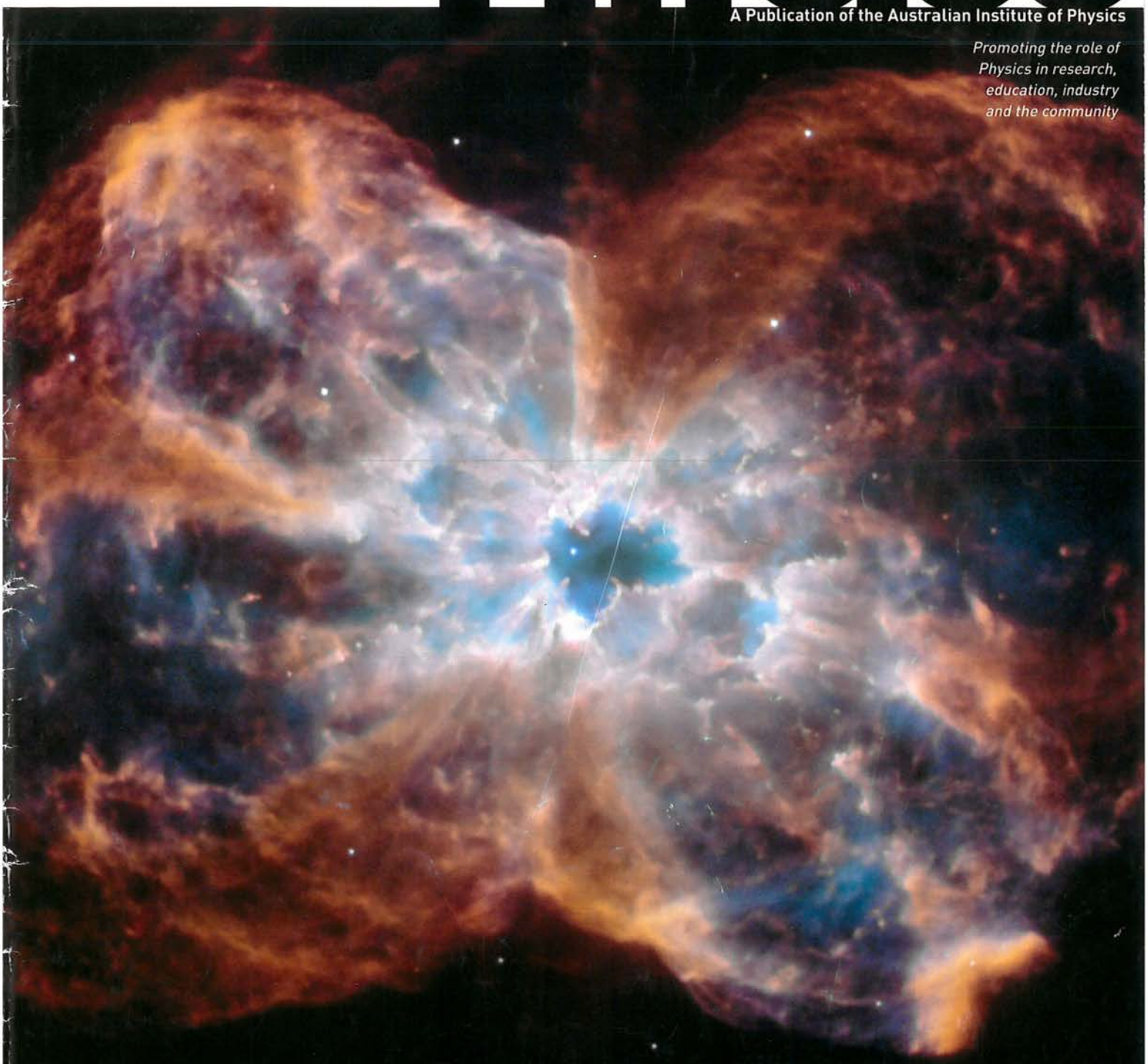
Australian PHYSICS

February/March 2007 Volume 43 Number6

A Publication of the Australian Institute of Physics

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



Superconductor electronics at CSIRO

Interview - Cathy Foley

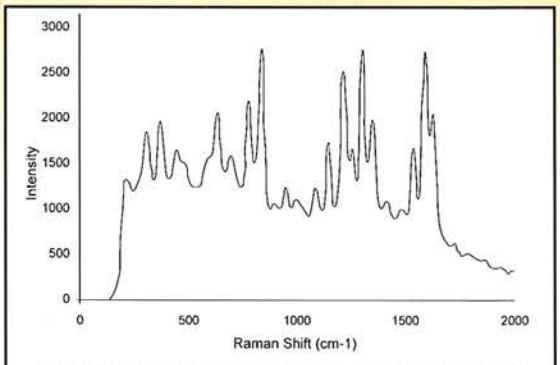
SF Competition winner

Detect up to 90% of the Photons in your Low-light Level Applications!

Ocean Optics Inc.
Fastest Photonics
www.oceanoptics.com

All-new QE65000 Spectrometer achieves up to 90% quantum efficiency

- Perfect for low-light level applications such as Raman spectroscopy, fluorescence, DNA sequencing and astronomy
- Back-thinned detector provides exceptional response in the UV; covers 200-1100 nm wavelength range
- Detector's columns are binned inside the detector prior to the readout process, minimizing readout noise and increasing S:N
- Detector can be cooled to -10.0 °C to reduce dark noise
- Integration times of up to 10 minutes for low-level fluorescence detection
- 10 user-programmable digital I/O lines for interfacing the QE65000 to other equipment
- Pulse generator for external device triggering
- Fast USB 2.0 interface



We used the QE65000, a 785nm laser and a Raman probe to acquire a Raman spectrum for acetaminophen tablets

LAS TEK

Lastek Pty Ltd
Thebarton Campus, University of Adelaide,
10 Reid Street, Thebarton SA 5031 Australia
Ph (08) 8443 8668 Fax (08) 8443 8427
Email: sales@lastek.com.au Lastek website: www.lastek.com.au

LTWAM4376

Celebrating 50,000 Spectrometers Sold!

LumaSense Technologies

formerly LUXTRON

Advanced Materials Process Applications

Photrix® High Speed Optical Pyrometer

- RTP, CVD (PECVD, MOCVD), MBE,
- Crystal growth
- Optical Fibre production
- Vacuum Chamber Temperature Monitoring & Furnace Control

- High Resolution
- Up to 1000-Hz Sampling
- Short Wavelength down to 25°C
- Silicon Down to 200°C

- Designed for Easy Integration
- Intelligent Software

Accufiber®TR Thin Film Deposition Monitor

Simultaneous Temperature & Reflectance (TR) for advanced material deposition processes such as MOCVD, MBE and high temp CVD.

The Accufiber®TR instrument fully integrates two sophisticated metrology functions with our class-leading radiation thermometer system:

- Automatic Real Time - Emissivity Corrected true Temperature measurements

- In-Situ Film Growth Monitoring via dual wavelength Reflectance measurements.

WARSASH Scientific
Advanced Instruments for Research & Industry

Sydney
PO Box 1685
Strawberry Hills
NSW 2012
Tel: (02) 9319 0122
Fax: (02) 9318 2192
sales@warsash.com.au
www.warsash.com.au

Australian Physics

A Publication of the Australian Institute of Physics

Contents

Volume 43 Number 6

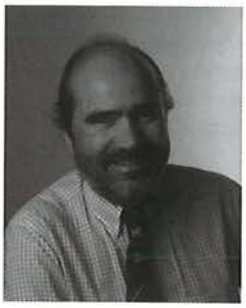
President's column	183
Editorial	184
Executive meeting summary	185
Samplings	186
Science fiction copetition winner - Love is	190
Conferences	192
Superconductivity at CSIRO	193
Press Room	202
News	203
Obituary	205
Product News	206
Interview	208
Reviews	210

Cover image: This image, taken by NASA's Hubble Space Telescope, shows the colorful "last hurrah" of a star like our Sun. The star is ending its life by casting off its outer layers of gas, which formed a cocoon around the star's remaining core. See Samplings for more detail.
Image credit: NASA/ESA

Published 6 times a year, on behalf of the Australian Institute of Physics by Cliff Lewis Cronulla Printing Co. Pty. Ltd.

ISSN 1036-3831

President's Column



The power at our disposal as individuals, both in Watts and knowledge, has given us unprecedented abilities and options in an increasingly complex society.

This column is mainly about anniversaries and the future.

But first, I am just back from 'Riverphys', the 2006 AIP Congress held in Brisbane. Birgit Lohman, Halina Rubenstein-Dunlop and their dedicated team are to be congratulated for their excellent organisation, informative invited speakers and innovative program. The nuclear energy panel discussion, with the audience participation via hundreds of electronic "clickers" issued to audience members, was a fabulous innovation and created a lively atmosphere! The Congress was attended by more than 650 delegates and attracted attention from the media.

Now to the anniversaries. This is the 102nd anniversary of Einstein's miraculous year (I am sure you are well aware of that) and the 176th anniversary of the birth of James Clerk Maxwell. Maxwell's work, more than anything else, brought the benefits of the industrial revolution into our homes. For without electricity, the industrial revolution brought immense benefits to the wealthy, but immense misery to the poor. With electricity, even the average person can live like a king - as we do. The issue of electricity, or rather how we generate it, is very much in the news at present. Hence the debate at the Congress.

Maxwell's work led to one of the most important inventions of the 20th century: television! Last year was the 50th anniversary of the advent of television in Australia. Just in time to "televise" the 1956 Olympic games from Melbourne. It is worth noting that one of the earliest justifications for television was its potential for educating the masses. Although TV has, in my view, not lived up to its educational potential, it has nevertheless become one of humanity's most popular entertainment activities with universal appeal that transcends race and culture. Bhutan[1] was the last country to be conquered when it introduced television in 1999. Never has a physical theory been of greater service to humanity. Are any emerging grand unified theories displaying the same potential?

This year is the 39th anniversary of the release of Stanley Kubrick and Arthur C. Clarke's revolutionary film: "2001 a space odyssey" which presented a really compelling vision of the 21st century. Now that we're in the 21st C, has this vision been realised? Where are the fusion-plasma-engine spaceships sending astronauts to the outer planets that should have been underway by 2001? Where are the HAL 9000 talking computers? The real computer revolution, despite its wonders, has been very disappointing in comparison. With the Research Quality Framework (RQF) looming, why can't I just speak to my real 21st C computer and say: "Hey computer, just grab my 4 best publications off the web, select them by the RQF criteria on the DEST website, roll them up with the other stuff like citations, impact statements and so on and put it all in the right format required by the research office and print it so I can check it out." Unfortunately this sort of capability is nowhere in sight.

Although he was wrong about 2001 talking computers, Arthur C. Clarke did clearly describe the world-wide-web in his 1974 novel "Imperial Earth" nearly twenty years ahead of time. Thanks to Tim Berners-Lee[2] and the needs of Physicists at CERN in 1991, we can now celebrate the sixteenth anniversary of the web. Remarkably there are now more than two thirds of a billion computers connected to the web in some way and this number is expanding at a frantic pace. It is expected to reach 1.3 billion by 2010[3].

Now I would like to consider the future. The power at our disposal as individuals, both in Watts and knowledge, has given us unprecedented abilities and options in an increasingly complex society. So complex that to realise our full potential - or at least the option of reaching our full potential, a realisation reserved only for the very rich in the pre-electricity society - we have to receive 12 years of compulsory formal education before we are allowed out in the world! We have to master the three 'R's at the very least: Reading, Writing and 'Rithmatic (Arithmetic). It is becoming clear that even 12 years is not enough and perhaps another 3 or more years of post secondary education is becoming the norm.

Maxwell's work, more than anything else, brought the benefits of the industrial revolution into our homes.

With the three 'R's now routine, we have raised our expectations. Our society is now increasingly driven by what I define to be the three 'E's: Education, Entertainment and 'Ealth (Health). Delivery of the three 'E's requires substantial and sophisticated infrastructure to say nothing of a highly skilled workforce. Consequently there are difficulties delivering the three 'E's outside the major cities. Our major hospitals, universities, opera houses, nightclub belts, casinos, mega sports arenas, international art galleries and high speed internet connections are all concentrated in our major cities. It is a great challenge to deliver high quality tertiary education, particularly Physics, in regional areas. But we must find a way of meeting that challenge.

Physics has always risen to challenges, and met the challenge driven revolutions in what we can do. The challenge of unifying electricity and magnetism was met by Maxwell and gave us the industrial revolution for the ordinary person. Physics now faces several more difficult challenges that may also deliver revolutions. Challenges for physics have been listed by various luminaries over the past few years. See for example Maddox[4], May[5], The National Research Council Committee on Physics of the

continued on page 185

Editorial

Change is one of the constants of our modern world and lifestyle. I've been editor of *Australian Physics* for a little over four years now and during that time the publication has undergone quite a few changes – its name and its design to mention the most visible ones. Your editor is also not immune to change.

About a year ago, my work circumstances changed considerably. This involved increased responsibilities and work hours. Over the year since, I've found it increasingly difficult to give this publication the time and mental energy that I think it deserves. I've also been unable to go to events such as the AIP Congress. Going to such events is important to keep a finger on the pulse of what is happening in physics in this country.

As a consequence, I've notified the Council of my desire to step down as editor as soon as possible, though I will remain as editor until other arrangements are made.

Consequently, this may or may not be my last editorial, so I'd just like to say that I've enjoyed my stint as editor - although not so much during some of the recent 3 a.m. sessions. There are a lot of people to thank – the Executive for its support, the authors who have contributed articles, the people who have sent me news and information from the physics community around Australia, the people who have read articles for me and, of course, all of you readers out there.

Enough of this maudlin stuff! I'd also like to apologise for the combination of technical difficulties and bad timing of events that has made this issue so late.

In this issue: Cathy Foley is the new President of the AIP. I've known Cathy for many years and took advantage of this to persuade her to give an interview to *Australian Physics*. Coincidently, there is also an article written by Cathy about superconducting electronics at CSIRO.

You may also remember that last year there was a notice about a science fiction short story competition, with the winner to be published in *Australian Physics*. You will find it in this issue. Sci-fi had a definite influence on may view of science when I was younger and it's still one of my favourite fiction genres. This one isn't a 'physics' story, but I enjoyed it and I hope that you will as well.

You may also notice that the President's column was written by Prof. David Jamieson – who is now the Immediate Past President. That's what happens when an issue is significantly delayed.

Corinna Horrigan

Deadline for next issue: 10th April 2007

Submission guidelines

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

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

AIP news

Summary of Executive Meeting E266 held Friday 1st February 2007

DSTO Scholarships:

The winners of the 2006 DSTO scholarships were confirmed as Tom Griffin (University of Sydney) and Paul Altin (Australian National University). These students will be invited to attend the AGM to receive their awards. It was noted that the previous year's scholarship winners had obtained excellent results in their honours courses.

AIP Awards:

Advertisements for the Bragg and Boas medals will be published in Australian Physics. Branches should go through the normal procedure for the Bragg medal nominations and all AIP members are asked to consider making nominations for the Boas medal.

International Year of Astronomy:

The International year of Astronomy is scheduled for 2009. The Astronomical Society of Australia has asked for support from the AIP for the organization of the year, particularly following the successful staging of the Einstein International Year of Physics. It was resolved that the AIP would cooperate with the ASA for this event.

Carrick Institute:

The Carrick Institute supports research into physics education. The Institute has sought support from the AIP. It was resolved that the AIP would provide travel grants to members, within an allocated budget, and within specified guidelines.

Physics for the Future:

Hans Bachor, of the ANU is working on the development of a "Physics for the Future" program aimed at high school students, and is seeking support for this work. Details of the proposal need to be refined, and when this has been done, the AIP will consider what support can be offered.

Council Meeting:

Plans were made for the AIP Council meeting, scheduled for February 19/20.

Web Site:

The Tasmanian Branch has advised that the University of Tasmania will no longer host the branch web site. The AIP will look into setting up the hosting of a web site that can be made available to the Tasmanian branch, and perhaps to other branches as well. A common hosting will be investigated, one possible outcome being to have web sites more uniform across the States.

Ian Bailey,

Hon secretary.

President's column

continued from page 183

Universe[6,7], 2004 Noble laureate David Gross[8] and Science magazine[9]. It is a little depressing that none of these future challenges appear to be of interest to our parliamentarians. At the recent "Science meets parliament" our parliamentarians all asked questions on applied science. There was not a single question on the Higgs boson, the significance of string theory or when will quantum mechanics and general relativity ever be unified! I eagerly look forward to these and the other challenges being addressed in my lifetime.

Finally, this is the second anniversary of my term as President of the AIP. So this will be my last column and will be handing over to Cathy Foley in at the February 2007 AIP Council meeting. I would like to thank everyone who has made my presidential term enjoyable, especially the branch committees that were very hospitable when I visited, my fellow members of the Executive and members of the AIP in general.

My best wishes for the future.

Prof. David Jamieson

[1] http://www.onlineopinion.com.au/view.asp?article=5036
[2] http://en.wikipedia.org/wiki/Tim_Berners_Lee
[3] http://news.bbc.co.uk/2/hi/technology/4095737.stm
[4] Book in 1999: "What remains to be discovered: Mapping the secrets of the universe, origins of life and the future of the human race"
[5] BBC program in 2003: http://www.bbc.co.uk/radio4/science/whatremains.shtml
[6] Report from 2002: http://newton.nap.edu/catalog/10079.html#top
[7] Ibid: http://darwin.nap.edu/html/quarks/q2csummaryc1.pdf
[8] http://qd.typepad.com/24/2005/01/the_future_of_p.html
[9] http://www.sciencemag.org/sciext/125th/

AIP QLD Branch

Chair: Dr. Brad Carter
Department of Physics,
University of Southern Queensland

Secretary: Mr Mark Young
7 Highview Drive
Cleveland, Queensland 4163
Tel: 0410 821 129
aipqld@physics.uq.edu.au

AIP SA Branch

Chair: Dr. Jamie Quinton
School of Chemistry, Physics & Earth Sci.,
Flinders University,
G. P. O. Box 2100
Adelaide SA 5001
Tel: 08 8201 3994 Fax: 08 8201 2905
jamie.quinton@flinders.edu.au

Secretary:
Dr Laurence Campbell
School of Chemistry, Physics & Earth Sci.,
Flinders University of South Australia
G. P. O. Box 2100
Adelaide 5001
Tel: 08 8201 2093 Fax: 08 8201 2905
laurence.campbell@flinders.edu.au

AIP TAS Branch

Chair: Dr John Humble,
University of Tasmania
Private Bag 21
Hobart 7001
Tel: 03 6226 2867 Fax: 03 6226 2867
John.Humble@utas.edu.au

Secretary:
Dr Elizabeth Chelkowska
Mathematics&Physics,
University of Tasmania
GPO Box 252-21,
Hobart 7001
Tel: 03 6226 2725 Fax: 03 6226 2867
Elzbieta.Chelkowska@utas.edu.au

AIP VIC Branch

Chair: Dr Andrew Peele,
QEII Research Fellow,
Department of Physics
LaTrobe University
Bundoora VIC 3086
Tel: 03 9479 2651 Fax: 03 9479 1552
a.peele@latrobe.edu.au

Secretary: Dr. Alex Merchant
Applied Physics,
RMIT University
GPO Box 2476V,
Melbourne VIC 3001
Tel: 03 9925 3388 Fax: 03 9925 5290
alex.merchant@rmit.edu.au

AIP WA Branch

Chair: Prof. Ian McArthur,
Department of Physics
University of W. A.
Stirling Highway,
Nedlands WA 6009
Tel: 08 6488 2737 Fax: 08 6488 1014
mcarthur@physics.uwa.edu.au

Secretary: Mrs. Katrina Lyon
School of Mathematical & Physical Sci.
Murdoch University
South St., Murdoch 6150
Tel: 08 9360 2865 Fax: 08 9360 6183
k.lyon@murdoch.edu.au

Samplings

People

Wolf Foundation Prize for Physics

The 2006/7 Wolf Foundation Prize for Physics has been jointly awarded to Albert Fert (Unité Mixte de Physique CNRS-Thalès Orsay, France) and Peter Gruenberg (Institut fuer Festkoerperforschung, Germany) for their independent discovery of the giant magnetoresistance phenomenon (GMR), thereby launching a new field of research and applications known as spintronics, which utilizes the spin of the electron to store and transport information.

Wolf Foundation

Short Notes

Supersolid's existence remains in dispute

The existence of a new state of matter called a "supersolid" has been called into question by the reports of two groups with apparently conflicting results. Physicists from Cornell University in NY, USA claim to have reproduced previous findings of a supersolid transition in helium below 250 mK (*Phys. Rev. Lett.* 97 165301). On the other hand, a group from Helsinki University of Technology in Finland has found no transition when helium is cooled down to 10 mK (*Phys. Rev. Lett.* 97 165302).

PhysicsWeb

IPCC adopts major assessment of climate change science

Working Group I of the Intergovernmental Panel on Climate Change (IPCC) adopted the Summary for Policymakers of the first volume of "Climate Change 2007", also known as the Fourth Assessment Report (AR4).

"Climate Change 2007: The Physical Science Basis", assesses the current scientific knowledge of the natural and human drivers of climate change, observed changes in climate, the ability of science to attribute changes to different causes, and projections for future climate change.

The report was produced by some 600 authors from 40 countries. Over 620 expert reviewers and a large number of government reviewers also participated. Representatives from 113 governments reviewed and revised the Summary line-by-line during the course of this week before adopting it and accepting the underlying report.

IPCC media release

Bubbles compute in logical devices

Logic gates that use tiny bubbles moving in a fluid have been created by Manu Prakash and Neil Gershenfeld of the Massachusetts Institute of Technology in the US. The two gates, which perform different logical functions, could be combined to perform any computation currently done by a conventional computer, says Prakash. The researchers have also used bubble logic to create a one-bit memory for storing information and therefore have all the components necessary to build a "bubble computer" (*Science* 315 832).

PhyscisWeb

Diamond light source ready for business

The biggest scientific facility to have been built in the UK for over 30 years is finally ready for use. The Diamond Light Source -- a "third-generation" synchrotron near Oxford -- has cost £250m to build and will provide researchers with monochromatic beams of light from microwaves to X-rays. The first scientists to use the facility are arriving this week.

Light from Diamond is emitted by electrons as they are steered around a ring with a circumference of 560 metres by powerful electromagnets. The lab's beams are 100,000 times brighter than those from the Synchrotron Radiation Source in Daresbury in the north-west of England – the "second-generation" facility that it replaces. This is possible thanks to devices called "undulators" that are inserted into straight sections of the ring, which make the electrons wiggle about their otherwise straight trajectory.

PhyscisWeb

Multibillion-dollar collider plans unveiled

At a meeting in Beijing, particle physicists released an outline design for the proposed International Linear Collider (ILC). The design details the components needed to build the 31 km-long facility and comes with an initial estimate of the collider's cost: a cool $6.5bn for the core project. Researchers see the ILC as the next big facility after the Large Hadron Collider, which is due to switch on at CERN later this year.

PhysicsWeb

Novel Atom Refining Boosts Entanglement of Atom Pairs

Physicists at the National Institute of Standards and Technology (NIST) have demonstrated a method for "refining" entangled atom pairs (a process called purification) so they can be more useful in quantum computers and communications systems. The advance is a significant step toward transforming quantum entanglement—an atomic-scale phenomenon described by Albert Einstein as "spooky action at a distance"—into a practical tool for applications such as "unbreakable" data encryption.

The NIST work, reported in the Oct. 19, 2006, issue of *Nature*, marks the first time atoms have been both entangled and subsequently purified; previously, this process had been carried out only with entangled photons (particles of light). This also is the first time that scientists have been able to purify particles non-destructively. Since direct measurement destroys the entangled state under quantum rules, the experiment avoids this by entangling two pairs of atoms and measuring only one pair.

NIST media release

UC San Diego physicists observe new property of matter

Physicists at UC San Diego have observed the spontaneous production of coherence within "excitons," the bound pairs of electrons and holes that enable semiconductors to function as novel electronic devices.

Scientists working in the emerging field of nanotechnology believe that this newly discovered property could eventually help the development of novel computing devices and provide them with new insights into the quirky quantum properties of matter.

Details of the new finding appear in a paper published in the November 3 issue of the journal *Physical Review Letters* by a team of four physicists at UCSD working in collaboration with a materials scientist at UC Santa Barbara.

The effort was headed by Leonid Butov,

a professor of physics at UCSD.
UCSD media release

NASA approves mission t service Hubble

Shuttle astronauts will make one final house call to NASA's Hubble Space Telescope as part of a mission to extend and improve the observatory's capabilities through 2013.

NASA Administrator Michael Griffin announced plans for a fifth servicing mission to Hubble Tuesday during a meeting with agency employees at NASA's Goddard Space Flight Center, Greenbelt, Md. Goddard is the agency center responsible for managing Hubble. The flight is tentatively targeted for launch during the spring to fall of 2008.

"We have conducted a detailed analysis of the performance and procedures necessary to carry out a successful Hubble repair mission over the course of the last three shuttle missions. What we have learned has convinced us that we are able to conduct a safe and effective servicing mission to Hubble," Griffin said. "While there is an inherent risk in all spaceflight activities, the desire to preserve a truly international asset like the Hubble Space Telescope makes doing this mission the right course of action."
Hubble media release

The Colorful Demise of a Sun-Like Star

A new image from NASA's Hubble Space Telescope shows the colorful "last hurrah" of a star like our sun. (See cover photo)

The star is ending its life by casting off its outer layers of gas, which formed a cocoon around the star's remaining core. Ultraviolet light from the dying star makes the material glow. The burned-out star, called a white dwarf, is the white dot in the center. Our Milky Way galaxy is littered with these stellar relics, called planetary nebulae. The objects have nothing to do with planets. Eighteenth- and nineteenth-century astronomers named them that because through small telescopes they resembled the disks of the distant planets Uranus and Neptune.

The planetary nebula in this image is called NGC 2440. The white dwarf at the center of NGC 2440 is one of the hottest known, with a surface temperature of nearly 200,000 degrees Celsius. The nebula's chaotic structure suggests that the star shed its mass episodically. During each outburst, the star expelled material in a different direction. This can be seen in the two bow tie-shaped lobes. The nebula also is rich in clouds of dust, some of which form long, dark streaks pointing away from the star. NGC 2440 lies about 4,000 light-years from Earth in the direction of the constellation Puppis.

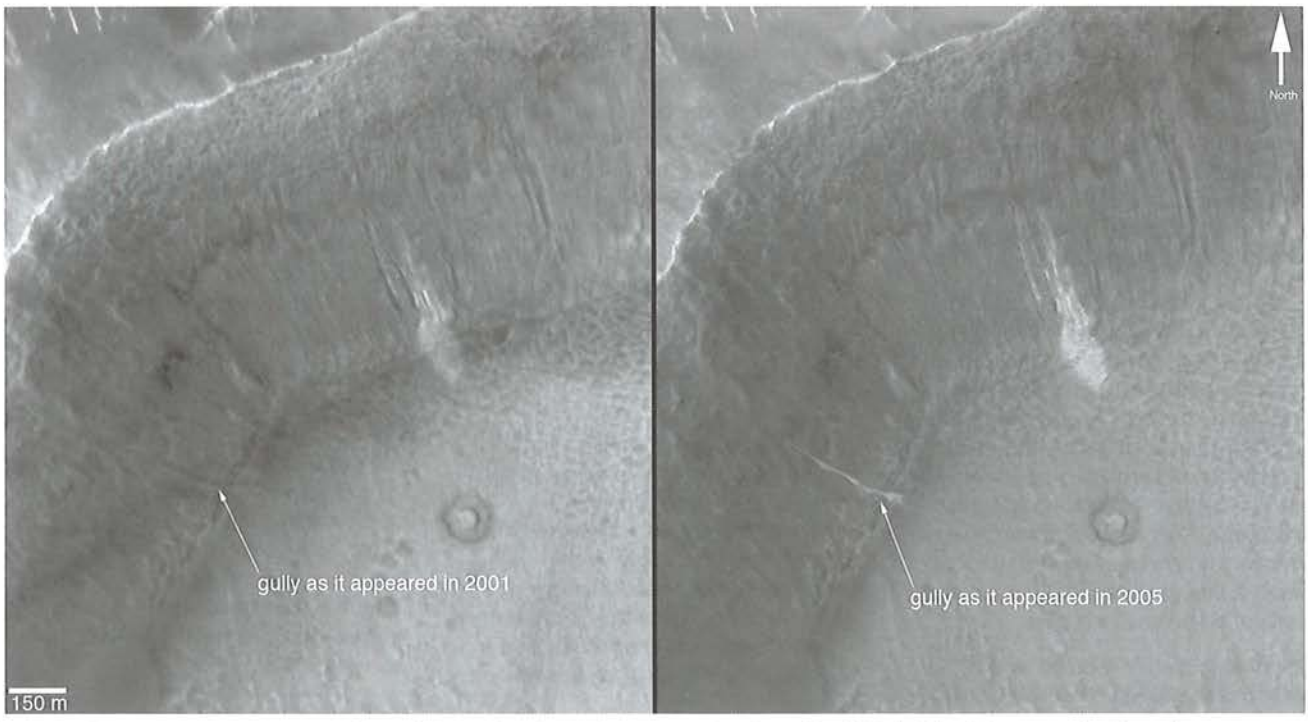
The colors in the image correspond to material expelled by the star. Blue corresponds to helium; blue-green to oxygen, and red to nitrogen and hydrogen.
Hubble media release

NASA Images Suggest Water Still Flows in Brief Spurts on Mars

NASA photographs have revealed bright new deposits seen in two gullies on Mars that suggest water carried sediment through them sometime during the past seven years.

"These observations give the strongest evidence to date that water still flows occasionally on the surface of Mars," said Dr. Michael Meyer, lead scientist for NASA's Mars Exploration Program, Washington.

Liquid water, as opposed to the water ice and water vapor known to exist at Mars, is considered necessary for life. The new findings heighten intrigue



This set of images shows a comparison of the gully site as it appeared on Dec. 22, 2001 (left), with a mosaic of two images acquired after the change occurred (the two images are from Aug. 26, 2005, and Sept. 25, 2005).
Image credit: NASA/JPL

Samplings

about the potential for microbial life on Mars. The Mars Orbiter Camera on NASA's Mars Global Surveyor provided the new evidence of the deposits in images taken in 2004 and 2005.

"The shapes of these deposits are what you would expect to see if the material were carried by flowing water," said Dr. Michael Malin of Malin Space Science Systems, San Diego. "They have finger-like branches at the downhill end and are easily diverted around small obstacles." Malin is principal investigator for the camera and lead author of a report about the findings published in the journal Science.

The atmosphere of Mars is so thin and the temperature so cold that liquid water cannot persist at the surface. It would rapidly evaporate or freeze. Researchers propose that water could remain liquid long enough, after breaking out from an underground source, to carry debris downslope before totally freezing. The two fresh deposits are each several hundred meters long.

NASA media release

First Direct Evidence of Turbulence in Space

If you think chaos is complicated in the case of simple objects (such as our inability to predict the longterm velocities and positions of planets owing to their nonlinear interactions with the sun and other planets) it's far worse for systems with essentially an infinite number of degrees of freedom such as fluids or plasmas under the stress of nonlinear forces. Then the word turbulence is fully justified.

Turbulence can be studied on Earth easily by mapping such things as the density or velocity of fluids in a tank. In space, however, where we expect turbulence to occur in such settings as solar wind, interstellar space, and the accretion disks around black holes, it's not so easy to measure fluids in time and space. Now, a suite of four plasma-watching satellites, referred to as Cluster, has provided the first definitive study of turbulence in space.

The fluid in question is the wind of particles streaming toward the Earth from the sun, while the location in question is the region just upstream of Earth's bow shock, the place where the solar wind gets disturbed and passes by the Earth's magnetosphere. The waves in the shock-upstream plasma, pushed around by complex magnetic fields, are observed to behave a lot like fluid turbulence on Earth.

One of the Cluster researchers, Yasuhito Narita (y.narita@tu-bs.de) of the Institute of Geophysics and Extraterrestrial Physics in Braunschweig, Germany, says that the data is primarily in accord with the leading theory of fluid turbulence, the so called Kolmogorov's model. Narita *et al.*, *Physical Review Letters*, 10

Physics News

Warm Detectors Look At Brain Magnetism

The brain and heart both generate weak magnetic fields which can reveal subtle clues about such maladies as epilepsy and arrhythmias in ways different from electric fields. Sensitive magnetometers, based on superconducting quantum interference devices (SQUIDs), have been used to prepare detailed magnetoencephalograms (MEGs). Unfortunately, these devices require liquid helium and all its associated cryogenic equipment.

Michael Romalis, a Princeton University physicist, detects the brain's faint magnetic fields using instead a vessel filled with potassium atoms, which have been polarized by a laser beam. The brain fields cause the potassium atoms to precess in a measurable way. Already, Romalis (romalis@princeton.edu) says, his device has attained a sensitivity 30 times better than previous atomic magnetometers used for biosensors, and a spatial resolution comparable to that for SQUIDs, with the prospect of improving by another factor of ten.

In a related paper, Romalis's group in collaboration with Karen Sauer from George Mason University used a different kind of potassium magnetometer to detect radio-frequency signals generated by ammonium nitrate (which is often used in explosives) with a sensitivity some 10 times better than with conventional devices.

Xia *et al.* and Lee *et al.*, two articles in *Applied Physics Letters*, 20 November 2006

Physics News

Chaos on a Chip

For the first time physicists have shown that well-structured chaos can be initiated in a photonic integrated circuit. Furthermore, this represents the first time scientists have been able to study optical chaos at gigahertz rates.

The output of a semiconductor laser is normally regular. However, if certain laser parameters are tweaked, such as by modulating the electric current pumping the laser or by feeding back some of the laser's light from an external mirror, the overall laser output will become chaotic; that is, the laser output will be unpredictable.

To make the chaos even more dramatic — and exploitable — Mirvais Yousefi and his colleagues at the Technische Universiteit Eindhoven, in the Netherlands, use paired lasers, lasers built very close to each other on a chip in such a way that each affects the operation of the other. The Eindhoven chip, using the paired-laser mutual-perturbation approach to triggering chaos, is the first to exhibit chaos directly — revealing telltale strange attractors on plots of laser power at one instant versus laser power at a slightly later instant-rather than indirectly through recording laser spectra.

Looking ahead to the day when opto-photonic chips are covered with thousands or millions of lasers, the Eindhoven approach could allow troubleshooters to pinpoint the whereabouts of misbehaving lasers – not only that but possibly even exploit localized chaotic effects to their advantage.

According to Yousefi other possible uses for chip-based chaos will be the business of encryption, tomography, and possibly even in the establishment of multi-tiered logic protocols, those based not on just on the binary logic of 1s and 0s but on the many intensity levels corresponding to the broadband output of the chaotic laser system. Yousefi *et al.*, *Physical Review Letters*, 26 January 2007

Physics News

THE 2007 BRAGG GOLD MEDAL FOR EXCELLENCE IN PHYSICS

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

Aim

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

Background to the Award

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

Conditions of the Award

The medal is awarded annually to the student who is judged to have completed the most outstanding Ph. D. thesis under the auspices of an Australian university, whose degree has been approved, but not necessarily conferred, in the thirteen months prior to the closing date for applications to the State Branch (i. e., from the beginning of July 2004 to the end of July 2007). No candidate may be nominated more than once.

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

Nominations

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

Time Line:

Nominations from the universities should reach the secretary of the local State Branch by Monday 16th July 2007.

The selected nominations from the State Branches, accompanied by three copies of the thesis, the citation and referees' reports, should reach the Honorary Secretary at P. O. Box 16, Willetton, WA 6955 by Wednesday 19th September 2007.

The announcement of the winner of the 2007 Bragg Medal shall be made by the end of January 2008.

Presentation of the Award

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

Previous Winners

2004 Dr. Warrick Bowen
Australian National University.
2005 Dr. Philip Bartlett,
Murdoch University
2006 Dr. Alex Argyros,
University of Sydney.

Further information about this award can be obtained by email from secretary@aip.org.au or by phone to (08) 9332 1513.

Ian Bailey
Honorary Secretary

Science fiction

Love is...

Evelyn Webster

"Young man," said a pompous voice sharply, "my daughter is not responding to the Happiness you sold me last week and I should like to know why." The lady belonging to the voice brandished a prescription slip in Siggy's face. He sighed,

"Does she know you've given it to her?" It was the most likely problem. Emotional supplements changed your feelings on an unconscious level so you didn't really notice it, but people who knew what was happening sometimes resisted, especially if they were as resolutely depressed as Mrs Vanderbelt's daughter.

"Of course not! I slipped it into her meals exactly as instructed!"

Siggy decided the girl would have to be blind as well as depressed not to suspect her mother; the woman was about as subtle as a bulldozer. Of course, he couldn't say that to a customer. Instead he reached for one of the tall glass jars that were arranged behind the pharmacy counter. Happiness powder was bright yellow, and nearly all gone. He consulted the label, "Warmth 30%, Sunshine 17%, Chocolate 16%, Lie-ins 10%," he read. "Ah, here we are; Essence of Kitten. Mrs Vanderbelt, is your daughter perhaps allergic to fur?" The well-dressed lady nodded, chins wobbling.

"Well then she'll be allergic to Happiness as well. Tell you what, I'll try her on a mixture of Contentment and Joy – it won't work quite the same as Happiness but it'll be pretty close." He slid Happiness back into place, pulling down the two jars wedged either side of it. He checked the labels again, just in case.

"Right, no kittens or puppies in either of these." He motioned the lady towards the shiny scales, tipping some golden Contentment into the pan and adding a sprinkle of orange Joy. He scooped the mixture into a plastic bag, and handed it to Mrs Vanderbelt. "One pinch in every evening meal - no more. Do not exceed the dosage recommended by your pharmacist..."

"Yes, young man, I know!" exclaimed the lady, seizing the bag and stalking out. The bell tinkled over the door as she left.

"You're welcome," muttered Siggy. He grabbed a cloth and wiped down the countertop with a little more ferocity than was actually required. The cloth flicked a neat stack of leaflets detailing the new advances in ERT – emotion replacement therapy – and suddenly the whole lot was on the floor. He cursed under his breath and a voice from the back room bellowed,

"Sigfreid! You being clumsy again? I hope you haven't damaged my stock out there!"

Did you hear a smash? thought Siggy. No, so your precious jars are safe. He wasn't in a good mood today. Damson hadn't come in yet, that was probably it.

"Take yourself a chill pill!" His boss's voice continued, using outdated slang as always. "A bit of Calm should do it!" Laughter echoed. Everyone who worked at Walker and Co. Pharmacy knew Siggy refused point blank to take emotional supplements. His boss in particular never left off teasing him about it, claiming he couldn't presume to advise customers if he had never tried the stuff himself.

Siggy ignored his co-workers and crouched down to retrieve the leaflets. The doorbell tinkled again. "Can I help you?" he called.

"What?"

Siggy grabbed the last of the wayward leaflets and hauled himself up. A nervous face that was trying to hide behind a quivering moustache jumped in surprise.

"Sorry, I didn't see you there!"

"Can I help you?" repeated Siggy, slightly more civilly.

"Um, yes, well, I hope so. It's just, well, I've got a date tonight, and I really like the lady but I'm so damn nervous I know I'm going to make a fool of myself!"

The man blushed. He should be twisting a cap in his hands, Siggy thought unkindly. He slammed a jar of cobalt blue powder on the counter. "This is Confidence, it's great for getting rid of nerves. I'll give you a pill to take with water about an hour before your big date. Sign the receipt to indicate it's for your own personal consumption. Come back if you need more, okay?" His boss would have liked a little more enthusiasm with the sales pitch, but Siggy wasn't in an obliging mood.

"Um, okay."

Briskly, Siggy weighed out half a gram of Confidence, tipped it into the pill compressor and pulled the handle. The machine whirred and clunked and spat out a small blue pill, which Siggy handed to the man.

"That's three fifty." Money changed hands, and the man left, smiling in an endearingly nervous way. Sometimes Siggy thought pharmacies had turned into sweet shops overnight. He could quite easily imagine the bashful man asking for breath mints for his big date, not Confidence. It would almost be a relief to sell something that rotted teeth, instead of rotting minds.

After that he really couldn't think of anything to do, so he did some more stuff anyway. Damson didn't come in. He half-hoped she wouldn't, but something in him couldn't stand not to see her. At least if she came in he'd know she'd survived another night.

Damson was a powderhead, a junkie, addicted to emotional supplements. She was a mess, and part of the reason Siggy himself never took them. It was so easy these days to override every negative emotion, replace apprehension with Contentment, change regret into Relief. That was bad enough, but Damson didn't just want the uppers, she wanted everything. For her, it was all about experiencing different emotions, pleasant and unpleasant. She was working her way thorough Walker and Co.'s complete stock, one powder at a time.

Siggy remembered when she'd started, and watched her face light up as she felt the tingle of Delight dissolving on her tongue. It had been so innocent; neither of them could have predicted at that moment what Damson would become.

Then she walked through the door, eyes flashing with Excitement, bobbing to a song in her head that kept escaping from her lips in nonsensical bursts. She wore a short skirt,

showing off her legs, and a baggy jumper. It looked an odd combination unless you knew, as Siggy did, that the top's long sleeves concealed arms peppered with red needle marks tracing along her veins. Damson had soon realised that you got a faster and more potent effect if you shot melted powder straight into your bloodstream, rather than ingesting it.

Her now unnaturally pale face grinned at him and, weakly, Siggy grinned back. He was glad the counter separated them because he was suddenly overcome by the urge to gather her up in his arms and hug her out of existence. He was convinced the next hit would kill her; he always was. Someone could rape her, rob her, murder her, and she wouldn't be able to do a thing about it. You couldn't get a powderhead mad if they were on uppers, not even if you kicked them in the gonads; the powder just negated the brain's natural emotional response.

Every day on his way home from work, Siggy passed alleys where junkies congregated, sitting in filth, leaning against dumpsters and holding a spoon of bright powder over a lighter flame, watching it melt into a bubbling liquid. After that he always had to look away; needles made him feel sick. Sometimes they were still there when he walked to work the next morning.

"Hi Damson."

"Hiya! I need a top up of my usual, and something else, something a little special. So, recommend me something!" she commanded. Obediently, Siggy began weighing out powders: 10 grams of Excitement, 5 of Delight, 1 of Misery and 1 of Impatience. She liked variety.

"We have a new powder just in, called Pride. It's supposed to be for people who always do themselves down, but I hear it's enjoyable."

"Naw," she drawled, "I need something nasty today. "Specially nasty!" Siggy nodded, reaching for the jar of Fear – it was one of her favourites.

"Naw, not Fear again! There's only so many times you can be frightened by darkness, spiders and monsters under the bed! I'm bored with that, but I'm still in the mood to be scared."

"Damson..." Siggy pleaded.

"What have you got that'll make me shit my pants in fright?" She thought it was something to celebrate. Damson glanced at the shelves of powder jars even as Siggy moved to block her view. "Oh, how about Panic?" she whispered. But then she saw the exact one he'd been hoping she wouldn't notice. It was jet-black and even looked sinister.

"What's that?"

"Terror," he said shortly.

"What's in it?"

"Pain. And death in the future."

"Huh?"

"Death in the past creates grief, death in the future creates terror – no one can help fearing death."

"Gimme five grams."

What could he do? It was a lot for a first time usage, especially of something as vile as Terror. But technically it wasn't illegal to sell it to her; the government had decided that it didn't care what people chose to put into their own bodies. Why should they? Generally the supplement powders meant people were happy and content, so the government didn't get hassled to actually do anything. The only restriction was on Lust, which you had to be over eighteen to buy. But the crux was that if he refused, she'd just go and find another pharmacist. And he'd never see her again.

Was he complicit in the very thing he abhorred because he gave her the powders? Did that make him responsible? Yes. Yes of course it did, but that wouldn't stop him. He started weighing out black powder.

It was too late for Damson anyway; she was already dependant. Her brain was so used to the powders that it couldn't produce any emotion without them. If she stopped taking them, all that awaited her was emptiness. That was how they destroyed you. Although it hurt, Siggy clung to his own emotional turmoil, the terrible longing for her touch, the fear that she wouldn't come back, the hope that one day she'd love him too. But she wouldn't; she couldn't.

The only way Siggy'd get her to return his feelings would be to sell her a concoction of Love, Hope, Fear, Anguish, Lust and Guilt. And that would make a pretty volatile combo. He was a pharmacist, he knew which emotions could be mixed together, and what effect they'd produce, but if you took an incompatible combo like, say, Happiness and Sadness, the brain couldn't handle it. You got brain damaged, irreversibly. Fortunately Damson wasn't into that, yet. She liked her emotions pure.

"Damson, why do you do this?" Siggy wasn't really expecting an answer; he asked her the same question every day and she usually just teased him, saying, "Gotta do something!" or "Because I can!"

But instead she leaned over the counter and brushed his cheek with her cold fingertips. For a moment her eyes lost a little of their Excited sparkle,

"Aw, you're sweet to worry about me Siggs, but we both know I've got no choice! I've gone stale. I'm empty! There is nothing left in this whole world that can shock or thrill me, except this." Reverently, she picked up the little bag of black powder, and slipped it into a pocket.

So she walked out the door with a spring in her step and Terror in her pocket, leaving Siggy with a mental picture of her lying in an alley, petrified of every shadow, and the knowledge that it was his fault.

Evelyn Webster is 19 years old, and lives in Cheshire, in the UK. She's just started her first year of an English Language and Linguistics degree at York University. She loves science fiction and has been writing stories since she was about 11.

Conferences

2007

March 10 - 17
NanoTech Insight 2007
Luxor, Egypt
www.nanoinsight.net

March 12 -16
Nano and Giga Challenges in Electronics and Photonics
Phoenix, Arizona, USA
www.ngc2007.asu.edu

April 10 - 14
Crystal XXV
Pokolbin, NSW
www.sca.asn.au/crystal25/

April 15 - 19
5th World Conference of Science Journalists
Sydney, Australia
www.scienceinmelbourne2007.org/

April 23 - 25
Air Pollution 2007
Arlgive, Portugal
www.wessex.ac.uk/conferences/2007/air07/index.html

April 28 - May 1
37th Annual Scientific Meeting of the Australian and New Zealand Society of Nuclear Medicine
Adelaide, SA
www.anzsnm2007.com/

May 16 - 18
CRCA2007
Perth, Australia
www.crca.asn.au/conference/index.html

June 12 - 13
Nanopolymers 2007
Berlin, Germany
www.rapra.net/products_and_services/Conferences/Nano_Conference_2007.asp

July 8 - 13 ,
18th International Conference on General Relativity and Gravitation & 7th Edoardo Amaldi Conference
Sydney, Australia
www.grg18.com/

July 4 - 6
Materials and Austceram 2007
Sydney, Australia
www.materialsaustralia.com.au/ma2007/

July 8 - 12
World Conference on Science and Technology Education
Perth, WA
www.WorldSTE2007.asn.au

July 9 - 12
14th International Congress on Sound and Vibration
Cairns, QLD
www.icsv14.com/

September 9 - 14
14th International Union of Air Pollution Prevention and Environment Protection Associations (IUAPPA) World Congress/18th Clean Air Society Conference
Brisbane, Australia
www.casanz.org.au

October 8 - 12
Advanced Infrared Technology and Applications 2007 Giorgio Ronchi 9th International Workshop (AITA 2007)
CIO, Leon, Guanajuato, Mexico
ronchi.iei.pi.cnr.it/AITA2005

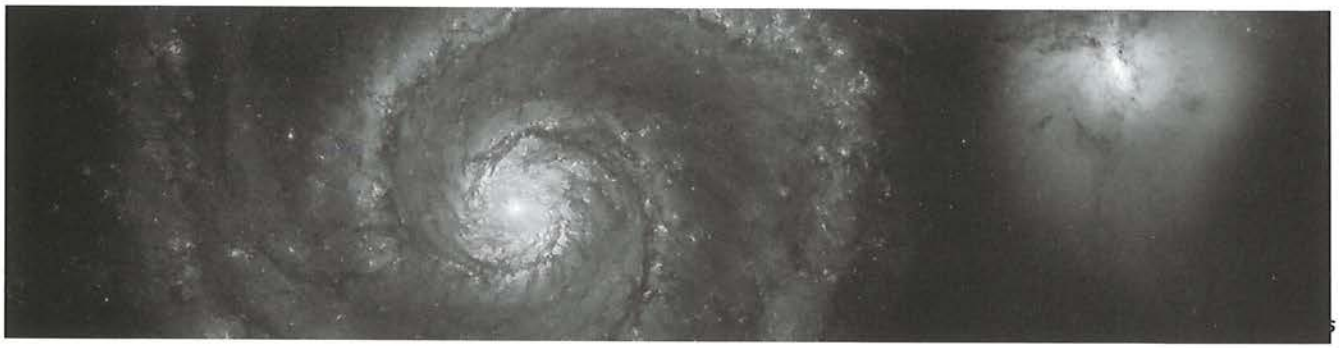
October 9 - 13
SPERA 2006 - 9th South Pacific Environmental Radioactivity Conference -
Royal Society Victoria, Melbourne
www.arpansa.gov.au/spera/index.cfm

November 21 - 23
15th AINSE Nuclear and Complementary Techniques of Analysis
Melbourne University, Melbourne, Australia

2008

May 28 – June 1
8th World Biomaterials Congress
Amsterdam, the Netherlands
www.wbc2008.com

Jun 15 - 19
17th World Hydrogen Energy Conference
Brisbane Convention and Exhibition Centre
www.whec2008.com

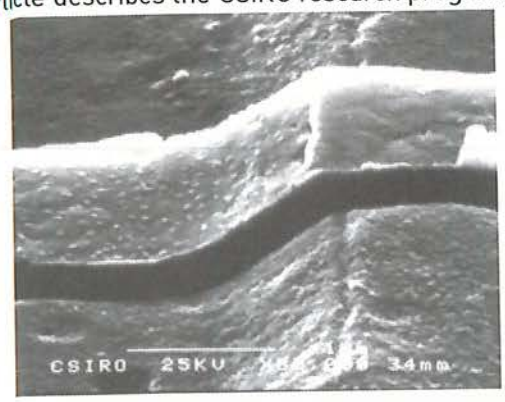


Superconducting electronics research at CSIRO

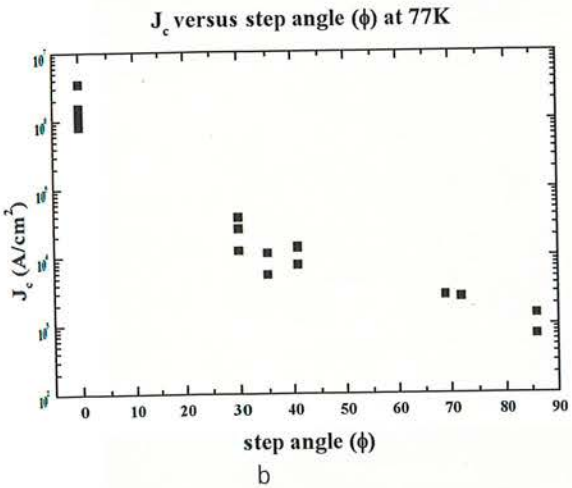
C.P. Foley
CSIRO, Division of Industrial Physics, Lindfield,NSW

Introduction

Since the discovery of the Josephson junction and superconducting quantum interference devices (SQUIDs) in the 1970's, the CSIRO Division of Industrial Physics has had a research program in superconductivity. Initial work focussed on low-temperature superconductivity (LTS) with the invention of the superconducting current comparator,[1] the development of the Josephson voltage standard[2] and low temperature superconducting (LTS) SQUIDs for magnetoencephalography[3]. When high temperature superconductivity (HTS) was discovered in 1987, CSIRO formed a team to focus on the study of these new ceramic materials. The team started with fundamental studies of the physics and materials preparation. They then progressed to develop thin films and step-edge Josephson junctions for SQUIDs and their application. This article describes the CSIRO research program in superconducting electronics since 1987 outlining the HTS junction and device technology, the various applications developed by the group and the recent move into LTS devices for quantum engineering.



a



b

Fig. 1: a) HTS step-edge Josephson junction on MgO with a patterned YBCO thin film, and b) the variation of the junction critical current with step-edge angle.

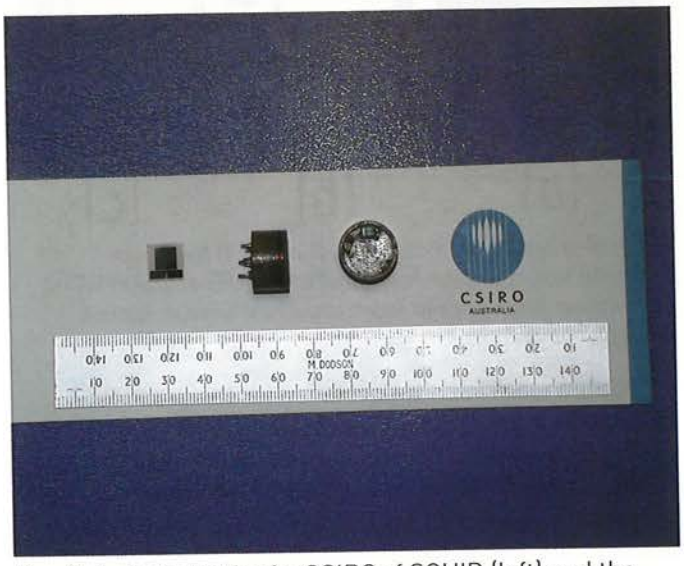


Fig. 2: A photograph of a CSIRO rf SQUID (left) and the encapsulation of the device for incorporation into the SQUID system.

HTS Josephson Junctions and SQUIDs:

CSIRO developed an unbalanced magnetron sputtering process[4], which was used to fabricate high quality *a-b* aligned *c*-axis oriented $YB_2C_3O_{7-x}$ thin films on MgO[5]. The group decided that it would be necessary to develop Josephson junctions that could be positioned anywhere on a substrate if subsequent SQUIDs were to be fabricated in a cost effective process using standard electronic device techniques.

Although the preferred method of forming Josephson junctions in HTS materials is to use bicrystals, this gives limited control on the junction critical current, so we opted to develop step-edge junctions on MgO (001) substrates[6,7]. These junctions had the advantage that they could be placed any where on a substrate, had only one junction (as a consequence of the fabrication of "rounded-bottom" steps with a gentle return step that did not form extra junctions) and gave control of the junction critical current over four orders of magnitude by variation of the step angle. Fig. 1 shows a micrograph of the step-edge junction technology used in all the CSIRO HTS devices and applications and a graph of the variation of the critical current with step edge angle.

CSIRO has developed both rf and dc HTS SQUIDs.

Superconducting electronics research at CSIRO

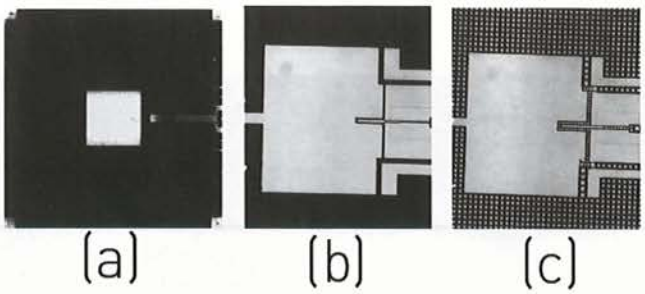


Fig. 3: Micrographs of dc SQUIDs showing a) the whole device, b) and c) a magnification of the SQUID amplifier with and without grids used to improve performance in applied magnetic fields.

Rf SQUIDs were initially developed for the practical reasons that there was only one junction (one less to worry about than dc SQUIDs), they did not require wire bonded contacts and they had inherent reverse biasing to reduce low-frequency excess noise. Rf SQUIDs are used in the transient electromagnetic (TEM) systems[8] and the spinning rock magnetometer. Subsequently we developed dc SQUIDs with optimisation of the SQUID amplifier design and fabrication techniques to ensure that the SQUID could be operated in unshielded applications with little drift and creep[9]. Our SQUIDs are now fabricated in batches of 30 as required, with designs modified for specific applications. Fig. 2 shows a photograph of rf SQUIDs and Fig. 3 shows micrographs of various dc SQUIDs.

Ground-based TEM:

Initially CSIRO developed SQUIDs for non-destructive testing of steel for an Australian steel company, BHP (now BHP-Billiton). On their recommendation, this research was redirected to use SQUIDs for mineral exploration with a view to replacing the industry standard coil with a SQUID receiver. TEM is one of many mineral exploration techniques. By placing a coil about 100-200 x 100-200 m^2 on the ground and pulsing a current through it, eddy currents are induced in any conductors under the soil. A magnetic receiver is used to detect the decay of the eddy currents over a period of time. This is recorded and analysed to determine the presence of unseen deep magnetic anomalies. Fig. 4 shows a schematic of TEM principle. This exploration technique is most useful for the detection and delineation of highly conducting ore bodies such as nickel sulphides, silver and gold.

The use of *B*-field sensors for TEM is stimulated by the need to separate the TEM response of highly conductive targets, for example nickel sulphide deposits, from either conductive host rocks or conductive over-burden. CSIRO developed an HTS rf SQUID-based sensor for ground-based TEM with the first field trial in Cooper Pedy in 1991. Initially this work was supported

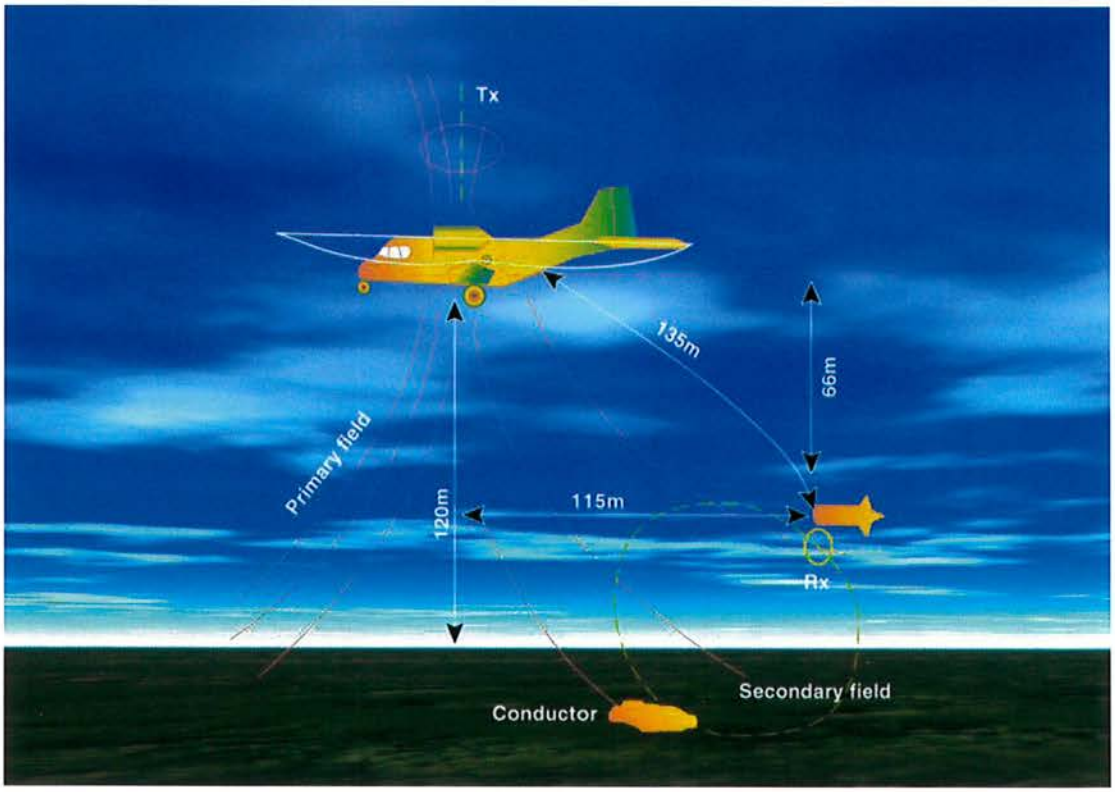


Fig. 4: A schematic diagram showing the principle of TEM for the airborne use of SQUIDs. A similar approach is used for ground-based systems but with the transmitter coil stationary on the ground.

Superconducting electronics research at CSIRO

a b

Fig. 5: The development of the SQUID receiver for TEM from experimental prototype (a) to a commercial systems (b). These photographs show the system in use in Raglan, Canada.

by both CSIRO and BHP with surveys conducted by Geoterrex (now Fugro Ground). An initial survey in 1993 over the Cannington silver deposit was instrumental in identifying the nature of this deposit[10]. Since BHP withdrew from further development, CSIRO has built systems in collaboration with Falconbridge, a Canadian mining company. Falconbridge has being using the systems for 28 months of survey over hundreds of line kilometres over their Raglan prospect[11].

After offering this system at four ASEG Conference Exhibitions, Outer Rim Development approached CSIRO and after negotiations, has begun manufacturing the SQUID system called LANDTEM under license. A small engineering company now manufactures the rf SQUID system with CSIRO supplying the rf SQUIDs under contract. Currently five systems have been manufactured and are in use in Australia, Canada and USA. This technology transfer required persistence and on-going support from a sister division in CSIRO, the Division of Exploration and Mining. It also required us to become involved in the Australian Geophysics community to gain acceptance of a liquid nitrogen cooled system in field applications. The mineral exploration industry has taken a long time to adjust to these changes even when then benefits are very large. There has also been a lot of competition with other technologies, such as the use of flux gates, which has confused the usefulness of SQUID-based magnetometers for TEM. Fig. 5 shows the development of the SQUID systems from a "science experiment" to a commercial system. Fig. 6 and 7 shows the comparison of the SQUID with coils and flux gates.

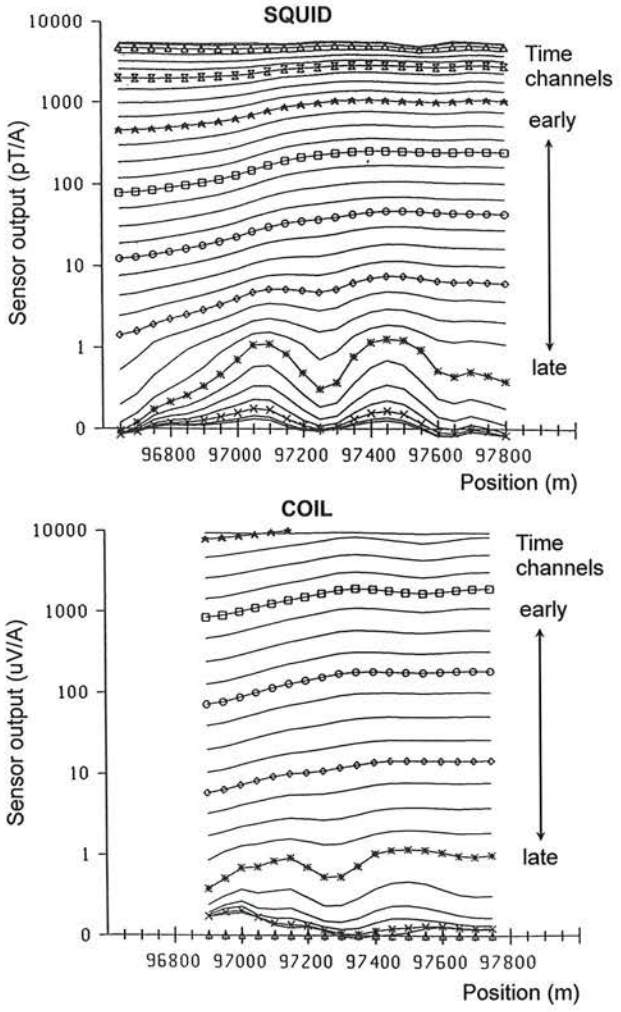


Fig. 6: Comparison of a SQUID and coil system over a target with identical measurement set-ups with measurements taken at the same time.

Airborne TEM

Initial reconnaissance for mineral exploration relies

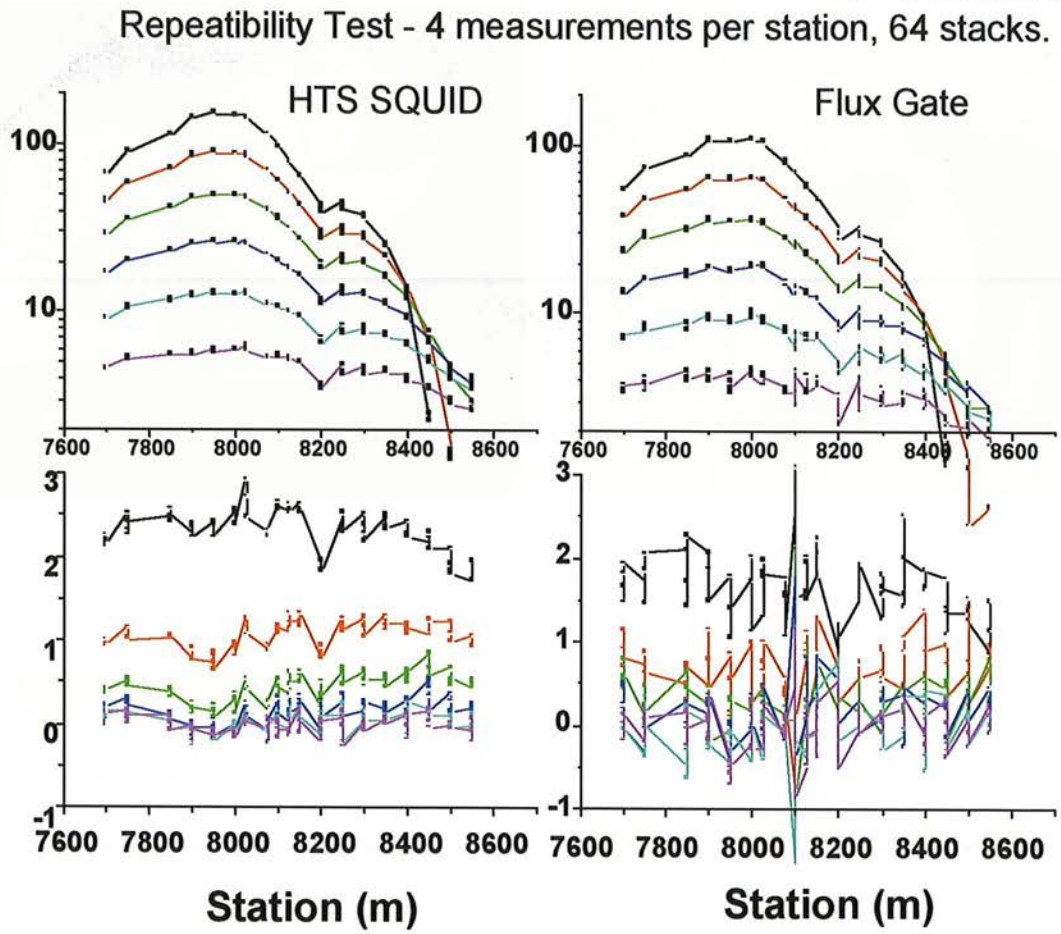


Fig. 7: Comparison of a SQUID and flux gate system over a target with identical measurement set-ups with measurements taken at the same time.

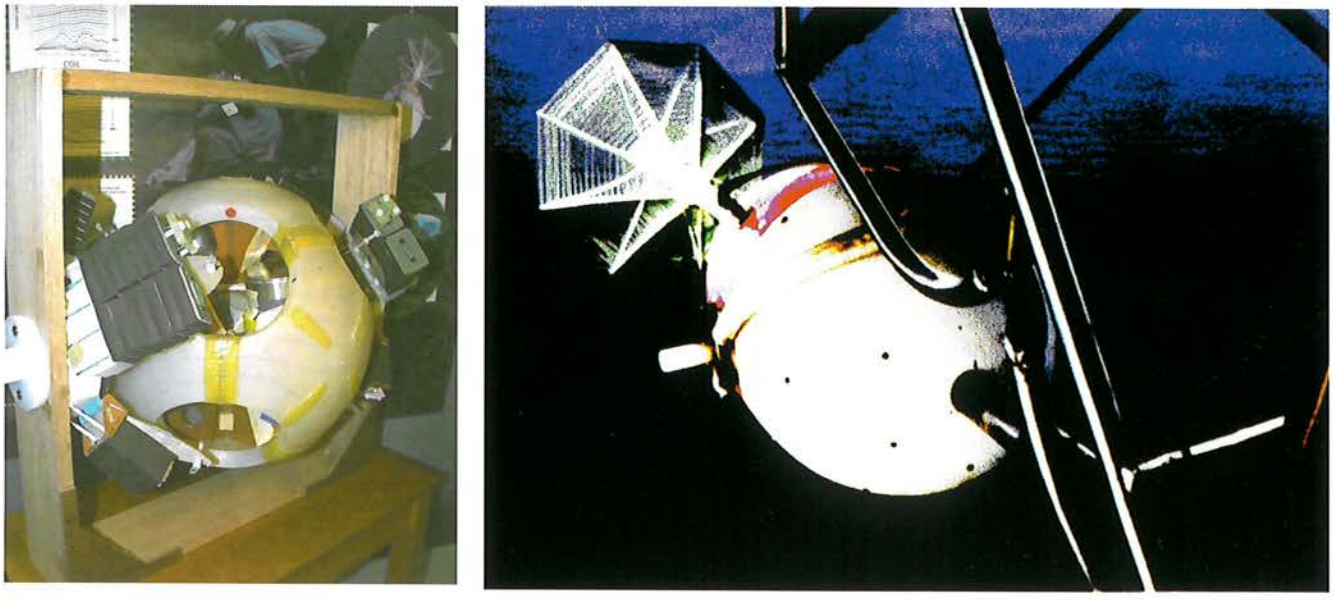


Fig. 8: Photographs of the suspension system and SQUID in the bird while airborne.

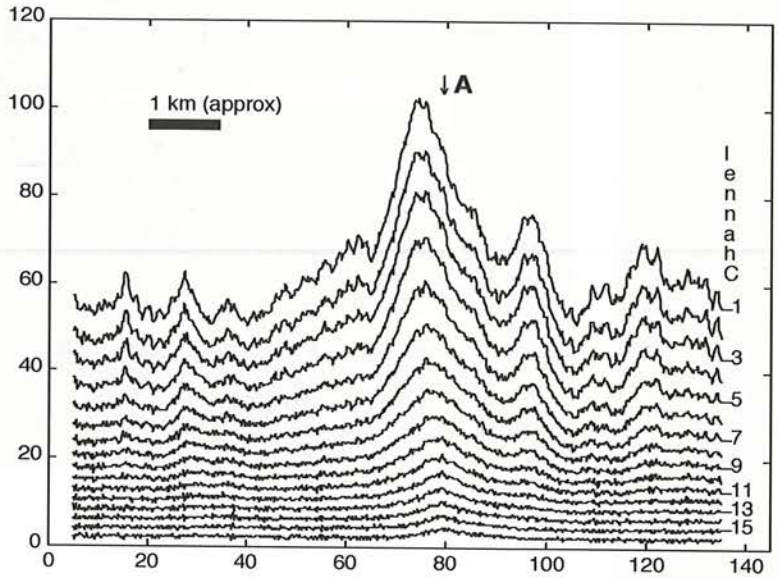


Fig. 9: Line profiles of a South Australian airborne SQUID TEM survey

on airborne data. CSIRO and BHP used the rf SQUID system in 1994-1997 as an airborne receiver placed in a bird suspended from a fixed-wing aircraft. This application has severe requirements on the ability of the SQUID to operate in a continuously changing field while in motion. Five airborne trials were undertaken. The development was suspended due to the depression in the mineral exploration industry resulting from a severe fall in mineral commodity prices[12-15]. Fig. 8 shows the suspension system developed and the SQUID in operation in the bird. Fig. 9 shows an example of SQUID data and Fig 10 shows a comparison of the signal to noise ration of the coil and the SQUID over the time measurement channels. Here the SQUID indicated that late times showed an advantage. It is the late time measurements that are of most interest to the geophysicist. Currently this work is awaiting a resurgence of interest from the exploration community before it's pursued further. SQUIDs, electronics and system design have improved significantly since these trials. A signal-to-noise improvement from 2.5 to 7 is expected.

Spinning Rock Magnetometer

Use of SQUIDs for the measurement of rock magnetism has been very successful. 2G Enterprises offer an LTS system with 1000 days helium hold times and close to 100 systems have been delivered to various

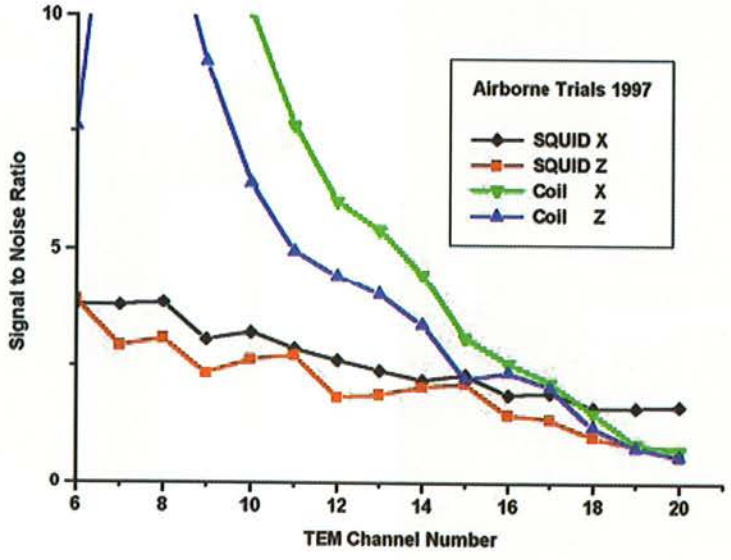


Fig. 10: Comparison of the SNR of a SQUID and coil.

Fig 11: A HTS SQUID based Spinning Rock magnetometer.

laboratories around the world. CSIRO was asked to build an HTS rock magnetometer for Macquarie University for student use, which was cheap and simple to use with liquid nitrogen coolant. We designed a system based on rf HTS SQUIDs that rotated the sample in a planetary motion to allow measurement

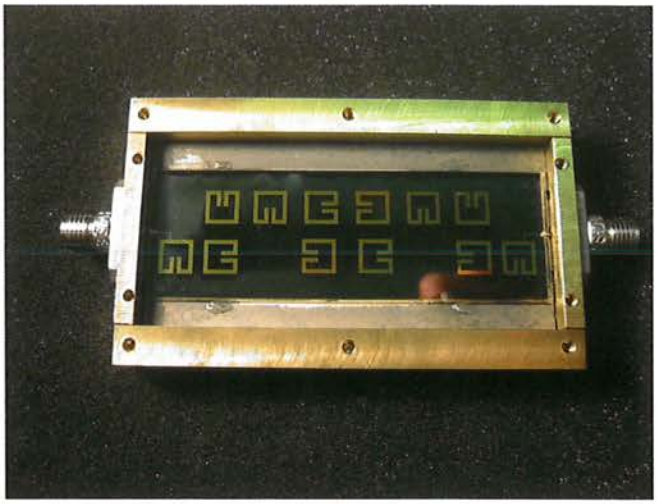


Fig. 12: A photograph of a microwave filter.

of all three axes of the magnetic moment with one measurement and one SQUID[16]. The system achieved a sensitivity of 10^{-6} A/m, which is only marginally less sensitive than the 2G LTS system[17]. Fig. 11 shows a photograph of the spinning rock magnetometer.

Microwave Filters

CSIRO has strong telecommunications and radio astronomy research programs. Collaboration with researchers in these programs has led to the development of microwave filters for use in radio telescopes and mobile communications. Fig. 12 shows an example of a microwave filter[18].

Metal in Food Detector

CSIRO has developed a prototype metal in food detector to detect stainless steel fragments for

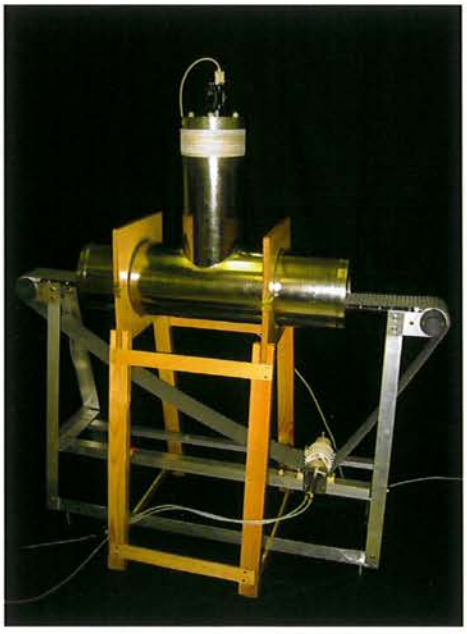


Fig. 13. Prototype SQUID based metal detector and industrially designed metals detector.

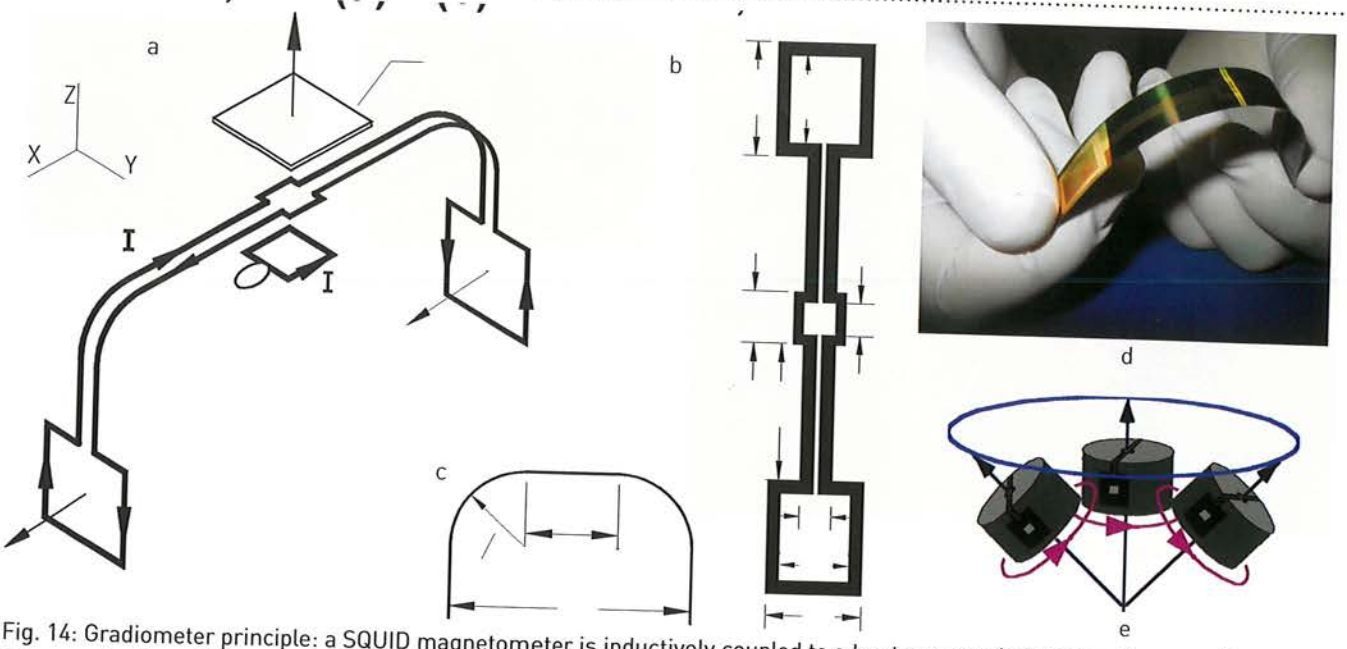


Fig. 14: Gradiometer principle: a SQUID magnetometer is inductively coupled to a bent symmetric flux transformer. a) A superconducting shield reduces the magnetometer response to B_z-fields, b) layout of the transformer in planar, c) bent configuration, d) the flexible tape and e) a schematic of umbrella configuration.

quality assurance in manufacturing. Fig. 13 shows the experimental system and the industrially designed system. This work has identified a need for the SQUID sensor to be packaged so that the use of cryogenics is not obvious to the end user. The implementation of an HTS SQUID on a mini cryocooler head would allow the SQUID to be sold as a complete coolable package. However, issues relating to vibration and electromagnetic interference need to be tackled if this is to be achieved. Success would create a significant role for superconducting electronics in the security industry, which is high in the minds of governments. Such a development would enable stainless steel metal detectors (metal detectors at the airport do not pick up surgical stainless steel) to become standard use in correctional centres and airports.

Rotating Gradiometer

Following some preliminary experiments and trials with a crude two-SQUID differencing gradiometer[20], in 2000 we began a collaboration with Division of Exploration and Mining (DEM) and five mining companies on a magnetic tensor gradiometer project to develop an HTS SQUID system that could measure all nine components of the earth's magnetic field tensor. Previous modelling by DEM had indicated the advantages of magnetic tensor gradient measurements and had identified that a system with a sensitivity of 0.01 nT/m would detect all magnetic contrasts that would be of economic value[21]. Subsequent modelling of the system design found that achievement of this sensitivity would require a common mode rejection ratio (CCMR) of 10^9; the traditional two-SQUID differencing gradiometers would have to be aligned to within the diameter of a hydrogen atom to achieve this. An innovative approach of rotating the gradiometer about its axis enables data to be manipulated in the frequency domain and the noise level of a SQUID in the white noise region to be used rather than in the region dominated by 1/f noise. Theoretically, this concept would achieve this CCMR. Concerns about introducing noise via slip rings used for the electrical connections to the SQUID were overcome by the use of a single stationary SQUID with a rotating flux transformer fabricated from a hastelloy flexible tape coated with YSZ and YBCO[22, 23].

The superconducting thin film was formed into a flux transformer using a standard lithographic process. Initial trials of a manually rotated system verified the usefulness of the system concept and the benefit of magnetic tensor gradiometry for mineral exploration. This project has recently received funding from the Australian Department of Defence to develop a new magnetic anomaly detector for the PC3 Orion aircraft based on the same concept. Fig. 14 shows the rotating gradiometer concept and a photograph of the flexible tape. Fig 15 shows a photograph of the trial using the rotating gradiometer. Fig. 16 shows a comparison of the gradiometer measurements with tensor measurements calculated from a parallel set of an over-sampled Total Magnetic Intensity (TMI) survey undertaken at the same time.

Superconducting electronics research at CSIRO

Fig. 15: A photograph of the trial of the rotating gradiometer.

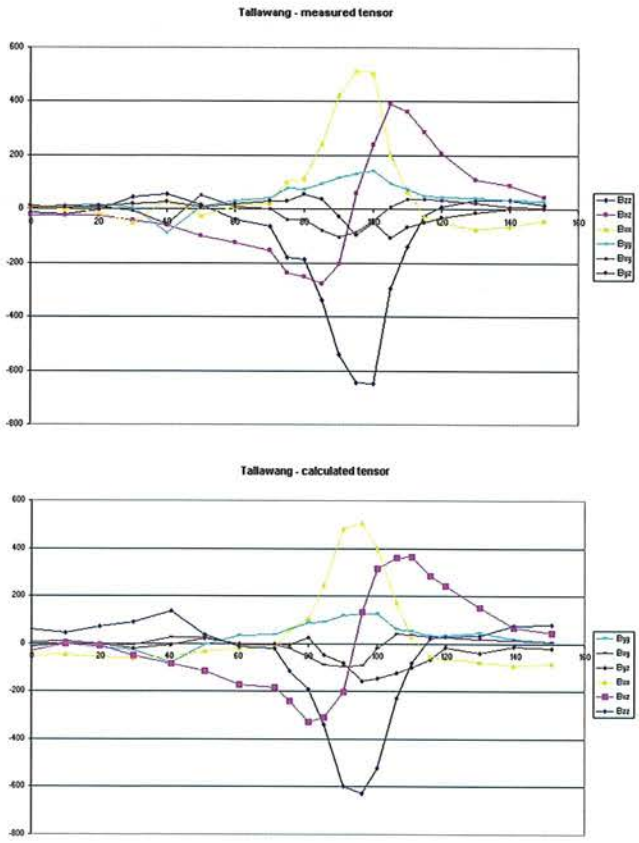


Fig. 16: A comparison of the data for the rotating gradiometer (top) and the calculated tensor using TMI data.

LTS Nano-SQUIDs

The Australian Centre of Quantum Computer Technologies at the University of New South Wales is developing a Kane Quantum Computer, which will use the spin of single phosphorous atoms embedded in silicon. CSIRO has been developing nano-SQUIDs

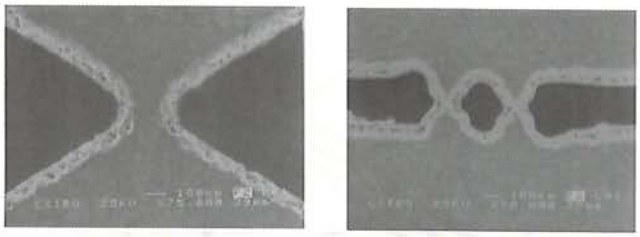


Fig. 17: A micrograph of a nano-bridge and a nano-SQUID.

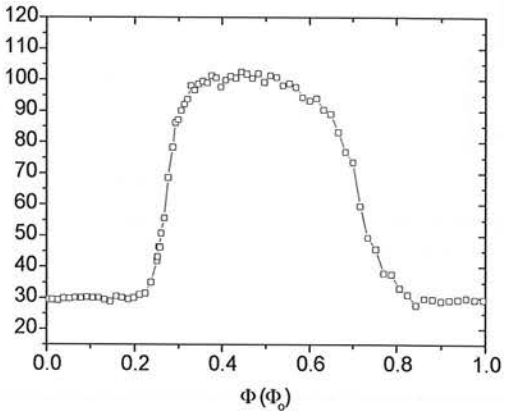


Fig. 18: The output voltage of nanoSQUID at different bias currents when an ac modulation voltage (lowest trace) is applied on the calibration coil, which provides a magnetic field perpendicular to the plane of the SQUID. The peak-to-peak value of the ac flux is 25 mF_o.

using Nb and nano-bridges to measure atomic spins[24]. These nano-SQUIDs could be used as read-out devices for the Kane computer as well as for single photon detectors and nano-NMR[25]. Fig.17 shows a micrograph of a nano-SQUID and Fig. 18 shows the SQUID output.

Superconducting Macroscopic Quantum Systems

CSIRO has been renewing its capability in LTS junctions and developed a Nb/YZS/Nb junction[26] and standard Nb and Al SIS junctions using Al_2O_3, AlN and TaO as the insulation layer. CSIRO plans to study the materials aspects of these structures to understand how to improve devices to achieve long-term quantum controlled states useful for qubits and other quantum engineering. Fig. 19 shows a micrograph of a Nb/YSZ/Nb non-hysteretic LTS junction.

Conclusion

CSIRO has had a long-term research effort in superconductivity and has benefited from the close collaboration with end user industries and researchers in the application area. All research has been approached with the application in mind and created

Superconducting electronics research at CSIRO

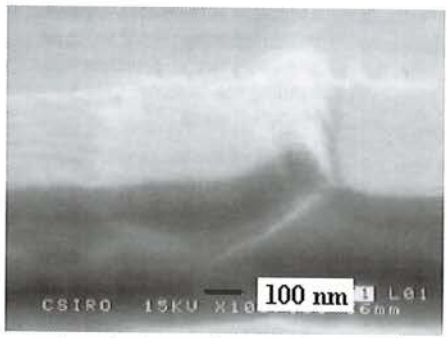


Fig 19. A scanning electron micrograph of a Nb/YSZ/Nb ramp junction.

innovative solutions to the problems at hand. There were, with the discovery of HTS, promises of big returns in a short time. This has not been realised. The reality is that disruptive technology shifts (especially when cooling is required) can take a long time to have an impact commercially. HTS superconductivity is in the nasty "teenage" years when, as is the case for our own teenage children, one is are tempted to "kill them off". But with patience and dedication, they will grow up into fabulous adults! Adoption of superconductivity by industry will do so too.

References

1. *Review of Scientific Instruments*, 1972, (43), 1626.
2. *Metrologia*, 1972.
3. *J. Biomagnetometers*, 1987,189.
4. *J. Vac Sci Tech A – Vacuum Surfaces and Films 4* (3): 504–508 Part 1 May–Jun 1986.
5. *Thin Solid Films* 228 (1–2): 182–185 May 15 1993, *Applied Physics Letters* 81 (7): 1282–1284 Aug 12 2002.
6. *IEEE Transactions on Applied Superconductivity 9* (2): 4281-4284 Part 3 Jun 1999.
7. Institute of Physics Conference Series (158): 507-510 1997.
8. *Thin Solid Films* 437 (1-2): 101-107 Aug 1 2003, *Applied Superconductivity 6* (10-12): 669-673 Oct-Dec 1998, *IEEE Transactions on Applied Superconductivity 7* (2): 3044-3047 Part 3 Jun 1997.
9. *IEEE Transactions on Applied Superconductivity 13* (2): 849-852 Part 1 Jun 2003.
10. *IEEE Transactions on Applied Superconductivity* 9 (2): 3786-3792 Part 3 Jun 1999, *IEEE Transactions on Applied Superconductivity* 13 (2): 759-762 Part 1 Jun 2003.
11. *CSEG Recorder*, Nov (2002) 45-48.
12. *Geophysics* 67 (2): 468-477 Mar-Apr 2002.
13. *Superconductor Science and Technology* 15 (12): 1641-1645 Dec 2002.
14. *Exploration Geophysics* (24), 29, 30, 1998.
15. *Exploration Geophysics* (32), 7, 2001.
16. *IEEE Transactions on Applied Superconductivity* 11 (1): 252-255 Part 1 Mar 2001.
17. 2G Enterprises.
18. *Superconductor Science and Technology* 12 (11): 1027-1029 Nov 1999.
19. ????
20. *IEEE Transactions on Applied Superconductivity* 11 (1): 1375-1378 Part 1 Mar 2001.
21. *Preview*, Nov 1998.
22. *Applied Physics Letters* 84 (26): 5347-5349 Jun 28 2004.
23. *Physica C – Superconductivity and its Applications* 407 (1-2): 1-9 Aug 1 2004.
24. *Applied Physics Letters* 82 (7): 1078-1080 Feb 17 2003.
25. *Superconductor Science and Technology* 16 (12): 1479-1482 Dec 2003.
26. *Applied Physics Letters* 83 (4): 716-718 Jul 28 2003.

Press Room Government media releases relating to science

Minister announces financial support for RQF

On 18th December, the Minister announced more than $87 million in financial support for the implementation of the first cycle of the new Research Quality Framework (RQF).

Of the $87.3 million being allocated for implementation of the RQF project, $41.9 million will be provided to universities to implement the first cycle of the RQF. This programme funding will be provided over three years, commencing in 2007-08, and includes:

- $16.4 million - Implementation Assistance Programme - to assist universities in meeting the costs of implementing the new requirements for data gathering; and
- $25.5 million - Australian Scheme for Higher Education Repositories programme - to assist with the establishment of university digital data storage systems that will allow research outputs to be submitted for RQF assessment.

The remainder of the funding will be utilised for preparatory work for the RQF in 2007 and for implementation in 2008, including: pre-implementation trials; discipline specific workshops; preparation and distribution of RQF guidelines and panel specific guidelines; continuing consultation with the sector; and remuneration of reference committee members and assessment panel chairs and assessors.

Further information about the RQF, IAP, ASHER and Assessment Panels is available at *www.dest.gov.au/research/rqf*

$500 million boost for Australian science infrastructure

Australian science infrastructure will be significantly upgraded by $500 million in Australian Government funding.

"The investments, provided under the National Collaborative Research Infrastructure Strategy (NCRIS), are essential to build our national capacity to generate knowledge and use it to advance our economic, social and environmental objectives," Minister Bishop said.

"The infrastructure will support emerging industries, such as nanotechnology and biotechnology products, underpin mature industries and help to address national challenges, such as generating sustainable energy and managing our natural resources."

Facilities are being developed by a collaborative effort between the Australian Government, state and territory governments, universities, research agencies and industry. An extra $640 million in cash and in-kind contributions have been pledged thus far for the facilities, in addition to the NCRIS funding.

Further information, including fact sheets, is available at *www.ncris.dest.gov.au/*

Australia's best university teachers recognised

On 28th November, the Minister for Education, Science and Training, the Hon Julie Bishop MP, congratulated the country's most outstanding university teachers who received Carrick Awards for Australian University Teaching at a ceremony at Parliament House.

Twenty-two university teachers from across Australia were recognised at the highly competitive 2006 Carrick Awards for Australian University Teaching.

"I congratulate the winners on their commitment to excellence and wish them all the best in their teaching careers."

For a complete list of winners go to: *www.carrickinstitute.edu.au/*

New Chairman of the CSIRO Board

The Minister for Education, Science and Training, the Hon Julie Bishop MP, announced the appointment of Mr Peter Willcox as the new Chairman of the CSIRO Board, effective from 1 January 2007.

"Mr Willcox, who has been a member of the CSIRO Board since 16 February 2006, will bring a wealth of experience to the CSIRO Chairman position," Minister Bishop said.

Minister Bishop said Mr Willcox's wide-ranging industry experience is also complemented by his scientific background which included a degree in physics from the University of Cambridge.

Mr Willcox has substantial industry experience gained from an executive career in the international petroleum industry and, more recently, through having served on the boards of many of Australia's top companies across a range of sectors.

Minister Bishop also acknowledged the outstanding contribution made by the current Chair Ms Catherine Livingstone.

"Ms Livingstone has played a major role in refocussing CSIRO's corporate strategy during her tenure as Chair," Minister Bishop said.

Science grants announced - $310 million boost for sector

On 22nd December, the Minister for Education, Science and Training announced grants of $310 million for world-class research and innovation under the Australian Government's Cooperative Research Centres (CRC) Programme.

This funding round's 14 successful CRCs will undertake research in a diverse range of sectors, including information and communication technology, manufacturing technology and medical science and technology.

TMinister Bishop also announced that, pending further work on its proposal, she has given in-principle approval for funding the National CRC for Advanced Manufacturing.

Details of the successful applicants, including funding and contact information can be found at, CRCsuccessfulapplicants. For further information about the CRC Programme, go to *www.crc.gov.au*

CSIRO to receive more than $2.5 billion

The Minister for Education, Science and Training, the Hon Julie Bishop MP, announced that CSIRO will receive more than $2.5 billion in funding over the next four financial years.

A significant change in the Australian Government funding is that it will be confirmed in a four-year funding agreement from 2007-08 to 2010-11. CSIRO had previously been funded for three-year periods.

"Increasing the funding cycle to four years provides CSIRO with an even more stable financial environment that will enhance resource planning in scientific research, permitting development of multi-year research programs," Minister Bishop said.

"CSIRO plays a very significant role in Australia's national innovation system and will continue to do so. It carries out scientific research in areas including energy, information technology, health, minerals, agriculture, the environment and natural resources and ranks in the top one per cent of world scientific institutions in 12 of 22 research fields," the Minister said.

Reactor farewelled after 49 years of service

On 30th January, an icon of Australian science, the High Flux Australian Reactor (HIFAR) at Lucas Heights, was officially closed down by the Minister for Education, Science and Training, the Hon Julie Bishop MP, making way for a new, state of the art reactor.

"HIFAR is now technologically outdated and is being replaced with a state of the art, multipurpose research reactor, the Open Pool Australian Light-water (OPAL) reactor," Minister Bishop said. "An era in nuclear science is ending here at the Australian Nuclear Science and Technology Organisation (ANSTO) today. For 49 years, HIFAR has been a source of neutrons and radioisotopes which have benefited Australia in areas as diverse as medicine, the environment, agriculture, industry, mining, science and education."

Following the shutdown of HIFAR, it will be decommissioned over a 10-year period and its radioactive parts removed and safely stored.

News

Taming 900 vortices gives plasma energy insight

After designing a simple experiment in their laboratory which creates 900 vortices in electrolytic fluid, ANU researchers have come closer to understanding how energy is retained in turbulent systems that self-organise — such as the atmosphere, the universe and plasma. The researchers watched as the 900 mini-vortices 'self-organised' to form one giant vortex. At this high-energy state, the fluid developed powerful regions of 'zonal flow' which in turn created transport barriers — the key to reducing energy loss from the fluid.

The finding is particularly exciting for the study of turbulence in plasma that is known to self-organise to a high-energy state. The loss of energy from confined plasma has been one of the main challenges to making it a source of energy.

In their latest paper published in the journal *Physical Review Letters*, Dr Shats and colleagues Dr Hua Xia and Dr Horst Punzmann detail how the powerful zonal flows that create the transport barriers, which in turn restrict the loss of energy from the system, are the result of turbulence self-organisation in plasma.

"When the plasma confined by a magnetic field reaches the high energy point of self-organisation, a zonal flow is generated. These zonal flows produce regions in the plasma known as transport barriers, which stop the loss of particles and energy out of the plasma system," Dr Shats said.

ANU media release

Hypersonic flight takes off

In November, the Defence Science and Technology Organisation (DSTO) and the US Air Force signed a $US54m deal to advance research into hypersonic flight.

Hypersonics is the study of velocities more than five times the speed of sound (Mach 5). The Hypersonic International Flight Research Experimentation (HIFiRE) project is one of the largest collaborative ventures undertaken between Australia and the US.

According to Australia's Parliamentary Secretary for Defence, Senator Sandy Macdonald, the HIFiRE project would see up to ten hypersonic flight experiments conducted over the next five years at Woomera in South Australia.

Senator Macdonald said hypersonic flight promised to have a significant impact on Defence as well as on international transport and future access to space.

UNSW media release

Apollo Moon-landing award for telescope engineer

A former Officer-in-Charge at CSIRO's Parkes telescope receives an award for his role in the 1969 Moon landing.

Long-time Parkes resident David Cooke was the senior receiver engineer at the telescope during the time of the Apollo 11 landing in July 1969.

He received one of the inaugural "Stars of Australia" awards on 27 January (26 January in Australia) at the Australia Day Gala event at the Hotel Derek in Houston. The awards were presented by Captain Eugene Cernan, the Commander of Apollo 17.

Mr Cooke was the Officer-in-Charge of the Parkes Observatory from 1988 to 1993.

His role during the 1969 mission was to look after the receivers that capture the radio signals as they come in from space: to install them on the telescope, test them, and monitor their performance while the spacecraft approached the Moon and landed.

ATNF media release

New head for School of Physics

Astrophysicist, Associate Professor Anne Green, has been appointed as the Head of the School of Physics at the University of Sydney.

A member of the teaching and research staff and Director of the renowned Molonglo Observatory for the past decade, Professor Green is an alumna of the University of Sydney, and was the first female PhD student to be enrolled in the Physics Department, originally working with Professor Bernard Mills.

Professor Green is an active member of an international team that is planning to build the next generation radio telescope known as the Square Kilometre Array (SKA). She is currently leading the SKA Molonglo Prototype project, known as SKAMP, which is a test-bed for SKA digital signal technologies and some of the key science goals.

Sydney University media release

Cosmic explosions reviewed after Gamma burst

A cosmic explosion unlike any observed and recorded before has astronomers the world over reviewing theories of how the largest bangs in the Universe (since the Big One) actually occur.

The strange Gamma Ray Burst (GRB) occurred on June 14 in a galaxy two billion light years away, and although it had some features in common with typical GRBs, it was also quite different.

Professor Brian Schmidt, Dr Bruce Peterson and postdoctoral student, Karen Lewis, from the Research School of Astronomy and Astrophysics at ANU, tracked the Gamma Ray Burst at Siding Spring Observatory near Coonabarabran for the first few hours after it was recorded by NASA's Swift Space Mission on June 14. They were part of an US led team to study the GRB and publish a paper in upcoming edition of the journal Nature.

"Gamma Ray Bursts are the most powerful of cosmic explosions observed in the Universe and usually they come in two types — either short (less than two seconds) or long. This burst was clearly in the long category lasting 102 seconds," Professor Schmidt said.

"Before this explosion, conventional wisdom was that short GRBs were the result of two dead stars – called neutron stars - merging to form a black hole. Long bursts were the result of the death of a star more than 40 times more massive sun forming a black hole. These long bursts have always been associated with a stellar explosion – or supernova – that typically last tens of days and are billions of times brighter than the sun.

"But with this GRB no matter how hard we looked, from how many angles and how many times, there was no supernova. Furthermore, Gemini Observatory and Hubble Space Telescope observations revealed that the explosion occurred in a galaxy that contained almost no massive stars. So the object is puzzling. It's a long way outside the box of what we have seen and predicted before – and has

thrown a spanner into our theories of how these objects explode," Professor Schmidt said.

The ANU astronomers were part of an international team to publish a paper in a special edition of the international science journal Nature on GRB 060614 (referring to the date it was detected, 14 June 2006).

Although it was the first recorded observation of a 'hybrid' gamma ray burst, the astronomers believe it is probably not an uncommon phenomenon. .

More information: *www.astro.caltech.edu/~avishay/grb060614.html*

ANU media release

Discovery points to new generation of planets

An international team of astronomers has observed what they believe could be the formation of a new class of planetary system around one of the most well studied stars in the galaxy.

Professor Peter Tuthill from Sydney University's School of Physics and Sydney graduate Michael Ireland (who is now working at the Californian Institute of Technology) are part of a team that has shown that material from the dying star Mira A is being captured into in a disk around Mira B, its companion.

This observation is particularly exciting as astronomers have traditionally assumed that the dusty disks where planets form are only found around young stars in stellar nurseries, and this is the first time that a protoplanetary disk has been found in the environment of a dying star.

Mira A is losing its dusty outer layer at a rate of around one Earth mass every seven years. The researchers have calculated that around one per cent of this material is being captured in the gravitational field of its companion star Mira B.

Observations using new imaging methods were made at the 10 meter Keck I telescope in Hawaii and the 8 meter Gemini South telescope in Chile and revealed new details that were thought to be impossible to detect due to the blurring by atmospheric turbulence.

The intense radiation from Mira A, which is 5,000 times brighter than the sun, heats the edge of the disk to about Earth's temperature and causes it to glow in the infrared. The researchers were able to show that the material was indeed the edge of a disk and not just a "clump" in the wind from Mira A.

The team announced its findings at the most recent meeting of the American Astronomical Society.

Sydney University media release

Licence agreement for superconducting breakthrough

The University of Wollongong has consolidated its standing as one of the world leaders in the development of superconductivity materials with the announcement that it has signed a licence agreement to patent a breakthrough technology with a US-based company.

Deputy Vice-Chancellor (Research), Professor Margaret Sheil, said the agreement represented one of the largest licensing deals ever entered into by the University.

Researchers at one of the University's world class teams, the Institute for Superconductivity and Electronic Materials (ISEM), have made a breakthrough in the fabrication of wires from the newly-discovered superconductor compound magnesium diboride (MgB2) by using nano-scale silicon carbide and carbon doping. They have achieved a world record high critical current density and upper critical field in superconducting MgB2 wires.

UOW media release

Advanced microanalysis for Adelaide

South Australian researchers and industry will have access to the most advanced microscopy and microanalysis facilities in the country under a new national network being established. With potential benefits for all science-based research and development — including medicine, engineering, physical sciences and plant and animal sciences — the national network will have a node in each major capital city.

In Adelaide, new development will be centred on the existing Regional Facility for Microscopy and Microanalysis, a collaborative arrangement between the University of Adelaide's Adelaide Microscopy, the University of South Australia's Ian Wark Research Institute and Flinders University's School of Chemistry, Physics and Earth Sciences and the Flinders Microscopy & Image Analysis Facility.

Adelaide Microscopy Director John Terlet said the new facilities would enable significant advancement in this area.

The National Network of Microscopy and Microanalysis Facilities will be funded under the Federal Government's National Collaborative Research Infrastructure Strategy which recently allocated $47.5 million for the `Characterisation Capability', most of which will go towards establishing the network. The Adelaide facility has been boosted with another $2.5 million from the State Government with a total of almost $7 million new investment in South Australia.

University of Adelaide media release

Nature science mentoring awards for Melbourne two

The inaugural winners of two new *Nature* awards for mentoring in Australasian science – one for a scientist in mid-career and the other for lifetime achievement – are two University of Melbourne scientists.

The winner of the mid-career award is Professor Rachel Webster, an astrophysicist (Physics). The lifetime award goes to Professor Tom Healy, a physical chemist (Chemical and Biomolecular Engineering).

"We are delighted to recognise the efforts and commitment of these two exceptional science mentors," says Editor-in-Chief of *Nature*, Dr Philip Campbell.

Chair of the judging panel, and head of the Australian Academy of Science, Professor Kurt Lambeck, says *Nature* received 74 high-quality nominations from across Australia and New Zealand in a broad range of disciplines. "Judging these awards was the hardest task I've ever had to undertake," he reports.

University of Melbourne media release

Obituary - Jack Hopkinson Smith (27.7.1920 - 14.11.2006)

Assoc. Prof Jack Smith (1970) (courtesy Monash University Archives (N5172).

Jack Hopkinson Smith was born on the 27th July, 1920 at Arnold in Nottinghamshire, England. He was to be the eldest of three children born to George and Florence Smith. Jack's brother Peter and his sister Jean were to follow. His father was a respected Civil Engineer.

Jack grew up in Arnold, a town where his family had lived for generations. He matriculated from Secondary School in 1935 at the age of 15.

He continued with his education by studying mining surveying, but with the outbreak of the 2nd World War, Jack saw active service as an engineer with the Royal Air Force in 221 Squadron. In 1941 he was posted overseas to the Middle East and Mediterranean Commands. He was listed for commission to Sergeant in the Engineering Branch in 1945 and was eventually discharged from the RAF in 1946.

Jack returned to further education, studying physics at the University of Nottingham and graduating with a BSc (Hons II2) in 1950. Between 1952 and 1954 he held the appointment of Assistant Lecturer in Physics, Nottingham and District Technical College where he studied the temperature dependence of the resistivity of mixed cobalt and nickel oxides. The lack of facilities and a heavy teaching load severely restricted the progress of this work.

In 1955, Jack moved to the University of Sheffield to a Lecturer position and completed his PhD concerned with antiferromagnetism in manganese alloys, in 1060. This research, which resulted in his most cited publication (*Proc. Roy. Soc.*, **241**, 223-8 (1957)) was conducted in collaboration with Dr G.E. Bacon, (Atomic Energy Research Establishment, Harwell) and Dr R. Street who was to become the foundation Head of the Physics Department, Monash University. Jack's contribution to the research program entailed the measurement of the temperature dependence of the elastic modulus, the ΔE effect, resistivity and magneto-resistance, together with X-ray and micrographic analysis of structure.

While at Sheffield, Jack displayed a keen interest in the welfare of the students, which was to be a hallmark of his long academic career.

Jack married Joy Mills, in late 1955 at West Bridgeford, Nottinghamshire. They had three children, the first being Paul, born in 1956. Nicola followed in 1958, with Robyn born in 1962 in their new home of Australia. Jack had accepted a foundation position of Lecturer in the Department of Physics, Monash University, and the family moved to Australia in 1961.

Jack played a key role in the development of the new Department, particularly in the setting up of the second-year, teaching laboratories. He had a passion for laboratory teaching and was constantly re-writing the laboratory scripts and urging his colleagues to do likewise. Jack also established a research laboratory for the study of the magnetic properties of materials. One of the significant items of equipment brought from Sheffield to Monash was a Sucksmith Ring Balance, for the measurement of magnetic susceptibility and which he and one of his postgraduate students improved by doubling the sensitivity. In addition, Jack and his postgraduate students played an important role in the introduction of neutron diffraction studies of magnetic alloys by accessing the facilities at the Australian Research Reactor at Lucas Heights. Between his first appointment at Monash and his retirement, the research involving the PhDs of seven students, produced 24 publications in peer-reviewed journals.

Jack was promoted to Senior Lecturer on 21 March, 1962 and to Associate Professor on 11 June 1969.

He had a strong rapport with students, particularly those from overseas. This lead him to serve as Warden of Howitt Hall, one of the Monash Halls of Residence, from 1979 to 1985. During this period the family lived on campus in a house next door to the Halls of Residence.

While Jack devoted so much of his time to education, he is also remembered for his enjoyment of various recreational pursuits. These included swimming, sailing and listening to classical music, the latter of which could be done in conjunction with another passion – eating and drinking!

Prepared by W.A. Rachinger, T.F. Smith, T.J. Hicks, R. Street and T.R. Finlayson

Product News

Coherent Scientific

Gas Analyser from Stanford Research System

The QMS series gas analysers from Stanford Research Systems offer an efficient, cost-effective solution for a wide range if applications. These mass spectrometers simplify the task of online process monitoring, analysis of gas species, leak detection and troubleshooting.

The QMS instrument samples continuously at pressures from above atmospheric to as low as 10 mbar. Response time is 0.5 seconds, with mass resolution better than 1 amu and available mass ranges of 100, 200 and 300. The instrument is packaged in a compact, transportable unit, and is supported by a Windows based software package.

For further information contact Dr Paul Wardill
paul.wardill@coherent.com.au
Ph: (08) 8150 5200
Fax: (08) 8352 2020
sales@coherent.com.au
www.coherent.com.au

TMC Delivers the Ultimate Vibration Isolation System to NASA

At the Technical Manufacturing Corporation (TMC), precision, reliability and performance are paramount to their entire product range. All products, ranging from the humble breadboard to highly advanced pneumatic and piezoelectric isolated solutions are constructed with due diligence and to the exacting standards required by today's advanced photonics industries.

TMC's wide range of catalogue items are suitable for most demanding photonics applications, however if your application requires something better then the best, TMC has the capability to custom manufacture products for extreme applications. Once recent example is the delivery of two high precision table assemblies to NASA Goddard's AIM (Advanced Interferometer and Metrology) laboratory. NASA took delivery of two TMC actively controlled optical tops to fulfil their metrology/interferometry requirements.

These Class 100 clean-room compliant table-top solutions were designed and constructed based around TMC's 794 Series ClassOne Clean Top II Optical tops and provide a vibration free work surface of nearly 7.5m.sq. each (4.7m in length by 1.5m in width and over 600mm thick). As thermally induced table top fluctuations can have a large negative impact on high precision interferometers, reducing their overall performance and accuracy, TMC customised the 794 Series with low expansion INVAR top and bottom face sheets, providing a thermally stable work surface. The lowest possible vibration environment was realised as each tabletop is supported by six Stacis 2100 active vibration control modules. The Stacis 2100 employ inertial vibration sensors and piezoelectric actuators to sense floor vibration and cancel these in real time for both amplitude and frequency. With a bandwidth of 0.6-250Hz the Stacis active vibration control system effectively eliminate unwanted floor vibration at frequencies typically amplified by pneumatic isolation systems. The coupling of TMC's experience in high precision vibration control and capability for custom manufacturing has allowed TMC to provide the best solution possible for NASA Goddard's AIM's Laboratory. To see how a TMC solution can best suit you contact Coherent Scientific.

Coherent Scientific
Ph: (08) 8150 5200
Fax: (08) 8352 2020
sales@coherent.com.au
www.coherent.com.au

Lastek P/L

Melles Griot Optics Group Adds to Absolute(tm) Fizeau Family of Test Optics

The Melles Griot Optics Group have announced that they have released additional Fizeau test optics to complement their Absolute(tm) Fizeau l40 transmission sphere product line. The addition of Absolute(tm)

Fizeau l50 concave and convex reference spheres will allow the user to record and store reference wavefronts for subtraction from interferometric test data, substantially improving their interferometer system's absolute accuracy. Also added to the product lineup are Absolute(tm) Fizeau l50 transmission and reference flats that cost-effectively increase the absolute accuracy of Zygo® style Fizeau surface and wavefront-testing interferometers to l50 without the need to store, manipulate, or subtract reference wavefronts during the testing process.

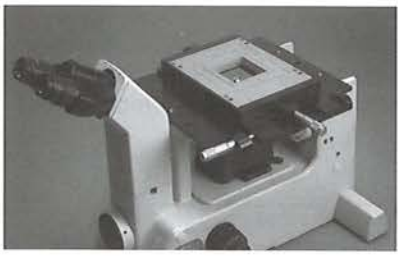
The new Absolute(tm) family of test optics will enable the interferometer user to quadruple the accuracy of their existing Fizeau interferometer. This should be of great interest to every optics lab that wants to upgrade their test capabilities.

For further information please contact Lastek at *sales@lastek.com.au*

Lastek Pty Ltd
Adelaide University - Thebarton Campus
10 Reid St, Mile End, South Australia 5031
Phone: (08) 8443 8668
Fax: (08) 8443 8427
Toll Free: 1800 882 215 (NZ: 0800 441 005)
email: *sales@lastek.com.au*
web: *www.lastek.com.au*

Product News

Nano-View(tm)/M Series from Mad City Labs Inc.



The Nano-View(tm)/M system integrates manual micrometer driven XY coarse positioning with a high resolution, long range XY or XYZ nanopositioner - either ultra-low profile or ultra-high speed, depending on the application.

The Nano-View(tm)/M system provides both simplicity of operation and the highest level of positioning accuracy. A stable blocking force of 10 N built into each axis of the coarse positioning stage provides a secure base for precision nanopositioning. Standard manual microscope stages without this feature often drift enough to make accurate nanopositioning impossible. Once the manual stage has been moved into position, high-resolution nanopositioning can be used to acquire images over 50 µm to 200 µm ranges in X, Y, and Z. Closed loop control of the nanopositioner via the Nano-Drive(tm) results in sub-nanometer accuracy over the complete range of motion. Compatible with National Instruments LabView(tm), the Nano-Drive(tm) controller has standard analog control inputs or an optional USB digital computer interface. The Nano-View(tm)/M is a cost effective, high performance positioning system for Olympus, Nikon, Leica, and Zeiss inverted microscopes.

Product Highlights
* Manual micrometer coarse positioning up to 25 mm
* High performance two or three axis nanopositioning
* Sub-nanometer precision
* Integrated position sensors (nanopositioner)
* Retrofit to any inverted microscope
* High speed USB digital interface available
* Compatible with user written LabView(tm) software
* Suitable for high-resolution microscopy applications

For further information please contact Lastek at *sales@lastek.com.au*

Lastek Pty Ltd
Adelaide University - Thebarton Campus
10 Reid St, Mile End, South Australia 5031
Phone: (08) 8443 8668
Fax: (08) 8443 8427
Toll Free: 1800 882 215 (NZ: 0800 441 005)
email: *sales@lastek.com.au*
web: *www.lastek.com.au*

NewSpec Pty Ltd

New Diffraction Grating Mount

Newport's new model DGM-1 mount is designed specifically for precision positioning of diffraction gratings. This mount is capable of holding square or rectangular gratings having dimensions of 12.5 mm, 25 mm, or 50 mm, all 6-mm-thick. Its unique clamp design allows the grating, regardless of size, to always sit at the centre of rotation of the mount. Four degrees of freedom are provided to achieve ideal alignment. Angular adjustments pitch and roll are driven by two precision 100-TPI threaded screws, and a linear x-axis adjustment allows the grating to be located right at the centre of yaw rotation. All adjustments are lockable. The DGM-1 is supplied with two BR-U clamps to allow mounting to an optical table top.

- Hold various sized gratings, square or rectangular 12.5 mm, 25 mm, or 50 mm
- 4 axes of precision adjustment
- Yaw and roll adjustments made about centre point on grating surface
- 10 arc sec of angular sensitivity
- All adjustments lockable

For more information please contact:
Neil or Graeme
sales@newspec.com.au
Tel: 08 8273 3040
Fax: 08 8273 3050

New Hand-held Optical Power & Energy Meter

For applications requiring the measurement of low-power, high-power or energy of continuous or pulsed light sources, Newport's model 1918-C Hand-Held Optical Power and Energy Meter is the new instrument of choice. This new optical meter squeezes the advanced features and display capabilities of Newport's latest 1935-C Series optical meters, into a compact, wall-plug and battery powered device, making it ideal for use in the lab or in the field.

The 4 inch, full colour, graphical LCD display enables both numerical and graphical measurement representation, with a selection of various colour palettes to allow viewing through laser safety goggles.

The 1918-C is compatible with Newport's large range of high and low power and energy detector heads. Pulseed, peak-to-peak and DC source measurements can be displayed in units of W, dBm, dB, J, A, and V.

Advanced features include a 250,000 data point storage buffer, analogue and digital filtering, programmable sample rates, moving statistics, plotting and multiple user-configuration storage.
- Measurement rep-rates up to 4 kHz
- *True rms* measurements
- Power measurements, 1 nW to 6 kW
- Energy measurements, 100 mJ to 75 J
- USB computer interface
- Data storage via internal memory (250k data samples) or *USB Flash Drive*
- Plotting, graphing, math, statistics, and on-board data post-processing

For more information please contact:

Neil or Graeme
sales@newspec.com.au
Tel: 08 8273 3040
Fax: 08 8273 3050

THE 2007 WALTER BOAS MEDAL

Nominations are invited for the award of the 2007 Walter Boas medal of the Australian Institute of Physics. These should be sent to the Honorary Secretary, in electronic format, by July 31.

Aim

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

Nominations

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

Previous Winners

2004 Professor George Dracoulis, ANU
2005 Professor Yuri Kivshar, Nonlinear Physics Centre, ANU
2006 Professor Michael Tobar, University of WA

Presentation

The award is conditional on the recipient delivering a seminar on the subject of the award at a meeting of the Victorian Branch of the AIP in November 2007. The recipient is also expected to provide a manuscript based on the seminar for publication in Australian Physics.

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

Interview - Cathy Foley

Cathy Foley is the incoming President of the AIP. Your editor felt that this made her the ideal candidate for an interview in Australian Physics.

First interest in Physics?

Even though I come from a more business-oriented family, as a primary school student, I loved "Nature Studies", my brothers' Boy's Own books and the Harry Messell Blue Science texts. In high school, I entered the science teacher's association competitions several times and won a small prize each time.

My older brother introduced me to physics when he did it for the HSC so it was a natural step for me to do physics at high school too - even though I went to an all girls catholic convert school. We had an inspirational teacher, Barry Price, who was introducing the Harvard Physics Program and I just loved how physical concepts were so pervasive and made the world make sense. However I thought it was necessary to be Einstein's cousin to be a scientist and so left school planning to be a high school science teacher.

Tertiary education?

I did all my university education at Macquarie University (B.Sc. (Hons) Dip. Ed. Ph.D.) with a short 6-month stint at Oregon State University on a UVISTA Welch Foundation Scholarship. During the third year physics lab program, I started to get a sense of how to be a scientist and how you went about becoming one. So after doing my Dip. Ed. I decided to try for a research career.

Where do I work?

I work at CSIRO Division of Industrial Physics. I have been working there for 22 years. Currently I am the Research Program Leader for the Division and I am responsible for all the science direction and capability development in the Division. I am also a project leader of the Quantum Engineering Project and participate in all the superconductivity projects at CSIRO. My current projects are:

— Quantum Engineering- where we are developing superconducting electronics that operate at milli-kelvin temperatures. The devices we are working on are qubits, nanoSQUIDs, transition edge detectors and other new superconducting devices such as absolute value magnetic field sensors and improved SQUIDs.

— MAGSAFE: A defence funded project to develop a magnetic tensor gradiometer for the detection of submarines from fixed wing aircraft. The team have developed a new concept rotating gradiometer that is currently undertaking the first airborne trials.

— LANDTEM: This is the commercialisation of a SQUID magnetometer for mineral exploration. The system has been licensed to an Australian company for manufacture.

— Informal work: looking at new possible organic superconducting materials.

Manager vs scientist?

I always feel that I don't do enough hands on research. However I do get enormous pleasure from creating a good research environment and obtaining funding for research that is performed by other colleagues.

I love the opportunity I currently have of looking for new research developments happening around the world and seeing the potential connections and opportunities for CSIRO to build on and take our science to new places. I enjoy taking fundamental research and developing applications that are then commercialised. I love to see my colleagues take over the projects I have initiated and take them to new levels I could only dream about. This is very satisfying. So I feel I have a pretty good balance. I try to ignore the paper work that does not add value. So far it seems to work!

Major scientific influences?

For scientific discovery by a great scientist, my hero is John Bardeen who invented the transistor and the BSC theory of superconductivity and won two Nobel prizes. My initial influence was Sr. Rosemary Kinney the head of science at my high school who encouraged me to enter science competitions and do research projects

very early on.

Dr Heather Adamson from the School of Biology at Macquarie University encouraged me to do an honours year and assumed that I would naturally get first class honours and should go on to a research career via a PhD and a scholarship. (I had previously never thought I was capable). Prof. Jim Piper and Prof Trevor Tansley at Macquarie University during my postgrad years, John Macfarlane (originally at CSIRO and now at NPL) and Graeme Sloggett who both taught me to do better experiments and data analysis. Tony Murphy taught me about what is important to be an effective scientist, Rod Day and John Dunlop who appointed me as a Research Fellow giving me my dream job at CSIRO and Bill Blevin and John Lowke who gave me an indefinite appointment at CSIRO even though I was 7 months pregnant at the time of the interview. That was 18 years ago when it was not really the thing to do.

Changes in the AIP?

I have been on the AIP exec for the last 6 years (4 years as treasurer and 2 years as vice president). In that time I have seen that AIP become a more professional organisation with greater accountability. I have seen it begin to use professional services to do our administration, book keeping, communications and design work. I have seen the AIP try to modernize its appeal and relevance to its members.

Main issues in the next 2 years?

- Physics teaching at schools
- a majority of science teachers will retire in the next 5-10 years. How can we encourage scientists and physicists into the teaching profession?

- Universities have more students and less teaching staff. How can university physics teaching be sustainable and maintain excellent teaching outcomes?

- The overhead costs of applying for ARC grants where only 20% are successful is a very poor use of resources. Writing an inch thick research proposal knowing that there is an 80% chance that it will not be successful needs to change.

- Recognition of the impact of physics and the need for physics in society.

- Improve the coordination between different organisations that represent physicists and be more effective working together.

- Careers in physics are not obvious and hard to point to. Can we provide better resources, more definitive career paths and a better understanding of who needs to employ a physicist and let this been know to career advisors etc?

Longer term?

- The impact of physics on society needs to be understood and examined.

- Equity and diversity of people who do physics

- Recognition that physics research and science research are human activities like our interest in art and music.

- Establishment of a good balance in how we determine what research to fund. Should we only fund research for national priorities or should be also fund the individual who may come up with the next big and new idea? How can we achieve a good balance?

What would you like to achieve during your term as President?

I hope that I can help the AIP develop into an organisation that makes a difference to its members and make it worth belonging to. I want to see if we can achieve better coordination between organisations that represent physicists in Australia and overseas. I want to get the various Australian government departments to develop a good strategy that will provide the best scientist teachers for the future. I hope I contribute to physics being seen has having enormous benefit for our society and the key to a prosperous future.

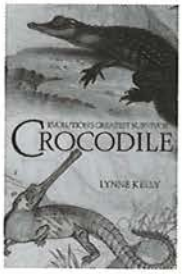
Kids and Careers?

My eldest has just finished high school and wants to be a mechanical engineer and movie maker. My daughter wants to be a medical doctor and possibly undertake medical research and my youngest son and step son both have no ideas as yet. My eldest step son wants to be a political journalist; the next step son wants to work with computers and IT. As they have got older, they have begun to appreciate my work and no longer tell me to get a real job like their friends' parents have.

Free time?

I don't have a lot but I love to watch kids sport, watch the cricket in the summer holidays, drive the kids around in Mum's taxi, be a Joey Leader, just experience family life including my very extended family and friends, fight for public education via the P&C, travel, read, cook but most of all spending time with my husband, cooking a meal together and sharing a glass of wine in our new house.

Prompt Critical



Physicists Must Like Crocodiles

Some physicists have a strange fascination for crocodiles. Beginning in the 70's the Head of the School of Physics at Sydney University, Professor Harry Messel, initiated a research program to study these huge amphibian creatures. It was then thought that the Australian saltwater crocodile was on the verge of extinction, and possibly its fresh water cousin as well. Messel's work led to at least a dozen published papers that brought their plight as endangered species to world attention.

Messel was not the only scientist with an interest in members of the *Crocodylia* order of *Reptilia*. They were studied by Benjamin Helpman as far back as the second voyage to Australia of the famous sloop *Beagle* in the late 1830's. Progress in studying and conserving these ancient animals has been engagingly undertaken by yet another physicist: Lynne Kelly, a highly talented high school science teacher in Melbourne. She is also a versatile author, her books including *The Skeptics Guide to the Paranormal* which could only have been written by a hard-headed scientist!

Lynne's book *Crocodile: Evolution's Greatest Survivor*, is a treasure of fact and legend and a rare delight to read. I must say, however, that I am a little nonplussed by the omission of any mention of Messel's work in her book while the efforts of most other leading crocodile conservationists, including the late Steve Irwin, are well reported.

The book *Crocodile* is published by Allen and Unwin. In hardcovers, with several colour plates, it is priced at A$35 and bears the ISBN 978-1-74114-498-7.

I thoroughly recommend this book for pleasure or gift. It could even make you smile at a crocodile, but not too close, thankyou.

Colin Keay
Reviews Editor

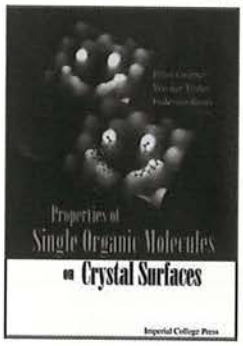
Reviews

The Quantum Mechanics Solver (2nd ed.)

Jean-Louis Basdevant, Jean Dalibard
Springer, Berlin Heidelberg 2006
xiv + 292pp., EUR 49.95 (hardcover)
ISBN 3-540-27721-8

This problem based textbook is a concise and particularly useful reference of quantum mechanics as used in a large range of modern applications in physics. The book begins with a brief review of quantum mechanics from Hilbert space to entanglement, density operator and approximation methods – as such all that is required to set the stage (concepts and notation) for the applications and problems to follow. This introduction section is new to the 2nd edition. The applications are grouped in three parts, and within each of these major grouping the sections cover a host of interesting and important applications of quantum mechanics, some 27 distinct areas in total: I *Elementary Particles, Nuclei and Atoms* (e.g. including neutrino oscillations, atomic clocks, positronium spectrum), II *Quantum Entanglement and Measurement* (e.g. including EPR and Bell's Inequality, quantum cryptography, quantum measurement), and III *Complex Systems* (e.g. including three-body problem, Bose-Einstein Condensation, electron spin resonance). Pedagogically, the sections are self-complete and serve to present the core requirements of background knowledge for each given application. Following a necessarily brief introduction to the area in question, each section is then divided into sub-sections based on a number (typically two to four) of graduate-level problems. At the end of each section worked solutions, references and general comments are given. I worked few some of these problems and found the style and material to be appropriately pitched at that expected of PhD entry level quantum mechanics. As physics becomes more interdisciplinary and students and researchers alike are expected to be conversant in an increasingly broader range of areas this book of problems would be very useful for any physics departmental, or indeed individual research group, library. Highly recommended.

Lloyd C L Hollenberg
School of Physics
University of Melbourne



Properties of Single Organic Molecules on Crystal Surfaces

Peter Grütter, Werner Hofer and Federico Rosei (Editors)
Imperial College Press, London 2006
xii + 430 pp., US$108.00 (hardcover)
ISBN 1-86094-628-3

This book contains a number of separate articles that collectively provide an excellent review of the current state-of-the art in relation to the study of organic molecules on the surfaces of metals and semiconductors. Whilst the main emphasis is on single molecules, molecular assemblies such as superlattices and monolayers are also discussed. The text is logically developed, commencing with reviews of the basic properties of metal and semiconductor surfaces before moving on to discuss the interaction of individual molecules, and combinations of molecules, with these surfaces. The book is pitched at the level of a graduate student but contains a wealth of resources for any established researcher working in the fields of surface physics, nanoscience and molecular electronics. While an active researcher in these areas, I found all of the articles to be of real interest and to contain information that broadened my existing knowledge. The articles were also helpful in not only presenting current research, but in providing critical comment and highlighting areas for future work. I was also impressed by the balance between experiment and theory.

In summary, I believe that this book would be a very valuable text for graduate students, teachers and researchers interested in the interaction of organic molecules with surfaces.

P V Smith
School of Mathematical and Physical Sciences
University of Newcastle

Reviews

Statistical Mechanics (2nd Ed.)

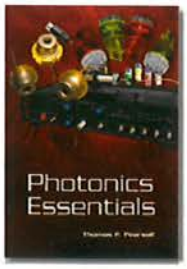
Franz Schwabl
xviii + 577 pp., EUR 74.85 (hardcover)
ISBN 3-540-32343-0

Statistical mechanics forms a cornerstone of modern physics. Starting from a basic knowledge of the interactions of physical systems of particles at the microscopic level, it provides the formalism for calculating observable properties at the macroscopic level. Statistical mechanics thus describes a range of physical phenomena, from nanosystems to stars.

This book gives a thorough account of the subject in a logical though well trodden manner. It begins with the basic principles, including the central limit theorem and the difference between classical and quantum statistics. The following chapters cover equilibrium ensembles, thermodynamics, ideal quantum gases, real gases, liquids and solutions, magnetism, phase transitions, renormalization group theory and percolation, Brownian motion, Fokker-Planck equations and the Boltzmann equation. It concludes with a chapter on irreversibility and the approach to equilibrium. Several more technical topics are left to the appendices.

Each chapter concludes with a reference list and a number of detailed problems. There are 195 problems in total. The book has a clear pedagogic style and is recommended for physics students from third year on. Any book that makes it to a second edition must be doing something well. This one will be a valuable resource for both researchers and teachers alike.

Murray Batchelor
Mathematical Sciences Institute
Australian National University



Photonics Essentials

Thomas P. Pearsall

SPIE Press (McGraw Hill) New York NY 2003

xii + 284 pp., US$70 (hardcover)

ISBN 0-8194-6508-5

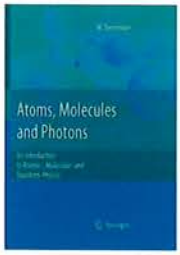
This is an introductory text well suited to the teaching of early-level undergraduates and/or those with a secondary or more practical interest in photonics. The book contains many worked examples and has a strong emphasis on practical measurement and testing. As such it is a particularly useful guide for introductory, laboratory-based photonics courses.

The book is presented in four parts, the first dealing with basic concepts, such as the properties of electrons and photons and introductory band-structure; the second examining the operation of key photonics devices, such as photodiodes, light emitting diodes and lasers; the third dealing

briefly with the modulation of laser diodes, waveguides, modulators, switches and fibre amplifiers; and the fourth considering practical device characterisation concepts and a range of specific experiments.

Although the book has a practical slant it does provide sufficient theoretical background to serve its intended purpose. This is sufficient to describe and understand key device characteristics and to gain an appreciation of photonics design concepts. Both theory and concepts are presented clearly and are supported by many worked examples to assist the reader. The book does contain a number of minor typographical errors, mainly in equations and figures, which can be a little disconcerting for students or less confident readers. Most will be self evident to more experienced readers but any future editions would benefit from further proof reading!

Rob Elliman
Electronic Materials Engineering Department
Australian National University



Atoms, Molecules and Photons

Wolfgang Demtröder

Springer-Verlag, Berlin 2006

xvi + 573 pp., EUR 69.95 (hardcover)

ISBN-10 3-540-20631-0

This book is an outstanding introduction to Atomic, Molecular and Quantum Physics. It reflects the author's detailed knowledge of and very many years of scholarship in the field. I find it to be well written, conveying the intricate detail of atomic and molecular structure clearly and, most importantly, in a manner that will provide the conceptual basis for student understanding. I particularly like the chapters on the experimental techniques in atomic and molecular physics and the modern developments in the field such as optical cooling and the quantum-optics trends.

The text has very many pertinent diagrams that elucidate the mathematical equations and physical interactions under discussion. Chapters are neatly summarised and there are problems for each chapter.

I believe that this book is a valuable addition to the texts on the topic and that those lecturing the material should evaluate is for adoption as a text. It is a very worthwhile addition to the library shelves.

John Holdsworth
School of Physics
University of Newcastle

Newport
Experience | Solutions

Spectra-Physics
A Division of Newport Corporation

Newport's new 1918-C Benchtop Performance in the Palm of Your Hand

Measure a lot, with just a little! Newport's new 1918-C Series handheld Power Meters bring the leading edge performance and advanced features you'd expect to find in a benchtop instrument, right into the palm of your hand.

In designing the 1918-C Optical Power Meter, we combined the feedback received from you the customer, and our own 20+years of experience designing, manufacturing and using laser measurement instruments every day. The result is an instrument that sets a new standard in Optical Power Meters.

Whether you are using the power meter to tweak up your laser, or in an application such as laser spectroscopy, multiphoton microscopy, biophotonics, or nanophotonics, we think you'll be impressed with the 1918-C.
Visit www.newport.com/1918-C

> Compact and ergonomic design ideal for use in the lab and in the field
> Power measurements from 1 nW – 6 kW
> Energy measurements from 250 µJ – 75 J
> Measurement rep rates up to 2 kHz
> Built-in stand for fexible viewing
> Compatible with all Newport "Smart" power and energy detectors

Contact us for a free copy of the Newport Resource catalogue

NewSpec

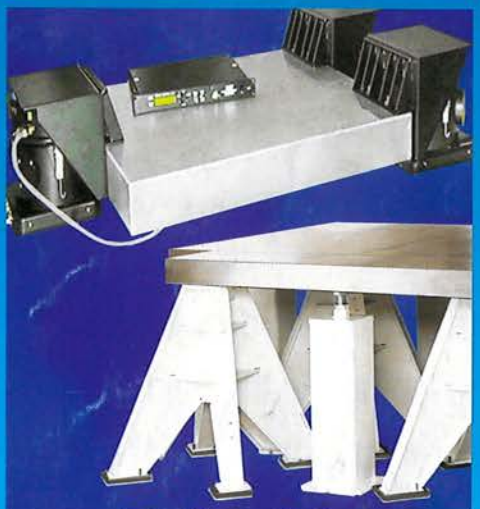
Freecall 1800 153 811
Phone 08) 8273 3040
Fax 08) 8273 3050
sales@newspec.com.au
www.newspec.com.au
83 King William Road
Unley SA 5061
ABN 82 882 831 899

Precision Vibration Isolation Systems for Photonics

Optical Tops Breadboards & Supports

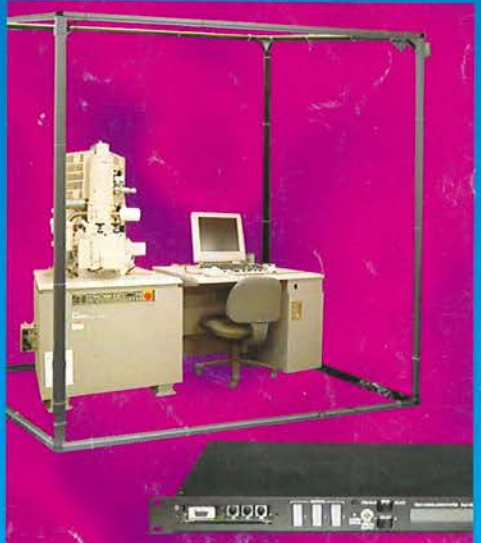
Laboratory Tables & TableTop™ Platforms

STACIS® 2100 Active Piezoelectric Vibration Control System



Raised & Solid Floor Platforms

Electro-Damp® II & OEM Advanced Products



Magnetic Field Cancellation

116 Sir Donald Bradman Drive,
Hilton SA 5033
Phone (08) 8150 5200
Fax (08) 8352 2020
Freecall 1800 202 030
sales@coherent.com.au
www.coherent.com.au

Coherent
SCIENTIFIC
Established in 1989

Coherent Scientific Pty. Ltd., Inc. in South Australia, ABN 20 008 265 969