For some optical tops this would be a problem. Not ours.

Oops! Accidents happen. But if you’re working on a TMC table, they don’t become disasters.

We’ve designed our CleanTop to safely contain spills and small crystals, and to prevent outgassing. Unlike imitations, our all-steel CleanTop design also maintains the highest level of structural damping and stiffness needed for the most critical applications.

Thanks to the high density and small cell size of our steel honeycomb core, TMC optical tops are extraordinarily rigid, flat, and inert to low-frequency vibration. Because we use all-steel construction, no plastic layers or wood, our tops are thermally stable and unmatched in strength.

Our industry standard System 1 modular supports are available with simple levelers, active air isolators, or advanced electromagnetic suspension. You can upgrade or expand your table anytime. On-site.

With a few basic tools. Economically.

And, our world-wide technical service organization assures that while your work is isolated, you won’t be.

So for support you can count on, even during traumatic moments, contact our Technical Sales Group today.

Technical Manufacturing Corporation
Australian Distributor: Lastek Pty Ltd
PO Box 2212, Adelaide SA 5001
Vibration Solutions
ANZIP 20TH CONDENSED MATTER PHYSICS MEETING
CHARLES STURT UNIVERSITY, WAGGA WAGGA

GENERAL INFORMATION
The 20th Condensed Matter Physics Meeting (Wagga 96) will be held at the Convention Centre at Charles Sturt University, Wagga Wagga, from January 30 - February 2, 1996. Accommodation is available on Campus close to the Convention Centre and registration forms can be obtained either from your own institution or from the Conference Secretary at the contact address below.

Financial assistance is available to postgraduate student members of the AIP or the NZIP and application should be made through the Branch Secretaries.

The format of Wagga 96 will be a mixture of review and keynote invited talks on selected topics, contributed talks and poster sessions on all aspects of condensed matter (solid state physics and chemistry, materials science, thin solid film and surfaces etc). There will be no parallel sessions. Abstracts will be published in the conference handbook.

Time will be available for informal discussion and the traditional evening "pursuits". The extensive leisure and sports facilities at the University will be available to all conference participants.

IMPORTANT DATES
Distribution of 2nd notice and registration form
Registration deadline
Abstract submission deadline

End of October 1995
1 December 1995
1 December 1995

ABSTRACTS
Abstracts are requested in all areas of condensed matter. Type abstracts on a single A4 page leaving 25mm border on all sides. Clearly identify the authors and affiliations. Submit the original camera-ready abstract by mail or by e-mail in postscript format. Further details of abstract format will be circulated with the Second Notice. Please note that we cannot accept fax submission of abstracts. Details on presentation and poster board size will be sent with the acceptance notice.

FURTHER INFORMATION
Assoc Prof Trevor Finlayson
or Assoc Prof John Cashion
Department of Physics, Monash University
Clayton VIC 3168 Australia
Tel +61 3 9905 3652, fax +61 3 9905 3637, e-mail wagga96@sci.monash.edu.au

JANUARY 30 - FEBRUARY 2, 1996
November 1995 Volume 32, Number 11

CONTENTS

PRESIDENT'S COLUMN 235
What Do Physicists Do?  Ron MacDonald

EDITORIAL 236
Opportunities For Graduate Students.  Jak Kelly

LETTERS 237

ARTICLE 238
Opportunities for Postgraduate Studies
and Research in Physics.  David Whitehead

PRODUCT NEWS 259

REVIEWS 260
Prompt Critical: Another Fine Book
about Light and Sky Phenomena.  Colin Keay

CONFERENCES & MEETINGS 232

Published 11 times a year, on behalf of the Australian Institute of Physics
and the New Zealand Institute of Physics by Oztactel Pty Ltd.

Contributions should be sent to
Prof Jak Kelly, Editor
ANZ Physicist, Physics, UNSW
Sydney NSW 2052
Tel (02) 385 4597
Fax (02) 663 3420
AH Tel (02) 419 6877
kelly@unsw.edu.au

Enquiries & Advertising
Judith Nikolecki
Production Manager
Impress Studios
13 Hudson Street
Hamilton NSW 2303
Tel (049) 61 3733, fax (049) 61 3747
planet@cc.newcastle.edu.au

Design and Artwork
Impress Studios, Newcastle

Printer
Newcastle Camera Print

ISSN 1036-3831
Copyright 1995
Pub. No. PP 224060 / 00008

Editor
Prof JC Kelly

Reviews Editor
Dr CSL Keay

Editorial Board
Dr MA Box
Prof Ian Johnston
Dr CSL Keay
Prof RJ MacDonald
Dr RJ Stening
Assoc Prof DJ O'Connor

Associate Editor - Education
Mr Malcolm Bowling

Associate Editors
Prof R John Sandeman
Physics & Theoretical Physics
Faculty of Science, ANU
Canberra ACT 0200
Tel (06) 240 0784, fax (06) 249 0741
John.Sandeman@anu.edu.au

Prof Geoffrey Stedman
Physics Department
University of Canterbury
Christchurch NZ
Tel +64 3 364 2549, fax 464 3364 2469

Brad Powe
12 Evan Street
Gladstone NSW 2111

Dr Ian Edmonds
School of Physics
Queensland University of Technology
PO Box 2434
Brisbane QLD 4001

Dr David Liebling
DESTO Maritime Operations Division
PO Box 1750
Salisbury SA 5108
Tel (08) 259 6298, fax (08) 259 5239

Dr ML Duldig
Antarctic Division
c/- Physics Department
University of Tasmania
GPO Box 252C
Hobart TAS 7001

Dr MJ Manton
BMRC
GPO Box 1289K
Melbourne VIC 3001

Liesl Folk
Department of Physics
University of WA
 Nedlands WA 6009
liesl@earwax.pd.uwa.edu.au

The crystals which form the basis of this month’s front cover were grown by A Hartmann of the Advanced Electronic Materials Group, School of Physics, University of New South Wales. The photograph was submitted by Associate Professor GJ Russell, Superconductivity Group, School of Physics, University of New South Wales.

These optical micrographs (magnification 400X), using polarised light, are of the twin structure seen on the a-b surfaces of single crystals of the high Tc superconductor YBa2Cu3O7. The upper photo shows the very fine pattern associated with high purity, high quality, crystals having Tc = 92K, while the lower photo shows a much broader pattern associated with aluminium doped crystals having Tc = 91K. The crystals have similar oxygen content.

234 Australian & New Zealand Physicist Volume 32, Number 11, November 1995
What Do Physicists Do?

At the recent Heads of Departments of Physics meeting in Canberra, we spent a lot of time discussing ways in which we could improve the future of Physics Departments. This, of course, means we spent a lot of time discussing ways in which we can increase the number of students in Physics Departments. This in turn meant we spent time discussing ways in which we can promote Physics as a career.

The Western Australian Branch has produced a careers video to be used to promote Physics as a career in secondary schools. The video is very good and professionally executed - it shows physicists working in a variety of areas, it shows male and female physicists and it shows physicists enjoying themselves at work and away from work.

On reflection though, is it conveying the right message? The physicists used as examples were those engaged in very advanced levels of our craft. I can’t remember all, but two examples were research orientated, with the physicists having PhDs. If we are to create a market for physicists so that we can then promote Physics as a career at the secondary school level, we must also promote the work and career opportunities for a physicist with a first degree.

Many Heads of Departments will confirm that their budgets are strongly influenced by the postgraduate component of their student load. Most universities use some form of funding model which weights the postgraduate student as being at least twice as effective in attracting funding to the Department. Postgraduate studies in Physics are still attractive to the student who tends to major in Physics and Maths. I haven’t seen a detailed study, but I suspect that Physics would rank as one of the disciplines with the highest proportion of majors at first degree level converting to postgraduate enrolees.

In many cases our Physics graduates of today do not need to be sold Physics as a career. They have their plans well set out early in their undergraduate course, and they do Physics for the excitement of it - they tend to worry about a career later.

Of course, we do Physics research well in this country. Again, I haven’t seen a detailed analysis, but I would have thought that Australian Physics is well regarded and contributes in a significant way to the world knowledge, particularly when considered in terms of the number of contributors.

The posters which the AIP supported and which have been distributed to many secondary schools in Australia, do emphasise the part a Physics education can play in a range of careers. The education of a physicist is always strongly based on the development of models. This is very useful in many areas, including positions in financial areas.

Perhaps we need a new initiative which emphasises the opportunities which education as a physicist provides in a wide range of areas. The AIP surveyed some of our members employed in industry recently and we have a number of possible case studies we can follow and perhaps develop into further career oriented material directed at students in their secondary school years. We should also direct this material at parents, since parental input into career choice, particularly when choosing the subjects for the last two years of secondary school, can be quite high.

We would like to receive advice of more case studies which can be used to demonstrate to students the benefits of an education which includes a significant amount of Physics. Physics as the mainstay of much of the science needed to support and improve our environment is also an important piece of advice to emphasise. Finally, and perhaps cynically, Physics as a high TER entry discipline compared with Science in general might be a worthwhile hypothesis to investigate.

Ultimately the fate of Physics as a discipline in tertiary institutions will depend on how well we can manipulate the inputs which the counters-of-beans use to distribute resources. This we must recognise and work on.

Ron MacDonald
vjrjm@cc.newcastle.edu.au
Opportunities For Graduate Students

This issue of the Physicist carries David Whitehead's annual compilation of which Australian university physics departments are doing what. It was originally and still is, intended to help potential graduate students make an informed choice of where they would prefer to do a higher degree. It still fulfills this function admirably but is also extensively used by others as a reference source. It is not ideally suited to this function. It takes some time to discover who is working on the interaction of charged particles with surfaces, for example. In electronic format a key word search would quickly produce the answer. Since we have it in digital form we could do this and similar compilations but the question is should we and if we did, how should we make the information available?

The size of the document has grown over the years. Whether this means an increase in research, or an increase in the verbosity of the physics departments supplying the data is left for you to decide but this seems like a good time to review what we are doing. There is no doubt the annual article fulfills a useful function but perhaps it is becoming redundant with the rapid recent increase in World Wide Web sites. Most physics departments and indeed some physicists, are now on the WWW and their pages contain more information than we can fit in the annual article. They are also in colour, can easily show pictures and in time will not doubt come to incorporate all the singing and dancing features that the technology has to offer. So drop us a letter, fax or preferably email and let us know your opinion on this issue.

In talking to potential physics students you sometimes get replies like "I'm no Einstein so what is the point?" To which a good reply is "How do you know?" It is extremely unlikely that people like Einstein, Newton and Maxwell were utterly genetically unique. What counted, aside from being extremely bright and diligent, was the good luck to be in the right place at the right time and to be interested in the right problem. None of this can be detected in advance and it does not necessarily correlate with exam results. Einstein for example was a poor student. His results were not good enough to secure an academic position on graduation and he only got an undemanding job in the Swiss Patent Office in Bern through the influence of Marcel Grossman's father. This dismal start to his career however left him ample opportunity to think about the right problems at the right time. Fortunately, the patent office was not managed in the manner enthusiastically supported by present day efficiency advisors, with overheads slashed, the staff reduced to a minimum and young Albert staggering home late and tired after the usual compulsory overtime with not a free moment during the day to turn his mind from patents.

What if the student isn't an Einstein? One of the great consolations of a life in physics is that physics has usually been minimally effected by the waves of political and economic lunacy that from time to time seem to sweep through societies. After years of training in cooperation and the recognition of our dependence on the work of others, both our contemporaries and our predecessors going back centuries, we do not easily believe that competition is much more important than cooperation, that winning is everything or that the untrammelled interplay of market forces will optimise the quality of life or produce a well adjusted and stable society.

The long accumulated support systems of physics mean that you are joining one of the world's greatest international clubs with the prospect of making close contacts and indeed good friends, all over the world. There is a general willingness to help, which many find surprising. For such a significant enterprise it is remarkably free from the egomania found in many other large social groups. You may also make significant contributions to knowledge. As Newton remarked, standing on the shoulders of giants, even the vertically challenged can see further ahead.

Jak Kelly
kelly@unsu.edu.au

EXECUTIVE AIP
President
Prof Ron MacDonald Tel (049) 21 5442
Vice President
Prof Jan Ottman Tel (02) 385 4596
Honorary Secretary
Maita Welch Tel (02) 685 9530
m.welch@unsw.edu.au
Honorary Treasurer
Dr R.J. Fleming Tel (03) 565 3672
Honorary Registrar
Prof David Booth Tel (03) 688 4202
Address
Australian Institute of Physics
1/21 Vale Street
North Melbourne VIC 3051
Tel (03) 326 6669, fax (03) 326 2670

EXECUTIVE NZIP
President
Prof Geoff Stedman
Vice President
Mr John Booreboom
Honorary Secretary
Dr Grahame Fraser
Honorary Treasurer
Dr Mike Reid
Address
Department of Physics & Astronomy
University of Canterbury
Private Bag 4800, Christchurch, NZ.
Tel +64 3 364 2581, fax +64 3 364 2469
m.fraser@esc.canterbury.ac.nz

BRANCH SECRETARIES
Dr Rob Elliman
RSFSE
Australian National University
Canberra ACT (0200)
Tel (06) 249 0521
Fax (06) 249 0511
rge109@rsphys.lanu.edu.au

Dr Fred Merk & Dr Bruce King
Department of Physics
University of Newcastle
Callaghan NSW 2308
Fred Merk Tel (049) 21 5424, faxes (049) 21 6907
Home Tel (049) 51 6888
phys703@cc.newcastle.edu.au
Bruce King Tel (049) 21 5448, faxes (049) 21 6907
Home Tel (049) 46 8572
physbrk3@cc.newcastle.edu.au

Dr Ian Edmonds
School of Physics
Queensland University of Technology
PO Box 2434
Brisbane, QL.D 4001
Tel (07) 864 2584, fax (07) 864 1521
iedmonds@qu.edu.au

Dr Laurence Campbell
Dept Physics/Mathematical Physics
University of Adelaide, Adelaide SA 5005
Fax (08) 303 4380
lcampbell@physics.adelaide.edu.au

Dr G.B. Burns
Australian Antarctic Division
Channel Highway, Kingston TAS 7050
Tel (02) 32 3381, fax (02) 32 3351
burns@antd.gov.au

Dr Michael J. Morgan
Department of Physics
Monash University, Clayton VIC 3168
Tel (03) 950 3645, fax (03) 950 3637
Michael.Morgan@sci.monash.edu.au

Dr Chris Lund
School of Mathematical & Physical Sciences
Murdoch University
Murdoch WA 6150
Tel (09) 360 2102, fax (09) 310 9166
c.lund@fmsy.murdoch.edu.au

Australian & New Zealand Physicist Volume 32, Number 11, November 1995
Net Restrictions

Dear Editor,

I have recently received the June issue of the Australian & New Zealand Physicist and read your President's excellent column.

Ever since I began using email on the former BITNET around ten years ago, I have felt an ambiguity about the use of the electronic networks quite similar to your point of view. I am very glad that you as President of the AIP express such a balanced and thoughtful view on the upcoming developments. Most of the time, I see and hear either a much too enthusiastic opinion (mostly from people using the Internet a lot) or, on the contrary, a very restrictive view (mostly from people politically controlling the network resources without having much actual contact with the Internet).

I can add another example to your example of NZ censorship. The administration of the University of Hannover in Germany has banned all newsgroups from the UseNet newsserver of the University with either the character sequence ‘erotic’ or ‘sex’ in the newsgroups title, regardless of the actual topic. This means that even the limited number of scientific sexual science groups or groups in which victims of sexual harassment are discussing their topic are banned. Note that all students at the University of Hannover are adults.

Another point: the upcoming WWW services seem to be the main reason for the exploding network. During the last months I have been writing a paper in collaboration with a colleague from ADFA. In contrast to the situation of two years ago, I was not able to log into the ADFA computer to look at my data files there. The connection simply broke down, or couldn’t be established at all. This situation is at least partly due to the many commercial sites now on the Internet, which was designed as an academic network, not as a global marketplace. Perhaps we will have to build up a new, purely academic network parallel to the increasingly commercial Internet.

A last remark on electronic publishing: obviously I would see my copy of the ANZP much more quickly if sent via electronic mail (I would not have a chance to see it at all if it were only published on the WWW, due to the above mentioned connectivity problems). On the other hand, I would have to pay for both the download (as I run a private connection, not via a university) and for the printout (paper and ink/toner) in addition to the membership fee. This might not be very much and it might be circumvented, but it shows that some of the costs saved at the publishers end would just be shifted onto the customer. I think that this aspect of electronic publishing is quite often left out of the discussion.

Christian Beutiger
roo@wombat.han.de

Obsolescence of Electronic Technology

Dear Editor,

Concerning your editorial, in the September 95 issue of the ANZP, regarding the future of paper as publication medium versus electronic publication, it is important to realise that paper has an important archival property. Paper publications require no hardware or software to read, are stable for hundreds or thousands of years, if the paper is of good quality, allow efficient random-access data retrieval and browsing and individual publications are readily portable.

There is no indication that electronic publications will be supported years into the future by compatible hardware and software systems, nor are there many popular mass-storage media whose stability and readability can be guaranteed into the long term.

Furthermore, the possibility of civil strife and even technological regression may prohibit the use of electronic publications by future generations.

Under these circumstances, paper has a much better chance of survival. If this is not recognised, vast amounts of knowledge stored exclusively in electronic format may become inaccessible to future scholars. An example of lost knowledge is data from the 1960's which is stored using obsolete and unreadable formats.

While recognising that electronic publication is necessary and highly desirable for a variety of reasons, publications should continue to be published in both electronic and printed formats, even if the paper version is produced just for libraries and other knowledge archives.

David Maddison
maddison@fencer.cis.dsto.gov.au

MAG-03 Three Axis Magnetic Field Sensors

FOR PRECISION MEASUREMENTS
OF STATIC AND
ALTERNATING MAGNETIC FIELDS

- Noise levels down to 7 pTrms/√Hz at 1 Hz
- Measuring ranges from ±70 μT to ±500 μT
- Wide bandwidth - dc to 3 kHz, low noise versions to 4.5 kHz
- 3 analog outputs, 0 to ±10 V, proportional to Bx, By, Bz
- Cylindrical, square and submersible enclosures
- ±12 V supply, battery power supply unit available
- 6 channel data acquisition module with 24 bit resolution

Also available: Single axis fluxgate magnetometers with range of probes for measurements from 0.1 nT to 2 nT

ALPHATECH INTERNATIONAL PTY LTD

PO Box 1118, Maroubra Junction 3535 Scarborough Terrace, Parnell, Auckland
Tel: 2-314 2230 Fax: 2-340 8990 Tel: 9-377 0092 Fax: 9-309 8514

Australian & New Zealand Physicist Volume 32, Number 11, November 1995 237
OPPORTUNITIES FOR POSTGRADUATE STUDIES & RESEARCH IN PHYSICS

DAVID WHITEHEAD

Department of Physics & Theoretical Physics, Faculty of Science
Australian National University, Canberra ACT 0200
Head: Dr A Baxter

Quantum and Atom Optics
Nonlinear optics, quantum optics, squeezed states of light, precision optical measurements, interferometry, detection of gravitational waves, manipulation of atoms by light.

Gravitational Wave Detection
Gravitational waves, or ripples in the curvature of spacetime, are predicted by Einstein's general theory of relativity. They are emitted in the most violent events in the universe such as supernovae, binary pulsars or binary black hole coalescence and from the Big Bang itself. They can be detected using ultra-high precision, quantum noise limited (qul) laser interferometers with kilometre scale baselines. As part of the Australian Consortium for Interferometric Gravitational Wave Astronomy (ACIGA) we are designing and testing on the bench top, advanced detector concepts for installation in an eventual Australian long baseline interferometer. We offer projects in: qul interferometry; light recycling; injection locking; numerical modelling; and the application of squeezing to interferometers.

Nuclear Physics
Pure and applied nuclear structure physics, especially gamma-ray and conversion-electron spectroscopy of high spin states of nuclei, materials science studies using gamma-ray techniques.

Quantum Theory
Basic issues in quantum theory, quantum measurement theory.

Aerophysics and Laser Diagnostics
Laser diagnostics for hypervelocity flight and supersonic propulsion studies: planar laser-induced fluorescence for thermometry and species imaging, degenerate four-wave mixing, coherent anti-stokes Raman scattering, multi-photon imaging techniques, interferometry, tomographic recovery of three dimensional phase information, molecular spectroscopy. Computational Fluid Dynamics simulation of atmospheric re-entry flight conditions. Study of combustion re-entry flight conditions. Study of combustion efficiency and measurements of specific impulse in supersonic combustion engines. Augmentation of hypersonic mixing.

Department of Applied Mathematics
Head: Professor B W Ninham

This department works at boundaries of science where physics, chemistry, biology, mathematics, and earth sciences merge. More than half of the research is experimental - in Chemical Physics, Colloid and Surface Science, Biophysics and Condensed Matter Physics. There are closely linked experimental and theoretical groups and collaborative programs with other Departments in these areas. We have particularly strong working links with Chemistry in the Faculties (Prof R. Pashley). Research emphasis can be pure or applied. The latter are represented by externally-funded projects in synthetic membrane design, and materials science.

Experimental Surface Science
The main experimental laboratory is concerned with direct measurements of molecular forces across thin films in simple and complex fluids and between biological membranes; adsorption, condensation and melting. Atomic force microscopy is also available.

Materials Science and Colloidal Theory
Experimental: the experimental work is concerned with microstructured fluids like microemulsions via low angle x-ray and neutron scattering. There is also a strong program in mechanical alloying where a whole range of new materials is being developed.

In the first area the focus is on processing effects on the fibre/matrix adhesion, microstructure of interface down to 1-2 nanometre scale, kinetics of curing and phase separation in the presence of fibres, fracture resistance and damage tolerance, transcrystallinity and polymer blends.

The second area covers design of experiments and optimisation of manufacturing processes; blow moulding of polymers, forging and stamping of automotive components, discrete event modelling of mining operations and materials handling.

Solar Energy and Semiconductor Technology
Research is conducted at the Department in solar photovoltaics, solar thermal energy conversion and solar thermochemistry. In addition, research is conducted in the area of silicon technology. Specific topics include radiation tolerant space cells, concentrator solar cell and epitaxial growth of high quality silicon on low cost substrates for solar cell applications. A well equipped device fabrication laboratory is available, as well as 400m² and 20m² parabolic dishes for solar concentration.

Research School of Physical Sciences & Engineering
Australian National University, Canberra ACT 0200
Director: Professor E Weigold

Emeritus Professor David Whitehead is in the Department of Physics at the University of Queensland.
Theoretical: the theoretical effort is in structure and transport in random and chaotic materials, the statistical mechanics of liquids, especially electrolytes at interfaces, and self-assembly of biological and membrane mimetic molecules in solution.

ATOMIC AND MOLECULAR PHYSICS LABORATORIES

Head: Dr MT Elfed

The work in the Laboratories is focused on the study of fundamental atomic and molecular processes and their application to technological devices and the understanding of atmospheric and astrophysical processes. Experimental and theoretical studies are carried out in three groups, the Diffusion Research Unit, the Electron Physics Group and the Ultraviolet Physics Unit.

Diffusion Research Unit

The Unit studies the properties of pure fluids, liquid mixtures and electrolyte solutions as well as their constituents, by experimental measurements of diffusion, viscosity, conductance and p-V-T properties as pressures up to 400 Mpa.

The aim of the Unit's work is to obtain a better understanding of the interactions between particles in liquids and solutions to enable prediction of health effects. For example, for the properties of new refrigerants to replace current ones that attack the ozone layer, the amount of water attached to ions, etc. The interpretation of the experimental data uses computer models obtained from simulation, and theoretical approaches based on statistical mechanics which provide cross-linking between equilibrium thermodynamics and transport processes (thermodynamics of irreversible processes).

Low Energy Electron Scattering and Transport

Experimental studies of low energy scattering by atoms and molecules are carried out using both single collision and swarm techniques. Current projects include high resolution spectroscopic studies of heavy metal vapours, electron transport in atomic and molecular gases, electron scattering from NOx and SOx and other molecules of atmospheric importance, and scattering from excited atomic species. These experiments are carried out on a wide range of high resolution electron spectrometers and drift/diffusion apparatus. Most of the work involves close collaboration with scattering theorists.

Electron Momentum Spectroscopy

High energy electron impact is used to study ionisation using the (e,2e) technique. Much of this work is devoted to the application of Electron Momentum Spectroscopy (EMS) to the study of the electronic structure of matter. EMS enables the direct determination of the momentum densities (the square of the momentum wave function) of the electrons in the material of interest, as well as the determination of the electron binding energies. Experimental facilities include a versatile (e,2e) spectrometer which is also capable of studies with spin-polarised projectile and target beams. This work is generally carried out in collaboration with quantum chemists and structure theorists.

Ultraviolet Physics Unit

The Unit studies problems of atmospheric, aerodynamic and astrophysical significance relating to the interaction of vacuum ultraviolet radiation with gaseous matter. Such studies are fundamental in understanding, for example, the vertical distribution of ozone in the atmosphere, and atmospheric residence times of pollutants. Photodissociation in molecular gases is studied experimentally at a range of wavelengths, temperatures and pressures with the aid of the Unit's 2.2 m and 0.2 m vacuum monochromators and powerful sources of ultraviolet radiation, including UV lasers. The experimental programme includes studies of fluorescence and laser spectroscopies. Semi-empirical modelling of spectra, which enables interpretation of experimental results and extraction of fundamental molecular parameters, is performed using the wide range of computing equipment available to the Unit.

Atom Manipulation with Lasers

The cooling and trapping of atoms by laser light is being used to develop controlled atom beam sources for fundamental atomic collisions and atomic optics experiments. Current projects include the development of a high brightness beam of metastable excited atoms for electron scattering experiments and for direct-write lithography with applications to microcircuit fabrication and atomic waveguides. This is a collaborative venture between the UPI, the Laser Physics Centre and the Physics Faculty, which has been funded as a strategic initiative within the University.

LASER PHYSICS CENTRE

Head: Professor B Luther-Davies

The Centre concentrates on the application of lasers to solid-state spectroscopy; ultra-violet laser spectroscopy of atoms and molecules; nonlinear optics; quantum optics; and plasma and x-ray physics. The Centre houses a wide range of laser equipment including ultra-short pulse systems based on Ti:sapphire; optical parametric generation; and chirped pulse amplification of Nd lasers to support the work in nonlinear optics; excimer pumped dye lasers are used for VUV spectroscopy; CW high resolution dye and Ti:sapphire lasers are the main tools of research into solid-state spectroscopy and quantum optics.

Laser-Plasma Interactions

Research on plasmas produced by intense laser beam radiation include studies of absorption and scattering processes; generation of fast electrons and ions, hard x-rays and magnetic fields; effects of light pressure, self-focusing, wave-guides, surface waves, non-linear phenomena in laser created plasma; spectroscopy of laser produced plasmas; surface plasmons and polaritons. Now we are stepping into new fields of laser-matter interactions at relativistic intensities, which promises insight on matter behaviour at electric field amplitudes a few times larger than the interatomic field (E = 7.10^10 W/m).

Solid-State Laser Spectroscopy

High resolution tunable dye lasers are used to eliminate inhomogeneous broadening in solids and allow new experimental techniques to be used to study fundamental dephasing processes, spectral diffusion, hyperfine and superhyperfine interactions and Stark and Zeeman effects. An ultra-high resolution laser has been developed and used to burn the narrowest ever spectral line in a solid. The line has potential for use as a frequency standard. A further study involves the fundamental interaction between electromagnetic radiation and a two-level system. Materials of interest include semiconductors multi-quantum wells as well as colour centres and impurity centres in insulators.

Atom Optics

Research on the laser manipulation of atoms is used to create devices which are the direct analogues of optical elements for light. The wave-like properties of the atomic de Broglie wave have been exploited to create gratings and beamsplitters for atoms. Lasers are also used to steer atomic beams for direct-write lithography with applications to microcircuit fabrication and atomic waveguides. The cooling and trapping of alkali atoms by laser light is used to provide sources of controlled atoms for these experiments.

UV Laser Spectroscopy

Nonlinear optical techniques are studies at a fundamental level to examine, for example, quantum mechanical interference between competing, laser-induced transition pathways in atomic systems. The same nonlinear optical techniques are applied to the generation of high intensity, narrowband, tunable UV radiation which is used for high resolution VUV laser spectroscopy of atmospheric molecular systems in collaboration with the Atomic and Molecular Physics Laboratory.
Nonlinear Optics

A major part of our nonlinear optics program focuses on the development of novel nonlinear optical materials and structures for use in photonics. Nonlinear optical phenomena are researched including: photorefractive effects in bulk materials and waveguides; second order nonlinear processes such as optical parametric generation and harmonic generation; third order nonlinear processes for all-optical switching and spatial solutions; and nonlinear waveguide physics including the processes relevant to ultra-short pulse generation from lasers.

Quantum Optics

Experiments in quantum optics concentrate on high resolution atomic spectroscopy involving the nonlinear interaction of atoms with intense radiation fields. Of particular interest is the back-reaction of the nonlinear process onto the optical field which produces novel forms of light which can then be used for new measurements.

OPTICAL SCIENCES CENTRE

Head: Professor AW Snyder

The Centre performs fundamental and applied research in optical physics and in vision research, stressing inter-disciplinary approaches. A dynamic team is working at the forefront of new ideas where each theme involves fundamental research and is rich in potential technological spin-offs. Most importantly of all, these advances at the ANU could well signal the advent of futuristic all-optical technology. The Centre arguably has the most distinguished faculty world-wide in the mathematical physics of nonlinear wave optics, particularly in the dynamics of spatial solitons. Furthermore, the OSC is a key player in the largest cooperative research centre (Australian Photonics Cooperative Research Centre) and is also highly active in applications-oriented research.

Visual Sciences

Global Strategies for Brain and Machine Vision: The manner in which the brain incorporates prior knowledge of the visual environment to accelerate visual information processing in general and object recognition in particular. This research is performed in collaboration with visual biologists and computational scientists. The most recent approach to these questions probes the extraordinary capabilities of autistic child artists.

Optical Physics

Light Guiding Light: Guiding and manipulating light by light itself without any intervening fabricated structures. A topic revolving around the physics of dynamic spatial solitons and one relevant to futuristic all-optical devices. This research has been a passion at the Optical Sciences Centre since 1990 and was featured in the New Scientist, (Vol. 12 January 1991, p.14). Various theoretical predictions have now been realised collaboratively with the experimental program of the Laser Physics Centre.

Unification of Linear and Nonlinear Waves: A new conceptual approach whereby nonlinear waves are viewed from the perspective of linear physics. This philosophy not only unifies nonlinear waves but it has also been the crucial inspiration for several discoveries of major significance, including dynamic solitons and the universal stability criterion on nonlinear guided waves.

Nonlinear Dynamics of Multi-Component Solitons: Research in this area covers several modern problems in optics: short pulse propagation in birefringent optical fibres, solitary waves in nonlinear coupled, and spatial and temporal vector solitons in nonlinear media, etc. The theory of Hamiltonian dynamical systems with an infinite number of degrees of freedom is developed to describe these type of phenomena and to predict novel effects.

Nonlinear Waves and Solitons in Higher Dimensions: The aim here is to observe and identify spatial and temporal solitons in experiments, with the higher dimensions being analysed in detail. This includes two and three-dimensional spatial (dark, grey and bright) solitons as well as soliton-like objects ("light bullets") in waveguide structures. One of the purposes is to establish a link between realistic physical models and exact integrable equations.

Optically Written Photonic Circuits: Collaborative development of the direct writing of waveguides and passive, active and nonlinear devices for the processing of light in photonic circuitry using a computer-controlled focussed laser beam on trilayers of optically transparent material containing a doped central region with a high photoelectric response.

Planar Waveguides and Devices: Novel planar optical devices, such as mode combiners, separators and transformers, multiport couplers, multilayered guides, grating assisted devices and integrated-optics interfaces, are being devised for a broad range of applications, including optoelectronic circuitry, telecommunications networks, optical sensing and confocal microscopy.

Optical Fibres and Devices: Collaborative development of practical application-specific fibres, such as multicore fibres for devices and capillary and evanescent field fibres for optical sensing, as well as optimised fibre devices, including multicore connectors, grating-assisted wavelength demultiplexers and hybrid couplers for confocal microscopy applications.

PLASMA RESEARCH LABORATORY

Head: Professor RL Dewar

Toroidal Experiments and Diagnostics

The Laboratory's largest single line of research concerns the properties and behaviour of hot plasma (1-10 million K) confined by strong toroidal magnetic fields. The Laboratory is playing a leading role in the development of an advanced plasma confinement for controlled geometry, the helical axis stellarator (helias). A large Heliac (H-1) is part of an internationally co-ordinated program on plasma confinement for controlled fusion research and forms the focus of a national collaboration by a consortium of Australian universities.

Postgraduate opportunities encompass development of advanced plasma diagnostics, experimentation on high-temperature pulsed plasma as part of a team, or basic plasma physics experiments performed on a single, continuous mode of operation. This includes research into innovative laser-based methods of imaging and tomographic reconstruction of turbulent plasma interiors, including "real-time" processing and display, investigation of the basic equilibrium, stability and transport properties of magnetically confined plasma, characterisation and identification of waves and instabilities in the plasma, and investigation of the magnetic geometry from external measurements or by direct visualisation of the vacuum magnetic field.

Plasma Wave Propagation and Interactions

Another major activity is the experiment by experiment and computation of the interaction on radio frequency power with plasma for many diverse applications (e.g. optical lasers, industrial processing, magnetic confinement) as well as studies of wave propagation and nonlinear wave-particle interactions in situations relevant to space and astrophysics.

Plasma Processing of Materials

The Laboratory has developed the new generation Helicon plasma processing systems and is actively researching the etching of silicon, silica, silicon-germanium alloys, gallium arsenide, indium phosphide and materials and flat panel displays. Helicon and electron beam evaporation systems are used for the deposition of silicon, silica and silicon-germanium films. A full range of diagnostics, including optical and mass spectroscopy, particle energy analysis, ellipsometry and plasma probes, is used for gas phase and surface studies. The results of these experiments have had major implications to processing microelectronic circuits. In collaboration with the Optical Sciences Centre, the laboratory has fabricated silicon planar optical waveguides for telecommunications.
Theoretical and Computational Plasma Physics

The experimental work is complemented by theoretical and computational studies aimed at understanding the underlying fundamental processes which are observed in a wide range of theoretical concepts and tools, e.g. non-linear dynamics and large-scale computing, with extensive use of supercomputers. This is conducted jointly with theoretical plasma physics group of the Department of Theoretical Physics.

ELECTRONIC MATERIALS ENGINEERING

Head: Professor JS Williams

Research in this Department concentrates on the near-surface processing, modification and characterisation of materials. Silicon, gallium arsenide and III-V compound semiconductor structures are emphasised but other materials, particularly the preparation of novel metallic alloys, are also of interest. The Department collaborates with other staff of the Research School of Physical Sciences and Engineering and in addition has strong collaborative programs with other Australian and overseas Universities and Research laboratories. Equipment and facilities include: a 1.7MV tandem high current ion implanter, a Riber Secondary Ion Mass Spectroscopy system for ultra sensitive elemental profiling, an MOCVD reactor for growing III-V epitaxial layers, thin film deposition facilities, Rutherford backscattering and channeling for near surface analysis, a ball milling laboratory, x-ray and DSC facilities for structural and thermal analysis, electrical analysis facilities, and device processing capabilities.

Ion Implantation

Research in this area involves the physics and materials science of ion-irradiated semiconductors and related materials. Central to this research are the Department’s world-class experimental facilities, including a 1.7MV high-energy, high-current ion accelerator (ion-implanter) and a broad range of physical and electrical characterisation techniques. Studies involve both fundamental and applied research and provide graduate students with a strong background in experimental physics and materials science. Current studies include: the nature and evolution of radiation damage in semiconductors; ion-irradiation induced phase changes; solid phase epitaxial crystallisation of amorphous layers, diffusion in crystalline and amorphous semiconductors, quantum-well superlattices; the formation of ternary alloys and compounds, the electrical properties of ion-irradiated semiconductors, and many others.

Epitaxial Growth of Semiconductor Multilayers

Novel multilayers of III-V compound semiconductors are grown by metal organic chemical vapour deposition (MOCVD). Research involves the study of reactor chemistry, growth of atomically abrupt layers of GaAs/AlGaAs/InGaAs on GaAs, InP and Si substrates for optoelectronic applications such as lasers, waveguides and modulators. Research also involves abrupt high doping profiles and the detailed characterisation of grown layers by optical or electron based techniques and electrical measurements. The characterisation of defects by DLTS and other techniques is also emphasised.

Ball Milling/ Mechano-Chemistry

Research concentrates on the engineering of new microcrystalline, nanocrystalline and amorphous alloys and compounds using mechanical alloying and solid state reaction techniques. The stability of these materials is also studied. Mechanical alloying technology is used to produce metallic alloys that cannot be synthesised with traditional techniques. It can be achieved by ball milling at room temperature to produce a mixture of powder particles of extremely fine microstructure in either crystalline or amorphous form. X-ray diffraction and TEM are employed to study structural properties, differential scanning calorimetry, to provide the kinetics of phase transformations, SIMS and other techniques are also used to fully characterise the material.

NUCLEAR PHYSICS

Head: Professor GD Dracoulis

The Department operates the premier facility in Australia for accelerator-based research in Nuclear Physics. The experimental program exploits the flexibility and selectivity of heavy-ion induced reactions to study nuclear properties. Most areas of research in this field are complementary and overlap in terms of both shared techniques and in providing an understanding of inter-related aspects of nuclear structure and nuclear interactions. The facilities are centred on the H4U electrostatic heavy-ion accelerator which operates at voltages in excess of 15 MV. Many experiments make use of the ability to pulse the beam, in selectable time regimes, from nanoseconds to seconds. The accelerator is being augmented by the addition of a modular superconducting linear accelerator which will substantially increase the mass range of heavy ions that can be accelerated above the Coulomb Barrier. Instrumentation for γ-ray and electron spectroscopy includes an array of Compton-suppressed γ-ray detectors recently expanded with a compact particle detector array, a superconducting solenoidal electron spectrometer, and a fast transport irradiation device. The fusion and fission studies exploit a 2 metre scattering chamber and a range of multiple-angle hybrid gas proportional detectors designed and constructed in-house. A new high-efficiency fission fragment detector array is undergoing its first tests. The AMS program uses a dedicated beam-line with a specialised heavy-ion detector system. The beam transport and selection system is to be expanded to include a Wien filter. The PAC facility utilises an array of four barium fluoride detectors with associated fast electronics. Data acquisition and analysis is based on a system of VAX computers, networked to the School and University systems.

Dynamics of Heavy Ion Reactions

Study of the fusion of heavy nuclei and the modes of decay of the nuclei so formed, particularly through the competing processes of particle evaporation and fission. Fusion and Fission dynamical timescales; nuclear viscosity; dependence on angular momentum, nuclear ground-state shapes and level densities at high temperature.

Nuclear Spectroscopy

High-resolution, time-correlated γ-ray and electron conversion techniques: identification and characterisation of new, very neutron-deficient nuclei; shape co-existence; high-spin states; high-spin isomers, competition and transition between single-particle and collective excitations.

Nuclear Moments, Hyperfine Fields

Configurational structure of nuclear levels through measurement of nuclear gyromagnetic ratios using; externally applied magnetic fields and time-dependent angular distributions for isomeric levels and internal hyperfine field and integral perturbed angular correlations for short-lived states. Studies of transient and static hyperfine magnetic fields acting on ions moving or at rest in ferromagnetic materials. Nuclear quadrupole moments by perturbed angular distributions caused by electric field gradients in non-cubic crystals.

Accelerator Mass Spectrometry

Measurement of 13C1, 15N1, 14C, 95Te, 18Be and 129I with many dating and tracing applications in the fields of archaeology, geology, hydrology and biomedicine. Development of AMS techniques.

Perturbed Angular Correlations

Materials: Implication of radioactive nuclear species with known nuclear moments to probe the local electric and magnetic fields in solids. Application to the study of semi-conductor materials.

THEORETICAL PHYSICS

Head: Dr RJ Baxter

The Department provides an exceptional environment for promoting theoretical activities in many related branches of physics, with researchers sharing information and ideas about common techniques. A substantial part of the work relates to the experimental interests of the Research School. Principal research interests are: ▶
OPPORTUNITIES FOR POSTGRADUATE STUDIES AND RESEARCH IN PHYSICS

**Biophysics**
Model studies of ionic channels in cell membranes, molecular dynamics simulations.

**Atomic and Molecular Physics**
Ab initio calculations of electron scattering and photon absorption from atoms and molecules. Transport theory of ions and electrons.

**Condensed Matter Physics**

**Nonlinear Dynamics**

**Nuclear Physics**
Heavy-ion reactions; investigation of resonant structures using optical model, coupled-channels LCNO and DWBA methods. Quantum chaos in nuclear reactions. Interacting boson model; high spin states. Meson exchange effects in medium energy reactions.

**Particles and Fields**
Quantum chromodynamics. Models of hadrons. Non-perturbative methods in quantum field theory; quantum electrodynamics in two space and one time dimensions. Relativistic wave equations.

**Plasma Physics**
Linear and nonlinear studies of instabilities, especially in geometries relevant to fusion power. Three dimensional magnetohydrodynamic equilibrium and stability. Nonlinear dynamics and chaos in plasmas. Computational physics.

**Statistical Mechanics**
Exact solutions of lattice models with their phase transitions and critical exponents. Integrable models; uniformising substitutions for high genus Riemann surfaces.

**Geochronology and Isotope Geochemistry**
Leader: Professor W Compston
Studies of isotopic abundances in terrestrial, planetary and meteoritic materials, with particular emphasis on uses of radiogenic isotopes in age determination of geological and meteorite material. Development of techniques of microbeam analysis including applications of laser, electron and ion beams to isotopic and chemical analysis of natural materials.

**Scholarships**
In addition to Commonwealth Postgraduate Research Awards and ANU Ph.D Scholarships, a limited number of endowed scholarships are available for Honours Year and PhD study.

---

**Mount Stromlo and Siding Spring Observatories**
Australian National University
Private Bag, Weston PO ACT 2611

**Director:** Professor JR Mould

Astrophysical research encompassing observational and theoretical aspects of stellar atmospheres and evolution, the interstellar medium, the structure and stellar populations of the Milky Way Galaxy, the Magellanic Clouds, external galaxies, radio sources, quasars and cosmology.

The Observatories operate eight optical telescopes (up to 2.3 metre aperture) on Mount Stromlo and Siding Spring Mountain, equipped with modern instrumentation permitting low and high resolution spectroscopy, photometry from near ultraviolet to infrared wavelengths, and faint object imaging. There is access to the 3.9 m Anglo Australian Telescope, the 64 m Parkes Radio Telescope, and the Australia Telescope Synthesis Array. Staff and students at MSSSO seek and are given access to overseas ground-based facilities such as the infrared facilities on Hawaii and the Very Large Array in the USA together with space-based facilities such as ultraviolet and x-ray and infrared satellites.

Theoretical work is currently being done on plasma astrophysics, stellar atmospheres, stellar and galactic evolution, galactic dynamics, and cosmological modelling. Powerful computing facilities (a suite of SUN workstations and the ANU's Fujitsu VP2200 supercomputer) are available for data acquisition and analysis and theoretical model building.

**Scholarships and Support**
There is a postgraduate (PhD) student body of about 20 at the Observatories. Scholarships supporting the PhD course are available through the APA Scheme and directly through the Observatories. A Vacation Student Program for third year physics, mathematics or engineering students is conducted each year between December and March.

---

242  Australian & New Zealand Physicist / Volume 32, Number 11, November 1995
**Biophysics**

Mechanical measurements to probe the molecular mechanisms of muscle contractions.

**Laser and Optical Physics**

Including the ARC Special Research Centre for Lasers and Applications.

Development of high-average-power metal-vapour lasers, particularly studies of kinetic processes and optical characteristics; frequency conversion of high-power metal-vapour lasers; optical characteristics of rare-gas-halide excimer lasers; diode-pumped solid-state lasers, particularly self-frequency-doubling lasers; mode control of mid-infrared lasers; development of line-selectable mid-infrared lasers based on tunable solid-state lasers and nonlinear frequency shifting; theoretical modelling of gas and solid-state laser systems; basic studies of nonlinear optical phenomena; laser applications and systems development for medicine and biomedical diagnostics; uv-vis laser micromachining in metals, polymers and ceramics; external-cavity laser diodes, systems and dynamics; Tcapphire lasers; laser cavity design; fm lasers; infrared lasers. Hamiltonian optics, semi-geometrical optics, diffraction, optical design, global optimisation, interferometry.

**Materials Physics**

Ceramic/polymer composites: electronic, optical, mechanical and thermal properties of conducting polymers; dielectric, electro-optic and piezoelectric properties of ferroelectrics, laser ablation of polymers.

**Quantum Optics**

Cavity quantum electrodynamics; micromaser theory, quantum trajectories methods; fundamental tests atomic field theory; quantum tunnelling through laser beams, ultracold atoms, Bose condensation; optical tests of quantum theory.

**Solid State Physics**

MOCVD growth of III-V semiconductors, quantum confined structures and optoelectronic devices (eg SEEDs), infrared detectors, liquid-phase epitaxial growth, radio-frequency reactive sputtering, photodissociatively deposited nitride dielectrics, high-mobility semiconductors, quantum theory and transport theory of electrons in imperfect crystals.

**Scholarships**

Australian Research Awards, Macquarie University Postgraduate Research Awards, Centre for Lasers and Applications Research Awards.
High Energy Physics
Current activities involve an accelerator experiment on neutrino oscillations, a program to investigate heavy ion collisions and development of particle detectors.

Microscopy and Microstructural Analysis
Studies of the microstructure of materials; defects in semi-conductors; microanalysis using x-rays and electrons.

Optics
Optical instrumentation, Fourier optics, diffraction and imaging theory, development and applications of scanning optical microscopy; adaptive optics; image processing and 3-D reconstruction; quantum optics; fundamentals of the photosynthesis process.

Optical Fibres
Theoretical and experimental research in optical fibres, including special geometries, gratings and non-linear effects; fibre devices for telecommunications and sensing. The research is carried out in association with Sydney University's Optical Fibre Technology Centre, part of the Australian Photonics CRC.

Physics Education
Investigation of conceptual relationships in Physics. Areas include the development of conceptual understanding, use of computational and numerical techniques and their effects on curricula, and the development of effective modes of presentation.

Plasma Physics
Tokamak studies of wave-plasma interactions, development of plasma diagnostics, gyrotron and laser development and applications, laser and spectroscopic studies of processing plasma discharges, including helium wave and microwave discharges used for thin film deposition.

Theoretical Astrophysics
Studies in theoretical astrophysics, particularly plasma astrophysics, high energy astrophysics and solar physics.

Theoretical Physics
Optical properties of surfaces, electromagnetic scattering theory, optical fibre theory, transport properties of composite materials, non-linear plasma theory, processes in laboratory plasmas, quantum electrodynamics.

Scholarships and Support
Australian Postgraduate Awards and University Postgraduate Research Scholarships. The School of Physics provides excellent research facilities and support from academic and technical staff. Further details of all aspects of postgraduate study can be obtained from the Postgraduate Coordinator, Dr. B.W. James (email: james@physics.uq.oz.au).

NSW
School of Physics
University of New South Wales
Kensington NSW 2033
Head: Professor J Olimaa
Postgraduate Director: Assoc Professor GJ Bowden

The School has about 40 academic staff and 60 research students and offers supervision in a wide range of fields. A detailed brochure entitled Research Profile of the School of Physics and Opportunities for Postgraduate Studies is available upon request.

Astrophysics and Optics
Optical infra-red and radio astronomy; observational cosmology; quasars; planetary nebulae; star formation; supernova remnants; photo-dissociation regions; astronomical instrumentation; infra-red detector arrays; Antarctic astronomy.

Biophysics
Structure and properties of biological and artificial membranes; cryobiology; in vitro NMR spectroscopy and imaging; x-ray diffraction; electrical cell fusion; molecular biology; biological sensors.

Condensed Matter Physics
Surface and thin film physics; XPS and Auger spectroscopy; cleavage processes; semiconductors; optoelectronics; high temperature superconductors; laser studies of quantum well and layered semiconductors; magnetic resonance techniques including NMR, EPR, NQR and Mossbauer; new magnetic materials; rare earth intermetallic compounds; high pressure (diamond anvil) and low temperature studies of low-dimensional semiconductor systems.

Environmental and Applied Physics
Atmospheric and ionospheric physics; remote sensing; air pollution; water purification using membranes; acoustics; underwater acoustics; musical acoustic; sonar.

Low Temperature and Pulsed Magnet Facility
The National Pulsed Magnet Laboratory is housed in the School of Physics. Intense pulsed fields to beyond 60 Tesla are available, together with cryostats capable of reaching 25 mK. Research is focused on low dimensional semiconductors including nano-structure devices, superconductors, heavy fermion and magnetic materials.

Theoretical Physics
Atomic, nuclear, and elementary particle physics; condensed matter theory and statistical mechanics; solid surfaces and high temperature superconductors.

SALES
Physics Instruments
ALPHATECH SYSTEMS is a leading distributor of equipment to the Physics Research, Nuclear Medicine and Oncology Departments of New Zealand. We are currently seeking a highly motivated person to take responsibility for sales of this equipment throughout New Zealand, based in Auckland.

The successful applicant will be required to combine selling skills and technical expertise. A tertiary qualification in Physics or Physical Sciences would be advantageous. Selling experience is preferable but of highest importance is the ability to absorb and communicate technical product information. A competitive package will be provided.

Please reply to:
C. Bishop, Alphatech Systems Ltd,
Box 37583, Parnell, Auckland NZ
SCHOOL OF PHYSICS

RESEARCH FELLOW IN ATOM OPTICS (EXTENDIBLE TENURE)

An innovative motivated experimental physicist is sought to work in an established program to develop optical elements for manipulating beams of laser-cooled atoms for atom interferometry. This is part of an industrial collaborative project between the School of Physics at The University of Melbourne and the CSIRO Division of Materials Science and Technology in Clayton. You will be based at the School of Physics but will work in close liaison with scientists at CSIRO.

You should have a PhD in experimental physics, with demonstrated skills in optics, vacuum technology and computer modelling. It would also be advantageous to have experience in laser cooling techniques and theory of atom-laser interaction and to have experimental skills in laser diode systems, magnetics and electronics.

The appointment is expected to be for a period of three years.

Salary: $29,539 - $40,087 p.a. (Research Fellow Grade 1)
Academic enquiries may be directed to: Professor G I Opat, School of Physics, The University of Melbourne (03) 9344 5121; fax (03) 9347 4783; email: opat@physics.unimelb.edu.au or Dr P Hannaford, CSIRO, Division of Materials Science and Technology (03) 9542 2874; fax (03) 9544 1128; email: hannaford@irwett.msv.csiro.au
Applications close: 20 December 1995
Reference number: Y0002980
Applications (including the names and facsimile numbers of three referees) should quote the reference number and be sent to the Director, Personnel Services, The University of Melbourne, Parkville, Victoria, 3052; fax (03) 9344 4694.

The University of Melbourne is an equal opportunity employer and has a smoke-free workplace policy.

Scholarships and Support

Australian Postgraduate Research Awards; supplementary scholarships include the Gordon Godfrey Scholarship in Theoretical Physics; support from ARC and other research grants is sometimes available. A limited amount of part-time demonstrating in the school is usually available. More details can be found in the school brochure.

The major research interests of the Department are in the areas of materials technology, electron microscopy, medical physics, physics education, theoretical physics and computational physics. There are several major funded research projects currently underway in all these areas, and several of the projects link closely with industry. There is also significant interaction between members of the Department and other research organisations such as CSIRO, ANSTO and other Australian universities. Extensive experimental facilities and computing facilities are available within the University and through external collaboration. Some of the research projects underway are:

Materials Physics and Technology

Thin films, nanocomposites, ellipsometry, advanced windows (electrochromic and angular selective), x-ray, electron and atomic force microscopy, and RBS; neutron diffraction, inclusions, defects and optical properties of high temperature ceramics and compound semiconductors, cathodoluminescence, structural studies of SYNROC related compounds, high Tc materials, materials probes fields.

Imaging Science and Medical Physics

Medical imaging techniques: emission tomography; magnetic resonance imaging; ultrasonography; image fusion; tomographic reconstruction; motion correction; image segmentation; volume estimation satellite data retrieval and atmospheric imaging, image reconstruction in electron microscopy.

Theoretical and Computational Physics

Polarisation of complex particulates and arrays, advanced effective medium theory, exact fields and trajectories in multi-electrode ion optics, physical applications of hypercomplex variable theory, flux dynamics in high Tc superconductors, ion motion in fractal systems, climate modelling and 'greenhouse' predictions, defects in ceramics and semiconductors, deconvolution of x-ray diffraction spectra.

Physics Education

Computers and multi-media techniques in Science Education, cross-cultural science education, diagnostic testing as a guide to teaching strategies, new approaches to laboratory teaching in physics courses.

Scholarships

Candidates for postgraduate degrees are eligible to apply for Commonwealth Postgraduate Awards and Universities awards. Part-time study is available to all postgraduate courses, and some positions may be available from time to time through funded research projects.

Department of Applied Physics
University of Technology, Sydney
PO Box 123, Broadway NSW 2007

Head and Postgraduate Coordinator:
Professor GB Smith

NSW

Department of Physics
University of New England, Armidale NSW 2351

Head: Associate Professor CA Sholl

Gaseous Electronics

Ionisation growth in electrical discharges through gases; detection and characterisation of neutral metastable particles excited in gas discharges; the Penning effect; the chemistry of sulphur hexafluoride in coronas and glows.

Laser Physics

Optogalvanic effect: effects of mode structure and polarisation; development of a modeless dye laser; Raman scattering.

Materials Physics

Sound transmission and electrical conduction in granular media; acoustic impedance of sintered powder compacts.

Optical Fibre Sensing

Development and application of optical fibre interferometry and chemical sensing techniques for the study of electrical discharges in gases; applications in rural science.

Plasma Physics

Plasma nitriding of steel surfaces; transport studies in magnetically confined plasmas (in collaboration with ANU).
Theoretical Condensed Matter Physics
Solid state diffusion due to point defects; diffusion of hydrogen in metals; nuclear spin relaxation in condensed matter.

Postgraduate Scholarships
Scholarships available are Australian Postgraduate Awards and University of New England Research Scholarships. Applications close on 31 October. There is also the possibility of casual paid teaching in the Department.

NSW Department of Physics
University of Newcastle
University Drive, Callaghan NSW 2308
Head: Associate Professor DJ O'Connor

Surface Physics
Ion-surface Interaction: low and medium energy ion-surface scattering for composition and structural analysis; electron exchange processes in ion-surface interaction; molecular effects in ion-surface scattering; sputtering and secondary ion emission; excited state distributions in sputtered atoms, laser positionisation, scanning tunnelling microscopy. Ion Implantation: recoil implantation from thin films; ion mixing and radiation enhanced diffusion; surface property modification. Electron Surface Interaction: low energy electron diffraction; Auger electron spectroscopy; electron loss spectroscopy; x-ray photoelectron spectroscopy and scanning Auger microscopy; electronic structure of transition metals and compounds; surface compositional analysis of alloys.

Space Plasma Physics
Generation and propagation of ULF plasma waves in near-Earth space, including ion-cyclotron waves and heavy ion effects; resonances of geomagnetic field lines; interaction of ULF waves with the ionosphere; studies of ELF waves. The group operates extensive ground magnetometer arrays in Australia and Antarctica and uses ground and spacecraft data from the international space physics community. Group members have participated in numerous Antarctic expeditions. Facilities which exist for data analysis and exchange and theoretical studies include an 8-station 386-486 PC LAN accessing Antarctic, U.S. and Japanese data source.

Theoretical Studies
Semi-empirical and ab initio total energy and molecular dynamics calculations of the reconstruction of semiconductor surfaces, and the chemisorption and etching processes which take place upon such surfaces; epitaxial thin film growth on diamond and silicon surfaces; adsorption at stepped surfaces.

Medical Physics
Dosimetry of mega-voltage electrons for radiotherapy treatment of cancer: in vivo dosimetry on patients using thermoluminescence dosimeters (TLDs) and semiconductor dosimeters; dosimetry of ionizing radiation using ion doped agarose gels and magnetic resonance imaging (NMR dosimetry); dosimetry at field junctions.

Astronomy and Astrophysics
Infrared mapping and spectroscopy of star forming regions; image digitising and analysis systems; comparative planetology; industrial applications of image analysis; photometric and spectroscopic studies of long period variable stars in the Magellanic Clouds; x-ray observations of gas in galaxies and clusters of galaxies. Campus observatory plus 0.4m telescope.

Nuclear and Medical Physics
Neutron capture cross-sections, aspects of nuclear fission and reactor physics; applications of nuclear physics in medicine; boron neutron capture therapy; macro and microdosimetry measurement and computer simulation; environmental aspects, radon monitoring.

Solid State Physics
Piezo, Zeeman, piezo-Zeeman and magno-optical studies of the electronic states of impurities in semiconductors by far infrared spectroscopy; laser induced photoluminescence of compound semiconductors, superlattices and quantum wells and the effects of hydrogen passivation on these materials. Phenomena relating to quantum mechanical tunneling in low dimensional semiconductors.

Theoretical Physics
Extragalactic dynamics and gas dynamics; galaxy formation; jet formation; computation of fundamental quantities of atomic systems. Manybody theory in condensed matters and in quantum and classical plasmas; electronic and transport properties in semiconductor nanostructures; magnetophot effect in low dimensional semiconductors; magneto-transport and magneto-optics in interacting electronic systems.

NSW Department of Physics
University of Western Sydney, Nepean
PO Box 10, Kingswood NSW 2747
Head: Dr TG Emeleus

Astronomy and Astrophysics
Astronomy, galactic and extragalactic radio astronomy using the Australia Telescope, Very Long Baseline Interferometry, history of Astronomy, instrumentation, astronomy education. Facilities include a campus observatory with a 0.6 m telescope.

Medical Physics
Film dosimetry of radiotherapy beams; microbeam radiation therapy; electron therapy; experimental radiation biology, cell survival studies after irradiation, investigation of rate of growth factors in the repair of radiation damage to normal tissue.

Physics Education
Use of demonstrations in secondary and tertiary level physics.

NT Faculty of Science
Northern Territory University
PO Box 40146, Casuarina NT 0811
Contact: Dr J Singh

Theoretical Physics
Solid state physics: excitonic processes in crystalline solids, amorphous materials and quantum well structures, and solar cells; structure of atoms, interactions of electrons and photons with atoms, and computational methods.

Laser Physics
Opto-acoustic and pump-probe modulation spectroscopy, CO₂ and SMM lasers.
OPPORTUNITIES FOR POSTGRADUATE STUDIES AND RESEARCH IN PHYSICS

QLD Department of Physics
The University of Queensland
St Lucia QLD 4072
Head: Associate Professor JS Mainstone

Astrophysics
Transfer of radiation through outer layers of the sun and stars; cosmic abundance, experimental determination of relevant atomic properties.

Geophysics
Gravity: improved methods for terrain corrections; instrumentation for measurement of coal dust at working faces underground; earthquake prediction, rock physics and magnetotelluric studies.

Laser Physics and Non-Linear Optics
Optical trapping of atoms and microscopic particles; planar laser induced fluorescence; degenerate four wave mixing; holographic interferometry; non-linear optics in semi-conductors; chaos in lasers; pattern formation in lasers; optical phase singularities; microwave studies of fluidised beds.

Marine Physics
Modelling and monitoring of circulation and transport in estuaries; generation and propagation of waves in bounded seas.

Solid State Physics
X-ray and thermal neutron scattering; structural determination and refinement for powders, phase transitions, molecular orientations, order disorder, computing methods.

Space Physics
Physics of sporadic E clouds and their stability; generation of travelling disturbances in the auroral zone.

Theoretical Quantum Optics
Interaction of light with atomic and molecular systems; multi-photon processes, non-classical radiation fields, squeezed states; theory of quantum non-equilibrium structures, quantum solitons; atomic optics; quantum feedback; quantum measurement theory; quantum chaos.

School of Physics
Queensland University of Technology
GPO Box 2434, Brisbane QLD 4001
Head: Professor JM Pope

The Centre for Medical and Health Physics located within the school provides a focus for fostering through education, research and development, the application of physics to clinical and occupational health areas of our society. Specific research and development activities encompassed within the school include:

OCCUPATIONAL AND ENVIRONMENTAL PHYSICS
Ambient light enhancement in the office environment using ‘daylighting’ devices; monitoring of environmental radioactive radon gas levels in various environments; determination of UV-B dosage to monitor harmful exposure to ultraviolet; ultraviolet radiation, eg transmission through materials; studies involving the modelling of atmospheric conditions to measure air pollution; measurement and interpretation of radioactivity in soil; water, building materials, etc; aerosol characterisation; air quality determination.

Medical Physics
Digital enhancement of x-ray images; detection of abnormal growths and melanoma using compact diagnostic instrumentation; quality assurance programs for medical imaging systems to extend their working life; 3D visualisation and modelling of anatomical structures through medical images; auto-correlation of images; enhancement of tomographic reconstruction techniques; development of imaging techniques using non-ionising radiation.

Materials and Solid State
The research emphasis in these fields is in micro and nano structures of surfaces and bulk materials. Experimental techniques include scanned probe microscopies, surface analysis, neutron and X-ray scattering and electron microscopy. Current topics include image formation processes in scanned probe microscopy and nanotechnological implementation of the techniques; theory of weak forces, including the van der Waals force, and applications to scanned probe technology; surface reactivity of high temperature.

Radio Physics
Low frequency electromagnetic techniques of geophysics; antennas and communications.

Laser/Atomic Physics/Collision Physics
The Laser Atomic Physics Laboratory undertakes research into electron-atom collision processes and laser-atom interactions.
OCEAN SURFACE BACKSCATTER RADARS

The development and application of a variety of ocean surface radar techniques to measure parameters of the ocean surface in research and consultancy. Systems are being investigated with frequencies in the low HF band up to microwaves, and from coastal to airborne and satellite based platforms.

CORAL GROWTH

Mathematical modelling of corals to determine how historical climate records are stored in large corals.

SOIL PHYSICS

The measurement and modelling of heat storage and heat flux from solid to the atmosphere; physical properties of soils.

METEOROLOGY

Micro-meteorology and meso-scale meterology in the tropics including measurement, numerical modelling and theoretical development.

Scholarships

Scholarships

Australian Postgraduate Research Awards: James Cook University Scholarships (set annually to be of similar value to APRA): Physics Department Scholarship. Some projects in the Physics Department are attracting financial support from industry and government agencies.

Atmospheric Physics

The atmospheric physics group uses ground-based radars and optical techniques to study the dynamics of the atmosphere at locations within Australia, in the Antarctic and at the Equator. Three radars, located at a field site near Adelaide, operate at frequencies of 2.6 and 54 MHz; the 2 and 6 MHz systems use a 1 km diameter antenna array which is the largest of its kind in the world. Together, they are used to investigate the dynamics of different atmospheric regions, the meteorology of the lower atmosphere, turbulence and meteors.

Optics and Lasers

This group is working on a multitude of topics ranging from high power lasers and nonlinear optics, to holography and problems in conventional......
This experiment will detect the highest energy cosmic rays currently known. A world-wide project is underway to design and build the next generation of high energy cosmic ray detectors and the group is playing a major part of that design process with the possibility that the final experiment may eventually use Woomera as one of its sites. A long-running scintillator experiment has operated at Buckland Park at intermediate energies.

Mathematical Physics

Research within the group covers a wide range of interests in mathematical physics. Particular areas of current interest are field theoretical models of hadron and nuclear structure, algebraic methods in statistical mechanics and quantum field theory, general relativity, cosmology, quantum gravity and superstring theory.

Theoretical Nuclear and Particle Physics

Our concern is with the structure of matter at its deepest levels. Particular areas of interest include gauge theories, supersymmetry, chiral symmetry, chiral quark models (including chiral solitons), deep-inelastic scattering and structure functions as well as intermediate energy physics. We have very close contact with overseas centres, notably CERN, Los Alamos, Saclay and TRIUMF. Approximately a dozen overseas scientists spend at least a month each year working in this group.

Ultra-Violet Physics

This group studies atomic and molecular quantum states by experimental measurement and theoretical modelling of the absorption of ultraviolet radiation by atoms and small molecules. The experimental program is based on a tunable high resolution dye laser frequency doubled to produce ultra-violet radiation, equipped for high precision absorption measurements. A molecular beam apparatus is being used to study the properties of low temperature polymers.

Physical Archaeometry

The physics of thermoluminescence, and its application to archaeological and geological dating, are the main activities of this group.

Medical Physics

Research into medical physics is carried out as a joint activity with the Department of Medical Physics at the Royal Adelaide Hospital and with physicists at other hospitals. A course-work Masters program in Medical and Health Physics is also offered.

Scholarships

Students within Australia are, of course, encouraged to use a Commonwealth Postgraduate Award to study at the University of Adelaide. In addition the University offers a number of postgraduate scholarships each year. The stipend is presently under review, but is generally very close to the value of the Commonwealth Scholarship.

Discipline of Physics

School of Physical Sciences
Flinders University of South Australia
Bedford Park SA 5042

Head: Associate Professor RG Storer

Experimental

Atomic and molecular reactions with electron beams; electron momentum spectroscopy involving the measurement in coincidence of the momenta and energies of all continuum electrons in a high-energy symmetric ionisation experiment; electron swarm physics using a technique of measuring electron distributions by observing the photons produced in reactions; gas discharge tomography and analogue imaging.
devices; plasma physics research which is concerned with an investigation of a method of driving plasma currents by use of the Hall term; the application of this technique to the generation and sustenance of compact torus and tokamak configurations; high density plasma source for plasma processing and surface modification; neutrino physics.

Theoretical
Atomic scattering theory; few body nuclear theory; quantum field theory; the application of functional integral techniques to quantum chromodynamics; theoretical plasma physics focusing on resistive magnetohydrodynamics and the generation of plasma currents by means of the non-linear Hall term; cellular automata.

Electronic Structure of Materials Centre
This is a Centre of Excellence specially funded by the Australian Government. Its purpose is to develop the instrumentation and computer programs for investigating the electron spectroscopy of solids and to use them to discover the electron motion and correlations in semiconductors, superconductors, metals, magnetic materials and surface-adsorbed molecules.

Scholarships
The closing date for applications for Commonwealth and Flinders University scholarships is October 31 in each year. Initial enquiries to the Coordinator of Physics are welcome.

School of Applied Physics
University of South Australia, The Levels SA 5095
Head: Professor JC Thomas

The School offers research programs for M App Sc and Ph.D degrees. In addition, the School operates an M App Sc degree in Medical and Health Physics, by course work and project, in cooperation with the Department of Medical Physics, Royal Adelaide Hospital. The three main groups active within the School are:

Centre for Materials and Colloidal Science
This Centre houses three groups: Light Scattering and Materials Science, Lasers and Opto-electronics Materials, and Surface Structure and Spectroscopy. Activities include: development of metal vapour laser systems; Visible laser diode applications; development of lasers for medical applications; development of miniature all-solid-state light scattering systems; industrial application of laser light scattering (e.g. particle size measurement); electron/ion scattering techniques for surface material analysis; structure and behaviour of concentrated colloidal dispersions; surface and interfacial structure and interactions.

Centre for Radiation Physics
This Centre undertakes research and consultancies in the broad areas of Radiation and Health Physics, including both ionising and non-ionising radiations. Activities include: radiation dosimetry of both nuclear and x-radiation; dosimetry of alpha-particles using solid state memory cells; dosimetry of radon in bone marrow and the induction of leukaemia; development of dosimetric phantoms for paediatric radiographic examinations; low-level γ-spectroscopy; provision of a γ-ray meter calibration service. Photometry and radiometry of optical radiations (ultraviolet, visible and infra-red); provision of an accelerated UVR weathering facility; measurement of ozone in the ground level atmosphere by means of UVR absorption. Radiation protection and control of ionising (nuclear and non-radiation) and non-ionising optical radiations. Collaboration is ongoing with the School of Applied Geology and Electronic Engineering. The Centre also has well-established liaisons with the Royal Adelaide Hospital, Adelaide Children's Hospital and various industries.

Geophysics and Instrumentation for Agriculture
Activities include studies of physics of the atmosphere and the ionosphere with emphasis on meteorology, radio communications and applications to agriculture. Particular interests relate to GPS satellite observations (with La Trobe University) and irrigation sprinkler technology.

Department of Physics
University of Tasmania
GPO Box 252C, Hobart TAS 7001
Head: Dr JE Humble

Astrophysics Groups
Optical astronomy and optics, radio astronomy and radiophysics, cosmic rays, x-ray and g-ray astronomy. Projects range from techniques and instrumentation of the astronomical objects concerned. Available instruments include a 1-metre optical telescope, 26-metre and 14-metre radio telescopes, a 0.25 m2 X-ray telescope and a range of cosmic ray detectors and telescopes. Current projects concern variable stars, X-ray and radio pulsars and collapsed objects, active radio sources using VLBI techniques, interstellar masers, cosmic ray anisotropies and high energy particles from astronomical sources.

Theory Group
Gauge theory and supersymmetry, including electrodynamics, chromodynamics, flavour-dynamics and gravitation. Areas of current interest include the realisation of the quantum versions through dimensional reduction and non-perturbative solutions of gauge models. Extra dimensional and supersymmetric aspects of these theories are under study. Topics in mathematical physics include Lie and Kac-Moody algebras and field theory applications. Universal features of chaos are also being investigated.

Biophysics Group
Electric characteristics of plant cells and tissues and individual cells are studied using microelectrode, tracer and modelling techniques. Current studies include mechanisms of nutrient uptake, of hormone-induced growth and the morphogenetic effects of light.

Scholarships
Details of courses, scholarships and other assistance are available from the Head of Department.

Materials and Surface Science Group
Head: Professor RCG Leckey

Much of the work of the group centres on the investigation of the electronic properties of materials, including photoelectron spectroscopy of semiconductors, hetero-structures and superlattices based on both silicon and gallium arsenide. Extensive use is made of the synchrotron radiation facility in Berlin. Facilities are available for the preparation of crystalline materials by the technique of molecular beam epitaxy. The use of a wide variety of surface science techniques for the study of surfaces and interfaces; for example, the absorption of chemical species on clean well-defined surfaces, bonding in newly-synthesised materials (piezoelectrics & ferro-magnetics), and surface properties of samples relevant to industry. Electron-atom interactions, particularly studies related to resonance effects in scattering processes.
Theoretical and Space Physics Group  
*Head: Professor PL Dyson*

Theory of the earth's upper atmosphere, ionosphere and magnetosphere; general relativity, statistical mechanics, theory of liquids, atomic physics, musical acoustics.

Studies relating to the properties of the ionosphere and magnetosphere using radio and optical techniques, auroral physics, solar-terrestrial relations. The Theoretical and Space Physics Group operates a field station in Kilmore Shire and encourages collaborative projects with outside agencies, especially the Antarctic Division. Opportunities exist for students to spend a year at an Antarctic Base as part of an MSc or PhD program. Studies of atom/ion interactions are conducted in the group's laboratories.

Scholarships  
La Trobe University postgraduate scholarships are available.

---

VIC  

**Department of Physics**  
La Trobe University  
Bendigo VIC 3550  
*Head: Dr P Searle*

The major interests of the Physics Department are in research and development in scientific instrumentation, particularly as applied to electron microscopy, vacuum systems and the measurement of agriculturally important parameters, and research in physics education.

**Microscopy and X-ray Facility**

A centralised laboratory providing transmission and scanning electron microscopy, image analysis, x-ray diffraction and x-ray fluorescent spectroscopy facilities.

Current research programs are in the areas of plant physiology, microbiology, minerals processing and structural properties of binary and ternary semiconductors.

**Centre for Instrumentation**

Current projects include application of microcomputers and PLCs in vacuum systems, measurement of total available soil moisture content and other soil characterisation parameters, automatic measurement and recording of rainfall and evaporation rates, information transfer techniques in the agricultural environment, and field direct measurement for sheep classing.

**Physics Education**

The learning process and misconceptions in elementary physics are being investigated to enable definition of areas in which special care must be taken in the presentation of courses. The use of PCs in the laboratory to simulate experimental apparatus is beginning.

**Scholarships**

Candidates for graduate degrees are eligible to apply for Commonwealth Postgraduate Awards and for a limited number of College awards available to research centres. BEMAL supports one position which is half technical/half research. Enquiries to the Head of the Physics Department.

---

**School of Physics**  
University of Melbourne, Parkville VIC 3052  
*Head: Professor AG Klein*

**Theoretical Physics**


**Experimental Particle Physics**

Participation in international collaborative experiments at CERN (Geneva), viz.: the NOMAD experiment to search for the origin of particle masses. Development of semiconductor particle detectors for such experiments.

**Fundamental Experiments**

Optical experiments (interferometry) with light, neutrons, and neutral atoms. Laser cooling and trapping of atoms; experiments with slow atoms. Gravitational experiments. International collaborations in USA, Europe and Russia.

**Solid State Physics**

The study of crystal structures, crystal defects and their interactions and quasi-crystalline solids by the diffraction of x-rays, neutrons and electrons and by high resolution electron microscopy and spectroscopy. Advanced materials. Diamond thin films; Fullerenes; Ferroelectrics etc.

**Optics**

Experimental and theoretical approaches to X-ray optics, (including the development of satellite-based X-ray telescopes; high brightness synchrotron physics, and nano-tomography), physical aspects of near-field scanning optical microscopy; waveguide fabrication (in collaboration with MARC—see below) wave-field retrieval; optical coherence; laser atom; interaction of x-rays with photographic emulsions and matter; precision spectroscopy and QED measurements.

**Astrophysics**

Observational and theoretical studies in a range of extragalactic astrophysics and cosmology, including gravitational lensing, quasars, clusters of galaxies and large-scale structure; all aspects pulsar research and problems in the formation of the solar system. Observational work at leading observatories in Australia and overseas.

**Nuclear Science**

Studies of intermediate-energy photnuclear physics and applied nuclear physics including interdisciplinary studies. Medical imaging.

**Micro-Analytical Research Centre (MARC)**

Research based on a Proton Microprobe - a high spatial resolution analytical microscope which uses a beam of protons or other ions from a 5 MeV Pelletron accelerator. MARC undertakes applied research in materials physics, biology, medicine, geology, and many other areas of technological importance. The Centre also houses a Raman microscope and associated analytical equipment.

**Scholarships**

Melbourne University Postgraduate Scholarships and several other types of Scholarships are available. For further details see: http://www.ph.unimelb.edu.au

---

**EDITORIAL PLEA**

Please submit corrected and updated 2nd and third versions of articles with the changes clearly marked in red on a paper copy of the original version.
The Department of Physics offers opportunities for postgraduate work in experimental, applied and theoretical physics and materials science. A student enrolling for an MSC, MAppSc or PhD degree under the guidance of an assigned supervisor, pursues an individual research project. Postgraduate students are expected to attend departmental colloquia and other research seminars. The Department of Physics at Monash University offers postgraduate students the opportunity of working in a multi-disciplinary and dynamic environment. There are more than 50 postgraduate students currently enrolled in the department, spread evenly across disciplines and project stage. In addition to Commonwealth Postgraduate Awards, there are some Monash University scholarships available. For full details of these and the above research activities, applicants should contact the department.

Research projects are currently offered in the five broad areas listed below. A detailed listing of research projects is published annually.

Theoretical and Computational Physics
Electron Scattering in Materials: Inelastic electron scattering in Si and GaAs, propagation of waves in disordered systems, phase transitions from extended to localised states.
Condensed Matter Physics: Field theoretic studies in condensed matter, electronic properties of graphene, 2D polymer statistics, models of high temperature superconductivity, stochastic processes, modelling porous Si from position anihilattion spectroscopy studies, itinerant magnetism, effective medium theories, theoretical studies of nanostructures.

Foundations of Quantum Mechanics: Multiparticle interference using entangled states, quantum chaos, quasi-probability distributions in quantum mechanics, non-linear extensions to quantum mechanics.

Computational Physics: Wavelet transforms and the renormalisation group, computational models of memory, neural nets, foundation studies in mathematical morphology, Monte Carlo studies of diffraction and scattering, x-ray and microwave tomography, reconstruction algorithms in diffraction tomography, cellular automata and determinism, thermodynamics and complex systems.

Geometrical and Topological Methods in Theoretical Physics: The gravitational Aharonov-Bohm effect and topological defects, studies of geometric phases in physical systems, topology on discrete lattices, holonomy and path space formulation of gauge theories, Ashkar loop variable approach to quantum gravity.

Electric and Magnetic Properties of Materials
Electron Paramagnetic Resonance: Pulsed and continuous-wave EPR studies of free-radicals and transition metal ions in crystals, minerals, chemical complexes and biological materials, theoretical studies of lineshapes, asymmetries and computer simulation of random and partially ordered systems, line narrowing effects studies at low microwave frequencies, electron spin echo envelope modulation, FT-EPR, 2-D EPR and other multiple pulse sequence techniques, spin dynamics using time domain spectroscopy.

Magnetic Studies: Magnetic properties of disordered and low dimensional materials, including spin glasses, studies by SQUID magnetometry, polarised neutron diffraction, and spectroscopy with polarisation analysis. The focus is on the stability of spin glasses and low dimensional magnetic structures through measurements of magnetic correlations at the atomic level.

Mössbauer Spectroscopy: Studies of the magnetic and crystallographic properties of solids containing iron, tin, rare earths or gold and their relation to materials development and use. Areas of interest include adsorption of gold and other metals onto activated carbon and polyurethane foams, magnetic properties of invar and iron-nickel meteorites, exchange-spring magnets, fine iron oxide and hydroxide particles and related minerals, coal and coal products.

Polymer Physics: Studies of charge transport and storage in polymeric dielectrics mapping of the spatial distribution of excess charge in dielectrics using the pulsed electroacoustic and laser-induced pressure pulse techniques, electrochemical synthesis and characterisation of novel conducting polymers, especially those based on pyrrole, studies of the conformational properties of model polymer chains using computer simulation and Monte Carlo technique.

Mechanical and Microstructural Properties of Materials
Materials Science: Studies of flux pinning in type I superconducting materials, thermal expansion and related properties for martensitic alloy systems, dimensional stability of ceramics and cements, studies of porous Si using positron annihilation spectroscopy, materials for hollow cathode applications, electronic and structural studies of graphic materials, residual stress studies of Al-Si alloys.

Diffraction Studies: X-ray and neutron diffraction studies of crystal structure and residual stress, electron diffraction studies of surfaces.

Instrumentation and Imaging
Acoustics: Acoustic impulses applied to a variety of environmental problems, including propagation through an atmosphere with wind and temperature gradients, the effect of atmospheric turbulence, shielding of sound by barriers, measurement of ground impedance and the effect of moisture on the acoustic properties of soil.

Computed Tomography: Low energy x-ray transmission microtomography studies for the non-destructive evaluation of low atomic number materials, development of low energy elastic scatter computed tomography (CT) using synchrotron quality x-rays, high energy x-ray and gamma-ray CT system development for industrial materials like ceramics and advanced materials, Compton profile CT for atomic species imaging and hybrid scatter CT, x-ray densitometry for moisture and density distribution studies in wood, strain measurements in materials using CT and image warping methods, automated feature extraction and classification in CT images, CT modelling and reconstruction algorithm development.

Computer Image Processing: Mathematical morphology, design of optimal filters, feature recognition, subjective assessment of texture, co-occurence matrices, fractal and covariance analysis of texture, texture and edges in colour or multiband images, Microwave imaging of defects, machine vision applied to industry and agriculture, neural networks and cellular automata for image processing.

Optics and Optical Astronomy
Laser Studies: Development and study of high efficiency hollow-cathode discharge-pumped ultraviolet lasers as coherent light sources for biomedical instruments, for monitoring gaseous pollutants and for other spectroscopically-based applications.

Astronomy: Optical photometry and spectroscopy of variable stars such as binary stars, pulsating stars and particularly, known and suspected active chromosphere stars. Observations may be made at the Monash Observatory or at the Mount Stromlo and Siding Spring observatories. Data are analysed using the photometric reduction programs, spot wave synthesis program and spectral synthesis programs available at Monash. From time to time simultaneous observations are undertaken in collaboration with either the Parkes radio telescope or spectroscopic observations with the 3.9 m telescope at Siding Springs, or both. An astronomical CCD imaging system is also available.

Research Facilities
The department has a range of sophisticated research equipment including superconducting magnets producing fields up to 14 tesla, a variety of 4He and 3He cryostats, high pressure-low temperature facilities, ten Mössbauer spectrometers, Varian CS and Bruker FT/IC electron paramagnetic resonance spectrometers, Quantum Dynamics 7.
tesla SQUID magnetometer, Varian and Cary spectrophotometers, Hitachi scanning electron microscope with a Kevek energy dispersive x-ray analysis unit, Scintag x-ray powder diffractometer with automated search-match capabilities, a number of x-ray and gamma-ray computed tomography scanners, precision magnetic susceptibility balances, image and signal processing equipment. In addition the department has supporting facilities that include a mechanical workshop, electronics workshop, a computing support group and materials preparation facilities. The department also possesses a Koch 1410 helium liquefier to provide cryogenic fluids for the low temperature research. Postgraduate students also have extensive access to research facilities throughout the country such as the reactor HIPAR at Lucas Heights to use the neutron scattering instruments including LONGPOL.

Industrial Collaborations

Monash University is situated close to a number of established high technology industries. There are frequent opportunities for projects which arise from collaborative work of staff members with industrial organisations. These projects are supported by the facilities and expertise of the department, in addition to the infrastructure of the collaborating industrial partner.

Department of Applied Physics
Victoria University of Technology
PO Box 14428 MMC, Melbourne VIC 3000
Research Coordinator: Professor D Booth

Optical Technology

Optical fibre sensors; intensity and polarisation sensors, rare earth doped fibres as sensors; optical fibre interferometry, in-fibre Bragg gratings; fibre optic communications; optical fibre lasers and amplifiers; fibre photonic and optoelectronic devices.

Laser Physics

Diode-pumped solid state lasers, microchip lasers and amplifiers; optical parametric oscillators; new laser material development; laser applications (laser radar).

Applied Optics

Applications of optical spectroscopy; use of lasers and fibre sensors for non-contact optical excitation and sensing for non-destructive testing; optoelectronic imaging; confocal microscopy; imaging in diffusing media; non-linear optics.

Vacuum Technology

Vacuum physics; thin film coatings.

Scholarships and Support

APRS, University Postgraduate Research Scholarships and Departmental scholarships. Paid casual teaching is available. Communications and Optical Technology is one of the University’s Major Research Areas in its Research Management Plan, and the Department offers good facilities in this area.

Department of Applied Physics

RMIT, GPO Box 2476V, Melbourne VIC 3001
Head: Professor John J Millar

Condensed Matter Physics

Crystallisation kinetics in colloidal suspensions; dynamic light scattering studies of colloidal glasses; transition dynamics in binary systems of hard model atom. Computer modelling of surfaces, interfaces and thin film growth; porosity and small angle X-ray scattering in coal and sintered ceramics; theoretical and experimental studies of secondary electron emission from surfaces. Adhesion and electrical conductivity of contacts on semiconductors and high temperature superconductors. Transmission and scanning electron microscopy of materials; ultra-high coherence convergent beam electron diffraction for the direct determination of phase; optimisation and characterisation of thin films; the effect of stresses on dopant diffusion; Compton scattering from atoms; heavy ion recoil spectrometry of semiconductors and ferroelectric films nuclear reaction analysis of thin films. Study and modification of...
OPPORTUNITIES FOR POSTGRADUATE STUDIES AND RESEARCH IN PHYSICS

Surfaces and Interfaces: Nanometre dimension materials analysis of single crystal diamond, corrosion coatings, industrial alloys and other materials.

Optics
Optics - an optical transform computer package; computer-generated holography; electronic speckle pattern interferometry; optical non-destructive testing and embossed holograms; image analysis applications in microscopy.

Acoustics
Acoustics absorption of various materials in high pressure nitrogen by the rapid impedance tube method; acoustic enhancement of combustion; modelling of acoustic response using small area samples.

Intelligent Instrumentation
Ultrasonic measurement of particle size, density, fluid flow; radiation dose measurement; intelligence in remote sensors for process control.

Scholarships
Students holding an appropriate honours degree or equivalent are encouraged to apply for Australian Postgraduate Awards, Overseas Postgraduate Scholarships and RMIT Research Scholarships. A limited number of endowed scholarships are also available. Postgraduate students are also often funded by industrial and collaborating organisations.

Department of Physics
The University of Western Australia, Nedlands WA 6007
Head: Dr EN Mansen

Present experimental research activities in the Department are centred on studies of atomic and surface physics and gravitational physics. Smaller research efforts concern solid state physics, magnetic materials and high $T_c$ ceramic superconductors, and crystallography. Theoretical and computational studies cover atomic physics, condensed matter physics, cosmic astrophysics and high energy physics, statistical mechanics and non-linear phenomena.

Astronomy and Astrophysics
Gravitational radiation; supernovae; gravitational collapse and pulsar astrophysics; optical astronomy; neutron star dynamics and pulsars.

Atomic and Molecular Physics
The atomic, molecular and surface physics research centre conducts research into: electron scattering phenomena in gases; spin polarized electron interactions with atoms and surfaces; coincidence auger experiments in rare gases; molecular ion dissociation.

Theoretical Physics
Semiconductor media, quantum fluids, collective phenomena in spin-polarised systems, neutron scattering. Computational physics; theoretical high-energy physics and quantum field theory; modern statistical mechanics; wavefunctions and pseudopotentials for atoms, molecules and solids quantum theory of atomic collisions.

Condensed Matter Physics
Magnetism and magnetic materials; advanced materials; electronic and surface properties of materials.

Biophysics and Medical Physics
Application of magnetometry, Mössbauer spectroscopy, atomic and magnetic force microscopy and diffraction, magnetic resonance imaging, neutron diffraction, extended x-ray absorption fine structure analysis, and theories of small particle magnetism to the study of iron biomagnetization and bioelectromagnetics in humans and other biological systems. The research is related to widespread iron overload diseases, weak magnetic field effects on the central nervous system and epilepsy and thus involves interdisciplinary collaborations. Application of magnetometry, Mössbauer spectroscopy, atomic and magnetic force microscopy, electron microscopy and diffraction, magnetic resonance imaging, neutron diffraction, extended x-ray absorption fine structure analysis, and theories of small particle magnetism to the study of iron biomagnetization and bioelectromagnetics in humans and other biological systems. The research is related to widespread iron overload diseases, weak magnetic field effects on the central nervous system and epilepsy and thus involves interdisciplinary collaborations. Medical physics and bioengineering (Royal Perth Hospital); applications of statistical physics to pharmacology.

Instruments and Techniques
Development of a cryogenic gravity gradiometer; spin polarisation of electrons and atoms; electronic imaging and data processing; ultra-stable sapphire resonators; and applications to VLBI radio astronomy applications.

Scholarships
Australian Citizens and Permanent Residents: Australian Postgraduate Research (APRA) Awards and University Research Studentships may be available to students who hold, or expect to obtain, a good honours degree or equivalent and who wish to undertake research leading to an MSc or PhD degree. The awards are normally tenable for 3 years (2 for MSc). Overseas Students: The Australian Government offers approximately 300 Overseas Postgraduate Research Scholarships (OPRS) Australia-wide each year to postgraduate researchers of exceptional promise. They are awarded to individuals on the basis of academic merit and research capacity.

School of Mathematical and Physical Sciences
Murdoch University, Murdoch WA 6150
Head: Assoc Professor P Jennings

Surface Physics
Theory of the metal/vacuum interface; LEED fine structure measurements; density of states determination by Auger line shape analysis; studies of the metal-semiconductor interface; chemisorption and catalysis; scanning tunnelling microscopy; and holography.

Atomic Physics
Theoretical modelling of electron-atom collisions; scattering theory; Auger electron coincidence spectroscopy of gases.

Experimental Thermodynamics
Determination of the thermophysical properties of natural gas from precise measurements of the speed of sound; studies of the phase behaviour of hydrocarbon mixtures (natural gas); hydrocarbon water heats of solution and phase behaviour; measurement of thermal conductivity, heat capacity and speed of sound in fluids; investigations into the mechanisms of formation of nitrogen oxides in gas burning appliances; equations of state and condensate yields from North West Shelf natural gas reservoirs.

Plant Biophysics
The development of non-invasive techniques for the study of transport processes in the xylem, phloem and organelles of plants. Bioelectric potential, laser holography and scanning probe microscopy are used.

Photovoltaics
The preparation and characterisation of thin film materials such as amorphous silicon for use in optoelectric and photovoltaic devices.
research programme includes preparation, measurement and theoretical analysis of amorphous materials and devices.

Scholarships
Commonwealth Postgraduate Research Awards and Murdoch University Research Scholarships are available to full-time students.

Department of Applied Physics
Curtin University of Technology
Bentley WA 6102
Head: Dr HI Bailey

Remote Sensing
The determination of land, vegetation, ocean and atmospheric physical variables from remote sensing radiometric measurements; application of these products to Earth systems and interactions; enhanced greenhouse, coastal zone management, ocean energetics, land parameterisation schemes, precipitation prediction, tropical cyclone studies, environmental pollution, global change. Cooperative research with the WA Satellite Technology and Applications Consortium (WASTAC) and the Leeuwin Centre for Earth Sensing Technologies.

Isotope Studies
Thermal ionisation mass spectrometry including application to astrophysics, meteoritics, fission products, environmental science, geochronology, isotope geochemistry and medical physics.

Marine Research
Marine acoustics; scattering and propagation theory and applications; underwater instrumentation and technology development; oceanography, including satellite techniques; sea state prediction and estimation; dynamics of marine vehicles. Collaborative research is undertaken with the Centre for Marine Science and Technology and the Australian Maritime Engineering Cooperative Research Centre.

Materials
Crystallography, x-ray analytical science (diffraction and fluorescence), scanning electron microscopy and radiative physics; electrical, thermal and optical properties; abrasion resistance, deterioration due to ultra-violet and to other factors of a range of materials (metals, ceramics, polymers, rubbers, minerals); development of aluminium-based toughened ceramic materials; high temperature superconducting ceramics. Advanced composite materials. Layered and functionally-gradient ceramics.

Scientific Data Acquisition and Analysis
Digital image processing of scientific data including image enhancement procedures, feature/pattern recognition, frequency and spatial domain transforms; use of low-cost image processing systems and associated video digitising facilities; system software for image arrays.

Astronomy
Research is in association with the Perth Astronomy Research Group and conducted at the Perth Observatory, CCD astronomy associated with an automated supernova search program; transient event detection; photometry; optical search for extra terrestrial intelligence (SETI); search for brown dwarf stars; image processing research on faint objects; stochastic annealing.

Physics Education
Assessment of the education effectiveness of computer-based multimedia physics instruction; Development of physics coursework and assessment procedures; Assessment of student understanding in key physics concepts; Assessment of the problems experienced by, and the needs of, first year university science students; collaboration in this area of research is being undertaken together with the Curtin University Key Centre for Science and Mathematics Education Research, the University Computing Centre and the University Teaching Learning Group. This area of research supported by the National Committee is for Advancement of University Teaching and the ARC.

Scholarships and Support
Students are eligible for Commonwealth Postgraduate Award (CPGA). Scholarships. Supplementary loadings may be paid to CPGA recipients. Industry and public-sector scholarships, other than CPGA, are offered from time to time. Part-time teaching is also available. Some students undertake thesis studies part-time while working as research or teaching assistants within the Department.

Department of Exploration Geophysics
Curtin University of Technology
Bentley WA 6102
Head: Associate Professor NF Uren

Seismic Processing
Multiple attenuation, noise elimination, inversion, anisotropy, AVO, reservoir geophysics, vector fields.

Seismic Acquisition
High resolution 3-D technology, VSP surveys, fracture detection.

Groundwater
Salinity, pollution.

Prospecting
Electromagnetic interpretation, Geographical information systems, ground probing radar, regolith studies.

Isotope Science
This interdisciplinary activity provides opportunities for participation in the following research fields, astrophysics, meteoritics, fission products, environmental science, geochronology, isotope geochemistry and medical physics. Extensive facilities are available within the WA Centre for Isotope Science including Thermal (VG354) and Secondary (SHRIMP) instruments supported by well equipped ultra sensitive sample preparation laboratories. Collaborative research with scientists of countries is a feature of this field.

Department of Physics
Massey University,
Palmerston North, New Zealand
Head: Professor PT Callaghan

Analytical Ultracentrifugation
and Electrophoresis
Molecular transport studies using centrifugation and electrophoresis for the separation and characterization of macromolecules in solution; electrical conductivity and dielectrophoresis as methods for investigating biological particulate systems.

Biomechanics
Computational simulation of expiratory airflow from human lungs and prediction of common clinical respiratory function tests in normal subjects along with simulation of pathological conditions; investigation of some aspects of the physics of the merging of unequal flows in a...
OPPORTUNITIES FOR POSTGRADUATE STUDIES AND RESEARCH IN PHYSICS

Electronic junction, as well as the relationship between tube properties and flow limitation mechanisms.

Electronics
There is a continuing programme involving the development of instrumentation for use in teaching and research. Recent projects include a waveform synthesiser and a microprocessor trainer. At present the design of a fast multiplex digital correlator is being investigated with a view to eventually producing a VLSI correlator chip.

Nuclear Magnetic Resonance
An NMR imaging system has been developed to provide proton spin density maps of microscopic systems. Various pulse techniques enable relaxation contrast and the imaging of spin echoes under the influence of intense field gradient pulses. This latter experiment reveals molecular dynamics at specific locations in dispersion phases. The spin system is being used to investigate plant tissue, food materials and polymers.

Polymer Physics
Diffusion of large molecules in solution studied by observing the scattering of laser light; ternary solutions of two polymers in a low molar mass solvent are being investigated; dynamical properties of synthetic and biological polymer systems studied by various NMR techniques including pulsed field gradient spin echo NMR, proton density imaging and relaxation measurements. The work on synthetic polymers seeks to elucidate reptation motion and internal modes in high (1–10–6 dalton) molar mass semi-dilute solutions and in gels using molecules labelled with both protons and deuterium; rheology of polymer solutions and melts.

Structural Biophysics
Developmental studies of connective tissues using electron microscopy as the major technique; relationships between the mechanical properties of a tissue and its collagen fibril diameter distribution; structural and functional roles of other components in connective tissues; image analyses techniques used to enhance the signal/noise ratio in electron micrographs and to deduce structural information from assemblies of biological macromolecules; computational analyses of the main acid sequences of fibrous proteins.

Theoretical Particle Physics
The relationship between low energy quark models of nucleon and the high energy scattering data.

Scholarship and Support
As well as New Zealand Commonwealth Scholarships and NZ Vice-Chancellors' Committee Postgraduate Scholarships, competitive Massey University Ph.D Scholarships and Graduate Assistantships are available.

Physics Department
University of Auckland, Auckland, New Zealand
Head: Professor GL Austin

Architectural Acoustics
Applications of signal processing to architectural acoustics, modelling of sound fields in buildings, active noise control.

Cloud Physics/Applied Meteorology
Field studies on the mesoscale and microscale of the characteristics of raindrops, rainfall and orographic influences; optical scattering in rainfall; radar meteorology; development of instrumentation for microphysical studies of precipitation; meso-scale field studies of boundary layer processes including development of instrumentation for remote sensing of wind and turbulence profiles; satellite image analysis of cloud properties.

Ionosphere
F-region morphology and its relation to atmospheric and solar changes.

Laser Physics/Photoelectronics
Research in the laser physics laboratory is concentrated on the construction of new lasers, modelocking of lasers and the application of short optical pulses; high peak powers generated by novel techniques are used to investigate a variety of non-linear optical processes, notably optical parametric amplification, frequency doubling stimulated radar scattering in optical fibres and modulation instabilities in optical fibres. Work is also in progress on novel optical modulators and optical information processing systems.

Nuclear Physics
Nuclear physics using 4MV vertical tandem accelerator AURA II. Fundamental tests of the Weak Interaction by measurement of parameters (t values) of pure Fermi beta-decays to high accuracy. Surface elemental analysis by PIXE, proton induced x-ray mission, of Polynesian obsidian artefacts and medical samples of muscle tissue.
In collaboration with the Nuclear Physics Department at ANU, Canberra; nuclear spectroscopy of high spin states using heavy ions provided by the 14UD Pelletron accelerator at ANU. (The superconducting booster accelerator upgrade will be operational by 1996).

Quantum Optics
The Quantum Optics group undertakes theoretical research into the interaction of light with atoms; topics include photon statistics, squeezed states of light, laser theory and nonlinear optics; laser manipulation of light by atoms, laser cooling of atoms, and atomic interferometry. Quantum measurement theory and quantum non-demolition measurements.

Signal Processing
Signal design for underwater acoustics applications; high gain signal processing using pulse compression of pseudo random sequences; optimal finite band signals.

Solid Earth Geophysics
Thermoluminescence and electron spin resonance dating; environmental radiation dosimetry; speleology; internal structure of the Earth; monitoring and theory of geothermal systems.

Underwater Acoustics
Theoretical studies of sound propagation. Topics include shallow water bottom interactions and complex ray and saddle points analysis of the acoustic field; long range, deep water propagation studies to monitor ocean temperature; ocean wave generation of seismic noise; fisheries SONAR.

Scholarships and Support
As well as New Zealand Commonwealth Scholarships and New Zealand Vice-Chancellors' Committee Postgraduate Scholarships, a limited amount of Departmental postgraduate funding is allocated each year.
optical, EPR and Mössbauer spectroscopy. The group has cooperative programmes with overseas institutions, particularly in core burning, the glassy state and the development of up-conversion lasers.

Atmospheric Physics

Radar and satellite techniques are used to study upper atmosphere winds and temperatures, the orbits of meteors striking the atmosphere and the nature of the ionosphere above Christchurch and the Antarctic. Field stations are located at Birdling's Flat, at Mount John and at Arrival Heights (near Scott Base) Antarctica.

Astronomy

The group operates the University observatory at Mt John which houses the 1m McElhan Telescope. Current projects include the study of pulsations and abundances in Cepheids and hydrogen deficient stars, the measurement of high precision stellar radial velocities and the use of a CCD camera to study variable stars in the Magellanic Clouds.

Theory

Theoretical research, the largest research group at Canterbury, concentrates on group theory and quantum field theory. Symmetry principles developed at Canterbury cover the computer implementation and applications of Racah's and Sehr's insights into Lie group and point group theory, particle physics, nuclear physics, condensed matter, ring interferometry and nonlinear optics including gyrotropic optical effects. Related time reversal selection rules are also being extensively developed. Computer algebra techniques have been extended to develop new methodologies for the use of standard packages such as Mathematica in quantum mechanics. Condensed matter applications include the study of lanthanide spectra, including ligand field splittings and intensities, Jahn-Teller theory, and thermopower. There is also a strong interest in principles of quantum field theory and of general relativity, with application to quantum field theoretic aspects of models of inflationary cosmology.

Ring Laser

As a special project a 1 m-square ring laser built in an underground bunker and with supermirrors has reached a novel frequency precision of 3 parts in 10^12. At this level, measurements of seismology activity as well as new tests of relativity and quantum theory are possible. A German collaboration are funding and building an improved model which is due for installation in 1996 and which will enhance interest in all these applications.

Medical Applications of Lasers

A copper vapour laser is used to treat port wine birthmarks and a tattoo removal process is being trialled. The interaction of light with human blood vessels and tissue is being studied. Monte Carlo modeling of radiotherapy is undertaken in conjunction with Christchurch Hospital.

Department of Physics

University of Otago
PO Box 56, Dunedin, New Zealand

Acting Head: Assoc Professor CG Carrington

Atomic and Laser Physics

The group carries out theoretical and experimental research in the field of interaction of light with atoms. Topics under current study include dynamical switching in optical systems; atom cooling; raman lasers; spatial and temporal reshaping of interacting laser beams; a variety of photonics applications. A new era of interest within the group is pulsed laser development. Current projects involve compact tunable holoscopic laser systems, characterisation of high dopant level gain media and single frequency pulsed laser amplification.

Thin Films and Optics

The anisotropic properties of optical coatings caused by thin film microstructure are being investigated by experiment and by computer modelling. Currently, particular emphasis is placed on in situ measurements of optical anisotropies during the early stages of growth of evaporated dielectrics materials. A cooperative medical optics project, with the Department of Ophthalmology, involves the development and testing of instruments for detecting defects in the young eye and cataracts in the aged eye.
Upper Atmosphere Radiophysics
This group has a world-wide network of computer controlled receivers of VLF transmissions and natural waves for location of plasma columns in the magnetosphere and of propagation anomalies in the earth-ionosphere wave guide produced by 100 keV electron precipitation and by cloud-ionosphere electrical discharge (CID).

Acoustic Emission
When material is loaded some of the non-recoverable work generates acoustic emissions from within the material. Such emissions are being measured both in artificial sea ice grown in the laboratory and in situ in Antarctica, with the aim of identifying the source of the emissions. The behaviour of teeth subject to load is also being investigated using the same techniques in a joint project with the School of Dentistry.

Energy Utilisation
The principal interest of this group is in the efficiency of energy processes, in particular in the study of dissipative mechanisms, and their effect on process efficiency. Current projects include practical investigations of heat pump applications, thermal power station loss mechanisms, and product drying. The group is increasingly involved in the numerical simulation of energy processes for the analysis of losses by second law methods.

Wind Energy and Acoustics
Studies in meteorology relevant to wind energy utilisation: remote sensing of wind, employing a UHF radio data link; atmospheric turbulence using optical and anemometer measurements; applied acoustics relating to meteorology, buildings and music.

Theoretical Physics
All of the above groups maintain theoretical programs. Independent fields of interest are those of classical electrodynamics, quantum field theory including gravitational field theory, exact solutions of Einstein's field equations, relativistic wave equations for particles of higher spin.

Materials Science
Electronic properties of materials: high temperature superconductors - the preparation of a series of perovskite superconductors and ruthenate perovskites, measurement and modelling of their vibrational and transport properties and magnetic susceptibility, micro-structural studies using electron microscopy; conducting polymers - measurement and interpretation of electronic transport properties; superlattices - the preparation of superlattices of Ta/Ge, Ge/Ge-H and Ge/Si with layers as thin as 5 atomic layers and the study of their structure, electrical properties and stability.
Interaction of light with condensed matter systems: ellipsometry studies of gas adsorption on solids; theory of reflection of electromagnetic, acoustic and particle waves from interfaces, with applications to ellipsometric studies; statistical mechanics of dielectric functions; study of gas adsorption on the surface of ice.
Accelerator physics, ion implantation and electron microscopy in the study of materials; the development of a technique for the energy calibration of Tandem accelerators using nuclear resonance reactions induced by heavy ion beams; research into accelerator and nuclear techniques for the study of materials of relevance to NZ science and the development of new technologies for industry; the application of computer based processing techniques to the electron microscopy of materials; a theoretical study of electron diffraction from ordered defect structures in metals.

Antarctic Physics
Physics in the Antarctic; the measurement and interpretation of the optical, thermal and microstructural properties of sea ice; properties of ultraviolet light in the Antarctic and interaction with algae.

Astronomy
Photometry and Spectroscopy; photometric and spectroscopic observations on a range of cataclysmic variable stars; observations of selected southern hemisphere stars using the Vitilus photometry system and expansion of the observational base to include the two-channel photometer and CCD system at Mt John; photometric and spectroscopic observation and analysis of binary stars to derive meaningful parameters for such systems; hardware and software development of the two-channel photometric computer-based system located at Mt John Observatory, Lake Tekapo.

Biotechnology and Medical Physics
Physics in Biology: continuation and development of the application of radiation physics, nuclear and allied techniques including electron microscopy in the area of biotechnology and medical physics.

Scholarships and Support
NZ Universities Post Graduate Scholarships and VUW Post Graduate Scholarships.

Department of Physics
University of Waikato, Hamilton, New Zealand
Chairman: Dr WH Round

Plasma Physics and Kinetic Theory
Moment equations and application to transport in high temperature plasma; theoretical studies on anomalous transport in magnetically closed systems; plasma torch; plasma processing.

Theoretical Quantum Optics
Squeezed light and quantum noise; anti-bunched light; intensity correlations; fundamentals of quantum theory and proposed experimental tests; atom laser theory; macroscopic tests of quantum mechanics; violations of Bells inequalities; PDR paradigms.

Remote Sensing
Passive remote sensing, analysis of infrared AVHRR data, atmospheric properties; sea surface temperatures; land surface temperatures.

Medical Physics
Exercise quantification; physiological monitoring and modelling; radiotherapy dosimetry; ultrasonic imaging; objective testing (evaluation of medical technology).

Technology
Electronics; plasma processing; electric fences; biological effects of electricity; radio-astronomy; agricultural and horticultural applications; microelectronics, mechatronics, loud-speaker design, sensor technology; environment imaging.

Lasers and Optics
Industrial applications.

Scholarships
University of Waikato Post Graduate Scholarships.

NZ

Department of Physics
Victoria University of Wellington
Wellington, New Zealand
Chairman: Professor John Lekner

Materials Science
Electronic properties of materials: high temperature superconductors - the preparation of a series of perovskite superconductors and ruthenate perovskites, measurement and modelling of their vibrational and transport properties and magnetic susceptibility, micro-structural studies using electron microscopy; conducting polymers - measurement and interpretation of electronic transport properties; superlattices - the preparation of superlattices of Ta/Ge, Ge/Ge-H and Ge/Si with layers as thin as 5 atomic layers and the study of their structure, electrical properties and stability.
Interaction of light with condensed matter systems: ellipsometry studies of gas adsorption on solids; theory of reflection of electromagnetic, acoustic and particle waves from interfaces, with applications to ellipsometric studies; statistical mechanics of dielectric functions; study of gas adsorption on the surface of ice.
Accelerator physics, ion implantation and electron microscopy in the study of materials; the development of a technique for the energy calibration of Tandem accelerators using nuclear resonance reactions induced by heavy ion beams; research into accelerator and nuclear techniques for the study of materials of relevance to NZ science and the development of new technologies for industry; the application of computer based processing techniques to the electron microscopy of materials; a theoretical study of electron diffraction from ordered defect structures in metals.

Antarctic Physics
Physics in the Antarctic; the measurement and interpretation of the optical, thermal and microstructural properties of sea ice; properties of ultraviolet light in the Antarctic and interaction with algae.

Astronomy
Photometry and Spectroscopy; photometric and spectroscopic observations on a range of cataclysmic variable stars; observations of selected southern hemisphere stars using the Vitilus photometry system and expansion of the observational base to include the two-channel photometer and CCD system at Mt John; photometric and spectroscopic observation and analysis of binary stars to derive meaningful parameters for such systems; hardware and software development of the two-channel photometric computer-based system located at Mt John Observatory, Lake Tekapo.

Biotechnology and Medical Physics
Physics in Biology: continuation and development of the application of radiation physics, nuclear and allied techniques including electron microscopy in the area of biotechnology and medical physics.

Scholarships and Support
NZ Universities Post Graduate Scholarships and VUW Post Graduate Scholarships.

Department of Physics
University of Waikato, Hamilton, New Zealand
Chairman: Dr WH Round

Plasma Physics and Kinetic Theory
Moment equations and application to transport in high temperature plasma; theoretical studies on anomalous transport in magnetically closed systems; plasma torch; plasma processing.

Theoretical Quantum Optics
Squeezed light and quantum noise; anti-bunched light; intensity correlations; fundamentals of quantum theory and proposed experimental tests; atom laser theory; macroscopic tests of quantum mechanics; violations of Bells inequalities; PDR paradigms.

Remote Sensing
Passive remote sensing, analysis of infrared AVHRR data, atmospheric properties; sea surface temperatures; land surface temperatures.

Medical Physics
Exercise quantification; physiological monitoring and modelling; radiotherapy dosimetry; ultrasonic imaging; objective testing (evaluation of medical technology).

Technology
Electronics; plasma processing; electric fences; biological effects of electricity; radio-astronomy; agricultural and horticultural applications; microelectronics, mechatronics, loud-speaker design, sensor technology; environment imaging.

Lasers and Optics
Industrial applications.

Scholarships
University of Waikato Post Graduate Scholarships.
PRODUCT NEWS

Revolutionary Raman Imaging Microscope

The Raman Group of Renishaw Transducers plc of the UK has developed the dispersive Raman Microprobe, a device which combines fast full range scanning confocal Raman spectroscopy and direct 2-D Raman imaging in one system. One such Renishaw System 2000 is now available in Australia through Warsaw Pty Ltd for demonstration and evaluation to interested parties.

The system is compact and does not require a fully vibration isolated table. It can be assembled, calibrated and operational within one hour - most unusual for any Raman system.

Typically a sample can be measured within a few seconds rather than minutes or hours.

The result is a low cost, user-friendly unit that can be used for both fundamental scientific research and investigation, or technician-operated for quality assurance. Applications include materials identification and analysis of semiconductors, polymers, oxides, films (such as diamond), gemstones, superconductors, corrosion studies, ceramics, composites, liquids, fibres, etc.

Optics have a 25% optional throughput which compares with much lower values from multiple grating spectographs. The result is that low power lasers can be used, for example 25mW or lower, with the expensive 5W water cooled lasers used previously for Raman type measurements.

The unit also has several accessories with computer control: x-y scanning with 1μm spatial resolution, ability to strain map, confocal design with 1.5 - 2μm vertical resolution, low wavelength filters giving <50cm⁻¹ shift from the laser line, photoluminescence, fluorescence spectra and imaging, high pressure cell, high and low temperature cells (from 150K down to 4.2K).

Renishaw's range of lasers include a 325nm HeCd, 488/514nm Ar⁺, 633nm HeNe and Renishaw's own 780nm diode laser.

Further information is available from the exclusive distributors in Australia: Warsaw Pty Ltd PO Box 1685 Strawberry Hills NSW 2012
Tel (02) 319 0122
Fax (02) 318 2192

Diode Pumped Nd:YAG and Nd:YLF Lasers from Coherent/Adlas

Coherent Laser Group has recently concluded an agreement for the acquisition of Atlas GmbH of Lübeck, Germany. Atlas, a pioneer in diode pumped solid state (DPSS) technology, is the leading manufacturer of DPSS lasers used in commercial applications such as semiconductor inspection, rework processes, material processing and analytical instrumentation.

The Atlas technology complements Coherent's present DPSS laser product line. The merged product line of Coherent/Atlas compact solid-state lasers will include the following laser systems:

- CW 1064nm (Infrared) lasers, with output powers from 100mW to 3W
- Single-Frequency 1064nm lasers, with output powers from 80mW to 600mW
- CW326nm (Green) lasers, with output powers from 10mW to 400mW
- Q-Switched 1064nm lasers (up to 50kHz), with pulse energies from 15μJ to 750μJ
- Q-Switched 1047nm lasers (up to 50kHz), with pulse energies from 30μJ to 350μJ
- Q-Switched 532nm lasers (up to 50kHz), with pulse energies from 7μJ to 250μJ
- Q-Switched 523nm lasers (up to 50kHz), with pulse energies from 15μJ to 120μJ

For more information, please contact:
Rob Purvinskis or Narrelle Murphy
Coherent Scientific Pty Ltd
116 Burbridge Road
Hilton SA 5033
Tel (08) 352 1111, fax (08) 352 2020
email 100351.1471@compuserve.com

InGaAs Arrays & Cameras to 2.5 Microns

Sensors Unlimited of Princeton NJ has released a new series of detectors that respond from 0.8 micron to 2.5 microns.

The devices are available as line scan cameras, with array lengths of 128, 256 and 512 elements as well as camera based on 128 x 128 element focal plane arrays.

They also produce a single element InGaAs detectors, room temperature, TE cooled and fibre coupled, with response out to 2.6 microns.

The founder of Sensors Unlimited, Dr Craig Olsen, previously of Epixat, has cooperative projects underway with Princeton University's Opto-electronic Materials Centre directed by Professor Steven Forrest and the New Jersey Institute of Technology, Electronic Imaging Centre directed by Professor Walter Kowalsky.

Sensors Unlimited 2.5 micron InGaAs technology is an indicator of their leadership in this important sensor technology.

For more information call Alex Stano at Lastek Adelaide on Tel (08) 328 6668, fax (08) 438 427

Advertisers, please email your press releases for publication in this section of the ANZ Physicist.
Another Fine Book about Light and Sky Phenomena

Marcel Minnaert's famous Light and Colour in the Outdoors, the latest edition of which I reviewed in our first issue last year, now has a direct competitor. Its title is very similar: Color and Light in Nature and its coverage is much the same, although the treatments often differ. The authors, David Lynch and Bill Livingston, are two astronomers with the same deep fascination for terrestrial atmospheric phenomena that drove Marcel Minnaert.

Both books have beautiful colour illustrations. In this respect I must judge the latest edition of Minnaert to be above the outstanding photographs by the Finnish photographer Pekka Parviainen. However Lynch and Livingston's book has a greater number of colour pictures, mostly very good, adorning its larger format pages.

The explanations of atmospheric optical phenomena are somewhat better treated by Lynch and Livingston. Between their colour shots they have many graphs and line drawings showing the essential physical basis for the effects illustrated. Most of their descriptions are accurate: a glaring exception is in their two-page coverage of meteors. To state that meteors are brightest at an altitude between 130 and 80 kilometres is half wrong: meteors are rarely visible above 105 kilometres. And to say that those dropping meteors are no longer visible below 80 kilometres, is completely wrong. Twenty kilometres would be much more accurate. Their concepts in this area are quite outdated. Fortunately the remainder of their astronomy chapter is much better.

In the treatment of haloes, I liked Lynch and Livingston's well-conceived catalog of halo classifications, although it is bit terse and technical for many. Minnaert, on the other hand, takes diagrams of three historical halo events to illustrate their various features and he also presents a schematic representation of them on the celestial vault.

Lynch and Livingston explain some phenomena which Minnaert overlooks, such as irisation, and they often use different terms, like 'skypools' for reflections from gently undulating water where Minnaert uses the description 'light pools'. It is instructive to read both books together to embellish or reinforce one's understanding.

Many of the explanations in Lynch and Livingston's volume are very clear, especially for why foam is nearly always white; the 'greyness' of clouds; and how one may sometimes see colored clouds.

Minnaert's volume has a better index. Lynch and Livingston provide a very good 15-page glossary, which Minnaert does not have. Both books provide good lists of references, but Lynch and Livingston only reference the early Dover edition of Minnaert's book: they should have caught up with the new Springer edition.

In short, both volumes are worthy of purchase. Each is good for either reference on your bookshelf or display on your coffee table. Color and Light in Nature, by DK Lynch and W Livingston, is a large format (250 x 250 mm) glossy paperback of 238 pages. It is published by the Cambridge University Press for the reasonable price of A$45 and has the ISBN number 0 521 46835 1. It does not appear to be available in a hardcover edition. Even so, I happily recommend it for the many hours of enlightenment it will provide.

Colin Kelly
Reviews Editor

The Properties of Optical Glass

Bach & N Neuroth (eds)
Springer-Verlag, Berlin 1995
xxiv + 410pp., DM268 (hardcover)
ISBN 3 540 58357 2

From the time of Newton to the 1880s, only a few simple crown and flint glasses were available for the design of optical systems. Glass quality was usually poor, with widely varying optical homogeneity, strain and bubbles. In the 1880s, Ernst Abbe challenged glass makers to produce new optical glasses to achieve high performance, not quality predicted by his design work on microscope objectives and other optical instruments. Otto Schott accepted the challenge and heralded the beginning of a new scientific approach to glass development which continues to this day. In 1884, Otto Schott introduced the first optical glasses having "anomalous dispersion" thereby enabling the realisation of apochromatic lenses corrected over a wide wavelength range. Schott was also responsible in 1911 for the development of the fluorine-borosilicate glasses having low index and low dispersion. It is fitting then, that the present volume should be produced by the staff of the present day Schott Group of companies, the world's leading manufacturer of quality optical glasses.

The book is the first in a series reporting on R&D activities, products and processes developed by the Schott Group. The next two volumes, expected to be published in 1996, will be entitled Low Thermal Expansion Glass Ceramics and Thin Films on Glass. These are to be followed by four volumes on fibre optics and integrated optics, surface analysis, analysis of the composition and structure of glass and glass ceramics, and the electrochemistry of glasses and glass melts. Other glass topics are under consideration as part of a publishing program which must eventually result in a landmark series.
The Properties of Optical Glass aims to fill the gaps between the basic materials science and the product descriptions provided by glass manufacturers. The book does this with excellent chapters on the fundamental issues from physics, chemistry, and engineering, and links these fundamentals to current applications of optical glass, the status of new developments and future trends. As the title suggests, the major theme of the book is optical glass properties, that is, the properties that are critical for the successful application of glass in optical systems. The reader will find a deeper understanding of optical glass as a material and at the same time find answers to questions such as: Within what limits can the properties of glass be reliably manufactured? How does glass behave in processing? Which physical and chemical properties are important for an application? In addition, the book provides a supporting bibliography of exceptional depth and the text is illustrated with approximately 150 figures and 60 tables. The book should be acquired by all libraries with a significant interest in glass science and applications. The expense is great but the book will be useful for many years as the standard work on the properties of optical glass.

II Wilson
Optical Systems Engineering
CSIRO Division of Materials Science & Technology

Surface Acoustic Waves in Inhomogeneous Media
Biryukov et al
Springer Verlag, Berlin 1995
vi + 388pp., DM148 (hardcover)
ISBN 3 540 58460 9

A wide range of problems in surface acoustic wave propagation and scattering are addressed in this book. The ‘inhomogeneities’ referred to in the title include single grooves and bumps (2- and 3-dimensional), periodic irregularities, randomly rough surfaces, surfaces with slight curvature, thin films, sub-surface layers and surfaces with deposited electrode structures. Coverage of each of these topics is necessarily brief, with extensive references to existing literature. Unfortunately, for the western reader, as the book is a translation of a 1991 Russian edition, the references are strongly biased towards the Russian literature and are not very up-to-date. In addition, the translation into English is surprisingly poor in places.

Several theoretical approaches are presented in the book. Considerable emphasis is placed on a formal solution to surface wave propagation and scattering, in which the mechanical stress and the magnetic field on the surface are related to the surface displacement and electric field through an impedance matrix (chs 3-5, 11, 14). Other, less rigorous but more tractable approaches (second order perturbation theory, Born theory, normal mode theory) are used for periodic irregularities, curved surfaces, wedge irregularities and randomly rough surfaces. Comparison with experiment is disappointingly limited.

Although this book might be daunting to a newcomer to the field, it should be a useful reference book for specialists in areas such as acousto-electronics and seismology.

JA Ogilvy
CSIRO Division of Applied Physics
Lindfield

Energy-Filtering Transmission Electron Microscopy
Ludwig Reimer (ed)
Springer-Verlag, Berlin 1995
424pp., DM149 (hardcover)
ISBN 3 540 58479 X

This timely contribution to the Springer Series in Optical Sciences extends Reimer’s earlier volumes on Transmission (TEM) and Scanning (SEM) Electron Microscopy to cover the exciting developments in energy-filtering transmission electron microscopy (EFTEM). The book has been made to high resolution imaging of materials and their quantitative analysis via electron diffraction and electron energy-loss spectroscopy (EELS). After a succinct introduction to the principles and modes of operation of TEM, EFTEM, EELS, and electron optical design of different filtering lenses, together with the inherent aberrations and correction procedures are analysed. A critical overview of the current theory of plasmons and inner-shell ionisation, which should satisfy the theoretician and experimentalist alike, provides the background for a detailed discussion of quantitative elemental analysis by EELS. Honest comparisons with competitive methods are included, such as that between energy-dispersive X-ray spectroscopy (EDX) and EELS which indicates that although the software for elemental quantification is better established for EDX, the techniques have similar accuracy and EELS yields information on specimen thickness as well as providing the interpretive foundation for energy-filtered TEM imaging.

The high quality diffraction patterns and images presented in the later chapters should convince electron microscopists of the benefits of investing in an energy-filtering system for their laboratory and the theoretical understanding of electron-solid interactions. The astounding clarity achieved by the removal of the inelastic background scattering in electron diffraction patterns allows quantitative electron crystallography comparable to that achieved by X-rays. Visibility of thermal diffuse scattering due to electron-phonon interactions is enhanced, as are microstructural features, when zero-loss electrons are selected. Phases with different plasmon losses can be imaged selectively, elemental distribution images formed and comparisons with computer simulations improved.

The final chapter holds a personal attribution in that it highlights recent developments in reflection electron microscopy (REM) and diffraction (RHEED). With the addition of energy-filtering, these techniques now promise high temperature, high speed, high resolution surface analysis in ultra-high vacuum; applications range from elucidation of the kinetics and mechanism of crystal growth to the study of semiconductor interfaces.

The comprehensive and up-to-date reference list at the end of each chapter should enable material scientists and electron microscopists to benefit further from a text which clearly explains the theory and practice of some stimulating advances in analytical electron microscopy.

Heather Kennett
Department of Physics
Australian National University

Brittle Fracture Safety Assessment
B Droste & K Sorensen (eds)
Nuclear Technology Publishing, Ashford UK 1995
vii + 122pp., £24.00 (hardcover)
ISBN 1 85066 40 X

This bound volume of RAMTrans Vol 6 Nos 2/3 reports the proceedings of a progress workshop of a group of international specialists addressing the brittle fracture safety assessment of ductile iron containers for shipping and storage of radioactive materials. Some 17 contributed papers cover regulatory codes and standards, and techniques for materials characterisation.
The hub of the meeting was a debate over the use of fracture mechanics as a tool for fracture safety assessment of container materials, against the arbitrary drop test for containers themselves.

The fracture mechanics argument itself is complicated by a stand-off between protagonists of a very conservative stance by applying classical linear elastic fracture mechanics to assess the fracture resistance of materials which deform far beyond the regime of low constrained ductility, and the followers of F.M. Burdekin (an internationally recognised authority appointed by IAEA to sort out the issue) who argue that elastic plastic fracture mechanics must be used to describe the behaviour of highly ductile container materials - as has been adopted everywhere else in engineering. Burdekin strongly recommends recourse to the British PD 6493/R6 failure analysis diagram which covers the whole spectrum of failure behaviour.

Consensus for this new approach was not forthcoming from member nations, and contributions cover the whole gamut of approaches to testing for critical fracture safety; it is of particular interest to anyone interested in the practical (and critical) application of fracture mechanics. This volume gives insight into the modus operandi of an expert panel under IABA, and highlights the conflict between enlightened materials science argument on the one hand, and proven conservative empiricism on the other. An interesting read for any fracture mechanic, it deserves a high specialised field.

JC Ritter
Ship Structures & Materials Division
Defence Science & Technology Organisation

Lattice Methods for Multiple Integration
H Sloan and S Joe
Oxford Science Publications 1994
xi + 239pp., AS$5.00 (hardcover)
ISBN 0 19 835472 8

Even the fastest and largest computers of today and tomorrow will only be able to solve the simplest of problems in molecular dynamics, astrophysics and theoretical physics unless mathematics is used to streamline the process in one way or another. The point of focus for such mathematics must be the entities which are evaluated repeatedly. In many physical and chemical simulations, the central activity is the repeated evaluation of multiple integrals.

Much numerical and mathematical research has been devoted to the efficient computation of multiple integrals. The current book, though primarily devoted to one class of such methods, the lattice methods, starts with a brief, precise and useful summary of the various methods and finishes with a detailed comparison of lattice methods with some of the alternatives.

Any quadrature rule of the form
$$\frac{1}{N} \sum_{j=0}^{N-1} \sum_{k=0}^{N-1} \left( f(x_j, x_k) - f(x_{j+1}, x_{k+1}) \right) dx_j dx_k$$

is a lattice rule if the points $x_j x_k$ are all the points of an "integration lattice" that lie in the half-open unit cube $[0,1]$, where an "integration lattice" is a discrete set of $\mathbb{R}^2$ which is closed under addition and subtraction and which contains all the integer vectors. It is this precise and structured mathematical definition which allows quite deep pure mathematical results to be applied and developed for the manipulation and analysis of lattice rules.

Among other things, the book motivates the use of such results to obtain more efficient (lattice) methods for the evaluation of multiple integrals. It represents an excellent example of modern mathematics where the power of deep theory is used to resolve important practical questions. For such reasons, this book will be of interest to a wide readership, the student and the scientist who wish to learn about the computational evaluation of multiple integrals, the numerical analyst who wishes to design better lattice methods, and the mathematician who wishes to have practical motivation for theoretical investigations such as number theoretic manipulations.

The book is an ideal text for a course on lattice methods. For theoretical and computational physicists and chemists as well as applied and industrial mathematicians, with a non-trivial interest in multiple integrals, the recommendation is to keep a copy in easy reach.

R Anderssen
Mathematics & Statistics
CSIRO

Notes on Quantum Mechanics
2nd Edition
Enrico Fermi, with problems compiled by RA Schulte
Univ of Chicago Press, Chicago 1995
vii + 188pp., US$14.95 (paperback)

The first edition of Fermi's 1954 lecture notes on quantum mechanics was regarded as a classic. Now, thirty four years after its original publication, a second edition has appeared. The notes in both editions are reproduced in facsimile from original handwritten duplicate master sheets, prepared by Fermi for his students at the University of Chicago. What is new with the reissue is the addition of a set of sixty problems at the end of the notes which were given to the students by Fermi at the close of each lecture.

The value of these handwritten notes is twofold. Firstly they provide a neatly packaged reference source, both for students of later year undergraduate quantum mechanics and for lecturers preparing courses. Fermi's treatment of such things as the hydrogen atom and spin orbit coupling are clear and concise and are set out in a notation consistent with current conventions. Secondly, the notes are an interesting historical document. The marginal jottings, the scribblings out and alterations, and the very occasional spelling mistakes ("prove" for "prove" and "discrete" - Fermi learnt English from Berlitz as an adult) offer a personal touch that polished typeset notes cannot.

Also of historic interest is the laborious detail with which matrix algebra is explained to advanced physics students; an indication of how mathematics courses must have changed since 1954.

The added set of problems will be a useful source for those needing to set assignments for quantum mechanics courses, though solutions are not given so you will need to work them through for yourself. They are directly relevant to the material in the lectures and contain a high percentage of "real world" problems to keep students interested.

In all, good value at the price of a paperback novel.

CJ Burden
Theoretical Physics Department
Australian National University

The Materials Science of Microelectronics
Klaus J Bachmann
VCH Publishers, New York 1995
541pp., DM128 (hard cover)
ISBN 0 89573 289 7

Microelectronics is a special field of engineering characterised by rapid progress over the last 35 years with important inputs from chemistry, physics, mathematics and electrical engineering. This book attempts to provide a concise overview of materials science and engineering that supports
this industrial development. It is based on lecture notes used by the author at North Carolina State University. The book is structured as an introduction followed by three chapters on the structure of atoms, crystalline solids and semiconductor devices. The next four chapters cover the manufacturing processes of crystal growth, epitaxial deposition, lithography and oxidation with a concluding chapter on optical electronics.

It is difficult to determine the target audience for this book. It is over extensive for undergraduate use and the basic sections would not be required for postgraduate students while the strong theoretical and mathematical approach adopted would not be very suitable for industrial practitioners. The introduction section tries to cover a lot of ground from basic crystallography to a variety of devices but lacks a continuous thread and requires considerable device background knowledge to understand the wide range of devices mentioned. Although the book has just been printed, figures and text in this chapter seem to have not been updated from 1990. The next two chapters on the structure of atoms and molecules and the electronic structure of crystalline solids are heavily mathematical but standard treatments of the subject matter. A recent addition to experimental surface physics is the scanning tunnelling microscope and the third chapter concludes with some pictures of crystal surfaces. The chapter on devices starts with standard theory and moves on to a variety of modern heterostructures. A practical description of the full CMOS process occupies only just three pages in a chapter of 50 pages. The next four chapters on manufacturing are the real substance of this book. They all tend to have the same format of a theoretical introduction followed by short descriptions of a wide variety of techniques and processes.

To gain full advantage of this book the reader needs to be prepared to follow up on the long list of references that conclude each chapter. The book concludes with a short chapter on optical electronics covering transmitters, receivers and optical fibers.

This is an interesting subject and I think the author should not have tried to cover the basic theory of the earlier chapters, which is well done in other texts, but have spent more time in developing the chapters on current material processing. There are also a number of minor errors in the figures which should be corrected in later editions.

AJ Marriage
Microelectronics Centre
University of South Australia

New Books

Thermodynamics and Statistical Mechanics
W Greiner, L Neise & H Stocker
Springer-Verlag, Berlin 1995
xvi + 463pp., DM78 (paperback)
ISBN 3 540 94299 X

The Data Handbook Second Edition
B Forster
Springer-Verlag, New York 1995
xxvi + 350pp., DM59 (hardcover)
ISBN 0 387 94505 9

Radiation Exposure and High-altitude Flight
Commentary No 12 National Council on Radiation Protection and Measurement Bethesda MD 1995

Third Granada Lectures in Computational Physics
PL Garrido & J Marro (eds)
Springer-Verlag, Berlin 1995
xvi + 346pp., DM 106 (hardcover)
ISBN 3 540 91718 8

Low Magnetic Fields in Anisotropic Superconductors
AJ Greer & WJ Kossler
Springer-Verlag, Berlin 1995
vii + 161pp., DM58 (hardcover)
ISBN 3 540 91672 3

Potential Theory in Gravity & Magnetic Applications
RJ Blakely
Cambridge University Press, New York 1995
xix + 441pp., AS115.00 (hardcover)
ISBN 0 521 41508 X

Quantum Networks: Dynamics of Open Structures
C Mahler & VA Wehrruss
Springer-Verlag, Berlin 1995
xv + 390pp., DM98 (hardcover)
ISBN 3 540 58850 7

Operational Quantum Physics
P Busch, M Grabowski & PJ Lahti
Springer-Verlag, Berlin 1995
xi + 230pp., DM62 (hardcover)
ISBN 3 540 59325 8

Quantum Mechanics: Introduction for Device Physicists & Electrical Engineers
DK Ferry
IOP Publishing, Bristol 1995
ix + 288pp., £25.00 (paperback)
ISBN 0 7503 0328 X

Microwave & Optical Waveguides
NJ Cronin
IOP Publishing, Bristol 1995
xii + 119pp., UK£15.00 (paperback)
ISBN 0 7503 0216 X

Mathematical Foundations of Quantum Statistical Mechanics
D Ya Petrina
xvi + 444pp., US$224.50 (hardcover)
ISBN 0 7923 3258 X

The Enigmatic Photon: Vol 2 Non-Abelian Electrodynamics
M Evans & J-P Vigier
x + 171pp., US$89.50 (hardcover)
ISBN 0 7923 3288 1

Electrochromism Fundamentals and Applications
PMS Monk, RA Mortimer & DR Rosseinsky
VCH, Weinheim 1995
xiii + 216pp., DM168 (hardcover)
ISBN 3 527 29063 X

Photonic Crystals
J DE Joannopoulos, RD Meade & &N Winn
x + 137pp., US$35.00 (hardcover)
ISBN 0 691 03744 2

Renormalization Group
G Benfatto & G Gallavotti
viii + 142pp., US$14.95 (paperback)
ISBN 0 691 04446 5

Gamma-Ray Spectrometry in the Environment Report No 53
International Commission on Radiation Units & Measurements Bethesda MD 1994
x + 84pp., US$50.00 (quarto paperback)

Semiconductor Optics
C F Klingshirn
Springer-Verlag, Berlin 1995
 xviii + 490pp., DM79 (hardcover)
ISBN 3 540 85312 2

The Quantum Hall Effects Second Edition
T Chakraborty & P Pietilainen
Springer-Verlag, Berlin 1995
xii + 302pp., DM58 (paperback)
ISBN 0 387 58515 X

Modern Instrumentation: A Computer Approach
G Silverman & H Silver
Institute of Physics Publishing, Bristol 1995
xi + 453pp., UK£40.00 (hardcover)
ISBN 0 7503 0298 4

Australian & New Zealand Physicist Volume 32, Number 11, November 1995

263
1995

November 20 - 24  Engineering and Physical Science in Medicine Conference '95 & 3rd Asia/Pacific Regional Conference of the IEEE Engineering in Medicine and Biology Society, Queenstown, New Zealand.
Contact Conference Secretariat, Centre for Continuing Education, University of Canterbury, Private Bag 4800, Christchurch New Zealand.
Tel (64) (3) 364 2162, fax (64) (3) 364 2057, email m.brown@csc.canterbury.ac.nz

November 27 - 29  The 9th Australian Conference on Vacuum Techniques of Analysis and 3rd Vacuum Society of Australia Congress, University of Newcastle, Australia.
Contact Assoc/Prof D.J. O'Connor, Department of Physics, University of Newcastle NSW 2308,
Tel (049) 21 5439, fax (049) 21 6907, email phjoc@ee.cc.newcastle.edu.au

1996

January 8 - 25  Ninth Physics Summer School: Computational Physics, National Centre for Theoretical Physics, Department of Theoretical Physics, RSPhysSE ANU Canberra.
Contact Ms Martina Landsmann, tel (06) 279 8123, fax (06) 249 4676, email Martina.Landsmann@anu.edu.au

January 8 - 12  IAU Colloquium 160 Pulsars: Problems & Progress, Sydney Australia.
Sponsored by: IAU, ATNF, RCITA, URSI
Contact Prof DB Melrose, RCITA, School of Physics, University of Sydney NSW 2006. Tel (02) 351 2542, fax (02) 660 2903, email iau@physics.usyd.edu.au, WWW: http://www.physics.usyd.edu.au/iau160.html

January 29 - 31  GEM-9, Ninth Gaseous Electronics Meeting, Flinders University.
Contact Dr Bruce Wedding, School of Applied Physics, University of South Australia, Levels Campus SA 5095.
Tel (61) (8) 302 3244, fax (61) (8) 302 3389, email phabw@levels.unisa.edu.au

July 1 - 5  Twelfth AIP Congress, University of Tasmania, Hobart.
High profile speakers will present papers on the challenges of physics in their areas of expertise. See the conference web page at http://www.utas.edu.au/docs/physics/AIPCongress for additional details.
Contact (accommodation and registration) ApplePhys'96, Mures Convention Management, Victoria Dock, Hobart TAS Australia 7000.
Tel (002) 34 1424, email mures@hbo.trumpet.com.au
Contact (scientific program) Prof R Delbourgo, Physics department, University of Tasmania, GPO Box 252C, Hobart Australia 7001.
Tel (002) 20 2403, email Bob.Delbourgo@phys.utas.edu.au
Why OEMs Move In Our Direction.

Piezotechnology Nanopositioning Solutions in x,y,z

Zygo required a compact device to focus microscope objectives to subnanometer accuracy over a 100 µm range. They chose a Physik Instrumente PIFOC, off-the-shelf from PI. The result? The NewView 100 3D Imaging Surface Structure Analyzer, Photonics Circle of Excellence and R&D 100 Award Winner.

When Technical Instrument Company needed a precise Z-Stage for the KMS300T Photomask Inspection System, they also called us. We responded with a custom, 8x8 inch clear aperture piezoelectric stage providing 30 µm motion and 5 nanometer resolution.

Dozens of companies serving semiconductor, disk drive and medical industries rely on Physik Instrumente for off-the-shelf and custom solutions to unusual and demanding nanopositioning problems. We can help you too; with over 20 years experience in harnessing piezotechnology, we have a wide repertoire of solutions adaptable to your needs at a fair price, with reasonable delivery. Give us a call.

WARSASH PTY LTD
PO Box 1685 Strawberry Hills NSW 2012
Tel (02) 319-0122 Fax (02) 318-2192

- Boxcar Averagers
- Lock-in Amplifiers
- Digital Delay Generators
- Photon Counters
- High Voltage Supplies
- Thermocouple Monitors
- Low Noise Amplifiers
- FFT Spectrum Analysers
- Function Generators

Separate the signals from the noise

Coherent Scientific Pty Ltd
116 Burbridge Road, Hilton
South Australia 5033
Telephone (08) 352 1111
Facsimile (08) 352 2020
Internet 100351.1471@compuserve.com