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<td>1990</td>
<td>Nov 16</td>
<td>&quot;Using Switch Mode Power Supplies To Their Best Advantage&quot; IEEE Workshop, Melbourne</td>
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<td><strong>Doug Parton</strong> (03) 565 5508, <strong>Harry McDonald</strong> (03) 658 8761 or Fax (03) 565 4597</td>
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<td>Dec 2-6</td>
<td>Conference on Optical Fibre Technology, Sydney Convention and Exhibition Centre- Darling Harbour</td>
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<td><strong>Cherie Morris</strong>, <strong>Convention Administrator</strong> Fax + 61 2 362 3229</td>
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<td>Dec 4-7</td>
<td>Fourth International Symposium on Neutron Capture Therapy for Cancer, Sydney</td>
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<td><strong>B.J. Allen</strong>, <strong>Nuclear Applications</strong>, <strong>ANSTO</strong>, <strong>PMB 1</strong>, <strong>Menai</strong>, <strong>NSW 2234</strong></td>
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<td>Dec 27-31</td>
<td>International Conference on Teaching Physics - &quot;Changing Face of Physics Education in Developing Countries&quot;, Karachi</td>
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<td><strong>S.A. Hasnain</strong>, <strong>Department of Physics, University of Karachi, Pakistan</strong></td>
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<td>1991</td>
<td>Jan 7-25</td>
<td>4th Physics Summer School: Nonlinear Dynamics and Chaos, Canberra,</td>
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<td><strong>R.L. Dewar</strong>, <strong>Department of Theoretical Physics, R.S.Phy.S., ANU</strong>, <strong>GPO Box 4, Canberra ACT 2601</strong>, <strong>Tel (062) 49 2949/49 2943</strong>, Fax (062) 49 1884</td>
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<td>Feb 3-6</td>
<td>International Conference on Disordered Materials (Structure &amp; Properties), Indore, India</td>
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<td><strong>Dr. S.K. Srivastava</strong>, <strong>School of Physics, D.A. University, Indore - 452 001</strong></td>
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<td>Feb 4-6</td>
<td>18th AINSE Plasma Physics Conference</td>
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<td><strong>The Australian Institute of Nuclear Science and Engineering</strong>, <strong>Lucas Heights</strong>, <strong>Sydney</strong></td>
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<td><strong>Conference Secretary Ms. Joan Watson</strong> (02) 543 3411, 3436; Fax (02) 543 9268</td>
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<td>Feb 6-8</td>
<td>15th AIP Condensed Matter Physics Meeting, Wagga, NSW</td>
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<td><strong>I.K. Snook</strong>, <strong>P.J.K. Paterson</strong>, <strong>Dept of Applied Physics, RMIT</strong>, <strong>GPO Box 2476V, Melbourne 3001</strong>, <strong>Tel (03) 660 2600</strong>, Fax (03) 662 1921</td>
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<td>Feb 10-15</td>
<td>Polymer 91, IUPAC International Symposium on Polymer Materials, Melbourne</td>
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<td><strong>Charles Sturt University - Wagga Wagga, NSW</strong></td>
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<td>July 1-5</td>
<td>Gordon Godfrey Workshop on Strongly Correlated Electron Systems</td>
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<td><strong>Dr. D. Neilson</strong>, <strong>Physics, UNSW, Kensington 2033</strong></td>
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<td>Sep 29-Oct 4</td>
<td>Australian Conference on Optics, Lasers &amp; Spectroscopy - ACOLS'91</td>
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<td>Sep 30-Oct 4</td>
<td>International Conference on Ion Sources (ICIS '91), Bensheim, W. Germany</td>
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Cover Picture: A graduate student (Mr. Chit Shwee) testing an optically bistable etalon at the School of Physics of the University of N.S.W. Optical bistability is being investigated as possible future all optical memory devices by Dr. Mike Gal (UNSW), in collaboration with Telecom Australia and the University of Utah (USA). Photograph taken by Mr. Tony Potter, UNSW.
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Gosh! I’ve been doing this for almost two years! Sitting down at my word processor to produce something informative, entertaining or provocative for your information, entertainment or provocation, preferably all at the same time. So, here we go again!

The hardest part is to project forward in time, to around the twentieth of the following month. On this occasion it will be nearly Christmas by the time you read this — traditionally stock-taking time for many of us in the physics business. How are we doing? Not too well, actually, as we found out earlier this year, but next year is the year to do something about it! Science funding is up; scientists’ salaries are up (for some of you, anyway); job prospects for physicists are improving and the Physics Strategy Plan will lead to more concentrated efforts in better defined directions.

I wish I could be as optimistic about the economic situation in general. The great entrepreneurs of the 1980’s have left the Australian economy in a rut: old mess and have caused untold hardship, debt, bankruptcy, unemployment and so forth. To make matters worse, they have given all entrepreneurs a bad name just at the time when the country needs new enterprise more than ever! Is there a contradiction here?

I stumbled across a thought that I might like to share with you, but please don’t say that it was obvious when you finished reading it. If it were so obvious how come the media are not shouting it from the roof tops, how come politicians are not preaching it on the street corners and how come industry appears to be ignoring it?

It was in a book I picked up in a sale, entitled The Instant Image — a biography of Edwin Land and a history of his Polaroid Corporation, by Mark Oshaker (Stein and Day, New York, 1978). The book contains quite a few interesting things, although it is somewhat too detailed and slightly idolatrous about its subject, that unique physicist-turned-industrialist and entrepreneurial genius.

Just as I was beginning to get bored with the book, a very neat summary line jogged my awareness: While remaining fiscally conservative, Edwin Land was always ready to apply some of his scientific daring towards expanding the company’s interests.

There you have it — now try it on any of the cowboys who have sent such a large section of corporate Australia broke! Weren’t they the exact opposite? Weren’t they wildly adventurous in the world of finance while manifestly conservative in the technology that their enterprises involved? (Real estate, brewing, media, etc.)

Had their gambling instincts led them to the backing of adventurous Australian science and technology, together with prudent business practices such as risk-spreading, long-term outlook and good employee relations, the Australian economy might have been in a very different shape today.

Instead, the inventive scientists and technologists, the real entrepreneurs who may have had something daringly new to offer, were left in the hands of naive public servants (and the failed businessmen who advised them), as well as assorted loan-sharks running so-called MIC’s. Or else they were taken to the cleaners by overseas “experts”. However, I hope that the Very Fast Train and other new enterprise projects of the 1990’s will be a different story. Optimism is a moral duty according to Edwin Land!

Mind you, I am only an arrogant physicist who doesn’t understand these things. The corporate world, no less than the world of politics, continues to be run by lawyers and accountants. That’s why a limited demand for university places in physics, mathematics and other such boring subjects. The real excitement must be in law, economics, accountancy and management — at least that’s where the student demand appears to be!

Now, what brought that on, you may well ask? Well, I’ll come clean: This disturbance was occasioned by the necessity to set in train the steps required to change the A.I.P. — a company limited by guarantee under the Victorian Companies Code — into an Incorporated Association under the Incorporated Associations Act. This move will allow us to carry on precisely as we are, after spending time, effort, and lawyers’ fees. ³
EDITORIAL REFLECTIONS

Once more we arrive at the end of another year and another volume of the Australian Physicist (now incorporating the New Zealand Physicist). As usual at the end of an exercise like this (living another year, producing another volume) one reflects on life and its meaning, in respect to the particular exercise nearing completion.

What have we accomplished this year? Firstly, and very importantly, the AIP and the NZIP have formed an Association and The Australian Physicist will now serve as the house journal for physicists in Australia and New Zealand. Secondly, we have paved the way for a better cooperation and collaboration with the Physical Society of Japan. Thirdly, a house journal of the Asia Pacific Physical Societies has been launched properly and will serve to better link this region. All these moves are beneficial for Physics in the Asia-Pacific 'state'.

We have managed to produce eleven issues of the Physicist, launching a section aimed at providing better background and resource material for teachers of secondary school Physics. Without John Cashion from Monash and his "Physics of Sports" series, that effort may well have folded, but we are distributing 1000 copies of the Fix-on-Physics to secondary schools in Australia. Unless this effort is supported by the membership of the AIP and NZIP, it will not continue long into 1991. We need contributions. Many physicists use simple experiments, etc. in lectures which are effective in demonstrating the principles of Physics. Most of those physicists do not bother to take the time to write them up - Fix-on-Physics provides potentially valuable resource for teachers in the schools and Universities.

As the 'Letters' section of this issue demonstrates, we have managed to provoke a little reaction from our readers on occasions. We wish there were more reaction. Perhaps Peter Fensham's article will provoke some thought and comment.

The NSW Branch of the AIP convened the first discussion meeting on the formulation of a strategy plan for Physics. The meeting was well attended and a number of the proceedings will appear in this or a later issue of the AP. The major concern expressed at the meeting and identified as a problem of prime importance for Physics into the 21st century was the state of Physics education. This includes the secondary school syllabus, the number of students attracted to Physics as a career, the tertiary syllabus and modes of teaching, standards, career prospects, what does a Physics-major do etc. . . . Peter Fensham's article challenges physicists (or chemists, biologists) on their own attitude to teaching, both in content and in mode. Physicists involved in teaching at whatever level must really take note of both the reaction from the Sydney meeting and the Fensham article and ask themselves - "Can I/we improve? Can I/we better convey to students at all levels the appeal that Physics has for me as an individual?" The last question perhaps involves even deeper analysis - "Am I still a physicist?" - for example.

A sense of gloom usually pervades our profession at this time of the year. This year we have the AZTEC profile to still come to terms with, plus for those in Universities, moral questions regarding strike action in support of wage justice, etc. It would seem that science as a lobby force may be spent. Government incentives such as Cooperative Research Centres and changes in the ARC/NH and MRC funding array could be claimed to have addressed many of the problems identified by lobby groups working on behalf of science, and what science must do now is deliver on the basis of these incentives. Science in general cannot expect dramatic increases in funding without demonstrating the effectiveness of its usage of current funds. The growth areas are likely to be those of concern to politicians - greenhouse, ozone layer, environmental science, technology of importance to Australia as a possible industry. This Christmas will not see a large bonus for science in general.

The doom and gloom is heightened when I contemplate the emptiness of my Australian Physicist in-tray. You, the membership of the AIP and NZIP, are not supporting your journal. News from branches is generally spasmodic, with a few exceptions who keep us in touch. Articles are almost non-existent unless the Editorial Board coerces members into writing. General interest, news, etc. is obtained mainly by combing other publications. This journal will only ever be as good as the material which you, the members, provide. Make a New Year's Resolution - write at least one piece for The Australian Physicist.

However, this is the season of good cheer, hearty fellowship, love thy fellow man, etc. 1991 must be a better year for Physics in Australia and New Zealand. Enjoy Christmas and return in the New Year with the aim of returning to Physics something of the pleasure that Physics as a discipline has given to you over the years.

Merry Christmas, Happy New Year!

R.J. MacDonald
Honorary Editor

The Editorial Board of the Australian Physicist (incorporating the New Zealand Physicist) extend Christmas Greetings to all of our readers. This Christmas the Editorial Board has asked Santa Claus for an unusual present - a steady flow of contributions of all types from its readers. There may be enough material in hand now to produce a Jan-Feb issue. After that date you may get an issue containing only the President's column.

Please help put a smile on the face of the Honorary Editor - CONTRIBUTE!!!
AINSE & ANSTO

Dear Editor,

It would be unfortunate if readers of your Editorial “AINSE-To Be or Not To Be” (A.P. 27 8 Aug 1990 p139) were to gain the lasting impression that AINSE is “an organization under attack and potentially in trouble”.

It is true that the AINSE Council is concerned that in two of its 26 member Universities the “user pays” principle has been applied to AINSE membership subscriptions, for not only will the application of such a policy cause financial problems for those already receiving AINSE grants, studentships and fellowships but it may deter others from seeking access through AINSE to the wide range of nuclear-related facilities and expertise at Lucas Heights. Fortunately, however, in the overwhelming majority of Universities the advantages of continuing centralised funding of AINSE membership subscriptions is well recognized and we hope that there is no immediate threat to AINSE or the range of its operations.

Your Editorial identifies a second attack on AINSE as coming from ANSTO. The direct financial contribution provided by ANSTO is in excess of $800,000 p.a. (over twice the sum total of University membership subscriptions) and in addition ANSTO provides, for over 100 AINSE-sponsored projects, essentially free access to their research facilities. The cash value of this is difficult to calculate accurately but the total ANSTO contribution to AINSE supported projects is probably of the order $4 to $5 for each dollar provided by the Universities in the form of membership subscriptions. This is very generous provision indeed and it undoubtedly achieves the objectives for which it was intended, namely, to stimulate research in nuclear science and engineering and to make available to academics and their postgraduate students the unique facilities at the Lucas Heights Research Laboratories.

As for the suggestion that ANSTO has aspirations to control AINSE, it should be pointed out that AINSE’s research policy and the disbursement of its funds is determined by the Council of AINSE on the advice of its Executive and Specialist Committees. Although ANSTO is represented on these committees, the membership of them is drawn predominantly from the Universities and it often happens that grants are made for projects (e.g. in Plasma Physics) which are only marginally related to work in the main ANSTO programme areas.

Of course the ANSTO Councillors, as well as those from the member Universities, exercise their right (and responsibility!) to constantly keep under scrutiny the question of “return on investment in AINSE”. This healthy internal appraisal is welcomed by AINSE and, indeed, it has led to the present review which will formally define our objectives and strategies for the future.

With the benefits of this newly formulated Strategic Plan, the recognition by the Universities of the value of AINSE membership and the ongoing dynamic partnership with ANSTO, Australian research in nuclear science and engineering seems to be faring much better than that in many other fields.

D.R. Miller
President, AINSE

Special Research Centre Selection

Dear Editor

I don’t really want to become a regular correspondent, but your account of the Council’s recent Special Research Centres round (vol 27 No 9) can’t be allowed to pass unchallenged. I enclose a detailed account of the selection process, which you might like to make more widely available.

First, let me make clear what is at issue. Successful Special Research Centres which survive review will, in their nine years, receive as much as eight million dollars in public funding. Only the very best deserve that opportunity. Those that receive it combine outstanding research talent, an ingenious and creative research proposal, a proven track record, a strong management structure and wholehearted institutional and other support. While the Council received 96 proposals which represented what the institutions believed to be their best, it can’t seriously be suggested that all 96 satisfied the high standards for recommendation. The 1/7 success ratio in 1990 compares with 1/8 ratio of the last round, in 1987.

The selection committee for this round consisted of the Council’s Institutional Grants Committee, which included several people who had been on the 1987 selection committee. It is a highly experienced group. The IGC divided the proposals into four sets corresponding broadly to the Council’s disciplinary divisions, establishing sub-groups responsible for each set. These sub-groups culled 42 of the 96 proposals after lengthy discussions within the Committee as a whole. The remaining 54 were sent out for extensive peer review. When the assessments were in and had been considered, the 54 were reduced to 28 whose initiators were then interviewed to explore management, budgetary, strategic and resource issues. Of that 28, 13 were recommended for funding. It is not surprising that the Council would have wished to be in a position to fund a few more.

Since I have been dealing with Special Research Centre rounds since the first review of Centres in 1986 I am in a position to say that the selection process was exemplary, the best ever.

Don Aitkin

Women in Australian Science

Dear Editor,

The time is ripe for a collective book on Women in Science in Australia. Our plan is to gather together lively and well-written short biographies of women who have been conspicuous contributors to science in Australia and those, less well known who need to be retrieved, who have participated in Australian scientific life, distinctively or representatively, across the past two hundred years.

We would welcome your help in identifying these women and ensuring that we have cast the widest net. Inclusions will cover early illustrators and collectors, honorary members of Colonial scientific societies, notable secondary and tertiary teachers, talented women in our scientific institutions, women who were important – though often publicly unrecognised, assistants of scientific or inventive husbands, and the rising regiment of women who have played pioneering or creative roles in 20th century science and technology in every State.

Nominations, and if possible, a suggested contributor to write the

Continued on page 259
The Proposed
“Strategy Plan for Physics in Australia”
Report of the November Meeting of the
NSW Branch AIP

Brad Powe, Chair

The final NSW Branch public meeting for 1990 was used as a venue for discussion of the ‘Strategy Plan for Physics in Australia’, details of which were first published in the August issue of The Australian Physicist. Held at the UTS Broadway Campus, the meeting was attended by over 80 people representing university, government, industry, and secondary education. The meeting opened with presentations by:

- Professor Bruce McKellar, Melbourne University
- Dr John Collins, CSIRO Applied Physics
- Professor Max Brennan, Sydney University
- Professor Bob Clark, University of NSW
- Professor Ron MacDonald, University of Newcastle
- Professor Jim Piper, Macquarie University

These introductory addresses were followed by questions and observations from the floor. A summary of the themes expressed in the speeches is presented here.1

McKellar: Profiles in Australian Science (ASTEC, 1989) shocked many people with its report on the state of physics in this country. In many areas it has been increasingly difficult to stay at the forefront of science, and this has been particularly true of physics. This conclusion is based on the number of ‘research workers’ in higher education and (technological) development – while the total grows up with time, the number engaged in the physical sciences has remained roughly constant (and even then, the statistics include research students), as has the ‘real’ value of funding.

Australian output is gradually declining as a percentage of world science (although the comparison does depend somewhat on the definition used). An article in Search (April-May 1990) concluded that Australian physics was almost certainly severely underfunded in comparison to that of Europe, regardless of the basis of comparison. Faced with mounting evidence, the National Committee for Physics proposed to the Australian Academy of Sciences that a strategy plan be drafted for, and ultimately ratified by, the Australian physics community.

An examination of the distribution of funding reveals that, for example, the astronomers have been very successful in forward planning - 1/6 of the physics practitioners receive 1/3 of the funds. Physics as a whole needs to convince government that it is worthwhile, but this will require the presentation of a coherent vision: the employment statistics compiled by John Prescott are one element of this, since they show where the physics trained are capable of working. Without such a plan, we will see the tertiary sector growing, but the physics component remaining the same.

The view of the National Committee is that it is best to have a national plan for the development of physics: in it the medium term should be strongly mapped out, with more general treatment for the long term. The Working Group (McKellar, Collins, and Don Nichol of OTC) was set up in order to draft the plan in consultation with the National Committee and the physics community. There will also be consultation with other national committees, such as those for atmospheric science and materials science. However, Ian McCarthy (Chairman of the National Committee) has indicated a desire for all kindred groups to be united under one umbrella.

The timetable initially envisaged has been put back by some four to six months while full funding for the exercise was sought. It is now hoped to finish the project in about a year’s time. It is important to recognise that no formal structure for the proposed Plan currently exists, and that input (in writing) is requested from all interested parties.

Collins: The report Setting Directions for Australian Research is readily linked to the proposed strategic exercise. It reveals that there has been a levelling out in the research endeavour, and continuous prioritisation of the effort. Despite the 7 - 10 years needed to double the size of the research effort in Australia, this is still a faster rate than that of economic growth – so this levelling is perhaps not surprising.

Research has been pretty much the province of Federal Departments (DEBT, DITAC etc). However, since May 1988 the Prime Minister’s Science Council and the Co-ordinating

1 A complete report, including more detail of the questions and contributions from the audience, will be presented in the next issue of the Australian Physicist.
have provided a means of formal overview and hence co-ordination of resources. To maintain relative proportions of funding, a plan is needed for the acquisition and allocation of 'national', 'strategic' (eg CSIRO), and 'operational' (eg ARC) priorities. There is not much in the way of national priorities planning.

The Federal government is signalling that it wants planning and priority setting, and physics should work to benefit from this attitude by trying to decide what areas we should be concentrating on. Physics needs a combination of high feasibility and high benefit. Environmental physics (atmospheric, noise, E/M effects, etc) is thus a strong contender especially since funding is also a political exercise. A united front will provide benefits through integration of research, since shared resources bring better value to the participants and provoke a positive response from governments.

Brennan: With respect to its practice in Australian universities, the broad objectives of physics are:
1. Direct benefits/results which lead to new products/processes (although commercialisation is a tortuous process which does not have a glorious history).
2. Provision of a research environment for higher level students (who may be able to work at more than their nominal qualifications suggest).
3. The maintenance of Australian credibility in the world research community.

The give-and-take between peers/colleagues (ie equals) is an issue which has not been sufficiently emphasised in the past. The primary role of university physics may well be to strengthen and maintain such contacts. The question is something like 'Can we afford to relinquish any of our current research areas (which we cannot always financially afford, eg plasma physics) just in order to concentrate on work in industry related matters?'. Collaboration overseas will help us to stay in touch, but even so physicists must find more effective ways of communicating their results and virtues to both government and industry.

Clark: There is a need for much more R & D co-ordination. Universities and 'government science' (essentially, but not exclusively, the CSIRO) are really the only significant areas of research, and are virtually equivalent in both research output and government funding. Together they need to do more for both graduate and undergraduate students (eg large scale vacation employment).

In R & D funding, the ARC will provide up to $100,000, the IR & D Board up to $80,000, and new the CRC Panel can arrange $10M (albeit spread over several years). Too often, the IR & D Board expects unrealistic commercialisation timetables to be met - especially when the necessary R & D requires a factor of ten funding boost, and industry by and large, can't or won't help. However, the influence of the CRC may improve things, at least in terms of providing a funding framework for continuing research. Greater collaboration between the universities and the CSIRO may be able to link the various levels of grant and thus obtain a synergistic effect.

The tertiary entrance scores to do physics (and the majority of the sciences) are generally too low, and we have to ask if we are getting sufficiently good applicants. Physics is taking a nose dive in terms of comparative/real income, career prospects, and community prestige.

We need to find funding to send students overseas to attend conferences. This will increase their motivation and encourage better performance. Similarly we need to share in experimentation with our colleague overseas rather than attempting to merely absorb information while on fleeting visits. We should also try to host more conferences and build up our facilities to make them attractive for foreigners to come here and conduct experiments.

DITAC is nowadays somewhat happier to fund both outwards and (to a lesser extent) onwards travel - so physicists should not be shy about asking for (genuine) travelling expenses.

MacDonald: Over the next six to eight months, we have to be careful not to be overwhelmed by the plethora of reports about 'problems' in science - and we have to present one of our own containing a 'solution'. We can't realistically expect 'vast' increases for science as a whole, and FASTS, for example, may well have to change its lobbying thrust as a consequence; it is probable that only special, well-directed scientific programmes in areas such as the environment, minerals processing etc, still have good prospects for substantial funding.

It will be hard to compete with medicine and the biological sciences in the static pool of funding, so how can we best use the funds that physics has? So many physicists are involved in education in one way or another. How do we make use of the people we have, and where will the new ones come from, since the nation is already a net recruiter of PhDs from overseas?

Trying to keep winners is a sure way to go broke - at least in terms of fields of study: we would do better to back people.

What technology should we try to acquire? More neutron sources, accelerators, or gravity telescopes? There is very little chance of acquiring many new devices, so we would do well to pool our resources, establish co-operative centres, and then have manageable sums spent on both upkeep of the combined facilities and ensuring access to them by all physicists (with worthwhile projects).
Piper: In 1991, perhaps 50 to 100 of the 85,000 HSC students will formally nominate to do physics through the UCAC applications system. In 1990, 140 Honours students are enrolled — but probably less than half will go on to do PhDs. If we develop a strategy, we then have to sell it to both our source of funds and (our) students; that way will ensure that there will be a supply of practising physicists into the future.

How do we increase our attractiveness? It is not good enough to say that the value of physics is self-evident, nor to say that physics is behind modern technology. Instead, we have to make it clear that physics is modern technology (and vice versa). This is not to say that we should all convert to applied physics — but like Macquarie University, we can consider the offering of new or repackaged courses such as the successful Bachelor of Technology (a 'BSc in disguise').

This success has been achieved by identifying elements of physics that are tied to modern technology in a distinct way, and combining them with a bit of management and a comprehensive maths course. Similar things could easily be done in the field of materials science. This approach is definitely attracting greater numbers of enrolments, and is clearly one means of attracting the ‘new blood’ we need in order to create more physicists — and thus ensure the continuation of physics as an independent field of endeavour.

LETTERS
Continued from page 256
‘biography’ should be sent to either of the undersigned and will be gratefully acknowledged. ‘Science’ covers pure and applied science and its development, technology and invention, medicine, anthropology, psychology, health, horticulture, and art in science. In general, those included will no longer be alive, though exceptions will be made for major elder figures in their field.

The book, which will draw on the assistance of Wisenet (Women in Science Enquiry Network) will, we believe constitute an important social history in tracing the accomplishment and struggles, and the character and context of women in two centuries of Australian science.

Ann Moyal
8/12 Kareela Road
Cremorne NSW 2090
Tel (02) 953 8982

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26 George Street
Yowie Bay NSW 2228
Tel (02) 524 6796

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If you would like a copy of our selection criteria, please contact Vivien Nissen on (02) 413 7462.

Applications should quote reference number AS90/26 and should include relevant personal particulars, including qualifications and experience. Please address your applications to:

The Chief
CSIRO Division of Applied Physics,
PO Box 218,
Lindfield, NSW 2070.

Science Education Policy for the Australian Institute of Physics

Comments on the attached draft education policy are invited from all interested members of the AIP. It will be discussed at the AIP Council Meeting in 1991.

Preamble

More than ever before, Australia needs an educated population with a strong basis of scientific and technological skills. This is essential to enable us to keep abreast of the new discoveries coming from both local and overseas research and to create the new ideas and technologies which we need to remain competitive in our established industries and to build new export industries. It is a serious cause for concern therefore that there seems to be a declining interest in science education among most students, and a particularly low participation rate for girls. This concern is heightened by the fact that so few academically able students are offering for teacher training in science.

From the individual point of view, a knowledge and understanding of science is recognised to be an important part of a person's intellectual development. Furthermore, it is impossible to gain competence in any aspect of science without the development of understanding of a core of knowledge drawn from Physics, the study of the most basic processes of nature.

What Australia needs from Science Education

The Australian Institute of Physics (AIP) suggests that the desired outcomes of science education, both for society and the individual, are as follows:
1. A general population familiar with the scientific and technological principles and processes which influence their lives.
2. A general population capable of informed discussion on the scientific and technological choices facing our society.
3. Policy makers and opinion influencers who can appreciate the significance of scientific arguments.
4. An adequate supply of people with the scientific training to service our technology-based society.
5. An adequate supply of people, highly trained in science and mathematics, who can generate new ideas and processes in Australia and also adapt overseas information to meet local needs.

Implications for School Science

Courses
1. Science courses should be coordinated between the primary and secondary systems.
2. Primary school courses should include a significant component of science, in particular the physical sciences, for all students.
3. In Years 7 to 10, school courses should provide at least 200 minutes per week of science content.
4. In Years 7 to 10, material of a physics-related nature should constitute about 1/3 of all General Science courses.
5. Science courses should draw on student experiences and should emphasize the relevance of science to a student's everyday life, now and into the future.
6. All students should include a science/technology component in their courses up to and including Year 12.
7. Positive and continuing action should be taken to increase the percentage of girls who study Physics through to Year 12.
8. Provision should exist for all students with strong interest and aptitude in Physics to study at accelerated and advanced levels.
9. Physics courses at the upper secondary level should provide a firm foundation for tertiary studies while also providing an enriching experience for those students who do not intend to take the subject further.
10. Novel teaching methods and materials are to be encouraged, provided that professional physicists are consulted to preserve the accuracy and suitability of the course content.
11. All secondary schools should have suitably designed science laboratories adequately equipped to provide all students with practical experience in science. This will include suitable technical support staff.

Teachers
The success of any education system depends ultimately on the quality, training and enthusiasm of the classroom teachers. This is particularly important in science education where many of those called upon to teach science, especially in primary and junior secondary classes, have a limited background in science themselves. The AIP recommends the following:
1. The training courses for all primary school teachers should equip teachers to handle the science component which we believe should be included in all primary school curricula.
2. All science teachers at Years 7 to 10 level should be sufficiently conversant with the concepts of Physics that they can confidently and competently teach Physics at junior and middle secondary school level. Teacher training courses should reflect this need.
3. All teachers of Years 11 and 12 Physics should have a minimum academic qualification of second-year Physics at the tertiary level.
4. There should be suitable in-service courses available for teachers to improve their academic qualifications, especially in the science and maths areas.
5. Salaries, working conditions and career structures should be such as to attract and retain suitably competent and qualified teachers.

Involvement of the AIP
1. The AIP recognises that school physics teachers are an important part of the Australian physics community.
2. The AIP supports moves to improve the teaching of physics-related courses at primary, secondary and tertiary level.
3 State branches should see themselves as the main agents for achieving the broad educational aims and objectives of the AIP. One important step would seem to be the setting up of branch Education committees.

**Possible Activities**

Some ways in which state branches could support physics education are suggested below.

1. Disseminate accurate and up-to-date information to students, teachers and career advisors on the wide range of tertiary courses that recommend or require Physics and of the rewarding and exciting careers for which Physics is a suitable preparation. This may include:
   - running specific careers seminars
   - offering speakers to contribute to the regular conferences held by Careers advisors or Physics teachers
   - writing articles on careers in Physics for science teacher publications
   - preparing a video for schools featuring interviews with young physicists.

2. Establish links with the relevant science teacher associations (particularly the Physics teacher group) and work cooperatively with them. For example:
   - co-opt Physics teachers onto the branch education committee
   - make one of the monthly branch lectures a combined meeting with the association
   - provide speakers for science teachers conferences: for example
     - talks to bring Physics teachers up-to-date with current research in Physics
     - talks which provide real-world applications of the ideas and techniques taught in school Physics courses
   - run joint seminars on topics of interest to physicists in industry, research and education
   - run joint workshops on the teaching of new or difficult topics in the school curriculum.

3. Support activities which improve the public perception of Physics and foster student involvement in science. Some possibilities:
   - provide funds for activities such as Science Talent Search and Science Fairs
   - be involved with organizing and running activities such as the ANZAAS Junior Science and Technology Festival
   - run a Science Quiz Night among a group of local schools
   - offer prizes to encourage excellence in Year 12 and undergraduate students
   - run coaching sessions for students interested in entering the Physics Olympiad Examinations.

4. Organise speakers to deliver a series of Youth Lectures around the state, particularly in country centres. These could be aimed at Year 10 and 11 students to encourage them to see Physics as an interesting and worthwhile subject to continue at school.

5. Foster links between physicists in industry and research and school teachers:
   - visits by teachers and/or students to industrial and research establishments to observe how Physics ideas and techniques are used in practice
   - form joint working groups to develop units of work based on applications of Physics
   - provide speakers to visit schools.

6. Be involved in the development of new secondary Physics syllabi
   - offer professional physicists to be representatives on the bodies which construct new syllabi
   - make submissions to the course designers.

7. Establish a cooperative dialogue between tertiary and secondary physics educators, particularly those involved at the school Year 12 and first year tertiary interface. For example, first-year co-ordinators should attend Physics teachers conferences and meet regularly with teachers on the Physics Course Management Committee or its equivalent.

8. Support and assist groups such as Women in Science provide positive role models for girls interested in science.

**Summary**

The quality of Physics education at school and tertiary level is crucial to the long term health of the physics community and, ultimately, the nation.

As the professional organisation which represents the physics community we recognise and accept that the need is urgent and that our response must be immediate and sustained.

The AIP commits itself at both the national and state levels to initiate, encourage, support and participate in activities which will improve Physics education at all levels.

F. G. Armitage

Federal Science Policy Committee

Submissions should be forwarded to
Dr. F. G. Armitage
MCEGS, Domain Rd, South Yarra Vic 3141

**STANDARDS AUSTRALIA COMMITTEES**

The Australian Institute of Physics is entitled to have a member representative on each of the following committees:

- CH/30 Temperature Measurement
- ME/49 Oil & Gas Measurement
- ME/71 Quantities, Umstand Conversions

Any member who is willing to participate in the work of any of these committees should send a name and brief description of the relevant experience to the AIP Melbourne office, 191 Royal Parade, Parkville 3052 addressed to Dr. F. Bryant.

It is important that the AIP be represented when it is entitled to do so and when a physicist's contribution has been requested.
The International Physics Olympiad is a competition for students who have not yet enrolled at University and have not reached the age of 22. Nations send teams of 5 students to complete, in two 5-hour examinations. One theoretical and one laboratory, and medals are won on individual performance.

The Olympiad in 1990 was held in Groningen in The Netherlands, from July 5 to July 13. Australia’s team, the selection of which will be set out in another article to be submitted to a later issue, consisted of 5 students: John Wiltshire, Simon Wilson, Andrew Robertson, Keith Brain, Brett Meyers, and three leaders – Rodney Jory, Mark Gorbatov and Colin Taylor.

For the first time the team was not required to raise its own funds and entry was made possible by a Government grant of $100,000 and a generous rebate of $10,000 by Qantas from the fares. The team was known as the Qantas Australian Physics Team.

Departure was on 28 June following a farewell function in Sydney at which Mr Dawkins, Minister for Employment, Education & Training, presented student and leaders with their tickets, Qantas presented them with their travel documents and Dr John Collins, on behalf of the Australian Institute of Physics, presented them with an AIP tie and the students with a cheque for $500 each being the proceeds of the AFA Harper Scholarship granted by the AIP.

Brett Meyers from WA was farewelled in Perth at a previous function hosted by the AIP and attended by Mr Dawkins, and joined the team in Singapore.

After a week in Munich, both to allow jet lag plus any other biological and cultural imbalances to settle and to spend another week together working on physics, the team arrived in Groningen on Thursday, July 4th.

Finalising the Examination Papers

Friday was spent at the inevitable Opening Function, giving those who make the Olympiad possible a chance to say their piece. On that evening the International Committee, made up of the leaders from 32 nations, met to finalise the theoretical paper. As always, the paper was set by the host country with a team of physicists being responsible for each of the three questions. After around 7 hours the final paper in both English and Russian was settled upon and all leaders were then required to translate the paper to their own language.

In some senses translation of the English paper is harder because not only is the paper “almost correct” to start with but there are 8 persons from 4 English speaking nations anxious to contribute. The Swedes, for instance, must start with a clean sheet and have only two persons to decide on the paper so they finish in one hour. An English language paper took around 3 hours while the British paper, used by the UK, took many hours longer. The final English language version used for Canada, US and Australia constitutes Appendix A.

Examination Results

Students were given 5 hours on Saturday July 6th to complete the paper. All but one of the Australian students felt this was long enough to produce good answers, one finding the time a little restrictive.

As can be seen questions were specifically of an applied nature and aimed to produce problems of maximum difficulty using basic Newtonian physics with minimum calculus. Marks of students from all nations ranged from 28 out of 30 (10 marks per question) to the inevitable zero.

Australia appeared to score extremely poorly until it was found that high marks were a rare event and that the average was quite low.

Australia’s position improved on the following day at the moderation session when Mark and Colin were able to persuade the examiners to increase the marks by a total of around 20% overall. ▷
The Laboratory Examination

Consideration of the laboratory examination paper on Sunday night saw a repeat of the process used for the theory paper and a copy of the English language version of the laboratory paper constitutes Appendix B.

The students were divided into 4 groups to take the laboratory examination on Monday. One set of each piece of equipment was given to each leader and Australia’s now are lodged at the University of Canberra and will be used in Training Schools in later years.

For this reason readers are asked not to show this article to potential students who will gain more from seeing the paper as an exercise without any previous knowledge.

Australian students performed well in the laboratory examination as had been expected and only one extra mark could be extracted from the examiners at the following moderation session.

Relaxation and Results

The balance of the week was filled for the students visiting places of interest in The Netherlands and for the leaders marking the papers. Social life for the students was somewhat limited, there being around 97% males.

After three days of marking and moderation, the medals were awarded at the Closing Ceremony at the University of Groningen.

Medals were awarded on the basis of the average of the top 3 marks achieved out of 50 in the competition, a device used to ensure that no one student, or nation, can by themselves influence the competition. Using this top mark (43):

Students who achieve 90% receive a gold medal
Students who achieve 75% receive a silver medal
Students who achieve 65% receive a bronze medal
Students who achieve 50% receive an Honourable Mention

The top 3 students this year achieved outstandingly high marks while the “average” performance of all students appeared not to change significantly. For this reason the number of medals awarded was around one-third less than usual.

Since all Australian students performed as well as in past years despite the more difficult paper, the number of medals received was less. Had the same number of medals been awarded as last year Australia would have had one silver, two bronze and two certificates. As it happened the results were:

John Wiltschke, Concordia Mem. College, Toowoomba, QLD Bronze Medal (28.4 marks)
Keith Brain, James Ruse Agricultural College, Sydney, NSW Honourable Mention (24.7 marks)
Brett Meyers, Rossnoy State Senior High School, Perth, WA Honourable Mention (22.5 marks)
Simon Wilson, Canberra Grammar School, Canberra, ACT (20.8 marks)
Andrew Robertson, St Edmund’s College, Canberra, ACT (20.5 marks)

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Discussion

The main thing to be noticed is the consistency of the Australian scores. For the third year from three, the results came within the 20 – 28 out of 50 range. Figure 1 gives the frequency distribution of marks out of 50 for all students. All Australians earned the mean score or above.

This would appear to indicate that the limitation on Australian students is the amount of information they can be taught in the very short time available and that Australia is not relying on finding occasional geniuses who might come up with a “one off” extraordinary mark.

Australia scored 116 marks from a total of 250 (5 x 50). This places Australia twelfth out of 32 competing nations as given in the list in Table 1. (In 1989 Australia had ranked around fifteenth from a smaller number of countries.)

Australia’s greatest strength lies in the consistency of marks across the team. While other nations may have the occasional high score, most will just as often have a low one which keeps down the total score. The consequence of this to Australia is that the probability of scoring medals decreases while the total marks increase. It is remarkable to note that if a check is made of those nations whose students all scored above 20 (the average mark) only 5 countries including Australia achieved this. Most countries with gold medals had a poor score somewhere. Of the 72 students who scored more than 20 marks, 54 came from the top 12 countries leaving very few medals and certificates to go to the other 20. The Gold and Silver medals were restricted to 8 countries only. The top mark of 45 went to a student from Great Britain but Great Britain only achieved 2 medals and came 5th.

Figure 1: Frequency Distribution of scores for the 1990 Physics Olympiad

<table>
<thead>
<tr>
<th>Nation</th>
<th>Total Marks out of 250</th>
<th>Gold</th>
<th>Silver</th>
<th>Bronze</th>
<th>Hon. Mention</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Soviet Union</td>
<td>177</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2 PR of China</td>
<td>177</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td></td>
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<tr>
<td>3 FR of Germany</td>
<td>170</td>
<td>-</td>
<td>3</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>4 DDR</td>
<td>162</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>5 Great Britain</td>
<td>153</td>
<td>1</td>
<td>1</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>6 Poland</td>
<td>141</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>7 Bulgaria</td>
<td>135</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>8 Hungary</td>
<td>128</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>1</td>
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<tr>
<td>9 Netherlands</td>
<td>127</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>4</td>
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<tr>
<td>10 Romania</td>
<td>127</td>
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<td>1</td>
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<tr>
<td>11 USA</td>
<td>122</td>
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<tr>
<td>12 Australia</td>
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<td>13 Czechoslovakia</td>
<td>108</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>2</td>
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<tr>
<td>14 Italy</td>
<td>102</td>
<td>-</td>
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<td>1</td>
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<td>15 Iran</td>
<td>99</td>
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<tr>
<td>16 Sweden</td>
<td>95</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>4</td>
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<tr>
<td>17 Austria</td>
<td>90</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
</tbody>
</table>

Other Bronze (28): Cuba (63), Colombia (55), Vietnam (86), Singapore (84)
Other Honourable Mentions (24): Turkey (53), Finland (78), Ireland (71)
Cut-offs: Gold 39, Silver 33, Bronze 27, Honourable Mention 21
Table 1 shows a much more significant problem ahead for Australia. To rise two (or four) places on the total mark scale would have required another 11 or so marks, an increase of an average of 2 marks or 10% for each student. This is no small target to set and just as last year we aspired to climb three places, and achieved it, so we hope to do it again next year. The task will, however, be far more formidable and will probably take more than one year.

To rise four places would put only the big league ahead of us, a frightening prospect.

One consolation appears. The DDR, who did extremely well, will not attend in future leaving only 10 in front of us. The combined resources of the BRD and the DDR will make Germany a very strong opponent.

Information on the training programme will be given in a later article and ideas will be included as to how we might seek this additional 10% each.

Thanks

It is necessary at this point to thank those who assisted with the preparation of the team. This assistance is not limited to those who purely helped the final 5 members. It must go back to the schools and parents who assisted the initial 23 students, to the Universities and staff who helped with the final 8 and to the students who were not selected who helped the others along.

Special thanks must go to the University of New South Wales, the University of Western Australia, University of Southern Queensland, University of Canberra and the Australian National University, who helped with the laboratory work for the final 5, to Dr John Rayner and the examination team from the Australian Institute of Physics in Canberra, to the lecturers, tutors and demonstrators of the training schools and to the Australian Science Olympiads Committee itself. The list of those who helped is of gigantic proportion and hopefully all concerned can find themselves under one of these heads.

Our greatest thanks go to the team members themselves who have put in six months of almost continuous physics, giving up everything to keep up. They will use this knowledge in later studies. They all gave their best and worked very hard to do it.

Members and others who feel they could assist might like to wait until the next article to see how they might make a contribution.

Finally, Australia has been listed as the host for the 1995 IPhO. This will require around half a million dollars in cash and the assistance of literally hundreds of physicists, and especially those with language skills. A commitment on this is needed by May 1991. This will be the subject of a later article. ▶

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*Australian Physicist* Volume 27, Number 12, December 1990 265
Examination Paper 1

XXI INTERNATIONAL PHYSICS OLYMPIAD
GRONINGEN
THEORETICAL COMPETITION

July 7th 1990
available time: 5 hours

Question 1: X-Ray Diffraction From a Crystal

We wish to study X-ray diffraction by a cubic crystal lattice. To do this we start with the diffraction of a plane, monochromatic wave incident normally on a 2-dimensional grid consisting of \( N_x \times N_y \) slits with separations \( d_x \) and \( d_y \) respectively. The diffraction pattern is observed on a screen at a distance \( L \) from the grid. The screen is parallel to the grid and \( L \) is much larger than \( N_x d_x \) and \( N_y d_y \).

a) Determine the positions and widths of the principal maxima on the screen. The width is defined as the distance between the minima on either side of the maximum in question.

We consider now a cubic crystal with lattice spacing \( a \) and size \( N_1 \times N_2 \times N_3 \) with \( N_3 \) much smaller than \( N_1 \) and \( N_2 \). The crystal is placed in an X-ray beam parallel to the \( z \)-axis and incident at a small angle \( \theta \) (see Fig. 1). The diffraction pattern is again observed on a screen at a great distance \( L \) from the crystal.

![Figure 1](image1)

b) Calculate the positions and widths of the maxima as a function of the angle \( \theta \) (for small \( \theta \)). What in particular are the consequences of the fact that \( N_3 \ll N_2 \)?

The diffraction pattern can also be derived by means of Bragg's theory in which it is assumed that the X-rays are reflected from atomic planes in the lattice. The diffraction pattern then arises from interference of these reflected rays with each other.

c) Show that this Bragg reflection yields the same conditions for the maxima as those that you found in part b.

- In some measurements a powder method is employed. A beam of X-rays is scattered by a powder of very many, small crystals. (Of course, the sizes of the crystals are much larger than the lattice spacing, \( a \).) Scattering of X-rays of wavelength 0.15 nm by potassium chloride [KCl] results in the production of concentric dark circles on a photographic plate. KCl has a cubic lattice (see Fig. 2) and the K\(^+\) and Cl\(^-\) ions have almost the same size and therefore may be treated as identical scattering centers. The distance between the crystals and the plate is 0.10 m and the radius of the smallest circle is 0.053 m (see Fig. 3).

![Figure 2](image2)

Figure 3

d) Calculate the distance between two neighbouring K\(^+\) ions in the crystal.
Question 2: Electric Experiments in the Magnetosphere of the Earth.

In May 1991 the spaceship Atlantis will be placed in orbit around the earth. We assume that this orbit will be circular and lie in the earth's equatorial plane. At some predetermined moment the spaceship will release a satellite S, which is attached to a conducting rod of length L. We suppose that the rod is rigid, has negligible mass, and is covered by an electrical insulator. We also neglect all friction.

Let $\alpha$ be the angle that the rod makes with the line between Atlantis and the center of the earth (see Fig. 1). Assume that the mass of the satellite is much smaller than that of Atlantis, that L is much smaller than the radius of the orbit, and S also lies in the equatorial plane.

![Figure 1](image)

- a.) Deduce the value(s) of $\alpha$ for which the configuration of the spaceship and satellite remain unchanged (with respect to the earth)? In other words, for which value(s) of $\alpha$ is $\alpha$ constant?

- b.) Discuss the stability of the equilibrium in each case.

If the rod deviates from a stable configuration by a small angle, the system will begin to swing like a pendulum.

- b) Express the period of this oscillation in terms of the period of Atlantis' orbit.

In Fig. 1, the magnetic field of the earth is oriented perpendicular to the diagram and directed toward the reader. Due to the orbital velocity of the rod, a potential difference arises between its ends. The environment (the magnetosphere) is a rarefied, ionized gas with a very good electrical conductivity. Contact with the ionized gas is made by means of electrodes in A (Atlantis) and S (the satellite). As a consequence of the motion, a current I flows through the rod.

- c.) In which direction does the current flow through the rod (take $\alpha$ - 0)?

Data:
- the period of the orbit $T = 5.4 \times 10^3$ s
- length of the rod $L = 2.0 \times 10^4$ m
- magnetic field strength of the earth at the height of the satellite $B = 5.0 \times 10^{-5}$ T
- the mass of the shuttle Atlantis $M = 1.0 \times 10^5$ kg

Next, a current source in the shuttle is included in the circuit, which maintains a net direct current of 0.1 A in the opposite direction.

$c)$ How long must the current be maintained to change the altitude of the orbit by 10 m? Assume that $\alpha$ remains zero. Ignore all contributions from currents in the magnetosphere. Does the altitude decrease or increase?

Question 3: The Rotating Neutron Star

A "millisecond pulsar" is a source of radiation in the universe that emits very short pulses with a period of 1 to several milliseconds. Since this radiation is in the radio range, a suitable radio receiver can be used to detect the pulses and measure their period with great accuracy.

These radio pulses originate from the surface of a neutron star. These stars are very compact: they have a mass of the same order of magnitude as that of the sun, but their radius is only a few tens of kilometers. They spin very quickly. Because of their fast rotation, a neutron star is slightly flattened (oblate). For this section, we assume that the axial cross-section of the star is an ellipse with almost equal axes.

Let $r_p$ be the polar radius, $r_e$ the equatorial radius, and define the flattening factor to be

$$\varepsilon = \frac{r_p - r_e}{r_p}$$

Consider a neutron star with a mass of $2.0 \times 10^{26}$ kg,

- an average radius of $1.0 \times 10^6$ m,
- and a rotation period of $2.0 \times 10^{-2}$ s.

a) Calculate the flattening factor, given that the gravitational constant is $6.67 \times 10^{-11}$ N m$^2$ kg$^{-2}$.

Over many years the rotation of the star slows down due to energy loss and this leads to a decrease in the flattening. The star, however, has a solid crust that floats on a liquid interior. The solid crust resists a continuous adjustment to the equilibrium shape. Instead, glitches (star-quakes) occur with sudden changes in the shape of the crust toward equilibrium. During and after such a star-quake, the angular velocity is observed to change as shown in Fig. 1.

![Figure 1](image)
EXPERIMENT ONE

INTRODUCTION
In this experiment you will use a light emitting diode (LED) and a photo-diode (PD).

In an LED, part of the electrical energy is used to excite electrons to higher energy levels. When such an excited electron falls back to a lower energy level, a photon with energy $E_{\text{photon}}$ is emitted, where

$$E_{\text{photon}} = \frac{hc}{\lambda}$$

Here $h$ is Planck's constant, $c$ is the speed of light, and $\lambda$ is the wavelength of the emitted light.

The efficiency of the LED is defined to be the ratio of the radiated power to the electrical power $P_{\text{LED}}$ used:

In a photo-diode, radiant energy is transformed into electrical energy. When light falls on the sensitive surface of a photo-diode, some (but not all) of the photons eject some (but not all) of the electrons from the crystal structure. The ratio of the number of ejected electrons per second $N_e$ to the number of incoming photos per second $N_p$ is called the quantum efficiency $\eta$.

THE EXPERIMENT
The purpose of this experiment is to determine the efficiency of an LED as a function of the current through the LED. To do this, we will measure the intensity of the emitted light with a photo-diode. The LED and the PD have been mounted in two black boxes and they are connected to a circuit box. By measuring the potential difference across the LED and across the resistors $R_1$ and $R_2$, one can determine the potential differences across the LED and the PD and the currents through the LED and the PD.

Use the multimeter to measure VOLTAGES only. This is done by turning the knob to position "V". The meter selects the appropriate sensitivity range automatically. If the display is not on "AUTO", switch the multimeter off and on again to "V". The leads should be plugged into the connections marked "COM" and "V-2".

The box containing the photo-diode and the box containing the LED can be moved freely over the board. If both boxes are positioned opposite to each other, then the LED, the PD, and the hole in the box containing the PD remain in a straight line.

Data:
- quantum efficiency of the photo-diode $\eta = 0.88$
- detection surface of the PD $2.75 \times 2.75 \text{ mm}^2$
- wavelength of the LED light $535 \text{ nm}$
- Planck's constant $h = 6.63 \times 10^{-34} \text{ Js}$
- charge of the electron $e = 1.6 \times 10^{-19} \text{ C}$
- speed of light in vacuum $c = 3.00 \times 10^8 \text{ ms}^{-1}$
- internal resistance of the voltmeter $100\Omega$ when the voltage $200 \text{ mV}$
- $10\Omega$ when the voltage $200 \text{ mV}$

(The range is indicated by small numbers on the display.)

$R_1 = 100\Omega$
$R_2 = \text{ variable resistor}$
$R_3 = 1\Omega$

INSTRUCTIONS
No points will be allocated for error analysis (in THIS experiment only).

Summarise your data in tables and graphs with clear indications of quantities and units.

1. Before we can determine the efficiency of the LED, we must first calibrate the photo-diode. The problem is that we know nothing about the LED.

2. Show experimentally that the relation between the current $i$ through the photo-diode and the intensity $I [\text{Js}^{-1} \text{m}^{-2}]$ of the light falling on it is linear.

3. Determine the current for which the LED has the maximum efficiency.

4. Carry out an experiment to measure the numerical value of the maximum efficiency of the LED.

EXPERIMENT TWO

Determination of the ratio of the magnetic field strengths of two different magnets.

INTRODUCTION
When a conductor moves in a magnetic field, eddy currents are induced. As a consequence of the interaction between the magnetic field and the induced currents, the moving conductor experiences a retarding force. Thus an aluminium disk rotating in the neighbourhood of a stationary magnet experiences a braking force.

APPARATUS
- 1.1 stand
- 2.1 clamp
- 3.1 uniform aluminium disk that rotates on an axle
- 4.2 sets of magnets. The geometry of each set is the same (within 1%); each set consists of a clip containing two small magnets of identical magnetization and area. The uniform magnetic fields of the sets are defined as A1 and B2.
- 5.2 weights; one weight has twice the mass (within 1%) of the other
- 6.1 stopwatch
- 7.1 ruler

THE EXPERIMENT
The aluminium disk is fixed to an axle, around which a cord is wrapped. A weight hangs from the cord. When the weight is released, the disk accelerates until a constant angular velocity is reached. The terminal speed depends, among other things, on the magnitude of the magnetic field strength of the magnet.
Two sets of magnets of different field strengths B1 and B2 are available. Either can be attached to the apparatus that holds the aluminum disk.

INSTRUCTIONS
1) Design an experiment to measure the ratio of the magnetic field strengths B1 and B2 as accurately as possible.
2) Give a brief theoretical argument indicating how to obtain this ratio from your measurements.
3) Carry out the experiment and determine the ratio.
4) ESTIMATE YOUR EXPERIMENTAL ERROR.
LIFE IN THE F.A.S.T.S. LANE

by Ken Baldwin, Research School of Physical Sciences A.N.U.

Ken Baldwin gives a personal account of the recent A.G.M. of the Federation of Australian Scientific and Technological Societies and examines the directions that Science Policy is taking.

The fact that the president of the Federation of Australian Scientific and Technological Societies couldn't get the National Science and Technology Centre's audio system to work didn't seem to bother the delegates at the annual general meeting on November 5th. They had more important issues to worry about.

Professor John White of the ANU's Royal Australian Chemical Institute crystallised the situation. He pointed out that FASTS is now entering a watershed in its short and controversial history. It is no longer simply the strident voice of the nation's scientific community reacting to ill-advised and short-sighted government policy. FASTS has managed to turn the heads of Ministers and at least has them mouthing the right words, even if not following the right actions. A period of alternate praise and chastisement has been entered into, but with no definite plan or direction. In Professor White's words, now is the time to become "pro-active".

Not that FASTS has been inactive. Tony Wicken outlined FASTS recent contributions in his President's report: the separation of the Department of Science from Customs and Small Business; the improvement in the number and awards of postgraduate students; the recognition of the need to support outstanding young researchers via Australian Research Fellowships.

However, FASTS cannot claim all the credit for these achievements, and there is a perception that its influence has waned in recent times. Indeed, it has become embroiled in controversy over the recent ARC Chairman's appointment as was described by Executive Director David Widdup. While the Minister may have not wanted a ranking of the short list of candidates, that is what he got, with a clear message to that effect via DEET representative Gregor Ramsay. The fact that both parties chose to ignore the wishes of the other was then blown up by the press to imply that Dawkins was going against the recommendations of FASTS whose advice he had sought. Never in any of this was there any criticism of the successful candidate or his appointment, just a collision of barrows being pushed. DEET's won.

The increasing power of the bureaucracy to influence science policy and to take it out of the hands of the scientists was brought out in an address by a factotum from DITAC. It wasn't so much what he said (which included a lot of moonshine statements) - it was the way he said it. Included were words like framework, strategy, formula, mechanism - words which left the impression that if only the government could put together the right machinery for research success, then it could turn the handle like a sausage factory and crank out the economic miracle which had replaced socialism in its ideology.

For all that he was a pleasant enough and thoughtful young man, I talked to him in the break and tried to persuade him that genius, inspiration and (wash my mouth out) serendipity could not be prescribed in a formula which delineated lines of research in the National Interest. Oh, but that was allowed for in the part of the mechanism that allowed scientists to run fundamental research by peer review. Which bit was that again?

There are worrying moves afoot (apart from the controversy over the appointment of the ARC Chairman) to place a greater stranglehold of bureaucratic influence over the Council itself. DEET and/or the Minister have been manoeuvring to remove the members of the scientific disciplines panels, and replace them with externally appointed members such as the Chief Scientist and the Chairman of CSIRO. This would break the nexus between the discipline panel and their representation - or rather their very existence. It was said that Professor Slattery himself does not feel it appropriate for him to sit on the committee (for which reason he also proposed that the ARC and the Cooperative Research Centre funding would be completely separate). However, even Blind Freddy can see that kite flying exercised like this by DEET are but the thin edge of the wedge for bureaucratic control over even basic research.

So back to being pro-active. FASTS needs to set in place a strategy that will ensure that the environment for learning and research become a part of Australia's culture, and that more people are attracted to this pursuit and are adequately rewarded for it. But before we do that we also need to tidy up our own act a bit, and this includes getting back the Science Teachers Association into the FASTS fold. For that matter, the duplication of membership by cognate societies needs to be sorted out in such a manner that everyone is getting value for the money out of FASTS. The AIP and its cognate societies could well consider joining with the RACI to form an umbrella Council for the Physical Sciences, which could then coordinate strategy for discipline reviews in this area (as for, example, has been done in mathematics). Indeed, such a Council could help determine the constitution and agenda of discipline review committees, rather than (as in the past) fight a belated rear-guard action.

Such pre-emptive action may be necessary sooner than you think. The representative from DITAC revealed that a White Paper was being planned for next year in which research priorities for the nation's development will be set for the next four years. The first stage, the canvassing of issues, has already been approved, and FASTS has the opportunity to ensure that these national priorities do not cut across the need to retain a strong base of fundamental research. Not only should this pro-action be directed at the bureaucrats and the government - it should be bipartisan and should involve industry and the community at large.

A tall order? Perhaps, but if we don't back our only lobby group in the coming years, we have only ourselves to blame for the deterioration of our research environment. Otherwise FASTS may not need a microphone at future AGMs, they may be held in a telephone box.

Ken Baldwin is a research fellow at the Research School of Physical Sciences, A.N.U., and is secretary of the A.C.T. branch of the A.I.P.
Yanchep, Silk, Foley, Jory and Ramsey

The WA Branch has had a very busy four weeks indeed starting with the third biennial Yanchep Postgraduate Research Conference held on September 24, 25th at the Yanchep Inn north of Perth. (See also Australian Physicist, April 1990, p57) and concluding with the public lecture by Professor Norman Ramsey on October 22.

The third Yanchep Conference was a great success, with approximately 38 attendees from the UWA, Curtin and Murdoch campuses and 17 talks given on a variety of subjects leading to formal and informal discussion. Presentations by students from Murdoch discussed recent work on amorphous silicon films, atomic physics and scanning tunneling microscopy, while those from Curtin covered various aspects of remote sensing, X-ray powder diffraction, and seismic data analysis. From UWA, work on sapphire clocks, time-dependent effects in superconducting and magnetic materials, (e, 2e) spectroscopy, gravity gradiometry and spin polarised electrons was presented. On the first evening, Tom Lyons from Murdoch, in an after dinner talk, gave an engrossing description of the work done on modelling air turbulence near the Darling Scarp, including a discussion on the importance of this phenomenon for aircraft using Perth airport. After dinner the more ‘senior’ participants retired to their rooms where, from a distance, they were scrutinised for many delightful hours on the piano.

Speakers and the titles of the talks were as follows, the first named (student) author presented the paper in each case:

- Low Field Flux Creep
  N J McDonald, A G Mann & F J van Kann (UWA)

- A Study of Gold Surface Using STM
  N Hindarto, Murdoch U

- Microabsorption Influences in X-ray Powder Diffraction
  A Zyldek, Curtin U

- Effect of Annealing on Hydrogen Bonding in Sputtered a-Si:H Alloys Studied by Infrared Absorption and Thermal Effusion
  G Talukder, J C L Cornish, P Jennings, G Hefer, C P Lund & B W Clare, Murdoch U & J Livingstone (UWA)

- Assessment of Texture by X-Ray Powder Diffraction Pattern-Fitting
  H Sitteu (Curtin U)

- Surface Analysis Studies of a-Si:H Films & Their Properties
  C Lund (Murdoch U)

- A Model for Estimating the Hourly Diffuse Radiation from Hourly Global Radiation on a Horizontal Surface in Western Australia
  A A Lim, P J Jennings & T L Pryor (Murdoch U)

- Atmospheric Corrections to the Remotely Sensed Normalised Vegetation Index
  P M Matala (Curtin U)

- Investigation into the Intensity of W Tropical Cyclones using Data from the NOAA Series Polar Orbiting Satellites
  J L van Burgel (Curtin U)

- Felix Bloch, Spinning Tops and the Sapphire Clock
  A J Gilles, D G Blair & M J Buckingham (UWA)

- Pseudostate Methods in Atomic Scattering
  T Wintara (Murdoch U)

- Spin Polarised Electrons
  I Humphrey (UWA)

- Mobile Gravity Gradiometry: Why and How
  R Matthews, F J van Kann, M J Buckingham, M H Dransfield, C Edwards, A G Mann, R D Penny & P J Turner (UWA)

- Seismic Data Processing Systems - Installation, Evaluation and Customization
  M Hill (Curtin U)

- The Magnetic Viscosity of Rare Earth Magnets
  L Folks (UWA)

- Optical Properties of Amorphous Silicon Thin Films
  S Sidopeko (Murdoch U)

- Land Degradation Studies using Remotely Sensed Data
  C E Rustana (Curtin U)

- Trace Gas Signatures in High Spectral Resolution Radiance Observations
  P vanDelft (Curtin U)

A visitor to ANU/Mount Stromlo, Professor Joseph Silk of Berkeley made a brief trip to Perth sponsored jointly by the WA Branch and by UWA as a Distinguished Visitor to the Physics Department. In a well attended (100 plus) evening public lecture on 9 October, with the title “The Big Bang and Galaxy Formation”, he reviewed our knowledge of the history of the universe from 1990 back to the big bang. As far as the physics is concerned, we can simulate in the laboratory and test conditions back to the age of the universe about one year, from there back it is more speculative. In a beautifully lucid presentation, illustrated with superb transparencies, the speaker presented evidence, from the motion of spiral galaxies and other observations, for the presence of large amounts of “dark” or “unseen” matter and its implication for a closed or open universe. In a well filled few days Joe also presented a Physics seminar and managed to see our West Australian wildflowers at the peak of a bumper season.

The Annual WA Branch Youth Lectures were delivered on October 16, 17th to adequate (80-100 each night) though disappointing audiences of Year 11 and Year 12 students. Our lecturer, Dr. Catherine Foley of CSIRO Division of Applied Physics, Sydney, used the double significances of her title “Are You Mad to be a Physicist” as a lead in to examining the stereotype of a physicist, then to look at some simple though interesting experiments in electromagnetism, to show how these basic phenomena impinge on her own areas of research in glassy metals, neodymium iron boron magnets and high T, ceramics (also illustrated by experiments) and finally to a discussion of a career in physics as she personally had experienced it.

The conclusion one drew was, that far from being mad to be a physicist, there was a very real excitement and a fully rewarding career to be had in return for the investment in the effort needed to graduate into the profession. On both nights Cathy was swamped with many interesting questions and comments and discussion after the lecture. All those attending seemed to be swept up by her enthusiasm and the group who had made the trip from as far afield as Busselton (270 km away) I am sure had much to talk about on the long, dark drive home. D>
WHAT PHYSICISTS CAN DO FOR SCIENCE TEACHERS

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I was recently asked to address an audience of academic biochemists on "What can wimps do for Australian Science Education?". In the event it seemed to be clear that the wimps were the academic scientists who, collectively and individually, prevent the science they know and practice being shared with undergraduates and with the students in Australia's schools. I will argue in this paper that Australian academic physicists also often warrant this title.

The constraints that such academic physicist impose on school physics, and on science more generally, were understandable and perhaps even excusable when secondary education, and particularly the serious study of the sciences in it, was restricted to a small minority or elite group who were interested in proceeding to university for further studies in medicine, engineering, science, and other science based faculties. Since the early 1970s this has not been the case in Australia. As the 1990s begin, more than two thirds of each age cohort will complete full secondary education and there is a desperate urgency to make science education at school more inclusive.

Firstly, the serious study of the sciences, as exemplified by the physical sciences in the final two years, has not kept pace in popularity terms with the increased retention at school. Secondly, physics, in particular, is unattractive to girls, and thirdly, large numbers of the too few students who do study science seriously at school are simply using it as the means to move into studies in the highly competitive faculties of law and business.

Compared with the early 1970s when about a third of the graduates in science and mathematics went into school teaching, less than ten percent of these graduates from university faculties of science are now considering teaching and those that are, tend to be among the less distinguished of the graduates.

In the face of such a gloomy scene, we could have expected to find academic scientists leading the reforms of school science curricula that are now underway as they undoubtedly did in the 1960s when the last major reforms occurred. Instead, it is rare to find academic scientists in the front lines of these current reforms and it not uncommon to find them resisting, with all sorts of techniques, the various suggestions that would make science at school more meaningful, attractive and worthwhile for students.

A recent look at the science education of science teachers

The National Disciplinary Review of Teacher Education in Mathematics and Science, 1988-89, had included in its terms of reference the science education of teachers as well as their education for teaching. Accordingly, the Review Panel had to address how they, as essentially mathematics and science teacher educators, could usefully and credibly review what was going on in mathematics and science in Australia's 52 institutions producing teachers.

Methodologically, three main sources of data or information were used. The first were the course handbooks and print details that the Review’s liaison person in each institution was able to deliver to the Panel. The second were the science staff members to whom the Panel had access for a substantial discussion during its two day visit to each institution. Usually these staff included spokespersons from the major science departments, although in a few institutions some of these departments were conspicuously absent. The third source were final year science students who had, and had not chosen, to prepare for teaching.

Science teachers in secondary schools in Australia are expected to teach one or more of the science disciplines in the later years of schooling. Up to Year 10 (and probably soon beyond that level), however, these same teachers are required to teach science in courses that draw from at least chemical, physical, biological, and earth science. The expectations about the teaching of science, on which the various state science curricula for these levels in Australia have been portrayed and continue to be based, require a more integrated approach, than is the case in many other countries.

These requirements are described in Australian teacher education scene as the "depth/breadth" demands, and it is in these terms that they have an obvious translation into the structure of the courses in science universities and colleges provide.

The Review found that most of the science courses that future secondary teachers take did require three years of study in one of the science disciplines or in an applied science such as agriculture or environmental studies. There was, however, a considerable discrepancy between the amount and hence the quality of this major science that was studied. At the bottom end of the range of "amount" were a number of the CAs that had their origins as teachers colleges. It appeared that these institutions have timetables that are controlled by a perspective that relates to senior secondary school time tables or to an Arts type of faculty. That is, each subject, regardless of its learning demands, has the same allocation of the students' timetable.

There was not a counterpart in these institutions to the pattern of increasing concentration on the major study as the three years of a course progresses that is common in university science faculties. Accordingly, and because of deficiencies in >
the sort of the learning these time constraints imposed, the Panel recommended that all secondary teachers include one major study of a science discipline that is made up of at least 1/4 of first year, 1/3 of second year, and 1/2 of third year.

With respect to the "breadth" demand, on the other hand, the courses in these former teachers colleges were more likely to require students to include some studies in the four fields of science above together with mathematics. The science degree courses in universities rarely encouraged the breadth of studies described above, but a number were structured in a way that would allow it. One recommendation of the Review addressed to deans of science, asks them to review the structure of their degree requirements to ensure that it is possible for the depth/breadth demands to be met. Another asked them to publicise the desirability of the breadth option for any students who may want to contemplate teaching at some stage.

In addition to such structural and advisory support, there is the question of how a future teacher can gain benefit for teaching from one or two units of study of a science discipline. The Panel was struck by the existence in a number of institutions (but by no means all) of well designed single units (semester or year long) that provided an overview of the fields of biological or geological sciences. These units introduced students to the central perspectives these sciences represent, to some of the major questions that have been and are being asked in them, and the concepts and methods of investigation that have been invented to answer them. There was almost a complete lack of any such units in chemistry and physics. The usual first year units in these disciplines equip future teachers with only a very inadequate base from which to portray these sciences as a whole to their future students.

**History and philosophy of science**

The Review was confronted with a major dilemma with respect to both the history and more explicit philosophy of the sciences. Apart from isolated lecturers and the rare occurrence of assignments that identified the contributions of a particular scientist to physics or chemistry, the Panel found almost no historical or philosophical emphasis in the undergraduate teaching of the sciences in Australia's institutions of higher education. This situation appears to have persisted for more than 30 years so that almost no present science teachers have learnt these dimensions of science through their own study of science. A few have acquired them through the separate study of subjects like History and Philosophy of Science, that may have been possible as part of their degree or subsequently through their own initiatives. Academic physicists urgently need to re-approach this disregard in their teaching of an explicit treatment of the nature and origins of their own science.

**General concerns**

School science curricula for the 1990s in Australia (and quite generally overseas) have a number of emphases that distinguish them from the curricula that were introduced in the 1960s and 1970s and have only been tinkered with through the revisions in the 1980s.

These emphases are (i) a concern for better quality learning, (ii) an interest in more socially meaningful science, (iii) recognition of the relationships between science, technology and society, (iv) an appreciation of the variety of ways scientific investigations can contribute to solving problems of interest to the scientific and general communities, (v) a concern for environmental issues in Australia and globally, (vi) a desire to include groups of students (particularly girls) who have not been substantial participants in science education and (vii) the potential that computers in schools offer for better teaching and new sorts of science learning.

These distinctive emphases in the new curricula are a response to demands society has been and is now putting on schooling and to the very considerable body of research findings that now exist about science education in schools. The former are evident in the terms of reference of numerous reports and enquiries during the 1980s in Australia. The 1986 report of the Technology Task Force of the Australian Education Council, and the National Disciplinary Reviews of Engineering and of Teacher Education in Mathematics and Science for the Department of Employment, Education and Training (D.E.E.T. 1988a, 1989) are examples. The Australian Science and Technology Council set up an investigation into the capacity of the school system to meet the needs of the nation's economic strategy (ASTEC, 1988). In 1990, the recently formed Science Council devoted most of its second meeting to the topics of science and mathematics education in schooling as it saw these areas of the curriculum as vital for Australia's good health as a nation in the years to come (Science Council, 1990).

The Schools Commission's report in 1986 highlighted again a concern it had had for more than a decade that girls are not participating as much as boys in those sciences that open up career prospects in science and technology. (Schools Commission, 1986). This led to the adoption nationally and in a number of states of a policy statement on Girls and Science Education (A.S.T.A. 1988) and a further expression of concern by D.E.E.T. (1988b). If these emphases are to be translated into the learning experiences that Australian students have in science in the 1990s, the pre-service and in-service education of Australia's teachers has much to contribute. These contributions will require more than recruiting campaigns that lure girls at school into the study of physics in Senior Secondary School and in University Science faculties or entice biology teachers to retrain in physics. Changes in the contextual presentation of physics have been tried with success in a number of countries and some quite different approaches to teaching are beginning to be used in Australia (1989). The maintenance of a supply of well equipped new teachers into the system of schooling will become increasingly important in the later 1990s as the size of the secondary age group continues to expand again and as more existing teachers start to retire from the service.

What aspects of science learning and of science education for teaching can enable teachers to gain the knowledge and skills they will need if they are to include the old and new emphases of school science curricula in their pedagogical contributions to students? Some of the new emphases relate more heavily to the science education component of teachers' education. It is well known, however, that the experiences of teaching and learning that Australia's secondary school teachers get in the science component (70-80% of their initial education) of their higher education has a very strong socialising and normative effect on the way teachers view and teach science. Accordingly for the emphases (i), (vi) and (vii) above for which science educators are largely responsible, their efforts will be more successful if their future teacher students have experienced in their own tertiary studies of science some of the teaching/ 

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learning strategies that lead to quality learning, that recognise gender inclusiveness in science, and that involve computers both as teaching and learning tools as a means of defining some of the ways physicists are now thinking and acting.

As this paper is addressed to physicists, the science component of undergraduate education is the part to be discussed in more detail. Emphases (ii) (iii) (iv) and (v) above are those that relate more substantively to that component.

The Panel for the review of teacher education in mathematics and science did gather quite considerable information about science courses in higher education. It was conscious that since science teaching is now much less a career option for university science graduates than it was in the 1970s (when as many as 30 - 40% of university graduates in physics became teachers), it was not reasonable (apart from the teacher education CAEs) to expect science courses to include aspects of physics that are of specific interest to its teaching in secondary schools.

There have, however, been several recent listings of competencies that industrial and other non-academic employers are seeking in science graduates. These are additional to their interest in, and expectation of a solid core of up-to-date knowledge in a science discipline(s) of the sort that the three year B.Sc. degree generally provides in Australia. It is common to find initiative, breadth, capacity to develop inventiveness, communication, skills experience and team work in these lists. Some of these competencies bear an obvious relation to some of the new emphases in school science curricula, and so would also be very helpful to those graduates who may on graduation or later in their careers move into school teaching.

The Panel thus sought specific information from science departments (from course details and handbooks, and from staff and student, departmental representatives during visits to the institutions) about the presence and extent of the following aspects that are teaching and learning that contribute to these human competencies in science.

1. Nature of scientific investigation
   When, if ever, did the undergraduate students have to 'design and carry out an extended investigation into a problem? (As distinct from spending time doing prescribed practical experiments.)

   When, if ever, did the students have to consult and extract data and information from the original literature in their chosen fields of science? (As distinct from referring to textbooks or recommended reference book in the library.)

   When, if ever, did students receive instruction in, and have to practice communicating science (their findings and others) to scientific and non-scientific audiences? (As distinct from answering questions on examination paper or writing up standard practical work.)

2. Technology and Science
   What examples (if any) of the applications of physics in society or technology are studied in detail and when?

   In what ways and when is technology (including computers but not only computers) used to facilitate teaching and learning of physics?

   What new content, if any, has been introduced in physics because computers are now available?

3. Australian Content
   In what way, if any, are students made aware of the Australian-ness of some physics and of the importance of its fields to Australian society?

Findings

In general, the physics courses in Australia's universities and C.A.E.s scored (degree of presence and earlier rather than later years of undergraduate degree) on these indices as follows:

- Geology > Biological Sciences > Chemistry/Physics Courses
- Physics in Applied Science Courses, (including Agriculture) > Physics in Pure Science Courses
- Physics in C.A.E.s (with Applied Science) > Physics in Universities/C.A.E.s (with teacher education)

There was little change in this general order for any of the rather different aspects described above. University courses were not, for example, better on the measures of the Nature of Science than those in C.A.E.s. The C.A.E.s that now produce Applied Science graduates in addition to secondary teachers usually scored better than those that were devoted more exclusively to teacher education. These latter were more like universities with respect to most of these aspects but, as mentioned above, the amount of physics content in one of their major studies was considerably less. A few university courses were exceptions to the generalisations above, but even in these the exceptions were confined to individual lecturers and seemed not to be part of a coherent approach by the department.

The science staff in both sorts of C.A.E.s were more conscious of the sort of graduate they had in mind in making decisions about the science content of their courses. University staff fumbled over this question of the graduate-in-mind although in discussion of it the answer emerged that it was a research scientist. This type of outcome graduate relates to only a small fraction of the undergraduate students in any of the universities we visited. However, such a graduate-in-mind does explain the curriculum decisions that were made to delay individual investigations in physics and access to its original literature, and to leave the skills of scientific communication, computer instruction, and topics like modelling, to the individual education of postgraduate research students in their fourth and subsequent years of physics study.

Issues like gender and physics, and the use of computers in physics had much less attention in the curricula of all these tertiary science courses than they are being given by ministries of education through their curriculum support services. Physics departments in general saw gender issues at best in recruiting terms and not, as in the case in schools, as essentially curriculum issues. Although most institutions now have equal opportunity officers we saw little of them during our visits and they are being kept well away from the curriculum of higher education. There seemed to be little professional development available to assist staff in general to use computers in teaching and learning and few new topics in physics had been introduced because computers are now available.

Prerequisite knowledge

One helpful thing that academic scientists could do for school science education is to address themselves seriously to the issue of pre-requisite knowledge.
WHAT PHYSICISTS CAN DO FOR SCIENCE TEACHERS

Traditionally university scientists have assumed that their incoming students will have studied physics, chemistry and mathematics in the last two years of schooling. Studying biology for two years is, conversely, essentially ignored or discounted even for students going on to majors in the biological sciences.

Biological science study can begin at university but there has been strong resistance or reluctance to do this for chemistry and physics even though, in Australia, 'the horse has now bolted'. Insufficient numbers of students with high achievement in these subjects and mathematics at school are now choosing tertiary science studies. Further more, the quality of senior secondary physics and chemistry that students will bring from schools is, judged by traditional content standards, becoming more and more dilute as science teachers try, with optional topics and less quantitative and laboratory based science, to interest and attract into their classes the quite different young people who are now at school.

These teachers at secondary school would be helped by the specification by staff in higher education of a core of learnings in chemistry and physics that are both central to the understanding the sorts of physics topics that are known to appeal to young people (see Jorg and Wubbels, 1987), and that are a useful basis from which university scientists can begin their teaching. The specifying of this list of learnings is a quite different task from simply saying we assume 'Years 11 and 12 of physics' etc. The task will need to recognised that the list itself must not require more than a fraction (say 50%) of the traditional teaching time in the last two years that has been hitherto been assumed as available for physics. It must also be specific enough for it to be offered in intensive bridging courses of say one semester to students (from school or in mature age) who have not, for various reasons, achieved these learnings previously. One very successful course, designed on the basis of these ideas about prerequisite learnings has recently been described (Mitchell, de Jong and Brown, 1990).

I suspect that a number of the pre-requisites that academic scientists really need are more to do with the ways physicists and chemists invent concepts and use language, symbols and formula to describe the quantity phenomena, and less to do with repeating the extensive but superficial sets of facts, principles, and skills of low level application of algorithms, that have traditionally made up the last two years of Australian school physics and chemistry.

Conclusion

In summary then there are four things that physicists can do for science education.

Teach for understanding - not merely recall;
Teach the nature of science - not just its outcomes;
Teach the physics of technologies - not just physics without applications or with superficial reference to technological applications;
Set out prerequisite learnings in physics - not prerequisite subjects.

References


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Death of John (Bell's Theorem) Bell

John Bell, who died in October, in Geneva at the age of 62, will be remembered as the physicist who demonstrated how to measure the strange interconnectedness of quantum particles that are widely separated in space.

What Albert Einstein had referred to as spooky action at a distance, and refused to accept, Bell put on a secure mathematical footing in the mid-1960s.

In the early 1980s, Alain Aspect and colleagues in Paris actually measured the Bell inequalities for pairs of photons flying out in opposite directions from a particle event, and proved that their properties were correlated in the way that quantum physics requires.

Although Einstein did not like it, Aspect and his team showed that the phenomenon of spooky action at a distance is real, and that two particles that were once part of the same interaction are forever after interconnected in the same way.

Bell, an Ulsterman who worked as a lab assistant at Queen's University in Belfast before taking his first degree, spent the past 30 years based at CERN, in Geneva, where as well as investigating fundamental problems in theoretical physics he contributed to the design of particle accelerators. He visited Australia and gave several public lectures in 1982.

John Bell will be particularly remembered in Australia for his visit and the series of public lectures he gave in 1982. The clarity and intellect he brought to physics will be sadly missed.
OBITUARY

BETTY LOUISE TURTLE (1941 - 1990)

Louise Turtle died peacefully at her home in Paddington on September 29, 1990, after a long illness. Louise was a prominent member of the Australian astronomical community, recently serving as Head of the Department of Astrophysics and Optics at the University of New South Wales.

Following an undergraduate career at the University of Adelaide, Louise Webster (as she then was) became one of the early students in the graduate school in astronomy at Mt. Stromlo. Under the enthusiastic directorship of Bart Bok, Louise worked with Bengt Westerlund during her doctoral studies. Her thesis was on Southern Planetary Nebulae, a topic in which she retained an active interest through the whole of her career.

After graduating with her Ph.D. degree in 1967, she held an instructor position at the University of Wisconsin, U.S.A., before becoming a Scientific Officer and then Principal Scientific Officer at the Royal Greenwich Observatory, Herstmonceux. There, she worked initially with Sir Richard Woolley. Later, with Paul Murdin, she made the exciting identification of the x-ray source Cygnus X-1 as a possible black hole. This source is still regarded as one of the most plausible black hole candidates. Part of Louise’s time with RGO was spent at the South African Astronomical Observatory, and a further part as a Commissioning Astronomer with the Anglo-Australian Telescope Project Office during the period when the 150-inch was nearing completion.

In 1978, she was appointed to the staff of the School of Physics at the University of New South Wales, where she served for the remainder of her career. Louise took a leading role in establishing the University of NSW as an important centre for astronomical research. As well as continuing the work on planetary nebulae and abundance gradients for which she is best known, she played a key part in the development of the Automated Patrol Telescope. Situated on Siding Spring Mountain, this telescope was opened in 1989. Louise provided the main astronomical guidance on this project, and was tireless in her efforts to obtain funding, to clear bureaucratic hurdles, and to bring the project to fruition.

As a physicist, Louise was exceptionally good. Her gentle and self-effacing manner occasionally led people to underestimate her - but not for long. At a time when we all would like to see more women in Physics, the University of NSW was uniquely blessed to have Louise on the staff. Anyone clinging to the old-fashioned idea that physics is a male preserve found this view utterly untenable in the face of Louise’s personal example.

Louise was keenly interested in teaching and in the welfare of her students, and did much to promote astronomy to young people. Her development of a fourth-year honours course in astrophysics did much to encourage several University of NSW students to pursue careers in astronomy. This course remained one of the most popular fourth-year electives for all the years that Louise taught it.

Another innovation was the development of a Liberal Arts astronomy course at early undergraduate level. Although this type of course was new to Australia, it was quickly successful and is still one of the most popular courses of its type at UNSW. It has served as a model for several similar classes, and has inspired a love of astronomy in hundreds and hundreds of students.

Louise will be remembered as a person of the utmost integrity, always completely fair and always dependable as a person of great common sense. Because of these qualities she was much in demand to serve on various committees both within the School and in the wider University context. The more delicate or difficult the issue to be resolved, the more grateful we were people to see Louise on the committee.

Her services to the astronomical community during this time have been constant and unselfish, and all of us working in the field of astronomy in Australia have benefitted from her efforts. A member of the International Astronomical Union (IAU) and the Astronomical Society of Australia (ASA), Louise was also a former fellow of the Royal Astronomical Society. She served a term on the Council of the ASA, and on the time allocation committee.

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for Parkes, the Anglo-Australian Telescope and Mount Stromlo.

In 1983 she played a leading role in the organisation of the Annual General Meeting of the ASA, bringing this conference to the University of NSW for the first time. Later, she chaired the Scientific Organising Committee of the Fifth Asian-Pacific Regional IAU Meeting, before ill-health forced her to step down. Both meetings were important chapters in Australian astronomy, and the structure that Louise put together for each ensured their success.

Another important gathering which Louise was largely responsible for putting together was the 1988 ANZAAAS session The History of Astronomy. This session, which was Louise’s idea, brought eight eminent Australian astronomers together to present their views and be recorded on videotape for posterity. Sadly, the videotapes do not include Louise herself, her characteristic modesty keeping her behind, rather than in front of the camera.

It was largely at her initiative that the ASA established an annual award for the best undergraduate project of an astronomical nature. This award, the Bok medal, is named after someone who was also a great encourager of talented students. One of these students whom Bok encouraged was, of course, Louise herself.

Louise was married to Tony Turtle in 1978, although she retained the name Webster on her published papers. Their marriage was a source of delight to all their friends. Following the birth of their son, Michael, in 1980, Louise managed the dual role of mother and physicist with characteristic aplomb.

Her strength, courage and cheerfulness during the years of her illness have made a lasting impression on all who have known her. At no time were these qualities better shown than when she attended the dinners of the two international conferences held in Sydney during last July. Although the physical effort that her involvement required was obviously very great, she was, throughout both occasions, her usual cheerful self. It is a mark of the respect in which she is held that a great many of her Australian and overseas colleagues took the opportunity, at the second conference, of paying tribute to her work, and to her life.

With the passing of Louise Turtle, Australian astronomy has lost one of the most highly respected members of our community - an excellent astronomer, a valued colleague, and a greatly loved friend.

J.W.V. Storey and D.J. Faulkner
University of New South Wales

PRODUCT NEWS

**Dual-Beam Photometer and two box coaters**

Leybold Ltd. is displaying two Box Coaters designed for the precision optics market, the new A924 and the well established L560 with integrated ellipsometer.

The A924 uses advanced software in the Leycom IV Microprocessor Controller to ensure reproducible ultrahigh quality. Also on display are the OMS3000 Dual-Beam Photometer for absolute measurement of thin-film transmittance or reflectance, the ES550 Electro-Beam Gun with rotary water-cooled multipot crucible plate, the IQ170 RF-induced Ion-Beam Gun, the OGC1 Partial Pressure Controller and the OX2000 Residual Gas Analyzer.

For further information, please contact Javac Pty Ltd.

**Leybold solves thin-film problems in R & D Labs**

The L560: the right tool for “state-of-the-art” applications. More than 200 of these systems worldwide give us, and you, a superior experience in thin-film R & D for:

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For further information please contact Javac Pty Ltd.

**Computer for thin films**

Leybold Technologies Inc. is offering Leycom AG’s Leycom IV computer for control of evaporation processes in the production of optical thin films.

Using the Leycom IV Dialog-mode Automatic Process Controller for high vacuum evaporation systems, 1280 process steps are programmable, and 80 evaporation materials and 160 types of layers can be stored. The Leybold IV offers extensive user communications features including a display terminal that lists all essential system and processing-status parameters, and menu-driven software and on screen operator prompting. Simple operation is by a cleanroom-compatible membrane keypad.

For further information please contact Javac Pty Ltd.

**New Small Frame Argon Ion Laser offers high U.V. Power**

Coherent will introduce at OPTICON '90, in Boston, Massachusetts, a new Ion Laser System - the Innova-328. The Innova-328 is the newest member of the Innova-300 family - the new generation of intelligent laser ion systems by Coherent.

It is designed specifically to provide high UV powers from a small system. The Innova-328 provides a 1 watt multiline UV output from a small frame laser (1 metre cavity) and uses sealed mirror technology. This design reduces breather window power losses, reduces cavity cleaning requirements to two optical surfaces, provides polarised output with mode control, and is fully compatible with Powertrack (patent number 4,939,759) - Coherent’s actively stabilised optical cavity.

For more information please contact Coherent Scientific.

**Mode Locked Titanium:Sapphire Lasers**

Considerable interest in ultrashort pulses in the 800-900nm range, from mode locked Ti:Sapphire lasers, was generated by a number of reports presented at this year’s Ultrafast Phenomena Conference. These reports described an extensive array of mode locking techniques which have been used to produce a range of pulse durations, output powers and stability levels.

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Laser eyewear from Coherent Scientific

As the recognised leader in ultrafast laser technology Coherent is continuing to extensively investigate the commercial product potential of all of these techniques as well as developing several novel techniques. For more information please contact Coherent Scientific.

High Quality Laser Eyewear

Coherent Scientific has recently been appointed as Australian distributor for LaserVision GmbH, the German manufacturer of high quality laser eyewear.

LaserVision has a range of standard products suitable for the common laser types, such as Nd:YAG, CO₂, Argon, Helium-Neon etc., as well as offering the capability to design and supply specialised products for more unusual applications.

Unlike conventional products, LaserVision's eyewear offers good luminous transmittance for good visibility, scratch resistant lenses and good peripheral vision.

Perhaps more importantly, LaserVision's comfortable frame designs mean that they are more likely to be worn more of the time.

For more information on these products please contact:
Norman Jones or Paul Wardill at Coherent Scientific Pty Ltd,
138 Greenhill Road, Unley,
South Australia 5061
Tel: (08) 721 4755 Fax: (08) 271 1202

AIP News

Continued from page 271

We thank Cathy for the time and effort she put into making the trip across and her excellent presentations - as always the demonstrations were assembled and went off smoothly thanks to the devoted efforts of our Physics Senior Teaching Technician, Lance Maschmedt, who is always a tower of strength for our functions at UWA. Australian Airlines generously donated Cathy's fare and this was a very real help for our budget. Their support on this and other occasions is valued and much appreciated.

The Physics Olympiad was the subject of an evening lecture by Associate Professor Rodney Jory of ANU and University of Canberra. He was joined by Caroline Montgomery and Peter Simpson, both of All Saints College, who are coaching students in Physics and Chemistry respectively in the Olympiad programs. Rod Jory is well known as the organizer of the National Science Summer School and coordinator of the Australian Olympiad teams and in his lecture he presented a detailed insight into the workings of the program and training sessions which precede it. He paused at times for comment and informed opinion from Brett Myers (Rossowyn Senior High School) who was a WA representative to the Physics Olympiad in the Netherlands earlier this year. We thank Rod and the other three participants for making the evening such a success for all who attended. The enthusiasm of the teachers involved and the students who participate is to be marvelled at and provides much food for thought to all involved in education.

"Time and the Physical Universe" was the title of the public lecture presented by Professor Norman Ramsey of Harvard University, 1989 Nobel Laureate and AIP visiting lecturer, on the evening of 22nd October. A large crowd, in excess of 100, heard the speaker explain how the measurement of time had improved by at least 20 orders of magnitude over the last 2000 years as we progressed from the use of simple waterclocks or hour glasses to the present day hydrogen maser. He went on to discuss the many applications of the present day super accurate time pieces from the esoteric tests of general relativity to the very practical very long baseline interferometry (VLBI) and its application to geodesy and earthquake prediction. Professor Ramsey's lecture elicited a number of questions which in the answers further demonstrated his enormous and varied experience.

This was a fitting lecture to conclude the 1990 WA Branch "season", there remains only the AGM next month.

Attendance at WA Branch 1990 lectures has been very good, usually in excess of 50 persons, and we attribute this in part to a policy of advertising in the "Suburban Post" newspaper where talks have had other than specialist impact and making them all, in effect, public lectures. Post Newspaper advertising is relatively cheap ($50-$60 for a good sized ad), covers a large and relevant area geographically and supplements the notices to members and advertising through University networks. We recommend this approach to other Branches; we find the members of the public who come are interested, go away informed and seem to come back for more!

Severin Crisp

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Prompt Critical

Buy a Book of Catastrophe for Christmas

"Comets in Collision" is the title Immanuel Velikovsky might well have chosen for the latest scientific blockbuster "The Cosmic Winter". It is, in fact, the book Velikovsky might well have written had he been trained as an astronomer rather than a psychiatrist. But maybe I am doing the authors of "The Cosmic Winter", solar system astronomers Victor Clube and Bill Napier, somewhat of a disservice by as much as mentioning Velikovsky's name, because they have succeeded brilliantly where the planetological psychiatrist failed.

Velikovsky's scenarios of planetary chaos were crude contrivances with no dynamical foundation, devised to provide a modern explanation for the enigmatic descriptions of ancient celestial and terrestrial upheavals which abound in the bible and the lore of various other religions and mythologies. Clube and Napier, on the other hand, provide a wholly convincing explanation for the many catastrophes of antiquity which have so luridly coloured the historical record from all corners of the globe. Modern men tend to downplay these events as fictions of religious ecstasies, a most unwise attitude because Clube and Napier closely tie their thesis to the latest research discoveries in the geosciences.

In brief, Clube and Napier show that cometary intrusions, under the influence of galactic forces, periodically expose the Earth to bombardment by hundred-kilometer-size masses of primordial material and swarms of lesser missiles. They can set alight whole continents, trigger ice ages and global warming, cause major species-extinctions, interrupt plate tectonics and even reverse the Earth's magnetic polarity. The evidence is most persuasive because of its scientific coherence and because of the illumination it throws on so much of the history of civilization.

The most startling revelation, to all of us conditioned to the apparent stability of celestial affairs, is the identification of the Taurid meteoroid complex as the current threat to the world. At any moment an impact equivalent to a hundred hydrogen bombs could wipe out several states or small countries and trigger a nuclear reprisal to complete the annihilation. The Tunguska event of 1908 was just a sampler. And don't forget the estimate that ninety-five percent of the Apollo Earth-crossing asteroids have yet to be discovered. We only have a short reprieve after a few months ago Clube and Napier urge a thorough search for all cometary asteroids in Earth-crossing orbits in order to give some hope for deflecting the path of the more threatening ones. It is interesting to note that Duncan Olsson-Steel of Adelaide University has recently submitted a new search.

"The Cosmic Winter" is an instructive reading for all who concern for the future of the human race. It is not sensational. Just scary in a thought-provoking way. The writing is clear, but there are some lapses: a few of the Figures (14 and 15) are incomplete; a number of necessary references have not been cited in the extensive reference list; and there is the odd definition missing, such as the intended meaning of "years" in ancient reckoning (where there is evidently a difference from what we understand as a year).

Clube and Napier's last sentence reads "There is a need for this book". I agree. Every library in the land should have a copy and not least the Parliamentary Library. Maybe you could send your favourite Pollie a copy for Christmas (provided you can get a guarantee it will be read). Throw out the Velikovsky rubbish and get the real thing. "The Cosmic Winter" is published by Basil Blackwell and retails in hardcover for $39.95 (good value at today's prices). And have a happy Christmas!

Colin Keay
Book Reviews Editor

Optical Computing in Japan

S Ishihara (Ed.)
Nova Science, New York, 1990. vi + 525 pp., US$98.00 (hardcover)

Work in Australia to develop optical computers has been noticeable by its absence. In this volume, the research into this topic in Japan is reviewed. The advantages of an optical device in parallel processing, image recognition etc. has long been recognized, but the potential uses for a computer where light replaces or partially replaces electricity are extended in this book. New architectures are presented in ingenious ways of utilizing light. Whereas optical bistability corresponds to binary logic, optical tristability and multistability suggest higher order logic. For example, binary logic has 16 basic functions while ternary logic has 19,683 and quaternary logic has greater than four billion. Processor sizes could be drastically reduced.

Apart from discussing fundamentals, chapters in this book review advances in systems and systems architecture, interconnections, devices and materials. The problems of switching

Reviews

MHD and Microinstabilities in Confined Plasma

W. M. Manheimer and C.N. Lashmore-Davies. Adam Hilger, Bristol, 1989 x + 294pp., UKE9.00 (Hardcover)

This book was begun in 1977 when Manheimer, from the Naval Research Laboratory in Washington, spent a sabbatical year at Culham Laboratory in the UK, where he and Lashmore-Davies wrote the first section. This section, on linear magnetohydrodynamic (MHD) stability theory, provides much more detail than is to be found in introductory plasma physics texts (e.g. Chen), presented in an eminently physical and simple way. It covers tearing and gravitational modes in slab, cylindrical and toroidal geometries (tokamaks and reversed-field pinches) with some discussion of experimental results. Unfortunately there are no references to work published later than 1982, so this section is rather dated and is probably largely superseded by recent books such as Freidberg's and White's. It is nevertheless useful as a subsidiary reference to get the benefit of the author's physical insights and clarity of exposition.

It is the second (non-linear MHD) and third (microinstabilities) parts of the book, by Manheimer alone, which make it unique, since much of the material does not appear elsewhere and the author has a considerable amount of physical insight into physical mechanisms. Unfortunately it too has very few recent references. This book is certainly a must for a library, and would be a useful addition to a plasma researcher's bookshelf if he could afford the price.

R L Dewar
Research School of Physical Sciences
The Australian National University
BOOK REVIEWS

Speed and power consumption are not over-emphasized although figures of 25 ps and 10 PJ respectively for CdS:Se, microcrystalline doped glasses are impressive. A data transfer rate of 350 Mbps and 340 MHz clock speed are also more than respectable for an interconnection device consisting of laser diodes, optical waveguides and photodetectors.

This book gives a very good overview of the capabilities of optical components for use in computers. I feel that not only does it describe the state of the art in Japan but probably world wide. It would be an essential reference for anyone working in the area, so I guess that means there will not be too many buyers in Australia.

W R MacGillivray
Division of Science and Technology
Griffith University

Megagauss Fields and Pulsed Power Systems
V.M. Titov & G.A. Shvetsov (Eds)
Nova Science Publishers,
New York, 1990
xii + 859pp., US$167 (incl. post) (Hardcover)

The practical generation of very intense ('megagauss') magnetic fields is important to widely diverse scientific and technological research interests, ranging from solid-state and dense-plasma physics to weaponry. Necessary transient fields up to a few megagauss (1 MG = 100 T) can be achieved by purely electrical means (eg, by using low inductance capacitor banks), the currently accepted upper limit for this approach being about 5 MG. Higher fields require techniques whereby the magnetic flux obtained by such means is compressed to a higher flux density usually by a cylindrical implosion of the flux-conserving walls driven by high-explosives. Since material in the collapsing boundary is subject to Rayleigh-Taylor instability, the compression is best done in stages in a so-called cascade generator. Fields up to 16 MG (1,000 T) have been produced in a usable volume in this way. Under those extreme conditions, the magnetic pressure exceeds 10 Mrbar and the electron cyclotron resonance approaches optical frequencies.

Not surprisingly, most of this activity has been conducted in laboratories, particularly in USA and USSR, largely concerned with nuclear weapons: this is reflected in the authorship of the 101 papers (including two historical overviews) collected here and presented to the 5th International Conference on Megagauss Field Generation and Related Topics which was held in Siberia in July 1989. Most of the papers provide a detailed account of the techniques used to generate and diagnose the intense fields, with several on their application to electromagnetic propulsion (eg, rail-guns).

It is perhaps unfortunate that, presumably to reduce publication delay, the contents lack the benefit of editing by a native English speaker, for which the Soviet editors apologize. Thus it remains a good example of the use of what the late Lev Artsimovich called 'the language of international science - broken English'!

The book has great value as an up-to-date reference source, but is strictly for the specialist or the library shelves.

S.M. Hamberger
Plasma Research Laboratory
Research School of Physical Sciences
The Australian National University

Solid State Physics - 1
M.A. K. L. Dissanayake, R. Attlee & K. Tennaakone (Eds)
Nova Science Publishers,
Connick, New York, 1990,
xii + 345pp., US$98.00 (Hardcover)

Conceived in Kandy, delivered in New York, blessed by Abdus Salam, this book is about the major growth area in semiconductor physics and about the major preoccupation of Sri Lankan solid state scientists, which are not the same. It is, in fact, the record of the First International Symposium on Solid State Physics (April 1987), a sort of Ceylonese Wagga, but with more countries represented (11) and fewer attendees (42).

The bulk of the book (Part I - Overview, 227pp., 13 articles by invitees, most extrinsic) is largely about quantum size effects in semiconductors. The remainder of the book (Part II - Short Presentations, 93 pp., 14 articles, mostly by indigenes) is largely about solid state ions.

In Part I, K. F. Berggren treats quantum phenomena in semiconductors generally, using a GaAs FET to illustrate many points; P. N. Butcher and B. Gallagher deal in separate articles with electron transport in 2-D. Other semiconductor articles are "hot topics" (M. Z. Iqbal, density of states for heavy doping (V. Sa-yakanit) and photocathodeelectrochemical cells (K. Tennaakone). Four other articles (M. A. Careem, B. E. Mollander, S. Skarup) deal with solid electrolytes and batteries, forging a link with Part II, where most papers deal with conductivity in sundry ionic solids. Two short papers concern solar cells.

The articles vary in clarity and interest as well as in referencing, figure placement and font styles, but share in a superabundance of errors - typographical, grammatical, orthographical and other e.g. "Hull was awarded the Nobel prize in physics 1985."

For such poor production a 3 year gestation is hardly justified and not befitting the contents which, while substantial, are topical rather than archival in nature.

R. A. Lewis
Department of Physics
University of Wollongong

Theory and Practice of Force Measurement
A. Bray, C. Barbato and R. Levi
xiv + 380 pp., UK £45.50 (Hardcover)

The book combines theory and application of force measurement in a most useful way to both novice and practitioner of force measurement. Anyone who has ever worked, at or visited, one of the National Measurement Laboratories around the world will have undoubtedly observed a variety of dead-weight force machines. These machines have evolved over many decades through international comparisons between researchers. They are one of the primary standards for force measurement and are immensely important to technological and industrial progress. A description of their operation is given by way of the accuracy of force measurement that is obtainable today. However the calibration and scaling methods that have been described are by no means trivial or merely historical, for they themselves contain the ideas of many great scientists who have experimented and theorised with electrical measurement equivalence methods and mechanical structures. A variety of shapes to overcome, often, nature's very resistance to man's effort to accurately measure force, have been devised by these scientists and engineers. The authors have demonstrated a breadth and depth of understanding of force measurement that could only have come about by a lifetime of research. It is noteworthy that such a book embraces fundamental laws of physics, error evaluation, measurement by electrical/mechanical means and design criteria for force measurement machines. This, coupled »
with the inter-comparisons of the value of g at the international level, provides us with a most up to date reference on the subject of force measurement.

As an ex-member of the National Measurement Laboratory, CSIRO, who worked on the 50kN dead weight machine in 1979, I find the book useful in the modern context because I am now faced with measuring dynamic loads up to 1000kN. Accuracy of dynamic load measurement in non-linear materials is one aspect not really dealt with in this book, although dynamic settling and repeatability are discussed in relation to force-standard machines in steady-state operation. Transient or shock force loading is not discussed but many of the basic principles that are taught in this book will have valuable application in new areas of force measurement. The book clearly demonstrates that force measurement is a difficult science to master, particularly at the standards level.

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Measured Tones
The Interplay of Physics and Music
I. Johnston
Adam Hilger, 1989
xi + 397 pp., $35 (paper)

Ian Johnston's newly published book "Measured Tones" uses an easy to understand conversational style to present the physics required to analyse vibrating systems. The material presented does not require advanced mathematical knowledge and should be easily followed by final year High School Physics Students. The book describes how the development of western music and musical instruments paralleled and was intermingled with developments in physics and technology, from ancient to medieval to modern times. The development of the well tempered musical scale, the design, development and characteristics of the various classes of musical instruments (string, woodwind, brass, percussion), the science of acoustics and the mechanism of voice production are all treated in some detail. There are many good diagrams and drawings of musical instruments to clarify the description given in the text, but many diagrams are not labelled leading to some confusion. The book particularly points out how production of new materials and manufacturing processes has led to the development and modification of instruments eg., the development of the modern pianoforte from early keyboard instruments. The development of modern sound recording and playback systems and the influence of radio on modern music are covered; the importance of psychology in deciding what is music and other psychoacoustic effects are pointed out. The production of electronic waves, transistors and integrated circuits are described to show how these devices have been used in electronic musical instruments (guitar and keyboard) and in recording systems.

The chapter on the human voice treats this topic in a much better way than other descriptions I have seen and presents the subject in a logical scientific way without a laborious discussion of (fictitious?) vocal registers. Mention is made of the fact that opera singers lower the larynx on high notes. Many (but not all) singers do this and it leads to a flattening of the harmonics produced. More quantitative research is required on this topic.

Measured Tones covers all the material needed for the NSW HSC physics elective on the Physics of Music (and provides good background reading for several other electives) and should be a necessary purchase by every High School library in Australia. It should be a necessary purchase for every physicist who is interested in music and by every musician who is interested in science; it is written to be understood by both.

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Stochastic processes, with strong motivation from application areas. This text allows the student to benefit from his clear scholarly insights and careful pedagogical style. As a consequence, it is seen as having appeal to wider international market areas than to the U.S. graduate student market, but as occurs in so many cases here in Australia, the greater than $100 retail price tag will limit sales.

New Books

Sensor Technology, Part 1: Materials and Devices, A.J. Jones
Dept. of Industry Technology and Commerce, Canberra 1990.
xvi + 172 pp. Available from publisher (Paperback)

Uranus: the planet, rings and satellites, E.D. Miner
334 pp. A$39.95 (Hardcover)

Giovanni Giorgi and his Contribution to Electrical Metrology, C. Egidi (Ed.)
Politecnico, Torino 1990.
ix + 202 pp. (Hardcover)

The Early Universe, E.W. Kolb and M.S. Turner
Addison-Wesley, Redwood City CA 1990.
xxii + 547 pp. US$ 48.50 (Hardcover)

Kiwi Reviewers Wanted
New Zealand physicists interested in reviewing books for our journal should send me from four to twelve key-words covering their areas of expertise and interest.

From the Book Reviews Editor
Greetings and Good Wishes for the Festive Season to all readers of our Book Reviews and in addition special thanks to our Reviewers who have devoted precious time to their valuable task. Through their efforts, readers have a better idea of the worth of some of the deluge of scientific books on the market. Thanks are also due to those publishers who have contributed review copies: I trust that they are pleased with the review responses.

Colin Keay

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