and I was lost fairly early in the piece.

After the plenary, the conference divided into 6 parallel streams. By keeping the sessions to a strict timetable, it was, theoretically, possible to chop and change between streams. By and large, this worked well, though not altogether perfectly. That it worked at all was a credit to the organisers and the many session chairs – it’s not an easy job getting people to keep strictly to time.

At Lunchtime, the Sutherland Lecture was presented by Professor Emeritus R.W. Home. You may remember a short piece on William Sutherland was included in our Einstein article (The Physicist May/June 2004) This talk expanded on that brief outline of Sutherland’s career and achievements and I hope to have some more about it in The Physicist at a later date.

After the afternoon talks, there was an AIP Council meeting and the AIP AGM. These are summarised elsewhere in this issue.
Day 3 - The Press Club

It was a close thing, but I did make it to the beginning of the first plenary on this day. This was a good thing as it was a fascinating talk by Prof. Karsten Danzmann on gravitational wave detectors on earth and in free space. This was followed by a second plenary on Reaction Microscopes by Prof Joachim Ullrich.

After the morning talks, some of us caught the bus to the National Press Club for the Luncheon. It was quite a good steak for lunch - though I don't remember being asked whether I had any dietary requirements, so it's a good thing that I'm not a vegetarian.

Graeme Pearman gave a very interesting address which was also, I thought, quite carefully worded. The talk was about the science of climate change and how it should underpin the policy, both private and public, in this area. After the talk, came the questions. Dr Pearman's answers seemed to me to be very polite, so I was surprised at the negative response from the government. I had been impressed by the way he made his points without pointing any fingers and can only conclude that there was some misinterpretation somewhere.

After returning to the University, I spent most of the afternoon listening to the talks in the Education stream which included the Keynote presentation by Marjan Zadnik, the winner of the inaugural AIP Education Medal.
Day 4 – The Dinner

Having heard the talk at the Press Club Luncheon, I decided I could miss the first plenary by Dr Pearman. And only arrived in time for the talk by Professor Steven Chu, the 1997 Nobel Prize-winner in Physics for the development of methods to cool and trap atoms with laser light. He used this talk to describe the way in which physics can help explain some of ways biological systems work and how understanding these can feed back solutions to other problems in physics and engineering.

After the morning talks, I decided to take lunchtime to do a little shopping before taking in the Schools Outreach over in Llewellyn Hall. Unfortunately, I got caught in an unseasonable (for Canberra) downpour as a very cool change came in. This left me cold and wet, so I decided instead on a hot shower and dry clothes.

I was going to give a long description of the dinner, but perhaps the pictures will be more eloquent. At about 1000 words to a page, you can work out how many words each is worth.

Day 5 – The sounds of physics

Those who have read this far won’t be surprised to learn that I missed the first plenary for this day. I did catch the second one, however by Dr Catherine Cesarsky on the current Golden Age of astronomy. Having originally been lured into physics by an interest in astronomy, I was delighted with this talk.

I had lunch with the Women in Physics group and later in the afternoon went to the talks in this stream. A good summary of the status of women in physics, both in Australia and overseas, was given by Cathy Foley.

However, the title of this section was determined by the acoustics presentations that I went to in the afternoon. As a chorister, I was interested in singing strategies and fascinated by the tri-tone paradox.

Unfortunately, due to other commitments, I missed Prof. Helen Quinn’s public lecture at Questacon in the evening. Prof Quinn is the Women in Physics Lecturer for 2005 so she will be presenting her talk on the apparent asymmetry between matter and antimatter at many venues around Australia.
Day 6 – The Prizegiving

The prizes and awards were presented on this, the final day of the Congress. I’ve listed the winners and the citations in a separate awards section in this issue. But I have included some photos here. There was also the signing of the agreement between the AIP and the Institute of Physics.

For a change, this one ended with two plenary talks. One by Prof. Marcela Bilek on plasma physics in the nano-age and Prof. Helen Quinn gave a somewhat more technical version of her public talk on the asymmetry between matter and antimatter.

The Congress was then closed, though there were still some lab tours and a farewell BBQ for those who had the stamina.

In summary, a most successful congress!
Two industry leaders are now one

Spectra-Physics, including Oriel Instruments, Hilger Crystals, Corion Filters and Richardson Gratings are now part of the complete solution at Newport

One Company, One Source, One Solution.
AWARDS PRESENTED AT THE AIP BIENNIAL PHYSICS CONGRESS 2005

AIP Walsh Medal

This award recognises significant contributions by a practicing physicist to industry in Australia. It is named for the late Sir Alan Walsh, Kt, FAA, FTS, FRS, one of Australia's most eminent and distinguished scientists, who was the originator and developer of Atomic Absorption Spectrophotometry (AAS) and pioneered its application as a tool in chemical analysis.

The award consists of a Medal and is open to competition every second year among persons resident in Australia for at least five of the seven years preceding the closing date for applications. The award will be given for physics research and/or development that has led to patents, processes or inventions which, in the opinion of the judging panel, have led to significant industrial and/or commercial outcomes, such as devices that are being manufactured or have influenced a major industrial process.

Winners: Brian Sowerby and James Tickner)

Brian Sowerby

Brian Sowerby is currently Chief Research Scientist, On-Line Analysis and Control in CSIRO Minerals at Lucas Heights. He holds a B.Sc. (Hons. 1) in Physics from the University of NSW and a Ph.D. in Nuclear Physics from the Australian National University. Following post-doctoral work in Canada he has, since 1969, carried out research and development on the application of nuclear and ultrasonic techniques in the mineral and energy industries in the Australian Atomic Energy Commission and CSIRO. This work has led to the commercialisation of techniques for the bulk analysis of copper and nickel ores, the on-line analysis of coal (two of the Coalscan gauges) and the on-belt determination of coke moisture. His work also led to the development of the UltraPS particle size analysers, the UltraPF coal mass flow measurement system and various on-conveyor belt analysers. His current main research interest is the development and application of techniques to detect contraband in air cargo. He has received ten awards for his work including the inaugural Sir Ian McLennan Achievement for Industry Award (1985) and the 1992 Australia Prize (shared with Watt, Cutmore and Howarth). He was elected a Fellow of the Australian Academy of Technological Sciences and Engineering in 1986.

James Tickner

James read physics at Oxford University, graduating in 1994. He completed his DPhil at the same institution, measuring proton structure functions at the ZEUS experiment based at the DESY laboratory in Hamburg. In 1998 he moved to Australia to join the On-line Analysis and Control group at CSIRO Minerals. Since then he has worked on the development of nuclear instrumentation for the minerals industry and more recently for security applications, specialising in the development of Monte Carlo methods for designing and optimising nuclear analysers. In 1999 he joined the International Atomic Energy Agency's coordinated research project on the application of nuclear technologies for humanitarian demining, developing the concept for a hand-held, 3-dimensional gamma-ray camera capable of one-sided imaging. In 2002 he co-developed the fast-neutron/gamma-ray radiography method for cargo screening which is due to be trialled at Brisbane airport next year. James has authored over 70 publications and patents in the fields of particle physics and nuclear instrumentation.

Malcolm McIntosh Medal

The Malcolm McIntosh Prize for Physical Scientist of the Year is awarded for an outstanding achievement in science that advances, or has the potential to advance, human welfare or benefits society. This Prize is awarded only to an individual. The Malcolm McIntosh Prize is comprised of a silver medallion and a grant of $50,000.

The objectives of the Prize are to recognise and reward outstanding research by younger scientists; and to demonstrate to the public, and to school students and science undergraduates in particular, that early-stage career achievement in science can be of world-class importance.

Winner: Ben Eggleton

Benjamin J. Eggleton is currently an ARC Federation Fellow and Professor of Physics at the University of Sydney and the Director of CUDOS, an ARC Centre of Excellence. In 1996, he joined Bell Laboratories, Lucent Technologies as a Postdoctoral Member of staff then transferred to the Optical Fiber Research Department. In 2000 he was promoted to Research Director within the Specialty Fiber Business Division where he was responsible for forward-looking research supporting Lucent Technologies business in optical fiber devices. Prof. Eggleton has co-authored over 100 journal publications and numerous conference papers and was the recipient of the 2004 Malcolm McIntosh Prize, the 2003 ICO prize from the International Commission on Optics, the 1998 Adolph Lomb Medal from the OSA the distinguished lecturer award from the IEE/ELEOS, is an OSA fellow and recipient of an R&D100 award.

ANZAAS Medal

The ANZAAS medal is awarded for services in the advancement of science or administration and organisation of scientific activities, or the teaching of science throughout Australia and New Zealand and in contributions to science which lie beyond normal professional activities. The ANZAAS Medal is only presented to the recipient at a suitably prestigious scientific gathering or event.

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Winner: David Blair

In recognition of his outstanding contribution to world science through his pioneering research work on gravity waves, the Council of the Australian and New Zealand Association for the Advancement of Science has awarded the ANZAAS Medal to Professor David Blair.

Professor Blair, from the School of Physics at the University of Western Australia, is a high profile scientist who has researched gravity waves for more than 25 years. This research has led to the development of the world's most accurate clock and to the development of a new form of astronomy - gravitational wave astronomy - the spectrum of which is awaiting discovery. When harnessed, gravitational waves will offer a powerful new probe of the universe. This research has received much media attention and captured the public's imagination.

Professor Blair is Director of the Australian International Gravitational Research Centre at Gingin, approximately 80 km north east of Perth, in Western Australia. The Centre involves collaboration between Australian and international scientists and incorporates one of the largest astronomy centres in the southern hemisphere, the Australian International Gravitational Observatory. The public arm of the Observatory is the Gravity Discovery Centre which features science education and tourist displays designed to stimulate interest in science.

Professor David Blair's commitments to the advancement of science and to the promotion of science for secondary and tertiary students make him an outstanding role model and worthy recipient of the ANZAAS Medal.

Boas Medal

The Medal was established in 1984 to promote excellence in research in Physics and to perpetuate the name of Walter Boas. The award is for physics research carried out in the five years prior to the date of the award, as demonstrated by both published papers and unpublished papers prepared for publication, a list of which should accompany the nomination.

Winner: Professor George Dracoulis

George Dracoulis is a graduate of Melbourne University and has been on the staff at the Australian National University since 1973. He has been Head of the Department of Nuclear Physics since 1991. That Department operates a major facility based on a Heavy Ion Accelerator, which is used for a broad range of research, from basic studies in nuclear physics and nuclear reactions, to innovative applications.

His main interests, pursued both at the local and various international facilities, are in the structure of unusual nuclear states populated in heavy ion reactions and studied with time-correlated, gamma-ray spectroscopy. The recent focus of this work has been on the identification of metastable states, or isomers, and in their use as a probe of the underlying nuclear structure, including elucidation of the mechanisms which control the formation of multi-quasiparticle states in deformed nuclei, and the orbital-dependence controlling nuclear shape co-existence.

He was awarded the 2003 Lyle Medal of the Australian Academy of Science.

2004 AIP Massey Medal

The Massey Medal was proposed at the AIP Congress in 1988 as a gift from the Institute of Physics, UK, to the AIP, to mark the 25th anniversary of the founding of the AIP as a separate institution in 1963. It was first awarded in 1990.

The medal is awarded every two years for contributions to physics or its applications made by an Australian physicist working anywhere in the world, or by a non-Australian physicist resident in and for work carried out in Australia.

Winner: Peter Drummond

Peter Drummond is the Professor of Theoretical Physics at the University of Queensland, and UQ Director of the Australian Centre for Quantum-Atom Optics. He has degrees from Auckland, Harvard and Waikato Universities, and is a Fellow of the AIP, APS and AAS.

He has worked on: techniques and tests of quantum theory, theory of quantum and classical solitons, computational physics, physics of communication and information, laser physics, Bose-Einstein condensation and atom lasers.

He has published over 135 research papers in refereed journals, with more than 4100 citations. The calculations are generally closely related to experiments - and have been verified in many laboratories in the USA, Europe, Japan and elsewhere.

The most significant work was the development of novel theoretical phase-space representations of quantum operators. A practical application of this technique was the prediction of the first evidence for quantum solitons in optical fibers.

This was verified in several laboratories, and featured on Nature's front cover.

In addition, he has contributed to the field of computational physics, through the development of new programs and algorithms, which are widely available to the physics community. He is currently working on new techniques for correlated fermions.

AIP Education Medal

The purpose of the prize is to recognize an outstanding contribution to physics education in Australia. It was proposed as an initiative of the Physics Education Group at the 2002 AIP Congress in Adelaide. The prize is awarded to any member of the AIP who is judged to have made a significant contribution to physics education in Australia. In determining the recipient of the award, the quality of the work, the significance to physics education, and the creativity displayed will be taken into account. The inaugural prize was presented at the 2005 AIP Congress in Canberra.

Winner: Marjan Zadnik

Marjan Zadnik is the inaugural Professor and Dean of Teaching and Learning in the Division of Engineering, Science and Technology at Curtin University of Technology. Prior to this position he taught and carried out research in the Department of Applied Physics at Curtin. Before joining Curtin he carried out research on the isotopic composition of noble gases trapped
in meteoritical and terrestrial samples at the Enrico Fermi Institute, University of Chicago, and at the Max-Planck-Institut für Chemie, in Germany. He has a strong commitment to student learning and supporting staff to improve their teaching. He has been a co-investigator on over 40 competitive research and development grants totalling over $12.2 M. These include 5 national Committee for the Advancement of University Teaching and the Committee for University Teaching and Staff Development grants, plus a large ARC research grant. Awards and honours include the Vice-Chancellor’s Award for Excellence in 1993, a CAUT National Teaching Fellowship in 1996, the inaugural Curtin Student nominated Guild Award for Excellence in Teaching (1999), the Dean of Science Medal (2000), the Most Valuable Paper published in 2000 in the Aust Science Teachers Journal and was a National Finalist for the Australia Awards for University Teaching, in 2002. He has published over 120 papers and presented at over 100 conferences.

2003 AIP Bragg Medal

The Bragg Medal was established in 1992 as an initiative of the South Australian Branch, to commemorate Sir Laurence Bragg and his father Sir William Bragg. The medal is awarded annually to the student who is judged to have completed the most outstanding PhD thesis in Physics under the auspices of an Australian university.

Nominations from each university are submitted to the State Branch Committee, which selects a state winner. A national selection panel then selects the national winner.

Winner: Michael Bromley

Michael completed his PhD on -Positron-atom interactions studied using configuration-interaction methods- in 2002 for which he was awarded the 2003 Australian Institute of Physics Bragg Gold Medal for Excellence in Physics. His computer-based research, on anti-matter/matter interactions, was performed under the supervision of Dr. Jim Mitroy at the Northern Territory University in Darwin. The main result of this research was the identification of a number of new positronic atoms (i.e. atoms which could stably bind a positron to them).

Post-PhD, he has been a Research Associate at Kansas State University (U.S.A.) investigating atom optical elements ("atom chips") with Prof. Brett Esry. He recently returned to Australia for a short-term Postdoctoral Fellow position at the (now renamed) Charles Darwin University, while looking for further work. He was a Young Australian of the Year winner in 2001 (Northern Territory, Science and Technology category) and, as of October 2004, has published 23 scientific papers with an emphasis on computational atomic physics; ranging from the electronic structure of atoms through to matter-wave (e.g. Bose-Einstein condensate) propagation and manipulation.
A Word from FASTS President Professor Snow Barlow

The Minister for Science, Brendan Nelson, will outline the government’s fourth term science and technology agenda in an address to the National Press Club next week as part of FASTS annual Science meets Parliament program. While I am looking forward to this address and any new ideas and or initiatives within it, it is clear the government’s policy agenda has already shifted. The government has clearly indicated that it wants to evaluate the effectiveness of its research investments within Backing Australia’s Ability across the whole R & D spectrum.

This began in 2004 with a report on Commercialisation in publicly funded research agencies. The pace will increase this year with the establishment of the Research Quality Framework for publicly funded research and a Productivity Commission enquiry into economic, social and environmental returns from publicly funded research.

Work on the Research Quality Framework (RQF) or Research Assessment Exercise (RAE) has already begun with the establishment of an expert advisory group chaired by Sir Gareth Roberts and a round of discipline workshops. This Research Assessment Exercise has several important implications for Australian Science and its Scientists. While I welcome the opportunity for Australian Scientists to demonstrate the quality of their research it will be particularly important for all member societies to be fully engaged in the development of the RQF this year.

Similar RAE’s in Great Britain and New Zealand have demonstrated the strong possibility of unintended consequences and perverse outcomes from these RAE’s if inappropriate assessment criteria and ‘metrics’ to measure research quality are chosen. It will be particularly important for Australian science to demonstrate the confidence and maturity to develop assessment criteria and processes that truly reflect the objectives and culture of various types of research and the nature of our economy. A ‘one size fits all’ approach will not serve the interests of Australian science well. This exercise must find assessment criteria that measure the outcomes as well as the outputs of R & D.

I strongly encourage you and your societies to be fully engaged in this exercise which has the potential to shape the way we do science in Australia in the immediate future. The DEST website has the details and timetables of this process at

Government and Shadow Ministerial Appointments

The new Ministry of the re-elected Government has relatively few changes of relevance to scientists. Brendan Nelson retains the Education, Science and Training portfolio although the junior ministry will transfer from science to training. This change reflects the Governments increased focus on skills shortages (in the trades, VET sector etc as distinct from shortages in statistics, parasitology, entomology, systematics etc). In one sense this change strengthens science to the extent it will be a cabinet position (previously Peter McGauran was not in cabinet). Jenny Macklin is the Shadow Minister. Peter McGauran has moved to Citizenship and Multicultural Affairs, Tony Abbott has Health and Ageing (Julia Gillard is the Shadow Minister). Ian MacFarlane retains Industry, Resources and Tourism (the Opposition spokesman is Martin Ferguson), while Warren Truss retains Agriculture, Fisheries and Forestry (Gavan O’Connor is the Shadow Minister) and Senator Helen Coonan retains Communications, Information Technology and the Arts (Senator Stephen Conroy is the ALP Shadow).

FASTS Conference in 2005 – The Governance of Science

FASTS is hosting a conference on the ‘Governance of Science’ in Canberra on September the 13th and 14th. It is timely for a rigorous and critical examination of the organisation and governance of science and technology in the light of significant global changes in the funding and structure of science and research over the past two decades.

Characteristics of these changes include:

- Development of new modes of knowledge production - disciplinary based research supplemented/surpassed by transcultural, problem-based research with more defined time frames and more informal networking, communication and dissemination.
- Governments increasingly linking R&D investment to economic outcomes - knowledge economies;
- Politicisation of science inputs into public policy - climate change, water;
- Scepticism and cutbacks in Government’s investment in big science - e.g. superconducting super-collider debate in early 1990s in USA;
- More instrumental, vocationally oriented "user-pays", "student choice" models of education with consequences for science as generalist degree;
- Changing academic culture - the entrepreneurial university;
- Emergence of "triple-helix" arrangements - state, industry, publicly funded research;
- Emergence of new modes of science publication - "open access", "author pays";
- Declining membership of science societies.

These changes raise important questions including:

- How should science represent itself to scientists, community and Government in the changing political, economic and institutional climate?
- How does science inform policy? - What does it do well? What doesn’t it do well? How best to organise to influence policy?
- What responsibilities do scientists have to and from whom?
- How does the practice of science sit with changes in accountability, transparency and institutional governance imperatives?
- Is the hierarchical structure of science, particularly academic science, a strong base for effective representation?
- What role and representation for the ‘silent’ voices in science - lab technicians, postdocs, science and technology in the VET sector, RAs, industry based scientists and so forth?
- What is the role and prospects of science societies?

Further information about this conference will be posted on www.fasts.org

Research Infrastructure

In March 2004, the National Research Infrastructure Taskforce released a paper with a raft of recommendations concerning resource allocation for research infrastructure. The Government’s response was to establish a National Collaborative Research Infrastructure Strategy, announced as part of Backing Australia’s Ability 2 in May 2004.

FASTS supports the Government initiative to provide $542 million over 2004-06 to 2010-11 for the National Collaborative Research Infrastructure Strategy to provide researchers with access to major infrastructure, link infrastructure funding to National Research Priorities and to foster greater research collaboration and the collaborative use of research infrastructure.

However, FASTS urges the Government to adopt the recommendation of the National Research Infrastructure Taskforce “That a National Research Infrastructure Council (NRIC) be established to further develop, implement, review and monitor the National Infrastructure Strategic Framework and, in particular, to develop and implement a national process to identify and prioritise research infrastructure needs” so that the continuing needs for infrastructure can be
developed. Our concern is that the while research infrastructure is very important it is only one third of the infrastructure required to ensure that our investment in science and technology contributes effectively to wealth generation in Australia.

Two other areas of infrastructure investment need urgent attention. The first is the infrastructure in Universities, TAFE Colleges and schools, which is used to encourage people to become scientists and technologists and to train them to international standards. There is strong evidence that this infrastructure is not up to scratch and falling behind.

The second area of infrastructure investment which needs to be addressed is the infrastructure that is needed to take research from the laboratory into prototype development and then to full scale production. The latter investment is clearly the responsibility of the private sector. The intermediate stage which is variously described as 'proof of concept', 'pilot scale production' or 'prototype development' is seldom performed in Australia, thus vastly increasing the possibility that the value adding to our inventions will take place overseas. Public investment needs to be made in open access facilities for these purposes.

We recommend that the Government set up a 'National Science and Technology Education Infrastructure Taskforce' to report on the true state of the first issue and a 'National Prototype/Pilot plant Infrastructure Taskforce' to report on strategic investments to address the second issue.

National Science, Engineering and Technology Skills Audit
The government will undertake a National Science, Engineering and Technology Skills Audit this year. The audit will focus on the extent to which Australia's current and future industry and research body needs are being met by the higher education and vocational education and training (VET) sector in the supply of science, engineering and technology graduates.

In particular, it will provide an understanding of where shortages lie and will examine:
- the supply of science, engineering and technology skills from all training and education sectors and report on supply trends;
- public and private sector demand for science, engineering and technology skills from industry, the research community and education providers, both now and into the future;
- how successful the education sectors are in meeting existing science, engineering and technology skill needs and responding to emerging needs;
- the long and short-term trends in the emigration and migration of science, engineering and technology graduates, and the impact this 'brain gain, brain drain' issue will have on Australia's skills base - particularly as we face an ageing workforce and countries with greater research expenditure. Global demand for skills in these fields will also be analysed.

The audit will consider the supply and demand of science skills across a broad range of science, technology and engineering disciplines and conduct case studies of specific industries.

FASTS President, Professor Snow Barlow, is on the steering committee appointed to oversee this audit process.

FASTS Structure and Constitution
The 2004 Annual Council Meeting of FASTS held in Canberra on 24 November 2004 decided that the FASTS's structure and Constitution need to be changed. After much discussion there was consensus that:
- FASTS should no longer maintain the distinction between corporate and affiliate members in terms of voting - all members have to have a vote;
- Whatever final structure is determined it should be simple;
- FASTS look to develop alternate funding sources other than just membership; and
- Need to broaden the FASTS base including industrial, technical colleges and VET.

There was also discussion over the structure of the Board. It was agreed the structure committee under Vice-President Bob Norris would develop various models for further consideration, and a new model and constitution will be presented to the Annual Council Meeting to be held in November 2005.

DISCLAIMER: The Federation of Australian Scientific and Technological Societies (FASTS) has taken all reasonable precautions.

THE 2005 WALTER BOAS MEDAL
Nominations are invited for the award of the 2005 Walter Boas medal of the Australian Institute of Physics. These should be sent to the Honorary Secretary, in electronic format, by July 31.

Aim
The Medal was established in 1984 to promote excellence in research in Physics and to perpetuate the name of Walter Boas. The award is for physics research carried out in the five years prior to the date of the award, as demonstrated by both published papers and unpublished papers prepared for publication, a list of which should accompany the nomination.

Nominations
Any AIP member may make a nomination or may self nominate for the award. Nominees should be members of the AIP and be Australian citizens and should have been residents of Australia for at least five of the seven years preceding the closing date for nominations. The Medal shall not be awarded more than once to any person.

Previous Winners
2002 Professor Peter Robinson, University of Sydney
2003 Professor Gerard Milburn
2004 Professor George Dracoulis, ANU

Presentation
The award is conditional on the recipient delivering a seminar on the subject of the award at a meeting of the Victorian Branch of the AIP in November 2005. The recipient is also expected to provide a manuscript based on the seminar for publication in The Physicist.

Further details may be obtained from:
The Honorary Secretary
Australian Institute of Physics
PO Box 16, Willetton WA 6955
Phone: 08 9332 1513 email: secretary@aip.org.au
2005 AUSTRALIAN MUSEUM
EUREKA PRIZES

REWARDING OUTSTANDING SCIENCE!

Entries are invited for the 2005 Australian Museum Eureka Prizes, Australia's premier and most comprehensive national science awards. The Eureka Prizes reward outstanding science, research, business and ICT innovation, education and science communication and raise the profile of science in the community. They are also the largest national award scheme for research into critical environmental and sustainability issues facing Australia.

A record 23 prizes worth almost a quarter of a million dollars will be awarded in four categories: education; innovation; research; and science communication.

Applicants can either enter themselves or be nominated by others. Entries close on Friday 13 May 2005. Winners will be announced at a gala award dinner in Sydney's celebrated Royal Hall of Industries on Tuesday 9 August 2005.

Details and entry forms for all prizes can be obtained from the Australian Museum's webpage at www.amonline.net.au/eureka or from eureka@austmus.gov.au

$2000 PRIZE FOR VACUUM SCIENCE ARTICLE

AS2000 cash prize is to be awarded by the Vacuum Society of Australia (VSA) for the best article published in it's Newsletter OZVAC.

There will be no restriction or limitation on the use of the funds. The article must appear in OZVAC and will be judged by the executive.

The article should be related to the Vacuum Science Field and be well presented informative and interesting.

Preference will be given to early entries with younger engineers, students, postdocs and early career academics being given priority.

Winner to be announced March 2006.

Please contact the OZVAC editor for details.

Bill Stanton Ph (02) 66856902

Email: bill@stantonscientific.com
Earth is still ringing from quake

Almost two weeks after the earthquake and ensuing tsunami that devastated huge areas of Asia, the Earth was still ringing like a bell, according to ANU scientists, Dr Herb McQueen, from the Research School of Earth Sciences.

The Superconducting Gravimeter is Australia’s most sensitive gravity measuring instrument and is located at Mt Stromlo Observatory. It relies on the exotic superconducting properties of metals at extremely low temperatures to detect faint changes in gravity caused by tides and major earthquakes. These signals are used to map the structure of the interior of the Earth. Charts produced by the gravimeter tracking the motion of the Earth can be viewed online at: www.rses.anu.edu.au/geo/dyna/SG.

ANU Press release

Galaxy patterns reveal missing link to Big Bang

Australian astronomers from the Anglo-Australian Observatory, The Australian National University and the University of New South Wales, together with their UK colleagues, announced that they have found the ‘missing link’ that directly relates modern galaxies like our own Milky Way to the Hot Big Bang that created our Universe 14 thousand million years ago.

This is the result of a 10-year effort to map the 3D distribution in space of over 220,000 galaxies using the 3.9-m Anglo-Australian Telescope (AAT) in New South Wales—a project called the 2-degree Field Galaxy Redshift Survey (2dFGRS).

This survey was almost ten times larger than any previous such study. It measured in detail patterns in the distribution of galaxies, on scales from 100 million to 1 billion light-years. Subtle features in these patterns were set by physical processes that operated when the universe was very young, and reveal the ‘missing link’ between present-day galaxies and the Big Bang.

“This is an enormously important finding,” said Dr Matthew Colless, Director of the Anglo-Australian Observatory, and the lead scientist of the 2dFGRS team. “Although there have been hints before of these features, this is the first high-confidence detection. We are increasingly confident that gravity was the driving force that created today’s galaxies.”

“Some features tell us the mass density of the Universe—the amount of mass for a given volume of space—with an uncertainty of less than 10 per cent.”

Independent corroboration of the 2dFGRS result was also announced today by the US-led Sloan Digital Sky Survey (SDSS), at the winter meeting of the American Astronomical Society in San Diego. The SDSS team used a sample of 46,000 highly luminous red galaxies and a different method of analysis from the 2dFGRS team’s. “Happily, the two groups’ conclusions are consistent,” said 2dFGRS team member Dr Joss Board and the Anglo-Australian Observatory. The robotic 2dF instrument, which made the survey possible, was designed and built by the Anglo-Australian Observatory. It measures the ‘redshifts’ of galaxies—a change in the light they emit that varies with distance, and which can be used as a measure of distance.

“The 2FGRS is the world’s most efficient machine for measuring redshifts,” said 2dFGRS team member Dr Russell Cannon, a former director of the Anglo-Australian Observatory during whose term the 2dFGRS had been initiated.


It has been submitted to Monthly Notices of the Royal Astronomical Society for publication.

ANU Press release

University of Sydney and ANU sign historic cooperation agreement

Two of Australia’s most prestigious universities have signed an agreement of collaboration which could have a major impact on Australia’s higher education landscape. The partnership between the University of Sydney and the Australian National University will see them cooperating in a wide range of areas covering research and higher education. The agreement follows a year of discussion and negotiation between the two institutions.

“We want to enhance the objectives and the research strengths of both universities,” said Sydney’s Vice-Chancellor Professor Gavin Brown. “We want to be judged by international standards and we are keen to develop a real competitiveness in the areas of Australia’s national research priorities.”

Professor Chubb said: “This agreement extends the ability of two leading Australian universities to provide major research, educational and international opportunities to the benefit of the nation. There are many areas of complementary strength.”

Collaboration between the two universities may include:

- The establishment of new cooperative research programs, as well as joint bids for new centres and resources.
- Joint graduate coursework degrees and honours degree programs.
- Joint undergraduate courses which will be offered by both institutions and will be co-badged allowing students to move between different courses with reciprocal credit and guaranteed enrolment.
- Joint international marketing, recruitment and study abroad programs. In 2005 an international recruiting tour will be undertaken by both universities as a prelude to possible further collaborations in 2006. As well, the two universities will collaborate in joint recruitment and planning of the study experiences within Australia of foreign study abroad students in 2005 and subsequent years. Offshore offerings may also be developed through sharing resources.
- Sharing of facilities and major infrastructure for research, teaching and outreach programs.
- Joint benchmarking in teaching and research.

Both Vice-Chancellors said they had been encouraged to reach agreement on greater cooperation and this agreement, while encouraging a preferred partnership in areas of complementarity, may include other partners in joint projects and does not inhibit bilateral ventures with other partners.

ANU/Sydney University media release

UNSW appoints new research head

The University of New South Wales announced the appointment of Professor Leslie (Les) Field as Deputy Vice-Chancellor (Research). Professor Field is currently Professor of Organic Chemistry at the University of Sydney, where he has also served in a number of senior roles including Acting Pro-Vice-Chancellor (Research) and Head of the School of Chemistry.

In a distinguished academic career, Professor Field has worked at the University of Southern California and at the University of Oxford as a Research Fellow. He has been awarded the Rennie Medal, the Edgeworth David Medal and the Organic Chemistry Medal for his research. Professor Field is a Fellow of the Australian Academy of Science and the Royal Australian Chemical Institute.

Professor Field takes up his appointment at UNSW at the end of March.
Network of women in materials science and engineering

Women are underrepresented in a number of science and engineering based disciplines and can face barriers to their career development. The School of Materials Science and Engineering is running a program called Materials NOW (Network of Women) which is designed to address these issues.

At a Network seminar last week a panel of women from both industry and academia spoke about their careers in the industry. The speakers included Professor Veena Sahajwalla, Director of the School’s Sustainable Materials Processing Research; Dr Clara van Aswegen, Director of Marketing for Air Liquide; Bernie Hobbs, science reporter for the ABC; Patricia Martyn, Patents examiner at IP Australia; and Jo Hugman, research engineer with Conalco Rio Tinto.

“We hope to see a change in the culture of not only the School but also the Faculty,” said Professor Sahajwalla, the Network's founder. “It can be quite intimidating to be one of four girls in a class of 30 plus boys so it's reassuring for our female students to know there is a network available to give them support in their studies.”

In collaboration with the Equity and Diversity Unit, the NOW program has received a second University grant to develop a mentoring program.

UNSW media release

Commercialisation of revolutionary “daylighting” technology begins

Revolutionary Australian technology that “pipes” heat-free natural light anywhere in a building is to be commercialised in a partnership between Australian company Skydome Holdings Ltd and the University of Technology, Sydney, as sealed in a set of recent agreements.

The agreement between UTS and Skydome subsidiary company FluoroSol Systems Ltd is the culmination of 15 years of research into natural light-based indoor lighting by a team led by UTS applied physicists and daylighting experts Professor Geoff Smith and Jim Franklin.

Professor Smith said he believed the daylighting system was as revolutionary as the filament light bulb was 125 years ago. It would provide daylight economically and efficiently to the inner core of a building envelope, a function not readily available today.

The polymer optic daylight system, which can be roof or wall mounted, collects and channels sunlight through a flexible light guide. At the other end special outlets disperse the light much like a standard electrical light fitting.

“It’s the realisation of an ideal - daylight available almost anywhere it is needed, on any floor of a building, with virtually no associated heat or ultraviolet radiation,” Professor Smith said.

Professor Smith said the daylighting technology could be installed easily in new and existing buildings without the need for significant structural alteration.

UTS media release

UOW becomes an additional node of NANO

The University of Wollongong and the NANO-Major National Research Facility (MNRF) announced today that the University has entered into an agreement to become an Additional Node of the NANO-MNRF from 1 March 2005.

NANO-MNRF (www.nano.org.au) operates as an unincorporated joint venture between The University of Sydney, The University of Queensland, The University of New South Wales, The University of Western Australia and The University of Melbourne. It receives funding from the Commonwealth and State Governments as well as industry.

NANO unites major Australian microscopy and microanalysis centres to form an integrated research facility that brings together outstanding equipment and research expertise. It provides the peak Australian facility for the characterisation of physical, chemical and biological materials from the macro to the micro and down to the nanoscale.

UOW media release

Straight sevens earn uni glory for super science duo

An incredible dual effort by two science graduates to achieve top marks throughout their entire honours degrees in physics has been rewarded with top academic awards.

And while you may think Sarah Beavan and Kristy Vertain could have been rivals on their path to win prestigious science medals at a recent QUT graduation ceremony, the brilliant graduates say nothing was further from the truth.

“There was absolutely no rivalry between us - in fact it was extremely handy to have someone to check answers with,” Sarah laughed.

As best friends, Sarah, 21 from Rockhampton and Kristy,19, a former Dean’s Scholar from Nangaroo, both completed their bachelor degree of applied science with a major in physics achieving the maximum possible grade point average (GPA) of 7.00. They both then went on to complete an honours degree last year, also with an overall GPA of 7.00.

For their honours projects, Sarah and Kristy worked in the emerging area of nano-optics and photonics. “It’s great to be finished because, honestly, the last year has been the most difficult of my life,” Sarah said.

For Kristy, physics is truly a labour of love. “Ever since I was invited to watch a rocket launch at Woomera in Year 11, I knew physics was what I wanted to do,” Kristy said. “It’s a very challenging area, always something new and exciting, which is what I really enjoy.”

TIGER opens second eye across the Tasman

TIGER – the Tasman International Geospace Environment Radar – will take a much larger bite at southern skies from this week with the opening of its second radar base in Invercargill, New Zealand, helping to measure the impact of auroras and detect echoes from meteors.

Operated by a consortium of Australian Research Institutes headed by La Trobe University, TIGER is part of the international SuperDARN (Super Dual Auroral Radar Network) operated by ten nations to cover both southern and northern polar regions.

The new radar is named after New Zealand scientist, Dr Bob Unwin, a pioneer of ionospheric studies in the 1950s and 60s who set up an auroral radar in New Zealand and explored the possibility of having a second radar in Tasmania.

It was opened by his son, Mr Martin Unwin, a scientist with the National Institute of Water and Atmospheric Research Ltd, Christchurch, NZ.

TIGER monitors the location of aurora and related phenomena in the ionosphere, 100 to 300 km above the Earth. Results from its full operation will include greater knowledge of space physics and space weather processes to help manage radio communications, navigation systems such as GPS, satellite operations, magnetic surveys for minerals and occasionally, under extreme solar conditions, impacts on electricity supplies.

La Trobe University operates TIGER on behalf of a consortium that also comprises Monash University, University of Newcastle, the Australian Antarctic Division, IFS Radio & Space Services, and the Defence Science and Technology Organisation.

TIGER explores an area half the size of Australia with one of four radio signals via the ionosphere towards Antarctica and detecting weak echoes from structures in the ionosphere. These echoes are used to form images of the ionospheric structures and measure their speed and direction of motion.

It also detects echoes from meteors which are used to calculate wind speeds at heights of around 100km, and it can even detect signals from the sea.

Professor Dyson says when the sun’s corona ejects huge amounts of matter that reaches the Earth, there are rapid changes in wind speed and temperature in the ionosphere as well as the magnetosphere, the outer region of the Earth’s magnetic field.

La Trobe media release

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The Physicist Volume 42, Number 1, January/February 2005
NSW Branch

AIP Christmas BBQ and trivia night at Macquarie.

The NSW branch Christmas get-together was hosted by the physics department at the very green Macquarie University campus. Attendees enjoyed a BBQ and drinks in the lush surroundings of the University parklands and despite the patchy drizzle the weather remained mild. The campus wildlife, rabbits, ducks (and the local post grad) put in their usual appearances making it a very pleasant evening for the families who braved the threatening weather to enjoy the BBQ.

The BBQ was followed by several rounds of Trivia with quiz master Jenna Shaw. Themes ranged from physics and astronomy to sport and Australiana keeping everyone interested and, until the final few rounds, several teams were in the running to take out the trivia masters title. The non-trivial trivia knowledge of Dr. David Coutts helped get his team “Baer’s Jackeys” (after Macquarie’s favorite technical assistant David Baer) over the line on the night. Some very good bottles of wine were awarded to the runners up on the night, and a very enjoyable time was had by all.

Special thanks to Scott, Jenna, and Sallie Cortis for organising and hosting the evening and also to the Australian Institute of Nuclear Science and Engineering (AINSE), the AIP and Macquarie’s physics department for providing some quality bottles of Australian wine for us to enjoy on the night.

SA Branch

The South Australian Branch has had an active start to 2005. So far we have hosted the 2003 Gold Bragg Medal lecture by Dr Michael Bromley (20th January) and the Claire Corani Memorial Lecture by Professor Helen Quinn (17th February). The latter lecture was given as a part of the 2005 AIP Women-in-Physics Lecture Tour, with about 200 people attending in the Union Hall at the University of Adelaide. Prof. Quinn also presented the Claire Corani Memorial Prizes to Ms Jessica Francis-Staite (Flinders University) and Ms Julie Barnes (University of Adelaide) and the Bronze Bragg Medal to Ms Emily Cooper. On the following day she visited the Australian Science and Mathematics School at Flinders University and gave a seminar at the University of Adelaide.

There were also some financial assistance to the students of School at Flinders University known as the: “Society for Physics, Astronomy, Cosmology and Experimental Devices” (SAPCD) (see the short article about SAC in the Education section). This support is to help them with their activities in 2005. Finally the branch is initiating an award to recognise the important contributions made by physics teachers to physics education in SA.

Tasmanian Branch

The physics year in Tasmania started on 14 January with an impressive event when the Huygens probe dropped from Cassini into the atmosphere of Titan. The University of Tasmania radio telescopes at Ceduna (in South Australia) and Mt Pleasant, near Hobart airport, where part of the international very long baseline interferometer (VLBI) array that was receiving signals from the probe. The VLBI array data would be combined with the Cassini data to allow a determination of the horizontal motion of the craft as it dropped to the surface, giving a measure of the winds at various altitudes in Titan’s atmosphere.

These two radio telescopes were the only two in the array not owned and operated by national institutions, a position in which the University of Tasmania took some justifiable pride. To mark the event the University held a public lecture in the early evening where Dr Melanie Johnston-Hollitt, one of the department’s radio astronomers, described the Huygens-Cassini mission and the role of the University’s telescopes in the mission. A short break with drinks and nibbles after the lecture was followed by a live link to ESA mission control where the audience was treated to first hand and real time updates and interviews with mission specialists. It was an wonderful night and the very good sized audience felt fully satisfied with science and the excitement of the occasion.

Soon after this event, members of the Tasmanian Branch executive were making the final editorial corrections to the AIP commissioned book “History of Physics in Tasmania 1792-1982” by Geoff Fenton. Unfortunately the book was not quite ready for presentation at the Congress and is at the printers at the time of writing this article.

Dr Helen Quinn, the 2005 AIP Women in Physics lecturer, visited the state following the Congress. Unfortunately Helen’s very tight schedule meant that she could not come during the University semester and so we did not have a Women in Physics lecture for the undergraduates this year.

We did have a public lecture and a departmental seminar from Helen. The public lecture was held on Monday night, 14th February which happened to be a public holiday in Hobart. The lecture competed with several events associated with the Hobart regatta but even so an audience of more than 50 attended. As most branches will have a visit by Helen her lecture is not summarised here but it is worth noting that she is an excellent speaker and the audience related well to her presentation.

The next event on the Branch calendar is the Science Teachers seminar conducted in conjunction with the RACI. Here later year high school science teachers are introduced to some of the physics and chemistry research that is being done around the state. In addition discussions about the curriculum are a central theme. The event will reported in more detail in the next issue of the Physicist.

Marc Duldig
PRESS ROOM

Government press releases relating to physics or science in general

$1 million in prizes for quality schooling award winners

On 17th February, Minister Brendan Nelson announced $1 million worth of prizes awarded to the winners of the 2004 National Awards for Quality Schooling, which recognise excellence and innovation in schools.

The winning schools demonstrated success in the priority areas of literacy and numeracy, safe school environments, school leadership, values education or, innovation in science, mathematics and technology. A total of 51 schools, six principals and 16 teachers were awarded prizes including:

- Best Achievement by a School prize ($65,000): Charles Darwin University Senior Secondary school;
- Best Achievement by a Principal prize ($30,000): Ms Wendy Teasdale-Smith of Parafield Gardens High School;
- Best Achievement by a Teacher prize ($30,000): Ms Felicity Mandile of Elanora State High School.

Twenty-three prizes of $20,000 each were also awarded for Outstanding Achievement by a School. Two prizes of $10,000 were awarded for Outstanding Achievement by a Principal and seven $10,000 prizes were awarded for Outstanding Achievement by a Teacher.

In the Highly Commended category, prizes of $10,000 were awarded to 27 schools, and prizes of $5,000 were awarded to three principals and eight teachers.


National inquiry into teacher training

Minister for Science, Educatio and Training, Dr Brendan Nelson, welcomed the decision by the House of Representatives Standing Committee on Education and Vocational Training to conduct an inquiry into the quality of teacher-training courses.

He said that the quality of teaching in our nation’s schools is one of the most important determinants of student success and every Australian child deserves to be inspired and informed by teachers of the very highest quality. World-class preparation of graduating teachers is essential if they are to meet the demands of teaching in the 21st century.

The House of Representatives inquiry will include an examination of:

- whether teacher trainees are being effectively prepared to deal with all the challenges they will face in the classroom;
- the adequacy of funding provided by universities to their education faculties;
- how teaching can become a more appealing career option;
- how the needs of mature-age entrants to the profession can better be met;
- the educational philosophy underpinning the teacher-training courses (including the teaching methods used, course structure and materials, and methods for assessment and evaluation) and an assessment of the extent to which it is informed by research.

Raising the respect society has for the teaching profession is vitally important, as too is the ability for the teaching profession to take responsibility for setting and maintaining teaching standards.

The Howard Government has provided initial support of $10 million for the establishment of the National Institute for Quality Teaching and School Leadership (NIQTSL), which will advance the standing of the teaching profession.

On-going professional learning is also vitally important for teachers. Through the Government’s Quality Teacher Programme, $159 million has been committed to enhance teacher knowledge and skills in areas of national priority.

As part of the Government’s $2.6 billion higher education reforms, additional funding of more than $109 million will be directed to support the costs associated with teaching practicum as part of university teacher-training courses.

The minister also said that the Committee had his full support and encouragement and that he would ensure that his Department provided it with any additional support or resources the Committee required as it undertook this crucial inquiry.

The Terms of Reference are available from the Committee at www.aph.gov.au/house/committee/evt/index.htm

AUSTRALIAN SYNCHROTRON
COMMUNITY OPEN DAY

Sunday 20 March 2005  10am - 4pm

The Australian Synchrotron Project is holding an open day between 10am and 4pm on Sunday 20 March 2005. The day is a once-only opportunity to see inside the synchrotron machine tunnels before installation of the machine starts.

You, along with your friends and family, are invited to come along and find out what the synchrotron will be used for, how it works and to enjoy free kids’ interactive activities and a free sausage sizzle. A ceremony to mark the completion of the building will be held at 11am.

Entry to the site is from Wellington Rd., Clayton (cnr. Blackburn Rd). Entry and parking is free; there is no need to register.

For more info and photos please see www.synchrotron.vic.gov.au

The Physicist  Volume 42, Number 1, January/February 2005
The Three Rs of Nuclear Science
If ever there was a subject demanding a good intermediate-level text it would have to be nuclear science. Existing materials are either too advanced or too polemic. Here is a book suitable for second-year university or college classes, covering many aspects of the subject. The authors, Joseph Magill and Jean Galy, have appropriately titled their book Radioactivity Radionuclides Radiation - the three essential R's. Their book is wonderfully up to date, with references right up to 2004, the year of publication. And it is not just the references - the emphasis in each chapter is on the latest progress, such as the inconstancy of decay constants in highly ionized atoms, laser-induced radioactivity and laser induced transmutation of elements - work in which the authors participated. There are chapters on applications in archaeology, medicine and industry with well-chosen examples and plenty of references. The authors do not shrink from controversy, calling into question the LNT hypothesis of radiation exposure and giving support to radiation hormesis.
The presentation runs to 259 pages including a good glossary, a fold-out Karlsruhe table of nuclides, a 30-page table of atomic masses and a CD-ROM Universal Nuclide Chart that is easy to load into a PC and call up whenever needed. It includes a decay-chain simulator and a neutron reaction-path simulator. These features make the book and its CD a very useful text except that it has no exercises.
Radioactivity Radionuclides Radiation is published in hardcover by Springer and costs a very reasonable EUR 49.95 - about AS100 depending how you order it. It bears the ISBN 3-540-21116-0. Great value.

Colin Keay
Reviews Editor

How Steam Locomotives Really Work
P W B Sommens and A J Goldfinch
Oxford University Press, New York 2003
vi + 348 pp., AS29.95 paperback
ISBN 0 19 860782 2

This book contains about 90 line diagrams, 20 tables, 130 plates, and a comprehensive index. The wealth of visual material succinctly explains the many components of a steam locomotive. Their development is well traced, from the 1829 Rainhill trials to the pinnacle of British steam (eg: the streamlined Flying Scotsman) and the 500 ton American mammoths.
The reader will be introduced to many quaint terms which add colour, such as: 'linking up, brick arch, fire at both ends, putting it to bed. Unfortunately, many (eg: tyre, journal, loading gauge) are not defined where first used, or at all. The many different types of locomotive are given their own personality. You would know that a 'tank' engine (such as Thomas) carries its own water and coal, the absence of a tender making it more maneuverable in a "works" application. Less familiar will be the banker, fireless loco, and articulated loco. It is a paradox that even low pressure exhaust steam can be used to inject water into the boiler at high pressure with no moving parts.
The application of knowledge from physics through engineering to working systems is well explained. The thermodynamics of steam are applied to the production of "tractive effort". The ideal thermal efficiency was lifted from about 15 to 17% through superheating. When diesels achieving perhaps 50% became common around 1950, the steam era was brought to a close, except for tourism usage.

Between Necessity and Probability: Searching for the Definition and Origin of Life
Radu Popa
Springer Verlag, Berlin 2004
xii + 252 pp., AS170 (hardcover)
ISBN 3 540 20490 3

"Where does life come from?" These are the first words in Popa's Preface to his monograph and he quickly establishes that he is interested in defining the likely paths to understanding how life in its most fundamental form appears in the Universe. This is not about the development of intelligence, but about the early origins of life. Incidentally, the discussion focuses on the genesis of life on Earth, but Popa constantly reminds that this must not prevent the development of a broader, all embracing outlook. Jumping to the first sentence of Chapter 8: "So far no theory, no approach, no set of formulas, and no blackboard scheme have been found satisfactory in explaining the origin of life".
The scale of the problem posed is the subject matter of this monograph, not the answer, which we are still seeking. Popa's contribution is a wide ranging critique of current thinking on life's origin. For those familiar with the problem, this is an engaging personal viewpoint. Will the novice, seeking entry to the field be satisfied as well? For them, it may be useful to start at the four appendices, since if it is helpful to learn early that there are other ways to define "closed systems" and that some life theories lead to a fourth law of
thermodynamics. The book is well presented and contains fewer types than usual, but it lacks an index, which I would have found most useful.

P J Wilkinson
IPS Radio and Space Services
Sydney

**Edward Teller Lectures**

**Lasers and Inertial Fusion**

Energy

H Hora and G H Miley (eds)
Hora & Miley, South Hurstville, 2004
xii + 366 pp., AU$40.00+IP&Sp (paperback)
US$88
ISBN 0 646 44226 0
Imperial College Press, London 2005
ISBN 1 86094 468 X

The Edward Teller Medal recognises outstanding contributions to the field of inertial confinement fusion and high energy density physics. This book presents a compilation of lectures by twenty one Edward Teller Medalists, with each lecture containing an overview of the subject from the perspective of the author. The book also contains occasional addresses by Edward Teller at Laser Interaction and Related Plasma Phenomena conferences from 1973 to 1997. These reveal some unique insights into the man himself.

This book has clearly been a labour of love for the editors, who have been keen players themselves in the quest for laser driven inertial fusion energy. Although still to be fully realised, it is clear that this Teller inspired adventure has uncovered a lot of new and fundamental physics along the way.

Murray Batchelor
Department of Theoretical Physics
Australian National University

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**Einstein’s Heroes**

Robyn Arianrhod
Queensland University Press, Brisbane 2003
x + 323 pp., AS$24.00 (paperback)
ISBN 0-7022-1408-7

This is, in places, a delightful account of the personal lives and science of some of the 19th century physicists, revealing how they struggled to find mathematical models for phenomena, such as the vector field description of electromagnetism in the case of Maxwell. The elementary aspects of mathematics are explained at a level suitable for high school students. However there are major misunderstandings and factual errors. We are told that the 1887 Michelson Morley experiment did not detect fringe shifts during its 36 rotations. This is historical nonsense, even if one of the great ongoing myths in physics. That experiment did detect the expected fringe shifts indicative of absolute motion, as given in the data table in the 1887 paper. Using a Newtonian model for the interferometer these fringe shifts gave a speed of some 8km/s, a value known to Michelson. But using a post-relativistic model for the interferometer, which takes account of the length contraction effect and the effect of the air present, which slowed the light slightly, the detected speed now becomes some 300km/s. Michelson reported his results as ‘null’ not because the fringe shifts were not seen, but because the speed he deduced was less than the orbital speed of 30km/s about the sun. There is no mention of the work by Miller who used a much larger interferometer and took readings from 20,000 rotations during 1925/26, and which, together with other experiments, confirmed the Michelson fringe shifts. Miller gave a speed of 200km/s together with the direction, using earth orbit induced variations over a year to calibrate his instrument.

So from the beginning the space-time construct was a blunder, which is not in conflict with the well established relativistic effects, or even the use of the space-time construct as a mathematical model in, say, quantum field theory. What experiments have indicated was that the 19th century physicists had in fact already by then got most of the relativity theory sorted out, and that the Lorentzian interpretation of these effects was correct, and not the subsequent Einstein Minkowski misinterpretation. In the book there is no mention of this significant Lorentzian interpretation, or of those physicists who first and correctly sorted out relativity. So this book is very misinformed in its historical accounts, and is more a repetition of the mythology of physics.

R T Cahill
School of Chemistry, Physics and Earth Sciences, Flinders University

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**Book requires reviewer:**

A reviewer is needed for a book that arrived last year from the Johns Hopkins University Press. It is “Introduction to the Physics of Gyrotrons” by G S Nusinovich. Gyrotrons are high-power generators of microwave and millimeter-wave radiation with many practical applications in radar, communications and industrial fields.

The book is available to any suitably experienced physicist or engineer who is willing to submit up to 250 words assessing its worth. Please email your request to the Reviews Editor <colin.keay@newcastle.edu.au>.
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**Profiling UV Lasers with Fluorescent Plates**

Warsash Scientific is pleased to announce new low-cost components for profiling of UV laser beams from Spiricon Inc. A plate whose surface fluoresces is placed in the path of a UV beam, and the fluorescence is imaged with a CCD camera and lens to capture the beam profile. The profile is analysed and displayed with Spiricon's LBA-700PC series beam analysis software. The plates provided by Spiricon are much lower in cost than previously used crystalline materials, and are available in sizes from 1” circles up to much larger 12” squares or circles.

Direct profiling of UV laser beams on CCD cameras has been difficult because of the lack of materials for beam attenuation. (A typical attenuation of 10^6 to 10^8 is needed to not overdrive the CCD.) The ND filters used for visible and IR lasers are typically made of glass which does not pass UV. Inconel metallised quartz.

ND filters are only made with non-fringing coatings up to ND = 1.5. (ND above 1.5 are metallised on both sides which causes interference fringes, and distorts the beam profile. Stacking multiple filters also creates interference fringes.)

The fluorescent plates provided by Spiricon provide a linear output of visible fluorescence to input UV stimulation. The fluorescence conversion provides the first attenuation, and additional attenuation is provided by the lens iris and visible attenuating ND filters placed in the path of the plate to the camera.

Beams from 5mm to 300mm can easily be imaged with standard camera lenses. Focused spots as small as 10um can be imaged by using microscope objectives with the CCD.

The UV fluorescent profilers are useful for viewing excimer laser beams and triple- and quadrupled Nd:YAG laser beams. The plates are also useful for dosimeter measurement of semiconductor photolithography UV illumination systems. The plates can be imaged from the back side (transmission), or at right angles using a turning mirror.

For more information on these and other laser beam profiling systems please contact WARSASH Scientific Pty Ltd on (02) 9319 0122 or sales@warsash.com.au

**New Scanning Stage**

PI (Physik Instrumente) has unveiled a long-travel piezo scanning and nanomanipulation system that offers integrated capacitive feedback and closed-loop control that boost linearity by up to three orders of magnitude over conventional stages.

The P-563.3CD PI-Mars provides 300 x 300 x 300-μm travel in the X-Y-Z axes, with nanometer resolution.

It has a 66-mm^2 clear aperture and a parallel kinematics design that features only one moving part.

Response is in the millisecond range.

Available versions include ultra-high-vacuum, invar, superinvar and titanium. Further information on these and other nanomanipulating systems is available from WARSASH Scientific Pty Ltd at (02) 9319 0122 or sales@warsash.com.au
CONFERENCES & MEETINGS

2005

March 13 - 17  Eleventh Australian International Aerospace Congress
Melbourne Convention Centre, Melbourne, VIC
www.aiac-11.com

April 10 - 14  Institute of Physics: Physics - a century after Einstein
Coventry, UK

April 10-15  12th International Conference on Near Infra-Red Spectroscopy 2005
Auckland, NZ
www.NIR2005.com

April 27-28  Science 2005
Melbourne Convention Centre

May 2-15  ICAN, Canberra’s ideas and innovation festival
Canberra, Australia
www.icanfestival.com.au

May 8 - 12  Nanotech2005
Anaheim, USA
www.nsti.org/Nanotech2005/

                   Nanotechnology Conference and Trade Show
                   Anaheim, USA
                   www.nanotech2005.com

June 6-10  20th European Photovoltaic Solar Energy Conference and Exhibition
Barcelona, Spain

July 25 - 29  International Meeting on Frontiers of Physics
(IMFP 2005)
Mines Beach Resort and Spa, Kuala Lumpur, Malaysia.
http://fizik.um.edu.my/imfp2005/

October 23 - 27  EPSM 2005 (Engineering and Physical Sciences in Medicine)
Adelaide, South Australia

November 3 - 5  Asia-Pacific Space Agency Forum
Canberra, Australia
http://www.aprasaf.org/

November 9-11  Acoustics 2005: National conference of the Australian Acoustical Society
Busselton, Western Australia, Australia
www.acoustics.asn.au
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