Laboratory Components Kit

- A simple way to acquire new lab capabilities
- Ideal for teaching laboratories
- Formed foam insert protects components

In two durable carrying cases, the new MK-2 Components Kit assembles a carefully selected assortment of Newport's most popular Standard and Mini Series optical positioning and fixturing components. Add just a laser, simple optics, and a Newport table or breadboard to make a wide range of opto-mechanical experiments possible.

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S Spectra Physics
2-4 Jesmond Road, Croydon VIC 3136
Ph: (03) 723 6600, Fax: (03) 725 4822

Optical Component Sets

- Sets for VIS, NIR, IR, and high power applications
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- All components edge-labeled for easy ID

OPTISET provides convenient access to a complete set of commonly-used mirrors, filters, lenses, beamsplitters and objectives. Each set includes a hardwood instrument case with separate trays for each component group. Part numbers are labeled on the trays as well as on the edge of each component.

THE AUSTRALIAN INSTITUTE OF PHYSICS

THE WALTER BOAS MEDAL

Nominations are invited for the 1990 award of the Walter Boas Medal of the Australian Institute of Physics and should reach the Honorary Secretary not later than 30th April 1990.

Any AIP member may nominate any qualified person (including himself or herself and including non members). Nominations must be accompanied by a letter from the person nominated enclosing a brief CV, a short account of the relevant research and a corresponding list of papers.

The Medal was established in 1984 to promote excellence in research in Physics in Australia and to perpetuate the name of Walter Boas. It is open to competition among persons resident in Australia for at least five out of the seven years preceding the date on which entries for the award close, supported, where appropriate, by unpublished papers prepared for publication recording work carried out during that period.

Further details may be obtained from
Honorary Secretary, Australian Institute of Physics,
Clunies Ross House, 191 Royal Pde, Parkville, Victoria 3052.
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Australian Physicist
Department of Physics
University of Newcastle
NSW 2308
Phone (049) 68 3237
Fax (049) 60 1661

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Cover: CAESAR - a new army of Compton-suppressed gamma-ray detectors comprising Ge crystals and Bronsholm Germanium anti-Compton shields. The device is used for high efficiency gamma-gamma coincidence studies to determine the structure of nuclei far from stability. The nuclei are formed using heavy ion beams from the 14UD accelerator in the Research School of Physical Sciences at the ANU. Photo by Gavin Gilmour, courtesy of Dr George Dracoulis.
Last November's issue of the Australian Physicist, with its emphasis on articles of educational interest, reminded me that I had vaguely promised Jan Powe, the Associate Editor (Education), to contribute such material but have not yet done so. Perhaps I can remedy that!

Along with her invitation to write something, Jan had sent me a cutting from an issue of the New Scientist of a couple of years ago, in which the author of a Letter to the Editor confessed that she had become a scientist as a result of a "Woorlookadat" experience: A classroom demonstration in which convection currents were illustrated by a crystal of potassium permanganate in a heated beaker of water had led to the spontaneous exclamation "Woor ..." and the later speculation that the intrinsic beauty of the experiment had "tumed her on" to science.

This struck a resonant chord in me because I distinctly remember the classroom experience which, well over 40 years (but considerably under 50 years) ago, permanently warped my mind. It happened one day that Mr. Horovitch, the fourth form teacher, came into the classroom carrying the battery of his motorcycle. He sat up on the corner of his desk, as was his habit, with his feet dangling over the side, and put the battery down beside him. He then took a few things out of his pocket, one at a time. A length of wire (dressing 'double cotton covered' they used to have in those pre-plastic days), a long bolt and a few nails. An air of suspense was building up. It was quite clear that he was going to do something unusual; he was that sort of bloke.

"Well", he said when he saw that he had our attention, "today I want to tell you a story about a young apprentice bookbinder, who was a very poor but very clever lad. His name was Michael Faraday and he lived in London in a long time ago. He used to like reading very much and had read many of the books that his master had given him to bind". ("Here we go: He is trying to get us to read more!"). As he was talking, we were all intently watching his hands. He seemed one was fiddling with that bolt winding the wire on it like one wins string upon a bobbin. Quite distracting, really.

The story continued, that Michael Faraday had heard about a very famous man who used to give very interesting science lectures, and that young Faraday went along to these lectures and was very impressed by what he heard and wrote down every word of it. ("How could he do that, I ask you. What's he trying to sell us here? Pay more attention to listening?""). And then he copied it all out in the finest copperplate handwriting". ("Here we go! Handwriting!"") and went along to see the famous man and presented him with a copy of these notes that he had, himself, bound into a handsome book."

- "Why did he do that? Are you paying attention, Klein?"
- "Yes Sir, you said he was a bookbinder, Sir"
- "Very good. An apprentice bookbinder actually. But when he took the book along he asked the famous man if he could become an apprentice chemist instead, and the famous man said all right". Or something like that. Meanwhile he had continued fiddling with the wire which by now was all wrapped around the long bolt.

"Now, I want to show you something very interesting", said Mr. Horovitch. "You all know that a magnet can pick up steel pins and nails, but this bolt can't, of course, because it isn't a magnet" and he showed us that indeed, it couldn't. Big deal! (Or equivalent ... the phrase had not yet been invented). "Well, I'll tell you something that young Michael Faraday did later on, when he had learned everything he could from that famous scientist and had become a famous scientist, himself. One day, he picked up a bolt like this one, and wrapped a lot of wire around it, just as I did, and then he took a big battery ...."
- "No Klein, not like this one. This one is off my motorcycle; they didn't have motorbikes in those days. He had another one. Now stop interrupting!"
- "So, Michael Faraday took the two ends of the wire that was wrapped around the bolt and touched them momentarily to the two bits of metal sticking out of the top of the battery, like this, and ...." Zap! Sparks. ("So what! He's seen bigger sparks than that ....")
- "Now just watch this." The bolt with the wire wrapped around it, just a piece of steel before, was now picking up the nails scattered on the benchtop!
ANNUAL REPORT FROM THE EDITOR

I must begin this column and this new year by apologising for the upsets to our production schedule for the Australian Physicist for November and December issues of 1989. Members of the Institute will be aware that the technical problems of the Physicist is in the hands of a commercial publishing company. They are responsible for aspects such as layout, advertising, etc. Up until November, the company was Hunter Technology Press, a small concern spawned in the incubator environment of Hunter Technology.

At the end of 1989, Hunter Technology Press ceased to exist and was reborn as Impress Studios. They will be responsible for production of the next few issues, but there will be discussion on the future of the Physicist in general and immediate plans for its continuation at the next council meeting. The problems are a little more complicated by the movement of Paul Hewitt to the University of Western Sydney. Paul has been the Technical Editor of the Physicist since its move to Newcastle. His contributions to its successful growth over the last two years have been great and his advice will be missed, though of course we wish him well in his new position.

The problems associated with Hunter Technology Press/Impress in transition plus the small but important contribution of the Newcastle earthquake, have led to the delays in mailing the last two issues. We aim to keep to schedule in 1990.

The Australian Physicist has continued to develop as a high quality journal for the profession. It is unfortunate that the disruption to our schedule has delayed the first edition of a major new initiative into education. At the beginning of 1989 the Editorial Board resolved to try to contribute to the betterment of physics education in secondary schools by developing a supplement containing ideas very relevant to school science and its teaching. In response to the success of the Education Editor and supplied articles at a reasonably regular rate. Some factors related to production delayed the supplement concept, so the November issue was devoted to publication of many of the articles or comments received. The supplement will develop as a regular feature in 1990.

There is no significant backlog of good articles, but the Editorial Board is continually in need of good reviews particularly where they can be successfully pitched to secondary school level while retaining the interest of other readers. There has also been an increase in advertisements, particularly of positions vacant.

I would like to pay tribute to the work of the Editorial Board, who willingly gave of their time for support of the journal. I would be remiss of me if I did not mention the special effort of Colin Keay as Book Review Editor. We must be providing the quickest turn-around of reviews of any journal and I expect publishers are well satisfied.

I must also thank the Hunter Technology team, particularly Paul Hewitt and Judith Nikolski. Without their technical help the journal would not function.

This time of the year is also one which brings some disappointment to university physicists. In universities we spend November and December trying to recruit good research students, particularly Australians, but often with depressing results. Come January and the newspapers are full of comment on the high achievers of whatever final secondary school exam your state offers. In NSW it is the Higher School Certificate. We read of the aspirations of the top 10 or so students and seek almost in vain for the student who wants to become a scientist or an engineer (we don’t bother to look for one who wants to do physics). The newspaper in general tells us of the students are off to this university or that “because I have a good scholarship to study commerce/ computing/actuarial studies” but not science or engineering. Alternatively the best students will do medicine, often because “my HSC grade qualifies me to enter medicine”.

There are few scholarships available at undergraduate level to allow (or encourage) students to enter the sciences in general or physics in particular. We must contend with the artificial elevation of medicine as a subject to be studied only by the very, very able, brought about by the ability of one of Australia’s strongest trade unions to limit intake into the profession and ensure the non-existence of strong competition in the market place.

Over and over, we hear of the need to train more scientist and technologists, of Australia’s dependence on such people for its economic growth and of the necessary contribution such people will make to our future. We cannot however, find those who will...
encourage their training through scholarships. We can't find those who will encourage their interest through development of teaching and the syllabus at secondary level.

Then, at least in NSW, comes the final blow. A senior person in secondary education even questions the need for the small emphasis which exists at HSC level on mathematics and science as subjects to be chosen for senior secondary study. "What does a student who is looking for a career in medicine, economics or ecology need with mathematics and physics?" we are asked by this leader of the secondary school community. "Why should there be advantage gained by those who do the higher level mathematics and science subjects for the HSC?"

No system of assessing the ability of individuals when applied to a large group is perfect. Superior performers will perform with superiority in almost any subject they attempt. The thought processes involved in mathematics and science are the processes which will aid any high level performer in any field of endeavour. Our system still recognises this, despite many attempts to erode the place of mathematics and science in our education system.

It is not sufficient to complain about the problems which face us as physicists, including the gradual devaluation of our subject and profession. We can ask government to do something (usually spend more money on us), but we as physicists are responsible for maintaining physics as a discipline. We must contribute to the education of society (but particularly of secondary students) so that physics is seen as an attractive and meaningful subject, suitable as a career choice, with reasonable prospects of getting a job. Equally as important, society and students must be convinced that they gain something extra from the subject in addition to the subject matter. Development of methods of logical thinking and problem solving are also attractive aspects of the training a physicist receives. We must ensure that this is appreciated by teachers and students at the secondary level. The future of our discipline lies in ensuring the importance of science and mathematics at higher secondary level is not eroded. Indeed, we might even aim to have science and mathematics returned to the prominence of several decades ago. It is always good to have a goal, irrespective of its attainability.

R.J. MacDonald
Honorary Editor

LETTERS

SACRE BLEU!

A brief inspection of the list of distinguished French physicists and mathematicians produced at ANU under the influence of tea, and reported by Drs Chadderton and Barbara (Australian Physicist, November 1989, p 258), revealed some curious inclusions. These were three Englishmen, one Scot and three Germans.

The Brits were:
- Joule, James Prescott, b. Lancashire
- Boole, George, b. Lincoln
- Airy, Sir George, b. Northumberland,

The Germans were:
- Jacobi, Karl Gustav, b. Potsdam
- Bessel, Friedrich Wilhelm, b. Westphalia
- Struve, Wilhelm, b. Altona;

Astronomer & father of 18 children!

Edgar L. Deacon
Beaumaris

THE AUSTRALIAN NATIONAL UNIVERSITY

Applications are invited for appointment to the following positions:

Faculty of Science

DEPARTMENT OF PHYSICS AND THEORETICAL PHYSICS

Senior Tutor in Physics

In addition to general teaching duties throughout the department, the appointee will be expected to assist particularly with first year teaching and its associated laboratory.

There will be opportunity to undertake research. The current research fields of the Department are laser physics and spectroscopy, quantum optics, shock-wave physics and the structure of atomic nuclei.

Applicants should have at least a good honours degree in physics. The appointment should be taken up by March 1990.

Closing date: 9 February 1990

Research Position in Experimental Quantum Optics

A new research project is starting in the quantum optics group aiming at the development of very sensitive optical phase measurement techniques. Instruments, in particular interferometers and polarimeters, will be developed measuring effects such as magnetic or electric fields which are limited in their sensitivity only by the quantum noise of the laser light source. Ultimately such devices could make use of currently developed noise reduction techniques such as the generation of squeezed light.

A position has been established for a research associate/senior research associate, depending on experience, for one year in the first instance with the possibility of extension for a further two years subject to the availability of outside funds. The project is supported by the Australian Research Council. The applicant will work in an already established research group, active both in theoretical and experimental quantum optics. The work will concentrate on the design and testing of the new instruments and the associated laser systems. Previous experience in optics, laser physics or spectroscopy and a PhD in one of these areas is desirable.

For further information contact Professor R.J. Sandeman or Dr Hans-A. Bachor, telephone (062) 49 2747, Fax (062) 49 0741.

Closing date: 23 February 1990

Ref FS 10.1.2

SALARY: Senior Tutor $27,953–$31,808 p.a.; Research Associate $27,953–$31,808; Senior Research Associate $32,197–$41,841.

APPPOINTMENT: Senior Tutor for one year in the first instance.

APPLICATIONS should be submitted in duplicate to: The Registrar, The Australian National University, GPO Box 4, Canberra ACT 2601, quoting reference number and including curriculum vitae, list of publications and names of at least three referees. The University reserves the right not to make an appointment or to appoint by invitation at any time. Further information is available from the Registrar.

THE UNIVERSITY IS AN EQUAL OPPORTUNITY EMPLOYER

OUR FULL COLOUR ADVERTISING RATES HAVE DROPPED. SEE BACK COVER OF THIS ISSUE FOR DETAILS.
Financial Statements

Because of problems with assessing subscription income and the late returns of financial statements from the NSW, SA, TAS and VIC branches, the audit was delayed this year.

The most obvious feature of the last financial year was the jump in subscription income - this is thought to be caused by the convenience of the credit card facilities we now offer. Expenditure for the year was restrained because there was no Council meeting during the year. Executive and Science Policy expenses have also been reduced as these meetings are now held in Melbourne. The costs of publishing the Australian Physicist have risen from 25% to 40% of our total income and we cannot comfortably increase this percentage. While our secretarial costs have dropped these are expected to rise again - if this is to be the case then the head office accounting procedures must also improve. Council funds have dropped again as more funds have been designated for specific groups, at the same time the overall Council balance has improved by $8,000.

### Australian Institute of Physics Council Funds

**Balance Sheet as at 30 September 1989**

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### Australian Institute of Physics Funds Held on Behalf of Groups

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### AIP ANNUAL REPORT

**Australian Institute of Physics Council Funds**  
*Income and Expenditure Account*  
*for the year ended 30 September 1989*

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### Statement of Councillors

We, Terence Edmund Freeman and John Douglas Riley being two Councillors of the Australian Institute of Physics state that in the opinion of the Councillors:

(a) The income and Expenditure Account is drawn up so as to give a true and fair view of the surplus of the Institute for the financial year ended 30 September 1989.

(b) The Balance Sheet is drawn up so as to give a true and fair view of the state of affairs of the Institute as at the end of the financial year ended 30 September 1989.

(c) There are reasonable grounds to believe that the Institute will be able to pay its debts as and when they fall due.

Signed on behalf of and in accordance with a resolution of the Council dated 1 February 1990.

This 1st day of February 1990.  

T.E. Freeman  

J.D. Riley
AIP ANNUAL REPORT

Treasurer's Report 1989-1990

Australian Institute of Physics Council Investments at cost 30 September 1989

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<td>Esanda</td>
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Australian Institute of Physics Benevolent Fund Balance Sheet as at 30 September 1989

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<th>Category</th>
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<td>Investments</td>
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<td>Same as previous year</td>
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FOURTH AUSTRALIAN CONFERENCE ON II-VI SEMICONDUCTORS

The Fourth Australian Conference on II-VI Semiconductors will be held at the Green Gables Chalet in Warburton from 23-25 April 1990. This conference follows the successful meetings at Telecom Research Laboratories in August 1984, Monash University in May 1987, and Adelaide University in April 1989.

Scope and Topics

II-VI Semiconductors 90 will cover fundamental and applied research relevant to narrow- and wide-gap II-VI compounds and alloys. It will provide a forum to present and discuss recent advances in materials preparation, characterisation and devices. Special emphasis will be given on new growth techniques, defect and impurity states studies and opto-electronic devices.

THE TOPICS OF THE CONFERENCE WILL INCLUDE:

- Materials preparation and structural properties:
  - bulk growth, epitaxy, heterostructures, doping methods
- Physical properties:
  - theoretical concepts, band structures, point and extended defects, surfaces and interfaces, optical properties, transport properties, magnetic effects, semimagnetics.
- Devices:
  - LED's and lasers, electroluminescence displays, detectors, solar cells optical, modulators.

Inquiries and Future Mailings

A second circular including further information and a call for papers will be mailed by February 1990. To guarantee the receipt of the second circular, please fill in the attached reply card and address it to the Conference Secretary:

Dr Andrew Stevenson, Secretary, II-VI Semiconductor Compounds Conference
CSIRO Division of Materials Science & Technology, Locked Bag 33, Clayton VIC 3168
Tel: (03) 542 2917, Fax: (03) 544 1128
The Cancellation of the NINTH NATIONAL CONGRESS

As Chairman of the Ninth National Congress Committee I write to explain the reasons for the decision taken on Monday, 4 December 1989 to cancel the 1990 Congress.

When the airline dispute first surfaced, preparations for the Congress were well underway and the Congress Committee, like the rest of Australia, did not believe such a dispute could last for more than a week or so at the outside. Even when the pilots resigned and it was certain the dispute would be prolonged it did not seem likely that our Congress still four or five months away would suffer. How wrong we were! As the weeks passed with no settlement in prospect we received signals from a number of quarters that:

(a) participants were uneasy about making travel plans with the real prospect of delays and uncertain schedules and
(b) the lack of discount fares was a very real disincentive and the financial bar to travel from East to West. (How well we in the West have appreciated this problem in the past when planning short non-apex trips!)

A number of the many respondents to the first circular subsequently made definite cancellations, while it was clear from phone conversations and other sources that some were going to wait and see before making a firm commitment. The Committee resolved that it would make its final decision whether or not to proceed with the Congress immediately after the closing date for abstracts (30 November) and in the interim would urge intending participants to submit registrations. At the final deadline, despite a number of last minute fax and phone calls fewer than 20 out of state registrations and promises were in hand.

In deciding to cancel, the Committee looked at a number of options; specifically a postponement to later in 1990 or a reduced meeting were rejected as unacceptable. The overriding argument was that this would be a National Congress of a professional body and as such a breadth of active participants across the discipline was essential: this is in contrast to a specialist meeting or single topic conference which can be intellectually viable with a small number of participants. The prospective Congress at that stage was neither intellectually nor financially viable and to proceed would not have been fair to those who were to make the trip to Perth at considerable expense nor would it have kept faith with the sponsors who had offered support in expectation of a major meeting. With regret then the Congress was cancelled. At the time of writing this (early January) it seems that the travel situation is easing, though it is by no means back to normal, and had we had sufficient confirmed support in hand the Congress might have gone ahead as planned. That was not obvious at the beginning of December and in any case with the holiday break intervening it was by then too late to extend the date for registration and abstracts and start a late recruiting drive.

I thank all members of the Committee, especially the Secretary, Dick Anderson, the Program Chairman, Cyril Edwards and the Treasurer, Ted Maslen, for the major effort so willingly expended towards the Congress and on behalf of the Congress Committee I extend my sincere regrets to all members of the Institute for the inconvenience and disruption caused to their plans.

I have received personally a number of expressions of sympathy and support for the difficult decision that had to be taken and I thank all members for their understanding.

R. Severin Crip
Chairman, Ninth National Congress Committee
IN SEARCH OF THE IDEAL PhD

Employment prospects for students who complete a PhD degree in physics are good. There is, of course, never any absolute guarantee of employment since other factors are also important, but physics PhDs can be more optimistic than most about their future.

It is strikingly apparent to those of us in industry who play a role in the recruitment of PhDs that the best are better than they have ever been. Even so, there is a growing shortage of very talented people at that level and we need to do more to encourage the very best students to embark on such courses and to ensure that these prepare them as effectively as possible for their future careers. PhD students are an important part of the research workforce in academia and some students are preparing themselves for academic careers, but the emphasis should be on ensuring that the individual talents of all are fostered to the fullest extent.

Physics PhDs are uniquely versatile—some continue to pursue research, others to exploit physics, some to teach, whilst many others now take up a variety of careers which are not directly related to science. To what extent are these different future roles considered when planning a PhD project? Indeed, do all prospective PhD students get advice on the varied prospects awaiting them on completion? Do they have some discretion to tailor their courses to meet their future career aspirations?

There are some very good examples of PhD education and training in physics in UK academia. Features which I see in the best include:

- A clear, precise definition of the aims of the course. For example, it could be to provide training in research skills for those who will continue to practise research; whilst concentrating on a specific project, there should also be encouragement for the student to acquire some interest in other fields. Alternatively, the course could lead in the provision of experts, either in research or in the exploitation of a new field. There are several other equally valid objectives of a PhD course, and my point is that the objectives should be specific and on an individual student basis.

- A work plan or schedule at the outset so that the student can see clearly what is expected of her or him. Additionally the nature, timing and training in specialist skills required for the project should be clear.

- Opportunity for each student to make an individual innovative contribution to the project and sustained encouragement to promote independent thinking.

- Arrangements for students to be members of a peer group of other research students on an interdisciplinary basis. Small departments, by necessity, often do this more effectively than large departments where (unless steps are taken to counter it) some students can become very inward-looking.

- A formal system led by the supervisor and according to individual needs for monitoring progress on the project, along with training in how best to prepare and present work both orally and in writing.

The planning of projects and resources is a feature of big physics such as astrophysics, particle physics and the low-dimensional structures and devices initiatives, to cite the three largest physics based programs in UK academia. These are also the physics subjects where demand from students for PhD places is greatest. There are several lessons to be drawn from this observation. One which is often not noted is that within the overall planning of these topics they encompass departments from the smallest to the largest, with all of them contributing to the research output.

The issue is not primarily one of size, either of program or department, but more of the whole research community agreeing the most effective way of deploying the available resources.

Prospective employers too have a role to play in the education and training of PhDs. The interaction of UK manufacturing industry with academia is exemplary when judged internationally and compared with only ten years ago. Credit for this rests almost entirely with the Science and Engineering Research Council (SERC) whose officials and recent successive chairmen have worked hard to bring about this state of affairs. Prominent amongst the SERC schemes is CASE (Co-operative Awards in Science and Engineering), where industry and academia share the supervision of research students. Industry involvement is almost always through its R&D departments and the indications are that for physics this particular scheme is reaching saturation in terms of the time available from industrial supervisors. There must be scope, especially in physics, for wider industrial involvement through other sectors of manufacturing industry. Also, it is time for those other commercial companies who have become such avid recruiters of physics PhDs in recent years to play a part in education and training. The scope and nature of this extended involvement of prospective employers will be different from that of the current CASE scheme and careful thought is needed on how we might proceed.

The Department of Education and Science too can play a more positive role in encouraging more talented young people to undertake advanced education and training at the PhD level. In the first instance it should restore immediately the real value of the PhD grant to the levels of a few years ago. It should then re-assess that restored level in the light of the many lucrative alternatives which the very talented have on completion of their BSc studies, and it should also lay the framework for a consistent career progression scheme for young researchers in academia.

Of course we need the quantity of PhD graduates, but increasingly we need ever-higher quality. Achieving this requires concerted effort by all concerned.

Dennis Sooter
Manager, GEC Hirst Research Centre, UK
Reprinted from Physics World 2, 13 (1989)
Nuclear Methods to Monitor Nutrition

by B. J. Allen

New nuclear methods are under development by ANSTO to monitor nutrition in cases of cystic fibrosis, renal disease, anorexia nervosa and long-term surgical trauma. Dr Barry Allen, of ANSTO's Applied Physics Program, summarises these developments.

Introduction

Malnutrition may be a consequence of gross physical injury, long-terns surgical trauma, and many diseases, including cystic fibrosis, chronic kidney failure, cancer, anorexia nervosa, heart disease, obesity, inflammation of the bowel and AIDS.

There are occasions when a disease causes a patient to be under-nourished, and in danger of dying as much of malnutrition as of the disease itself. It is therefore important to know if special feeding methods can be used to improve the patient's condition.

The traditional indicators of a patient's condition are, of course, still used, and they include measuring size and weight, and assessing body fat from skin-fold thicknesses. Expensive metabolic techniques which measure nitrogen balance, proteins secreted from the liver, and the degree of immune competence are also used by specialists.

ANSTO is collaborating with medical specialists in several Sydney hospitals to use:

- neutron activation of nitrogen and hydrogen in the body to measure protein content;
- a combination of nuclear and non-nuclear techniques to measure water in the body, and
- naturally radioactive potassium in the body to monitor lean body mass.

These nuclear methods allow medical specialists to assess the patient's condition before, during and after treatment, and to assess the efficacy of special diets or feeding systems.

Cystic Fibrosis

(Royal Alexandra Hospital for Children)

Cystic fibrosis, or CF, is the most frequent serious hereditary disease of Caucasians, occurring in about one in 2500 live births (but rarely in Negroes and Asians).

Cystic fibrosis is a disease in which the patient's mucus is very viscous, so the disease affects many functions of the body, particularly breathing and digestion. A patient with cystic fibrosis has insufficient dilution of mucus by watery secretions from (epithelial) cells that line the gut and the airways of the lungs. Life expectancy for a sufferer from cystic fibrosis used to be well under twenty years; in Australia it is now 23 years, and in some countries, where intensive treatment is available (as in Canada), it may be as high as 35 years.

These improvements have been brought about mainly by better management of the patient's breathing. Medical scientists in Australia are now turning to the better management of the patient's digestion. For this, nuclear methods developed by ANSTO are helping to monitor the patient's response to various diets and dietary treatments.

Physicians encourage CF patients to eat balanced diets, but in very large quantities to make up for losses due to poor absorption of nutrients. For patients who are very undernourished and who cannot eat enough to maintain condition, physicians may prescribe direct feeding through the stomach (gastrostomy) while the patients sleep.

The traditional measure of improvement (increase in body weight) may be misleading because it can be caused not only by protein increase but also by the accumulation of serous fluid in the spaces between tissue (edema) and/or accumulation of fat. A measurement of the total quantity of nitrogen in the body is an accurate measure of total protein, and a good indication of the patient's condition.

ANSTO's nitrogen measurements show that, over a six-month period, gastrostomy feeding of younger CF patients leads to a dramatic improvement in protein content and condition, and promotes them into the well-nourished CF class, (ie above the bottom 3 percent on a weight-for-age basis).

The other ANSTO measurements, on total body potassium, showed that the mass of potassium per kilogram of lean body mass is not a good indicator of condition in a CF patient, and may not correlate with the nitrogen measurements. This contrasts with the general experience that, for healthy people, potassium is a good indicator of condition and correlates well with nitrogen.

The Children's Hospital is also involved in a collaborative study on the effectiveness of a synthetic growth hormone (SHG) for the treatment of short, slowly growing children. A major element of this study is a classic 'double blind' experiment to measure total body nitrogen before and after a six-month trial, during which some patients receive the growth hormone and others a placebo.

Anorexia Nervosa

(University of Sydney, Royal Prince Alfred Hospital, Mount St Margaret Hospital)

Patients with anorexia nervosa become extremely thin because they lose both muscle protein and body fat through not eating. Successful treatment has many aspects, but the major hurdle is getting the patient to cooperate, especially in the matter of diet.

It appears that when the patient begins to eat again, the weight gain occurs mainly as a deposit of fat, and is not accompanied by an increase in muscle protein. This feature of the condition could account for the patient's fear of becoming obese, the likelihood of the rejection of food, and a return to the anorexic condition.

Australian Physicist Volume 27, Number 1/2, January/February 1990
NUCLEAR METHODS MONITOR NUTRITION

Longer-term measurements are in progress to determine whether, during re-feeding, a patient with anorexia nervosa accumulates some muscle protein as a consequence of a program of aerobic exercise, and whether, having regained 'normal' weight, they have excess body fat.

Chronic Kidney Failure
(Royal Prince Alfred Hospital, Royal North Shore Hospital)

If kidneys are not functioning properly, fluids are retained in the body, waste products accumulate in the body, protein decreases, and the patient loses appetite and condition. About one third of patients with chronic kidney failure (CKF) are undernourished, and their life expectancy is reduced. The dialysis machines commonly used by such patients may not remove all waste and may remove some nutrients.

In the measurements of protein content and lean body mass in CKF patients it has been shown that undernourished patients are low in both nitrogen and potassium. These measurements are continuing in order to assess the effect of certain diets, and to determine whether peritoneal or haemodialysis gives the better results.

Long-term Surgical Trauma
(Westmead Hospital)

Surgical trauma leads to a breakdown in body protein, and causes changes in serum proteins, nitrogen balance and delayed reactions to tests on the skin for hypersensitivity. The patient often loses condition abruptly, and 'looks ill'. The lean body mass goes down, and life expectancy is reduced. Recovery in the short-term (2-3 weeks) occurs in many patients, but patients who require long-term (3-4 months) recovery need careful management.

Body composition measurements on such patients are being made before admission to hospital and then at monthly intervals after discharge from hospital. In addition to the measuring techniques developed at Lucas Heights, a suite of conventional tests is also being made at the hospital.

It takes many months to recover lost protein, and even then many patients do not regain it all. Some patients who have had a large part of their bowel removed feed themselves at home via a drip into the bloodstream. The ANSTO-developed measurements of total body nitrogen are the simplest and most accurate means of monitoring their progress, and are of considerable interest to dietitians.

Aquired Immune Deficiency Syndrome
(AIDS) (Albion Street Centre)

One aspect of the fight to stem the dramatic spread of acquired immune deficiency syndrome (AIDS) is international collaboration to test the experimental drug zidovudine. This anti-viral drug may inhibit the human immune virus (HIV) from causing full-blown AIDS.

ANSTO, together with the Albion Street Centre (Sydney) and the AIDS Advisory Council, is considering participation in the tests by measuring body composition of HIV positive subjects. This will be a large test involving 500 subjects over three years: half of them will be taking a placebo. Information about body composition is important in evaluating the effects of this anti-viral drug. AIDS is causing a dramatic increase in the cost of public health, and zidovudine, if adopted, will add further financial burdens to the health system. It is therefore of considerable economic importance to ensure that every effort is made to properly evaluate zidovudine.

Neutrons to Measure Body Nitrogen

The measurement of the amount of nitrogen or hydrogen in a patient, which may be used to infer their protein content, begins with a small dose of neutrons. The patient, lying prone on a movable table, is carefully positioned to receive, from below, a known radiation dose from a collimated beam of neutrons from a radioactive source (50 micrograms of californium-252).

The neutrons activate a tiny fraction of the number of nitrogen atoms in the subject's protein, and convert them from nitrogen-14 to nitrogen-15. This causes them to emit 'prompt' gamma rays which have an energy (10.8 MeV) characteristic of nitrogen. They may be selectively detected against other kinds of radiation and analysed to provide a measure of the patient's protein content.

The neutrons also activate hydrogen nuclei, which are fairly evenly distributed throughout the body (except in bone where there are fewer). Prompt gamma rays of 2.2 MeV, characteristic of hydrogen, are measured by the detectors.

Two detectors are used, one on either side of the patient. They both receive gamma rays from the patient but not from the neutron source itself, which is in a well-shielded container below the patient.

After correction for the attenuation of the gamma rays on passing through the patient's body, the mass of nitrogen is derived from the ratio of the nitrogen and hydrogen yields, together with the known proportion of hydrogen in body weight.

Calibrating the Nitrogen and Hydrogen Measurements

A hollow plastic object, called a phantom is used to calibrate the nitrogen and hydrogen measurements. It is filled with an aqueous solution of urea, which contains a known amount of nitrogen. If the phantom and the patient are the same size, and if they exhibit the same gamma-ray response on irradiation, then one can deduce the nitrogen content of the patient. Similar calibrations are carried out for hydrogen.

Lower Radiation Dose

ANSTO's nitrogen monitor gives the patient a neutron and gamma ray dose lower than comparable equipment elsewhere. This was achieved partly by using more sensitive means of detecting the gamma rays, and partly by using the neutrons from the spontaneous fission of the rare man-made isotope, californium-252. These neutrons are slower and accompanied by fewer gamma rays than those from other sources.

Radiation dose is usually measured in units called sieverts; the world average radiation dose from natural background radiation is two millisieverts a year. A patient in one of ANSTO's measurements of body nitrogen would receive only about one tenth of this, or about the same as for a chest X-ray, 0.2 millisieverts. Naturally occurring radioactive potassium-40 in the body gives each person an annual radiation dose of 3.0 millisieverts.

Potassium Measurements

Potassium is distributed throughout the body in lean body mass. As with all natural potassium, a small fraction (just over one part in 10,000) is radioactive potassium-40. As it decays it emits a characteristic gamma ray. These gamma rays, of energy 1.46 million electron volts (MeV), though few in number, may be detected and analysed in ANSTO's 'whole body monitor', an instrument of very high sensitivity at the Lucas Heights Research Laboratories. Measurements are >
made inside a heavily shielded room in order to block out unwanted radiation from cosmic rays and from natural radioactivity in building materials and air.

**Total Body Water**

Most of the body’s water is in lean tissue, with very little in fat. Therefore a measurement of total body water would reflect the volume of lean tissue only if there is little extracellular fluid.

Total body water may be measured by the isotope dilution technique using heavy water (D₂O) as a non-radioactive tracer. Three to five hours after ingestion, samples of the patient’s plasma and urine are measured, using infra-red techniques, for their heavy water content.

The extracellular water, usually about 20 per cent of total body weight) may be measured in two ways.

The first is to use a sodium bromide solution. Because bromine behaves similarly to chlorine, an injected sample is soon distributed evenly in the blood. A small sample of blood is then activated with neutrons in a nuclear reactor, and then analysed for its bromine content.

The second method uses radioactive sulphur-35, which gives a radiation dose to the subject of less than one per cent of the annual natural background radiation dose. The sulphate which incorporates this radioisotope is not absorbed into body cells, and therefore provides an accurate assessment of the extracellular water.

The water content of the patient’s lean body tissue (ie in the cells) is then determined by subtracting the value for the extracellular water from the total body water.

The ratio of the water content inside and outside the cells of the body may turn out to be an important and low-cost diagnostic tool. The ratio can vary dramatically with disease or with physiological status, and its evaluation is a high priority task.

**Conclusion**

Three nuclear methods of measuring the nutritional status of patients who may have long-term surgical trauma or one of a range of diseases are under collaborative development by ANSTO and medical specialists from several hospitals in the Sydney region. The methods are assisting in the assessment of special diets and dietary procedures designed to improve nutrition.

The nuclear methods provide, for the first time in Australia, quantitative data for these assessments. It is now possible to link the study of body composition to certain physiological or psychological problems. There is a database under development in this area, which will lead to a deeper understanding of the importance of body composition in disease-induced malnutrition. Ultimately it will improve patient care and the quality of life.

This work epitomises the dynamic interaction in research and development between ANSTO and local hospitals. The considerable and continuing interest concerning body composition studies has led to a proposal for a collaborative venture to found an In Vivo Body Composition Laboratory in the inner city area. This Laboratory would provide the means to transfer the technology of using neutrons into clinical use.

Towards the Perfect Three-Way Junction: Plasma Etching & Planar Optical Waveguides

Two physicists at the Research School of Physical Sciences, Australian National University, Dr Rod Boswell and Dr John Love, have been awarded $1 million to carry out further research and development in the field of optical communications, seen as the key to the future in telecommunications.

The funds have been made available through a grant from the Department of Industry, Trade and Commerce and a contract from Telecom Australia. Telecom will also be involved in the basic research through its laboratories in Melbourne. The commercial collaborators are Alcatel-STC in Sydney and Australian Optical Fibre Research Pty Ltd in Canberra, and the project is being managed by the University's commercial arm, Anutech Pty Ltd.

At present, each pair of hair-thin optical fibres connecting Sydney, Canberra and Melbourne can carry some 8,000 telephone conversations simultaneously.

With further R&D, networks will within the next decade or so penetrate into businesses and homes with a single fibre bringing not only multiple phone lines, but also high-definition stereo TV channels and computer and facsimile links. The networks will be able to read gas, electricity and water meters automatically; they will be able to deliver a film without the need to go to the video shop.

One obstacle, however, is that no one so far has developed a single-fibre device that will split the signal on a single delicate fibre into two, four, eight or more fibres independent of the wavelength of the source generating the light. This is needed if the main fibre cables are going to sprout branches that can keep subdividing till they reach our front door.

Dr Boswell, of the Plasma Research Laboratory, and Dr Love, of the Optical Sciences Centre, are undertaking research into the design and fabrication of planar optical waveguides, which will help realise the full potential of the technology.

These waveguides are the optical equivalent of the silicon chip. They consist of lightguides and devices forming optical "circuits" on a single substrate (the base material used in the manufacture of circuits) the size of the palm of the hand.

When optical fibres first appeared on the scene, the big problem was to find a way of splicing the ends of two successive fibres together so that the signals they carried were efficiently coupled. Now that that difficulty has been overcome, the major difficulty is in bringing three ends together.

Three-way splitters (Y-junctions) can be fabricated using fibres, but they lose an unacceptable 30 per cent or more of the incoming energy. After more sets of junctions are established (to get, say, 16 terminals needed for a local-area network), there is very little signal left.

Dr Love and Boswell say the advantage of the planar technology lies in the ability to manufacture multiple low-loss, wavelength-independent Y-junctions in one operation.

Dr Boswell plans to use a plasma etching technique on a microscopic scale to fabricate a near-perfect Y-junction. Dr Love, who has been heavily involved in optical fibre theory and applications since 1973, will supply the theoretical underpinnings of the project.

Their initial idea is to apply plasma etching to the process normally used for integrated circuit production: that is, they want to lay down a thin layer of glass on a substrate and, using photo-resist techniques, each the layer away with a plasma beam to leave, standing proud, tiny waveguides in the shape of a Y. Another protective layer of glass, laid down from a 'cold' plasma, will cover it.

The advantage of plasma etching is that it allows unparalleled accuracy. The faces of the waveguide will be smoother than those produced by any other technique known, meaning that signal losses should be minimal. A scanning electron microscope will be an important part of the experimental apparatus: it will be used to look at any tiny imperfections in the waveguide.

Many scientists around the world are investigating ways of splitting optical signals, using ion etching, chemical etching, ion exchange and other approaches, but so far success has eluded them all.

Dr Love and Boswell believe the plasma-etching technique will win the day. The rewards are handsome: if every metropolitan home in Australia were connected to a fibre network, several hundred thousand such devices would be needed.

Alcatel-STC has been involved in optical fibres for a number of years, and is playing a major role in the trans-Tasman optical-fibre cable between Australia and New Zealand. Australian Optical Fibre Research Pty Ltd was established in 1984 in Fyshwick and has considerable expertise in the development of optical-fibre devices. Telecom Australia Research Laboratories have been looking at optical fibres too, but their collaboration in this work will focus on making the photographic masks.

Another application of Y-junctions could be in the transfer of data among computer networks, but it is possible many more uses would soon find favour. Integrated circuit chips could, on a single board, communicate with each other by optical means rather than by cumbersome wires.

Other optical devices could be incorporated on to the substrate, and these could, for instance, perform instantaneous spectral analysis or do other computations using optical computer elements. Solid-state lasers could amplify signals. The day of truly integrated opto-electronics would be brought much closer.

University Science For Sale
By Barry Luther-Davies

Gravity and granite conspired at Los Angeles International Airport to make me pay a visit to an optician in Atlanta, Georgia, to replace my broken glasses.

The optometrist struggled with a recalitrant machine used to test for glaucoma—one of those gadgets which puffs air at your eye to measure the fluid pressure inside. The test was completed; the result was announced as normal. "It doesn't matter in any case does it?" I chipped in, "that the device doesn't really detect glaucoma." The optometrist eyed me suspiciously, like someone caught in the act of selling ice to eskimos. "That's right," he replied, "but it's the best test we've got. How did you know it's not much good?" I explained that in my briefcase was a description of a new and very sensitive test for glaucoma invented by scientists at the John Curtin School of Medical Research at ANU. In that description the shortcomings of the existing test were explained. I sketched out the basis of the new test—it was non-invasive, using a sequence of patterns on a display screen to test the eye's sensitivity, and would be relatively easy to implement. "Sounds great! When can I get one?" she asked. Well that, of course, depends...
OF INTEREST

In fact it depends on a lot of things. At that moment it depended specifically on the timing and presence of five of my colleagues and I, representatives of the ANU and its technology marketing company Anutech, in the development of a Technology Transfer Conference in Atlanta. To put it bluntly, it depended on finding a backer to help commercialise the device.

Six of us were sent to Atlanta as salespersons for the ANU—a role somewhat foreign (but increasingly less so) to the three academics in the party (myself, Chris Bryant and Ian Ross) but more familiar to the Anutech group (Bob Culvert, Andreas Dubis and Lex Beardwell). In true free-market tradition there were the customers—representatives of ninety two companies based mainly in the USA or Japan (none from Australia of course); and the ‘competition’—fifteen other Pacific Rim universities all with high-tech goodies to sell. The ANU basket was filled with products from all over the campus—pharmaceuticals, scientific instruments, processes, computer software, etc. A number came from RSPhysS including work from Barry Nitham’s group on novel drilling muds; Boswell’s plasma etching machine; three energy research projects from the Energy Research Group; computer orientated projects in speech recognition and advanced computer architectures; and a project on novel crystal growth techniques for semiconductors from Jim Williams.

The conference format left the mornings for plenary sessions with each university given the opportunity to outline its products which had been grouped into the two areas—physical or life sciences. The afternoons were taken up with one-on-one sessions where the representatives from industry had the chance to ‘talk turkey’ with the university representatives and hopefully do the groundwork to establish further contracts. In fact no contracts were signed at the conference itself, nor was that expected, but follow-up meetings will occur and then the real benefits may emerge.

A disappointing feature of the meeting was the imbalance in the industrial representation. It is apparent well known in the USA that major chemical and pharmaceutical companies provide a large part of the industrial funding to universities—it appears that they have already realised what they can gain from university research. In other fields—in Atlanta, notably in computers, electronics and scientific instruments—there seems to be a view that universities offer little that large companies can’t do themselves. This may be an oversimplification although the point was illustrated very vividly in Atlanta where the products offered by the Universities were ill-matched with the industrial audience. Although this was particularly true for the Physical Sciences there were some star attractions, most notable from the RSPhysS portfolio was the work on drilling muds which attracted the interest of most of the representatives from the chemical and oil companies.

We learnt a number of important things during those few days at the conference. Firstly it was refreshing to find representatives from industry who were very keen to see what the universities had to offer—they had paid highly for the privilege of attending the conference. The organsing body (Technology Transfer Conferences Inc) and the industrialists made sure we novices in the technology transfer game took away at least one important message, namely that the technology transfer is very much a ‘contact’ sport. For it to be successful, a close relationship must be developed between academia and industry based upon mutual trust. Nothing much will happen if industry simply wishes to pick up new ideas from universities for free; industry is also kidding itself if it expects academia to provide it with a fully developed, no-risk product just right for the market; academia is also unlikely to direct its research to problems industry wants solving if it is unaware of them. The fertile ground necessary for close contacts to develop exists when the bodies have complementary capabilities and recognise each others strengths.

What else emerged from the Atlanta meeting? Our final dinner speech was presented by Dr Shiro Azami from the Central Research Laboratories of Dainippon Ink and Chemicals Inc—a company with an annual turnover of about $US6.5 billion. His speech contained a warning to the USA and one that should be heeded perhaps even more in Australia where industrial research and development is at very low levels and where our children are being turned away from the hard option of science to pursue better paid service industry jobs. The future for Japan, Azami maintains, will lie in the ability to produce scientists and engineers capable of leading Japan into the so-called third industrial revolution—to an information-oriented society.

Japan already produces more graduates with higher degrees (PhD, MSc) than the USA: a trend Dr Azami somewhat coyly describes as “a serious problem for manufacturing industry in the USA”. How far behind does Australia lag in percentage terms?

And why will Japan need all these technologists? Put simply, they want to do more innovative fundamental research, as the foundation of future technological growth rather than relying, as they have done in the past, on the fundamental research carried out in other countries. Self reliance is the aim. Additionally, Japan has already had its fingers burnt by the energy crises of the last two decades.

Advanced technology permits economic growth with little need for an increase in energy consumption or raw materials. This alone should send shivers through Australia where we still rely on primary produce and growth in those areas to peddle our economy along.

Back at the ANU the problems we face in selling university research to industry have been highlighted by Senate John Button’s recent outbursts at the low level of industrial R&D in Australia. Nevertheless, many of us think that the effort is worthwhile and are starting to reap the benefits in terms of improved resources. Perhaps it was a pity that we had to go as far as the USA to see what the buyers of our ideas—what’s wrong with selling them here? Oh that it was that simple!

1 Dr Luther-Davies is senior fellow and Head of the Laser Physics Centre at RSPhysS.

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Tomography: Recon- structing Plasma Sections

Reconstructing cross-sections of a whirling high-temperature maelstrom is exactly the sort of challenge plasma physicists embrace with gusto.

Plasmas are hostile environments. At scorching extremes of temperature around many millions of degrees, physical probes don’t stand a chance. They’re prone to rapid deterioration, or they simply evaporate. The only answer is to use remote sensing diagnostics.

Tomography (tomos, Greek—cut) is a remote diagnostic technique that allows researchers to view a cross- section of a body or medium, using line of sight averaged measurements. Computerised axial tomography (CAT) scanners are familiar to most people as >
powerful diagnostic tools which reveal much more information about tumours in the brain, for instance, than normal X-rays, for about one-fifth the dose. CAT scanners pass a beam of X-rays through the body which is selectively attenuated by tissues of different densities, so the ribs appear on the X-ray film as an opaque cage surrounding ghostly organs.

Dr John Howard and his colleagues in the Plasma Research Laboratory, Australian National University, use tomography for unravelling what is happening in a two-dimensional plasma cross-section from line integral measurements; that is, the sum of plasma properties along a line.

These techniques can be used in several ways: passively using the natural emissions of the plasma, such as its soft X-ray (SXR) emission; or actively by passing a beam through the plasma and recording those properties of the beam which have been modified across the plasma.

Dr Howard has been looking at plasmas which are marginally stable or unstable. When you puff gas into a plasma confined magnetically in a tokamak—a type of magnetic bottle—and increase the current through it, both the electron density and the temperature rise—conditions necessary for the achievement of fusion.

But plasmas can be downright ornery. Puffing in too much gas can quickly cool the plasma at the edges, triggering destabilising modes which can cause the plasma literally to tear itself apart.

Dr Howard is using the SXR emissions of the plasma to analyse exactly what happens as these destabilising modes erupt. He has observed that as the excess gas enters the system, rapidly growing oscillations appear in the plasma X-ray emission profile.

At a certain limiting amplitude, a 'saw-tooth' crash or plasma collapse occurs; the plasma bucks into the confining wall, depositing a large amount of energy into the wall and cooling itself rapidly.

Feedback control systems fitted to most tokamaks recrunch the plasma and nurse it back to equilibrium. As the plasma reforms, the density climbs, modes reform and the whole cycle begins again.

However, the plasma never quite recovers from these excursions. With each wall collision it gets 'dirtier', contaminated with heavy impurities from the wall—and because of this contamination the plasma begins to lose heat faster than it can be heated in compensation.

The cyclic process repeats itself a number of times with diminishing strength until the plasma can't recover and is finally extinguished. In machines with feedback capabilities, the plasma is often destroyed at the first crash.

Studies of passive plasma emission of soft X-rays have revealed some very interesting features and some previously unseen behaviours. Dr Howard has compiled a videotape of the whole process. The results are quite spectacular. Tomography reveals that as the plasma collides with the vessel wall, a 'cold bubble' forms; this 'sudden' of cooled gas wends away from the vessel wall and plumes, like Icarus, into the plasma's heart, perceptibly quenching its incandescence.

But passive tomographic techniques have their limitation. The plasma's natural soft X-ray emission depends in a complicated way on temperature, electron density and impurities. To obtain more information about fundamental plasma properties such as electron density, active electromagnetic probes must be employed.

Laser beams are active probes; when laser beams are passed through the plasma, they suffer a phase shift in proportion to the electron density. Researchers use interferometers to measure the extent of these phase shifts. Far infrared lasers are preferred because of their sensitivity to local variations in electron density.

Plasma researchers will have a unique 'window' on plasma behaviour with the commissioning of the H-1 flexible heliac, currently under construction in the Plasma Research Laboratory (see article in Advances, Vol 2 No 3).

H-1's distinctive geometry will offer almost unhindered viewing access to the plasma cross section, but its twisted helix has presented plasma physicists with conundrums in the design of laser diagnostic systems for tomographic measurements of plasma electron density.

Interferometers typically provide only around ten channels of information at a single viewing angle of the plasma. Unfortunately, a single view system provides little information about the plasma density profile. Only if the plasma shape is assumed to be known can density contours conforming with that shape be recovered. Many views of the plasma are needed to remove this dependence on prior knowledge.

However, sophisticated multi-view imaging systems employing arrays of discrete or integrated detectors require high laser power and are expensive to build.

Dr Howard and his colleagues have developed a new type of scanning interferometer which will overcome these problems by exploiting the quasi-steadiness of the H-1 plasma. The new interferometer will give 15 or more distinct spatial channels of information in a given view using only one detector.

Four detectors, say, viewing at four equispaced angles will provide as many as 60-80 channels of line integrated information, so the device is very powerful without being costly in hardware or detector resources.

The new interferometer scans the plasma spatially by rapidly switching a single probing laser beam through a sequence of fixed chords in a given cross-section and viewing angle. The scanning element is a multi-sectored blazed rotating diffraction grating wheel. The grating rasters the beam (flicking it like that of a television set).

The diffraction beam emerges at a different angle from each grooved sector each time the grating wheel rotates, giving rise to a fan array of discrete beams centred on a fixed viewing angle. Altogether, four fan beams will sweep the plasma cross section in the H-1 heliac.

Because the interferometer is a rastered device, the flicking beam does not deliver its signals simultaneously. They are multiplexed, that is, they reach the detector at different moments in time. Multiplexing signals from the probing chords sacrifices some time resolution for spatial resolution. Nevertheless, researchers will not miss much. In a typical plasma, each pulse lasts for at least a second. The new equipment has the potential to deliver 15 or more channels of information every six milliseconds, offering a best compromise for studies of the global evolution of the plasma electron density.

The new scanning wheel was designed and manufactured in RSPedS using the technical skills of Allen Campbell and Graeme Cornish. A special high speed low-vibration air turbine will drive the scanning wheel as smoothly as possible. With the grating wheel attached, the turbine drive has been successfully tested to about 10,000 rpm.

The new scanning interferometer will greatly enhance tomographic research capability in the Plasma Research Laboratory.

ASTRONOMERS SET PRIORITIES FOR NEW INSTRUMENTS

Astronomers believe that three major new facilities will be essential in the 1990s for the continued development of a vigorous astronomy program in Australia. The facilities selected are a large optical telescope, a millimetre-wave capability for the Australia Telescope and a facility for very high energy astrophysics.

These are some of the recommendations of a discussion meeting, sponsored by the Australian Academy of Science, on the future of Australian astronomy held in Canberra in June. The meeting, one of a series of discussion meetings on important scientific topics, was attended by leading astronomers from all six states. It was organised by the Astronomical Society of Australia and the Academy's National Committee for Astronomy.

Before the meeting the president of the Astronomical Society, Dr Brian Robinson, wrote: "Major astronomical projects such as the ANU 2.3-metre thin-mirror telescope, the Australia Telescope and Sydney University's stellar intensity interferometer were recommended for funding in reports in 1979 from the Australian Science and Technology Council (ASTEC) and in 1980 from the Astronomy Advisory Committee set up by the Federal Minister for Science and Environment. These projects have reached or are nearing completion. It is therefore timely to review the support that Australian astronomers are likely to need, especially given the very long times needed to plan and construct major facilities."

A working party of ASTEC requested the recent meeting to gain the opinion of the astronomical community on the ranking of a wide range of proposals for ground-based astronomy in the 1990s.

Twenty proposals were presented and discussed by 65 astronomers and physicists, joined by representatives of ASTEC and the Australian Research Council. The meeting set up an ad hoc committee to propose priorities for the next decade.

The astronomers divided the proposed facilities into major developments with a capital cost greater than $5 million, intermediate-sized facilities with a capital cost greater than $1 million, and smaller items with a cost of less than $1 million. The proposals varied greatly in their degree of readiness for funding.

The three major projects given top priority were described as essential in the sense that without each of them an area of astronomical research in which Australia is now a major player (radio astronomy, optical astronomy or high-energy astrophysics) would become non-competitive internationally. The fields might have to be closed down. However, if the three major facilities were built, they would be means to retain the vitality of a broad range of astronomical research in Australia and provide a continuing opportunity for Australia to make a significant impact on international science.

Access by Australian optical and infrared astronomers to a large, multi-purpose telescope with a wide field would make a profound impact on the central problems of modern astronomy. These problems range from the large-scale structure of the universe, its evolution and the nature of its unseen mass, to detailed studies of star-formation regions and the solar-stellar connection. These questions need to be addressed with a light-gathering power and efficiency an order of magnitude greater than that currently available. The first step is to determine whether there is an optimum site in Australia comparable to those in Chile and Hawaii.

The high-energy astrophysical telescope proposed by the Universities of Adelaide and Sydney would cover the range of processes that occur at energies above those found in earth-bound particle accelerators. This is a field of major interest, aiming to measure neutrinos from supernovae and gamma rays from neutron-star binary systems. The proposed telescope would have a collecting area some two orders of magnitude greater than existing neutrino experiments and would have close to the largest muon and hadron detector collecting area of any proposed experiment. The Australian experiment would use a lake to produce detectable Cerenkov light (radiation produced by the shock wave of a particle travelling faster than the speed of light in the atmosphere) from upward-moving energetic muons resulting from neutrinos passing through the earth and interacting with the rock below the lake. A suitable lake must be found.

The millimetre-wave capability for the Australia Telescope is a logical development of this radio telescope and was clearly foreshadowed in the original proposal. It would be unique in the southern hemisphere and would support a wide range of astrophysical observations of interstellar and protostellar matter in our own and other galaxies as well as energetic quasars in an early stage of evolution. The Australia Telescope antennas have been built for operation at millimetre wavelengths and the main work needed is in receiver systems and multi-beaming techniques in the focal plane. The highest priority for immediate funding of intermediate-scale projects were:

- Spectrum X Gamma, a USSR spacecraft scheduled for launch in 1993. Australian astronomers and industry have been invited to build an X-ray detector.

- Orbiting very long baseline interferometry, where Australians have been invited to participate and provide components for the spacecraft Radioastron (USSR, 1992) and VSOP (Japan, late 1990s). These projects will simulate a radio telescope five times larger than the earth by combining signals received by the antennas in space with existing antennas on the ground at Narrabri, Parkes, Tidbinbilla and Hobart.

- SOFIA (the Stratospheric Observatory for Infrared Astronomy) is a NASA Boeing 747 fitted with an infrared telescope which Australian astronomers may be able to use at relatively low cost.

- An astronomical data centre which would provide access to international data gathered by very expensive spacecraft and ground-based instruments.

The Academy's Space Science Committee told the discussion meeting about its report, Ready for Launch, which should be distributed soon. The report describes a number of the space-related projects mentioned above and how they fit into Australia's scientific and industrial future.

The report of the ad hoc astronomy committee and its recommendations on priorities is now being considered by the ASTEC working party on astronomy which plans to report to its council in September.

Reprinted from Australian Academy Science Newsletter, Sept 1989

We need material for cover pics! See ad on page 3.
PROFESSOR JOHN WARD, VICE-CHANCELLOR OF THE UNIVERSITY OF SYDNEY, argues that the multi-strand university must look to industry, as well as government, for support.

The amalgamation of small institutions with large institutions that was laid down as policy in the White Paper is transforming higher education in Australia. The concept of a multi-strand university has gained wide acceptance, especially in NSW, where amalgamations have proceeded relatively smoothly.

When colleges of advanced education are joined to universities or are joined together to form a new university, obvious questions arise about the relationships of the college types of teaching to university types of teaching and college research to the most extensive research common in universities.

The amalgamation of small institutions with large institutions is a particular important guide to action.

What is happening at Sydney and Western Sydney can be paralleled in most other parts of Australia. The vital element is the development of multi-strand universities replacing the former binary system of universities and colleges. How will the new multi-strand university work with the world outside higher education?

Generally the kind of relationships that already exist between universities and colleges on the one hand and industry, commerce and the professions on the other should not be prejudiced by amalgamation. On the contrary, there will be opportunities of combining or enriching projects by adding from the strength of one institution to the strength of another. That will require a collaborative effort by all concerned, including those outside higher education.

Amalgamation is taking place at a time when higher education is being challenged to become more venturesome and entrepreneurial. The White Paper drew attention to the rich possibilities that may be found in harnessing the resources of higher education, in teaching and research, to economic development. The Paper tended to forget or ignore the enormous extent to which some universities and colleges have already worked for the benefit of industry, commerce and the professions as well as for gains to their own research and teaching. But the general thrust of the paper was right in this respect even if it was over simplified and over optimistic in its estimate of the significance of increasing numbers of graduates in assisting the expansion of overseas trade and domestic employment.

Amalgamations are taking place at a time when the total numbers of students are growing rapidly. No university and no college spoke out firmly against this growth when it was announced by the Federal Government. Indeed, the growth was welcomed provided that adequate resources were available, a condition that is not being satisfied. It is now the responsibility of those who so responded to the federal initiative to ensure that the established teaching of the universities and colleges is maintained and extended. As usual the major problem of multi-strand universities is lack of resources. The colleges that embraced the Unified National System of Higher Education enthusiastically in the hope of being funded better than they had been for teaching and of gaining the means of conducting research are not faring nearly as well as they had hoped. The universities that have accepted the major responsibility for amalgamations are having to accommodate themselves to severe reductions of income and expenditure at a time when the vast process of change in which they are involved demanded helpful consideration from governments, federal and State, that enjoined amalgamation.

In this situation two courses suggest themselves. One is to point out strongly and publicly the lack of assistance from governments in carrying out policies on which governments have insisted. The other, which is certainly consistent with government policy, is to use the strength, intellectual and physical, human and material, of the multi-strand universities to produce their own resources by working more closely with industry, commerce and the professions than ever before.

The first duty of universities is to be good universities. The wiser part of industry, commerce and the professions—and governments—now recognise this essential truth. It has often been the case before, as it is increasingly now, that universities in order to preserve themselves, must seek new and enlarged co-operation with the world outside to the common benefit of all concerned. That is the inevitable pattern of the future and one in which industry and higher education can join forces in research and teaching for their advantage and the community's advantage.

NOW IT'S TIME FOR THE THIRD DIMENSION

Professor Mal Nairn, Vice-Chancellor of the Northern Territory University, says the industry-academic partnership is a model for better connections with the public.

Much has been written recently about the need for higher education institutions in general and universities in particular, to increase their interaction with industry. It is therefore encouraging to note that a number of worthwhile initiatives have emerged to demonstrate a serious commitment by universities that working closely with industry is essential for survival in the new political environment of funding for higher education.

While the industry/universities linkage should continue to be pursued vigorously there is another dimension to this interaction which deserves more attention. I refer to the public sector arms of State/Territory and Federal...
Experience has shown that universities can work effectively and closely with industry and government (including the public sector) without jeopardising their independence provided they set clear ground rules and do not insist on all members of academic staff participating in such collaboration.

A recent initiative by the Western Australian Product Innovation Centre (WAPIC) was designed to foster and promote interaction between the tertiary institutions and several major government departments by networking their research expertise and facilities so that better use could be made of scarce resources.

Under this scheme it is intended that industry "scouts" be appointed with joint funding from the collaborating institutions and departments to enable industry problems to be identified and matched with the most appropriate research group.

Over the past few years universities have become more interested and more effective in commercialising their intellectual property and marketing educational services. Their experience in encouraging and rewarding researchers, and the use of university companies and technology parks to meet commercial objectives could be shared more widely with those government departments with an interest in expanding their role in these areas.

A partnership approach between the two sectors would facilitate the exchange of information as well as the sharing of scarce resources.

The benefits of a university/public sector interaction extend beyond research. There are a number of management issues where collaboration would be mutually beneficial. For example, the formulation and implementation of policies such as equal opportunity, safety, animal and human ethics, staff development and training, energy management, financial management, building maintenance and communication systems. Joint training programs and staff secondment could be used more effectively by each sector.

Universities have been urged to explore staff secondment to industry but in practice this is difficult to achieve. Secondments between universities and the public sector however, are much easier to arrange and when positively supported by management usually have very beneficial results for the individual and the employer. Secondment is an under utilised tool for the development and training of middle-level managers.

Encouragement of the university and public service sectors to increase their collaboration with each other is not meant to imply that effort by universities to work with industry should be diminished. In my experience, successful interaction with the public sector opens up new opportunities for universities to increase their involvement with industry.
INDUSTRY AND ACADEMIE

UNIVERSITIES HELP POWER INDUSTRIAL ENTERPRISE

Professor John Ashworth
Vice-Chancellor, University of Salford
Greater Manchester, England

Collaboration between universities and industry is now a major item on the academic agenda and an accepted form of cooperative effort. In 1981 British universities received nearly 80% of their funds from the Government's University Grants Committee (UGC) and saw themselves as having two main roles—to provide the education needed by the top 7% of the country's school-leavers, and to carry out most of the fundamental research the country was prepared to pay for. Today the universities receive only some 55% of their income from the new Universities Funding Council which has replaced the UGC and the system has become much more diverse. Some universities have added a number of other roles to the traditional two.

Well over half of Britain's universities are now associated with some kind of business or science park. Few of these have yet to prove commercially very profitable for the university concerned, but all are symbolic of the desire of universities to be seen to be associated with new companies formed to exploit scientific or technological discoveries. In some cases such firms are created by working or former members of staff.

These companies have been greatly encouraged by the Government's decision to give universities any intellectual property rights that might arise as a consequence of their carrying out research with state funds. A small but significant number of academics are therefore becoming part-time businessmen and there is no doubt that this has greatly helped academics understand the motivations of industrialists. The ivory tower is on the wane.

There have been major differences in the way individual universities have reacted. Cambridge University, for example, has been content to provide its staff merely with sufficient time to see if they are suited to starting companies, and it has been tolerant of any who want to develop their careers in this way.

Others, such as Salford, in northwest England, have been much more active, actually setting up venture capital companies. Salford University Business Enterprises Ltd has both invested in its business or science park and acquired shares in those companies that have become tenants.

The universities that suffered the largest cuts in their incomes from the Government in the early 1980s have tended to be the most active commercially.

British universities have always allowed their staff to act as consultants to industrial or other clients and to keep most of the money they earned in fees. Since 1981 most universities have deliberately encouraged such activity and the amount of consultancy carried out by academics has increased considerably.

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All universities now have industrial liaison officers whose job it is to advertise whatever expertise is available and to act as a contact point for those who might wish to make commercial use of it. Some have gone a step further and created their own wholly owned consultancy companies which compete with longstanding commercial ones.

Many of these firms have been very successful and have grown rapidly in the 1980s; Salford University Business Service Ltd grew from a turnover of £500,000 in 1981 to over £6 million in 1988. Such companies depend on a much wider range of academic staff than those interested purely in setting up a new business, and their growth has been greatly helped by the fact that academic salaries have not kept pace with increases in average earnings.

The standard of living of many academic staff has come to depend on their being able to supplement their salaries with their consultancy earnings and many universities are now financially dependent on the continued commercial success of their wholly owned consultancies.

Vocational Orientation

There is evidence that some students have benefited from the more vocational orientation of many of the courses now offered by their universities. Further, the value of the research contracts won by British universities has gone up by at least 45% in real terms in the 1980s, and despite much debate the quality of research carried out by British academics seems to have been maintained.

What is undoubtedly true is that the British university system is now much more diverse than it was and that some institutions are now much more effectively underpinning the rejuvenation of British industrial and commercial enterprise that has also occurred in the 1980s.

The government encourages physicists to interact more closely with industry and the community to become more accountable and to establish other avenues of funding. Unfortunately, one branch of the institute seems to have gone too far!!

Anonymous

Australian Physicist Volume 27, Number 1/2, January/February 1990

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BOOK REVIEWS

Birth and Death of the Binary Policy

The Binary Policy of tertiary education in Australia is writting in its death throes. In every State (except maybe Tasmania where the end was swift) our institutes of higher learning are being amalgamated, consolidated, federated or undergoing a paroxysm of shotgun weddings. Some, like the National University, have resisted the bribes and blandishments offered (no marriage—no wedding presents) and are to be starved into submission. A sorry end, all in all, to a quarter century of educational experimentation.

The father of the binary system of tertiary education in this country, Sir Leslie Martin, was trained in experimentation by Lord Rutherford, who was a master at getting profound results from the simplest apparatus. Too bad the apparatus of higher education is not simple, and does not lend itself readily to experimental manipulation. When Sir Leslie and his Committee developed their binary model of tertiary education they left too much scope for governments to compromise its operation, and, in the name of the great god management, to ultimately destroy it.

In her detailed, scholarly and very readable study of The Martin Committee and the Binary Policy of Higher Education in Australia, just published, Susan Davies instructively traces the rise and demise of that unfortunate policy, which is causing much heartbreak in the halls of learning around the country. She relates how Sir Leslie led his committee in a new direction away from the notion of importing a foreign model, such as the American Junior Colleges—a system which he clearly misunderstood—but instead sought to upgrade technical and teachers’ colleges to quasi-university status catering for only pass-degree students caught by staff who were “not bugsed by all the research that people have got to do there”, “there” referring to the ‘real universities.

And so the new pass-degree granting institutions were born. At first the experiment seemed to work, mainly because both sides of the binary divide were growing vigorously. Martin achieved astonishing success in getting the Prime Minister, Sir Robert Menzies, to spend money on universities. On the occasion of the opening of the Menzies Building at Monash University, Sir Robert remarked that if he was remembered for nothing else, he would always be known for what he did for Australian universities. Some academics are now claiming that under the ministrations of Mr Dawkins the universities are done for.

Susan Davies follows the conclusion of her study of the Martin Committee with a seven-page postscript. A somewhat sad compendium of hopes raised and dashed, which the quarter-century separating them does little to soothe. But her account of higher education events spanning from the second world war to the present is cheerfully and sympathetically written. It reads well, anyone with an interest in the history of education in Australia will enjoy it.

The Martin Committee and the Binary Policy of Higher Education in Australia, by Susan Davies, is the first volume in a new series of Australian studies in the social sciences. And a splendid start to the series it is. Published as a paperback of 224 pages, it is available for $22.50 (plus $3.00 postage) from the publishers, Ashwood House, PO Box 290, Ashburton, VIC, 3147.

Colin Keay
Book Reviews Editor

REVIEWS

The MOCVD Challenge

Vol I A survey of GaInAsP-InP for phononic and electronic applications
M Razeghi
Adam Huiger, Bristol, 1989.
xii + 328pp, UK£5.5 (hardcover)

Although compound semiconductors occupy a significant technological niche, practitioners of the growth and device fabrication arts are rare fauna in Australia. The rival camps of molecular beam epitaxy (MBE) and metal-organic chemical vapour deposition (MOCVD, often pronounced MOVPE in American) are represented by about five and three machines respectively, three of the total devoted to In-VI compounds and none, to my knowledge, to indium phosphide based materials.

At first sight then, the potential local readership is small for a volume devoted largely to the practice of MOCVD growth in the GaInAsP-InP quaternary system. (A companion volume on gallium arsenide related compounds is promised.)

Dr Razeghi’s admirable book, however, deserves a wider audience, and is a fine example of the specialist monograph, written in the clear exposition fashion characteristic of her journal and conference contributions. Early chapters of general interest discuss the physics of InP, refer briefly to a range of alternative growth techniques and outline the methods of characterization of the end products.

The practical details of machine design, construction and operation along with choice of precursors and the safe disposal of by-products figure prominently. Device applications, both demonstrated and potential, illuminate the discussion throughout with both the lattice matched ternary InGaAsP (x = 0.53) and quaternary GaInAsP1-x alloys represented.

As a survey of a rather specialised field by an active and prolific participant, the book naturally shows a strong leaning towards the particular interests of the author. It is precisely this closeness to the action which makes it so valuable, however. Manjoo Razeghi’s tour de force will not be a priority acquisition for many (and the probable price of more than $120 will not help), but I would hope no science library would overlook it. Certainly a small number of individuals will find it invaluable, while a much larger number ought to at least sample the flavours of current practice in this area of applied semiconductor physics.

Trevor L. Tansley
Physics Department
Macquarie University

Electron-Excited Molecules in Nonequilibrium Plasma

Edited by NN Sobolev
Nova Science Publishers
Commack, NY, USA, 1989 (hardcover)

I ordered this book for our library with great enthusiasm. The book is a review of research work done at the Lebedev Institute in the USSR on the physics of gas discharges, and covers topics of great interest to applied physicists.

Research traditions and activities in the USSR and the West naturally differ in both the emphasis on different subject areas, and also in scientific style. The physics of gas discharges is very much motivated by applied interests. In recent years discharge lasers, plasma etching and physical vapour deposition have added much impetus to the study of gas discharges. Physicists in the USSR have made major contributions initially, for example in laser isotope separation and electron beam sustained lasers. Sobolev’s book gives a...
BOOK REVIEWS

valuable source of references to major USSR studies.

In this writer’s view, there are also strong differences in scientific style, at least as expressed in published scientific papers. Many is the time that I have rushed to read a paper with an appealing title in a Russian journal, only to be disappointed to find that I perceive as a confused jumble of algebra and experimental results.

I had hoped that this review would give a lucid account of the subject material and a satisfying introduction into the Russian literature. I am disappointed. The topics are: electronic, rotational and vibrational excitation, velocity distribution functions, experimental techniques of absorption spectrometry, analysis of Doppler broadening, etc. But the text to me is confusing and very difficult to follow. One would need to refer to the original papers, and we know that the original papers are also difficult to follow!

There is an evident difference in the availability of computers between East and West. The book contains many quotations of involved algebraic solutions of idealized equations. But our scientific style, because of the ready availability of numerical solutions from computers, tends to value analytic solutions only if they simplify insight. If analytic solutions are too complex, and only apply to a linearized equation, a numerical solution is preferable.

Nevertheless, the Levedev Institute has done a formidable amount of work, and the book serves as a valuable account of this work.

J.J. Lowke
CSIRO National Measurement Laboratory
Lindfield

Microelectronic Materials
C.R.M. Grover
Graduate Student Series of Materials Science and Engineering
Adam Hilger, 1989
Paperback edition
544 pp, £19.50 (paper)

This book in the series of Materials Science and Engineering is intended to explain how the microelectronic industry uses materials to construct and package semiconductor devices such as transistors, light emitting diodes, and solar cells by bringing together the sciences of physics, chemistry and electronics. The book is intended for advanced undergraduates as well as graduates and follows on from other more basic texts on microelectronic manufacturing technology. The text is tightly and lucidly written with clear explanations of phenomena adequately illustrated with diagrams and photographs. Mathematical equations are kept to a minimum and each chapter is well laid out with a good introduction section. The background and ability of the author in metallurgy clearly shows when dealing with the physics of material interaction, effects of lattice defects, crystal growth and diffusion, stress in thin films and phase diagrams. This fundamental knowledge will be of increasing importance as device dimensions diminish in the future and structure steps and interfaces become closer together.

As is inevitable in a book that covers a wide field the author goes into considerable detail in some areas while others seem a little bare. It is good to see the inclusion of lithographic polymer materials but the text stops short of details of the more advanced systems required for submicron device production. The chapter on packaging attempts to cover everything from packages, bonding systems, post processing, materials, thick and thin film hybrid circuits and printed circuit boards and the level of detail is of necessity much less than the preceding chapters. The final chapter on the investigation of device failures is a well illustrated conclusion, the text showing both the analysis techniques that can be used and examples of failure mechanisms.

The author has succeeded in producing a really readable advanced text for researchers and other workers to detail the complexity and problems of the wide variety of materials used in modern solid state products.

Alan Marriage
Microelectronic Centre
South Australian Institute of Technology

Flat and Curved Spacetimes
George F.R. Ellis and
Ruth M. Williams
351 pp, $60.00 (paperback)

There is a valued place for books such as this which explain the physics of an abstruse topic using as little mathematical complexity as possible. In so doing, this book follows the philosophy of texts such as those by Resnick, French, and by Taylor and Wheeler, which have provided important assistance to those studying introductory relativity and spacetime.

Ellis and Williams make few detailed references to source materials, choosing to make a general coverage in an afterword. I would have preferred the more usual approach of more detailed references in footnotes and at the end of each chapter. My own mild criticism is that occasionally there seems to be inconsistency in the level of background assumed of the reader.

The text is a pleasure to read, making lucid explanations which utilise plentiful diagrams. There are interesting exercises, including computer exercises. The authors achieve their stated goal, to "make a solid understanding of flat and curved spacetime accessible to a wider audience than hitherto".

P.T. Bagnall
Physics Department
University of Newcastle

Laser Microfabrication
Thin Film Processes and Lithography
Edited by D.J. Ehrlich and J.Y. Tsao
1988 xii + 587 pp, $89.50 (hardcover)

Since the initial studies at the beginning of the '80s, laser microfabrication technology has undergone explosive growth, particularly in microelectronics. This set of articles by experts in the field, reviews the fundamental scientific knowledge on laser-stimulated surface chemistry, particularly of thin films, and also provides a summary of state-of-the-art technology to 1988. There is also considerable reference data, particularly in the article on laser deposition by R.L. Jackson and 5 co-authors, and in Chapter 4, Photo-physics and Thermophysics of Light Absorption and Energy Transport in Solids, by C.I.H. Asby and J.Y. Tsao.

The book contains much basic science, together with details of applications and I found it to be an informative reference source. Testing a few areas where I had experience, such as laser-stimulated desorption, I found the article by T.W. Chuong did not minimise the complexities of the processes involved. There are good figures and tables and all the references include the titles of the articles. I recommend this book as an expert, up-to-date account of its field for persons interested in laser interactions with solid surfaces both on the fundamental level and in obtaining details of microfabrication technology.

D. Haneman
School of Physics
University of New South Wales

Tensor Properties of Crystals
D.R. Lovett
Adam Hilger, Bristol, 1989
179 + 139 pp, £9.95 (paperback)

Australian Physicist Volume 27, Number 1/2, January/February 1990
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Despite being a practising solid state theoretical physicist, I have always considered the subject of tensor both dull and rather daunting. This little book on the tensor properties of crystals, however, has shown me just how useful tensors can really be. Emphasising the physics rather than the mathematics, the author has succeeded in writing a book which will be of interest to undergraduates and researchers alike. After briefly introducing the concept of tensors, the author systematically considers their application to a variety of solid state phenomena which vary with the orientation of the crystal. These include electrical and thermal conductivity, elasticity, optical birefringence and the Hall Effect.

Each of these phenomena is used to illustrate different types and properties of tensors and to provide a basis for the extension of these ideas into other areas of physics. Some of these are considered in the last chapter of the book which deals with such diverse topics as magneto-resistance, piezoelectricity, photoelasticity and the pyroelectric and electro-optic effects. The book is easy to read and the extensive use of diagrams and worked examples makes for ready comprehension of the material. Each chapter also presents a few problems for which solutions are provided at the end of the book. All in all, I found it very interesting reading and an excellent introduction to the use of tensors in solid state physics. At just £9.50 (UK price) it represents extremely good value for money and I am sure would prove an invaluable acquisition for anyone who simply wants to understand what tensors are all about.

P.V. Smith
Physics Department
University of Newcastle

Chemical Sensing with Solid State Devices
M.J. Madou and S.R. Morrison
Academic Press, San Diego, 1989
xv + 556 pp, US$89.50 (cloth)

As the authors correctly state in their preface, the book looks at developments of chemical solid state sensors over the past 2 decades. Because of the multi-disciplinary nature of these sensors the book is written to be self sufficient and will provide an excellent reference to those interested in the field, no matter whether their background is in chemistry, biology, physics or electronic engineering.

The book is set out in a logical and systematic way with the early chapters outlining the scope of the book, defining terms and laying a theoretical foundation for the later chapters. Included are reviews of solid state theory, discussions on solid/gas and solid/liquid interfaces, as well as useful information on catalysts and membranes. Effects, through having ultra small sensors, are also raised.

Later chapters concentrate on particular sensor types, ranging from simple compressed powder types, through thin film up to those based on silicon technology, particularly FET structures. Theory of operation, materials, construction, variations in design and typical performance figures are all included. The authors have taken a realistic approach and acknowledged difficulties associated with solid state sensors. The last chapter even examines market needs and sensors that will be available at present (1987) commercially available. Each chapter has a good selection of references, with a special list of frequently used texts at the beginning of the book. The biosensor chapter has a useful glossary of terms.

The book is an informative text for beginners in the field and a handy reference for those who are experienced.

M.R. Haskard
Microelectronics Centre
South Australian Institute of Technology

Surface Acoustic Wave Devices and their Signal Processing Applications
Colin Campbell
Academic Press, San Diego, 1989
xv + 470 pp, US$95.95 (hardcover)

Surface acoustic wave (SAW) devices exploit the properties of acoustic waves propagating over the free surface of a piezoelectric substrate. They have become firmly established in the repertoire of electronic analogue signal processing hardware over the past 20 years. Perhaps best known initially as linear FM "chirp" processors in radar systems, SAW devices have found a host of consumer, commercial and military applications. In Australia, as elsewhere, they have been used in radar and sonar signal processing and in radio astronomy for real-time spectral analysis.

According to author Colin Chapman of the Department of Electrical and Computer Engineering at McMaster University, his text aims to provide engineering and physics students as well as workers in industry with an understanding of SAW circuit design principles, systems and applications.

The book has its genesis in the author’s electrical engineering graduate courses at McMaster and has drawn extensively from subsequent continuing education courses and Campbell’s own involvement in SAW research and development. It contains eighteen well-referenced chapters with worked examples to illustrate design principles. No problems have been included.

In the concise introductory chapter the author traces the historical development from Rayleigh’s 1875 address on surface waves to the London Mathematical Society, through the invention of the interdigital piezoelectric transducer at the University of California some 90 years later, to the development and proliferation of SAW devices and applications in Europe, Japan and the USA in the last decade.

Although a more detailed and less compressed treatment of piezoelectricity and crystallography might have been expected, the design principles of linear phase (constant delay) SAW filters is comprehensive. This is followed by extensive discussion of linear FM filters, resonators, delay lines and transducers.

SAW devices have retained their superiority as wide band real-time convolvers, correlators and Fourier transform processors, despite increasing competition from new digital technologies, and these applications are well treated in the latter chapters of the text.

The final chapter briefly explores recent SAW related developments, including the use of gallium arsenide substrates, rather than lithium niobate or quartz, offering wider bandwidth and opportunities for monolithic integration. Acoustic charge transport (ACT) devices utilising both the semiconducting and the piezoelectric properties of gallium arsenide are also mentioned as are shallow bulk wave (SBW) devices.

In summary, this is an excellent text for senior undergraduate and graduate students and professionals interested in SAW devices and applications. Unlike some contemporary texts in applied science and technology it shows evidence of careful preparation and audience tested presentation. Its comprehensive tutorial approach to modern communications and signal processing concepts with an emphasis on an understanding of principles commends it to a wide audience.

P.J. Edwards
Department of Electronics Engineering & Applied Physics
University of Canberra

Australian Physicist Volume 27, Number 1/2, January/February 1990
BOOK REVIEWS

The Early Universe
G. Börner
Springer-Verlag, Berlin, 1988
xvi + 439 pp, DM 125 (hardcover)

We live in exciting times for the observational cosmologist. Each new
deep-sky survey produces evidence of clumpiness in the distribution of
galaxies on ever larger scales. The
familiar picture of a homogeneous
universe undergoing a uniform and
peaceful expansion is a thing of the
past. In its place, we can glimpse a
universe containing structure on all
galaxies, a universe of sheets, filaments
and voids, where deviations from the
Hubble flow are the norm.

It takes a brave soul to write a
comprehensive review of an area which is changing so rapidly, and
whose theoretical foundations seem
suddenly so inadequate. This Gerhard
Börner attempts to do in The Early
Universe, the work of the Max Planck
Institute, is perhaps better known for
his work on neutron stars, but has
contributed some short review articles
on cosmology.

The third part of Börner's book is
dedicated to classical cosmology: the
Friedmann-Lemaître model, the Hot
Big Bang, the microwave background
and determinations of the scale and
density of the Universe. The
remainder treats more exotic topics
such as GUTs, supersymmetry,
inflation, strings and dark matter. The
Early Universe performs a valuable
service in collecting all the detritus of
modern cosmology under one cover,
and in many ways constitutes an
excellent reference book. The chapters
on inflation and the evolution of small
perturbations are particularly good, and
there are some beautiful colour plates.

However, I have two caveats. The
first is that the material covered is of
variable depth and quality. At one
point, Börner includes an unnecessarily
technical discussion of the Hawking-
Geroch singularity theorem which
presupposes a measure of expertise in
general relativity. By contrast, his
treatment of cosmic strings is cursory,
and belies their current theoretical
importance.

The second caveat is that the book
contains a number of misprints, and the
reader cannot always rely on key
equations. The book also badly needs
an index of symbols.

Overall, The Early Universe is a
detailed but rather technical work, and
is probably of more use to the
interested expert than to the general
reader.

M.R. Anderson
Department of Theoretical Physics
Australian National University

Neutrinos
H.V. Klapdor (Ed)
Springer-Verlag, 1988
338 pp, DM 54 (hardcover)

This book consists of a series of 10
review articles on the various aspects of
neutrino physics and their ramifica-
tions upon our current understanding
of particle physics, astrophysics and
astrophysics. It is the fifth member of a
series of graduate texts in

The level of presentations is uniformly
good (to excellent) but at a fairly
advanced level. Thus, this volume will
be invaluable not just to graduate
students but also to professional
scientists wanting an up-to-date
(1988) summary of neutrino physics on
their bookshelves.

The strengths of the book include:

(a) An extensive list of references at
the end of each article—sometimes
annotated with comments; obviously a valuable aid for
students.

(b) A broad coverage of almost all the
current areas of neutrino research
including neutrino mass,
oscillations (with and without
matter) neutrino counting, double
beta decay (with and without
neutrinos), neutrino-less flavour
violation, solar neutrinos, neutrinos
from SN 1987A and neutrinos in
cosmology.

(c) A balanced coverage giving equal
emphasis to both theoretical and
experimental aspects.

(d) Summary tables of the latest results
worldwide for various
experimentally measured and
theoretically predicted parameters.

There are two minor features that
detract from the overall presentation:

(i) A good deal of overlap. In some
cases the same material is covered
repeatedly with varying
nomenclature and conventions (up to 3 or
4 times). This is particularly evident
for neutrino oscillations, discussions of the structure of the
neutral weak current and
mechanisms for neutrinos to
acquire mass.

(ii) Considerable variation in the
quality of the typescript and the
diagrams.

It is obvious that neutrinos will
continue to play a pivotal role in our
understanding of modern physics and
that the field is rapidly changing. It is
regrettable that books such as this are
already out of date at the time of
publishing, (the Z° results from LEP
have already made the discussions
about the number of neutrino flavours
somewhat passe) but such is the pace of
particle physics!

Nevertheless, this book will remain a
valuable acquisition to any scientific
library for quite some time and no
doubt will help many a graduate
student wrestle with the often difficult
correlations of modern-day particle
physics.

L.S. Peak
Physics Department
Sydney University

The Invented Universe: The
Einstein-de Sitter Controversy
(1916-1917) and the Rise of
Relativistic Cosmology
P. Kerszberg
ix + 403 pp, A$75.00 (hardcover)

The main theme of this long and
closely argued book is the development
of relativistic cosmology in the period
between the advent of general relativity
and the big bang theory, namely
between 1915 and (about) 1930.
Kerszberg gives prominence here
to the role played by the Dutch
astronomer Willem de Sitter and his
debate with Einstein. But there is
much more besides in this book.
The author provides a good deal of useful
historical background material in the
form of foundational aspects of
Newtonian cosmology, such as
Newton's views on absolute space and
his controversy with the relativist
Leibniz, the influence of Ernst Mach
on Einstein's thinking about
relativity, etc. And in a more purely
philosophical vein, he contrasts the
different conceptions of de Sitter
Einstein, Edington and Weyl on the
nature of cosmology. De Sitter, for
instance, appears to be a realist,
someone who believes that theories
should aim to describe that the world
as it exists independently of us and
our experiences of it. A realist
believes that (correct) theories are
discoveries.

Einstein's position is less easy to
identify, but Kerszberg quotes a
famous passage in which Einstein
speaks of theories as "creations of the
human mind". This suggests that he
wishes to emphasise the idea that
theories are the result of human
invention rather than discovery.

The book is in the tradition of the
discipline of History and Philosophy of
Science: it is a philosophically
informed piece of history of science.
And, indeed, it is very competently
done.

What, then, was the de Sitter-Einstein
controversy? In essence this was a
debate about two different models of

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BOOK REVIEWS

A Sad Aside
Book Review Editors from time to time get some distressing stories. Here is part of a letter from a mature scientist who is a top expert in his field and has reviewed previously for our journal. To preserve anonymity, no name or other identifying details are disclosed. It is a very personal commentary on the way our good scientists are treated. Here it is:

I have been working (in Australia) for the last .... years. Since last year I have been employed on a three-year contract as a Research Fellow. As an immigrant from ...... I had to buy a cheap house one year ago for myself and my family. Due to high mortgage rates I am now in a very difficult financial situation and all my spare time I have to devote to extra work. I am simply saying that I have not time any more for unprofitable 'social work'. Sorry, ..........

I tried to find time to review the book but it was impossible.

On the other hand I am no longer a member of the Australian Institute of Physics because I have no money to pay the membership fee.

The sad truth is that my colleague who came to Australia at the same time, is now sending newspapers and fried chicken and has no financial problems at all.

Best regards.

NEW BOOKS RECEIVED

The Invented Universe
P. Koszegi
Oxford University Press, Oxford 1989
ix + 403 pp, AS75 (hardcover)

Studies of High Temperature Superconductors Vol 2
A. Narlikar (Ed)
xvii + 413 pp, US$87 (hardcover)

Injection Lasers in Optical Communication and Information Processing Systems
Yu M. Popov (Ed)
x + 325 pp, US$106 (hardcover)

The Physics of Ionised Gases
discussed by
L. Tanovic, N Konjevic, N. Tanovic (Eds)
ix + 728 pp, US$172 (hardcover)

Polymer Update: Science and Engineering
W.D. Cook and G.B. Guise (Eds)
Polymer Division of the Royal Australian Chemical Institute, VIC, 1989
xx + 285 pp, AS65 incl. post. (hárdcover)

Gauge Fields - Classification and Equations of Motion
M. Carmeli, K.L. Huleihil and E. Leibovics
World Scientific, Singapore, 1989
xii + 136 pp US$24 (hardcover)

Science of Ball Lightning
Y.H. Ohtsuki (Ed)
World Scientific, Singapore, 1989
xi + 339 pp, US$51 (hardcover)

The Martin Committee and the Binary Policy of Higher Education in Australia
S. Davies
Ashwood House, Melbourne, VIC, 1989
v + 224 pp, AS$22.50 (paperback)

Fundamentals of Statistical Mechanics: Manuscript and Notes of Felix Bloch
J.D. Walecka
Stanford University Press, Stanford, CA, 1989
xi + 302 pp, US$39.50 (hardcover)

Mars: The Next Step
A.E. Smith
Adam Hilger, Bristol, 1989
xi + 151 pp, £12.50 (paperback)

Lectures on the Sciences of Complexity, Vol 1
D.L. Stein (Ed)
Addison-Wesley, Redwood City, CA, 1989
xxv + 862 pp, US$48.50 (hardcover)

Plasma Etching: An Introduction
D.M. Manos and D.L. Flamm (Eds)
Academic Press, San Diego, CA, 1989
xvii + 476 pp, US$69.50 (hardcover)

Organometallic Vapor-Phase Epitaxy: Theory and Practice
G.B. Stringfellow
Academic Press, San Diego, CA, 1989
xviii + 398 pp, US$99.50 (hardcover)

Physics and Philosophy
W. Heisenberg (Intro. by Paul Davies)
vi + 201 pp, AS16.99 (paperback)

Chambers Concise Dictionary of Scientists
D.I.J. and M. Millar
461 pp, AS49.50 (hardcover)

BOOK NOTICE

Neils Bohr's Philosophy of Physics
D. Murdoch
x + 204 pp, $44.00 (paperback)

This softcover edition is a corrected reprint of the hardcover version which was first published in 1987. A searching review by Cliff Hooker of the University of Newcastle was published in the March 1989 issue of the Australian Physicist. He judged it to be a "worthwhile volume".

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Australian Physicist Volume 27, Number 1/2, January/February 1990
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Feb 6-9 5th International Symposium on Acoustic Remote Sensing of the Atmosphere and Oceans, New Delhi, India.
Dr S. Singal, Cl- NPL, New Delhi, 110012.

Feb 6-9 Fourteenth Australian Institute of Physics Condensed Matter Physics Meeting.
T.J. Bastow, CSIRO, tel (03) 542 2777, fax (03) 544 1128.

Feb 12 Workshop on Millimetre Waves, Sydney
Dr Bruce Thomas, Kieran Greene, or Lynette Loew, tel (02) 868 0222

Warren Wright or Lew Whibourne, tel (02) 413 7211.

April 1-6 Government, Engineering and the Nation, Canberra.
Conference Manager, IE (Aust) 11 National Circuit, Barton ACT.

Andrew Stevenson, CSIRO Division of Materials Science and Technology, Clayton.

April 23-27 International Conference on Physics Education Through Experiments.
Prof. Zhao Jinyuan, Nankai University, Tianjin, China, tel (086) 02 318264

IREE (02) 327 4822.

July 9-12 3rd International Conference on the Structure of Surfaces, Milwaukee, USA.
Dr M. Read, UNSW, tel (02) 697 4562

July 9-13 5th World Conference on Computers in Education, Sydney.
WCCE/90 PO Box 319, Darlinghurst 2010. Tel (02) 211 5855

July 16-20 Nonlinear Optics Conference.
LEOS, 445 Hoes Lane, PO Box 1331, Piscataway, NJ 08855-1331, tel (201) 562 3895

Aug 5-10 15th Congress of the International Commission for Optics, Bavaria.
Prof. F. Lanzl, DLR Optoelectronic, D-8031 Oberpfaffenhofen, Fed. Rep. Germany

Aug 12-16 International Conference on Optics for the Life Sciences, Munster.
G. von Bally, University of Munster D-4400, Munster, Fed. Rep. Germany

Sept 24-28 Joint Conference of Australian Radiation Protection Society and Australian College of Physical Scientists and Engineers in Medicine, Adelaide.
SAPMEA, GPO Box 498, Adelaide, 5001.

Oct 16-18 Communications '90. Electronic Communications in the 1990s.
Conference Manager, IE Aust, tel (062) 70 6549.

Oct 1-4 11th European Conference on Surface Science, Salamanca, Spain.
Laboratorior Fisica de Superficies, Instituto Ciencia de Materiales CSIC, Serrano 144, 28006-Madrid, Spain.

Dec 27-31 International Conference on Teaching Physics - "Changing Face of Physics Education in Developing Countries"; Karachi.
S.A. Hasnain, Department of Physics, University of Karachi, Pakistan.

1991

R.L. Dewar, Department of Theoretical Physics, R.S.Phys.S., ANU, GPO Box 4, Canberra ACT 2601, tel (062) 49 2949/49 2943, fax (062) 49 1884.
# THE AUSTRALIAN PHYSICIST

## 1990 ADVERTISING RATES

The *Physicist* is published on the 7th of each month excluding January (the Jan/Feb issue is number 1/2)

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**PRODUCT NEWS** is now sold at a rate of $2.50 per centimetre column or....

- Full page - $185, 2 columns - $122.50
- 1 column - $62.50 or half column - $31.25

**INSERTS** are $350 for 1 issue (2,600 distribution)

* Separations for full colour are an extra $300

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**ADVERTISING BOOKINGS** must be made by the 14th of the month before the date of issue and copy for typesetting and artwork sent to:

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PO Box 189
Jesmond NSW 2299

Tel: (049) 62 0911  Fax: (049) 60 1137

**CAMERA READY ARTWORK** for bookings already made must arrive by the 21st of the month before the date of issue and be sent to:

**Judith Nikoleski**
Production Manager
Impress Studios
PO Box 189
Jesmond NSW 2299

Tel: (049) 62 0911  Fax: (049) 60 1137

or courier to:

The Technology Centre (adjacent to Newcastle University)
Rankin Drive
Shortland, Newcastle, NSW

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