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In Physics, it is clear to me that we must have advanced research to inform the teaching program and so that the undergraduates learn Physics from those actively involved in advancing the discipline.

This column comes to you from the town of Nelson in the South Island of New Zealand. I am on summer holidays in this very interesting and beautiful part of the world. Nelson is of special relevance to Physicists, not just because of its excellent range of cappuccino bars and proximity to the Abel Tasman National Park but because it is the place where the great Ernest Rutherford was born on August 30, 1871. As reported in a previous issue of *The Physicist*, there is now a spectacular memorial to Rutherford on the site of his house, just south of Nelson itself. It must have been a crowded house; Rutherford was child number four of a total of twelve in the family. His mother was a teacher and his father a wheelwright. Rutherford obviously remained attached to his New Zealand roots because he adopted the title “Lord Rutherford of Nelson” after promotion to the peerage in 1931.

The Nelson Rutherford memorial provides fascinating details of Rutherford’s early education which took place during the introduction of the New Zealand Education Act of 1877. This Act mandated education for children from 7 to 13 years and free education up to age 15. It is likely he benefited from the introduction of the Education Act and it appears his early education provided a strong foundation for his later achievements. Indeed Rutherford had contemplated a career in teaching himself, but applied unsuccessfully for a teaching position in 1889 before moving on to other things.

After winning a scholarship, Rutherford left New Zealand at the age of 23 to pursue studies overseas. As it says on a plaque on the Nelson monument, by the time he left New Zealand Rutherford was a “highly skilled researcher at the forefront of advanced electrical technology.” So he obviously had the benefit of some excellent teaching during his studies after leaving school. His research work “altered our view of nature on three separate occasions through his brilliantly conceived experiments and special insights.” I imagine this list includes the discovery of the atomic nucleus by what we now call Rutherford scattering of alpha particles (a technique applied daily in my own laboratory), the discovery of the transmutation of nitrogen into oxygen by alpha particle bombardment and the demonstration of alpha and beta radioactive decay.

For his work on radioactive decay Rutherford won the Nobel Prize (for Chemistry) in 1908. The newspapers of the day reported Rutherford’s Nobel Prize and attributed Rutherford’s nationality to variously New Zealand, Canada or England depending, no doubt, on the depth of the research or nationality of the respective journalists. But Rutherford didn’t forget his early education from 25 years earlier. After winning the Nobel Prize, Rutherford sent his old school teacher the sum of 20 pounds in acknowledgement.

From his mother’s career to the foundations of his education, teaching laid the foundations of Rutherford’s life and career. At this time of the year, the teaching spaces in Australia are quiet with most students on summer holidays. But those of us that must compete for research funds from the Australian Research Council are far from quiet. It is a bit unfortunate that the most intensive time of the year for writing research proposals to the ARC should occur at the optimum time of the year for taking a holiday with friends and family.

However, this is perhaps not a coincidence. For those of us who also teach, it would be difficult to focus fully on writing a competitive research proposal while also teaching. The link between research and teaching is presently subject to intense debate at my institution. In Physics, it is clear to me that we must have advanced research to inform the teaching program and so that the undergraduates learn Physics from those actively involved in advancing the discipline. Otherwise what else has attracted the students into Physics in the first place? There is so much happening in Physics research than can find its way into the undergraduate program. To name just one, the astounding Cassini/Huygens mission data provide a wealth of examples in the fields of mechanics, electromagnetism and so on.

But there are now undesirable changes to the rules that govern some of the most desirable ARC fellowships that will break this nexus between teaching and research. Recipients of these fellowships will now be explicitly barred from contact with undergraduates for the five year duration of their fellowships. What is the host institution to do? Replace these fellowships with contract teachers who will not enjoy the same tenure or access to research facilities? Would Rutherford have approved of this situation? I wonder if the very important role of good teaching in advancing the discipline of Physics is as widely recognised as it should be?

At a recent forum on the developing Research Quality Framework I asked the DEST representative if teaching will be factored into the evaluation process. Given that many of the Physics researchers in Australia also carry a heavy teaching load, I felt that this aspect of our work needed to be considered. Needless to say, there will be no provision for this in the RQF. Institutions will have to decide how to maximise their outcomes as they see fit once the process is fully elucidated.

Regardless of whether your career in Physics involves teaching or not, I wish you happy new year and for a successful post-Einstein International Year of Physics in 2006.

Prof. David Jamieson
Editorial

Here we are at the beginning of another year. It’s the nature of a new year to make us look backward – one only has to look at the many science journals and their ‘Top Ten’ topics or discoveries or whatever. And, of course, the mainstream media milks the past for all it’s worth at an even faster pace than the year. Two of the sources I use for following physics news had their own top lists. However, they each had their own way of looking at it.

As it was the Einstein Year, Physics World compared 2005 to that annus mirabilis looking at what they felt were the top stories from each month. Unfortunately, the conclusion was that 2005 was not quite as miraculous as 1905.

The top stories selected were:

1. January: All-silicon laser makes its debut
2. February: Saturn and Titan reveal their secrets
3. March: The passing of a legend
4. April: Negative refraction goes optical
5. May: Particle physicists discover new meson
6. June: Europe beats Japan to fusion prize
7. July: Quantum boost for optical clocks
8. August: Fibres control the speed of light
9. September: Comet reveals its secrets
10. October: New look for Hall effect
11. November: Electrons lose their mass in carbon sheets
12. December: Entanglement reaches new levels

Physics News (web based physics news from the American Institute of Physics) took a different approach and didn’t confine themselves to just 10 or 12 stories. They chose one main story and listed about 20 other stories as significant. The story singled out was that at the Relativistic Heavy Ion Collider (RHIC) on Long Island, the four large detector groups agreed on a consensus interpretation of several year’s worth of high-energy ion collisions: the fireball made in these collisions was not a gas of weakly interacting quarks and gluons as earlier expected, but something more like a liquid of strongly interacting quarks and gluons.

Among the other stories that rated a mention were:

- the arrival of the Cassini spacecraft at Saturn and the successful landing of the Huygens probe on the moon Titan;
- the development of lasing in silicon;
- the biggest burst of light ever recorded from outside the solar system, from a soft gamma repeater;
- further evidence for superfluid behavior in a solid;
- detection of infrared radiation directly from an exoplanet;
- zepigrum mass sensitivity in a cantilever sensor;
- splashless impact of droplets at low pressures;
- the demonstration of pyrofusion, fusion reactions created with a pyroelectric crystal;
- the best-yet prediction of hadron masses using lattice QCD;
- the best measurement yet of the weak nuclear force;
- superfluidity directly observed in a sample of ultracold fermi atoms;
- geoneutrinos observed;
- hybrid atom-molecule dark states;
- hydrophobic water;
- molecules that walk;
- phonon Hall effect;
- short gamma ray bursts identified as coming from in-spiraling neutron stars;
- hyperentangled states.

In this issue: You may have seen over the last few months some media coverage regarding the interpretation of the Michaelson-Morley interferometer experiment. In his article in this issue, Dr Cahill gives more detailed information on this controversial subject. And we can’t leave the EIWOP without a final report on the activities funded by the AIP/DEG grants.

Corinna Harrigan

Deadline for next issue: 20th February 2006

Submission guidelines

All articles for submission to Australian Physics should be sent in electronic format, Word or rich text format are preferred, but other formats, such as PDF, may also be accepted. Please check with the editor if your article is in a different format.

Images should not be embedded in the document but should be sent separately in high resolution JPEG or TIFF format.
Dear Editor:

I was distressed to see that the author attribution for the SNAPSHOT piece in the September/October 2005 issue of Australian Physics by Dr. Ragbir Bhathal contains the phrase "He's considered the father of SETI in Australia."

While Dr. Bhathal has written extensively on SETI and more recently has been involved with a program of optical SETI, I contend that SETI in Australia had a singularly matriarchal origin. It was Dr. Roberta Vaile at the University of Western Sydney MacArthur who brought SETI to Australia, first as a teaching tool, then as a team member for our Phoenix

Project SETI observations at Parkes for six months in 1995, and finally as the initiator of the SETI Australia Centre and Southern SERENDIP observations. "Bobbie" is properly remembered at seti.uws.edu.au/main/Bobbie.htm.

I myself didn't get to know Bobbie until she presented a paper at the 1993 Bioastronomy Symposium wherein she described the experience that she and Dr. Frank Stoetman had had using SETI as part of a new Physics 1A course during the preceding two years. However, she had already been at the SETI Institute, where I now work, on several occasions collaborating with Dr. Frank Drake [the father of observational SETI] on a SETI textbook. From the first meeting, the final emails, I was impressed by Bobbie's courage in the face of cancer, her zest for life, her enthusiasm for SETI, and her determination to make a difference in the lives of her students. She changed my life, and we shared many many hours observing at the Parkes radio telescope. Therefore, I think it important to correctly trace the lineage of SETI in Australia, and remember her mother.

Jill Tarter
Director, Center for SETI Research

Jill Tarter's note is both hurtful, inaccurate and misinformed since Bobbie Vaile was a personal friend of mine. Unknown to Tarter I was the Foundation President/Chairman of the SETI Australia Centre and Chairman of the organising committee of the first international conference on SETI and Society held at UWS. My book Searching for ET was the first book published in Australia on SETI and I was responsible for introducing the first very popular fully illegal course ILife in the Universe! at UWS. Over the years I have, and continue to disseminate information on SETI through lectures and talks to schools, the public and scientific organisations. I have also appeared on several occasions in the media on SETI. I might be of interest to Tarter to know that the webmaster of the website she quoted removed my name deliberately as being the Foundation President/Chairman of the SETI Australia Centre.

The honour of being Father of SETI in Australia was conferred on me by the Australian SETI Society - a group of SETI enthusiasts in Australia. The honour is not of my making. SETI in Australia has both a mother and a father.

Dr Ragbir Bhathal
Past Foundation President/Chairman
SETI Australia Centre
Samplings

People

Einstein publishes on ArXiv
It seems appropriate that, in the Einstein Year of Physics that a paper by the man himself should turn up on arXiv (arxiv.org - a pre-print server). The paper, *Theoretical remark on the superconductivity of metals* (arXiv: physics/0510251) is a translation of some comments on superconductivity published in 1922 and titled *Theoretische Bemerkungen zur Supraleitung der Metalle*.

The paper was translated by Bjorn Schmekel of the University of California at Berkeley at the request of Neil Ashcroft, the distinguished theoretical condensed matter physicist at Cornell University. In the Einstein Year, Ashcroft thought it would be historically informative and interesting to see whether Einstein had anything to say about superconductivity. Eventually, he located the 1922 paper that, surprisingly, had never been translated.

*ArXiv, PhysicsWeb*

Einstein stars in global webcast
A live physics "webcast" took place on December 1 between 11:00 and 23:00 GMT. It was a series of talks, discussions and other activities held at physics laboratories and science museums across the globe, from Switzerland to Taiwan and Egypt to Antarctica. Physicists discussed the work of Einstein and other topics in modern physics, including relativity, gravitational waves, antimatter and neutrinos.

*PhysicsWeb/Physics News*

Short Notes

Faster than light sound?
Joel Mobley, a physicist at the University of Mississippi, has shown in simulations that ultrasound pulses could move at "superluminal" speeds when they enter water that contains thousands of tiny plastic beads.

Waves moving in a dispersive medium are described by a phase velocity and a group velocity. The phase velocity is the speed at which a wave of a single wavelength moves, and is typically about 1.5 kilometres per second for sound waves in water. However, pulses of light or sound actually contain a range of wavelengths that all move at different speeds: the group velocity is the speed at which the pulse itself moves.

In recent years, it has been shown experimentally that the group velocity of a laser pulse can exceed the speed of light in vacuum — 300,000,000 metres per second — in certain situations. However, special relativity is not violated in these experiments because they do not involve the transfer of information, matter or energy.

*PhysicsWeb/Physics News*

Measuring the size of a small, frost world
Observing a very rare occultation of a star by Pluto's satellite Charon from three different sites, including Paranal, home of the VLT, astronomers were able to determine with great accuracy the radius and density of the satellite to the farthest planet. The density, 1.71 that of water, is indicative of an icy body with about slightly more than half of rocks. The observations also put strong constraints on the existence of an atmosphere around Charon. [Nature, Jan]

*European Southern Observatory*

Silicon chip puts the brakes on light
Yuri Vlasov and colleagues at the IBM T J Watson Research Center in New York have now taken a step towards controlling the speed of light by using a photonic crystal waveguide made of silicon to produce slow light. The waveguide, which is 250 microns long, is etched with a pattern of tiny holes, each 109 nanometres wide, which give the silicon a very high refractive index. An electrical contact acts as a miniature heater.

When a current flows through the heater, it heats up the waveguide, which changes the refractive index and therefore the speed of light in the structure. Applying just 2 milliwatts of electrical power can change the group velocity by a factor of three within 100 nanoseconds.

The IBM work follows a spate of recent work on manipulating the speed of light with optical fibres and various semiconductor structures.

*PhysicsWeb*

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*PhysicsWeb*

Beetle sports photonic crystal coat
Why are some coleoptera beetles blue? Because light striking the beetle's external hard parts undergoes destructive interference. Precisely how this happens is now being studied quantitatively by a team of scientists in Namur, Belgium. Electron microscope pictures of the beetle's scaly cuticle, online at www.aip.org/pmc/2005/243 help to explain that each scale is made of alternating layers of pure chitin (high index of refraction) and mixtures of chitin and air (low index of refraction).

*Harvard-Smithsonian Center for Astrophysics/Penn. State University*
The resulting structure is a photonic crystal; because of wave interference, light of certain frequencies are excluded. In this case blue light is forbidden from being absorbed by the animal's shell; all blue light is reflected while other frequencies are absorbed in the cuticle, and the creature consequently has a blue appearance.

**Physics News**

**North-Pacific "boing" attributed to Minke whales**

Human singers send their voice into the supporting medium of air. Whales send their songs into ocean water. One particular song, a sort of fluttering echo, or "boing," sound first heard by human listeners in the North Pacific Ocean in the 1950s (and recorded by US Navy submarines) baffled scientists. Where was it coming from? Only now have the sounds been identified as coming from minke whales.

Shannon Rankin and Jay Barlow, scientists at the National Marine Fisheries Service in La Jolla, California, have gathered hydrophone data in the body of ocean between Mexico and Hawaii and combined this with visual sightings of the marine mammals. Not only has the source been traced to minke whales, but the songs seem to be somewhat different on either side of a certain longitude.

Rankin and Barlow, *Journal of the Acoustical Society of America*, November 2005

Numerous whale sounds, including the boing, can be accessed from the NOAA Web page.

**Physics News**

**Ferromagnets and superconductors make negative-index materials**

Physicists in Europe and the US have discovered a new type of negative-refractive-index material that is made from layers of superconducting and ferromagnetic thin films. Until now, negative refraction had only been achieved in metamaterials and photonic crystals. The team has also shown that the index of refraction can be switched between positive and negative values using an external magnetic field (Phys. Rev. Lett. 95 247009).

PhysicsWeb/Physics News

**Hubble reveals dark-matter details**

Astronomers in the US and Europe have mapped the location of invisible "dark matter" in unprecedented detail. The computer simulated images, generated by Myungkook James Lee of Johns Hopkins University and colleagues at the Space Telescope Science Institute in Baltimore, the University of California and the Institute of Astronomy at ETH Zurich, show "clumps" of dark matter surrounding two very young galaxy clusters. The results lend more weight to the theory that ordinary visible matter and dark matter should exist together (Astrophysical Journal to be published).

**PhysicsWeb**

**First Steps Toward Fusion at NIF**

Laser pulses shot into a cavity can produce the conditions required to trigger nuclear fusion reactions, scientists at Lawrence Livermore National Laboratory in California report. The finding was a crucial test of principle for Livermore's National Ignition Facility (NIF), the $3.5 billion machine now under construction and expected to start full operations in 2009. NIF will produce fusion reactions by focusing 192 powerful ultraviolet laser beams through small holes into the hollow interior of a gold cavity called a hohlraum. The laser light quickly heats up the cavity's inner walls, which generate x-rays, in a few nanosecond-long bursts of energy more than 60 billion times as bright as the surface of the sun. The outer shell of a small capsule containing frozen deuterium and tritium placed inside this mini-oven will be heated by these x-rays and rapidly expand, resulting in heating and compression of its core (to 1000 times its initial density) which will become as dense as the sun's center, triggering nuclear fusion.

During the first hohlraum experiments at NIF, a large team of physicists, engineers and technicians used the four existing NIF laser beams to prove NIF's x-ray production capability. NIF was operating at just 1 percent of its full design energy, and the cavity contained no fusion materials. However, the x-ray flux inside the cavity—the amount of energy per unit area and per unit time—has been shown to agree with expectations, and is similar to those required for future fusion experiments.

Dewald et al., *Physical Review Letters*, 18 November 2005

**Physics News**
Spitzer Captures Cosmic "Mountains of Creation"
A new image from NASA's Spitzer Space Telescope reveals billowing mountains of dust ablaze with the fires of stellar youth.

Captured by Spitzer's infrared eyes, the majestic image resembles the iconic "Pillars of Creation" picture taken of the Eagle Nebula in visible light by NASA's Hubble Space Telescope in 1995. Both views feature star-forming clouds of cool gas and dust that have been sculpted into pillars by radiation and winds from hot, massive stars.

The Spitzer image shows the eastern edge of a region known as W5, near the Perseus constellation 7,000 light-years away. This region is dominated by a single massive star, whose location outside the pictured area is "pointed out" by the finger-like pillars. The pillars themselves are colossal, together resembling a mountain range. For comparison, the pillars in the Eagle Nebula are less than one-tenth their size.

The largest of the pillars seen by Spitzer encompasses hundreds of never-before-seen embryonic stars, and the second largest contains dozens.

Spitzer was able to see the stars forming inside the pillars thanks to its infrared vision. Visible-light images of this same region show dark towers outlined by halos of light. The stars inside are cloaked by walls of dust. But infrared light coming from these stars can escape through the dust, providing astronomers with a new view.

The W5 region and the Eagle Nebula are referred to as high-mass star-forming regions. They start out as thick and turbulent clouds of gas and dust that give birth to families of stars, some of which are more than 10 times more massive than our Sun. Radiation and winds from the massive stars subsequently blast the cloudy material outward, so that only the densest pillar-shaped clumps of material remain. The process is akin to the formation of desert mesas, which are made up of dense rock that resisted water and wind erosion.

According to theories of triggered star formation, the pillars eventually become dense enough to spur the birth of a second generation of stars. Those stars, in turn, might also trigger successive generations.

Allen and her colleagues believe they have found evidence for triggered star formation in the new Spitzer image. Though it is possible that the clusters of stars in the pillars are siblings of the single, massive star, the astronomers say the stars are more likely its children.

NASA JPL/Spitzer Space telescope press release

Flashes from the Past: Echoes from Ancient Supernovae
A team of astronomers has found faint visible echoes of three ancient supernovae by detecting their centuries-old light as it is reflected by clouds of interstellar gas hundreds of light-years removed from the original explosions.

Located in a nearby galaxy in the southern skies of Earth, the three exploding stars flashed into short-lived brilliance at least two centuries ago, and probably longer.

The oldest one is likely to have occurred more than six hundred years ago.
The light echoes were discovered by comparing images of the Large Magellanic Cloud (LMC) taken years apart. By precisely subtracting the common elements in each image of the galaxy and looking by eye to see what variable objects remain, the team looked for evidence of invisible dark matter that might distort the light of stars in a transitory way, as part of a sky survey called SuperMACHO.

Harvard-Smithsonian Center for Astrophysics & National Optical Astronomy Observatory.

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$370 million for new research projects

Australia’s investment in research has been further enhanced with the announcement on 9th November that another 1214 new research projects are to be funded by the Australian Government over the next five years.

$370 million has been allocated to fund these projects, which are awarded following a rigorous peer review process and with the advice of the Australian Research Council (ARC).

Business partners include a number of the world’s biggest and most successful companies, including BHP Billiton, Orica, Dupont-Pioneer, Santos, Fujitsu, Westpac, Land Lease, McDonald’s and Bluescope Steel.

Community-based research partners include the Royal Flying Doctor Service, the Australian Federal Police, Australia Zoo, Volunteering Australia, Museum Victoria, the Murray-Darling Basin Commission, the Royal Women’s Hospital, National Library of Australia, the RSL and the High Court of Australia.

Details of the ARC research grants and projects can be found at www.arc.gov.au.

Comparing Y12 standards in key subjects — terms of reference announced

The terms of reference for an independent comparative study of Year 12 assessments throughout Australia were released on November 23. The study will examine the content, curriculum and standards in English (including Literature), Mathematics, Physics and Chemistry.

The terms of reference outline the criteria by which each of the selected subjects will be measured, compared and analysed, so that a clear picture can be drawn of comparative standards in subjects for the Year 12 certificate across States and Territories in Australia.

They include:
1. an examination and description of the variety of subject options available in the selected Year 12 certificate subjects in terms of content, curriculum and standards;
2. a comparison of the relative strengths and weaknesses of subject offerings across jurisdictions; and
3. a description of the extent of the involvement of university discipline specialists in the development of content, curriculum and assessment criteria.

The Minister consulted with peak educational groups in the four learning areas in developing the terms of reference for the study, which will be the subject of a Government tender to be announced shortly.

$56 million boost for teaching excellence in universities

Excellence in undergraduate teaching in Australian universities will be rewarded for the first time with the 29 November announcement that 14 universities will share in an additional $56 million in 2006. This funding is made available under the Australian Government’s 2006 Learning and Teaching Performance Fund, part of the Government’s reform package for Universities: Backing Australia’s Future.

Following extensive consultation with the higher education sector, a methodology was adopted which assessed universities on the basis of their undergraduate students’ employment outcomes or further full-time study, student satisfaction, attrition rates, and student progress.

This data was adjusted to take into account students and universities’ characteristics so that universities could be assessed on their contribution to the student’s learning.

Universities were invited to provide detailed information regarding their quantitative data and performance against the indicators used.

As part of these deliberations, an Expert Panel chaired by Sir David Watson, Vice-Chancellor of the University of Brighton UK, examined these responses and the quantitative data and made recommendations as to the final allocation of funding under the Fund.

The Australian Government looks forward to further enhancing the methodology used for the Learning and Teaching Performance Fund and has committed to a review, building on the current model.

Feedback from the sector on the 2006 process will be considered as part of deliberations leading to the 2007 round, when funding will be increased to $82 million.

Federal parliament passes legislation to ensure the responsible management of radioactive waste

Australia has made a significant move towards the responsible management of radioactive waste in this country, with the passage through the Federal Parliament on 9th December of the Commonwealth Radioactive Waste Management Bill 2005.

This legislation puts beyond doubt the Commonwealth’s authority to make arrangements for the safe and secure management of the small quantity of low and intermediate level radioactive waste produced by Commonwealth agencies as a by-product of medical, scientific and industrial processes.

It will prevent opportunistic attempts to use legal processes to frustrate the establishment of the Commonwealth Radioactive Waste Management Facility, and the Government will now proceed with field assessments of three potential facility sites in the Northern Territory early next year.

Importantly, the legislation also provides for other sites in the Northern Territory to be nominated for siting the facility. These provisions were included in response to sensible and far-sighted contributions from the Northern Land Council.

The legislation clearly stipulates that, after the selection of a site, Commonwealth regulatory processes under the Environment Protection and Biosecurity Conservation Act 1999, the Australian Radiation Protection and Nuclear Safety Act 1998 and the Nuclear Non-Proliferation Treaty (Safeguards) Act 1987 must be complied with.

Each year over 400,000 Australian patients benefit from a medical radiotopes produced in the Australian Nuclear Science and Technology Organisation’s ANSTO research reactor at Lucas Heights, including procedures used in the detection and treatment of cancer. All Australians, at least once throughout their life, will benefit from a medical procedure using medical radiotopes.

The Australian Government is fully committed to establishing this facility, consistent with its responsible attitude to the management of its radioactive waste. It is equally important that all State and Territory Governments do the same in relation to their waste as a matter of priority.

Study shows CRC programme boosts economic growth

On 13th December, Dr Brendan Nelson, the Minister for Education, Science and Training, announced the release of a new study — the Economic Impact of Cooperative Research Centres (CRCs) in Australia — which highlights benefits of the Cooperative Research Centres (CRC) Programme for the Australian economy. The report found that for every $1 of public funding invested in the CRC programme, $1.69 is added to gross domestic product (GDP).

Commissioned by the CRC Association and conducted by the Allen Consulting Group, the study also details the benefits provided by the first seven selection rounds of the CRC Programme.

These include manufacturing technology, information and communication technology, mining and energy, agriculture and rural based technology, medical science and technology, and the environment.

The Australian Government has committed $2.6 billion to the CRC Programme since it was established in 1990 to encourage collaborative research and development between the research community and industry.

The Programme is part of the Government’s commitment to building Australia’s capacity for research and development.

The study concluded that real consumption in the economy was up by $763 million, real investment by $477 million and tax revenue by $66 million, compared to what would have been the case without CRC research.

The net benefit is based on 25 examples where CRCs delivered measurable benefits to industry, such as cost savings of $20 million annually through the use of new gas pipeline technology developed by the CRC for Welded Structures.

The study also noted increasing industry participation in the CRC Programme over recent selection rounds, which is expected to further boost the Australian economy.

The Australian Government’s support for the CRC Programme is part of the Backing Australia’s Ability package — an $8.3 billion commitment to support Australian science and innovation.
On September 8th the SA branch held its annual "Student Night", at which a postgraduate from each university talks about their research work. Ben Lasscock from the University of Adelaide considered the question "Do Exotic Baryons Exist", while Darryl Jones of Flinders University spoke on "Electron Momentum Spectroscopy and Momentum Space Chemistry". The 2004 Silver Bragg awards (for the top 3rd year undergraduates at each university) were presented (see photographs) to Andrew Heitmann of the University of Adelaide and Tony Aitchison of Flinders University. On October 5th the branch held its annual joint meeting with the Astronomical Society of South Australia, at which Professor Frank Briggs spoke on "Exploring the Dark Age with radio telescopes in Australia".

The SA branch has continued with its public activities to promote the International Year of Physics. On August 7th Dr Olivia Samardzic presented a talk on "A Shortcut to Space" to about 200 people, including some very young and enthusiastic children, in a "Science Outside the Square" event. On September 14th Dr Ra Inta presented a public lecture on "Measurements of the Effects of Ageing and Playing on the Violin".

Laurence Campbell

Tasmania Branch

The end of the Einstein year has continued the trend of the whole year with a very busy Branch full of activities. The Branch AGM was held on 17 November and a new committee was elected for 2006. The committee comprises Marc Duldig as Chair, John Humble as Vice-Chair, Elizabeth Chelkowski as Secretary, Andrew Klekociuk as Treasurer and John Dickey, Claire Hotan, Melanie Johnston-Hollitt, Stuart Morgan, Stephen Newbery and Ian Newman as Committee members. The Chairmen's report will be included in the report to the AIP Council early in 2006 and will likely appear in these pages following that meeting. A small dinner for members and their partners was held at a local restaurant after the AGM.

The AIP was a major sponsor of the international "Quantum Field Theory and Its Ramifications" conference held in Hobart from 30 November till 2 December. This conference was in honour of the scientific contribution to the field by Prof Robert [Bob] Delbourgo on the occasion of his 65th birthday. Bob was unaware that the conference was being organised until about 6 months before it was held; by which time all the invited speakers had been arranged. More than 60 delegates from UK, Europe, USA, Japan, South America, Pakistan and around Australia attended and heard 28 very high powered invited talks. The conference dinner was also attended by a number of Bob's fellow former Physics staff from the University of Tasmania who heard a few anecdotal stories about Bob [there was no muck to be raked up from his past] and an extremely happy night was enjoyed by all.

The night before the conference dinner a public lecture was held at the Theatre Royal in Hobart. This is the oldest performing arts theatre in Australia and about 300 members of the public enjoyed Paul Davies presentation "Einstein's Greatest Mistake?". The use of this fine theatre was made possible by the generous private donation of David and Michelle Warren. David is a very successful businessman in Hobart and an honours graduate of Physics from the University of Tasmania who believes in promoting "rational debate on topics of public interest".

Perhaps the greatest highlight of the conference was during the opening. Unbeknown to Bob the Tasmanian Branch committee had agreed to nominate Bob for Honorary Fellowship of the AIP. Six Fellows of standing in the physics community were delighted to be invited to make the nomination and an extraordinary meeting of the AIP Council was arranged. As required by the AIP Constitution the nomination was passed unanimously. The award was kept in strict confidence until the conference. As we were about to enter the lecture theatre for the official opening by the Deputy Vice-Chancellor, Prof Rudi Lidl, Bob noticed David Jamieson and Marc Duldig, the AIP President and Tas Branch Chair respectively, and came over saying "I didn't expect to see you two here - experimentalists at such a heavily theoretical meeting". Little did he realise they were about to present him with his Honorary Fellowship. When the conference had been opened by Prof Lidl the LOC Chair asked David and Marc to come forward and the presentation was made. Bob was taken completely by surprise and there was a small tear in his eye. He joins 10 other outstanding Australian physicists in holding this prestigious honour.

A couple of days after Bob's conference, the Branch in conjunction with the RACI held a 2 day professional
development conference in Launceston for high school and matriculation college science teachers. The education system in Tasmania differentiates years 7-10 (high school) and years 11 and 12 (matriculation college). Bob Delbourgo delivered a public lecture entitled "The Big Questions in Physics - Some Answers?" on the evening of the first day of the conference and the cutting of the 4-dimensional Einstein International Year of Physics birthday cake was a highlight of the evening. The four-dimensional properties of the cake were aptly shown by the audience by consuming portions of the cake demonstrating movement in both time and space. The teachers' conference was a combination of presentations on topical research currently undertaken in Tasmania and discussions regarding the teaching of physics and chemistry, the curriculum and the new Essential Learning System (ELS) that the state Education Department was introducing into high school. ELS is an outcomes based system rather than a syllabus based one and has been hotly debated in the media and by the public. The teachers were less concerned about teaching under the system but there was a high level of concern regarding the assessment scheme and the reporting. Useful follow up plans were made and the professional bodies will try and influence the implementation of the ELS and its likely effect on the matriculation colleges so that there are no negative impacts for the cohort wishing to continue on to university science. About 30 teachers took part and were grateful for the opportunity to discuss their roles and concerns and to have their batteries recharged through the enthusiasm of some practising researchers.

Finally, the day after the teachers' event concluded the inaugural Grote Reber Memorial conference was held in Hobart. This was another major international conference on "New Techniques and Results in Low Frequency Radio Astronomy" and included the inaugural presentation of the Reber Medal to Prof Bill Erickson for lifetime innovative contributions to radio astronomy. Although this conference was not an AIP event it certainly involved most of the academic physicists in Tasmania and was a great way to see out the Einstein International Year of Physics. Now the Branch committee is looking forward to a short break from the frantic activities of the year before planning follow up activities to take advantage of the goodwill and profile generated throughout the year.

Marc Duldig

Summary of Executive meeting E259
Meeting held Monday December 5, 2005
Science Meets Parliament: Branches could send delegates to Science Meets Parliament in accordance with usual policy. FASTS had made additional places available for enthusiastic workers early in their research careers.

Definition of a Physicist: The Australia and New Zealand Standard Classification of Occupations had approached the AIP to validate the definition of a physicist for publication in the list of occupations. The definition is to be revised. A definition is also being considered that can be placed on the web site.

Archiving: Work is proceeding into the setting up a system for the archiving of electronic documents. When the system is in place, this could be useful for Branches as well as the executive.

Einstein International Year of Physics: The year had been very successful, and there had been widespread support of the activities. There was interest in running some of the activities again, in particular, the Eratosthenes project.

New Honorary Fellow: An extraordinary Council meeting had been convened to consider the nomination of Prof Bob Delbourgo as an Honorary Fellow. Council had approved the nomination. The Fellowship certificate had been presented at the conference on quantum field theory held in Tasmania.

AIP Merchandise: Merchandise has now been produced and is now available for purchase. The list of items available appeared in Australian Physics, and will be posted on the AIP web site.

DSTO Scholarships: Two Honours scholarships have been funded by DSTO on an ongoing basis. Applications for these scholarships were to be made through the branches.

Council Meeting: It was resolved that the Council meeting would be held in conjunction with Science Meets Parliament. The AGM was scheduled for Thursday March 2 at 1800 EST, and was to be held at ANU.

Next meeting: Meeting E260 was scheduled for February, at a date to be decided.

Ian Bailey
Hen secretary.
Conferences

2006

February 5 - 9
Australian Conference on Microscopy & Microanalysis
AJC Convention Centre, Sydney

February 7-10
30th Australian and New Zealand Institute of Physics 2006 Annual Condensed Matter and Materials Meeting
Wagga Wagga, NSW, Australia

February 22 - 25
Biophotonics in Australia: Showcase and Strategic Planning
Sydney, Australia
www.physics.mq.edu.au/research/fluoronet/BIA/

March 5 - 9 Mar
5th Annual International Astrophysics Conference
Waikiki Beach, Hawaii
www.igpp.ucr.edu/Conferences_Astro_2006.htm

March 5 - 10
2006 Conference on Optical Fiber Communication
Anaheim, Calif., USA
www.ofcnoec.org/

March 6 - 10
International Conference: Globular Clusters - Guides to Galaxies
Concepcion, Chile
www.astro-udec.cl/

March 13-14
Gravity Concentration 06
Perth, Western Australia
www.min-eng.com/
gravityconcentration06/index.html

March 13 - 16
The art of communicating science to the media: Sydney workshop
Sydney, NSW
www.dreamwater.org/workshop/sydney.html

April 27-May 1
Australian and New Zealand Society of Nuclear Medicine Annual Scientific Meeting
Perth, Australia

May 10 - 13
Asia Pacific Network of Science and Technology Centres Conference 2006
Perth, Western Australia
www.aspacificnet.org/conf.html

May 17-20
9th International Conference on Public Communication of Science and Technology
Seoul, South Korea
www.pcst2006.org

June 4 - 9
11th International Conferences on Modern Materials and Technologies
Acireale, Sicily, Italy
www.cimtec-congress.org/

June 25-30
NIC IX - International Symposium on Nuclear Astrophysics
CERN, Geneva, Switzerland
nic-ix.web.cern.ch/NIC-IX/

July 3-7
2006 International Conference on Nanoscience and Nanotechnology (ICONN 2006)
Brisbane Convention and Exhibition Centre, Old, Australia
www.ausnano.net/content/conn2006

July 9-12
Electrical, Transport and Optical Properties of Inhomogeneous Media.
-ETOPIM 7
Sydney, Australia
http://etopim7.mtci.com.au

July 22 - 26
International Symposium on Gas Kinetics
Orleans, France
www.gk2006.org

July 30 - August 4
International Conference on Nanoscience and Technology ICN&T 2006
Basel, Switzerland
www.icnt2006.ch

August 12 - 20
National Science Week
National
www.scienceweek.info.au

September 10 - 14
Megagauss XI - Ultra high magnetic fields: their science, technology and application
London, UK
http://conferences.ieee.org/MG-XI

September 27 - 1
17th International Mass Spectrometry Conference
Prague, Czechoslovakia
www.imsc2006.org

December 3-8
17th Biennial Australian Institute of Physics Congress
Brisbane, Queensland, Australia

2007

July 8 - 12
World Conference on Science and Technology Education
Perth, WA
www.worldSTE2007.asn.au
The Michelson and Morley 1887 Experiment and the Discovery of 3-Space and Absolute Motion

Reginald T. Cahill

Introduction
Physics textbooks assert that in their famous interferometer 1887 experiment to detect 3-space and absolute motion, Michelson and Morley saw no rotation-induced fringe shifts; it was a null experiment. However, this is incorrect.

The first detection of absolute motion, that is motion relative to 3-space itself, was actually by Michelson and Morley in 1887. However, they totally bungled the reporting of their own data, an achievement that Michelson managed again and again throughout his life-long search for experimental evidence of absolute motion. The Michelson interferometer is a brilliantly conceived instrument for the detection of 3-space and absolute motion. Of course in those days the belief system was that there was an ether embedded in a Euclidean 3-space. But that was no more than a half-way house model. The full experimental evidence is that 3-space is a complex dynamical system and is indeed probably a quantum system. Despite the enormous impact of that experiment on the foundations of physics, particularly as they were laid down by Einstein, it wasn't until 2002 that its design principles were finally understood and used to reanalyze, for the first time, the data from the 1887 experiment.

So great was Einstein's influence that the 1887 fringe shift data was never reanalyzed post-1905 using a proper relativistic-effects based theory for the interferometer, and worse, a myth developed that they had seen no fringe shifts. For this reason modern-day vacuum Michelson interferometer experiments, as for example in Muller, are badly conceived, and their null results continue to cause much confusion: only a Michelson interferometer in gas mode can detect 3-space and absolute motion, as we now see. As well, we find that they are considerably less sensitive than Michelson had assumed using Newtonian physics to calibrate the instrument and, in fact, the 1887 experiment demonstrated the failure of Newtonian physics not because there were no fringe shifts, but because they were smaller than Newtonian physics predicted. As better and better vacuum interferometers were developed over the last 70 years, the rotation induced fringe shift signature of absolute motion became smaller and smaller. But what went unnoticed until 2002 was that the gas in the interferometer was a key component of this instrument when used as an 'absolute motion detector' and, over time, the experimental physicists were using instruments with less and less sensitivity.

What has gone unnoticed for over 100 years is that the complex dynamical 3-space is relatively easy to detect by the way in which it affects the speed of EM radiation, but that it also affects the very devices that have been constructed for its detection. Only by a careful analysis have these phenomena, and the confusion that has confounded physics for 100 years, been finally understood.

Peer reviewed mainstream journals in physics continue to publish reports from vacuum interferometer and other null experiments as conclusive proof that, as Einstein had postulated, absolute motion is not observable - despite the fact that the apparatus is totally insensitive to absolute motion. It must be emphasised that absolute motion is not inconsistent with the various well-established relativistic effects; indeed the evidence is that absolute motion is the cause of these relativistic effects, a proposal that goes back to Lorentz in the 19th century. Then, of course, one must use a relativistic theory for the calibration of the Michelson interferometer. What also follows from these experiments is that the Einstein-Minkowski spacetime ontology is incorrect,
The Michelson and Morley 1887 Experiment

and in particular that Einstein's postulates regarding the invariant speed of light have always been in disagreement with experiment and from the beginning. This does not imply that the use of a mathematical spacetime is not permitted; in quantum field theory the mathematical spacetime encodes absolute motion effects. An ongoing confusion in physics is that absolute motion and the detection of a preferred frame of reference is incompatible with Lorentz symmetry. For subtle reasons this preferred frame is not manifest in the Lorentz symmetry because of the manner in which space and time intervals are defined within the Einstein measurement protocol. What is now emerging is a major development in our understanding of fundamental phenomena, and that the whole 100-year old spacetime paradigm was ill-founded.

The Gas-Mode Michelson Interferometer

The Michelson interferometer (Fig.1) compares the change in the difference between travel times, when the device is rotated, for two coherent beams of light that travel in orthogonal directions between mirrors; the changing time difference being indicated by the shift of the interference fringes during the rotation. This effect is caused by the absolute motion of the device through 3-space with speed \( v \), and that the speed of light, \( c \), is relative to that 3-space, and not relative to the apparatus/observer. However to detect the speed of the apparatus through that 3-space gas must be present in the light paths for purely technical reasons. The post relativistic-effects theory for this device is remarkably simple. The relativistic [meaning effects depending on \( v/c \) Fitzgerald-Lorentz contraction effect causes the arm AB parallel to the absolute velocity to be physically contracted to length.

Figure 2. All the Michelson-Morley July 1887 data from the 36 rotations of their gas-mode interferometer, with effective arm length \( L = 11 \) m, and readings over 22.5°, after removal of linear temperature induced fringe drifts, with local sidereal times indicated. The fringe shifts are measured in micrometer readings from the fringe-viewing telescope. The data shows the average from six 360° full turns and has been divided into the 1st and 2nd 180° parts and plotted one above the other. Data from the individual turns has never been located. The dashed curves show the best fit to the data using, giving the indicated value for \( v_\alpha \). The full curves show the expected forms using the Miller value for the magnitude and direction of \( v_\alpha \) and taking account of the latitude of Cleveland. The stone base of the Michelson-Morley experiment was later used by Miller, as seen in Fig.3.
The Michelson and Morley 1887 Experiment

Figure 3. The Miller interferometer, at Mt. Wilson in 1925/26, had an effective arm length of \( L = 32 \text{m} \), achieved by multiple reflections. The steel arms weighed 1200 kg and floated in a tank of 275 kg of mercury. Fringe shift readings were taken every 22.5', as shown by the markers. Here light paths are enclosed in an air-filled glass box. Fringe shifts were observed with the telescope seen above mark 12.

\[ L_{\phi} = L \sqrt{1 - \frac{v^2}{c^2}} \]

The time \( t_{\text{ABA}} \) to travel AB is set by \( Vt_{\text{AB}} = L_1 + L_{\text{BA}} \), while for BA by \( Vt_{\text{BA}} = L_1 - L_{\text{BA}} \), where \( V = c / n \) is the speed of light, with \( n \) the refractive index of the gas present [we ignore here the Fresnel drag effect for simplicity – an effect caused by the gas also being in absolute motion]. For the total ABA travel time we then obtain

\[ t_{\text{ABA}} = t_{\text{AB}} + t_{\text{BA}} = \frac{2LV}{V^2 - v^2} \sqrt{1 - \frac{v^2}{c^2}} \]

For travel in the AC direction we have, from the Pythagoras theorem for the right-angled triangle in Fig.1, that \( (Vt_{\text{AC}})^2 = L_2 \) and that \( t_{\text{CA}} = t_{\text{AC}} \). Then for the total ACA travel time:

\[ t_{\text{ACA}} = t_{\text{AC}} + t_{\text{CA}} = \frac{2L}{\sqrt{V^2 - v^2}} \]

Then the difference in travel time is to lowest order

\[ \Delta t = \frac{(n^2 - 1)Lv^2}{c} \]

after expanding in powers of \( v/c \). This clearly shows that the interferometer can only operate as a detector of absolute motion when not in vacuum (\( n = 1 \)), namely when the light passes through a gas, as in the early experiments on transparent solids a more complex phenomenon occurs and rotation-induced fringe shifts from absolute motion do not occur. A more general analysis \(^\dagger\) including Fresnel drag, gives

\[ \Delta t = k^2 \frac{LV^2}{c^2} \cos(2(\Theta - \Psi)) \]

where \( k^2 = n(n^2 - 1) \), while neglect of the Fitzgerald-Lorentz contraction effect gives \( k^2 = n^2 - 1 \) for gases, which is essentially the Newtonian theory that Michelson used. All the rotation-induced fringe shift data from the 1887 Michelson-Morley experiment, as tabulated in them \(^\dagger\), is shown in Fig. 2. The existence of this data continues to be denied by the world of physics.

The interferometers are operated with the arms horizontal, as shown by Miller's interferometer in Fig. 3. Then in \( n \) is the azimuth of one arm (relative to the local meridian), while \( \Psi \) is the azimuth of the absolute motion velocity projected onto the plane of the interferometer, with projected component \( v_p \). Here the Fitzgerald-Lorentz contraction is a real dynamical effect of absolute motion through the 3-space, unlike the Einstein spacetime view that it is merely a spacetime perspective artifact, and whose magnitude depends on the choice of observer. In operation, the instrument rotates at a rate of one rotation over several minutes and the shift in the fringe pattern is observed through a telescope during the rotation. Then fringe shifts from six (Michelson and Morley) or twenty (Miller) successive rotations are averaged, to increase the S/N ratio, and the average sidereal time noted, giving, in the case of Michelson and Morley the data in Fig.2, or the Miller data like that in Fig. 3. The form in (1) is then fitted to such data, by varying the parameters \( v_p \) and \( \Psi \). However Michelson and Morley assumed essentially the Newtonian value \( k = 1 \), while Miller used an indirect method to estimate the value of \( k \), as he understood that the Newtonian theory was invalid, but had no other theory for calibrating the interferometer. Of course the Einstein postulates have it that absolute motion has no meaning, and so effectively demands that \( k = 0 \). Using \( k = 1 \) gives only a nominal value for \( v_p \), being some 8 km/s for the Michelson and Morley experiment, and some 10 km/s from Miller; the difference arising from the different latitude of Cleveland in Ohio and Mt. Wilson in California. The relativistic theory for the calibration of gas-mode interferometers was first developed in 2002\(^\dagger\).

Fig. 2 shows all the Michelson and Morley air-mode interferometer fringe shift data, based upon a total of only 36 rotations in July 1887, revealing the nominal speed of some 8 km/s when analysed using the prevailing but incorrect Newtonian theory, which has \( k^2 = \)}
The Michelson and Morley 1887 Experiment

1 in [1] and this speed was known to Michelson and Morley. Including the Fitzgerald-Lorentz dynamical contraction effect as well as the effect of the gas present as in [1] we find that \( n = 1.00029 \) gives \( k^2 = 0.00058 \) for air, which explains why the observed fringe shifts were so small. We then obtain the speeds shown in Fig. 2. In some cases the data does not have the expected form in [1] because the device was being operated at almost the limit of sensitivity. The remaining fits give \( v_x = 331 \pm 30 \text{ km/s} \) for 7:00 hr sidereal time. The often repeated statement that Michelson and Morley did not see any rotation-induced fringe shifts is completely wrong; all physicists should read their paper [1] for a re-education, and indeed their paper has a table of the observed fringe shifts. To get the Michelson-Morley Newtonian based value of some 8 km/s we must multiply the above speeds by \( k = 0.00058 = 0.2471 \). They rejected their own data on the sole but spurious ground that the value of 8 km/s was smaller than the speed of the earth about the sun of 30 km/s. What their result really showed was that

(i) absolute motion had been detected because fringe shifts of the correct form, as in [1], had been detected, and that the theory giving \( k^2 = 1 \) was wrong, that Newtonian physics had failed.

Michelson and Morley in 1887 should have announced that the speed of light did depend on the direction of travel - that the speed \( c \) was relative to an actual physical 3-space. However, contrary to their own data, they concluded that absolute motion had not been detected. This mistake has had enormous implications for fundamental theories of space and time over the last 100 years, and the resulting confusion is only now being finally corrected.

The Miller Detection of 3-Space

It was Miller [4] who saw the flaw in the 1887 paper and realised that the theory for calibrating the Michelson interferometer was wrong. To avoid using that theory Miller introduced the calibration factor \( k^2 \), even though he had no theory for its value. He then used the effect of the changing vector addition of the earth's orbital velocity and the absolute galactic velocity of the solar system to determine the numerical value of \( k^2 \), because the orbital motion modulated the data, as shown in Fig. 5. By making some 12,000 rotations of the interferometer at Mt. Wilson in 1925/26 Miller determined the first estimate for \( k^2 \) and for the absolute linear velocity of the solar system. Fig. 4 shows typical data from averaging the fringe shifts from 20 rotations of the Miller interferometer, performed over a short period of time, and clearly shows the expected form in [1] only a linear drift caused by temperature effects on the arm lengths has been removed – an effect also removed by Michelson and Morley and also by Miller, and an extra term relevant when the mirrors are not completely orthogonal – a condition for fringes to be visible. In Fig. 4 the fringe shifts during rotation are given as fractions of a wavelength, \( \Delta L / \lambda = \Delta / T \), where \( \Delta \) is given by (1) and \( T \) is the period of the light. Such rotation-induced fringe shifts clearly show that the speed of light is different in different directions. The claim that Michelson

Figure 4. Typical Miller rotation-induced fringe shifts from average of 20 rotations, measured every 22.5°, in fractions of a wavelength \( \Delta L / \lambda \), vs. azimuth \( \Theta \) (deg), measured clockwise from North, from Cleveland Sept. 2, 1929 16:24 UT, 11:29 average sidereal time. This shows the quality of the fringe data that Miller obtained, and is considerably better than the comparable data by Michelson and Morley in Fig. 2. The curve is the best fit using the form in [1] but including a Hick’s component \( \cos(\theta - \beta) \) that is required when the mirrors are not orthogonal, and gives \( W = 158^a \), or \( W = 22^a \) measured from South, and a projected speed of \( v_p = 351 \text{ km/s} \). This value for \( v_p \) is different from that in Fig. 2 because of the difference in latitude of Cleveland and Mt. Wilson. This process was repeated some 12,000 times over days throughout 1925/1926 giving, in part, the data in Fig. 5.
The Michelson and Morley 1887 Experiment

Figure 5. Azimuth $\Psi$ [deg], measured from south, from the Miller data, plotted against local sidereal time [hrs]. Plots cross the local meridian at approximately 5 hr and 17 hr. This effect is caused by the rotation of the earth, but the data shows that the effect tracks sidereal time. The small monthly changes arise from the orbital motion of the earth about the sun. Miller used that effect to determine the value of $k$ in [1] and so calibrate his instrument. Reanalysis of his calibration protocol is now in agreement with the refractive index theory for the $k$ value, see references 2, 9 & 11. Curves show best fit from theory taking account of rotation of earth about its axis and about the sun.

Interferometers, operating in gas-mode, do not produce fringe shifts under rotation is clearly incorrect. But it is that claim that led to the continuing belief, within physics, that 3-space and absolute motion had never been detected and that the speed of light is invariant. The value of $\Psi$ from such rotations together lead to plots like those in Fig. 5, which show $\Psi$ from the 1925/1926 Miller interferometer data for four different months of the year, from which the RA = 5.2 hr is readily apparent. While the orbital motion of the earth about the sun slightly affects the RA in each month, and Miller used this effect to determine the value of $k$, the new theory of gravity required a reanalysis of the data [9, 11], revealing that the solar system has a large observed galactic velocity of some $420 \pm 30$ km/s in the direction [RA=5.2 hr, Dec= -67 deg]. This is different from the speed of 369 km/s in the direction [RA=11.20 hr, Dec= -7.22 deg] extracted from the Cosmic Microwave Background [CMB] anisotropy and which describes a motion relative to the distant universe but not relative to the local 3-space. The Miller velocity is explained by galactic gravitational in-flows; see [9, 11].

Two old interferometer experiments by Illingworth and Joos used helium, enabling the refractive index effect to be recently confirmed, because for helium, with $n = 1.000036$, we find that $k^2 = 0.00007$. Until the refractive index effect was taken into account the data from the helium-mode experiments was inconsistent with the data from the air-mode experiments; now they are in agreement. Ironically helium was introduced in place of air to reduce any possible unwanted effects of a gas, but we now understand the essential role of the gas.

The data from an interferometer experiment by Jaseja et al., using two orthogonal masers with a He-Ne gas mixture, also indicates that they detected absolute motion, but were not aware of that as they used the incorrect Newtonian theory and so considered the fringe shifts to be too small to be real, reminiscent of the same mistake by Michelson and Morley. The Michelson interferometer is a 2nd order device, as the effect of absolute motion is proportional to $(c/c)^2$, as in [1].

The DeWitte Coaxial-Cable Experiment and the Detection of 3-Space

However much more sensitive 1st order v/c experiments are also possible. Ideally they simply measure the change in the one-way EM travel-time as the direction of propagation is changed. Fig. 6 shows the north-south oriented coaxial cable radio frequency [RF] travel time variations measured by DeWitte in Brussels in 1991 [11], which gives the same RA of absolute motion as found by Miller. That experiment showed that RF waves travel at speeds determined by the orientation of the cable relative to the Miller direction. That these very different experiments show the same speed and RA of absolute motion is one of the most startling discoveries of the twentieth century. Torr and Kolen, using an [unfavourable] East-West oriented nitrogen gas-filled coaxial cable also detected absolute motion. It should be noted that analogous optical fibre experiments give null results for the same reason, apparently, that transparent solids in a Michelson interferometer also give null results, and so behave differently to coaxial cables. The DeWitte data also shows speed fluctuations, namely that the detected 3-space is dynamical and in differential and time-dependent motion. The speed fluctuations have been shown to be fractal [10]. These fluctuations produce weak gravitational effects, and amount to the discovery of the gravitational waves of the new theory of gravity [11].
The Michelson and Morley 1887 Experiment

Figure 6. DeWitte 1991 RF travel-time variations, in ns, in a 1.5 km NS orientated buried coaxial cable in Brussels, measured with cesium atomic clocks over three days and plotted against local sidereal time (hrs), showing that at approximately 5hr and 17hr the effect is largest. DeWitte observed this effect for 178 days and demonstrated that it tracked sidereal time, and not solar time. This is in remarkable agreement with the results from the Miller interferometer experiment. At least seven interferometer or coaxial cable experiments give consistent observations of absolute motion.

The Failure of Modern Vacuum Interferometers

Modern resonant-cavity interferometer experiments, for which the analysis leading to (1) is applicable, use vacuum with $n = 1$, and then $k = 0$, predicting no rotation-induced fringe shifts. In analysing the data from these experiments the consequent null effect is misinterpreted, as in Müller, to imply the absence of absolute motion. But it is absolute motion that causes the dynamical effects of length contractions, time dilations and other relativistic effects, in accord with the Lorentzian interpretation of relativistic effects. So in these devices an observable effect is not being separated from dynamical effects upon the instrument itself, which then happens to result in a total cancellation – the null effect. To avoid that cancellation requires the use of a gas in the instrument, an insight that has taken more than 100 years to discover. Using a gas within the resonant-cavity would enable these devices to detect absolute motion with much precision. However new coaxial-cable experiments are nearing completion at Flinders University and with modern techniques become laboratory sized apparatus. The detection of absolute motion is not incompatible with Lorentz symmetry; the contrary belief was postulated by Einstein, and has persisted since 1905. So far the experimental evidence is that absolute motion and Lorentz symmetry are real and valid phenomena. Lorentz symmetry parameterises dynamical effects caused by the motion of systems through 3-space.

Conclusions

So 3-space and [absolute] motion through it was first detected in 1887, and again in at least another six experiments over the last 100 years. Had Michelson and Morley been as astute as their younger colleague Miller, and had been more careful in reporting their non-null data, the history of physics over the last 100 years would have been totally different, and the spacetime ontology would never have been introduced. That ontology was only mandated by the mistaken belief that 3-space and absolute motion had not been detected. By the time Miller had sorted out that bungle, the world of physics had adopted the spacetime ontology as a model of reality because it appeared to be confirmed by many relativistic phenomena, mainly from particle physics, although these phenomena could equally well have been understood using the Lorentzian interpretation which involved a 3-space and absolute motion, and no spacetime. We should understand that space is a complex dynamical system in observable differential motion, and very unlike the Newtonian Euclidean model of space, which Newton believed was undetectable. There have been considerable developments in our understanding of this dynamical 3-space, and the most remarkable discovery is that experimental data has shown that the strength of the self-interaction of 3-space is determined by the fine structure constant. It is a remarkable situation that for over 100 years physics has denied the existence of such a fundamental aspect of reality as 3-space, and the explanation of gravity that follows from its differential and time-dependent dynamics. It now turns out that spacetime is purely a mathematical construct, i.e. it simply does not exist as an entity. It merely and indirectly encodes absolute motion effects upon, say, elementary particle systems, as in quantum field theory, but that there exists a physically observable foliation of that spacetime construct into time and 3-space. This dynamical 3-space is absent from the fundamental theories of physics, and modifications of the Schrödinger, Maxwell and Dirac equations have been necessary. One major outcome has been the derivation of the equivalence principle as a quantum effect. The emergent theory of gravity,
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in its relativistic form, agrees with all extant putative successes of General Relativity, but goes beyond that theory in also explaining the observed systematics of black holes in globular clusters and elliptical galaxies, and the rotation characteristics of spiral galaxies, and so does away with the need for dark matter. Papers dealing with the new discoveries in our understanding of gravity are available at the websites given in reference 13. This gravity work is supported by an ARC Discovery Grant.

References
11. R.T. Cahill, Process Physics: From


Dr Reginald T. Cahill is Associate Professor in Physics at Flinders University.

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New President for FASTS

Professor Tom Sparling took over as President of FASTS on 21st November. He received his BSc and PhD degrees in Physical Chemistry from the University of Western Australia in 1962 and 1966. He was a post-doctoral Fellow at the University of Maryland from 1965-1967 and a Lecturer in Chemistry at the University of Tasmania from 1967-1969. He joined CSIRO in 1969 where he became the Chief of the Division of Chemicals and Polymers in 1989 and the Chief of the Division of Molecular Science in 1997. He led the World Bank funded Management and Systems Strengthening-Lembaga Ilmu Pengetahuan Indonesia (MSS-LPII) project in Jakarta from 1999-2001.

He was appointed Professor of Molecular Science and Director of the Industrial Research Institute Swinburne in 2002 and was Dean of the Faculty of Engineering and Industrial Sciences at Swinburne University of Technology 2004-2005. He is now the Chief executive Officer of the CRC for Wood Innovations.

Tom is a Fellow of the Royal Australian Chemical Institute, a Fellow of the Australian Academy of Technological Science and Engineering and a Fellow of the Federation of Asian Chemical Societies. He was President of the RACI from 1987-1988 and of the FACS from 1989-1991. He will be the President of the Federation of Australian Scientific and Technological Societies for two years from November 2005.

Hot media topics
You might be interested in what were the hot media topics in November were in terms of where journalists sought expert opinion for their stories.

The data is from a service called expert guide. If you are interested in registering your society for expert guide then please contact Margaret Lawson at margaretlawson@expertguide.com.au or visit their site at www.expertguide.com.au

November Top Topics
1. Terrorism (and “terror”)
2. Singapore
3. Addiction
4. Islam
5. Industrial relations
6. Nuclear (and “nuclear power”)
7. Skin cancer

8. Death penalty (and “capital punishment”)
9. Sexuality
10. Asbestos

November Top Science and Health/Tech Topics
1. Addiction
2. Nuclear (and “nuclear power”)
3. Skin cancer
4. Sexuality
5. Asbestos
6. Brain
7. Allergies
8. Breast cancer
9. Aviation
10. Health

SMP
At the FASTS AGM in November 2005, it was decided to change the process for registrations for SMP 2006. [Tuesday 28 February and Wednesday 1 March, 2006]. Rather than simply putting the information on our website so that anyone could register, as in previous years, it has been decided that all FASTS' member associations or societies would be entitled to nominate two participants. Then as demand from Parliamentarians for specific topics became apparent additional registrants would be invited from relevant societies.
Ziggy Switkowski Joins ANSTO Board

Former Telstra boss, Dr Ziggy Switkowski was officially appointed to the ANSTO Board by the Governor-General of the Commonwealth of Australia on 1 January 2004 for a period of five years.

Dr Switkowski brings a wealth of business and technology development experience to the ANSTO Board, the governing body of Australia’s national nuclear research and development. ANSTO is responsible for delivering specialised advice, scientific services and products to government, industry, academia and other research organisations. In addition, 70 per cent of all radioisotopes used in Australian nuclear medicine are made in ANSTO’s nuclear research reactor.

Dr Switkowski, who has a PhD in nuclear physics and studied at ANSTO as a graduate student, will attend his first Board meeting in February.

ANSTO media release

New joint Academy and National Museum of Australia prizes

The National Museum of Australia has joined forces with the Australian Academy of Science and its National Committee for History and Philosophy of Science to establish two essay prizes, to be known respectively as The National Museum of Australia Student Prize for the History of Australian Science and The National Museum of Australia Student Prize for Australian Environmental History.

In each case, the Prize will consist of a certificate and $2500.

The prizes will be awarded for original unpublished research undertaken whilst enrolled as a student (postgraduate or undergraduate) at any tertiary educational institution.

The research should be presented as an essay written in English and fully documented following the style specified for the Australian Academy of Science’s journal, Historical Records of Australian Science.

The prizes will be awarded in alternate years in May. Applications will normally close on 28 February each year, with the history of science prize being offered in even-numbered years and the environmental history prize in odd-numbered years.

The initial prize (the history of science prize) will be offered in 2006. In view of the late announcement, a later closing date of 30 April has been set for 2006 only.

Submissions for the National Museum of Australia Student Prize for the History of Australian Science are now being invited. Further information is available at www.science.org.au/natmoms/award-hps.htm.

AAS media release

Fast & totally secure communication in quantum cryptography

Physicists at ANU have achieved possibly the world’s fastest transmission of ‘unhackable’ data using bright lasers to generate an absolutely secret ‘key’.

Researchers of the Department of Physics in the Faculty of Science, led by Dr Ping Key Lam, have developed an experimental prototype demonstrating this technology. They are currently investigating the commercialisation potential of the successful prototype.

The technology is based on a theory first proposed by Einstein and colleagues in 1935. They proposed the phenomenon known as entanglement, which manifests itself at the quantum level in nature. It has since been assumed that entanglement was a key ingredient in implementing systems that harness this quantum effect. However producing entangled states requires specialised and expensive optical equipment.

To address this difficulty, an innovation by the ANU group works on an extension of the idea of entanglement, known as ‘virtual entanglement’. This has resulted in a greatly simplified setup for the groups’ experimental prototype.

The group’s research has been published online in the international journal Physical Review Letters [http://prl.aps.org/].

ANU media release

Star near the Southern Cross is ringing like a bell

Astronomers have used telescopes in Australia and Chile as a ‘stellar stethoscope’ to ‘listen’ to a star near the Southern Cross that is ringing like a bell.

The researchers, led by Dr Tim Bedding (University of Sydney) and Dr Hans Kjeldsen (Aarhus University, Denmark), studied the star alpha Centauri B, one of the stars of the ‘Pointers’ near the constellation of the Southern Cross.

Over a week they observed the star with both the 3.9-m Anglo-Australian Telescope near Coonabarabran in New South Wales, Australia, and Kueyen, one of the four 8.2-m telescopes that make up the European Southern Observatory’s Very Large Telescope at Cerro Paranal in Chile. The team measured the rate at which the star’s surface is heaving in and out, getting clues about the density, temperature, chemical composition and rotation of its inner layers — information that could not be obtained in any other way. The research was published in December in the Astrophysical Journal.

The researchers were able to determine 37 modes of oscillation in alpha Centauri B. They also measured the mode lifetimes, the frequencies of the modes, and their amplitudes.

By using two telescopes at different sites the astronomers were able to observe alpha Centauri B as continuously as possible.

Sydney University media release

A solid foundation: $250k funds Messel Campaign

The Science Foundation for Physics has contributed an additional $250,000 to the Messel Endowment Capital Campaign.

The Messel Endowment was officially launched in 2004 to raise sufficient funds to ensure the continuation of the Professor Harry Messel International Science School for High School Students.

The Foundation’s President, Mrs Louise Davis, presented the $250,000 to Mr John Hooke, Chair of the Endowment Campaign - this is the second such contribution by the Foundation, bringing their support of the Campaign to a total of half a million dollars. It underlines the Foundation’s commitment to the International Science School, established by Prof. Messel in 1962.

Sydney University media release

Telling the time of the Earth’s core formation

In the prestigious international journal Nature [Oct 27], Professor Bernard Wood of Macquarie University and Professor Alex Halliday of Oxford University propose that a problem over differing ages of
the Earth's core can be resolved by considering the effect of the giant impact of a Mars-sized object with the Earth. The separation of metal into the Earth's core sequestered radioactive isotopes that can be used as clocks, allowing geologists to estimate the time at which the Earth's metal core separated from its rocky outer shell. Two of these isotope clocks seemed to give conflicting formation times. A giant impact (about 45 million years after the origin of the solar system) is thought to have contributed the last ten percent of the Earth's mass and formed the Moon. The scientists propose that this would have also changed the conditions of core formation. They put forward a model that eliminates the discrepancy between the hafniumtungsten and uranium-lead isotope clocks if the effects of the oxidation state of the mantle are taken into account.

Wood and Halliday suggest that the explanation may be that the hafniumtungsten clock represents the initial phase of core formation, whereas the upheaval introduced by the giant impact produced an oxidation state under which a sulphur-rich metal formed, into which lead would have dissolved readily, in effect resetting the uranium-lead clock to a younger age.

Macquarie University press release

UQ research team solves long-standing mathematical physics puzzle

A University of Queensland research team led by senior mathematics lecturer Dr Yao-Zhong Zhang has successfully solved a major long-standing problem in mathematical physics.

Dr Zhang and his postdoctoral fellows Wen-Li Yang and Shao-Yu Zhao, from the North West University in China, have discovered the determinant representation of correlation functions of the supersymmetric t-J model.

Dr Zhang said the theoretical problem had been around for many years. "The analytic computation of correlation functions was arguably one of the most challenging and notoriously difficult problems in mathematical physics and its solution will have important implications."

"It opens doors to further research in the theory of exactly soluble models as well as in pure mathematics, statistical mechanics and condensed matter physics."

Dr Zhang said the work had attracted a great deal of academic interest and had been described by world-leading authorities in the field as a "major breakthrough" and a "great discovery."

A paper on the solution will appear in the January 2006 issue of the Journal of Mathematical Physics, a leading international scientific journal published by the American Institute of Physics. A second paper has also been submitted to the prestigious mathematical physics journal Communications in Mathematical Physics. Dr Zhang and his research team have also been approached by the International Journal of Modern Physics B to write a review article on their research.

University of Queensland media release

New investigation shows nuclear power will last longer, cause less emissions

A group of scientists from the University of Melbourne, led by Associate Professor Martin Sevior in the School of Physics, has produced a dedicated study of the energy problems confronting Australia in the future. They compared the environmental impact, health risks, economic effects and social implications of the use of fossil fuels, renewable energy sources such as wind and solar energy, and nuclear power.

They have presented their results on a new website: nuclearrain.info.net.

Their investigation significantly impacts the nuclear debate, with findings showing that hundreds of times more uranium could be available than was predicted in a widely quoted study by van Leeuwen and Smith.

"We took care to select the most authoritative data sources and we've made these available on the website. The idea was to be totally transparent and make it as easy as possible for others to repeat our calculations. Everyone can scrutinise our calculations and sources of data."

Says Associate Professor Sevior.

He also said that nuclear technology is developing at a rapid pace, with new power plant designs proposed that will enable more efficient use of uranium, increasing the possible use of uranium fifty-fold and significantly reducing the amount of nuclear waste.

As energy consumption and the resulting pollution continue to grow, Associate Professor Sevior said that alternative energy sources need to be looked at in detail by impartial researchers, and academics with expertise in such areas have a responsibility to become involved.

"Groups that are for and against nuclear power can then have an open dialogue based on accurate figures and sound empirical research.

"Although we find there is a credible case for nuclear power plants, there have been many mistakes in its deployment in the past. If we decide to utilise nuclear energy we should learn from these mistakes."

Melbourne University media release

The future is clean and clear for young scientists

Algae-free fish tanks and barnacle-free boat hulls are closer to reality following the development of a self-cleaning technology for glass by two young scientists from Monash University and Nanotechnology Victoria.

Mr David Menzies, from Monash's Department of Materials Engineering, and Nanotechnology Victoria program manager Dr Larry Jordan came up with the novel application of nanotechnology that needs only light and water molecules to activate the cleaning process.

Their product is a transparent film that will initially be used to coat glass for aquariums. Experiments with the glass have been enormously successful. Potential uses for the product include more elaborate applications such as shower screens that don't allow scum build-up and automotive paints that don't get dirty.

Dr Jordan said the aquarium sector provided a low risk entry point to a market full of enormous possibilities.

Recognising the potential of this nanotechnology, a group of six young people aged in their 20s and 30s, including Mr Menzies and Dr Jordan, are marketing the product through their newly formed company Barracouta. The team has already secured $10,000 in funding in the Monash New Enterprise Challenge, along with sponsorship from Nanotechnology Victoria and financial support from several other businesses.

Monash University media release
From Physics to Poetry

To many Australian physicists the name of Neville Fletcher is well known on account of his versatile achievements, very notably in the science of musical instruments and related acoustics. Now we may add another talent in the form of prose and poetry composition. Recently I was delighted to be sent an autographed copy of Neville’s enchanting book *Brief Candles* – a joy to read. Its short stories are up there with the best and I wish it presented more than just two poems, one of them an evocation of fear and hope rising from the Canberra bushfires of 2003.

The short stories are an eclectic selection of themes ranging from science fiction to a kind of indomitable quasi-religion, something deep-thinking readers can relate to. In several of the stories there is a Japanese influence, in particular the unique oriental settings and the charming aspects of Japanese culture. One of the poems is set in the tightly constrained Haiku form, as singular as a classical sonnet. The surprise allusion to the Japanese bullet train in the third verse shakes one into realization of the intrusion of progress into natural serenity.

Short stories by their nature have some sort of twist at the end so I won’t give away any of them except to say that they were all quite satisfying. A joy to browse and read at one’s leisure. Copies of *Brief Candles* are available for twelve dollars a copy direct from the author, Emeritus Professor Neville Fletcher at the RSPSE of the Australian National University. An ideal present for those of a literary bent!

*Colin Keay*

Reviews Editor

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**Lidar: Range-resolved optical remote sensing of the atmosphere**

Claus Wei
tamp Springer, Berlin 2005

This book has each chapter written by a different expert in the field. This has the advantage of having some of the best expertise available but with the disadvantage that each chapter is written with a different style and depth. That being said, the book supplies a comprehensive view of all the important techniques and applications now used in the field of lidar atmospheric remote sounding.

Lidar is similar to radar with a pulsed optical laser replacing the radio transmitter, an optical telescope receiver and detectors consisting of various optical phonon counting and analogue devices. Thus basic equations are similar in the two cases. However, the interaction of light with atoms, molecules and particles with a range of sizes allows the use and observation of interesting physical phenomena including Raman scattering, resonance fluorescence, Doppler shifts as well as elastic backscatter and depolarisation. Thus with these techniques one can observe range-resolved profiles of atmospheric pollutants, ozone, water vapour, temperature, aerosols and clouds, with the power to distinguish water and ice clouds. Ladar can also measure winds by Doppler shift and atmospheric visibility.

The book covers the physics and mathematics of the interaction, instrumention and examples of applications with field results. There is even a chapter in the use of lidar from aircraft and space, including some recent results from the space shuttle.

In summary, the book succeeds in highlighting the extensive uses of lidar in the remote sounding of the atmosphere and its exciting future possibilities.

*C.M.R. Platt*

CSIRO Atmospheric Research

Aspendale, Victoria

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**Introduction to Optics**

Germain Chartier

Springer Verlag, Berlin 2005

This wonderfully useful book is a translation and update by the author of the 1997 Manuel d’optique which received the Arnulf-Francon award from the French Optical Society. The style of writing is excellent and with few of the quirks one might expect in a translation. The author explains his approach is after Feynman – maintain the interest of the best students and let the mathematics be an aid rather than a hindrance to understanding the Physics. His award was well deserved.

If I were planning or teaching a senior course in optics, Chartier’s *Introduction to Optics* would be my guide and chosen text. The topics covered are ideal, both in breadth and comprehensiveness, for a serious undergraduate course in optical physics and engineering. Like Feynman’s famous *Lectures in Physics*, this is not a text for those who want to know about optics; rather this is the modern text for those who want to know optics.

A nice feature of the text is that each chapter has been independently reviewed by senior practicing scientists and engineers. This enhances its currency as a modern practical text. Surprisingly there are no references at all, a weakness in my opinion. There are also no student exercises, software etc as are commonly found with other undergraduate texts. This will present a challenge to busy academics who often rely on text examples as students assessment exercises.

Thoroughly recommended for anyone teaching or researching optical physics and engineering.

*Tony Moon*

Faculty of Science

University of Technology Sydney
Marswalk
One: First
Steps on a
New Planet
David J
Shayler,
Andrew
Salmon and
Michael D
Shayler
Springer
Praxis,
Chichester

UK, 2005
Xxiii + 244 pp., UK£18.95 [softcover]
ISBN 1-85233-792-3

This book comes at a time when both
the USA and Europe are developing
plans leading to the human exploration
of Mars. President Bush's "Vision
for Space Exploration" announced in
January 2004, has refocused NASA's
planning on a program aimed at
carrying astronauts to the Moon, Mars
and beyond. The European Space
Agency's Aurora program has similar
aims. This publication aims to provide
an account of what will happen when
humans first set foot on Mars. Rather
than how to get to Mars, the main focus
of the book is how the astronauts
would operate on the Martian surface
and on what they would do there. A
larger chapter covers spacesuits for use
on the Martian surface. Others deal
with surface exploration, including the
hazards of operating on the surface,
scientific activities and habitations on
Mars.

Despite dealing with events that are
likely to be well into the future, the
presentation in the book is largely
historical. For example, the discussion
of spacesuits begins with early deep-sea
diving suits before looking at the
Apollo lunar suits and Shuttle EVA
suits. The book is aimed at the amateur
space enthusiast. The general reader
interested in Mars exploration and its
future is likely to be put off by the
dry technical style, numerous bullet
point lists and uninspiring selection of
illustrations (many pictures of models
of Russian space hardware, but very
few pictures from the recent Mars
missions).

Jeremy Bailey
Australian Centre for Astrobiology
Macquarie University

Nuclear Energy
Fallacies [2nd
dition]
Colin Keay
Enlightenment
Press, Waratah
NSW 2298, 2005
40 pp., A$ 5.00
(paperback)
ISBN 0-9578946-5-1

Nuclear power
is back on the Australian political
agenda, due to global warming and
the unreliability of fossil fuel supplies.
For reasons mysterious to this British
expatriate reviewer, Australians are
strongly antipathetic to the nuclear
industry, whether it is uranium mining,
power stations or waste disposal.
Nuclear-phobia reached the heights of
absurdity in the row over the proposed
repository for low-level waste in
South Australia. Evidently the South
Australian public believes it is safer
to leave the material in schools and
hospitals in Adelaide than bury it in the
desert.

Colin Keay is a long-time advocate
of nuclear power for Australia, and
in this little booklet he sets out to
systematically explode the myths
surrounding the health and safety
aspects. Even counting the cost of
Chernobyl, the nuclear industry is
far safer than the coal industry. It
is astonishing that governments still
permit chemical reactors such as coal-
fired power stations to discharge their
toxic brew into the air we breathe, laced
as it is with carcinogenic particles and
heavy metals (including uranium). I
well recall the thousands of Londoners
dead from coal smoke inhalation in
the smoggy 1950's, and the children
engulfed in the coal waste avalanche
in Aberfan in 1966. Even "clean"
hydroelectric power can kill thousands at a
stroke from a dam burst.

Alternative energy sources such as
wind-power could never meet all
Australia’s needs, so the nuclear option
has to be considered seriously if we
are to avoid becoming a carbon pariah
state. Keay's book should be mandatory
reading for both sides of the debate.

Paul Davies
Centre for Astrobiology
Macquarie University
Sparking physics events around the country

The Einstein International Year of Physics 2005 seed grant scheme

One of the Australian Institute of Physics’ experiments for Einstein Year was a seed grant program. Across Australia $37,115 seeded sixteen initiatives. Some recipients were individuals like ANU PhD student Melanie O’Byrne – her flowvis exhibition toured nationally and was seen by 100,000 people. Some grants helped our major research organisations reach new audiences – CSIRO ran a physics short film competition that was screened in 70 venues and reached 10,000 people.

Science in Public’s Duncan Byrne reports on some of the achievements of the grants program.

Over the Einstein Year the Australian Institute of Physics, with support from the Department of Education, Science and Training, offered two series of seed grants for individuals and organisations running events that celebrated the Einstein International Year of Physics.

Sixteen projects across Australia were awarded grant money. Each explored physics in unique and compelling ways from drama and art exhibitions to public forums.

Damian Harris and Graeme Cook from James Cook University used their grant to host Moonlight and Movies at the Strand, a public astronomy event held in Townsville, Queensland. Over 700 avid stargazers participated in the two nights at the beach. Professional commentary and multimedia presentations accompanied the hands-on activities to create, in the words of Damien and Graeme, a successful event ‘with a great vibe’.

The Sydney Observatory and the Powerhouse Museum hosted another major public event in Sydney. Despite gale force winds, over a thousand people braved the elements to learn about Einstein’s discoveries with dramatic performances and practical demonstrations at Sydney Observatory. This was organised by Toner Stevenson.

Helen Gardiner, a freelance science communicator, used her grant to stage a live music event with a scientific edge. Over a thousand families went a bit tribal with physics at Djeridu – Triumph of Mind Over Matter, a show that toured the Northern Territory and Victoria throughout National Science Week. Djeridu player Geoff Shores and harmonic singer Dean Frenkel amazed the audience while physicist Lloyd Hollenburger pulled apart the physics behind the music. The audience were encouraged to ‘BYO Didj’, but those without were given the next best thing – cardboard tubing.

Chris Kennedy from CSIRO Land and Water used a grant to promote physics in SCINEMA, a science film festival that toured 70 locations across the country. Ten thousand people attended screenings and participated...
Sparkling physics events around the country

in voting for a Short Physics Film competition. The grant allowed Chris to publicise the physics film competition nationally to schools and the films from the 13 finalists were collected into a 90-minute program which was screened nationally.

One of the most successful Einstein Year events was flowvis: the art of fluid dynamics. Run by Melanie O’Byrne from Australian National University, this travelling exhibition has been to almost every state allowing an estimated 100,000 people to experience the natural art hiding away in our labs. There was extensive media coverage, including ABC TV news and there is even talk of merchandising the images – expect flowvis calendars to become the must-have lab ornament for the discerning physicist.

Other successful public events made possible by this scheme included a bus tour of physics related heritage sites in Brisbane, a physics exhibit at a rural show in Koomdook, New South Wales and a live astronomy show and lecture at the University of Southern Queensland.

A number of projects focussed on students. Wade Shiel and Sean Manning from the AIP SA branch presented a physics show to eight primary schools in Pt Pirie and got on local television. They are now planning to take their physics show to other rural areas in South Australia. Dan O’Keefe from the AIP education branch created Playground Physics - a physics resource for teachers that uses school play equipment as the focus of physics exploration.

Over in Western Australia, Dianne Tompkins from Murdoch University designed and collated resources for high schools to explore hydrogen fuel cells and eco-friendly transport.

Craig Savage from the Australian National University created and distributed another teaching resource titled Through Einstein’s Eyes. This multimedia presentation CD for schools discusses relativity and includes a tour of the solar system.
Exeter High School in Tasmania hosted a 14-day Energy Exploration fair where year 9/10 students presented science shows to local primary students. Over 250 primary students witnessed demonstrations of plasma balls, hydrogen fuel and static electricity. Jane Hall-Dadson, the organiser of the fair, has since created a fair manual to assist others interested in running a science fair.

The Physics Demo Troupe from the University of Queensland created a stage show for schools covering the 'physics of everything'. The troupe, consisting of physics students Jenny Riesz and Joel Gilmore, took the show to 600 students in outback Queensland and the Torres Strait Islands.

Also touring regional Queensland was the Queensland University of Technology Smart Train with local ABC radio as a partner. At each stop through twenty-four rural towns, an estimated 21,000 visitors jumped onboard to take part in the displays and watch the 'Funky Physics Show' performed on the Physics platform. Melissa Falla, the coordinator, booked 152 schools in to see the show.

Through the seed grant scheme, thousands of Australians were exposed to a world so often sealed behind laboratory doors. And many project managers have expressed interest in continuing their initiatives into 2006.

The seed grant scheme achieved its goal of sparking off physics events around the country, which stimulated the natural curiosity of students, teachers and members of the community in the world around them.

The AIP thanks the Commonwealth Department of Education, Science and Training for their support of Einstein Year.
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**Product News**

**New FemtoFiber® Scientific [FFS] from TOPTICA Photonics**

With the newly released FemtoFiber® Scientific [FFS], TOPTICA Photonics merges the performance of traditionally Ti:Sapphire oscillators with the stability of an all fiber laser source. Combining pump sources, a mode-locked ring oscillator, up to two parallel amplifiers and optical pulse compression in a single compact housing, the FFS offers a maximum of user-convenience and flexibility without compromising performance.

The release of TOPTICA’s new mode-locked Er:fiber laser systems FFS marks a significant step towards the availability of cutting-edge fewsecond technology as a standard tool in any research environment. Based on direct pumping from fiber-pigtailed laser diodes and fiber-integrated, reliable telecom components, the FFS delivers 180 mW of linearly polarized and highly stable output power in sub-100 fs pulses from a user-friendly and compact design.

The laser emission wavelength of 1.55 μm is compatible with today’s optical telecom standard and facilitates studies of technologically relevant devices and materials. Optionally, the output may be frequency-doubled if operation in the Ti:Sapphire wavelength range is desired. As a unique feature, the FFS is available with a special continuum generation stage, permitting the generation of ultra-broadband output spectra covering more than a full octave in bandwidth. This way, the frequency comb emitted by the mode-locked oscillator can be conveniently characterized in an I-2I scheme for frequency metrology applications. Analog feedback inputs for active control over the frequency comb parameters are provided upon request. As a further feature, the wavelength of maximum spectral intensity in the nonlinearly broadened spectrum may be manually shifted over several hundred nanometers for spectroscopic studies in extended spectral windows.

Due to its superior performance, high stability, great flexibility, excellent cost-efficiency and advanced user-friendliness, TOPTICA’s new FemtoFiber® Scientific [FFS] can be the ideal solution for your research in fields as diverse as ultrafast spectroscopy, optical frequency metrology, THz spectroscopy, confocal microscopy, material sciences and many more.

**Precitec Contactless Measuring Technology**

CHRocodile - a new generation of optical sensors from Precitec Optronik - is setting new standards for distance and thickness measurement in terms of speed and precision. The high measurement precision and sturdy construction of the measuring head and the independence of the measurement from the condition of the object surface allow the CHRocodile systems to be used both in the laboratory and in the factory.

**Chromatic Sensor**

The chromatic coded principle utilises the chromatic length aberration of specialised lens to measure distance and thickness. Due to the independence of surface properties nearly all materials can be measured by the sensor. The coaxial set-up enables measurement on structures with high aspect ratio in spite of shading. The measurement range of the sensor stretches from some micrometers up to millimeters with corresponding resolution. Typical applications of the sensor are topographic measurement systems as well as inline use. The passive sensor probe is connected via an optical fiber to ensure the operation in problematic or hazardous environment like strong electromagnetic fields, vacuum or explosive areas.

**White Light Interferometer**

Beside the chromatic coded principle the sensor also works as a white light interferometer. It is possible to measure transparent film thickness between 2 μm and 250 μm optical thickness of single and multiple layers like functional coatings, varnish or adhesive foil.

**Properties:**
- Scanning rates up to 14 kHz,
- Resolutions to 10 nm
- The angle of the measuring head can be adjusted over a wide range for normal and reflective surfaces (90° ± 30°)
- White-light measurement (measurement results not falsified by speckled images)
- The confocal measurement principle eliminates seeing at the edges

**Typical applications:**
- Measurement of surfaces and transparent layers
- Topographical measurements of microstructures

Easily integrated into automated measuring systems to meet individual customer requirements.

Please contact us, or visit our website, for further details.

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Phone: (08) 8443 8668
Toll-free: 1800 882 215; NZ: 0800 441 005
email: sales@lastek.com.au
web: www.lastek.com.au

**New! Injection seeded, single longitudinal mode pulsed Nd:YAG laser option in a compact, user friendly package**

We are pleased to announce that Nd doped fibre laser injection seeding is now available within the Quantel Brillant B pulsed Nd:YAG laser series, as the Brillant B SLM.

Injection seeding reduces the spectral linewidth, increases optical coherence, smooths spatial beam profile and reduces modulation, with very high reproducibility.

These features offer specific benefits in spectroscopy, holography and OPO laser pumping in particular, where uniform beam quality is critical.
Product News

Quantel's 20 years of injection seeded YAG laser experience and the field-proven Brilliant B compact laser design ensures a highly reliable, high performance laser in a low maintenance system package.

The Brilliant B SLM joins Quantel's existing family of injection seeded lasers, including the high energy YG-Series of Nd:YAG lasers.

Brilliant B SLM specifications:
- 700mJ @ 1064nm
- 532nm, 355nm and 266nm harmonic options
- 10Hz repetition rate
- 0.005cm⁻¹ linewidth

For more information, please contact Karel Meeuissen (karel.meeuissen@coherent.com.au). Coherent Scientific Pty Ltd 116 Sir Donald Bradman Drive Hilton, South Australia, 5033 Tel: (08) 8150 5200 Fax: (08) 8352 2020 Web: www.coherent.com.au

**PI-MAX® High Performance ICCD Camera Systems – The best just got better**

The Princeton Instruments PI-MAX® gated intensified CCD (ICCD) camera series are used in cutting-edge, time-resolved imaging and spectroscopy applications around the world.

The new Gen III filmless intensifiers, now available with the PI-MAX®, help to achieve in the highest sensitivity and fastest gate speed, ideal for ultra-fast gated applications such as plasma diagnostics, fluorescence lifetime imaging microscopy (FLIM) and planar laser induced fluorescence (PLIF).

Along with this product addition, the PI-MAX® ICCD camera series of high performance ICCD camera series offers you the broadest choice of Gen II, Gen III, and Gen III filmless intensifiers and high frame rate capabilities (PI-MAX®) available today.

- NEW Gen III filmless intensifiers for > 50% QE and sub-nanosecond gate speeds
- Exclusive 5MHz/16-bit operation for greater than 15 frames per second for time-resolved imaging
- Gen III and Gen II super-blue intensifiers for applications requiring high spatial resolution
- Exclusive Unigen photocathode for highest sensitivity from deep UV to NIR
- Fibre-optic coupling between CCD and intensifier for the highest light throughput
- Sub-nanosecond gating capability
- High resolution 1k x 1k pixel CCD with gated dual-image capability
- Two full resolution images in quick succession of 2usec
- MCP gating technology for fast gating (<9 ns) without compromising the sensitivity
- Built-in, state-of-the art programmable timing generator [PTG™] for precise synchronisation with minimal insertion delay
- USB2.0 plug-n-play interface for easy set-up
- Kinetics capability for ultra high-speed image/spectral acquisition

For more information please contact Dr Paul Wardill (Paul.Wardill@coherent.com.au).

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**Record Travel Range by Piezo-Driven Nano-Translation Stages**

 Nanopositioning specialist PI (Physik Instrumente) has introduced the new long-travel, piezo-driven P-628 series of nanopositioning stages. The monolithic positioning and scanning systems set a new record in terms of travel range for closed-loop, flexure-guided, piezo stages. Despite the increased travel range of up to 950 µm, the units are extremely compact, while providing rapid settling with nanometer-scale resolution and guiding accuracy.

The long travel range is achieved by a combination of a novel, friction-free and extremely stiff flexure system and the award-winning, ceramic-encapsulated PICMA® multilayer piezo actuators.

A variety of 32-bit digital controllers provide fast communications and can read calibration data from ID-chips integrated in the nanopositioning stages. This feature allows easy interchangeability of stages and controllers without time-consuming recalibration. The stage's stiff design allows highly stable position control and higher throughput in automation applications.

P-628 stages are ideal positioning systems for applications such as nanometrology, (white light) interferometry, microscopy, spectroscopy, and precision alignment of optics.

Further information on these and other PI products and systems is available from WARSASH Scientific Pty Ltd at (02) 9319 0122 or sales@warsash.com.au

**New Fast Steering Mirrors**

Nanopositioning specialist PI (Physik Instrumente) offer a variety of piezo-driven, high-speed steering mirrors for use in image / beam stabilisation, resolution enhancement, scanning and tracking applications.
Product News

Just released, their latest fast steering mirror systems are designed to improve the performance of optics and imaging systems in a variety of applications ranging from lithography to bio-medical instrumentation.

They provide multi-axis motion with high bandwidth, sub-microradian resolution and optical deflection ranges up to 100 mrad.

PI steering mirrors are based on a parallel-kinematics design with a single moving platform and coplanar rotational axes, for jitter-free, multi-axis motion.

In addition, the single-pivot-point design provides better linearity and avoids the drawback of polarisation rotation, common with galvo scanners, where two single axis systems need to be stacked to provide XY motion.

Compared to stacked, multi-axis systems, the parallel-kinematics design provides faster response and better linearity with equal dynamics for all axes in a small package.

The flexure-guided, piezo-driven platforms can provide higher accelerations than voice coil actuators, enabling step response times in the sub-millisecond range.

Multiple integrated, absolute measuring position sensors feed the platform position information back to a piezo controller for enhanced linearity and stability.

A variety of analog and digital controllers in bench-top, OEM-board, and rack-mount designs are available to drive the units.

Further information on these and other specialist PI systems is available from WARSASH Scientific Pty Ltd at (02) 9319 0122 or sales@warsash.com.au

Vibration Isolation Workstation Provides Variable-Height Capacity

Kinetic Systems Inc. have released the 2000 Series Variable Height Vibration Isolation Workstation, which allows the user to raise or lower the tabletop to accommodate the work being performed.

A simple switch initiates a smooth, quiet transition to any tabletop height throughout a range of 24" (60.96cm) to 36" (91.44cm). Additional height ranges are also available.

It is well known that ergonomically correct posture can lead to better worker concentration, improved productivity, and less lost time due to fatigue and back strain. Users on different shifts can share the 2000 Series and the Workstation can be reassigned to new applications easily.

The 2000 Series Workstation features automatic levelling, delivers excellent vertical and horizontal isolation efficiencies, and has low natural frequencies. It is ideal for applications such as semiconductor tests and inspections, intercellular biology, use of confocal, tunnelling, or optical microscopes; wafer probing; mask aligning; roundness checking; and other repetitive processes in which external vibrations adversely affect the operation of precision equipment.

Accessories on the 2000 Series include fixed or sliding shelves, keyboard shelves, monitor supports, electrical outlet strips, enclosures, padded armrests, retractable casters, seismic restraints, and even Faraday Cages.

Further information on these and other vibration isolation systems is available from WARSASH Scientific Pty Ltd at (02) 9319 0122 or sales@warsash.com.au

About the Cover

One of the most successful Einstein Year events was *flows: the art of fluid dynamics*. Run by Melanie O’Byrne from Australian National University, this travelling exhibition has been to almost every state allowing an estimated 100,000 people to experience the natural art hiding away in our labs. See page ?? for a more detail about the Einstein events in Australia.

This photo, *Plumes*, comes from an experimental study at ANU by Mark Jellinek, Ross Kerr and Ross Griffiths. It shows convective mixing produced when one fluid is uniformly injected underneath a denser fluid. The blue injected fluid has a much lower viscosity than the yellow ambient fluid (by a factor of 726). The large viscosity ratio produces broadly spaced cavity plumes with large heads and narrow tails.

The purpose of the experiment was to understand the extent to which convective motions driven by the release of the buoyant (blue) fluid can produce mixing. In this case the blue fluid mostly passes through the ambient (gold) fluid as axisymmetric plumes that pond at the free surface. That is, convection produces stratification and no mixing.

More details on the experiments and their geophysical application can be found in:


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