Australian PHYSICS

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A Publication of the Australian Institute of Physics

Promoting the role of physics in research, education, industry and the community

Experiments with Antimatter
New Australian Facilities

Mt Kent Observatory
a Queensland facility for astronomy distance education

Highlights from the 2008 Adelaide Congress

Australian Physics
A Publication of the Australian Institute of Physics

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Write an article for Australian Physics

We are looking for articles covering all aspects of physics in Australia. Perhaps your area of Physics is not well known, is unusual in some way, or you work at a smaller univeristy; perhaps your career has developed in uncoventional ways; if so, why not write an article for Australian Physics?

For more information contact editor-in-chief A/Prof Brian James (B.James@physics.usyd.edu.au).

Cover Image

Dame Prof. Jocelyn Bell Burnell, President IoP speaks at the 2008 Adelaide Congress.

To see more image highlights of the Congress and some of the award winners turn to the centre spread on pages 14 - 15.

Contributions should be sent to
A/Prof Brian James
australianphysics@aip.org.au

Submission Guidelines
Articles for submission to Australian Physics should be sent in electronic format. Word or rich text format are preferred. Images should not be embedded in the document, but should be sent as high resolution attachments in eps, tiff or jpg. Authors should also send a short bio and a recent photo. The Editor reserves the right to edit articles based on length, space requirements and editorial content.

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Editorial

It may be a long time before another year tops 2009 for providing science with such an exceptional opportunity to show off a couple of our greatest achievements. In this single year we have a conjunction of anniversaries that straddles two of the greatest curiosities of our existence: our place in the universe, and our origin as a species. 400 years after Galileo wisely turned the newly invented telescope upwards to the sky, and 150 years since Charles Darwin published On The Origin of Species, these scientific triumphs remain deeply resonant.

There is no doubting the foundational value these two scientists and their work have provided the world. Today, no biological or medical advancement can be truly understood without relevance to its function in, and connection to, evolutionary development. It is impossible to comprehend, let alone teach, biology without its constructs pinned to the power of random variation and the pressures of natural selection. And although Galileo's optics isolated him to the narrow visual part of the spectrum, astronomers today are privy to the entire electromagnetic spectrum with instrumentation into every vista.

Fittingly, the real importance of these two scientists goes beyond the science and into the realm of how humans interact with, and value, our place in nature. Galileo forced us to face a once unspeakable truth: we are not at the centre of the universe; while Darwin showed us that we are not detached from nature but inescapably intertwined with it. With incisive arguments both proved that we were not then, nor are now, special. As a result of their leadership they faced intense, and necessary, scrutiny from their fellow scientists; but it was the deep ridicule and censure from a steadfast clergy bent on remaining the keepers of our place in the universe that proved most damaging. The many intervening years have done little to stifle that mentality from some.

Creationists, via their new creationist-lite proponents in Intelligent Design continue to wage war on science, and science education through their intrusions into the teaching of evolution, textbook content, or curriculum design. By and large that battle, publicly and in the courts, has been waged mostly against our colleagues in the life sciences; physics, for a number of reasons, has so far been immune from their unscientific gaze. Astronomy, cosmology and particle physics continue to be distant targets, but targets nonetheless.

We know now that any special status we hold in this universe ought to come from our own achievements, not from anyone, or anything else's doing. Galileo and Darwin proved that we are more than capable of discovery via our own abilities and under our own terms. 2009 can be a pivotal year for the communication of science, an opportunity to advance public discourse on its value and the challenge of reason that remains.

During this year's celebrations, let us show our colleagues in the life sciences that we not only support them in their struggles against the foes of science by attending the many lectures and presentations to come, but that we will stand with them, side-by-side, in public and in private, promoting reason, critical thinking, and the way forward.

John Daicopoulos

Submission deadline for the March/April 2009 issue is 23 March
Submission deadline for the May/June 2009 issue is 11 May

President's column

AIP...Why Bother?

Another year passes, another AIP National Executive is elected, another request to pay renewal fees for the AIP membership and another round of questions about why join the AIP any way.

In February 2009, I will complete my two years as the President of the Australian Institute of Physics. During this time I have, with the energetic and truly supportive executive and branch committees, tried to boost physics as a career choice, advance government and industry understanding and maintain funding of physics research, push for high educational standards and quality education at both the school and university levels, provide a place where physicists can network, find out more about what is happening in physics around the country, support the next generation of physicists with prizes, scholarships and travel support and tried to make the AIP as professional as possible. This has been at times a challenge, since the majority of the AIP activities are performed by volunteers[1] across Australia in branches, groups and cognate societies who are all very busy.

The AIP also ran a very successful Congress at the University of Adelaide due to the hard work and efforts of the South Australian Branch under the leadership of the Conference and Program Chairs Roger Clay and Olivia Samardzic. There were over 600 registrations, a wonderful conference and awards dinner, fabulous plenary speakers on many of the hot topics in physics, eminent visitors such as Dame Jocelyn Bell-Burnell, President of the "mother" organisation the UK Institute of Physics[2] and their CEO Sir Robert Kirby-Harris. The conference talks and posters were of a very high standard, along with terrific teachers' and industry days. The atmosphere at the Congress was one of energy, excitement and warmth. There were many meetings and gatherings such as the opportunity to give feedback to the AIP operations, women in physics meetings, quantum physics researchers, the proposed national curriculum discussion, heads of physics department meetings, student poster prizes thanks to the sponsorship of the CISRA, a session with the new Chief Scientist and eight new members signed up on the spot!

As I pass on the mantel of the presidency to Assoc. Professor Brian James from Sydney University, it is a good time to reflect on what the AIP does and could do. While being president, my greatest frustration was not having enough time or the financial resources to achieve all the things a strong and effective AIP could offer. I was also somewhat disappointed to be challenged by the question: "Why have an AIP"?

This often made me think about why I bothered to put so much of my "free" time into such an organization and began to research what other professional Physics organizations say. The American Institute of Physics has an excellent web site[3] that says: "Professional organizations provide an environment in which scientists can interact with other scientists in similar technical fields or with a similar technical background who have been working in the field much longer than they. Specifically, recent PhD graduates have typically had the opportunity to interact with other new PhD graduates and with their advisor. The opportunity to join professional organizations provides exposure to many other experienced scientists who may have worked in a field for decades." This is also the role of the specific discipline-based physics societies such as the Optical Society of Australia, the Astronomical Society of Australia, the Acoustics Society, the Australian Vacuum Society and our other cognate societies. However, the AIP is broader than providing the opportunity to participate in the physics community on a professional basis. This is participation important, but only one aspect of what is needed for the health of physics in Australia.

There are three aspects of the AIP's role:
1. Services to assist you in your career. This is the area that we have been working to develop and 2009 will see this come to fruition via a range of new initiatives including using the AIP web site as a portal to careers advice, planning, development and linkage with others. It is a challenge to create an effective web site that engages our younger generations and meets their needs! The AIP has a Face Book[4] page which we will build on to use as a way to communicate effectively with our e-savvy members.

2. Education of the next generation of physicists. The major initiative is accreditation of Australian university Physics degrees. In 2009, our accreditation activities will contribute to a campaign called "Think: Physicist". We will be using material from the IOP and material developed by the AIP about the skills a physicist has. This initiative aims to educate the broader community about careers that can use physics training and that a degree in physics can lead to many career opportunities, not just based in a laboratory. We plan to promote this with careers advisors, parents, schools, teachers, and HR professionals. We are also preparing a submission to the National Curriculum and assisting with promoting participation in the "Scientists in Schools" program[5].

3. Promoting the impact, role and need for physics in our society by outreach and advocating the importance of physics to all governments and participating in the political process via our involvement and membership of FASTS and directly to government when appropriate.

To be effective, the AIP needs a level of financial resources. This is currently provided by your membership fees. We have been working hard over the years trying to funnel as much of your membership fees into activities that directly assist you. We are currently moving to electronic management of our membership administration. We are also moving to increase advertising in the Australian Physics Magazine with a target for the magazine to be self funded. We are planning to vote on some new AIP By-Laws to allow the formation of a Physics Foundation Fund which will be eligible for tax deductible donations. These donations will be used to fund a broad range of initiatives for all levels of physics students including the Honours scholarships, travel bursaries and prizes and awards. We plan to use funds freed up by these initiatives on the development of our web site and to give branches more funds to undertake the very important local AIP functions.

So as we start 2009, the International Year of Astronomy marking 400 years since Galileo made his first telescope observations and with a world that has many problems that needs physics to solve, there is a greater need than ever for your membership. We want the AIP to assist you in your career and to satisfy your interest in physics with the knowledge that you are contributing to the greater community impact of what physics does for society.

Finally, it has been a privilege to represent the AIP as President. I have found the role to be one that has given me many opportunities and experiences. It has helped me develop and grow while hoping I have contributed to the long-term viability and effectiveness of the AIP. I also want to thank the Executive, the Branch and Group committees and the congress organisers past and future. I am constantly overwhelmed by the good will and hard work that so many members do for the AIP and from which we all benefit. Specifically I would like to thank Ian Bailey, our out-going national secretary, and David Jamieson, our immediate past president, for all their work, ideas and effort they have given to the AIP over the six or more years they have been on the Executive. I wish Brian James and his team the best for the next Executive and look forward to spending my two years as immediate past president completing some initiatives and to see the blossoming of ideas and initiatives for the last two years – because the AIP is definitely worth bothering about!

Footnotes

1 The AIP pays Materials Australia to administer membership operations and to undertake the financial management of the AIP, Science in Public to assist with our communications with monthly email bulletin and some specific communications activities such as the Congress media work and the Australian Physics Editor is paid an honorarium.
2 The AIP was a branch of the IOP until it became independent in 1964.
3 *http://www.aps.org/careers/guidance/guide/organizations.cfm*
4 *http://www.facebook.com/group.php?gid=12004370659*
5 *www.scientistsinschools.edu.au*

Letter

Dear Sir,
Thank you for the interesting article on Australia's participation in the Large Hadron Collider (LHC) project (*Australian Physics* Vol.45, No.5, p.164, 2008). You may be surprised that an Australian result obtained at the Australian National University in 1979 [1] could also be used for a new diagnostics scheme for the LHC.

The 1979 experiment demonstrated that the energy of electrons emitted from the focus of a laser beam could be used as a measure of the energy increment that they had received from the nonlinear (ponderomotive) force in agreement with the full Maxwellian exact nonlinear theory [2]. A similar mechanism for measuring the energy of particles produced by the interaction of a laser with the collider region of an electron accelerator was discussed at CERN in 1992 as a possible diagnostic tool for the LEP electron positron collider [3].

It now happens that the coincidence of B mesons with lifetimes in the picosecond range with the availability of lasers with petawatt power and picoseconds pulse duration, provides an opportunity to use the 1979 [1] method in the collider area of the protons and antiprotons. It is expected that very detailed information about the generation and annihilation dynamics of numerous charged particles should result, including fine structure information about the timing of the generation of the B mesons themselves and decay products such as protons, antiprotons and pi mesons [4].

[1] B.W. Boreham and H. Hora, Phys. Rev. Letters 42, 776 (1979); B. W. Boreham and B Luther-Davies, J. Appl. Phys. 50, 2533 (1979).
[2] L Cicchitelli et al, Phys, Rev. A 41, 3727 (1990)
[3] H. Hora, Laser acceleration of charged particles from a collider area. In *CERN Seminar Lecture*. Geneva, Switzerland, CERN (1992)
[4] H. Hora and D. H. H. Hoffmann, Laser and Particle Beams, 26, 503 (2008)

Sincerely,
Dr Bruce Boreham FAIP

Executive News

SUMMARY OF EXECUTIVE MEETINGS E275 AND E276

Meeting E275 held Thursday September 4
Meeting E276 held Wednesday November 5

Women in Physics: The president had found financial support to attend the Women in Physics conference in Seoul, Korea. This had been a very valuable experience and new contacts had been established. The number of women involved in the discipline of physics remains at about 25-30% across school, university and the workforce.

Honours Year Scholarship: The honours year scholarships have been popular and have attracted applications from very high calibre students. The executive has put considerable effort into finding new sponsors, and has achieved some success. The executive had reflected on the amount paid by the scholarships and it had been decided that that it would be better to offer more scholarships at a lower value, without detracting from the status of the award. Because of the high standard of applications, some very deserving cases had missed out in previous rounds.

AIP History: There has been good progress in the writing of the AIP history, but this has slowed somewhat recently. This is being followed up. The aim is to have the history available for distribution in the AIP fiftieth anniversary year.

Australian Physics: The editor, John Daicopoulos, has been working hard on upgrading the layout and content of Australian Physics, and the executive is pleased with the progress that has been made. A new printer has found, and issues are now being produced in full colour, and this has been achieved at a reduction in cost. Now that the changes have been put into place, other matters concerning publication can be cleared up. For example, advertising and subscription rates have been clarified.
The role of Editor-in-chief is the responsibility of the vice-president. The executive commends Brian James for the work that he has done in this role. This portfolio will pass on to Marc Duldig for the next two years.

Public Liability Insurance: We are all aware of the modern trend of litigation being taken over incidents occasioning injury. Because of the possibility of an accident occurring in public events run by the AIP, the executive has taken out a public liability insurance policy. This policy cover events run under the banner of the AIP, and this includes branch activities. In fact, some events entail a requirement that there is liability insurance, and this is a concern that that no longer needs to be considered in planning.

Credit Cards: There has been a request for the AIP to arrange for a credit card facility to be made available to branches. After making enquiries, it had become clear that there were great difficulties involved in setting up such a scheme. Although this would be a convenient way for branches to pay bills, it would be too difficult to manage.

Student Link Scheme: The number of AIP members has been an issue of great concern. One of the more important factors in this decline is that young physicists just starting their careers do not appreciate the value of membership. For this reason, a student link scheme has been set up in universities, where undergraduate students are provided limited services through a contact person in each university. These services include access to email news, provision of copies of Australian Physics to the university and access to job advertisements.
The value of membership needs to be made clearer to members as well as to students and other prospective members. One that is not often appreciated is the support of FASTS, which has a prominent lobbying role and has the ear of the government. FASTS obtains significant financial support from the government and this provides a lot of leverage from the subscriptions paid by members.

Accreditation: The most recent accreditation visits have been to Murdoch and UWA. In all, there have been five accreditations this year. The current round of accreditations is nearing completion. Some universities do not realize the value of accreditation. It is believed that graduates would gain greater value from their degrees if their graduation certificates showed that the course had been accredited.

Student Travel Grants: After reviewing the student travel grants provided to student members by the various branches, it became clear that there substantial disparities between the grants offered. This issue has been discussed with branches, and the consensus was that it would be more equitable for students if travel grants were dealt with centrally. John Humble has developed criteria for the offering of grants.
The major guidelines for grants would be that
• The scheme would commence in February 2009.
• Grants would be up to a maximum of $500.
• The grants would be for travel costs only, and would amount to no more than half the total cost.
• Applicants must have been members of the AIP for not less than six months.
• Applicants must have submitted a paper that has been accepted for presentation at the conference.

2010 Congress: The Victorian Branch has submitted an application to run the 2010 Congress, and this has been accepted. There was a concern that conferences such as this draw on the same pool of people as other conferences run by scientific bodies in Australia, and it has been suggested that it would be better to run conferences in conjunction with other scientific societies. The organizers of the Melbourne congress will be asked to consider this option.

Secretariat: The secretariat has appointed a new executive officer, and this necessitated a review of the relationship between the AIP and the secretariat. There were a number of problems initially, but these have been sorted out and the secretariat has been appointed for a further twelve months.
An important issue in the discussions was the database, and the related matter of making it possible to pay subscriptions on-line. It has been decided that the AIP will transfer its database to Coresoft. On-line subscription has now been implemented. Many members will realize there were a few teething problems with this, but these have now been sorted out and the system is operational.
There has been some discussion about the current model we are using for the secretariat. Another possible model

is for all professional scientific societies to have a common secretariat. A great advantage of this approach would be that all these societies have similar needs and similar operational models. It is possible that such a secretariat could attract government support since the government has expressed a desire to have good governance in professional societies.

Web Site: The web site has been maintained on a volunteer basis. Following the arrangements with the new secretariat, it may be feasible to move to a professional provider. The first move is to set down what we want from the web site and look for ways of getting this at reasonable cost. This is being followed up.

International Year of Astronomy: Members will be aware that 2009 is the international year of astronomy. The AIP is not directly involved with the organization of events in Australia, but would like to support any activities that take place. The Astronomical Society of Australia is responsible for the conduct of the Australian program and it is hoped that members will contribute to the planning of the events that are to take place.

Retirees' Subscriptions: The taxation department has now provided confirmation in writing that retirees can claim $42 of their subscription as a tax deduction. This information has been placed on the web site. Retirees should note that their claim should not be put in the professional society subscription part of the tax form, but in general deductions.

National Physics Curriculum: Members will have seen that the government has set up a process of developing national curricula for high schools, and this includes physics. It is important that the AIP contribute to this process. The AIP Education Group has been asked to develop position papers that will be put together to provide a response by the AIP. Because of the importance of this development, members are asked to contribute their views on what should go into the curriculum.

Innovation Review: The government has requested information about examples of where technological innovations have led to industrial development contributing a gain to Australia. The motivation for this is primarily political, but it gives the AIP an opportunity to stress the importance of supporting technological development, and in particular, to point out that there is a long time lag between the germination of an idea and its implementation into an industrial product. The Industry Ready grants introduced many years ago and now discontinued by the government have started to bear fruit, and there are quite a few examples of very successful programs. FASTS will be involved in putting together a package of information about these developments to be presented to the government.

Theoretical Physics Group: There has been enough support from members to form a theoretical physics group. A motion will be presented to the Council meeting asking for approval for the formation of the group.

Science Meets Parliament: The dates scheduled for science meets parliament are 17/18 March 2009. registration is now open.

Next meeting: The next meeting will be scheduled following the Council meeting and the appointment of the new executive.
Ian Bailey,
Hon secretary.

Branch News appears on page 23

Prime Minister's Prize for Science

The nomination round gives research organisations, universities, education departments and schools a unique opportunity to seek public acknowledgement of the outstanding efforts of their colleagues.

The major prize, the Prime Minister's Prize for Science, is one of the nation's most highly-regarded awards and the premier national award for scientific achievement.

A total of five prizes will be awarded:
- Prime Minister's Prize for Science ($300,000).
- Science Minister's Prize for Life Scientist of the Year ($50,000).
- Malcolm McIntosh Prize for Physical Scientist of the Year ($50,000).
- Prime Minister's Prize for Excellence in Science Teaching in Primary Schools ($50,000).
- Prime Minister's Prize for Excellence in Science Teaching in Secondary Schools ($50,000).

Nominations can be made online at:
https://grants.innovation.gov.au/SciencePrize/Pages/Home.aspx

The Department of Innovation, Industry, Science and Research will provide assistance during the nomination process.

Inquiries can be made by telephone to (02) 6276 1264 or by email to *pmprize@innovation.gov.au*

Nominations close on Friday, 8 May 2009.

News

2009 Pawsey Medal for research in physics

Dr Stuart Wyithe Senior Lecturer and Australian Research Council Queen Elizabeth II Fellow, Astrophysics Group, School of Physics, University of Melbourne.

Stuart Wyithe has made outstanding contributions to cosmology, and to our understanding of the likely structure of the universe as the first stars formed, with work on the birth of black holes, stars and galaxies. Together with collaborators, he has developed clear predictions of the expected observational signatures of these processes. Searches for these signatures are now being undertaken using new instrumentation on existing international observatories, such as the Gemini Telescopes and the Hubble Space Telescope, and on new long wavelength radio telescopes being constructed around the world.

Australian Academy of Science

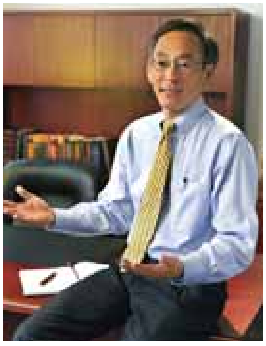
2009 Thomas Ranken Lyle Medal for research in mathematics or physics

Professor Victor Flambaum FAA Scientia Professor and Chair of Theoretical Physcis, School of Physics, The UNSW.

Victor Flambaum has performed pioneering research in the area of the violation of fundamental symmetries and tests of unification theories of elementary particles.

With collaborators he developed a new method to perform the most accurate atomic calculations of parity violation. These calculations allowed the standard model of elementary particles to be tested. Recently he proposed new ideas which have led to fresh directions in the search for variations of the fundamental constants of nature, including astrophysics (Big Bang nucleosynthesis, quasar spectra), nuclear physics (nuclear clock), and atomic and molecular spectroscopy (atomic clocks).

Australian Academy of Science



Courtesy: Lawrence Berkeley National Laboratory

Chu sworn in as DOE head

The Nobel-prize-winning physicist Steven Chu has been sworn in as Secretary of the US Department of Energy (DOE) — a post that makes him a member of president Barack Obama's cabinet.

Chu is the first working scientist to head the Department of Energy — which is a major source of physics research funding -- since it was created in 1977. He is an expert on energy policy and well matched to the challenges he will face. In his previous role as director of the Lawrence Berkeley National Laboratory in California, he refashioned the lab to focus on alternative-energy research and is a passionate advocate of biofuels.

Obama nominates physicist as science advisor

President of the United States, Barack Obama announced that he will nominate the physicist and environmentalist John Holdren as his presidential science adviser and director of the White House Office of Science and Technology Policy (OSTP). "Today, more than ever before, science holds the key to our survival as a planet and our security and prosperity as a nation," Obama said in a radio address on 20 December. "It's time we once again put science at the top of our agenda and worked to restore America's place as the world leader in science and technology."

Holdren, 64, has a variety of positions at Harvard University. He is professor of environmental policy and director of the programme in science, technology, and public policy at the university's Kennedy School of Government. He is also director of the Woods Hole Research Center, an ecological think tank on Cape Cod, Massachusetts.

Holdren earned a PhD from Stanford University, where he specialized in fluid dynamics and theoretical plasma physics. He has been a professor of energy and resources at the University of California, Berkeley and a consultant in magnetic fusion energy for the Lawrence Livermore National Laboratory.

Holdren has already served in government, having spent seven years as a member of President Clinton's Council of Advisers on Science and Technology, leading studies on protecting nuclear materials from theft, research on fusion, and American R&D on energy. At the same time, he chaired the National Academy of Sciences' Committee on International Security and Arms Control. He was also active in the Pugwash Conference, chairing its executive committee. In recent years, he has been identified most for his unambiguous views on climate change and related environmental issues. He has referred to global warming as "global climate disruption."

Courtesy: Harvard University

The scientific community has largely embraced the nomination. "He's a well-known science policy expert in energy and environment," said Bush science adviser Marburger. "I think he's well qualified to have this position." Neal Lane, who served as science adviser for President Bill Clinton, was more effusive. "John Holdren has the stature and all the knowledge and skills to be an outstanding science adviser to President Obama," he told physcisworld.com.

physweb

more news....

Hawking accepts post in Canada

Stephen Hawking has been appointed PI Distinguished Research Chair at the Perimeter Institute in Waterloo, Canada. The world-famous cosmologist will conduct regular stays at the institute, which is headed by his former Cambridge University colleague Neil Turok. Hawking's first stint in Waterloo is expected to begin in summer 2009.

Hawking, who is due to retire as Lucasian professor of mathematics at Cambridge next year when he turns 67, will however retain links with Cambridge. "I look forward to building a growing partnership between PI and our Centre for Theoretical Cosmology at Cambridge," he says. "Our research endeavour is global, and by combining forces I believe we will reap rich rewards."

Hawking is the first of what are expected to be 40 such appointments to the PI, which was founded in 1999 by Mike Lazaridis, chief executive of Research in Motion — the company that makes Blackberry wireless handheld devices. "The appointment marks a new phase in our recruitment that will see leading scientists from around the world establish a second 'research home' at Perimeter Institute", says Turok.

The PI is home to more than 60 resident researchers and focuses on fundamental questions in areas such as cosmology, particle physics, quantum gravity and quantum information.
Perimeter Institute

Indicators of excellence for the new ERA

The Australian Research Council CEO, Professor Margaret Sheil, released two key documents that will guide the Excellence in Research for Australia (ERA) initiative.

"ERA will use a range of indicators and peer review to support the evaluation of research excellence," Professor Sheil said. "…I release the ERA Indicator Principles and ERA Indicator Descriptors—two key documents that will assist institutions as they prepare for a trial of ERA in 2009.

"The ERA Indicator Principles provide the overall context and application of the indicator approach and the ERA Indicator Descriptors provide the detail of each indicator type."

The Minister for Innovation, Industry, Science and Research, Senator Kim Carr welcomed the release of the two documents.

"I know that many academics and others across Australia have made significant contributions to this work, and I thank them for their efforts."

"This work will substantially assist ERA in demonstrating the quality and diversity of research undertaken at Australian universities," Carr said.

Clusters One and Two will be evaluated in the first half of 2009 and this will help the ARC to further develop and test the indicators ensuring they are valid and robust.

Journal ranking lists for Cluster One and Two are complete and are now subject to a final review by discipline-specific experts. These lists will be released in early-2009 to ensure that institutions can prepare for the Cluster One and Two evaluations.

The ERA Indicator Principles and ERA Indicator Descriptors are available on the ARC website.
ARC

Jayden Newstead wins AIP prize for 3rd year laboratory

Monash student Jayden Newstead has received the Third Year Physics Practical Award from the Australian Insititute of Physics. The Award of $250 is given annually for the best practical report by a third year student at a Victorian university.

Jay elected to substitute some of the standard practicals for the opportunity to work on a research mini-project. Instead of doing a third-year practical, Jay designed a new one. Jay's new experiment, titled "Faraday Rotation: A New Twist on Signal Transmission", uses a laser beam to transmit an audio signal from the student's iPod (or similar) across the lab to a receiver which converts the laser beam back into sound. The "twist" is the use of polarisation modulation, rather than more conventional amplitude or frequency modulation, to encode the signal onto the laser beam.
Monash University

MyScience

MyScience has been recognised as the Best Education and Training Collaboration for 2008 at the Business Higher Education Round Table Awards, held in Melbourne on 21 November 2008. The Hon Julia Gillard MP, Deputy Prime Minister and Minister for Education, Employment and Workplace Relations, gave an address at the awards ceremony.

MyScience is an innovative and exciting primary school science and technology program, developed by a consortium of organisations including the Science Foundation for Physics based at the University of Sydney, Australian Catholic University, IBM and the NSW Department of Education and Training.

The program endeavours to support science in primary schools through the establishment of a sustainable model of collaboration between schools, industry/business and universities to stimulate interest and enhance capacities of primary science teachers and students in conducting authentic scientific investigations.

Teacher expertise and confidence are advanced through continuous professional learning, provided by expert facilitators, and students are mentored by practising scientists via face-to-face sessions and interaction in a secure online environment.
The achievements of students are acknowledged and showcased in school science fairs during National Science Week and then submitted to the Young Scientist awards (conducted by the Science Teachers' Association of NSW). To learn more about MyScience visit: *http://myscience.com.au/*

University of Sydney •

Why Physics is Important to Australia (and vice versa)

Thoughts from the Chief Scientist Professor Penny D. Sackett on the importance of physics to Australia, its people, and its future - and the role of scientists in an increasingly global society.

It is a delight to be here in Adelaide, and in particular at the 18th Biennial Congress of the Australian Institute of Physics.

Fortunately, I will be able to enjoy the Women in Physics session; unfortunately, I have missed a number of sessions on topics ranging from solar power to the Large Hadron Collider, climate change and the art of physics making music.

Today I would like to speak a bit about why physics is important to Australia, and why Australia is important physics.

But as I imagine that this audience is largely convinced of those points, I'd like to focus more on how this importance can grow.

An inspirational teacher in secondary school made me appreciate that physics is a way to seek understanding about anything --- everything --- in the world.

Australia has a rich tradition in physics of which any nation of its age would be immensely proud.

Sir William Lawrence Bragg, who was borne in North Adelaide, received the Nobel Prize when he was only 25 years of age for us work on the structure of crystals as deduced from the diffraction of X-rays, work that eventually led to our understanding of DNA.

London-borne Rachel Makinson began her studies in Cambridge, and finished them at the University of Sydney.

During an age when Australia was said to "Ride on the sheep's back" because of the importance of wool as the major export, Makinson became a world expert in the structure and characteristics of wool, pioneering new techniques to increase its usefulness and durability.

Howard Florey, also a native of Adelaide, has forever changed the world as a physicist who discovered penicillin. It is difficult for us to now imagine a world without antibiotics.

Physics has been important for Australia. Physics that is driven by curiosity and leads, sometimes decades later to unanticipated benefits, as it did with the work of Bragg, and physics focussed on providing solutions to immediate problems, as in the case of Makinson.

Never has Australia and the world needed more what physics can provide. Think no further than: the exhaustion fossil fuels, our primary source of energy; the realities of climate change; and the promise of nanotechnology.

And yet, a recent audit by the Australian government is predicting a shortfall of 19,000 scientists in the country in just three years time.

While the population grows, the numbers of Australians with degrees in physics has declined, on average, about 1.5% per year.

Against such a backdrop, it seems odd that physicists --- and scientists in general --- find themselves explaining to some in positions of influence that physics is a vital piece of any modern society.

My attention was drawn to a piece in the 22 November edition of The Economist quoting an academic from the Columbia Business School that what the world needed, or at least that part of the world occupied by America needed was not more PhDs but better MBAs.

Now few would dispute that better MBAs would be a benefit, but can we do with fewer citizens that understand in detail the mechanics of the world in which we live?

I think not. If you agree with me, then we need to ask why that message is not being heard. Perhaps we need to do better in getting the message out.

I am a physicist by training. An inspirational teacher in secondary school made me appreciate that physics is a way to seek understanding about anything --- everything --- in the world.

But as I progressed through graduate school, the definition of physics seemed to narrow, rather than widen. There was a sense that some science was just not "real physics, not fundamental physics," which led, in some, to an introverted and linear discipline that is more easily segregated from society.

But this meeting is an indication that physics is moving away from that narrow view and returning to its earlier roots, when physics encompassed or at least interfaced with all questions of how the universe works and why.

If physics is a volume, then the interactions occur at its surface, and the larger that surface, the more convoluted that surface, the more fractal that surface, if you like, the more interaction will take place.

More interaction means more ways for physicists to influence the world and more ways for the world in which we live to provide input and enrich our work.

That's my take home message.

Remember that as a physicist you can make a strong contribution to science policy, but to get action, you need to interact.

I hosted the Science Outside the Square session called Physics to Blow your Mind, a fantastic opportunity for physicists to talk about their work with people from all walks of life.

Professor Steven Carlip from the University of California and CERN's Professor John Ellis interacted with the crowds through a free exchange of questions and answers, challenging and expanding understanding on topics ranging from dark matter and energy, and black holes and The Big Bang.

One program set up by my predecessor, Jim Peacock, allows to form one-on-one partnerships with teachers in Australia. Scientists in Schools is a wonderful and very successful initiative, based on an earlier initiative born here in South Australia. I encourage you to consider participating in it, which is as simple as registering your name on a web interface.

Based on a visit I made yesterday, I assure you that the teachers and pupils of schools like Cowandilla Primary are waiting and depending on you.

We need, as scientists to interact with schools, with policy makers, and with the public to share our excitement of science, to explain its focus on questions as well as answers, and to fully integrate into the society that supports us and depends upon us.

Physics is not just a training, it is a life-long continuing education. We are learners as well as teachers.

As Chief Scientist for Australia, I need to wear many hats, as a: facilitator for innovation; bellwether for the nation's most important scientific issues; as communicator of and an ambassador for science; and a continuous advocate of evidence-based decision making.

But these aren't just my roles, they are yours as well. I need your help. Australia needs your help. You can and will help shape the future.

And so I look forward to working with you to increase the surface area of interaction between physics and the world in which it is so inextricably linked.

This is an edited version of the Chief Scientist's presentation to the 18th Biennial Congress of the Australian Institute of Physics, 5 December 2008. •

Five of the many helpful volunteers from the 2008 Adelaide Congress

More images from the 2008 Congress can be found on the centre spread on pages 14 and 15

Response to the National Curriculum

The Physics Education Group is a special interest group of the Australian Institute of Physics. It provides a forum for the advancement of Physics Education in Australia through research and practice and includes amongst its terms of reference that it will advise the National AIP Council on Educational matters. At the recent AIP Congress (Adelaide, 1–5th Dec, 2008) the group determined that a collated response to the national curriculum paper should be forwarded to the President of the AIP for incorporation into an AIP submission. An email inviting comment on the framing paper was sent to people who have been involved in recent physics education activities in Australia, including the Physics Education group meeting. Katherine Legge collated ideas put forward by individuals, and structured a document by the themes that emerged. A draft was circulated, subsequent comments incorporated. Margaret Wegener was responsible for the sending of emails, comments on aspects of the framing paper, and some editing of the document. This paper represents that response. A web link to the framing paper can be found at:

http://www.ncb.org.au/verve/_resources/National_Science_Curriculum_-_Framing_Paper.pdf

A National Curriculum for Australian Schools

The Physics Education Group (PEG) is very supportive of the concept of a National Curriculum in Science and is largely satisfied with the direction outlined in the National Science Curriculum Framing Paper. The framing paper presents a broad outline of what should be taught and what should be learnt in the national science curriculum from Kindergarten to Year 12.

Introduction

The PEG group is primarily involved with tertiary education including the transition between the secondary and tertiary sectors, but we are cognisant of the conceptions and understandings that students bring with them from their very early educational experiences. As a result we are concerned that the curriculum should not focus solely on the science content that is to be covered. Of equal importance is the manner in which the hierarchy of conceptual development is constructed from Kindergarten to Year 12. We welcome the introductory remarks in the framing paper alluding to the strategies that assist students to develop their understanding. "Becoming scientifically capable is a cumulative process that begins in early childhood and continues throughout schooling. The kinds of teaching and learning strategies that best assist students to develop science capabilities and understanding will vary according to the different needs and interests of young people. This has implications for the way science is taught." (item 15, p1)

We also recognise the concept of "scientific enquiry" in item 16 as a crucial element in nurturing the enquiring minds that young children bring to their learning.

Aims

"… school science should also provide a foundation for more specific pathways. These pathways include more specialised, discipline based study in senior school science that leads to science courses at university,…" (item 19, p2) We agree with the aims as stated in items 17 and 18 and note item 19 which recognises that there will be specialised discipline-based studies in senior school. Our comments in this paper are generally concerned with suitable preparation for the Physics discipline studies in Stage 4 of schooling.

Considerations

Selection of science content

In reference to the selection of content the framing paper makes the following cogent point (item 32, p3),
"Selection of content should recognise: the importance of the big ideas of science that students ought to understand in order to build a strong base of scientific knowledge; the importance of exposure to a range of science experiences relevant for each stage of learning; and the importance of understanding the major concepts from the different sciences."

In this quote, we highlight the word 'understand'. There is much research done into the understandings and 'misconceptions' held by commencing tertiary physics students. Indeed, it is the variety of understandings present in a large first–year university class that provides a greater challenge to the tertiary physics educator than the variety of content to which the students may previously have been exposed. PEG agrees that "…The challenge, in terms of science content, is to identify the key science concepts and focus on developing understanding and skill development rather than memorisation of a great range of knowledge" (item 30, p3) and it is for this reason that we would like to see a greater emphasis on understanding relevant physical concepts at an early stage.

Item 28 presents a major challenge for the curriculum "… how to take account of rapidly increasing body of science knowledge and not simply add more to what students are expected to know…" (item 28, p3). Item 29 states " …however structures of the current implemented science curriculum tend to be knowledge heavy and may be alienating for a number of students…"(item 29, p3). We acknowledge this as a real tension point, and present the example of superconductivity in the NSW HSC physics syllabus, a topic that cannot be explained at an appropriate level within the framework of the students' existing understandings.

Item 30 points to the challenge of identifying the key science concepts and developing understanding, and item 31 acknowledges that the amount of time allocated to science will influence the selection of the content. We point out that this will be crucial at the primary school level, as this is where students' attitudes to science are often set. By and large, current minimal allocations are insufficient. Many teachers will need support to achieve an increase in quality science lessons.

Flexibility and Equity

Physics education research and experience clearly shows that students are more actively engaged if they see personal relevance, so it is pleasing to see the recommendation that

The Physics Education Group is very supportive of the concept of a National Curriculum in Science and is largely satisfied with the direction outlined in the National Science Curriculum Framing Paper

the national curriculum allows for some local flexibility in science teaching, which can be used to implement material of particular local or contemporary relevance (items 36 and 60). It is also pleasing to see the acknowledgement that teachers will require support to do this effectively "…where required, teachers will be assisted to do this through the provision of quality, adaptable curriculum resources and sustained effective professional learning.' (item 39, p5)

Structure of Curriculum

The framework states that the science curriculum should be based on three elements: Science understanding, Science inquiry skills and Science as a human endeavour. "All three elements of science are important and should be evident across each stage of schooling. In developing the science curriculum the focus is on science understanding through the development of science concepts…" (item 44, p5). PEG agrees with these elements as the basis for the national curriculum but emphasises that early development in the first of these elements "Science Understanding" is vital to the success of students in later stages, particularly to specialised disciplines such as Physics that appear at Stage 4.

Organising Science Content for Stages 1 – 4 of Schooling

The natural world

The document seems to limit the curriculum to dealing with the 'natural world' in the early stages of learning which appears to preclude many technological and man-made aspects. This may be an artefact of wording choices, nevertheless it must be clear that the 'natural world' for the current and future generations includes technology that should not be ignored.

Hierarchical conceptual development and mathematical skills

Strong understanding and high level of skill in maths supports physics and we are strongly of the belief that there should be interaction in planning the science and mathematics national curriculum.

In relation to the Physics curriculum, mathematical representations and problem-solving skills would normally be commenced in Stage 4. It is therefore vital that there is a greater emphasis on conceptual development in earlier stages.

Students need to have developed the skill to conceptualise physical phenomena before they are introduced to mathematical representations of the same. Amongst the 'science inquiry skills' listed in Stage 2 and 3 should be

• using relevant terms and physical characteristics to describe phenomena.

(As an example, students who enter the Physics specialisation in Stage 4 should have already developed a clear understanding of the concept of acceleration that is related to but distinct from, the concept of velocity. They need to be ready to develop their understanding to describe the concept of acceleration using a mathematical representation and to see how it links to other terms used in the study of mechanics.)

Pedagogy and Assessment

The document's approach to assessment (items 62 – 64), including the insistence on a variety of assessment, is commendable.

Conclusion

"The national science curriculum will provide the basis for learning science that will engage students in meaningful ways and … help them to develop their science understanding… The desired result is that students will be interested in and understand the world about them, be able to communicate scientifically, be sceptical and questioning of the claims of others, and be able to identify and investigate questions and draw evidence-based conclusions. (Item 65, p12).

PEG strongly endorses the notion of a National Science Curriculum and is generally satisfied with the directions outlined in the framing paper. While we are largely supportive of the framing paper, we would like to see a more definitive approach to the ways in which students will be assisted to '…develop their science understandings'.
We are mindful of the importance of the early stages of schooling and stress the need for adequate time and teacher support to be given to science inquiry in Stages 2 and 3. The understandings the students bring with them from Stages 2 and 3 will be crucial to their success in Stage 4.

Specialised disciplines such as Physics appear in Stage 4. Here the challenge will be the selection of content such that students develop a deep understanding of key ideas rather than a superficial memorisation of many facts. A wide range of stakeholders should be included in drafting the details of the physics syllabus, including teachers from the tertiary level with school experience, teachers from the tertiary level with first year teaching experience and textbook authors. PEG recommends that AIP offers the services of the AIP membership in developing the details of the Physics syllabus.

Overall, successful implementation of a National Science Curriculum should be of great benefit to physics educators provided students embarking in tertiary physics studies share a coherent understanding of fundamental physical concepts and an ability to continue to learn.

Anyone who wishes to make personal responses can do so by visiting the website at:
http://www.ncb.org.au/get_involved/subscribe/ways_of_participating.html •

Highlights from the 2008 Adelaide Congress

An attentive audience at the opening conference session

Top (right)
Dr Duncan McFetridge, SA Shadow Minister for Science and Information Economy
Dr Olivia Samardzic, DSTO (Congress Cttee)
Prof Roger Clay, Uni of Adelaide (Congress Cttee)

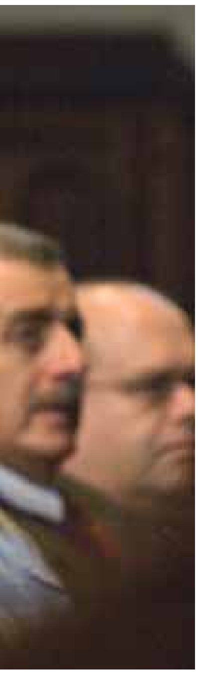
Middle (left)
Plenary speakers Prof Steve Carlip, UC Davis and Prof Marvin Geller, State University of New York

Middle spread (left to right)
Dr Duncan McFetridge, SA Shadow Minister for Science and Information Economy
Prof. Fred McDougall, University of Adelaide, Acting Vice Chancellor
Dr Laurence Campbell, Flinders University (Congress Cttee)
Prof. Warren Lawrance, Flinders University
Prof. John Thomas, Uni of South Australia (Congress Cttee)
Prof. Andrew Parfitt, Uni of South Australia, DVC

Bottom (left)
AProf Brian James, AIP President-elect (centre) with Walsh Medal winners Dr Trevor McAllister (left) and Dr Tony Murphy (right)

Left
Prof Tanya Monro University of Adelaide receives her Women in Physics Lecturer 2007 - 2008 from Prof. Jocelyn Bell Burnell, President IoP

Below
Dr Jackie Craig, centre, presents the 2008 DSTO/AIP Honours Scholarships to Emma Lawrance (left) and Kimberley Heenan (right).



Above
Dr Frank Ruess receives the 2008 Gold Bragg Medal from A.Prof Brian James.

Left
Christine Charles receives her Women in Physics Lecturer 2009 from Dame Jocelyn Bell- Burnell.

Mt Kent Observatory: a Queensland facility for astronomy distance education

by Brad Carter (USQ), Roy Duncan (APTA Pty Ltd), Rhodes Hart (USQ), John Kielkopf (University of Louisville, USA), Scott Sinclair (APTA Pty Ltd) and Ian Waite (USQ)

Summary
Mt Kent Observatory is an astronomy teaching facility located at a dark-sky site on Queensland's Darling Downs. The facility supports astronomy education through on-site field nights and queue-scheduled robotic and live remote observing. Students in Australia and the United States access the facility remotely for their astronomy studies.

Introduction
The University of Southern Queensland (USQ) has long been known for its efforts in distance education. In addition, astronomy has been taught at USQ and its antecedents from the 1980s, when a dark-sky site was established at Mt Kent, some 30 minutes' drive southwest of the University's Toowoomba campus. Installing remote-access telescopes for USQ's distance education students is thus a natural development for the Mt Kent site. With 2009 being the UNESCO-endorsed International Year of Astronomy, it is perhaps timely to present some information on Mt Kent Observatory's role in the teaching of astronomy and astrophysics by distance education.

Mt Kent's 3 telescopes
The Mt Kent site has a utility building (the EDG building donated by the local Educational Development Group) and three telescopes in separate domes, as follows.

• Webb Telescope: This instrument is used visually for USQ student field nights, and is a 40cm aperture Meade LX200 telescope housed in an Astrodome brand 6.5m diameter fibreglass dome. Student visitors thus get a chance to look through a telescope eyepiece and directly experience the starry riches of a dark-sky site.

• O'Mara Telescope: Named after the late Mt Kent Observatory pioneer Dr Jim O'Mara (University of Queensland), this telescope has a Paramount ME robotic mount, 30cm Meade optics, and an SBIG STL1301 CCD imaging camera. The telescope is housed in an unusual octagonal enclosure designed by Jim O'Mara. The O'Mara telescope is a robotic instrument that takes observing requests submitted over the web at any time, and schedules and executes the observations automatically when observing conditions permit. The O'Mara robotic telescope is the result of an alliance between USQ and APTA Pty Ltd in Brisbane.

• Louisville Telescope: This instrument is the latest and largest addition to the site and combines 0.5m Planewave Instruments CDK-20 optics on a custom Celestron mount and a variety of ancillary imaging and computer equipment. The telescope is housed in a Sirius Observatories brand fibreglass dome. Funding for this installation arose through a partnership between the University of Louisville and USQ that aims to provide reciprocal live remote observing services for students located in the USA and Australia.

Figure 1 Mt Kent Observatory, located in southern Queensland's Darling Downs region. Left to right are the domes of the Webb, O'Mara and Louisville telescopes. (USQ photo.)

In addition to the telescopes, a Davis Vantage Pro weather station monitors site rainfall, wind, temperature and humidity, and a Boltwood cloud sensor is installed. Electronic site security includes a remotely operable security camera used for monitoring the site. The EDG utility building has accommodation facilities, a computer server room and control room. A line-of-site 34 megabit/s E3 microwave link connects the Observatory to the campus and its 1 gigabit/s fibre-optic link to the Internet.

Operations at Mt Kent
The Webb telescope continues to be maintained so that undergraduate student field nights can be provided during each semester.

The O'Mara telescope automatically services imaging requests from USQ undergraduate and postgraduate distance education students in astronomy and astrophysics. Undergraduate students get a credit for 20 images after successfully completing an observing proposal designed to help them learn about some basic concepts in astronomy, and are quizzed on their observing experiences in the exam.

Figure 2 Louisville telescope image of the red dwarf Proxima Centauri, the nearest known star to our solar system. The image is a composite of three 30-second exposures through infrared, red and yellow/green filters. Proxima is the red star at the centre. (Copyright John Kielkopf; Creative Commons License.)

Figure 3 O'Mara telescope image of the galaxy NGC 5236 in the constellation Hydra. The observer submitted the image request via the web, and image collection was scheduled and performed automatically without the need for anyone on site. (Image by Roy Duncan).

Postgraduate students in USQ's Master of Science program get substantive access for time-series imaging of variable stars or other targets. These time-series observations are made very simple, as the student only needs to use a web page to select targets and other parameters.

The Louisville Telescope at Mt Kent provides live remote observations of southern skies as part of a collaborative project between USQ and the University of Louisville (and Northern Kentucky University). Telescopes at Mt Kent and Moore Observatory in Kentucky enable students to remotely observe otherwise inaccessible night-time skies by using a telescope located in the opposite hemisphere. Mt Kent Observatory delivers live remote observing using multiple electronic cameras for narrow and wide-field imaging. The use of an astronomer at the observatory is deliberately retained (at least for the time being), to supervise and interact with the remotely located class of US students. The project demonstrates the feasibility of live remote observing for astronomy education.

More information

For those who would like to learn more about Mt Kent Observatory visit our website at: *http://orion.mko.usq.edu.au/*

Dr Brad Carter is a Senior Lecturer in Physics at the University of Southern Queensland and serves on the AIP Queensland Branch. He is one of a team of people at the University of Southern Queensland involved in operations and development work at Mt Kent Observatory.

Experiments with Antimatter: New Australian Facilities

by James Sullivan and Stephen Buckman
ARC Centre of Excellence for Antimatter-Matter Studies
Research School of Physical Sciences and Engineering
Australian National University

New experimental facilities have been constructed to investigate the way in which low-energy positrons interact with atoms, molecules and materials, and how these interactions may be harnessed in the growing field of positron applications. Some background information on positron physics is provided, and the design and operation of a new, high-resolution, positron collisions apparatus is explained, along with a demonstration of the first experimental results.

Positrons – the most abundant form of antimatter
This year marks the 75th Anniversary of the experimental verification of the discovery of the positron by Carl D. Anderson and colleagues at Caltech [1]. Anderson's experiment verified the mind-boggling insight displayed a few years earlier by Paul Dirac in interpreting negative solutions for the 'Dirac Equation' – a relativistic version of Schrödinger's equation, which Dirac formulated to describe the behaviour of the electron - as the existence of a positive electron, or the positron [2].

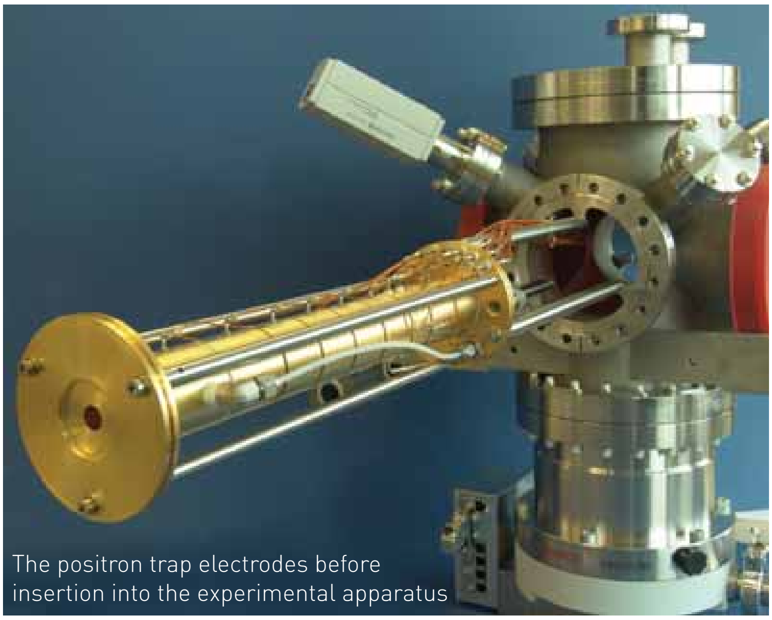
The positron was the first anti-particle to be experimentally verified and it has the same rest mass as the electron but the opposite charge. While positrons are the most common form of antimatter in our world, positron physics remains in its early stages as intense, reliable, and relatively small-scale sources of positrons remain elusive. Positrons can be produced for experimental purposes by a number of means, but the most common are either pair production, for which one generally needs a large-scale accelerator facility, or as a by-product in the radioactive decay of atomic nuclei. A number of unstable atomic nuclei produce positrons when they decay and the most common, and most useful, is ^{22}Na, as it has a high conversion rate and relatively long half-life of 2.6 years. In handling positrons, and antimatter in general, we must take care to isolate the anti-particles from their matter counterparts otherwise they annihilate and convert their rest masses to energy – in the case of electrons and positrons, two 511 keV gamma rays are usually produced by the annihilation. In order to conserve energy and momentum, these gamma rays are emitted 'back-to-back', 180° to one another.

While studies of positron interactions with matter are important in furthering our fundamental understanding in areas such as scattering physics, positrons are also becoming increasingly important, and useful, in applied fields such as materials research and development, and biomedical science.

The key to many of the applications of positrons lies in the fact that sometimes, when positrons and electrons come together, they do not immediately annihilate, but rather form a short-lived entity known as positronium (Ps), a bound electron-positron pair. If the spins of the electron and positron are anti-parallel (singlet or para-Ps) the natural lifetime is only 120 picoseconds and decay is via the two-photon process described above. If the spins are parallel (triplet or ortho-Ps), the positronium has a lifetime of 142 nanoseconds and the positronium atom annihilates, giving off 3 gamma rays. In recent years positrons have become one of the tools of choice for characterising nanoscale structures and pores in materials. When injected into a material they quickly thermalise and readily form positronium. The lifetime of the positronium in the material is greatly reduced as a result of the high density of electrons with which annihilation can take place, but if the positronium drifts to a void or open space it can live for a considerable time (several nanoseconds) before annihilation occurs. Such lifetimes are readily measurable with modern technology, and such measurements have become a key diagnostic of the size and distribution of 'open space' in materials.

The positron beamline for use in materials studies

Perhaps the most widely recognised, everyday use of antimatter is Positron Emission Tomography (PET) – an important imaging tool for cancer detection and metabolic function in the body. PET scans are now commonplace in most major hospitals and they involve the injection of a positron emitting radioisotope into the body. Typically the isotope is attached to a chemical to form a radiopharmaceutical, with the chemical form determining the particular function. The most common such radiopharmaceutical is FDG – fluorodeoxyglucose – in which radioactive ^{18}F is latched to glucose molecules. The glucose is attracted to areas of high metabolic activity in the body, such as a cancer, causing a concentration of the radioisotope at these sites. The positrons that are emitted, are quickly thermalised through scattering in the body before annihilating to produce two gamma rays. The PET technology relies on the detection in coincidence of these gamma rays and the reconstruction using sophisticated software of the vertices of formation. The spatial resolution of PET is limited by, amongst other things, the thermalisation length of the positrons in the body in the time between their emission and their eventual annihilation.



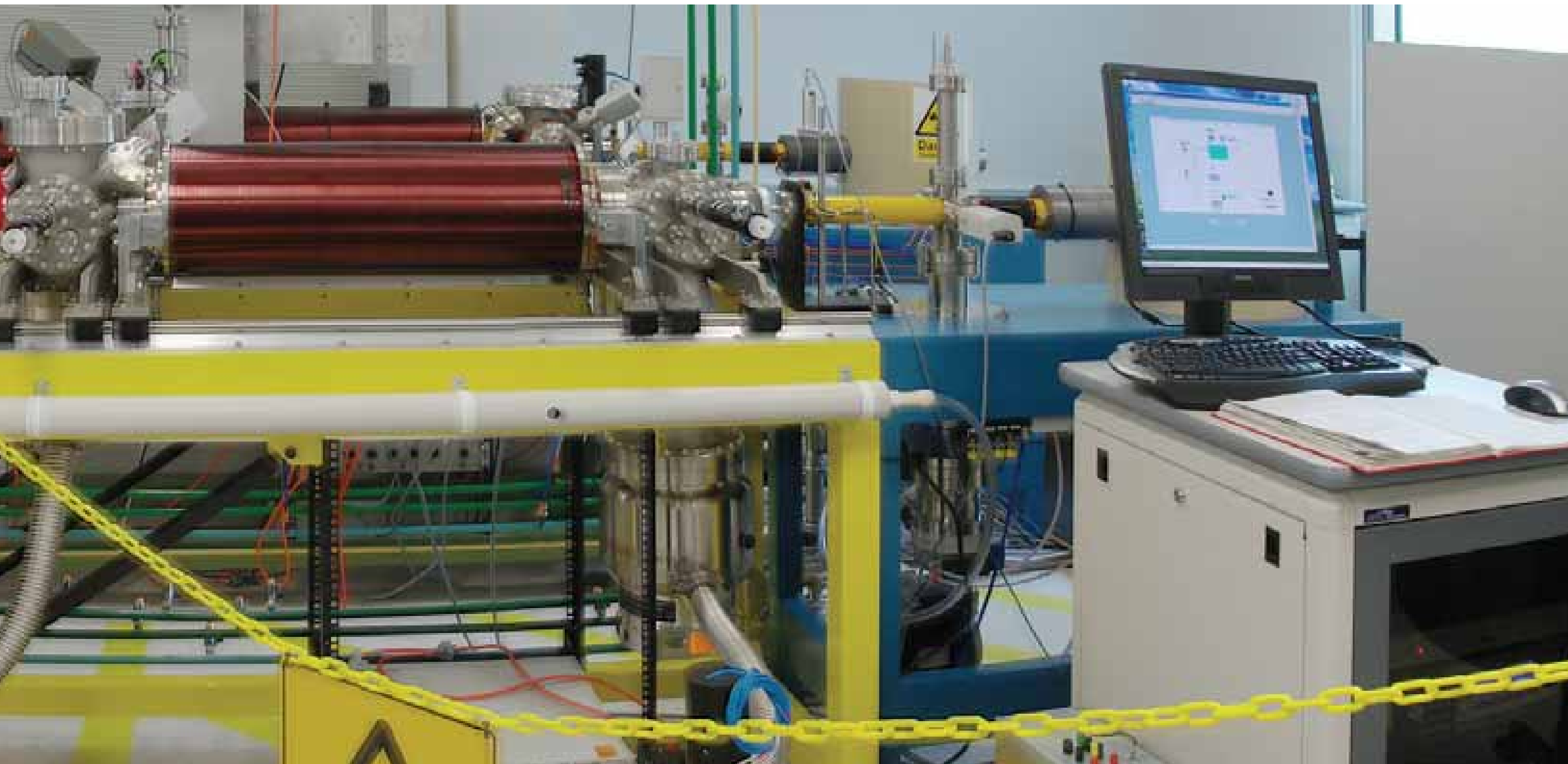
The positron trap electrodes before insertion into the experimental apparatus

Positron Beam Technology

Atomic and molecular physics studies with charged particles or photons require beams of sufficient resolution and intensity to resolve atomic transitions and/or vibrational and rotational levels. Positron studies have long been hampered by the lack of intensity and energy resolution available in conventional positron beams, particularly when compared to those available for electron interaction experiments. The biggest issue that confronts users of radioactive positron sources is that the positrons are emitted with large mean energies and over a broad range of energies (up to 1 MeV) and, as such, are not suitable for studies of atomic and molecular structure and interactions. Such sources require 'moderators' to lower both the mean energy of emission and the energy width of the emitted positrons. Refractory metal moderators (eg. tungsten foils) are commonly used and produce positrons with a low mean energy and relatively small energy width (~0.5 eV), but with an overall efficiency of 10^{-3} – 10^{-4}. Other moderation techniques in use are based around rare gas solids (eg. solid neon) and these have considerably higher efficiencies (~1%) but somewhat broader energy distributions (~2 eV). In either case, the beams that result, even with high activity radioactive sources (eg. 50 mCi ^{22}Na) are relatively low in intensity (< 1.5 pA, or 10^{-7} e^+/s) and with an energy width that is unsuitable for detailed atomic and molecular spectroscopy.

Trap-Based Positron Beams

The most significant advance in the field in recent years has been the development of techniques to trap and cool positrons. Cliff Surko and collaborators at the University of California, San Diego have pioneered the use of buffer gas traps in a strong magnetic field (typically ~0.1 T) to store



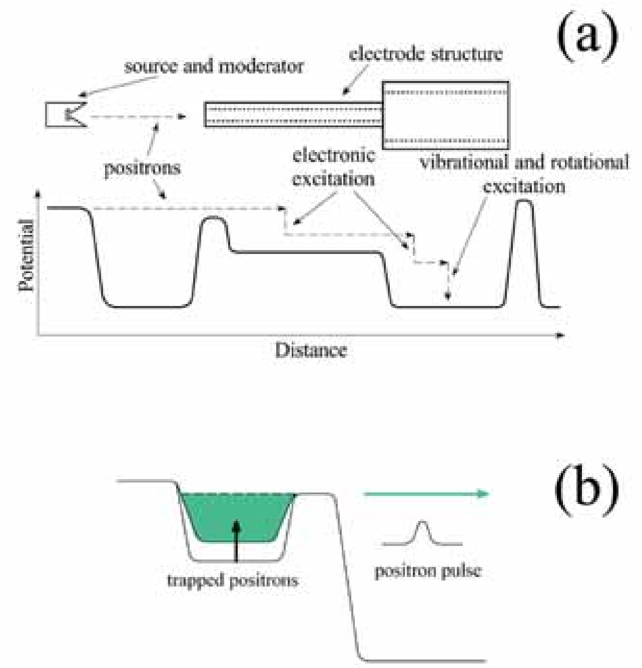


Figure 1: (a) Schematic representation of positron trapping (b) Positron beam formation

and cool large numbers of positrons which are subsequently formed into a high-resolution, pulsed beam [3,4] and this technique has revolutionised the field. It has made available, for the first time, a tool that allows the exploration of detailed state selective processes in positron scattering. The apparatus described here have been designed to take advantage of the techniques of trapping and cooling in a strong magnetic field, and to apply them to fundamental scattering measurements and materials research.

Within the ARC Centre of Excellence for Antimatter-Matter studies we have developed two new positron beamlines and each of these uses a neon-moderated, ^{22}Na source to provide an initial beam of low energy positrons. The moderated beam strength can be as high as 10^7 e^+/s for a 50 mCi source, and the positrons are radially confined using solenoidal magnetic fields. After emerging from the moderator stage, positrons are then guided into a 'Surko trap' [3], which consists of a series of cylindrical electrodes located in a field of 500 gauss. Voltages applied to the electrode structure form an electrostatic potential well, which is filled with a buffer gas consisting of N_2 and CF_4. The well has a stepped structure, as shown in figure 1, and the gas pressure and positron energies are tuned so that there is a high probability that the positrons entering the trap collide with a N_2 molecule to cause an electronic excitation (principally of the $a^1\Pi$ state). This results in an energy loss of ~8.3 eV and causes the positron to "fall" into the potential well and become trapped. Subsequent collisions in the trap result in the positrons being confined in the last stage, where they cool to the gas temperature (room temperature) by the same process, but in this case exciting vibrational and rotational modes of the gas molecules. This process takes advantage of the fact that collisional cross sections for positrons are generally much larger than the annihilation cross sections, so that there are few losses due to annihilation during this process. Losses due to positronium (Ps) formation are a limiting factor. Positronium can be formed when the positrons have an energy of more than (I.P. – 6.8) eV, where I.P. is the ionisation potential of the molecule and 6.8 eV is the binding energy of the positronium "atom". The overall efficiency of the trapping process can be as high as 20% (that is, positrons trapped from the moderated beam). Experiments at the ANU have, so far, obtained a maximum efficiency of 10%. It is possible that future design improvements may improve this performance.

The end result of the trapping process is the creation of a reservoir of room temperature positrons. The lifetime of this cold positron cloud is limited by annihilation, although trap asymmetries can play a vital role as well. At ANU the lifetime of our trapped positrons is around 80 ms. This is plenty of time for the next stage of the operation, which is to form a positron beam. At ANU, we have built two different positron beamlines based around this technology, which operate in substantially different ways.

Beamline 1 – Atomic and Molecular Physics

In this apparatus the pulsed beam is used for scattering studies from atoms and molecules and it is created by raising the bottom of the confining potential well, and letting the positrons spill out over a well-defined potential barrier (see figure 1). If this is done carefully, the energy spread of the positron cloud is unaffected, resulting in a high-resolution beam. This technique has been successfully applied previously to form positron beams with an energy resolution of ~20 meV. To date at the ANU, the best energy resolution observed has been 40 meV (typical resolutions are at the 60 meV mark), but this is still sufficient to easily resolve atomic transitions when performing scattering measurements.

The high-resolution beam is pulsed with a temporal width of around 2ms and a repetition rate of 100-300 Hz. It passes

The two positron materials beamlines, the atomic and molecular physics beamline is on the right, the materials beamline on the left.

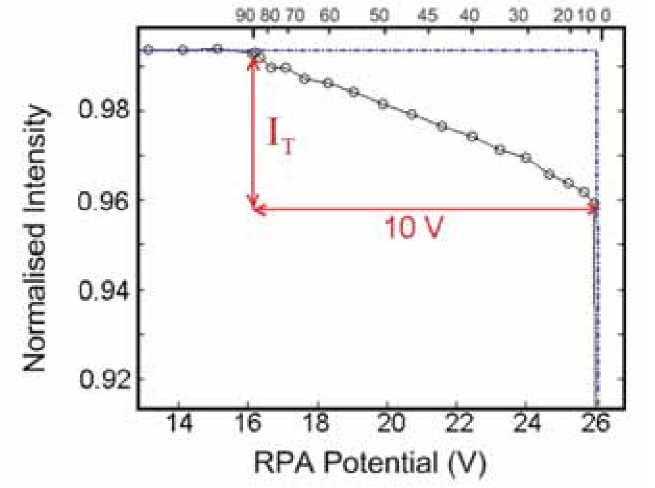


Figure 2: Typical scattering data from the atomic and molecular physics beamline. The circles are the positron signal after scattering from argon target gas at 10 eV. The blue line represents what would be seen if no target gas were present. IT is the total scattered current.

through a gas cell, containing the target of interest, and a retarding potential analyser (RPA), before being detected at the end of the experiment using standard charge-sensitive detectors. The RPA can be used to analyse the energy distribution of the positrons after the scattering cell.

In each of these sections of the apparatus, the beam is still radially confined by a relatively strong magnetic field, which provides a barrier to performing "traditional" scattering experiments. Typically (for instance in the case of low energy electron scattering), such experiments take place in a region free of magnetic fields while using electrostatic fields to control beam energies and for selection of detected scattered particles. Most techniques have relied on the ballistic trajectories of the scattered electrons remaining unaffected by fields of any type, until the particles enter an energy analysing and detection system.

In the case of scattering in a strong magnetic field, this is obviously not the case and different techniques need to be applied to extract scattering information using the positron beam. To do this, we rely on the fact that energy can be separated into two components in a magnetic field – a component parallel to the field, $E_{||}$, and one perpendicular to the field, $E_{\perp}$. The perpendicular component is due to the cyclotron motion of the charged particles. In the case of our magnetically confined positron beam, the initial energy in $E_{||}$ is much greater than $E_{\perp}$ and we can assume $E_T = E_{||}$, where E_T is the total energy of the positrons.

When positrons collide with the gas in the cell several possibilities arise, and the main interactions we are concerned with are summarised below:

$e^+ + M \rightarrow e^+ + M$ elastic scattering
$e^+ + M \rightarrow e^+ + M^*$ inelastic scattering
(vibrational, electronic excitation)
$e^+ + M \rightarrow Ps + M^+$ positronium formation
$e^+ + M \rightarrow e^+ + e^- + M^+$ direct ionisation

Consider the case of elastic scattering, where the positrons do not lose any kinetic energy, but are scattered through some angle, Θ. This has the effect of transferring energy from $E_{||}$ to $E_{\perp}$, so that $E_{\perp}=E_T\sin^2\Theta$ and, similarly $E_{||}=E_T\cos^2\Theta$. The RPA allows us to measure the intensity distribution of the positrons as a function of $E_{||}$. Such a distribution for elastic scattering from argon at an energy of 10 eV is shown in figure 2. It can easily be interpreted in terms of the proportion of positrons scattered at each scattering angle and, using straightforward techniques (explained in detail elsewhere [5]), we can extract the angular differential scattering cross section (DCS) for positron scattering from the target at the particular incident energy. Accurate measurements of the DCS are a very sensitive test of theoretical calculations of scattering processes and can be used to 'benchmark' them. In addition, the total scattering intensity, indicated in the figure by I_T, can be interpreted in terms of the absolute total scattering cross section.

Making use of the properties of a magnetized beam and the RPA analysis techniques, we can measure a host of scattering cross sections – for all the processes described above plus several more. These procedures, largely developed at UCSD in the group of Cliff Surko, have made it possible to perform a number of accurate positron scattering measurements for the first time. In fact, for some processes, the measurements are substantially more precise than their electron scattering equivalent, despite the advantages that electron experiments generally enjoy in both intensity and resolution. An example of the first such measurements form the ANU beamline is shown in figure 3. Here we compare the total scattering cross section for positrons interacting with the helium atom with the best available theoretical estimates [6]. The agreement is spectacularly good.

Future plans for this experiment include such 'benchmark' measurements on other atoms and molecules. In the near future, we shall also progress to the measurement of cross sections for biologically relevant molecules with a view to gaining a deeper understanding of the thermalisation and annihilation processes, which are of relevance to PET. There is no such information in the literature at present.

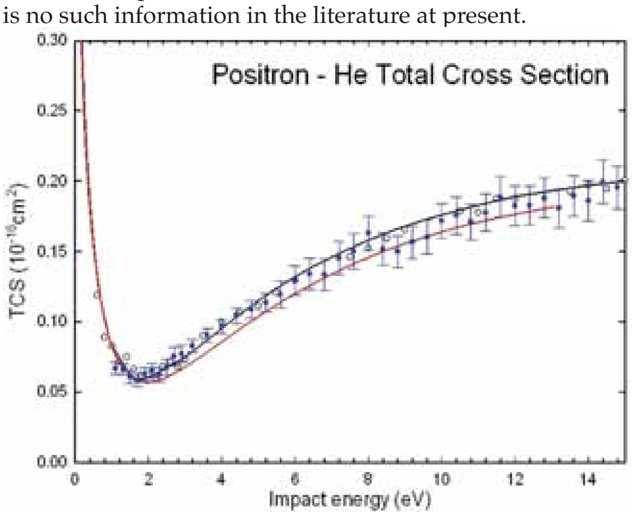


Figure 3: Positron-helium scattering measurements made at the ANU positron beamline. For details on the measurement, see reference [6]

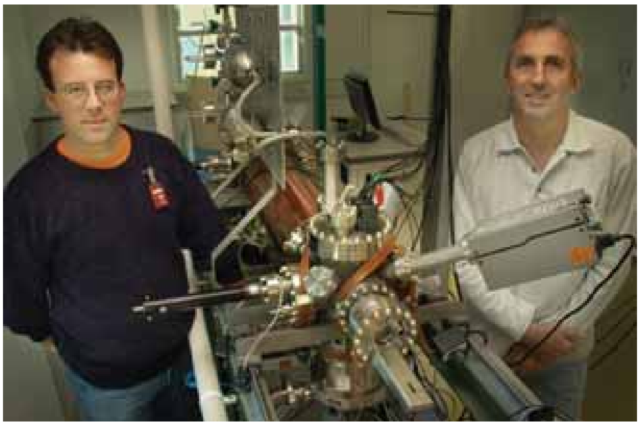
Beamline 2 – Materials Analysis

The second positron beamline operates quite differently to the first, and is intended for materials characterisation. Positrons injected into a solid will rapidly thermalise, typically within 100-200 ps. At this point a number of processes can occur. Positrons can "free" annihilate with electrons in the material with a typical lifetime of ~100 ps or they can form positronium. The para-Ps annihilates quickly (remembering that the lifetime is 120ps), but positrons that form the longer-lived ortho-Ps can live for long enough to diffuse significantly through the material. As they do, they are attracted to voids, due to the absence of nuclear (positive) charge in these regions. Positronium entering a void will have a lifetime that depends largely on how many times it collides with, or comes close to, the void wall. When this happens the Ps can annihilate through a process known as "pick-off" annihilation, where the bound positron annihilates with a surface electron of the opposite spin, rather than the one it is bound to – this leads to two-photon decay rather than the three-photon decay of self-annihilation. In larger voids, the collisions with the walls happen at a lower frequency so the lifetime of the ortho-Ps is longer. Voids with radii from 0.1 to 10's nm give lifetimes in the range of 0.1 to 10's ns, so that the size of the voids can be determined by measuring the annihilation lifetime within the sample. This technique is called positron annihilation lifetime spectroscopy, or PALS. PALS has been used widely with small, 'benchtop' radioactive sources that provide only "bulk" information about the sample to be analysed. With a variable energy beam-based source of positrons, it is possible to control the energy, and hence the implantation depth into the sample.

The construction of two positron beamlines at the ANU has given Australia new tools with which to investigate both fundamental and applied science involving antimatter interactions.

To use a positron beam for PALS, the positrons ideally need to be temporally bunched to a few hundred picoseconds, although it is possible to characterise some materials (such as polymers which have high open space volumes) with longer bunch times than this. As the positrons come from our trap with a pulse width of 2ms or so, some compression scheme needs to be applied to the bunches. We implement the "timed potential technique", as described by Allan Mills in 1980 [7]. To do this, as the positrons emerge from the trap, the confining potential is raised so that positrons exiting the trap later in time have more energy and catch up with those exiting earlier. At some point downstream there is a focussing of the bunch, in both space and time. The limit of this time focussing technique is set by the initial temperature of the positrons in the trap, and the shape of the raising potential as a function of time. Simulations indicate that it should be possible to bunch a positron pulse to 500ps or better with our current trap design, and the first characterisation measurements are underway. The best temporal spread achieved so far is a pulse with a FWHM of ~800 ps, and there is further room for improvement.

The second beamline will also be used to make Doppler spectroscopy measurements. In this case, the energy of



James Sullivan (left) and Stephen Buckman (right) with the first ANU positron trapping system

the back-to-back annihilation gamma rays is measured. Annihilation giving rise to two gamma rays gives equal energies of 511 keV, but if the positron annihilates with an inner shell electron there can be a Doppler shift in the energies of the two gamma rays, depending on the momentum of the electron. This technique can give information about the local chemistry of the ann of this capability will take place in the near future.

Conclusion

The construction of two positron beamlines at the ANU has given Australia new tools with which to investigate both fundamental and applied science involving antimatter interactions. As they come into full operation, this facility has the potential to place Australia at the forefront of positron science and to provide new opportunities for national and international research collaborations.

Acknowledgements

It is a pleasure to acknowledge funding from the Australian Research Council for the Centre of Excellence for Antimatter-Matter Studies (CAMS). CAMS is a collaborative venture between the Australian National University, the Australian Nuclear Science and Technology Organisation, the University of Adelaide, the University of Western Australia, Flinders University, Charles Darwin University and Curtin University.

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Professor Steve Buckman is Research Director of the ARC Centre for Antimatter-Matter Studies. He is based at the ANU.

James Sullivan completed a PhD at ANU in 2009 and worked for two and a half years at UCSD. He returned to ANU in 2004 where he designed and constructed the two positron beam-lines there.

Branch News

ACT
The ACT Branch held its Annual General Meeting on Wednesday 12th of November 2007. Approximately 30 guests boarded a boat for a dinner cruise on lake Burley Griffin on a perfect November evening in the ACT. Following some short business, the branch voted in the new local executive as follows:
Chair Dr Anna Wilson
Vice-Chair Dr Charles Jenkins
Program Secretary and Web Master Dr David Weisser
Treasurer Dr Tibor Kibedi
Secretary Dr Charles Harb
Social Secretary Dr Wayne Hutchison
Student Representative Sarah Beavan

We congratulate the new executive and look forward to a full program of activities in 2009.

The branch was delighted to welcome Prof Tanya Monro (pictured) who delivered the after dinner address. Prof Monro, Professor of Photonics and Director of the Centre of Expertise in Photonics within the School of Chemistry, was the 2008 winner of the prestigious Malcolm MacIntosh Prize for Physical Scientist of the Year. After a full day during which she also addressed a group of exceptional high school students in her role as AIP Women in Physics lecturer, Tanya gave us a look into the world of exotic optical fibres and their applications. Not only the guests, but crew members also seemed to be enthralled (if not bewildered) by Tanya's nice mix of science and anecdote - a great way to finish the evening and the year's activities.

Professor Tanya Monro clearly enjoying the occasion during her presentation to ACT branch Annual General Meeting.

ACT Branch members enjoying the evening aboard the Lake Burley Griffin dinner cruise.

South Australia
In the second half of the year the SA branch ran 3 meetings, while the education subcommittee ran two additional events in National Science week: the presentation of the "AIP Excellence in Physics Teaching Award" and the "Super Science Quiz". (This hard-working subcommittee also organized our contribution to the Oliphant Science awards, a joint lecture at DSTO and school visits.)

The SA branch held its annual Student Night on August 14th. Wendy Tuckwell of the University of Adelaide and Tristan Skawronski of Flinders University gave talks on their postgraduate research. Silver Bragg medals, awarded to the best 3rd-year Physics student at each University in 2007, were presented to Scott Berry of the University of Adelaide and Michael Bowen of the University of South Australia. On October 13th Kia Wallwork, Principal Scientist for Powder Diffraction at the Australian Synchrotron, addressed a joint meeting of the AIP and the Royal Australian Chemical Institute on "Research Opportunities at the Australian Synchrotron".

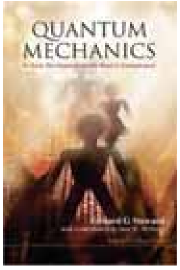
On November 5th John Sarkissian, Operations Scientist at the CSIRO Parkes Radio Observatory, addressed the annual joint meeting of the AIP with the Astronomical Society of South Australia, on "Dishing up the Data: Parkes and Space Missions". We thank Dr Scott Foster as the "meetings" convenor and Dr Boris Blankleider as "awards" convenor.

The "Australian Institute of Physics - SA Branch Excellence in Physics Teaching Award" was initiated in 2005 and is an annual award to recognise and honour the time, effort, commitment and excellence that teachers put into teaching and promoting physics in schools and in the community.

Branch News continues on page 28

AIP-SA Excellence in Physics Teaching Award, Mr Brian Parsons, (far right), pictured with representatives of Coherent Scientific Pty Ltd, Dr Paul Wardill (far left) SA President Engineers Australia, Mr Bill Filmer (second from left) and AIP-SA Branch Vice-Chair, Dr Pina Dall'Armi-Stoks (second from right).

Reviews



Quantum Mechanics: Its Early Development and the Road to Entanglement

Edward G. Steward
Imperial College Press, 2008
xxi + 257pp., $US55 (paperback)
ISBN-13: 978-1-86094-978-4

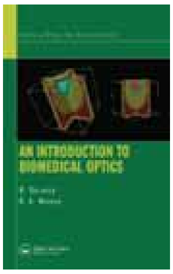
According to the author this book aims to combine a historical and biographical aspect of the development of quantum mechanics with a relatively detailed exposition of the underlying theory. In this aim it succeeds quite well.

Quantum theory is described in the context of the main protagonists and their scientific motivations at the time. This allows the reader to develop an appreciation of how the development of scientific theory is a story of how people develop ideas and theories. This is in contrast to many texts where the reader, particularly students, may form the impression that scientific theories are born fully formed, rather than a process of change and development.

The writing and the explanations are clear with consistent notation and terminology used throughout. As a relatively short paperback, the theoretical treatment lacks depth and rigour. This is not a book from which one would choose to learn or teach quantum mechanics. Although much of the treatment is given mathematically, there are no worked examples or problems; it is not a textbook. The level of theoretical detail means that it is not suitable for light bedtime reading or for a diversion on the train. The writing style is, for the most part, very dry and factual.

It is not entirely clear what audience this book is appropriate for. It is neither suitable as a text for learning about quantum mechanics or as an entertaining read. Readers who are most likely to benefit would already have an excellent understanding of theory and might enjoy looking through a book constructed slightly differently from the standard texts.

Vicki Keast
University of Newcastle



An Introduction to Biomedical Optics

R. Splinter, B.A. Hooper
Taylor and Francis, Boca Raton, 2007
Preface + 602pp., UK£18.99 (hardbound)
ISBN-13: 978-0-7503-0938-7

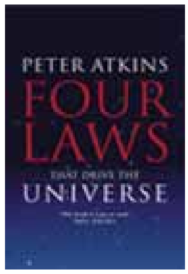
The title undersells this book as it is a very comprehensive overview of the interaction of light with the human body, the treatment modalities and the diagnostic applications of light.

Very soon after its invention, the ruby laser was applied to ophthalmology; forty years later, ophthalmology's use of lasers has diversified from coagulation to non-invasive surgery, cancer therapy and corneal reshaping. Nd lasers, Argon, Krypton, diode, dye and excimer lasers find application in the management of disease bringing relief and preservation of sight to humans. The science of the interaction of light with tissue and the effects generated is well covered.

There is a variation influence of twenty orders of magnitude between photophysical effects such as the disruption of tissue and the photochemical effects stimulated by light with duration of exposures ranging from fs to hours. The physics behind the different processes are well explained and the level of mathematical expression presented leads one to say that this book is pitched at the third year or honours physical scientist as opposed to a trained medical doctor.

The three broad sections of the book cover the general biomedical optics theory, therapeutic applications, and the diagnostic applications of light. While the authors have written this as a textbook with problems at the end of each chapter covering the concepts, as well as the calculations, of dose and penetration of light in tissue, it is well suited as a reference text for those working in biophysics and in biomedicine. I is recommended to those offering third year or Honours level courses in the subject.

John Holdsworth
University of Newcastle



Four Laws That Drive the Universe

Peter Atkins
Oxford University Press, 2007
vii + 130pp., UK£10.99 (hardbound)
ISBN-13: 978-0-19-923236-9

Peter Atkins is a very accomplished author whose concise and definitive style of writing makes this book a pleasure to read. Beautifully expressive gems such as "Turmoil and temperature go hand in hand" are littered throughout the text and serve to bring to life the four laws the author illuminates.

The subject matter is of course standard fare for first year university students in the physical sciences yet the subtleties and detail usually evade those young minds. Chemists I think do better than physicists at developing an understanding of free energy from the approach taken to chemical reactivity and it is the cosmological ramifications and statistical mechanics that engage physicists somewhat later on in the learning cycle.

This book wonderfully illuminates the topic and I would recommend it for inclusion in your libraries as support for students of thermodynamics.

John Holdsworth
University of Newcastle

Note: Book reviewers are needed for:
The Physics of the Z and W Bosons.

and

Large Scale Structure and Dynamics of Complex Networks.

and

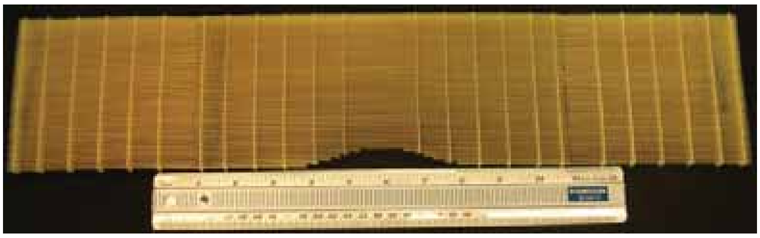
Order, Disorder and Criticality. Advanced Problems of Phase Transition Theory.

Expressions of interest should be directed to the Reviews Editor, John Holdsworth

Samplings

Broadband invisibility cloak unveiled
http://physicsworld.com/cws/article/news/37364
http://www.sciencemag.org/cgi/content/full/323/5912/366
A new kind of "invisibility cloak" that conceals an object lying on a flat, reflective surface has been built by researchers in the US. The device is an improvement over earlier microwave cloaks as it operates over a wide, rather than a narrow, range of frequencies. Built by a team led by David Smith at Duke University, the device is a metamaterial made of thousands of tiny H-shaped metallic elements. It was designed using a novel computer algorithm, which the team believes could be used to create other cloaks that work for infrared or even visible light.

Jensen Li and John Pendry at Imperial College, London, last year calculated that a broadband and low-loss cloak could be made from a metamaterial with only an electrical response. Such a cloak is what Smith and colleagues have built. Their metamaterial is a matrix of 10,000 elements, which are arranged in a flat sheet that is five elements thick. A thin edge of the sheet is placed on a reflective surface such that there is an empty pocket between surface and sheet. The object to be concealed is placed in this pocked (see figure above).



Smith's microwave cloak showing the pocket to be cloaked (indent at the bottom). (Courtesy: Science).

According to Smith, the algorithm could be used to design a variety of different devices including cloaks and superlenses, which could boost the performance of imaging systems. As for the cloak itself, Smith says that in principle it could be used to conceal objects from microwaves and therefore could be used to minimize interference between co-located communications antennas by making the antennas invisible to each other.

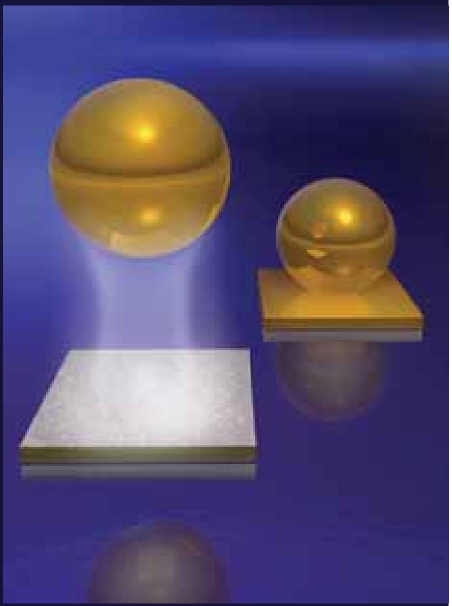
Experiment resolves century-old optics mystery
http://physicsworld.com/cws/article/news/37266
Since the early 20th century physicists have known that light carries momentum, but the way this momentum changes as light passes through different media is much less clear. Two rival theories of the time predicted precisely the opposite effect for light incident on a dielectric: one suggesting it pushes the surface in the direction light is travelling; the other suggesting it drags the surface backwards towards the source of light. Hermann Minkowski had proposed in 1908 that light momenta is proportional to a material's refractive index then the following year, another German theorist, Max Abraham proposed the opposite — momentum is inversely proportional to a material's refractive index. After 100 years of conflicting experimental results, a team of experimentalists from China believe they have finally found a resolution. It turns out that Abraham was right.

Weilong She and his colleagues from Sun Yat-Sen University have studied the effect of light at the interface of air and a silica filament and found that light exerts a push force on the surface (Phys Rev Lett 101, 243601). "This paper is a beautiful piece of work and may become one of the classic papers on the momentum of light" said Ulf Leonhardt a researcher in transformation optics at the University of St Andrews, UK. The authors suggest this finding could now pave the way for new applications like highly efficient fusion using laser 'compression'.
Samplings courtesy of Don Price.

Casimir effect goes negative
http://physicsworld.com/cws/article/news/37241
http://www.nature.com/nature/journal/v457/n7226/full/nature07610.html
Since the 1950s physicists have been able to show that quantum fluctuations in a vacuum will cause two surfaces to attract one another, a phenomenon known as the Casimir effect. Now researchers in the US have demonstrated the opposite — that under certain conditions surfaces can also repel each other. Given the importance of the Casimir effect over separations of tens to hundreds of nanometres, the result could lead to new types of nanotechnology device with extremely low levels of friction.

Casimir's 1948 prediction of the vacuum force was generalized for real materials by Evgeny Lifshitz in 1956, whose work was further generalized to show that the vacuum can in fact be replaced by a material. Moreover, it was shown that if the plates and the material between them, generally a liquid, have particular dielectric permitivities the force between the plates will be negative.

Now, Harvard University's Federico Capasso and Jeremy Munday (now at Caltech), and Adrian Parsegian of the National Institutes of Health in Bethesda, Maryland, have demonstrated this effect using gold and silica surfaces separated by the liquid bromobenzene.



Artist's rendition of how the repulsive Casimir-Lifshitz force between a gold-coated ball and a silica plate in a fluid can be used to quantum mechanically levitate an object of density greater than the liquid (left). However, when the ball and plate are both gold-coated, the force is attractive(right). (Figure is not to scale and courtesy of Jay Penni and Federico Capasso).

Product News

Coherent

Hysitron TI-950 Triboindenter™ with dual 30nN – 10N Nanoindentater Head

The new *TI-950 Triboindenter* from Hysitron incorporates a unique, automated dual-head design that allows seamless force range measurements from 30nN to 10N - the broadest force range available for nanomechanical testing.

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New nanosecond Nd:YAG laser in compact package

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The oscillator produces 300mJ @ 1064nm, 5ns, with a high quality beam profile (M^2<2). The Brilliant EaZy has excellent energy stability (<2%), proven field reliability and features the same harmonic modules and wavelength separation optics as the Brilliant.

Features:

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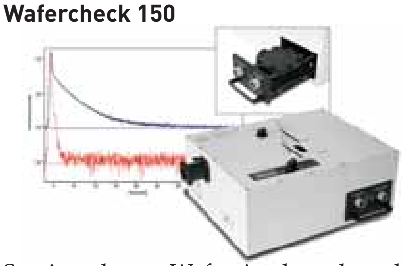
Lastek

Wafercheck 150



Semiconductor Wafer Analyser based on time-resolved luminescence (TRPL) measurements.

The application of TRPL in the semiconductor industry is focused mainly on the measurement and identification of electron-hole recombination rates. The length of time a photo-excited carrier can remain in the conduction (or valence) band is an important parameter directly related to material quality and device performance. The fluorescence lifetime decay value is an indicator for characterising semiconductor materials for use in e.g. photovoltaic devices (solar cells), photodetectors, LEDs, etc.

Features:

- Excitation with diode laser pulses as short as 70 ps (FWHM)
- Excitation wavelength 260 to 800 nm
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- Data acquisition based on Time-Correlated Single Photon Counting
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Pulsed Diode Laser Head LDH 485

The output power of the new LDH 485 has doubled. This laser head emits around 485 nm with pulsewidths less than 90 ps and can generate up to 2 mW average power at 40 MHz repetition rate.

The LDH Series picosecond diode laser heads produce light pulses as short as 70 ps (FWHM, on selection down to 50 ps for some wavelengths) at repetition rates from single shot to 80 MHz (depending on the wavelength). For selected wavelengths peak powers up to 1 W can be emitted. The short pulse width perfectly matches the time resolution of mainstream detectors, yet at a price ten times lower than that of commonly used Ti:Sapphire or Argon ion lasers.

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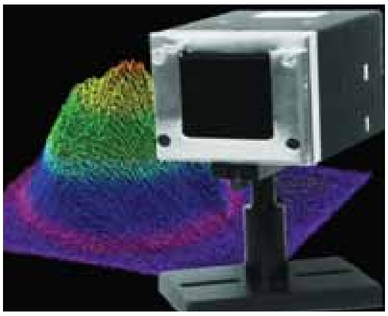
Warsash

Industry's largest area laser beam profiling system from Warsash Scientific



Warsash Scientific is pleased to announce the release of the USB L11058 Large Format Beam Profiling Camera from Ophir-Spiricon Inc, a global leader in precision laser measurement equipment. The USB L11058 camera is designed for measuring large ultraviolet laser beams. It's high resolution, 4008 x 2672 pixel format allows profiling of beams up to 24 x 36 mm without requiring reduction optics. Frame rates of up to 3.1 frames per second at full resolution increase throughput and productivity. This makes the USB L11058 ideal for use in applications that require a large field-of-view, fast frame rates, low noise, and high responsivity, such as high power lasers in semiconductor fabrication.

The USB L11058 Large Format Beam Profiling Camera accurately measures CW (continuous wave) laser beams over an extensive spectral range, from 190 nm to 1100 nm. The camera also has a wide dynamic range of 59 dB. The camera features a global shutter that allows simultaneous integration of the entire pixel array; its short exposure time is ideal for capturing objects in high speed motion.

An integrated USB 2.0 digital interface allows users to transfer measurement data to laptops and desktop computers. The USB L11058 is the industry's largest area laser beam profiling camera on the market. It allows large laser applications, which were previously unable to capture and analyse beams with diameters larger than a few millimetres, to accurately measure beam profiles and widths, understand power density and cavity alignment, and significantly improve the quality of the finished products.

Latest High Accuracy Laser Beam Profiling Software from Warsash Scientific

Warsash Scientific is pleased to announce the release of the latest version of LBA, Ophir-Spiricon's high accuracy laser beam analysis software. LBA measurement precision is based on Ultracal™, the company's patented, baseline correction algorithm that helped establish the ISO 11146-3 standard for beam measurement accuracy.

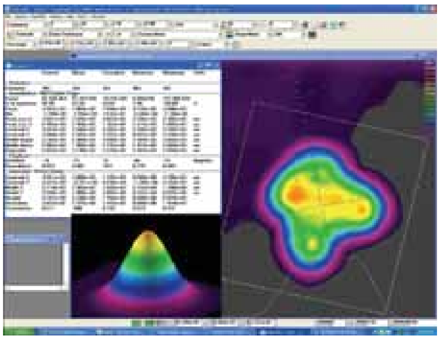
Ultracal™ ensures the highest accuracy and reliability in the industry by retaining negative signals essential for making correct beam width measurements and for extracting weak signals out of noise. With Ultracal™ the baseline can be calculated to better than 1/8th of one digital count, pixel by pixel, allowing profiling of the smallest spot sizes in the industry.

LBA also features a Pointing Stability program that collects centroid and peak data from the LBA core system and displays it graphically; this is critical for maintaining accuracy in welding, laser manufacturing, and military range finder applications. The newest version of LBA operates on the Microsoft® Windows® Vista 32 operating system and works with Ophir-Spiricon's SP503U and SP620U, new USB 2.0 CCD cameras featuring the highest dynamic range in the industry, up to 64dB.

Designed for a variety of scientific R&D and manufacturing applications, LBA contains all the algorithms and calculations necessary to make the most accurate beam measurements, including quantitative calculations, 2D and 3D viewing, user-defined apertures, multiple frames averaging and summing, zoom up to 32 times the original size, and user-selectable Z-axis (intensity) scaling. An ActiveX® interface allows data to be shared with other applications, including MAT-LAB® and LabVIEW®.

NEW High Power YAG Focal Spot Analyser from Warsash Scientific

Warsash Scientific announces the release of the new Ophir-Spiricon YAG Focal Spot Analyser, the next generation of the industry's only real-time system for measuring focus spot characteristics of high power lasers. The Focal Spot



Ophir-Spiricon LBA high accuracy laser beam profiling system

Analyser is a compact, laser beam sampler/attenuator for camera-based laser beam profiling systems. Designed for material processing applications – such as drilling, ablating, and marking. The Focal Spot Analyser attenuates high power, 1064nm YAG lasers with short, compact path lengths, from 50 to 200mm.

The Focal Spot Analyser supports powers levels from <1 to 400W and focal spot sizes as small as 25μm.

Adjustable attenuation up to 10^{-10} maximizes the system's dynamic range. The system measures focal spot characteristics as well as how focal distance shifts with power. A modular, C-mount unit, the Focal Spot Analyser can easily be added to virtually any CCD camera.

Ophir-Spiricon's patented process provides higher beam width measurement accuracy by determining the true background and preserving both positive and negative signals.

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Interacting Stochastic Particle Systems
Montréal, Canada
http://www.crm.umontreal.ca/Math-phys2008/stochastics_e.shtml

May 25-29
Planck 2009: From the Planck Scale to the Electroweak Scale
Padova, Italy
http://www.pd.infn.it/planck09/
May 26-30

The 8th International Conference on Radioactive Nuclear Beams
Grand Rapids, Michigan, USA
http://meetings.nscl.msu.edu/rnb8

May 26-31
The 10th Conference on the Intersections of Particle and Nuclear Physics (CIPANP 2009)
San Diego, California, USA
http://groups.physics.umn.edu/ci-panp2009/

May 27 - June 1
Flavor Physics and CP Violation
Lake Placid, New York, USA
http://fpcp2009.syr.edu

June 8-13
Disordered Systems: Spin Glasses
Montréal, Canada
http://www.crm.umontreal.ca/Math-phys2008/spin_e.shtml

June 14-20
The 21st Rencontres de Blois: Windows on the Universe
Blois, France
http://confs.obspm.fr/Blois2009/

June 15-19
International Conference on B-Physics at Hadron Machines
Heidelberg, Germany
http://beauty2009.physi.uni-heidelberg.de

June 29 – July 5
The 6th International Conference on Non-Accelerator New Physics (NANP'09)
Dubna, Russian Federation
nuweb.jinr.ru/~nanp

June 29 - July 24
Les Houches Summer School of Physics in Singapore: Ultracold Gases and Quantum Information
NTU, Singapore
http://www.ntu.edu.sg/ias/Pages/default.aspx
http://w3houches.ujf-grenoble.fr

July 1-5
The 11th International Conference on Topics in Astroparticle and Underground Physics (TAUP 2009)
Assergi, Italy
http://taup2009.lngs.infn.it/

July 16-22
Europhysics Conference on High Energy Physics
Krakow, Poland
http://www.ifj.edu.pl/hep2009/

July 23-25
The 13th Paris Cosmology Colloquium
Paris, France
http://chalonge.obspm.fr

August 3-8
The 16th International Congress on Mathematical Physics
Prague, Czech Republic
http://www.icmp09.com/

August 2-29
IAGA 11th Scientific Assembly August 23-30, 2009
Sopron, Hungary
http://www.iaga2009sopron.hu

September 7 - 11
9th International DYMAT Conference on the Mechanical and Physical Behaviour of Materials under Dynamic Loading
Brussels, Belgium
www.dymat2009.org

September 21-25
The 9th Conference on Quantum Field Theory under the Influence of External Conditions
Norman, Oklahoma, USA
http://www.nhn.ou.edu/qfext09/ Atomic Physics 2009

September 23
ICNEP 2009 - International Conference on Nanoscience, Electronics and Photonics
Vancouver
http://www.waset.org/wcset09/vancouver/icnep/

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Past winners of this award include Mr Allan Pepper, Unley High School and Mr Ian Faulkner, Norwood / Morialta High School. The award consists of a medal, a framed certificate of recognition and a $1000 cheque. Included also is a perpetual trophy that is presented to the winner, which is held by the winning school for 12 months. From 2007 the SA branch has presented this award at the National Science Week SA launch event in August, in the presence of the SA Minister of Science and Economy Hon. Paul Caica MP and other distinguished guests. This year the AIP-SA Branch obtained co-sponsors for the award including, Engineers Australia-SA division and Coherent Scientific Pty Ltd. The winner of the 2008 AIP-SA Excellence in Physics Teacher award was Mr Brian Parsons from Scotch College (see picture). We thank Dr Pina Dall'Armi-Stoks for her leading role in organizing the medal in 2008.

The "AIP-SA Super Science Quiz" is an annual National Science Week event organised by the Australian Institute of Physics (SA Branch) that has been designed to stimulate secondary school students' interest in science and to promote a greater awareness of the role of science, and physics in particular, in the wider community. The quiz has been running for over seven years and the competition invites schools and colleges from across Adelaide to nominate teams of six students each to compete for prizes and certificates, and contest a perpetual shield.

Each team sits around one table to negotiate the best answers to six rounds of ten questions. Team members must collaborate so that any disputes in a team are resolved, and an acceptable answer to each question recorded. In addition to the six rounds of ten questions, there are inter-round activities that are individually based, and also one major problem that students can work on throughout the afternoon in the hope of winning a major individual prize. This year the winning school was the Australian Science and Mathematics School. We thank Doug Medwell for taking the lead in organizing the quiz this year.

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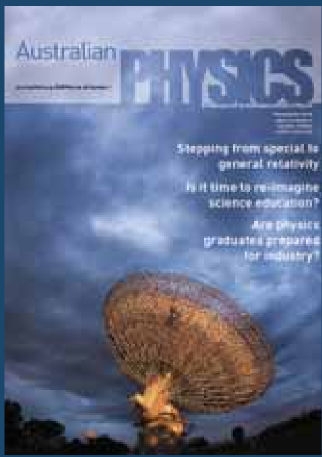

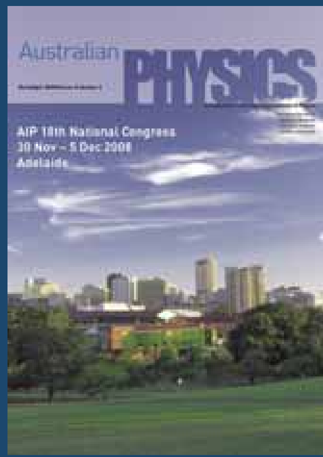

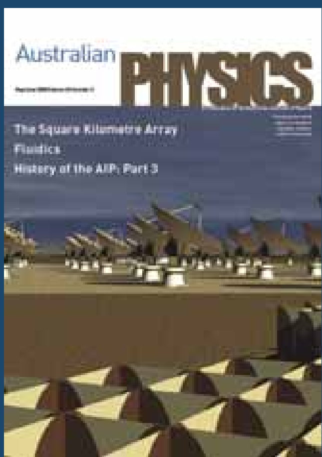

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