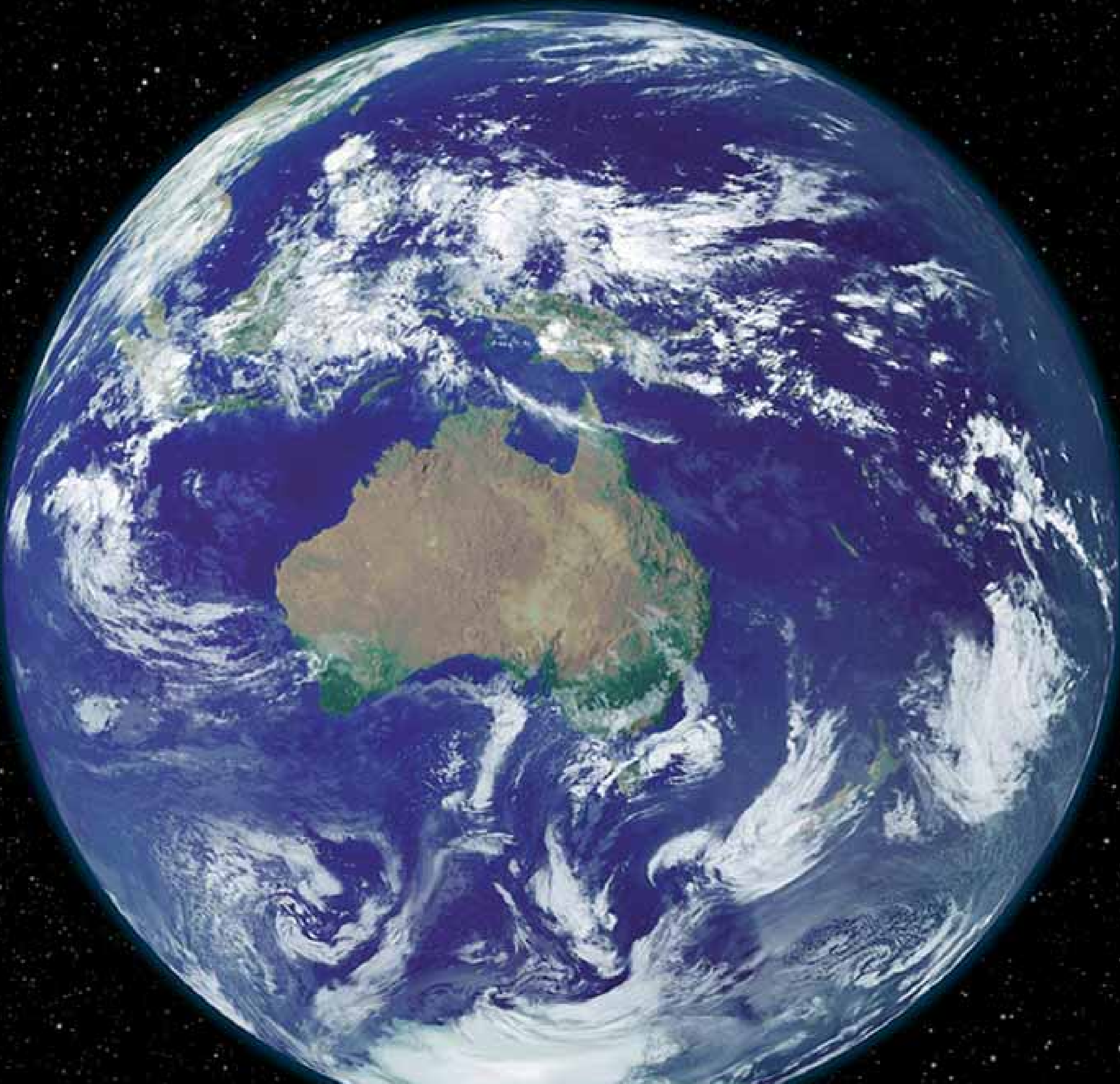
Australian PHYSICS

January/February 2010 Volume 47 Number 1

A Publication of the Australian Institute of Physics

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



Australia's stratagic plan for earth observations

ARPANSA's role in nuclear safety

Treating waste with plasmas

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Ophthalmic instrumentation

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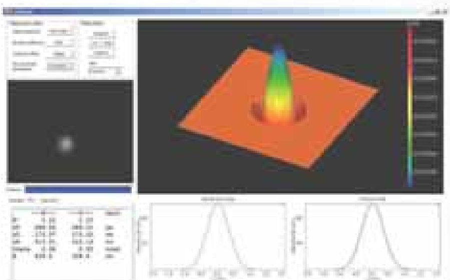

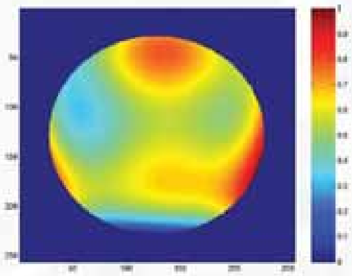

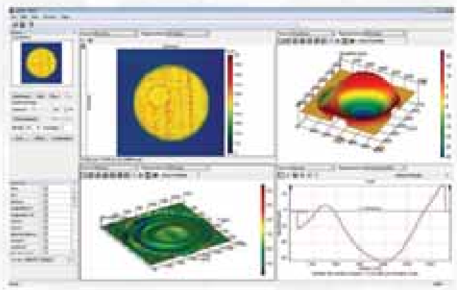

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Australian Physics
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Contents

Volume 47 Number 1

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 university; perhaps your career has developed in uncoventional ways; if so, why not write an article for Australian Physics?

For more information contact the editor-in-chief Dr M. L. Duldig at (Marc.Duldig@aad.gov.au).

Cover Image

Despite our contributions to the underlying science, Australia has so far remained essentially a free-rider on the international system of earth observations from space. Prof John Zillman outlines Australia's efforts to change this status.

Read the full article on page 14.

Image credit: NASA

Submission deadline for the March/April 2010 issue is 9 April


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Contributions should be sent to
Dr Marc Duldig
Marc.Duldig@aad.gov.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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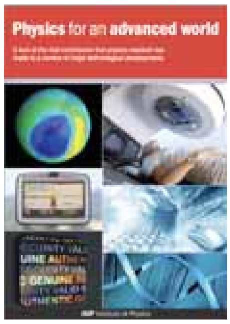
Editorial

Somehow I could not imagine an educational institution claiming "to make economics fun" or "we'll show you how medicine is relevant to your lives" and yet that seems to be de rigueur for physics, or at least when teaching it. I find that disappointing, but accept its necessity in a world where we need to compete at all levels for funding, particularly via student enrolments.

To aid us in this ongoing task, The Institute of Physics in the UK has developed a booklet called Physics for an Advanced World: a look at the vital contribution that physics research has made to a number of major technological developments.



The IoP's introduction to the booklet sets the agenda:

> *Focusing on 10 case studies – diagnosing and treating cancer, the structure of DNA, GPS in our daily lives, holographic techniques, the application of lasers, pioneering LCDs, life-saving MRI scanners, ingenious optical fibre technology, understanding and protecting the ozone layer and the World Wide Web – this booklet truly is a celebration of physics.*

The entire IoP publication can be downloaded at: *www.iop.org/activity/policy/Publications/file_36788.pdf*

This issue of Australian Physics is another contribution to that celebration, covering nuclear safety (page 9), earth observations from space (page 14) and waste treatment with plasmas (page 18).

This is my last issue as Editor for Australian Physics. The initial steep learning curve behind the science and art of layout design, choosing comfortable reading fonts and the endless tweaking of images and their placement to make everything fit nicely has, at times, been a chore, especially when all of that occurs simultaneously with the collection and editing of material as it trickles in month after month. However, except for my first few issues, I have managed to do so without printing any paper – I have become a solely on-screen editor and am delighted to have done this on your behalf. I now pass the baton onto Paulo de Souza (see below) who will take this journal to a wider audience via even more electronic means – we are in capable hands.

At times during my tenure as Editor I have found it unusual (often frustrating) that a membership as large as ours covering such a range of experience, depth of discipline, and heights of passion for physics can find it so difficult to produce content. Australian Physics may not be a peer-reviewed journal, and may never count for any publication quota you may need to achieve, but we can set our goal to making it the best academic members' journal in the country.

So before I depart I would like to make one last request of each of us, myself included, to ensure the ongoing survival, success and envy of Australian Physics: write.

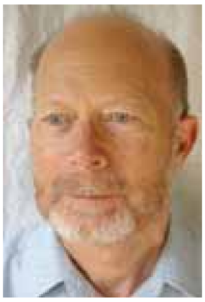
It has been a pleasure.

John Daicopoulos

The new Editor:

Paulo de Souza is a Physicist with a PhD in Natural Sciences. He is the Research Director of Tasmanian ICT Centre at CSIRO, and a collaborator scientist on NASA's Mars Exploration Rovers Project. He has worked in industrial research centres in Brazil and Europe. He has received many international awards as a result of his research in industry. Paulo has written over 100 scientific papers, and co-authored a series of papers identified as 'Breakthrough on the Year: 2004' by the prestigious magazine Science.

President's column



Congratulations to the Australian International Year of Astronomy (IYA) organisers and our cognate society, the Astronomical Society of Australia, for a very successful IYA. Many members, no doubt, heard talks by distinguished Australian astronomers, who travelled around the country to speak at public lectures arranged by AIP branches.

This model of using our branch structure to facilitate national speaker tours works well; we have used it for our own benefit during the International Year of Physics in 2005, and also on an annual basis for the Women in Physics lecturer series. A high profile speaker, and a topical theme, combine to help branches stage a public event, often in collaboration with an institution or other organization, that enhances the profile of physics and that of the AIP. We recently agreed to assist our cognate society, the Australian Optical Society in a similar way this year, for public lectures in recognition of the 50th anniversary of the first operation of a laser.

Due to the success of these activities, an AIP lecture tour as a regular annual event is under consideration. A number of ways of determining the theme for a particular year come to mind. It could be linked to a major event in physics (the opening of the Large Hadron Collider, for example) or the anniversary of some significant development in physics. There is no shortage of significant anniversaries. For example, 2011 is the centenary of the discovery of superconductivity by Onne.

There is an obvious event for us to celebrate in 2012: it is the 50th anniversary of the founding of the AIP.

I note that 2011 is also the International Year of Chemistry, in part to celebrate the centenary of the award of the Nobel prize for chemistry to Marie Curie. It is, however, also the centenary of Rutherford's proposal of the nuclear model of the atom. Rutherford has, of course, also has connections to this part of the world. (Some years ago, I visited an exhibit about Bohr in the Tycho Brahe Planetarium in Copenhagen that referred to "British physicist Ernest Rutherford". Somebody, presumably a New Zealander, had crossed out "British" with a marker pen and inserted "New Zealand".)

There is an obvious event for us to celebrate in 2012: it is the 50th anniversary of the founding of the AIP. Perhaps we should not be too inwardly focussed for the occasion, but it might provide an opportunity to celebrate the last 50 years of physics in Australia. Suggestions from members as to how we should celebrate this anniversary are invited.

I write this just after the 2010 AIP Council meeting in Melbourne. The AIP Council consists of the executive, the immediate past president and branch chairs, with AIP topical group chairs and representatives of cognate societies also invited to attend. It is a time to review the past year, but more importantly to determine priorities for the coming year. A major focus will be our website which we will begin to develop in a way that provides a gateway for physics in Australia, including, of course, the AIP.

Over the last two years under the editorship of John Daicopoulos Australian Physics has continued to improve, making good use of the change to an all colour format. John is leaving us soon, and I express my thanks to him, and wish him well in his new ventures. I also welcome the new editor Paulo de Souza, who will phase in over the next few issues. Paulo has particularly indicated a desire to develop an online presence for Australian Physics, which will be an important consideration when developing our new website.

The 2009 Australian Institute of Physics International Women in Physics Lecture Series

by Christine Charles

Plasmas have existed since the very first moments of the Universe. It is the stuff of stars. It fills the space between stars. It gives us the beautiful northern and southern aurorae. Our houses have plasma lights (fluorescent tubes) and plasma TV displays. Everywhere we look, there is plasma. But we stand on solid earth and the solid state accounts for less than one percent of the total mass of the Universe. The rest is plasma, a hot ionised gas containing positive and negative charges (except, perhaps, for dark matter). The physics content of the 2009 AIP tour was based on plasma, the fourth state of matter and its various applications.

The Australian Institute of Physics International Women in Physics Lecture Series was instituted to celebrate the contribution of women to advances in physics. Under this scheme, a woman who has made a significant contribution in a field of physics gives a series of lectures around Australia. The tour was carried out over four months (29-30 April [ACT], 18-21 May [NSW], 28-30 May [WA], 11-14 August [TAS], 19-21 August [VIC], 3-4 September [QLD], and 21-24 September [SA]) and comprised a total number of 35 events attended by a total of 1855 people: 1300 high school pupils from Year 9 to 12 and 325 members of the general public (age 10 to 70); university undergraduate and post graduate students, post-doctoral fellows, academics and professionals accounted for another 320 attendees. The time allocated for each state (including organisation, transport, lectures) was about 1 week per state with a total number of 7 states (there is no AIP branch in the Northern Territory) and the basic tour statistics are summarized on Figure 1. The lectures were to be of interest to a non-specialist physics audience and expected to increase awareness among students and their families of the possibilities offered by continuing to study physics, (and since I am an "experimental physicist") I decided that "hands-on" demos should be included in the tour.

I developed a demonstration suitcase, which was called the "James Bond suitcase" although a Terry Pratchett many-legged luggage would have been more fun (but we do not yet have plasma thrusters to carry us to the Disc World). Although the demonstrations were initially planned for schools only, the suitcase took over and was rapidly integrated in all other events (public and professional lectures). A few experiments with a Tesla high voltage induction coil, a neon tube, a light bulb and a spoon were carried out with volunteers from the audience to demonstrate the main properties of a plasma including breakdown voltage in air, light or photon emission, and the skin effect…

The school lecture entitled "Children of the stars, plasma is the fourth dimension of matter" was given as a power point presentation followed by "hands-on" demos with pupils. The length of the lecture varied from 45 minutes up to 90 minutes (talk, demos, questions) and the class size varied from 5 to 220 pupils (many schools gathering to the main event). This talk first used the example of adding energy to water molecules to describe the four states of matter: solid (ice), liquid (water), gas (water vapour) and plasma. Applications of plasmas ranging from plasma TV displays, plasma lights (fluorescent tubes) to plasma rockets for interplanetary space travel) were described with special emphasis on the 1970s revolution in the microelectronics industry: dry processing of silicon wafers using plasmas to create highly performant and cheap microchips (in computers, MP3 players, mobile phones, digital cameras, GPS devices) has changed the way we live today.

For the Tasmanian tour, our laboratory funded a female PhD student (originally from Hobart) to join me and interact with the pupils. An additional demonstration consisting of a small hydrogen car was carried out. New topics, such as electrolysis, catalysis and climate change were discussed in greater detail.

The public, professional and academic lecture was entitled: "To planets or just to the shops: Plasmas pave the path". The plasma state was described and it was shown that by properly harnessing the plasma state we can make microchips for computers, we can make plasma engines (thrusters) to get to the planets and we can make fuel cells to take people just down to the shops. The Australian National University's involvement in this research field was presented by giving the example of the Australian Helicon Double Layer Thruster (HDLT), a new space engine with potential applications to satellite control and deep space missions to remote parts of our solar system. The HDLT is based on the discovery of a current-free electric double layer (a cliff of potential like a river waterfall which energises charged particles falling through them) in our laboratory plasma. The double layer accelerates the plasma ions to form a low divergence ion beam, the source of thrust. The HDLT has been the focus of many documentaries (ABC Catalyst 2004 and 2007, Discovery Channel Canada 2008, ABC 2 Space Show 2007) and is currently under development in collaboration with the Paris Head office of ASTRIUM/EADS, the large aerospace company in the world and with the Surrey Space Centre in the UK. A launch is scheduled for 2013.

Examples of public lectures venues included the Australian Defence Force Academy in Canberra, the Powerhouse Museum in Sydney, the Science Centre and Planetarium in Wollongong and the Victorian Space Science Education Centre in Melbourne and the Claire Corani Memorial public Lecture in Adelaide. Overall the 7-week long tour was a success with a nice spread of events type and size.

Other important outcomes included a radio interview for the 936 ABC Hobart Radio Breakfast Program, enrolment of a female student who attended the public lecture at Wollongong into our Research School of Physics and

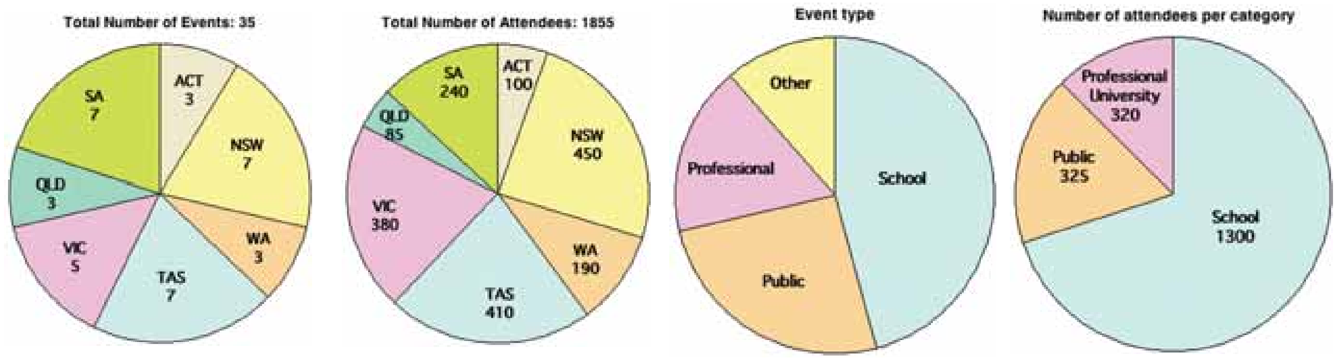


Figure 1: Statistics from the AIP International Women in Physics 2009 Tour (Other= open discussions)

Engineering 2009/2010 summer program and an invitation for a Keynote address at the SA Teachers Association Conference in April 2010. There was also positive feedback from all involved schoolteachers saying that the content was well balanced and well suited to the curriculum.

Acknowledgments

The author would like to thank all the Women in Physics Lecture Series National and State organisers for their tremendous effort and time.

Women in Physics Lecture Tour 2010 Award

The AIP Women in Physics Group is pleased to announce that Professor Elizabeth Winstanley has been awarded the AIP Women in Physics Lectureship for 2010. The Australian Institute of Physics Women in Physics Lecture Tour celebrates the contribution of women to advances in physics. Under this scheme, a woman who has made a significant contribution in a field of physics will give a series of public lectures around Australia. Professor Winstanley will visit each of the Australian State capital cities and present lectures to varied audiences: professionals, school students and the general public. This will include at least one public lecture arranged by each participating branch. AIP members will be notified when details of the lectures, their times and venues are finalised.

Elizabeth Winstanley is a Professor of Mathematical Physics at the University of Sheffield, UK. Her interests lie in general relativity, quantum gravity and quantum field theory in curved space-time. Her research focuses on black holes, particularly "hairy" (and more recently, "furry") black holes in general relativity and the Hawking radiation of black holes as might be produced at the Large Hadron Collider at CERN in Switzerland. The latter topic will form the basis of many of her lectures in Australia. She maintains a keen interest in developments in mathematics and science education, serving on a number of national mathematics education committees in the UK. She is a past-chair of the Gravitational Physics Group of the UK Institute of Physics and has recently been a member of the Council of the London Mathematical Society, the UK's learned society for mathematics.

Elizabeth Winstanley was born in Wigan, Lancashire and was educated at Abbey Gate College near Chester, both in the north of England. At school she harboured an ambition to be Governor of the Bank of England, but her academic interests lay in physics and mathematics. She decided to study mathematics at university, and obtained an MA in mathematics from St. Hugh's College, Oxford University. By now she had changed her mind about becoming Governor of the Bank of England, and wished to study physics further, completing a DPhil in theoretical physics at Oxford in 1996. After her doctoral studies, she was appointed as Fellow and Lecturer in Applied Mathematics at Oriel College, Oxford University, teaching a wide range of mathematics and theoretical physics courses. In September 2000, she was appointed as a Lecturer in the Department of Applied Mathematics at the University of Sheffield, where she has worked ever since. She has worked her way up the academic ladder at Sheffield, and was promoted to Professor of Mathematical Physics in January 2009.

Apart from physics, she enjoys watching sport, particularly cricket and rugby league, and has a broad taste in music, everything from Rachmaninov to Radiohead.

For further information: *http://www.aip.org.au/*
Or contact
Dr Chris Deller
AIP WIP Lecture Tour National Coordinator
CiSRA (Canon Information Systems Research Australia)
chris.deller@cisra.canon.com.au

News

Branch News

Victoria

Nicoleta Dragomir (Vic branch chair) and Peter Hannaford (Feb branch speaker)

In December 2009 the Victorian branch held a public lecture, its annual general meeting and presented a number of awards.

Professor Rudolf Grimm, from the Institute for Quantum Optics and Quantum Information (Innsbruck, Austria), presented a talk on the atomic quantum world at ultralow temperatures, extremely close to absolute zero. The winner of the 3rd year best physics practical award was Ms Sophie Dawson from Melbourne. The public lecture and 3rd year best physics practical award were sponsored by Technology Outcomes Pty Ltd and Gottfried Lichti Pty Ltd. The branch also made a presentation to Colin Hopkins in recognition of his many years of outstanding service to physics and physics education in Victoria.

In February the Victorian Branch hosted the federal AGM and a public lecture to mark the 50th anniversary of the laser. Prof. Peter Hannaford, from the Centre for Atom Optics and Ultrafast Lasers (Swinburne University of Technology) gave an interesting account of the historical development of the laser. The talk covered the various groups and personalities involved in the race to develop the first laser and the subsequent legal battles for the rights to the invention.

Other News

New mammography capability proposed for Australia

Australia could have its own synchrotron mammography capability within two to five years to complement current breast screening techniques and improve early detection.

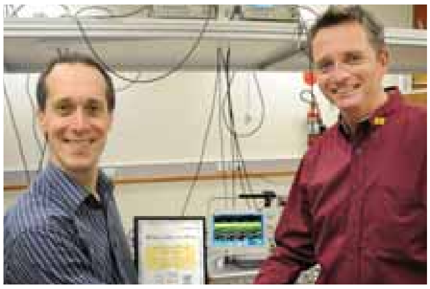
At the Photons for Medicine and Materials Science Workshop, 30 of Italy and Australia's brightest and best researchers will discuss how cutting-edge synchrotron techniques can help provide health, economic and social benefits for people across the globe.

Italy's Elettra synchrotron has the worlds' only clinical mammography facility using synchrotron x-rays for early detection of breast cancer.

Synchrotron mammography produces x-ray images with much finer detail than from conventional hospital x-ray machines – at a much lower x-ray dose.

"The Australian Synchrotron is developing its own clinical imaging facility, called the imaging and medical beamline," said Dr George Borg, Acting Facility Director of the Australian Synchrotron. "The Photons for Medicine and Materials Workshop will enable our scientists to learn from their Italian counterparts to assist them in developing a synchrotron mammography capability in Australia.
Australian Synchrotron

Edmund Optics bursary



The Monash University School of Physics has been awarded the inaugural Edmund Optics bursary valued at $5000. The bursary recognises Monash's commitment to teaching and research in all areas of optics. Edmund's Asia-Pacific marketing director Clark Harris presented Monash's Dr Lincoln Turner with the bursary, which will be used to purchase a high-precision helium-neon laser for the second and third year teaching laboratory.

Letter

I want to assure your readers that AIP's decision not to renew its contract with Materials Australia (MA) for provision of membership and financial services has not altered the commitment of the two organisations to work together to ensure that materials engineering and physics make a positive economic and social impact on Australia.

MA's introduction of a new membership and financial management system in 2008 created challenges for both associations and we can relate to the frustration that some AIP members and your executive have experienced over the past year. Although MA sought to respond to the concerns raised by AIP and negotiations over the contract renewal were conducted in a professional and cordial manner, the two parties chose to conclude that part of our relationship on fair and reasonable terms.

However, the overall relationship remains strong. Many AIP members are also members of MA (myself included) and I look forward to exploring new ways we can assist each other in our important roles representing professionals in the closely-related fields of physics and materials engineering.
George Collins
National President, Materials Australia

Brian James responds:
I and other members of the AIP Executive agree that it is important for the AIP and Materials Australia to continue to collaborate closely so that we can best represent the interests of our constituents, many of whom are members of both societies.

To that end I will seek an opportunity to discuss with MA President George Collins ways in which the two organisations can work together.

Brian James
AIP president

The Australian Radiation Protection and Nuclear Safety Agency

by Che Doering and Silvano Colmanet

The Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) is the national body for radiation protection and nuclear safety in Australia. ARPANSA has several roles, including the maintenance of scientific research capabilities and practical expertise in radiation protection and nuclear safety for national benefit as well as a regulatory role. This helps to ensure that Australia's high standards of radiation protection and nuclear safety are based on sound scientific principles and best practical knowledge.

A key mission for ARPANSA is the promotion of nationally uniform policies and practices to do with radiation protection and nuclear safety. Australia comprises nine legal jurisdictions (six States, two Territories and the Commonwealth), each having responsibility for radiation regulation, meaning that there is no one set of common laws with common requirements. In this regard, ARPANSA coordinates the national effort to achieve uniformity and promulgates a consistent and agreed framework for radiation safety, for both ionising and non-ionising radiation, through mechanisms like the National Directory for Radiation Protection, as well as through the publication of national standards and codes of practice.

This article profiles ARPANSA and some of the key work that it does to assure a safe radiation environment.

Background

ARPANSA was established on 5 February 1999 by merging the former Australian Radiation Laboratory (ARL) and the former Nuclear Safety Bureau (NSB) to create a new regulatory and scientific body with underpinning legislation. The *Australian Radiation Protection and Nuclear Safety Act 1998* (ARPANS Act) introduced for the first time a legislative framework to regulate the use of radiation sources within the jurisdiction of the Commonwealth – previously, the radiation activities of Commonwealth entities (mostly branches of the Australian Government) had not been subject to regulatory control. The ARPANS Act established the statutory office and functions of the Chief Executive Officer (CEO) of ARPANSA, who is responsible inter alia to make regulatory decisions about radiation protection and nuclear safety matters in the Commonwealth jurisdiction, and to undertake research and provide services and advice on radiation protection, nuclear safety, and related issues.

ARPANSA's two constituent bodies, the ARL and the NSB, had each contributed to the strong history of radiation protection and nuclear safety in Australia throughout their respective lifetimes. The ARL, the older of the two bodies, was responsible for providing advice to government and the community on the health effects of radiation and to undertake research and provide services in this area. It began operation as the Commonwealth Radium Laboratory in 1929, issuing radium and radon to major hospitals for use in cancer treatment. It was originally sited on the grounds of the University of Melbourne before relocating in the 1970's to custom-built premises at Yallambie, a northeastern suburb of Melbourne. The NSB was a much younger body, established in 1992 as a quasi-independent nuclear regulator through amendment of the *Australian Nuclear Science and Technology Organisation Act 1987*. It was based at Miranda in Sydney and was responsible for monitoring and reviewing the safety of Australia's research reactor capabilities at the nearby Lucas Heights Science and Technology Centre.

ARPANSA's current profile

ARPANSA is an Australian Government agency within the Health Portfolio. It is the agency created to administer the ARPANS Act, wherein it is charged with responsibility to protect the health and safety of people, and to protect the environment, from the harmful effects of radiation.

A legacy of past arrangements is that ARPANSA has two main sites that are geographically distant: a regulatory office at Miranda in Sydney and scientific laboratories at Yallambie in Melbourne. The agency also has a small liaison office within the Department of Health and Ageing in Canberra to facilitate its relationship with the rest of government. Total staff across the agency is approximately 150, with expertise in the physical sciences, government and regulatory processes, and legal and corporate services.

ARPANSA is organised into the statutory office of the CEO and five supporting branches. One branch provides support to the CEO in the exercise of regulatory powers and support in relation to ministerial services and policy initiatives. Three branches undertake research and the provision of scientific services: one is concerned with the occurrence of natural and anthropogenic radionuclides in the environment, activities that may perturb their occurrence, and their potential health and environmental impacts; one is concerned with the medical applications of ionising radiation; and one with the measurement and potential health effects of exposure to non-ionising radiation. Then there is one branch that provides internal corporate services and support to the agency, including human resources, IT, financial management, information management, and property management, industrial relations and general administration.

ARPANSA's annual operating budget is approximately $25 million. Around two thirds of this is appropriation funding from the Federal Government through the budget process. The other one third comes from sales of services to industry and the community, as well as through collection of licence fees and charges from the Commonwealth entities that the agency regulates. This means that ARPANSA is not only responsible for public good activity, but to also provide quality commercial operations and an effective and efficient system of regulation.

ARPANSA's activities

ARPANSA's activities reflect national priorities in existing and emerging radiation protection and nuclear safety issues, including medical exposure of patients to ionising radiation, uranium mining, radioactive waste management, ultraviolet radiation exposures and health effects, regulation of Commonwealth entities, national uniformity of radiation

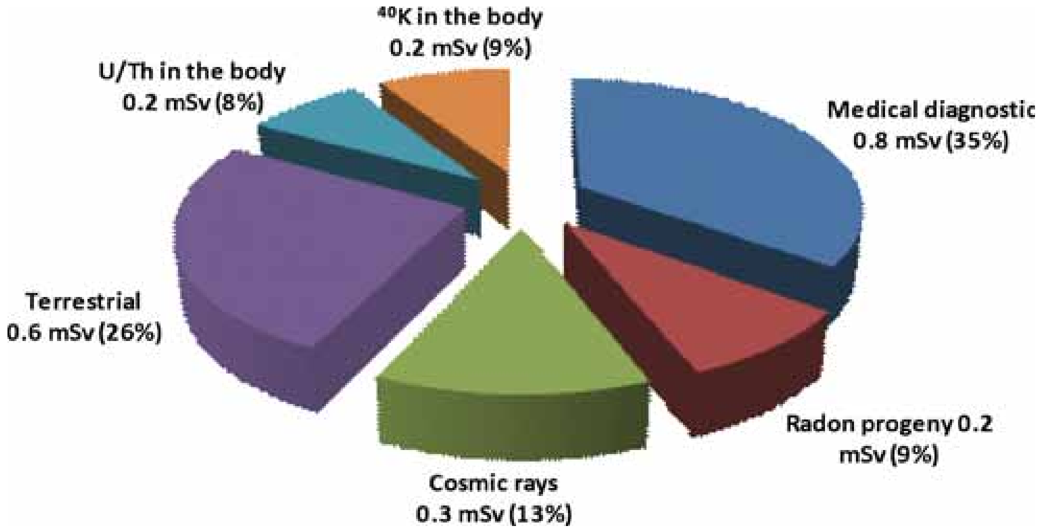


Figure 1. Australian annual per capita ionising radiation dose from natural and medical sources.

protection and nuclear safety policy and practices, and security of radioactive sources, among others.

The medical use of ionising radiation for both diagnostic and therapeutic purposes is the largest and increasing man-made source of ionising radiation exposure – it is estimated that around one third of the annual ionising radiation dose received by the average Australian from all sources (both natural and artificial) is due to medical exposure (Figure 1). ARPANSA is working with Australia's medical fraternity to help optimise and assure patient doses in the medical application of ionising radiation. To this end, the agency has recently purchased and commissioned a state-of-the-art Elekta Synergy Platform linear accelerator that is to be used as a medical standards machine (Figure 2). The output of the medical standards machine can be matched to that of linear accelerators used in clinical radiotherapy in Australia, including the 6, 10 and 18 MV photon beams of a Varian machine – the most popular brand linear accelerator and beam energies currently used in Australian radiotherapy

Figure 2. The ARPANSA medical standards linear accelerator will be used to calibrate ionisation chambers from hospitals and treatment centres against the Australian primary standard of absorbed dose to assure traceability of dose measurements in clinical radiotherapy.

applications. ARPANSA maintains the Australian primary standard of absorbed dose and will use the medical standards machine to provide a calibration service for ionisation chambers used in hospitals and treatment centres to assure traceability of dose measurements in clinical radiotherapy. The medical standards machine may also be used to verify patient doses and has the capability to import treatment plans and run them against anthropomorphic phantoms.

ARPANSA's annual operating budget is approximately $25 million.

Another way in which ARPANSA is helping health practitioners to optimise patient doses in the medical applications of ionising radiation is through a national survey of multi-detector computed tomography (MDCT) procedures to measure the dose impact of new technologies and clinical methods. The outcomes of the survey, or more specifically an evaluation of the spread in results, will help to establish diagnostic reference levels (DRLs) for this increasingly popular imaging modality – it is estimated that more than two million MDCT scans are carried out each year in Australia, representing the greatest source of patient dose from diagnostic imaging. DRLs are dose levels for radiation exposures in diagnostic practices that should not be consistently exceeded for standard procedures when good and normal practice regarding diagnostic and technical performance is applied. Although DRLs are set by the relevant professional bodies, a substantive survey of the observed distribution of patient doses, such as that to be undertaken by ARPANSA, provides a pragmatic means upon which a DRL may be selected that maximises the difference between the radiation benefit and risk without compromising the clinical purpose of exposure, typically the 75th percentile value is chosen.

Uranium mining and milling is an issue of concern because of the radioactive properties of the ore, product, and residues. Uranium workers are one of the occupational groups most highly exposed to ionising radiation. This exposure comes from inhalation of radionuclides in dusts, inhalation of

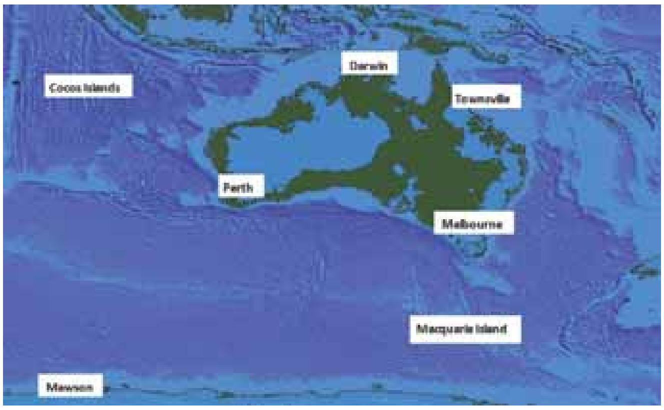


Figure 3a. Australia's seven CTBT radionuclide air monitoring stations are located across a wide geographic area that includes the mainland and three external territories.

Figure 3b. A typical CTBT radionuclide air monitoring station comprises a high volume air sampler, gamma-ray spectrometer and communications system. The station shown here is located on the Cocos Islands.

radon gas and its decay products, and gamma irradiation from proximity to ore and concentrates. Although mine operators are responsible for monitoring, assessing and recording the ionising radiation dose to workers, as well as reporting these results to the relevant State or Territory authority, there is no national system for providing dose histories to uranium workers, and subsequently no easy means for tracking the dose to workers who move between different operations or jurisdictions to ensure continuity of records and compliance with dose limits. ARPANSA, in consultation with industry and relevant State and Territory regulators, has developed the Australian National Radiation Dose Register as a centralised database to record and track the ionising radiation dose to workers engaged in the uranium mining and milling industry in Australia. The register is currently undergoing quality assurance testing before it enters into operation in 2010. It incorporates a secure web-based portal through which operators can remotely upload dose data for workers, coupled with a SQL server database backend for consolidation and storage of records. The register will provide assurance that records of ionising radiation dose for individual uranium workers are checked and maintained, and remain retrievable in the long-term, including when companies cease to operate. It is also able to generate statistical reports showing industry sector trends and comparisons, thereby providing a benchmarking tool for operators and regulators to review worker doses and strategies for the optimisation of radiation protection.

ARPANSA maintains a dynamic, multi-disciplinary scientific and regulatory culture that extends across radiation protection and nuclear safety.

In uranium mining and milling, as well as in certain other industries, there is potential for radionuclides to be released into the environment – this is an issue that can evoke strong emotion and debate within the community. International recommendations now make radiation protection of the environment (i.e. non-human biota and ecosystems) explicitly world's best practice, and Commonwealth legislation (specifically the *Environment Protection and Biodiversity Conservation Act 1999*) requires proponents to demonstrate through comprehensive impact assessment that the environment can and will be protected, particularly in the case of uranium mining and milling. ARPANSA is working towards a national framework for the assessment of radiation protection in Australian environmental conditions. It is currently reviewing models and methodologies developed internationally for assessing ionising radiation risks to non-human biota, together with associated data, to evaluate their applicability to the range of Australian climatic zones and biota. This important activity will see ARPANSA build strong cooperative linkages with national and international bodies with known radioecology expertise to ensure that a national framework and assessment approach for radiation protection of the environment are not only consistent with world's best practice, but are also relevant to Australian conditions and our unique biotic types.

Australia has signed and ratified the Comprehensive Nuclear-Test-Ban Treaty (CTBT) – an international agreement to ban all nuclear explosions. Under the treaty, a global network of more than three hundred monitoring stations incorporating four detection technologies (seismic, infrasound, hydroacoustic and radionuclide) is being established to sense nuclear events. ARPANSA is responsible for establishing and maintaining seven radionuclide monitoring stations in Australia and its territories: Melbourne, Perth, Townsville, Darwin, Cocos Islands, Macquarie Island and Mawson (Antarctica) (Figures 3a and 3b). It is also responsible for managing and maintaining a dedicated CTBT radionuclide laboratory at its Yallambie premises.

The radionuclide monitoring stations continually screen the air for radionuclides that provide unambiguous evidence of a nuclear event – a high volume air sampler is used to collect airborne particulate matter onto a filter, which is then analysed through high resolution gamma-ray spectrometry. Australian radionuclide stations at Melbourne and Darwin also use gas detection technology to continually monitor the air for radioxenon isotopes produced in nuclear fission reactions. Workflow and data from all stations across the

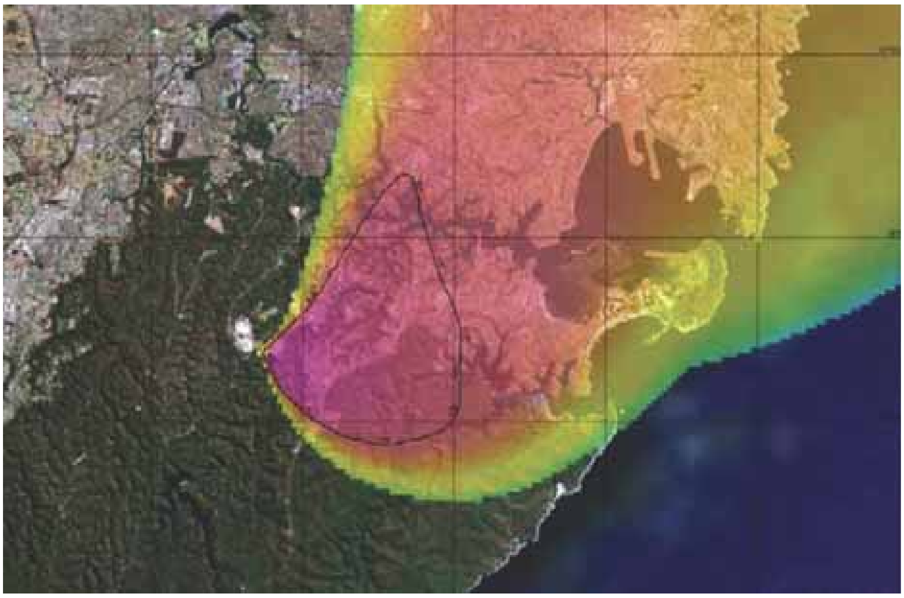


Figure 4. ARGOS (Accident Reporting and Guidance Operational System) is a modelling tool for predicting the trajectory and dispersal of radionuclides in the atmosphere. The output shown here is for a release scenario at a hypothetical reactor in southern Sydney.

global network are communicated back to an international data centre located in Vienna, Austria. By analysing and comparing data from the different stations within the network, the time, location and nature of a possible nuclear event can be determined.

To support Australia's CTBT commitment, as well as for emergency planning and response purposes, ARPANSA maintains atmospheric dispersion modelling capabilities. These capabilities allow predictive analyses to be made of the dispersal and trajectory of radionuclides and other contaminants released into the atmosphere. They also support backtracking methods to identify within reasonable uncertainty the source location of a radiological release.

ARPANSA has recently coordinated a governmental cross-agency evaluation of ARGOS (Accident Reporting and Guidance Operational System) for its suitability for Australian emergency planning, investigating several potential release scenarios. Given some meteorological data and information about a release, ARGOS was capable to generate a prognosis of areas that were likely to be contaminated, when and how much (Figure 4). This type of modelling capability ensures that appropriate decision support is available in certain critical instances, such as determining whether an Australian port is suitable for visits by nuclear powered warships and the necessary emergency planning and response arrangements. ARPANSA is continuing the ongoing evaluation and implementation of ARGOS as a modelling and decision support tool to help strengthen national emergency planning and response arrangements.

The main source of ultraviolet radiation (UVR) exposure to humans is the sun. Although small amounts of solar UVR can be beneficial, particularly in production of vitamin D, prolonged exposure can cause erythema (sun burn) and an increased risk of developing skin cancer. Australians experience the highest incidence of skin cancer in the world, with more than two hundred thousand new cases being reported each year, of which more than six thousand are potentially fatal melanomas. This alarming statistic can be explained by Australia's geographical location, a predominantly fair-skinned population, our outdoors lifestyle, the often cloud-free climate, and exposure to the resulting high levels of solar UVR. ARPANSA is helping to raise community awareness of solar UVR hazards across Australia. It maintains a highly reliable network of broadband solar UVR detectors situated in major Australian cities and the Australian Antarctic territories to measure and record exposure levels. The data is available as UV-Index values, displayed in real-time on the agency's website. The UV-Index provides a measure of the UVR exposure level at Earth's surface based on the potential for skin injury and permits members of the public to make informed decisions to better protect themselves against sun-induced skin damage.

A prime goal of regulation by ARPANSA is to provide assurance about the safe management of the radiation and nuclear activities of Commonwealth entities. The ARPANS Act establishes regulatory controls over radiation and nuclear activities in the Commonwealth jurisdiction and provides for enforcement of the legislation through the appointment of inspectors with enforcement powers. The Act prohibits Commonwealth entities from dealing with radiation sources or nuclear technology unless licensed to do so, or unless the dealing is exempt from regulatory control. Licences are issued by the CEO of ARPANSA under the Act. The Act and its associated regulations define the responsibilities of licence holders to meet certain conditions relating to radiation protection and nuclear safety. ARPANSA monitors the compliance of licence holders with the requirements of the Act and regulations through a program of inspections and regular reporting. Inspections may be announced or

A prime goal of regulation by ARPANSA is to provide assurance about the safe management of the radiation and nuclear activities of Commonwealth entities.

unannounced. The decision to inspect is usually based on the level of hazard of the regulated activity and the effective control maintained by the licence holder, but also takes into consideration geographical location, time between inspections, incidents, and compliance history.

The CEO of ARPANSA, as the statutory authority, is responsible for making regulatory decisions in accordance with the Act and regulations, taking into account the level of risk posed to people and the environment from the regulated activity as conducted by the licence holder. Where a breach of the Act is identified, the licence holder and nature of the breach are reported to the Australian parliament.

ARPANSA represents Australia on a number of key international bodies to do with radiation protection, such as the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), the International Commission on Radiological Protection (ICRP), the International Atomic Energy Agency (IAEA), and the International Commission on Non-Ionising Radiation Protection (ICNIRP). It also participates in global and regional initiatives that promote awareness and skills development in radiation protection and nuclear safety, including programs established through the World Health Organization (WHO), the IAEA and the Asian Nuclear Safety Network (ANSN). Such international experience ensures that Australia's high standards of radiation protection and nuclear safety continue to evolve and are consistent with that elsewhere in the world.

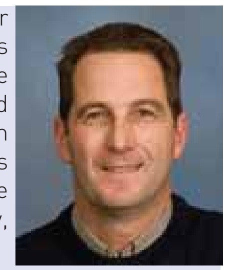
Conclusion

ARPANSA maintains a dynamic, multi-disciplinary scientific and regulatory culture that extends across radiation protection and nuclear safety. The agency aims to control exposure to radiation from man-made and natural sources that affects the health and safety of Australians both at work and at play.

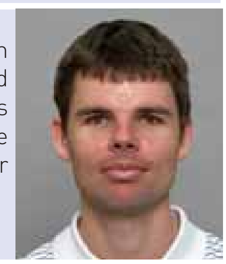
Further information

For further information about ARPANSA and its activities, visit *www.arpansa.gov.au*

Dr Silvano Colmanet is the manager of ARPANSA's Environmental Analysis and Monitoring Section, which has the responsibility for the implementation and operations & maintenance of the Australian CTBT radionuclide monitoring stations and CTBT radionuclide laboratory, the environmental radiochemistry laboratory, and radionuclide measurement facility.



Dr Che Doering is a senior scientist in ARPANSA's Environmental Impact and Assessment Section. His work includes the Australian National Radiation Dose Register and national framework for radiation protection of the environment.



Earth Observations from Space: Australia's Strategic Plan

by John Zillman

Abstract

Earth observations from space are the single most important and richest source of environmental information for Australia. As a nation, we have become an enormous beneficiary of international cooperation in Earth observation during the first 50 years of the space age. But despite our substantial contribution to the underlying science and especially to development of the application of space-based observations, Australia has so far remained essentially a free-rider on the international system. With many more countries now beginning to contribute actively to the implementation and application of a Global Earth Observation System of Systems (GEOSS) and with recent indications of a more purposeful Australian role in space activities, the time has come for a new and more strategic Australian approach to Earth observations from space. The Australian Academy of Science and the Australian Academy of Technological Sciences and Engineering have recently published 'An Australian Strategic Plan for Earth Observation from Space' to assist governments and the diverse Earth observation stakeholder communities to meet this growing national need.

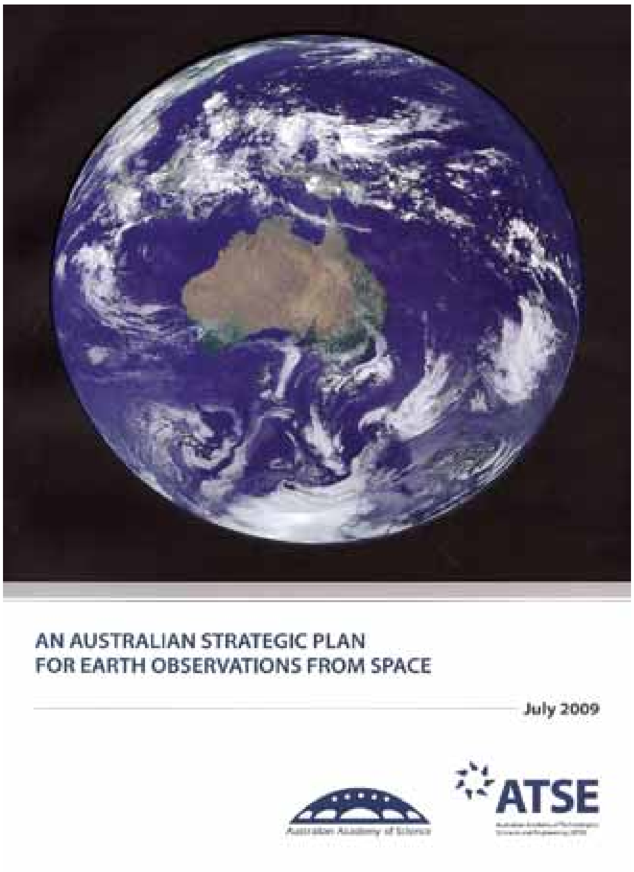


Figure 1(above) The AAS-ATSE Strategic Plan. The cover image is courtesy of NASA.

Introduction

It is more than 40 years since Australia became one of the first space-faring nations with the 1967 launch of WRESAT and 25 years since the Commonwealth Government commissioned the then Australian Academy of Technological Sciences (now the Australian Academy of Technological Sciences and Engineering (ATSE)) to develop a space policy for Australia (ATS, 1985). Despite its quick start, its early world leadership in several areas of application of space science and technology, and its increasing dependence on satellite information for a vast array of important national purposes, Australia has had a chequered history of participation in the space age. Only in the past few years, with the preparation of a Decadal Plan for Australian Space Science by the Australian Academy of Science National Committee for Space Science (NCSS) (Cairns et al, 2008, 2010), the Senate Inquiry into new directions for Australian space science and industry (Senate Standing Committee on Economics, 2008), the Government announcement of an Australian Space Science Program in the context of the 2009-10 Budget, and, most recently, the establishment of the new Space Industry Innovation Council, have there been signs that Australia is once again poised to become a significant player in the space age.

One of the most important applications of space science and technology is in Earth observation by satellite. The Bureau of Meteorology, CSIRO and Geoscience Australia have been major users of observations from foreign-owned earth observation satellites since the early 1960s. And, in addition to their ongoing use for weather forecasting and warning, national mapping and mineral exploration, Earth observations from space (EOS) are now essential to a wide range of Commonwealth, state and local government environmental and resource management programs and a host of other public and private sector applications that directly benefit almost every sector of the Australian community.

EOS bridges across the disciplines of Earth science, Earth system science and space science as well as between research, operations and applications. In the absence of an Australian space agency with the wide span of responsibility of organisations such as the US National Aeronautics and Space Administration (NASA) and National Oceanic and Atmospheric Administration (NOAA), the European Space Agency (ESA), the European Organization for the Exploitation of Meteorological Satellites (Eumetsat), the Japan Aerospace Exploration Agency (JAXA) and the more than 25 other national space agencies which now work together through fora such as the Committee on Earth Observation Satellites (CEOS), mission-oriented agencies such as the Bureau of Meteorology and Geoscience Australia have, over the years, done their best to serve the total national EOS need as well as working through their respective international channels of cooperation to obtain and use the observations they need from foreign satellites in order to carry out

Figure 2 The launch of the AAS-ATSE Strategic Plan for Earth observation from Space in Parliament House Canberra, 29 October 2009. From left ATSE CEO Dr Margaret Hartley, AAS President Professor Kurt Lambeck, Chief Scientist Professor Penny Sackett and AAS CEO Dr Sue Meek.

their own distinctive national roles. But all have long felt the need for a properly resourced and better coordinated national EOS effort. And, following the establishment of the intergovernmental Group on Earth Observations (GEO) in the wake of the First (2003), Second (2004) and Third (2005) Ministerial Earth Observation Summits, with responsibility for implementation of a 10-Year Plan for a Global Earth Observation System of Systems (GEOSS) (GEO, 2005), the need has become acute.

The Academies' Strategic Plan

In order to help gear Australia for its essential role in EOS acquisition and application over the coming decades, the Presidents of AAS and ATSE, in December 2008, established a Working Group of 16 Academy Fellows and other Earth science, Earth system science and space science experts to prepare 'An Australian Strategic Plan for Earth Observations from Space'. The AAS-ATSE study was supported by the Bureau of Meteorology, CSIRO, the Department of Climate Change, the Department of Innovation, Industry, Science and Research, and Geoscience Australia and guided by an informal Steering Committee of senior sponsor representatives that included also the Chief Defence Scientist.

The Working Group completed its report in July 2009 (Figure 1) and the Plan was launched by the Parliamentary Secretary for Innovation and Industry, Mr Richard Marles MP, in Parliament House on 29 October 2009 (Figure 2).

The major conclusions of the Working Group and the essential messages in its report (AAS-ATSE, 2009) were:

• Earth observations from space (EOS) are the single most important and richest source of environmental information for Australia. They enable a wide range of essential services to be given to the community, with multi-billion dollar annual benefits to the nation as a whole;

• Australia's needs for EOS data are increasing rapidly. Extensive EOS information is essential for addressing urgent challenges in climate change, water, natural disaster mitigation, transport, energy, agriculture, forestry, ecosystems, coasts, oceans and national security;

• The satellite-provider nations have many new missions planned for the next 10-15 years, providing powerful new EOS capabilities for addressing Australia's needs. We have, however, become fully dependent on foreign-owned satellites and can no longer significantly influence their capabilities in support of our unique requirements. Time is running out for our historical free-rider status on the international EOS system;

• Australia must immediately embark on a national strategy to secure long-term access to the international EOS system and to better focus its capabilities on Australian specific needs for EOS information. We must also greatly strengthen our national EOS operational data acquisition, data processing, research, education and industry infrastructure to take full and timely advantage of existing EOS satellites and the many new opportunities that will become available over the next decade; and

• The opportunity costs of living with the national EOS status quo are mounting rapidly. The strategy set down in the AAS-ATSE Strategic Plan will ensure that Australia realises the additional multi-billion dollar economic, social and environmental benefits that are potentially available from full participation in the global EOS enterprise, and which are likely to be widespread across the Australian community.

The Working Group set down the essential elements of a national strategy for EOS for the next 10-15 years in terms of a strategic goal, eight strategic objectives and seven major strategic initiatives.

The goal of the Plan was "To maximize Australia's social, economic and environmental benefits from the acquisition and application of Earth observations from space". More specific objectives are: "To use the critical value adding input of EOS to help Australia to:

• Monitor, understand and predict climate change and variability, to assess the impacts of climate change, and to develop strategies to mitigate and adapt to climate change on national, regional and global scales;

• Monitor, understand and predict the water balance across Australian catchments in order to optimise the management of water;

• Monitor natural disasters and to develop strategies to manage and mitigate the impacts of natural disasters in the Australian region;

• Monitor and predict the weather and other environmental factors in order to ensure the safety and security of Australian transport systems on land and sea and in the air

• Asses sites for renewable energy sources and to predict weather and climate conditions relevant to overall load management and to expected energy demand;

• Monitor, manage and plan agriculture, forestry and natural ecosystems;

• Monitor, manage and predict the environment of the coasts and oceans; and

• Monitor Australian borders and assure national security."

In the final chapter of its 108 page report, the Working Group set down nine recommendations, whose implementation, it believes, will get Australia back on the front foot on the international EOS scene and maximize Australia's social, economic and environmental benefits from the acquisition and application of EOS over the next decade and beyond. The nine recommendations were:

1 National EOS Policy. Australian government policy on space science and industry development should include an explicit national policy on EOS, based on strengthening, broadening and coordinating exiting EOS activities and a strategic commitment to full Australian participation in the international EOS system by 2025.

2 EOS priority setting. A high-level, cross-portfolio EOS advisory council should be established with the active involvement of the national EOS provider agencies, the learned academies and the EOS user community to advise on national priorities for EOS operations, research, education and applications across all sectors and all levels of government.

3 National EOS infrastructure. The main operational EOS agencies and ground station consortia should jointly establish a coordinated approach to strengthening and optimizing the national investment in the EOS data acquisition, processing, archival, distribution and applications infrastructure that will be needed to handle the massive increase in EOS availability and user needs over the next decade.

4 EOS research and education. A national plan and funding framework should be developed to establish and maintain a critical mass of strategic research and education expertise in Australian universities to underpin the operational EOS systems, services and applications in industry and government agencies.

5 EOS industry capability. In order to support a strengthened Australian role in the global Earth observation satellite community, the Space Science and Innovation Project Grants scheme should be enhanced within the framework of the national EOS policy to promote local industry capabilities in EOS systems development and applications.

6 Radio spectrum for EOS. Given the enormous social, economic and environmental benefits to Australia from the use of EOS data, those parts of the radio spectrum that are uniquely required for satellite remote sensing of atmospheric and Earth characteristics should be permanently protected from interference, in the public interest. Means should also be found for meeting the costs of commercial sharing of those parts of the radio spectrum that are used for public-good transmission of EOS data from satellites.

7 International engagement in EOS. Australia should strengthen its role and influence in international EOS through development of bilateral and multilateral (including regional) partnerships in EOS provision, greater involvement in the Committee on Earth Observation Satellites (CEOS), and enhanced contribution to the implementation of the Global Earth Observation System of Systems (GEOSS).

8 EOS National Office. An EOS national office should be established as part of the Australian Space Science Program, to support the EOS advisory council, to maintain links with the operational EOS agencies and to serve as the national focal point for Australian EOS activities.

9 EOS mission agencies. The EOS operational and research mandates of the Bureau of Meteorology, Geoscience Australia and CSIRO should be reaffirmed and strengthened and they should collaborate with the Department of Defence, other Commonwealth and State EOS agencies and universities in the progressive development of a more integrated national EOS service and research framework for Australia.

In their joint Foreword to the Report, the AAS and ATSE Presidents, Professors Kurt Lambeck and Robin Batterham, endorse the Working Group's conclusions that Australia can no longer meet its burgeoning national needs for Earth observations through relying on the generosity and goodwill of other countries; and that we must immediately commit to a much stronger national role in EOS in line with the strategy and recommendations of the Report. In launching the Report in Parliament House, Mr Marles welcomed the proposed strategic approach to Australia's future earth observation needs and opportunities over the next fifteen years.

The Report, including the membership of the Working Group and Steering Committee and the names and affiliations of the 90 other experts who contributed to the development of the Strategic Plan, its assessment of present Australian EOS capabilities and future needs and an elaboration of the proposed strategy may be found on the ATSE Website at *http://www.atse.org.au/indesc.php?section1d=128*.

Further Reading

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Professor John W Zillman FAIP is a Vice Chancellor's Fellow at the University of Melbourne and a former Director of the Bureau of Meteorology. He is a Fellow of AAS and ATSE and a former President of ATSE. He chaired the AAS-ATSE Working Group which prepared the Plan.

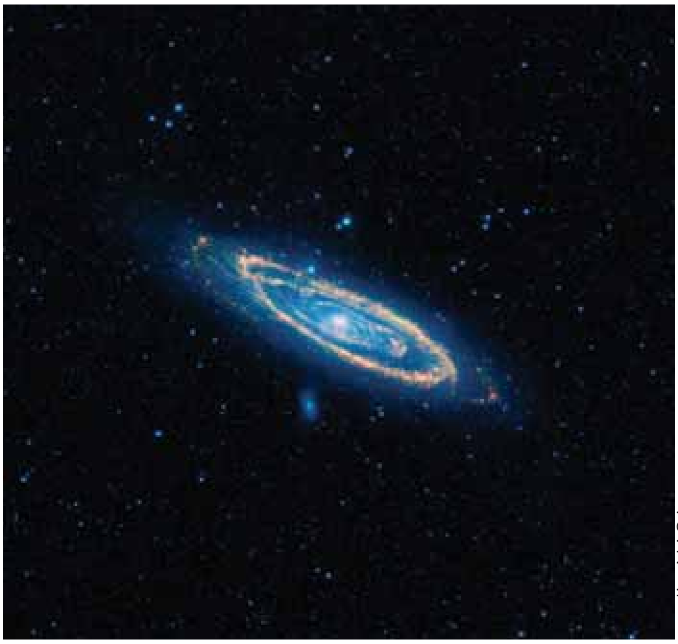
NASA News

NASA has released the first images taken by its Wide-field Infrared Survey Explorer (WISE) space telescope, which launched in mid December.

The seven awe-inspiring images include a star-forming cloud teeming with gas, dust and massive newborn stars, a detailed picture of the Andromeda galaxy — the closest large galaxy to the Milky Way — and a comet streaking across the sky.

Costing $320m, WISE is an infrared space telescope that will probe the coolest stars in the universe and the structure of galaxies at four wavelengths between 3 - 25 micrometres. As WISE is designed to detect infra-red radiation from cool objects, the telescope and detectors are chilled to 12 K with liquid helium.

WISE will circle the Earth's poles at an altitude of 525 km scanning the entire sky one-and-a-half times in nine months where it will also measure the diameters of more than 100 000 asteroids.



credit: NASA

Image of the Andromeda galaxy taken by NASA's WISE craft

Treatment of hazardous waste using thermal plasmas: garbage, greenhouse gases and more

by Anthony B. Murphy[1], Anthony J. D. Farmer[1] and Trevor McAllister[2]

Twenty years ago, Nufarm had a problem. The company, which produces agricultural chemicals, had been the target of a protest organised by Greenpeace, whose activists had blocked the pipe discharging waste into the sewer. Greenpeace objected to the presence of dioxins in the waste liquid from Nufarm's process to produce the herbicide 2,4D. Although Nufarm had all the required permits in place for discharge into the sewerage system, they nevertheless decided to search for a technology to treat the waste on site.

Just 30 km away, CSIRO researchers were experimenting with the electric-arc plasma systems that they applied for welding and cutting of metals, and spraying of heat- and wear-resistant coatings. The researchers reasoned that the high temperatures (up to 20 000 K) and heat fluxes produced in these atmospheric-pressure plasmas could be used to break down any hazardous molecule into constituent atoms.

So started a long story with a happy ending. Nufarm met CSIRO, and together with a third partner, SRL Plasma, they solved Nufarm's waste problem. The technology they developed, the PLASCON™ plasma waste treatment process, has been converting all of Nufarm's waste liquid into harmless substances for 15 years. Not only that, but the process is being used around the world to treat an increasing range of wastes: organic liquids, ozone-depleting substances such as chlorofluorocarbons, and, most recently, greenhouse gases. As we will see, one PLASCON unit can destroy the equivalent of the emissions of a small coal-fired power station.

While PLASCON was the first commercial plasma waste treatment process, it is now far from alone. Plasma systems are being used to treat everything from asbestos to garbage, often producing useful building materials and supplying energy at the same time.

In this article, after giving an overview of the status of plasma waste treatment, we will discuss how we reached this point, in particular emphasising some of the research that was required to develop the PLASCON process.

Waste

Humans produce a vast amount of a huge variety of waste materials, ranging from highly-toxic organic chemicals, through gases that contribute to ozone depletion and global warming, to municipal waste and sewage. Treatment of these wastes has always been a problem, one that continues to grow in severity as the rate of production of wastes increases, as traditional waste repositories such as landfills and oceans become less available, and as we gain more understanding of the hazards of particular wastes.

Incineration is widely used to burn many waste materials. However, there are drawbacks, including (1) the high exhaust gas flows, which increase gas cleaning costs, (2) the production of residues (fly ash and grate ash) that may contain hazardous materials, and (3) the fact that many wastes are difficult to burn and therefore require an additional source of fuel. Moreover, incineration facilities tend to be large and visible, and are often politically unacceptable. For example, in Australia, when a high-temperature incinerator for the treatment of intractable wastes was proposed in the mid 1980s, a strong public reaction led to the formation by the Commonwealth Government of the Independent Panel on Intractable Wastes. The Panel recommended against the introduction of a centralised high-temperature incineration facility, and instead proposed (in a 1997 update) that 12 different technologies be considered for destruction of intractable wastes.

The recommendation reflects that, even for one group of wastes, there are many possible treatment methods, and the choice will depend on the specific properties of the waste, the availability and cost of the different treatment methods, and on regulations and other local issues. One of the recommended technologies was plasma waste treatment.

[1] CSIRO Materials Science and Engineering, PO Box 218, Lindfield NSW 2070, Australia

[2] 2 Hall St, Clifton Hill VIC 3068, Australia

Plasma waste treatment

Both thermal plasmas and non-equilibrium atmospheric-pressure plasmas (see box) are used for waste treatment. The latter are particularly suited to gas cleaning, i.e., removal of small concentrations of pollutants such as volatile organic compounds (VOCs) and nitrogen oxides (NO_x). Since the background gas is not heated, the energy requirements are much lower than for thermal plasmas. Further, the density of radicals produced in the plasma, such as oxygen atoms and hydroxyl molecules, can be sufficient to destroy low concentrations of pollutants. Particular success has been obtained when the action of the plasma is combined with that of a catalyst [1].

Thermal plasmas require much more energy, since all the gas molecules are heated to high temperatures. They are therefore only economically viable for concentrated waste streams. Even for these wastes, thermal plasma treatment is usually more expensive than high-temperature incineration. For many years, only niche applications, to which the properties of thermal plasmas were particularly suited, were commercially successful. For example, the high temperatures meant refractory materials such as asbestos and incinerator ashes could be melted and transformed into inert glasses or slags. The limitations on rates in which chlorinated and fluorinated materials can be incinerated meant plasmas were competitive in the treatment of ozone-depleting substances such as chlorofluorocarbons (CFCs) and halons. In Australia, incineration was politically unacceptable, so plasma treatment was able to compete successfully.

In addition to being able to achieve higher temperatures and power densities, thermal plasma systems have other

Tony Murphy, Tony Farmer and Trevor McAllister were awarded the AIP's Alan Walsh Medal for Service to Industry in 2008, for their work on the application of the PLASCON process to the treatment of halocarbons (chlorofluorocarbons, halons and fluorocarbons).

Plasmas

The plasma state of matter is the most common in the universe, occurring in stars, interstellar space, the ionosphere, and terrestrial lightning. Plasmas with a very wide range of properties have been applied industrially for well over a century. We can classify industrial plasmas into three main types:

1. Low-pressure plasmas, in which gas at a small fraction of atmospheric pressure is ionised, usually by radio-frequency radiation. Such plasmas have hot electrons (a few eV; 1 eV ~ 11 000 K) and near-room temperature heavy species (ions, atoms and molecules). The electrons are heated by the radiation, but the collision rate with heavy particles is small because of the low pressure, so the transfer of energy is inefficient. Industrial applications include semiconductor etching, plasma-enhanced chemical vapour deposition (PECVD), and fluorescent and neon lighting.

2. Non-equilibrium atmospheric-pressure plasmas, which are formed by short-lived discharges that are interrupted before they become arcs or sparks. The interruption can occur because of the presence of an insulating barrier (dielectric barrier discharges), or because of the remoteness of the ground 'electrode' (corona discharges). There is insufficient time for energy to be transferred from electrons to heavy particles, so only the electrons reach high temperatures. Nevertheless, high densities of excited species and radicals can be formed. Applications include electrostatic precipitators, ozone generators and 'corona' treatment of plastics to render them hydrophilic.

3. Thermal plasmas are plasmas at or near atmospheric pressure, in which the electron and heavy particle temperatures reach equilibrium due to the high collision frequency. The temperatures are typically 1 to 2 eV, and very high power densities can be obtained. Most applications make use of these high temperatures and power densities, which are sufficient for the plasma to melt solids. Such applications include arc welding, plasma cutting, and electric arc furnaces and other mineral processing methods.

In plasma spraying, ceramic powders are melted before being blasted onto a substrate to form protective surfaces. Another property of thermal plasmas, their intense radiative emission, is used in arc lamps for lighting applications.

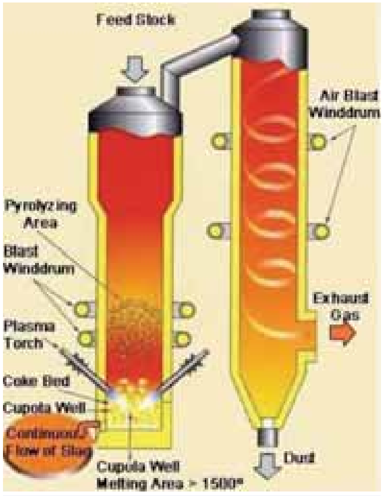


Figure 1. Schematic of plasma waste treatment system at Utashinai, Japan. Four Westinghouse plasma torches preheat the combustion air. The plant is designed to treat auto-shredder residue or municipal solid waste, producing a molten slag. The exhaust gases are burnt in the furnace on the right and used to drive a turbine.

advantages over incineration. They are ideally suited to small-scale installations, and can therefore be used in on-site or mobile facilities. This means that transport of waste to a large centralised installation can be avoided. Further, the fact that energy is provided by electricity rather than combustion means that the exhaust gas flows are relatively low, decreasing post-treatment costs. It also means that the facility can be shut off immediately should any problems occur.

These advantages have seen the expansion of thermal plasma facilities from niche applications to treatment of a wider range of wastes, including medical and hospital wastes, municipal solid waste (household garbage), auto-shredder residues, and sewage. Such facilities are particularly widespread in Asia, where high population densities mean landfill sites are less available. Many plasma facilities now produce syngas (a mixture of carbon monoxide and hydrogen), which can be burnt to produce energy, at least enough to supply the facility. For example, the facility designed by Hitachi Metals Co., operating in Utashinai, Japan, uses four Westinghouse plasma torches, which together require 1.2 MW in electric power, to heat the air in a furnace. The plant, shown in Figure 1, is mainly used to melt and compact auto-shredder residues, with a daily capacity of 165 t. Burning the exhaust gases in a second furnace produces 8 MW electric power, which is twice the total required for plant operation; the additional power comes from the chemical energy of the waste. A recent article presents a thorough review of the thermal plasma waste treatment facilities around the world [2].

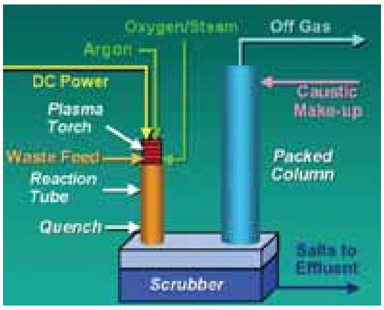


Figure 2. Schematic diagram of the PLASCON waste treatment process. The waste is fed, together with a gas such as oxygen or steam, into the argon plasma jet produced by a plasma torch.

PLASCON

The PLASCON process [3] uses a thermal plasma to convert hazardous gaseous and liquid chemicals into environmentally-benign substances. A schematic of the process is shown in Figure 2. The waste to be treated is fed, together with oxygen or steam, into a jet of argon plasma. The plasma is produced by a direct-current plasma torch, which uses electrical power of up to 150 kW. The waste is heated to well over 2000 K by the plasma, and is passed through a reaction tube, which keeps the gas mixture at a high temperature for sufficiently long for the waste to be transformed into atoms or smaller molecules. The gas mixture is then rapidly quenched using a water spray, avoiding the formation of dioxins, which is most likely to occur in the temperature range between about 500 K and 750 K. A sodium hydroxide scrubber is used to remove acid gases, such as hydrogen chloride and hydrogen fluoride, and

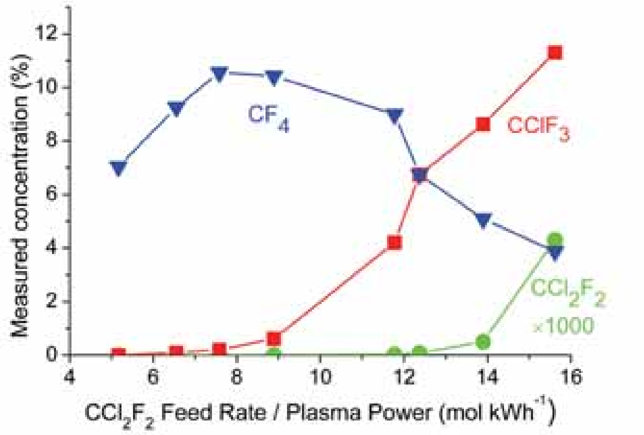


Figure 3. Measured concentration (mol%) of CCl_2F_2 (CFC-12), $CClF_3$ (CFC-13) and CF_4 in the exhaust gas for CCl_2F_2 feed gas and oxygen as co-injected gas, as a function of CCl_2F_2 feed rate normalised to plasma power.

halogens, such as chlorine and fluorine. The remaining gases can be flared if they contain carbon monoxide and hydrogen, or safely released to the atmosphere. Typically the byproducts are aqueous solutions of sodium chloride and possibly sodium fluoride from the scrubber, and carbon dioxide, water vapour and argon in the exhaust gases. The levels of dioxins, carbon monoxide, particulates and other pollutants in the exhaust gases easily meet the strictest environmental legislation. Destruction of the waste is typically at levels of 99.9999% (six nines), and in many cases seven nines or better.

Organic liquid wastes

The PLASCON process was initially developed to treat the liquid waste byproducts from the production of the herbicide 2,4D at Nufarm; the waste contains chlorophenols, phenoxies, toluene, and other organic chemicals, including dioxins and furans at the parts-per-billion level. The liquids are injected into the plasma jet as a fine spray. Oxygen is added at the same position; this prevents the formation of carbon soot from pyrolysis of the liquid droplets. The overall chemical reaction for dichlorophenols, for example, is

$$C_6Cl_2H_4O + \tfrac{5}{2}O_2 \rightarrow 6CO + H_2 + 2ClH.$$

The carbon monoxide and hydrogen are flared to form carbon dioxide and water vapour, while the hydrogen chloride is removed in the scrubber, where it forms a sodium hydroxide solution. The levels of dioxins and furans in the exhaust gases are well under the stringent German emission limit of 0.1 ng m^{-3} ITEQ (international toxic equivalent).

There are now two 150 kW plants operating at Nufarm that treat this waste stream as part of the production line. The first, commissioned in 1992, was the world's first commercial plasma waste treatment facility. The introduction of the PLASCON process has allowed the 2,4D herbicide production process to be altered to increase productivity and efficiency, since it ensured that all unwanted waste products could be safely treated.

PLASCON has since been applied to other organic liquid wastes, including PCB-contaminated oils, mixtures of PCBs and kerosene, and pesticides. A plant at SRL Plasma in Brisbane has treated over 1200 t of such wastes, and four plants were constructed at Mitsubishi Chemical Company in Yokkaichi, Japan in 2004 to destroy the company's stockpile of PCB–kerosene mixtures.

Ozone-depleting substances

The Montreal Protocol on Substances that Destroy the Ozone Layer and its amendments phased out the use of chlorofluorocarbons (CFCs) and bromochlorofluorocarbons (usually known as halons) in developed countries by the end of 1993 and 1995 respectively. As a consequence, the Australian government instigated a program to collect and destroy these substances at the Australian National Halon Bank in Melbourne. The destruction technology selected was the PLASCON process.

In adapting the PLASCON process for treatment of ozone-depleting substances, substantial technical difficulties were encountered. While the input ozone-depleting substance could be successfully destroyed to well above the level of 99.99% required by the Montreal Protocol [4], this was found to be accompanied by formation of other ozone-depleting substances [5,6]. For example, the destruction of CFC-12 (CCl_2F_2) led to the production of large concentrations (up to 10 mol%) of CFC-13 ($CClF_3$), which has the same ozone-depleting potential as CFC-12, and CF_4, a strong greenhouse gas with a global warming potential of 6500. Typical measured concentrations of the three substances in the exhaust gas are shown in Figure 3. Similar interconversion effects were found in the destruction of halons [7]. A program of experimental tests, chemical kinetic calculations and computational fluid dynamic modelling was implemented to

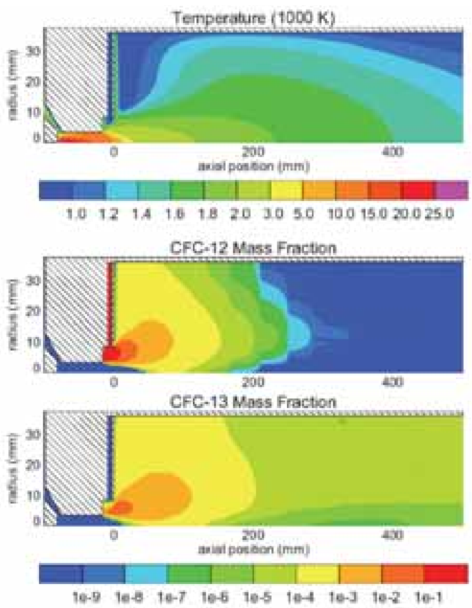


Figure 4. Calculated temperatures and mass fractions of CFC-12 and CFC-13 for typical conditions in a PLASCON research-scale reactor, for CFC-12 feed gas and oxygen co-injection. The production of CFC-13 is clearly apparent. The plasma torch is at axial positions z < 0, the CFC-12 is injected at z ~ 0, and the reaction tube is at z > 0.

investigate the problem. Figure 4 shows the predictions of a combined chemical kinetic and magnetohydrodynamic model of the destruction of CFC-12 in the PLASCON process [8]. It is clear that CFC-12 is rapidly decomposed after injection into the plasma jet, but CFC-13 is formed at the same location. The latter is more stable, and decomposes much less rapidly. Similar results were obtained for CF_4.

The crucial breakthrough occurred when calculations were made of the effect of using steam, rather than oxygen, as the co-injected 'oxidising' gas (required to prevent the formation of soot). The models predicted that production of CF_4 could be eliminated, and the production of CFC-13 and other ozone-depleting substances could be greatly reduced, even for the very high throughputs required for an industrial process [6,7]. Figure 5 shows typical predictions of chemical kinetic calculations. The presence of hydrogen is the decisive factor; hydrogen atoms react rapidly with halogen atoms, thereby interrupting the recombination reactions that would lead to the formation of CFC-13 and CF_4. The overall reaction is

$$CCl_2F_2 + 2H_2O \rightarrow CO_2 + 2FH + 2ClH.$$

The theoretical predictions were confirmed in experimental trials, and the PLASCON plant installed at the Australian National Halon Bank in Melbourne in 1995 (shown in Figure 6) was designed to use steam. Since then, all of the Australian and New Zealand stockpiles of CFCs and halons that have been collected, over 2200 t, have been successfully treated at the facility. The PLASCON process was one of only five technologies recommended for destruction of both CFCs and halons by the United Nations Environment Programme [4]. Further plants for destruction of ozone-depleting substances were installed in the UK and the USA in 2003 and 2006 respectively.

Fluorocarbon greenhouse gases

The most recent development has been the application of PLASCON to destroy fluorocarbons, which are extremely strong greenhouse gases. For example, trifluoromethane (CF_3H) has a global warming potential of 11 700 (compared to 1 for carbon dioxide; it should be noted that ozone-depleting substances also have high global warming potentials: 8500, for example, for CFC-12). Trifluoromethane is a byproduct of hydrochlorofluorocarbon (HCFC) production. HCFCs are CFC-replacement chemicals whose use is permitted until 2020 in developed countries and until 2030 in the developing world.

Two PLASCON plants have been installed at the Quimobasicos plant in Mexico to destroy trifluoromethane, in 2006 and 2008. Both oxygen and steam are added, giving the following overall reaction:

$$CF_3H + \tfrac{1}{2}O_2 + H_2O \rightarrow CO_2 + 3FH.$$

Thus each molecule of trifluoromethane is replaced by one of carbon dioxide. Of course, there is some carbon dioxide released in running the plant, in particular in producing the required electricity. However, only 7 t of carbon dioxide is produced per tonne of trifluoromethane that is destroyed, so

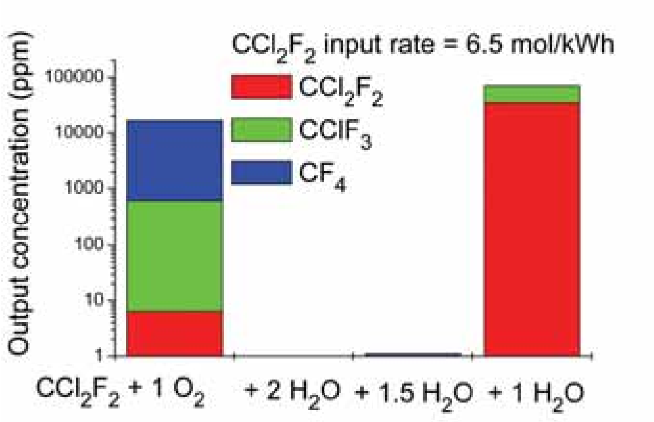


Figure 5. Predicted output concentrations of CCl_2F_2, $CClF_3$ and CF_4 for stoichiometric oxygen (1 O_2), stoichiometric steam (2 H_2O), and sub-stoichiometric steam (1.5 H_2O and 1 H_2O), as the co-injected gas.

the net equivalent carbon dioxide destroyed is 11 693 t [9]. Each year the PLASCON plants destroy over 200 t of trifluoromethane, which is equivalent to preventing the release of over 2.5 Mt of carbon dioxide. This is a truly significant amount, corresponding approximately to the carbon dioxide emissions of a 300 MW coal-fired power plant or 500 000 cars. Moreover, the process is very profitable. The plant is funded by carbon credits under the Kyoto Protocol Clean Development Mechanism. At a carbon price of $20 / tonne, the rate per tonne of trifluoromethane is about $240 000, which is well over 20 times the cost of destruction.

A further plant for the purpose of trifluoromethane destruction was purchased by Honeywell Specialty Chemicals in 2008.

Conclusions

PLASCON is undoubtedly an Australian success story. It began as a laboratory trial at CSIRO in the late 1980s, rapidly became the first commercially-successful plasma waste

Figure 6. The PLASCON plasma reactor for the destruction of ozone-depleting substances, installed at the Australian Commonwealth Government's Halon Bank facility in Melbourne.

treatment system, and is now well established, with thirteen plants having being installed around the world at last count. It has been joined by many other plasma waste treatment systems. While initially niche wastes such as asbestos and incinerator ashes were targetted, plasmas are now used to treat everything from garbage to greenhouse gases.

The PLASCON technology has sustained a small Australian company, SRL Plasma, for almost two decades (although with several changes in ownership along the way; initially SRL Plasma was a division of Siddons Ramset, was then purchased by BCD Technologies, and is now part of the DoloMatrix International). Moreover, PLASCON has resulted in immense benefit to the environment, through effective treatment of toxic organochlorine chemicals, ozone-depleting substances, and now greenhouse gases.

A key to the development of PLASCON was an intensive research and development program, which featured the collaboration of CSIRO with the Australian companies SRL Plasma and Nufarm. The problem of the interconversion of ozone-depleting substances highlighted above was one of many obstacles that had to be overcome in developing a reliable industrial process. For example, a high power plasma torch and power supply had to be developed, and component lifetimes had to be extended to the levels required for an industrial plant – not an easy task given the coincidence of high temperatures and aggressive substances such as chlorine, fluorine, hydrogen chloride and hydrogen fluoride. Further, the plasma is only part of any plasma waste treatment system – the waste has to be preprocessed before injection into the plasma, and the exhaust gases need to be treated. In solving all these problems, the collaboration of scientists and engineers from a range of disciplines (e.g., chemistry, physics, electrical engineering, chemical engineering, control engineering) and backgrounds (research, industry and project management) was critical.

PLASCON has long since completed the transition from R&D project to industrial process; CSIRO's last research involvement was in 2000, and its share of ownership was sold to SRL Plasma in 2006. Nevertheless, it remains an outstanding example of how physicists can assist in developing successful industrial processes.

Acknowledgements
There were many other contributors to the development of the PLASCON waste treatment process, including Laurie Besley, Austin Dayal, Rowan Deam, Corinna Horrigan, Trevor Kearney, Alan Munday, Rama Ramakrishnan, Bob Western and Paul Zemancheff of CSIRO, and Jeff Dibley, Geoff Frost, Robert Hawkes, Martin Krynen and Maurice Lane of SRL Plasma.

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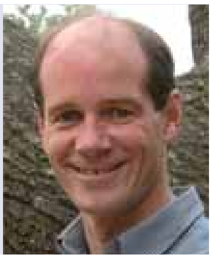
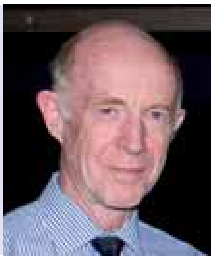
Dr Tony Murphy is a Chief Research Scientist with CSIRO Materials Science & Engineering, where he works mainly on thermal plasmas and their applications. As well as the 2008 Walsh Medal, he was awarded the 2000 Pawsey Medal by the Australian Academy of Science.

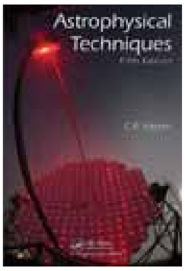


Dr Tony Farmer's research interests have included spectroscopy, plasma physics, sub-surface radar, sensing systems, intelligent sensor networks and high-power ultrasound technology. He is currently Deputy Chief of CSIRO Materials Science & Engineering.

Dr Trevor McAllister was with CSIRO from 1968 to 2000. He is now retired. He is a Fellow of the Royal Australian Chemical Institute.



Reviews



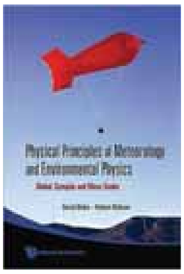
Astrophysical Techniques (5th Ed)
C.R. Kitchin
CRC Press
xxii& 564pp., $69.95USD (hardbound)
ISBN: 978-1-42000-8243-2

This venerable book has been going now since 1984, a period that has seen the near-extinction of photographic astronomy, the launch of the great space observatories, and the development of adaptive optics – to name only the most obvious changes in the sub-field of optical and near infrared astronomy. The book has evolved too, with (for example) 28 pages given to neutrino astronomy, gravitational wave astronomy, and the detection of dark matter and dark energy, and its treatment of the subject is still well rooted in older techniques such as optical spectroscopy, photometry and indeed photographic imaging (18 pages, beating CCDs – 13 pages). Radio astronomy gets 22 pages, about as much as the (regrettably) almost vanished art of polarimetry.

Another change is the rise to complete dominance of the common-user model, where astronomers are almost totally shielded from the complexity of the instruments they use, and increasingly do not even visit the telescope to obtain their data. Someone else builds the instrument, debugs it, calibrates it, and sends you a data file with the "instrument removed."

This book is strong in the traditional areas, such as spectroscopy, making it a good basis for part of a graduate course in instrumentation. In the more modern areas, the lack of detailed referencing means that it is a hard to use the book as an entry point to the current literature; which is what a professional needs in those cases where the instrument was not quite removed. For a whistle-stop tour of instrumentation, as part of an undergraduate astronomy course it would certainly be a very useful source. It would have to supplemented to give a realistic impression of the breadth of modern astronomical technology.

Charles Jenkins
CSIRO



Physical Principles of Meteorology and Environmental Physics
Global, Synoptic and Micro Scales
David Blake and Robert Robson
ISBN: 9812813848

This book comprises two parts: Theoretical Foundations derives from a course of about 40 lectures given at the senior undergraduate level, while Experiments in the Tropical Boundary Layer is based on work done as part of a PhD research project.

The content of the first part provides a very good introduction to the science of meteorology for undergraduate students with appropriate knowledge of dynamics and thermodynamics, and calculus and vector analysis. Topics are introduced in a logical manner with the reader being constantly challenged to perform intermediate mathematical derivations of main results. The scientific background to the various topics is presented and developed to highlight the difficulties associated with the analysis and modelling of the state of a continuum such as the atmosphere.

The second part of the book describes some practical problems associated with a particular experiment. A good, matter-of-fact description of the instrumentation and site conditions is provided, with shortcomings highlighted. Theories are then described and the main results presented in graphical form with accompanying description. This part closes with a summary of the issues encountered and suggestions of where effort is needed for further understanding of the problems.

The two parts of the book are written in two very different styles. As part one is based on a set of lectures there is often limited description of the theory being developed and most readers would need assistance to comprehend the content completely, either by reading some of the recommended texts in the bibliography, or having some topics elaborated by an expert in the field. In the second part there is much attention to some detail, so much so that the general reader is advised by the authors that they may wish to skip the chapter "Experimental Methods". In spite of this, this reader found some of the interpretation of results somewhat limited with some conclusions not as obvious as stated.

It has to be said that the edition supplied for this review had a significant number of typographic errors and editorial shortcomings. A revised edition is seen as necessary.

The book is good for stimulating interest in readers sufficiently prepared in physics and mathematics and would be a worthwhile addition to any library of physics monographs.

Russell Jaycock
Lecturer in Physics, James Cook University (1993-2006)
Meteorologist, Bureau of Meteorology (1977-1995)

Tony Collings
28/7/1937 – 11/1/2010

It is with great sadness that we report the death of Dr A. F. (Tony) Collings, following a two-year battle with bowel cancer. Tony had a distinguished 38-year career as a research scientist at CSIRO Materials Science & Engineering, Lindfield, NSW.

His scientific interests were diverse, but they generally spanned areas of rheology and the physics of liquids, biophysics (including sports science) and ultrasonics. Active until his last days, his most recent work has been in high power ultrasonics and its application in applied sonochemistry, with a particular focus on the remediation of contaminated soils. He was also a prominent sportsman and University sports administrator at local, national and international levels.

As both a friend and a scientist, Tony's wide-ranging knowledge, no-nonsense approach to science and life in general and his ever-present sense of humour will be sadly missed by his colleagues throughout Australia and worldwide. A fuller obituary will be published in Australian Physics in the near future.

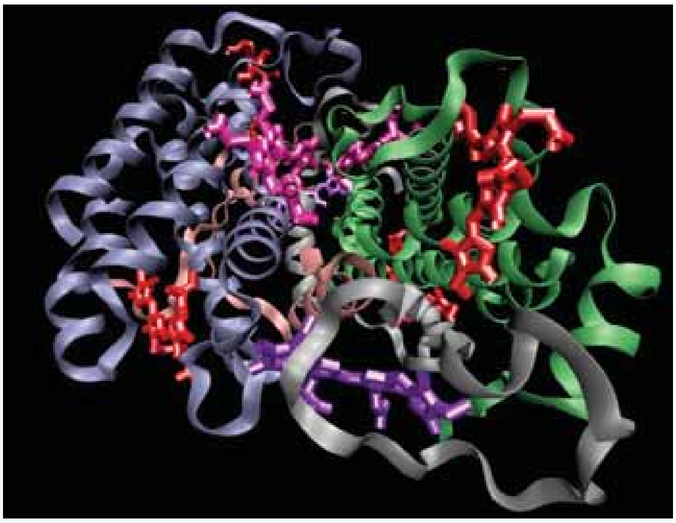
Don Price

Samplings

Quantum mechanics boosts photosynthesis (good image)
http://physicsworld.com/cws/article/news/41632
http://www.nature.com/nature/journal/v463/n7281/full/nature08811.html
Physicists in Canada and Australia (Krystyna Wilk and Paul Curmi of UNSW) have shown that nature exploits quantum mechanics to make photosynthesis more efficient. By probing light-harvesting proteins within algae using laser beams, the researchers found that quantum coherence links molecules within these proteins.

One of the most intriguing and most studied features of photosynthesis is the exquisite efficiency with which energy can be transferred within photosynthetic complexes. This new spectroscopic study confirms earlier hints that quantum effects might be at play, by directly revealing quantum-coherent sharing of electronic excitation across 5-nm-wide photosynthetic proteins from Chroomonas CCMP270 marine algae at room temperature. The observation suggests that distant units within the proteins are 'wired' together by quantum-coherence to enhance light-harvesting efficiency.

See also: *http://www.nature.com/nature/journal/v463/n7281/full/463614a.html*

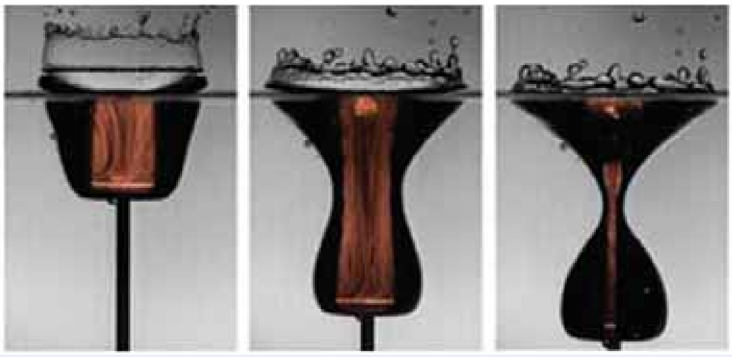


Atomic resolution structural model (from X-ray crystallography) of one the proteins from the study, the phycocyanin PC645 isolated from the cyptophyte alga Chroomonas CCMP270. Electronic interactions among the light-harvesting molecules within the protein scaffold cause light to be captured and manipulated in quantum-coherent states.

Splashing stones drive supersonic flow
http://physicsworld.com/cws/article/news/41496
There is something satisfying about the plonk and splash of a stone falling through the smooth surface of a pond. But now this seemingly ordinary, albeit pleasing, phenomenon appears to be anything but mundane. A sinking stone, it turns out, can create a supersonic jet of air.

When a stone plunges into water, a cylindrical sheet of water called the "crown splash" is sent up into the air. As the stone begins to sink, it pulls a cylindrical cavity of air down with it. The surrounding water then pinches middle of the cavity to create an hourglass shape. The cavity begins to collapse and the upward rush of air causes the spectacular finale – a jet of water that shoots high up above the surface of the pond.

Stephan Gekle and colleagues at the University of Twente in the Netherlands and the University of Seville in Spain (Phys. Rev. Lett. 104, 024501; 2010) have now shown that this final rush of air moves faster than the speed of sound.
See also: *http://www.nature.com/nature/journal/v463/n7280/full/463439b.html*



Series of photographs show the development of a de Laval nozzle as a disc is pulled below the surface: the diameter of the nozzle will continue to shrink. (Courtesy: American Physical Society)

Spider web inspires fibres for industry
http://physicsworld.com/cws/article/news/41622
http://www.nature.com/nature/journal/v463/n7281/full/nature08729.html
Spiders may not be everybody's idea of natural beauty, but nobody can deny the artistry in the webs that they spin, especially when decorated with water baubles in the morning dew. Inspired by this spectacle, a group of researchers in China has mimicked the structural properties of spider webs in creating a fibre for industry that can manipulate water with the same skill and efficiency.

Lei Jiang of the Chinese Academy of Sciences set out with his colleagues to look at the fine detail of spider webs and the way that the silks interact with moisture in the atmosphere. They found that the water-collecting ability of Uloborus walckenaerius – a common, non-venomous spider – is the result of a network of knots that form in the web when it gets wet. Individual knots begin to form when tiny water droplets condense at certain sites or "puffs" in the spider silk. Using Scanning Electron Microscopy (SEM), the researchers found that at these sites, known as "puffs", the nanofibrils that comprise the silk are no longer aligned but point in random directions.

Dotted periodically throughout the web, these structural features create gradients of energy and pressure between knots. The result is a sort of cascade whereby moisture condenses from the atmosphere and is then channelled towards these spindle knots. As a result, drops of water as big as 100 μm in diameter can form.

See also: *http://www.nature.com/nature/journal/v463/n7281/full/463618a.html*
Samplings by Don Price

Product News

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Hiden

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Hiden Analytical introduce their Transient MS system specifically designed for the analysis of fast transient gas events at pressures near atmosphere.

The compact benchtop system is founded on the Hiden HPR-20 QIC series gas analysers and features a purpose-designed fast response capillary inlet and the HAL/3F PIC mass spectrometer with pulse ion counting detector. The combination enables inlet system response times of less the 150 msec with measurement speeds of up to 500 data points per second over an entire 7 decade dynamic range. The system monitors species with molecular weights to 300 amu, with higher mass ranges available for specialist applications.

The MASsoft control and data acquisition program provides ease of operation with integral calibration routines together with user-programmable template files for automatic operation of routine analyses. Multiple I/O's permit integration of external parameters such as temperature or flow rates, and control of external equipment with species-specific pressure level sensors. Application areas include pulsed gas experiments for catalyst characterisation, surface reaction and reduction studies, respiratory analysis and, with high-speed rotating multiport valve, spacial gas distribution measurement as demonstrated in the award-winning (R&D 100 Awards) Hiden Spaci-MS system.

For information on this or other Hiden products contact:
Hiden Analytical
info@hiden.co.uk
www.HidenAnalytical.com

Product News continued over page...

SciTech

iXonEM Blue EMCCD Camera

iXonEM Blue EMCCD camera is the latest addition to Andor's award-winning performance EMCCD range, offering > 20% extra response in the blue. It represents the new benchmark for ultrasensitive imaging of blue photons. Compared to the 'standard' back-illuminated EMCCD, iXonEM Blue offers enhanced QE between 300nm to 470nm.

Until now, back-illuminated EMCCD cameras have been available only with a 'mid-band' anti-reflection coating, resulting in a Quantum Efficiency curve optimized for the green/red wavelength range. However, some applications specifically require superior sensitivity performance in a region below 450nm for which iXonEM Blue is specifically optimized.

Whether probing ultracool calcium ions or imaging blue emitting fluorophores under reduced phototoxicity, iXonEM Blue provides a valuable sensitivity boost. This blue-enhanced single photon sensitive camera will be put to good use across a number of specific applications, including ultra-cold ion imaging, luminescence detection and calcium signalling.

High Speed Camera System

SciTech is proud to announce the new pco.dimax, 4-megapixel digital high speed CMOS camera system with a 12-bit dynamic range. It provides 2012 x 2012- pixel resolution at a rate of 1100 fps with lower resolutions at rates as fast as 56,300 fps. The 31.4-mm-diagonal CMOS image sensor features 11 micron pixels and a quantum efficiency greater than 44%. The camera is available in colour and monochrome.

High Speed Camera System

The system features a variety of trigger options to cover all offboard applications that have been required by the automotive industry. The image data are transferred via GigE Vision or USB2.0 interfaces and there is a 32GB imaging memory.

For preview purposes a DVI interface is integrated. The pco.dimax has a smart battery control, which allows a full operation for 1 h and a data backup for 6 h. This digital CMOS camera system is perfectly suited for high speed camera applications such as material testing, offboard crash or impact tests or super slow motion movie clips.

12 bit ultra speed intensified imaging

Having a single optical input, this ultra speed camera system comprises an image splitter unit, four intensified CCD camera modules with fast switchable MCP image intensifiers and high resolution CCD image sensors. Each module with its 12 bit dynamic range and a high resolution CCD image sensor (SVGA) features an excellent signal-to-noise-ratio and the ability of single photon detection.

Four high speed serial fiber optic data links connect the system to the PC. It can be triggered externally by light or electrical input. This ultra high speed camera system is perfectly suited for the imaging of extremely fast events, like hypervelocity impacts, short time physics, ballistics or combustion imaging.

Contact: SciTech Pty Ltd
Melb: (03) 9480 4999
Syd: (02) 9705 8059

E: *sales@scitech.com.au*
W: *www.scitech.com.au*

Coherent

Verdi G-Series

Verdi is a family of compact solid-state CW lasers with output powers up to 18W at 532nm and up to 25W at 1064nm. With more than 5,000 units installed worldwide, Verdi has earned its reputation as the benchmark for performance and reliability.

The new Verdi G-Series of optically pumped semiconductor lasers (OPSL's) is available in 2W and 5W models at 532nm, offering improved optical noise, excellent beam quality and smaller footprint at a lower cost than previous 2W and 5W Verdi models.

For more information contact Paul Wardill *paul.wardill@coherent.com.au* or Gerri Stewart *gerri.stewart@coherent.com.au*.

CCD and EMCCD sensitivity redefined

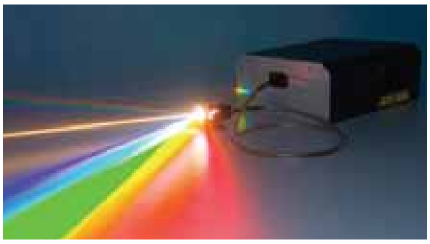
Princeton Instruments have introduced the new eXcelon technology to their range of CCD and EMCCD cameras. eXcelon provides the extremely high sensitivity of a back-illuminated CCD without the associated etalon effect which can cause problems for many applications.

The absence of etaloning is achieved without sacrificing noise performance, giving eXcelon-enabled cameras an advantage over traditional alternatives such as deep-depletion CCDs. eXcelon technology is available on Princeton's Pixis and ProEM range of cameras and is exclusive to Princeton Instruments.

For more information contact Paul Wardill *paul.wardill@coherent.com.au*.

Ultrafast fibre lasers and supercontinuum sources

Coherent Scientific now offers a range of compact, high-power ultrafast fibre



Ultrafast fibre lasers and supercontinuum sources

lasers from Fianium. These lasers are based on Master Oscillator, Power Amplifier (MOPA) configurations, providing picosecond or femtosecond pulses with high average power (>20W) and high energy (μJ) at 1064nm, 355nm or 266nm. These lasers are also integrated into Fianium's ultra-broadband supercontinuum sources, which provide high spectral brightness over the range 400nm to 2μm. An optional acousto-optic tunable filter allows the user to select up to 8 wavelengths simultaneously from the supercontinuum output. Applications include materials processing, fluorescence imaging and spectroscopy.

For more information please contact Paul Wardill *paul.wardill@coherent.com.au* or Gerri Stewart *gerri.stewart@coherent.com.au*.

New Ultrafast Laser Systems Catalogue

Coherent Inc has released a new 76-page catalogue covering their complete range of Ultrafast laser products, including oscillators, amplifiers, pump lasers, OPA's and OPO's and accessories.

The catalogue describes the most complete range of ultrafast laser products, with pulsewidths down to 15fs and pulse energies up to 100mJ.

Contact us (*sales@coherent.com.au*) to request a copy.

Coherent Scientific
116 Sir Donald Bradman Drive
Hilton SA 5033
Ph: (08) 8150 5200
Fax: (08) 8352 2020
sales@coherent.com.au
www.coherent.com.au

Warsash

Lightweight Benchtop Vibration Isolation

Warsash Scientific is pleased to announce a new lightweight benchtop vibration isolation system from Kinetic Systems, Inc. Specifically designed for portability, the ELpF can be easily repositioned on the benchtop, even with a load and in float. Its unique, self-contained design provides this without causing damage to the vibration isolators.

An economical alternative to heavyweight models, the Ergonomic Low-Profile-Format platform provides vibration isolation for sensitive devices. It features a load capacity of 100 or 300 lbs. in a lightweight, ergonomic system.

The platform has a low profile (only 3" high), uses a small tabletop (16" x 19" standard), and weighs 40 lbs., making it very portable. Ergonomic features include gauges tilted upward for easier viewing and recessed handles for easy carrying.

Designed for use in laboratories and Class 100 cleanrooms, the ELpF platform is ideal for supporting atomic force microscopes, microhardness testers, analytical balances, profilometers, and audio equipment.

Self-leveling and active-air isolation give the platform low natural frequencies (1.75 Hz vertical, 2.0 Hz horizontal) and typical isolation efficiencies of 95% (vertical) and 92% (horizontal) at 10 Hz.

Other tabletop sizes can be customized per specifications. The top, which can be ordered with or without mounting holes, can be aluminum plate, ferromagnetic stainless steel, plastic laminate, or anti-static laminate.

For more details on this or other vibration isolation equipment, contact *sales@warsash.com.au*

Real-Time Operating System for Systems Integration

PI (Physik Instrumente), the leading manufacturer of piezoceramic drives and positioning systems, offers a real-time module as an upgrade option for the host PC and also the connection of the GCS (PI General Command Set) software drivers. The module is based on Knoppix-Linux in conjunction with a pre-configured Linux real-time extension (RTAI).

The use of real-time operating systems on the host PC allows it to communicate with other system components, e.g. a vision system, without time delays with discrete temporal behavior and high system clock rate.

Real-Time Operating System for Systems Integration by Physik Instrumente

A library which is 100% compatible with all other PI GCS libraries is used for the communication with the real-time system. All PI GCS host software available for Linux can be run on this system.

The real-time system running in the real-time kernel can be used to integrate PI interfaces and additional data acquisition boards for control. Open functions to enable you to implement your own control algorithms are provided. Data, such as positions and voltages, is recorded in real time, and pre-defined tables, with positions, for example, are output in real time to the PI interface and to additional data acquisition boards.

You can program your own real-time functions in C/C++, MATLAB/SIMULINK and SCILAB.

The system includes a PI GCS server, which allows the system to be operated as a blackbox using TCP/IP, via a Windows computer, for example.

Product News continued over page...

The system can be installed on a PC or booted directly as a live version from the data carrier. A free demo version with restricted functionality is available.

For more information on the real time operating software or other PI positioning equipment, contact *sales@warsash.com.au*

E-618: 3.2 kW Peak Power for New Piezo Amplifier

Available from Warsash Scientific is the new PI (Physik Instrumente) E-618 high power amplifier for ultra-high dynamics operation of PICMA® piezo actuators.

The amplifier can output and sink a peak current of 20A in the voltage range between -30 and +130V. The high bandwidth of over 15kHz makes it possible to exploit the dynamics of the PICMA® actuators. This type of performance is required in active vibration cancellation and fast valve actuation applications.

The E-618 also comes with a temperature sensor input to shut down the amplifier if the maximum allowed temperature of the piezo ceramics has been exceeded. This is a valuable safety feature given the extremely high power output.

The E-618 is available in several open-loop and closed-loop versions with analogue and digital interfaces.

For more information on these and the range of other PI products, contact *sales@warsash.com.au*

Warsash Scientific Pty Ltd
Tel: +61 2 9319 0122
Fax: +61 2 9318 2192
www.warsash.com.au

New Sensors Improve Precision of S-340 Tip/Tilt Mirror

Warsash Scientific is pleased to announce the release of the new S-340 piezo tip/tilt mirror platform from PI (Physik Instrumente), equipped with new high-resolution strain gauge sensors.

The S-340 now achieves a resolution of 20nrad at angles of 2mrad about both orthogonal axes.

This large mirror platform is used for optics with diameters of up to 100 mm (4 inches) and achieves a resonant frequency of 900Hz for a mirror of 50 mm diameter.

The S-340 can be operated by the new, low-cost E-616 controller. Together, they form a compact, high-performance solution for beam control and image stabilization as employed in astronomy, laser machining or optical metrology, for example.

For more information on the S-340 Tip/Tilt Mirror platform or other Positioning equipment from PI, contact *sales@warsash.com.au*

Warsash Scientific Pty Ltd
Tel: +61 2 9319 0122
Fax: +61 2 9318 2192
sales@warsash.com.au
www.warsash.com.au

New Sensors Improve Precision of S-340 Tip/Tilt Mirror

Conferences 2010

June 8 - 11
Recent Developments in Gravity
Ioannina, Greece
http://neb14.physics.uoi.gr/

June 14 - 16
Heat Transfer 2010
Tallinn, Estonia
http://www.wessex.ac.uk/10-conferences/heat-transfer-2010.html

June 24 - 26
International Symposium on Photonics and Optoelectronics (SOPO 2010)
Chengdu, China
http://www.scirp.org/conf/sopo2010/

June 27 - July 2
SPIE Astronomical Telescopes and Instrumentation 2010
San Diego, USA
http://spie.org/astronomical-instrumentation.xml?WT.mc_id=RCAL-AS

July 4 - 10
18th International Conference on Composites or Nano Engineering
Anchorage, Alaska USA
http://www.uno.edu/~engr/composite

July 5 - July 8
Astronomical Society of Australia Annual Science Meeting
Hobart, Tasmania
http://www-ra.phys.utas.edu.au/ASA2010

July 11 - 16
9th International Conference on Excitonic and Photonic Processes in Condensed and Nano Materials (EXCON'10)
Brisbane, Queensland
http://www.cdu.edu.au/excon10/

July 12 - 16
The 7th Vigier Symposium: The Search for Fundamental Theory
London, UK
http://www.mindspring.com/~quantum.computing/index7.html

July 19 - 23
10th International Conference on Quantum Communication, Measurement and Computing
Brisbane, Queensland
http://qcmc2010.org

July 19 - 23
STATPHYS 24: The XXIV International Conference on Statistical Physics of IUPAP
Cairns, Queensland
http://www.statphys.org.au/

July 25 - 30
22nd Int. Conference on Atomic Physics CAP2010
Cairns, Queensland
http://www.swin.edu.au/icap2010/

July 28 - 31
3rd Conference on Nonlinear Science and Complexity
Ankara, Turkey
http://nsc10.cankaya.edu.tr/

August 2 - 10
Quo Vadis Bose-Einstein-Condensation?
Dresden, Germany
http://www.mpipks-dresden.mpg. de/pages/veranstaltungen/frames_veranst_en.html

August 23 - 27
20th International Congress on Acoustics (ICA 2010)
Sydney, New South Wales
http://www.ica2010sydney.org/

August 30 - September 3
9th Quark Confinement and Hadron Spectrum
Madrid, Spain
http://teorica.fis.ucm.es/Confinement9

September 13 - 18
4th International Congress on Advanced Electromagnetic Materials in Microwaves and Optics
Karlsruhe, Germany
http://congress2010.metamorphose-vi.org/

November 10 - 12
International Conference on Earth and Space Sciences and Engineering (ICESSE 2010)
Sydney, NSW
http://www.waset.org/conferences/2010/sydney/icesse/index.php

November 14 - 18
55th Conference on Magnetism and Magnetic Materials
Atlanta, USA
http://www.magnetism.org

December 6 - 10
2010 AIP Congress
Melbourne, Vic
http://www.aip2010.org.au/

December 13 - 16
International Conference on Nano materials and Nanotechnology (NANO 2010)
Nammakkal, India
http://ksrct.ac.in

December 16 - 17
ICSTIE 2010 - 3rd International Conference on Science & Technology : Applications in Industry and Education
Penang Malaysia
http://www.icstie.com

June 28 - July **2011**
IUGG Earth on the Edge: Science for a Sustainable Planet
Melbourne, Australia
http://www.iugg2011.com