But don't take our word for it. Our customers have told us that these instruments are the best and we believe them! After all, they buy more of these NIMS than any others. Why? Again, they've told us that performance, reliability, and service are important to them.

Find out for yourself why these instruments are the best. Call or write today for more information on these NIMS or any other item in our extensive product line. Or, better yet, see for yourself how we perform in your own laboratory.

Then you'll be glad we listened to you.

P.S. We'd like to hear what you think of the two new NIMS on the right!

ETPOXFORD
31 Hope Street, Emeryville, NSW 2195. Telephone (612) 854-5122, Telex 442986. Fax (612) 854-5198
214 Berkeley Street, Carlton, Vic. 3052. Telephone (03) 477 0731. Telex 444678. Fax (03) 346 8800
The Australian Physicist vol 25 no 1 1988

Published 11 times a year, on behalf of the Australian Institute of Physics, by Hunter Technology Press
PO Box 160
Jesmond NSW 2299
Telephone (049) 60 1681
Fax (049) 69 6981

Editor-in-Chief
Lionel Wisbey BSc, BA

Executive Editor
Paul Hewitt BSc, PhD

Editorial Assistant
Dawn McMillan

Advertising Manager
Susan Butterworth

Editorial Address
Australian Physicist
PO Box 160
Jesmond NSW 2299

Typesetting and layout
Econoquick

Printing
Dobson and McEwan

ISSN: 0004-9972
Copyright © 1987; all rights reserved

Registered Publication
No. WBP0582

The statements made and the opinions expressed in the Australian Physicist do not necessarily reflect the views of the Australian Institute of Physics, its Council or Committees.

Contents

Editorial
R.J. MacDonald
Lionel Wisbey

President's Column
‘Higher Education — a discussion paper’
John G. Collins

Annual Report
Minutes of 24th AGM; 25th Annual Report; Agenda
Ian Bassett

Financial Statements
Consolidated Accounts; Council Funds; Australian Physicist; Benevolent Funds
T.E. Freeman

Auditor's Report
F.J. Morton

Obituary
George Henry Briggs
A.F.A. Harper

Reportage
Report on the 19th Meeting of IUPAP
Anthony W. Thomas

Academic Standards Panel in Physics

Articles
The Amplitude of Solar Cycle Number 22
Richard J. Thompson

An Experimental Test on the Basis of Probability Theory
C.S. McCusker & B. McCusker

Letters to the Editor

Book Reviews

Front Cover
Diffraction pattern produced by a lithium-niobate Fabry-Perot etalon illuminated by a helium-neon laser. The etalon is being developed by Dr Clive Burton, Achim Leitner and Yves Gilliland and the CSIRO Division of Applied Physics. It is planned to use the solid-state etalon on a space-based telescope to be launched in 1994. The photograph was taken by Ms Maria Basaglia of the Division.
The Australian Physicist is embarking on a new age, with the commissioning of the Hunter Technology Development Centre to produce the journal on a continuing basis. Trudi Thompson and editors before her have grappled with the task of producing the journal themselves. This is time consuming, with the demands of meeting deadlines over-riding other commitments such as job and personal life. I continue to be amazed that those editors and their band of dedicated helpers have been able to produce issues continually of high quality and of interest. I congratulate them, but wonder what the Australian Institute of Physics will expect using the experts resources of the Hunter Technology Development Centre, supported by an advisory editorial board located mainly in the Physics Department of the University of Newcastle. Our aim will be to continue the quality production which has been the hallmark of the Australian Physicist in the past. I wish to thank Trudi Thompson for providing us with a journal of the highest standard to continue.

The charge given by the Australian Institute of Physics now provides for an Honorary Editor and an Executive Editor. The latter position will be filled by Dr Paul Hewitt of Hunter Technology Development Centre, while I will occupy the Honorary position. Editorial support on content and policy will be provided by many members of the Department of Physics, University of Newcastle, who will constitute the Editorial Board. The relationship between the Editorial Board and Hunter Technology is one which will be defined by developments. We expect it to be both fruitful and beneficial.

It is our intent to develop an editorial policy for the Australian Physicist which we will provide for wider comment in the journal in the future. In the meantime, we intend to provide an effective vehicle for communication amongst physicists in Australia and to this end we encourage readers to submit papers and items of interest to the journal as often as they wish. From time to time guest editors will appear and we will use the journal to comment on and draw attention to matters affecting physics and physicists in Australia. We would encourage our readers to use the ‘Letters to the Editor’ section to develop their own comments. One matter on which it is reasonable to expect comment in the future is the Green Paper on Higher Education released late in 1987 by the Minister for Employment, Education and Training, the Hon. J.S. Dawkins MP. (See also the President’s column.) This paper, which is intended to promote discussion of Federal Government policy on higher education, is the forerunner to major changes in higher education in Australia. This will, in time, have a marked effect on physics and physicists in Australian universities and colleges. In future editorials, I would like to expand on many of the changes likely to result from acceptance of recommendations in the Green Paper, but at this stage I would like to voice a protest at the theme that suggests it is up to the higher education sector, and hence the universities and colleges, to change if we are to address Australia’s problems. I do not deny there is a need for change in some areas of the higher education sector in Australia and, in general, would accept many of the proposals in the Green Paper as being reasonable. The higher education sector has been undergoing change for some time.

A slightly earlier CTEC report into higher education suggested that there had been very significant gains in efficiency and effectiveness in recent years and that there was little scope for further improvement without leading to decreasing standards. The private sector in Australia has not responded to the need for change in the same way. The investment of Australian industry in applied research is minimal and in basic research essentially zero. The contribution of Australian industry to education, particularly at the higher education level, is very small. Government incentives do not seem to be leading to a real increase in the level of commitment of Australian industry to research or higher level training.

If the proposals put forward in the Green Paper are to be successful in helping Australia address its economical problems, an equal or even greater change in attitude and commitment of Australian industry must also occur. There is a shortage of physicists in Australia, just as there are shortages of other highly trained personnel. One of the ways of attracting more students is for industry to broadcast its recognition of the need, contribute to the enrolments through cadetships, etc. and publicise the role physicists and other scientists and engineers play in the companies. Industry and the private sector in general must also exhibit a high
commitment to applied and basic research in higher education institutions. This will involve financial support of existing programs and the identification in general terms of new programs for which industry will provide further support.

Australia's economic problems are supposedly solvable by a greater degree of "value-added" processing of our existing array of primary products. A close collaboration of the higher education sector and the private sector will be essential to solve the problem. Changes in the higher education sector alone will not provide the answers Australia is looking for.

R.J. MacDonald
Hon. Editor

Hunter Technology is unique amongst technology development centres in Australia in insisting that the first priority of technology development and transfer is the people involved in this process. Quite mistakenly, governments and companies put too much emphasis on selecting the right technologies as opposed to selecting the right people.

It is for this reason that Hunter Technology recognises the importance of professional science and technology-based organisations such as the Australian Institute of Physics, and has embraced the opportunity to produce the Australian Physicist and use our people and communication skills to support and further the goals of the Institute.

Science begets technology which in turn forms a corner-stone of industrial competitiveness and thus Australia's future. Australian physicists form a vital part of the science pool from which our future technology will grow. We will encourage and support this resource to play a significant roll in providing the intellectual property of Australia's future industries.

In order to provide a prosperous and safe twenty-first century for all Australians, it is imperative that the voice and intellect of Australian physicists is heard and acted upon. Hunter Technology will be there behind them doing what it does best, namely, helping people to make things happen.

Lionel Wishey
Director, Hunter Technology &
Editor in Chief, Hunter Technology Press

Higher Education — a policy discussion paper

At $9.95 from your local AGPS Bookshop this 126-page document, published over the name of the Minister for Employment, Education and Training, the Hon. J.S. Dawkins MP, is highly recommended reading for all AIP members and should be mandatory for those who work in the higher education area. I write as an AIP member with no current affiliation with a tertiary institution but with a concern for the future of our discipline and for the quality of Australian scientific education.

In my opinion the 'green paper' is an extremely important and valuable contribution to the public debate initiated by Mr Dawkins and his Department. It is well written, clearly argued and, as a basis for promoting discussion, is a credit to its anonymous author(s).

There is much in it with which members will agree, particularly its quantitative analysis of our present and future needs for more of scientific and technologically trained citizens and its identification of the multi-faceted approach needed to achieve this: higher student retention rates to Year 12; better transfer rates from Year 12 to higher education; increased adult participation in higher education; and an improvement in graduation rates.

I think that most would also agree that a better educated workforce is essential for our national economic survival; there are advantages to having 'fewer and larger higher education institutions than at present'; there is a very basic need 'to increase proficiency in mathematics and science at the secondary level'; 'more and higher quality specialist mathematics and science teachers are needed'; there must be a correction of the 'substantial disincentive to study that (results) from education allowances that (are) substantially less than unemployment benefits'.

There will be less agreement on some of the specific measures put forward for increasing the size of our educated workforce. Here the arguments become quite tendentious: even-handed discussion of Government options is thickly interlaced with blunt ideological statements of predetermined Government intentions. Discussion is fine — as long as it tends towards a previously established Government position!

There will be downright opposition in some quarters to the Government's ideas on staffing issues and salary structures. There will be cynical comment on the paper's proclivity to point out the responsibilities of industry and the private sector to help finance expansion of the higher education system while making so much commitment on behalf of the Government. Table F1, which shows a drop in Commonwealth expenditure on higher education from 1.36% of GDP in 1975 to an estimated 0.99% in 1988, raises not a comment!

Some warning bells are set ringing, for example in regard to: the Government's aim to produce a 'unified national system of tertiary education' comprising universities and CAE/HEIT plus part of the TAFE system; imposing a 'more flexible' system of credit transfer between the above groups of institutions, perhaps assisted by 'some impetus...provided through the proposed Commonwealth/State consultative process'; the desirability of the 'unnecessary lengthening of courses from two to three years or beyond three years'.

These are sticky areas. The Institute knows, for example, from its own detailed accreditation studies of physics degrees that all courses may be equal but some are more equal than others (to misquote George Orwell).

I also detect more than a hint of achievement of objectives by redefinition of 'higher education'. Is this the bureaucratic equivalent to 'creative accounting' to boost R&D funding?

The paper pays lip service to the principle of 'decreased intervention by governments in the funding and management of the higher education system', but is quite blunt about the bleak financial future facing institutions that do not wholeheartedly espouse the Government's doctrine of funding based on an agreed 'educational profile', established by a process of consultation between the institution and the Government.

This is not the place for a full critical review of this important document. Perhaps inevitably, I have drawn attention to some of the disturbing rather than reassuring aspects of the arguments put forward.

My aim is to stimulate those of you who have not read the paper to do so without delay and to contribute to the subsequent discussion.

John G. Collins
President

Australian Physicist Vol 25 No 1 January/February 1988
Australian Institute of Physics — Minutes of 24th Annual General Meeting

The Meeting was held in Lecture Theatre 8, School of Physics, University of Sydney, on Tuesday, 10th March, 1987, commencing at 7.45 p.m.

1. Attendance

Professor T.F. Smith, the retiring President, took the Chair. Also present were Dr J.G. Collins (retiring Vice President), Dr A.W. Pryor (Honorary Registrar), Dr I.M. Bassett (Honorary Secretary), Dr T.E. Freeman, and thirty-four other members.

Apologies were received from Professor A.G. Klein, Professor R.J. MacDonald, Dr J.R. Harries and Dr A.J. Farrow.

2. Minutes

The Minutes of the 23rd AGM, published in the Australian Physicist (February 1987), were approved without further discussion.

3. 24th Annual Report and Financial Statements

Professor Smith presented the Report (published in the Australian Physicist, February 1987) and drew particular attention to a number of matters: the award of the Boas Medal to Professor Don Melrose; the excellent work of Dr Trudi Thompson and her team on the Australian Physicist, which included financing an improved appearance by an increase in advertising revenue; the value of the Congress format adopted at Adelaide in 1986 — parallel specialist sessions plus outstanding plenary morning sessions; the new structure of the National Education Committee under its Convener Ms Jan Powe; the work of the Science Policy Committee and the Employment Committee which includes alerting the Australian Government to pending shortages of physicists; and the new evanescent property of the membership grade of Graduate. The President then thanked the members of the Executive, and the members of the Branch and other Committees. He moved that the Annual Report and Financial Statements be accepted, and the motion was carried unanimously.

4. Special Resolution

The following Special Resolution was put and carried unanimously.

That a new Article (9A) be inserted between existing Articles 9 and 10:

The grade of Graduate shall be a vestibule grade which a member shall not hold for more than ten years.

5. Election of Executive 1987/89

The following were elected unopposed.

President Dr J.G. Collins
Vice-President Professor A.G. Klein
Hon. Registrar Dr A.W. Pryor
Hon. Treasurer Dr T.E. Freeman
Hon. Secretary Dr I.M. Bassett

The election formalities completed, Professor Smith handed over to Dr Collins the original and unique three-dimensional embodiment of the Institute's logo.

The new President thanked Professor Smith for his active and effective presidency, which included his central role in the establishment of FASTS.

He thanked Dr John Harries for his quiet and efficient service as Treasurer, and welcomed Dr T.E. Freeman to this office.

6. Appointment of Auditor

Unanimous approval was given for the appointment of Mr E.I. Morton as Auditor (Moved Dr I.M. Bassett, seconded Dr Ian Falconer).

7. There being no other business, the meeting closed at 8.05 p.m.

Australian Institute of Physics — 25th Annual Report

Introduction

Perhaps the most important Institute activity in 1987 was preparation for the Bicentennial Congress. The two-yearly Congresses are traditionally the responsibility of the state branches, in rotation, and the burden of preparation, the risk and perhaps the triumph, fell to NSW this time. The thought underlying the 1988 Congress format is to profit from both the unity and the diversity of physics, and is expanded upon in the National Congress section below.

This thought has been taken up in another way by inviting certain kindred societies — initially just two, the Australian Optical Society, and the Astronomical Society of Australia — to be represented at the AIP's Annual Council meeting, at the same time offering a modest AIP subscription to members of the kindred societies, and a subscription to the Australian Physicist at around the marginal cost to kindred society members who are not eligible to join the AIP. The invitation was accepted, and as a result Dr Brian Robinson, President of ASA, and Dr Michael Waterworth, President of OSA, attended the October 1987 AIP Council meeting and (as Council members will attest) made exceedingly valuable contributions to the discussions. It is hoped that this very gentle process of merging, which preserves fully the independence (and organisational efficiency) of the kindred societies but facilitates joint action where appropriate, may be extended.

The AIP, like any living thing, must adapt to survive. The kind of administrative arrangements required is a function of size. The smaller kindred societies appear to run efficiently on purely volunteer labour for next to nothing a year, defying the principle of economy of scale. On the other hand, there is no denying that members of the American Institute of Physics get more for less than members of the Australian Institute.

Perhaps we are just the wrong size. Whatever the answer, the computer is part of it, and the Executive's efforts to make administrative use of the computer continue.

As a result of 'economic' pressures on the universities and on CSIRO, voluntary labour is becoming harder to get, and the AIP will need to pay for some services which hitherto were provided voluntarily, and efficiency will in consequence be even more vital.

Production of the Australian Physicist furnishes an example. From the first issue of 1988, this will be the responsibility of Hunter Technology, under the direction of Dr Paul Hewitt. Honorary editorial services will be provided by R.J. MacDonald, Professor of Physics at the University of Newcastle, with assistance from colleagues. May they prosper in this, perhaps the most important of all the Institute's activities.

The heroic and unpaid efforts of Trudi Thompson and her Perth team deserve all our heartfelt thanks. They have left the Physicist in a buoyant condition which promises well for its future.
Thanks are due also to all those voluntary workers who together make the AIP whatever it is.

One example is provided by Dr Peter Dyson of the Victorian Branch who has prepared pamphlets on physics for use in schools which will be of interest to all Branches (see under Branch Activities below).

Mention may also be made of the fact that the AIP provides a representative on a number of outside bodies including the National Committee for Physics of the Australian Academy of Science, the Australian Journal of Physics, the National Association of Testing Authorities, and the committees of the Standards Association of Australia concerned with temperature measurement, oil and gas measurements, and acoustic standards.

National Activities

Walter Boas Medal

The 1987 AIP Walter Boas Medal was awarded to Anthony William Thomas, Professor of Physics at the University of Adelaide, for his outstanding work on the relationship between nucleonic and nuclear structure. (The Australian Physicist, November 1987)

National Congress

The Bicentenary National Congress will be under way as these words are printed, and it will be over when they are read, and there will be much about it in subsequent issues of the Physicist. It is a joint activity of the AIP, together with four of its groups and ten kindred societies, permitting parallel specialist sessions plus outstanding plenary sessions. The format is universal, and it will be interesting to see if it is supported and enjoyed, and if this format and perhaps also the January time slot is considered to be worth following at the next National Congress in Perth in 1990.

The Australian Physicist

Appearance has continued to improve, with greater use of colour, and time-tableting has been further tightened. The retiring Editor recommends that Australia Post and the AIP adopt pre-sorted bulk airmail as the best means of further reducing turnaround time. The number and quality of unsolicited articles has improved, but Branch News remains patchy. Gross advertising revenue has increased from $5,000 in 1985 to $17,000 in 1987.

Membership

The 1986 Council resolution making Graduate a 'vestibule' grade has been steadily implemented, (about three hundred Graduates upgrading to Member) with few complaints. The 56 new Graduate members in 1987 represents well under half of the eligible new graduates. A poster is being prepared to spearhead a new recruiting drive aimed at this market. A more lucid subscription notice was designed and employed.

Science Policy Committee

During the year the Committee considered, and sponsored reports on, a number of issues linking physics and public policy; in most cases the reports have been or will be published in the Physicist. Topics and principle authors include the National Science and Technology Budget (Dr Richard Payling), the OECD review of Australia's national science and technology policy (Dr Richard O'Sullivan), the Chernobyl nuclear accident (Dr Don Lang), Sweden's science and technology policy (Dr Richard O'Sullivan), Star Wars (Dr Arthur Fay), the DITAC-initiated discussion on selecting technologies for the future' (Dr Bernard Paitthorpe), and the national secondary education policy (Dr Ian Basset).

FASTS

The Federation of Australian Scientific and Technological Societies, established in November 1985, has had a full time Executive Director (Dr David Widdup) since June 1986. It is financed by a per capita contribution from some sixty member societies. This year FASTS co-ordinated the National Science and Technology Budget Analysis Group (NSTAG) whose other members are the Institution of Engineers and the two scientific Academies. FASTS has been active in bringing the views of the scientific community to the attention of government and opposition politicians, senior public servants and industry representatives, both by personal contact and written submission. It has perhaps been less successful in bringing its work to the attention of the general public and to its own membership, although a regular FASTS newsletter is sent to member societies who can use the material freely in their own journals. The AIP is a member of Group 9 (other members being the Australian Optical Society, the Australian Acoustical Society, and the Astronomical Society of Australia). By the somewhat informal mechanisms which still prevail in FASTS, Dr M.D. Waterworth (University of Tasmania) was nominated, and duly elected, at the FASTS Council meeting in November 1987, to the Board as Group 9 representative. Dr Waterworth stood on a platform of greater publicity for FASTS's excellent enterprises.

Solar, Terrestrial and Space Physics Group

Most of the Group's activities have been centred on planning for its section of the National Congress (January 1988), to consist of seven workshops. One of these workshops is concerned with Australia's future in space research. The local space physics community will be called upon to provide scientific input to planned space missions.

NUPP Group

The major activity was the Summer School at the University of Tasmania, on high-energy physics, which attracted a number of outstanding overseas lecturers. There has been much lobbying to see the first recommendation of a recent ASTEC report go ahead — the creation of a single high-energy physics group, based at Flinders and Melbourne Universities — but it falls outside the scope of any traditional funding category.

Branch Activities

ACT

About twelve scientific meetings were held during the active year. New activities include assuming responsibility for setting a qualifying examination to select a group of Year 11 students as prospective representatives at the 1988 International Physics Olympiad, and contributions to curriculum development through the Commonwealth Schools Commission and the ACT Science Teachers Association. As in previous years, the Branch provided assistance to the ACT Schools Science Fair and the National Science Summer School, and provided a display on physics-related careers at CAREERS '87.

Queensland

About twelve scientific meetings were held during the year. A number of Youth Lectures were again held in Brisbane and in provincial centres,
The Physicist

NSW

Nine scientific meetings were held during the year. Activities on the secondary education front included travelling country lectures (‘Physics Circus’), contribution to Science in Schools Week, provision of an ‘in-service’ course for science teachers at Mitchell CAE, and an offer, not yet accepted by the Education Department, to provide in-service courses on physics equipment. The main activity of the Branch has been preparation for the 1988 Bicentenary Congress (see the National Congress report above).

Victoria

Eleven scientific meetings were held during the year, with attendances ranging from 35 to 200. These included an outstanding lecture on warm superconductors by Dr A. Moodie, and the annual Boas presentation and lecture by the Medallist (Professor Don Melrose). Two pamphlets have been prepared by Dr P. Dyson for distribution in schools, one for year-ten students to encourage further study of physics, the other for year-twelve students to encourage the choice of physics as a career. Other branches are urged to consider purchasing copies for distribution in their own state. Three county Youth Lectures were presented. Financial assistance for students to attend conferences again accounted for a large fraction of Branch expenditure.

Tasmania

In addition to hosting the very successful NUPP Summer School (q.v.) the Branch held four scientific meetings during the year. All senior science teachers in Tasmania were invited to a science teachers seminar in August. Forty-four attended, and a very effective series of discussions were held, with the participation of the AIP’s national education convener Jan Powe, leading to some firm policy statements regarding curriculum development and teacher training.

South Australia

About seven scientific meetings were held during the year, including the Annual Student Night, and a joint meeting with the Astronomical Society. The Branch has been particularly concerned about developments in high school physics education, which reflect the trend towards a reduction in content in the name of breadth of coverage and accessibility to the greatest number of students.

Western Australia

About eight meetings were held during the year. The need for specialist scientific meetings being well met elsewhere, the emphasis was on scientific topics of outstanding general interest and on science-related public issues. In collaboration with the Science Teachers Association of WA and the RACI, the Branch gained access to the tertiary admissions database, and discovered a trend away from science enrolment among the more able students over the last ten years. A report containing recommendations for action received wide publicity and will provide useful quantitative and topical input to the nationwide debate on standards and content of high school science. The Branch hosted the Pawsey lecture (Professor John Cowley on ‘Diffraction and Imaging’). The Yanchep conference for WA honours and research students was again a great success. A topical half day review seminar on surface science usefully brought together scientists from a number of disciplines. As usual there were AIP prizes (for graduating students), a Youth Lecture, a Quiz Night, a Careers Night, and a Secondary School Afternoon.

Ian Bassett
Honorary Secretary

25th Annual General Meeting

Notice is hereby given that the 25th Annual General Meeting of the Australian Institute of Physics will be held on Tuesday, 8th March, 1988 at 7.45 pm, in the Burrows Lecture Theatre, University of NSW.

Agenda

1. Apologies and declaration of proxies.
2. Minutes of the 24th AGM.
5. Appointment of Auditor.
6. Other Business.

I.M. Bassett
Honorary Secretary
financial statements

The financial statements for the year ending 30 September 1987 appear below. Balance sheets and statements of income and expenditure are given for Council funds, the benevolent fund and the Australian Physicist. Members should also receive financial statements from the Branch and group to which they belong.

The consolidated accounts combine the individual accounts of the branches, groups, Council and Australian Physicist, and show a surplus of $5,561 for the year. The benevolent fund is not included in the consolidated accounts as its operation is independent of Council.

Consolidated Accounts
Balance Sheet
As at 30 September 1987

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>86861 Accumulated Funds</td>
<td>13099 Current Assets</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Balance as at 30th September 1987</td>
<td>22648 Cash at Bank</td>
<td></td>
<td></td>
</tr>
<tr>
<td>— See Consolidated Income and Expenditure Account</td>
<td>9093 Accounts Receivable</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>92422</td>
<td></td>
<td>1062 Stock on Hand at Cost</td>
</tr>
<tr>
<td></td>
<td></td>
<td>87066 Investment at Cost</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>67603</td>
<td></td>
</tr>
<tr>
<td>16581 Current Liabilities</td>
<td>3277 Fixed Assets</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accounts Payable</td>
<td>4758 Furniture/Fittings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laser Conference Funds</td>
<td>5769 At Cost</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10527</td>
<td></td>
<td>4240</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Less Depreciation</td>
<td>1697 2543</td>
</tr>
<tr>
<td>$103442</td>
<td>$102949</td>
<td>$103442</td>
<td>102949</td>
</tr>
</tbody>
</table>

Consolidated Income and Expenditure Account
For Year Ended 30 September 1987

1985/6

3123 Surplus from normal years activities after making the following charges and provisions: 1986/7

1190 Audit Fees 1370
561 Depreciation 734

83738 Accumulated Funds brought forward from previous year 86861

$86861 Leaving Accumulated Funds carried forward as per Balance Sheet $92422

Council Funds
Balance Sheet
As at 30 September 1987

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>25936 Accumulated Funds</td>
<td>693 Current Assets</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Balance as at 30 September 1986</td>
<td>22648 Bank Account</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less Deficit</td>
<td>25936</td>
<td></td>
<td></td>
</tr>
<tr>
<td>284</td>
<td>25652</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>723 Stock on Hand at Cost</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1900 Sundry Debtor</td>
</tr>
<tr>
<td></td>
<td></td>
<td>75537 Investment at Cost</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>16168</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>53080</td>
</tr>
<tr>
<td>50564 Current Liabilities</td>
<td>270 Fixed Assets</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sundry Creditors</td>
<td>4315 Office Equipment at Cost</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Funds held on behalf of Laser Conference</td>
<td>5769</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fund held on behalf of Branches &amp; Groups</td>
<td>33755</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>43839</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$76500</td>
<td>$69491</td>
<td>$76500</td>
<td>$69491</td>
</tr>
</tbody>
</table>

Australian Physicist Vol 25 No 1 January/February 1988
## Australian Physicist

### Statement of Income & Expenditure
**for the Period**
**1 October 1986 to 30 September 1987**

<table>
<thead>
<tr>
<th>Income</th>
<th>1987</th>
<th>1986</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australian Institute of Physics Grant</td>
<td>33000</td>
<td>30000</td>
</tr>
<tr>
<td>Subscriptions</td>
<td>2159</td>
<td>2088</td>
</tr>
<tr>
<td>Advertising</td>
<td>16612</td>
<td>7227</td>
</tr>
<tr>
<td>Magazine Sales</td>
<td>721</td>
<td>213</td>
</tr>
<tr>
<td>Reprint Sales</td>
<td>731</td>
<td>607</td>
</tr>
<tr>
<td>Fax</td>
<td>369</td>
<td>30</td>
</tr>
<tr>
<td>Interest</td>
<td>1447</td>
<td>1109</td>
</tr>
<tr>
<td>Other</td>
<td>90</td>
<td>53</td>
</tr>
<tr>
<td><strong>Total Income</strong></td>
<td><strong>$54415</strong></td>
<td><strong>$41135</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Expenditure</th>
<th>1987</th>
<th>1986</th>
</tr>
</thead>
<tbody>
<tr>
<td>Publication Costs</td>
<td>29222</td>
<td>22340</td>
</tr>
<tr>
<td>Printing and Typesetting</td>
<td>1406</td>
<td>346</td>
</tr>
<tr>
<td>Art &amp; Photographic Work</td>
<td>3630</td>
<td>—</td>
</tr>
<tr>
<td>Negative Separations</td>
<td>1123</td>
<td>—</td>
</tr>
<tr>
<td>Data Processing</td>
<td>34781</td>
<td>22686</td>
</tr>
<tr>
<td><strong>Distribution Costs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Postage</td>
<td>8389</td>
<td>6546</td>
</tr>
<tr>
<td>Packaging and Handling</td>
<td>1700</td>
<td>1708</td>
</tr>
<tr>
<td>Labels and Envelopes</td>
<td>1064</td>
<td>1461</td>
</tr>
<tr>
<td><strong>Total Expenditure</strong></td>
<td><strong>11153</strong></td>
<td><strong>9715</strong></td>
</tr>
</tbody>
</table>

| Reprinting Costs                |      |      |
| Printing                        | 616   | 629   |
| Postage                         | 18    | 43    |
| **Total Reprinting Costs**      | **634** | **672** |

### Administration Costs

<table>
<thead>
<tr>
<th>Item</th>
<th>1987</th>
<th>1986</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stationery</td>
<td>808</td>
<td>371</td>
</tr>
<tr>
<td>Telephone</td>
<td>463</td>
<td>298</td>
</tr>
<tr>
<td>Postage</td>
<td>40</td>
<td>155</td>
</tr>
<tr>
<td>Courier/Petrol</td>
<td>100</td>
<td>236</td>
</tr>
<tr>
<td>Depreciation</td>
<td>707</td>
<td>528</td>
</tr>
<tr>
<td>Fax Costs</td>
<td>88</td>
<td>112</td>
</tr>
<tr>
<td>Repairs &amp; Maintenance Equipment</td>
<td>—</td>
<td>78</td>
</tr>
<tr>
<td>Bank Fees</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>Audit Fees</td>
<td>100</td>
<td>75</td>
</tr>
<tr>
<td>Social</td>
<td>625</td>
<td>192</td>
</tr>
<tr>
<td>Software Costs</td>
<td>1628</td>
<td>—</td>
</tr>
<tr>
<td><strong>Total Administration Costs</strong></td>
<td><strong>4564</strong></td>
<td><strong>2056</strong></td>
</tr>
</tbody>
</table>

**Net Surplus**

- $3283
- $606

---

**Benevolent Funds**

### Balance Sheet
**As at 30 September 1987**

<table>
<thead>
<tr>
<th>Accumulated Funds</th>
<th>21745</th>
</tr>
</thead>
<tbody>
<tr>
<td>Add Members Contributions</td>
<td>702</td>
</tr>
<tr>
<td>Interest</td>
<td>2745</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$25192</strong></td>
</tr>
</tbody>
</table>

**Held as follows:**

- Bank Account: 8272
- Investments at Cost: 16200
- Sundry Debtor: 720

**Fund for Disabled Pensioners**

### Balance Sheet
**As at 30 September 1987**

<table>
<thead>
<tr>
<th>Accumulated Funds</th>
<th>3342</th>
</tr>
</thead>
<tbody>
<tr>
<td>Add Members Contributions</td>
<td>571</td>
</tr>
<tr>
<td>Interest</td>
<td>621</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$4534</strong></td>
</tr>
</tbody>
</table>

**Held as follows:**

- Bank Account: 8272

---

*Australian Physicist* Vol 25 No 1 January/February 1988
## Council Funds
### Income and Expenditure Account
#### For Year Ended 30 September 1987

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>96676 Members' Subscriptions</td>
<td>110113</td>
<td>8870 Legislative</td>
<td>2432</td>
</tr>
<tr>
<td>173 Group Subscriptions</td>
<td>375</td>
<td>Executive expenses</td>
<td>2479</td>
</tr>
<tr>
<td>Bank Interest &amp; Investment</td>
<td>8982</td>
<td>Committee expenses</td>
<td>2741</td>
</tr>
<tr>
<td>Income</td>
<td>8982</td>
<td>Education expenses</td>
<td>441</td>
</tr>
<tr>
<td>2669 Conference Repayments</td>
<td>2500</td>
<td></td>
<td>8093</td>
</tr>
<tr>
<td>121 Sundries</td>
<td>317</td>
<td></td>
<td>30000</td>
</tr>
</tbody>
</table>

#### Publishing
- **The Australian Physicist**: 33000

#### Branch & Group Activities
- **Branch Grants**: 26841
- **Group Grants**: 790
- **Conferences**: 18100
- **Interest Due to Branches**: 3752

#### Administrative
- **Secretarial Fees**: 22065
- **Printing & Stationery**: 3146
- **Postage & Telephone**: 2590
- **Depreciation**: 27
- **Audit & Accountancy**: 900
- **Bank Fees**: 127
- **Advertising**: 90
- **Sundries**: 20

#### Other Activities
- **Science Centre Foundation**: 100
- **Science Olympiad**: 1000
- **ASPEN representative**: 1360
- **Travel**: 570

#### Surplus (Deficit) for Year
- (5559)

### Total

<table>
<thead>
<tr>
<th>1986</th>
<th>1987</th>
</tr>
</thead>
<tbody>
<tr>
<td>$109016</td>
<td>$122287</td>
</tr>
<tr>
<td>$109016</td>
<td>$122287</td>
</tr>
</tbody>
</table>

## Funds Held on Behalf of Branches and Groups

<table>
<thead>
<tr>
<th>Balance</th>
<th>Interest</th>
<th>Balance</th>
<th>1986</th>
<th>%</th>
<th>Due</th>
<th>1987</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.10.86</td>
<td>30.9.87</td>
<td>30.9.87</td>
<td>5000</td>
<td>14.5</td>
<td>1.290</td>
<td>5000</td>
</tr>
<tr>
<td>VIC</td>
<td>6668</td>
<td>834</td>
<td>7502</td>
<td>5000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NSW</td>
<td>4540</td>
<td>568</td>
<td>5108</td>
<td>5000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SA</td>
<td>7886</td>
<td>9</td>
<td>8872</td>
<td>5000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WA</td>
<td>2440</td>
<td>305</td>
<td>2745</td>
<td>5000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>QLD</td>
<td>2120</td>
<td>265</td>
<td>2385</td>
<td>5000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACT</td>
<td>1874</td>
<td>234</td>
<td>2108</td>
<td>5000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TAS</td>
<td>1196</td>
<td>150</td>
<td>1346</td>
<td>5000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vacuum Physics</td>
<td>3279</td>
<td>410</td>
<td>3689</td>
<td>5000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$30003</td>
<td>$3752</td>
<td>$33755</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Council Investments at Cost 30 September 1987

<table>
<thead>
<tr>
<th>1986</th>
<th>%</th>
<th>Due</th>
<th>1987</th>
</tr>
</thead>
<tbody>
<tr>
<td>5000 Citicorp</td>
<td>14.5</td>
<td>1.290</td>
<td>5000</td>
</tr>
<tr>
<td>5000 WA Bonds</td>
<td>12.75</td>
<td>31.389</td>
<td>5000</td>
</tr>
<tr>
<td>5000 Custom Credit</td>
<td>13.5</td>
<td>31.689</td>
<td>5000</td>
</tr>
<tr>
<td>5000 Esanda</td>
<td>14.25</td>
<td>7.689</td>
<td>5000</td>
</tr>
<tr>
<td>5000 AGS</td>
<td>14.75</td>
<td>31.1289</td>
<td>5000</td>
</tr>
<tr>
<td>5000 Telecom</td>
<td>12.75</td>
<td>1.290</td>
<td>5000</td>
</tr>
<tr>
<td>5000 Australian Savings Bonds</td>
<td>14.75</td>
<td>1 month</td>
<td>5000</td>
</tr>
<tr>
<td>22537 St. George Building Society</td>
<td></td>
<td></td>
<td>On Call 80</td>
</tr>
<tr>
<td>18000 Commonwealth Bank</td>
<td></td>
<td></td>
<td>Term Deposit 6 months 18000</td>
</tr>
<tr>
<td></td>
<td>$75537</td>
<td></td>
<td>$53080</td>
</tr>
</tbody>
</table>
Benevolent Fund Investments at Cost:

<table>
<thead>
<tr>
<th>1986</th>
<th>1987</th>
</tr>
</thead>
<tbody>
<tr>
<td>700 State Electricity Commission Vic.</td>
<td>10.4 1.12.86 700</td>
</tr>
<tr>
<td>3000 Beneficial Finance Corp. Ltd.</td>
<td>13.5 7.5.88 3000</td>
</tr>
<tr>
<td>500 State Electricity Commission Vic.</td>
<td>10.6 1.12.91 500</td>
</tr>
<tr>
<td>4000 Australia Savings Bonds 14.75 1 Month 4000</td>
<td></td>
</tr>
<tr>
<td>3000 Commonwealth Bank Term Dep. 14.25 4 Months 3000</td>
<td></td>
</tr>
<tr>
<td>Commonwealth Bank Term Dep. 5000</td>
<td></td>
</tr>
</tbody>
</table>

$11200  
$16200

Auditor’s Report

Auditor’s Report
to Members
Australian Institute of Physics

I have examined the Council Balance Sheet as at 30th September 1987 and the Income and Expenditure Account for the year ended 30th September 1987 and in my opinion:

(a) The above accounts are properly drawn up in accordance with the Companies (New South Wales) Code, so as to give a true and fair view of:
(1) the state of affairs of the Institute and of the Branches as at 30th September 1987 and of the surplus of the Institute for the year ended on that date; and
(2) the other matters required by Section 269 of the Code to be dealt with in the accounts.

(b) The accounting and other records, and the registers required to be kept under the provisions of the Companies Code, have been properly kept. I have examined the accounts and Auditor’s Reports of those Branches which have not been audited by me which I have accepted without qualification.

I report that the returns of the Branches appear to be in a form and content appropriate and proper for the purpose of preparation of the Balance Sheet and Accounts of the Institute. No Auditor’s Reports on the accounts of the Branches was made subject to any qualifications under Section 285 of that Code.

F.J. Morton
Registered under the Public Accountants Registration Act, 1945, as amended.

Membership

AIP Register by States and Grades as at 27 October 1987

<table>
<thead>
<tr>
<th>ACT</th>
<th>NSW</th>
<th>VIC</th>
<th>QLD</th>
<th>SA</th>
<th>WA</th>
<th>TAS</th>
<th>OVS</th>
<th>TOTAL</th>
<th>UN</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Honorary Fellows</td>
<td>(H)</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Fellows</td>
<td>(F)</td>
<td>40</td>
<td>123</td>
<td>95</td>
<td>18</td>
<td>26</td>
<td>9</td>
<td>10</td>
<td>19</td>
<td>360</td>
</tr>
<tr>
<td>Members</td>
<td>(M)</td>
<td>95</td>
<td>289</td>
<td>261</td>
<td>91</td>
<td>112</td>
<td>82</td>
<td>27</td>
<td>61</td>
<td>1018</td>
</tr>
<tr>
<td>Graduates</td>
<td>(G)</td>
<td>47</td>
<td>156</td>
<td>199</td>
<td>56</td>
<td>59</td>
<td>72</td>
<td>18</td>
<td>35</td>
<td>642</td>
</tr>
<tr>
<td>Total Corporate</td>
<td></td>
<td>184</td>
<td>570</td>
<td>557</td>
<td>165</td>
<td>197</td>
<td>183</td>
<td>55</td>
<td>115</td>
<td>2026</td>
</tr>
<tr>
<td>Associates</td>
<td>(A)</td>
<td>5</td>
<td>10</td>
<td>22</td>
<td>4</td>
<td>6</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>53</td>
</tr>
<tr>
<td>Students</td>
<td>(S)</td>
<td>13</td>
<td>75</td>
<td>31</td>
<td>26</td>
<td>21</td>
<td>23</td>
<td>5</td>
<td>4</td>
<td>198</td>
</tr>
<tr>
<td>Subscribers</td>
<td>(O)</td>
<td>6</td>
<td>5</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>22</td>
</tr>
<tr>
<td>Total Members</td>
<td></td>
<td>208</td>
<td>660</td>
<td>615</td>
<td>196</td>
<td>226</td>
<td>215</td>
<td>60</td>
<td>119</td>
<td>2299</td>
</tr>
<tr>
<td>Company Subscribers</td>
<td>(C)</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>Company Nominees</td>
<td>(N)</td>
<td>2</td>
<td>5</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>17</td>
</tr>
</tbody>
</table>

NOTE: OVS = Overseas
UN = Address Unknown

NUMBER OF UNFINANCIAL MEMBERS = 94
NUMBER OF RETIRED MEMBERS = 176

The Membership combines to increase and is approximately 4% higher than in 1986.
Are high-density NIMs leaving you powerless?

BLACK MAX™
Rescues you with twice* the power!

Ask about the BLACK MAX™ Power Supply.

* DC power:

<table>
<thead>
<tr>
<th>12 A @ +6 V</th>
<th>12 A @ -6 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 A @ +12 V</td>
<td>4 A @ -12 V</td>
</tr>
<tr>
<td>2 A @ +24 V</td>
<td>2 A @ -24 V</td>
</tr>
</tbody>
</table>

EG&G ORTEC

QUENTRON OPTICS PTY. LIMITED
Laser Court, 75A Angas Street, G.P.O. Box 2212, Adelaide, South Australia 5001
Telephone: (08) 223 6224  Telex: QTRON AA82809  Fax: (08) 223 5289
Unit 22-23, 36-38 East Street, Five Dock, N.S.W. 2046
Telephone: (02) 712 3111  Telex: QTRNSY AA122113  Fax: (02) 713 8046
George Henry Briggs
PhD(Camb), DSc(Syd), Hon FAIP

In celebrating the life of George Briggs we are truly paying tribute to one of the founding fathers of modern physics in Australia; a founding father of precise physical measurement here and a founding father of the Australian Institute of Physics.

Born in Sydney on 23 March, 1893, he was the only child of William Briggs of Halifax, Yorkshire and of Hanna (nee Bennett) of Surrey, England. His childhood was spent at Concord, Sydney and his secondary schooling at Fort Street High School, Petersham, incidentally with N.A. Esserman and H.V. Evatt both of whom he was closely associated in later life.

On matriculation, Briggs entered University of Sydney in the Faculty of Engineering but transferred to Science in his third year. He graduated BSc with Honours in Physics and Mathematics in 1916, and, continuing in the Physics Department under Professor J.A. Pollock, he was appointed Lecturer in 1918. His early research, at the suggestion of Assoc. Prof. E.M. Welsh (Applied Mathematics), was concerned with radioactivity and this remained Briggs' main research interest until he left the University in 1939 to become Officer-in-Charge of the Physics Section of the CSIR National Standards Laboratory.

His principal concern, for which he was awarded his DSc by Sydney University in 1937, was the measurement of the absolute velocities of alpha particles from the products of radioactive decay. He was granted leave of absence from the University to study at the Cavendish Laboratory, Cambridge (Emmanuel College) in 1925 where he worked on a problem suggested by Rutherford on the nature of the charge of the alpha particle as it passed through gases. The laboratory in which he did this work was, in fact, next to Rutherford's own laboratory. There is no doubt that Rutherford's influence on Briggs was very considerable. These were the golden years of the Cavendish with such notables as J.J. Thompson (the electron), Chadwick (the neutron), C.T.R. Wilson (cloud chamber), Blackett (cosmic rays), Kapitza (high magnetic fields), Aston (mass spectrometer) and Oliphant making their mark.

After two years at Cambridge, Briggs gained his PhD and returned to the University of Sydney, where in 1928 he was appointed Associate Professor.

It was my privilege to work with him in 1933-35. While Briggs was measuring the absolute velocities of alpha particles, under his guidance, I was making somewhat similar measurements on the velocities of beta particles from Ra(B+C). The key to these precise measurements was a Cotton-type current balance which 'weighed' the magnetic field used to deflect the particles.

In 1935-37, Briggs went overseas on sabbatical leave, spending time at the Cavendish and the University of California, Berkeley and elsewhere.

When the Government decided CSIR should establish a National Standards Laboratory, Briggs with N.A. Esserman and D.M. Myers were appointed to head its three Sections and proceeded to the National Physical Laboratory, UK to study the organisation and techniques of a national measurement laboratory and to purchase the basic equipment for the Australian laboratory. They were later joined by six other appointees, including Clother, Bell, Thompson, Giovannelli and Harper.

When war was declared in September 1939, our services were made available to NPL for a period but we then again took up the task of preparing for the establishment of NSL, which was effected in 1940-41.

Dr. Briggs continued as head of the Physics Section (Division of Physics after 1945) of the Laboratory until his retirement in 1958, when he was made an Honorary Research Fellow and continued research until failing eyesight and ill health intervened. His chief concern at this time was the measurement of the gyromagnetic rotation of the proton and, as an offshoot from this, the development of electrical resistors which were particularly stable (to about 1 part in 10^8 per year).

I have no doubt Briggs' interest in research outweighed his concern for administration and indeed, from the day he retired as Chief, he was noticeably much more relaxed. But nevertheless he was a good leader and built up a Division which was well regarded nationally and internationally. He was heavily involved in work related to the war effort in 1940-45 including work on temperature measurement and control for munitions production, optical design and testing, dark adaptation for night fighter pilots, viscosity of glue for plywood used on Mosquito aircraft, search light arcs, goggles for aircraft spotters to avoid 'eclipse blindness' and instrument jewels. Briggs was an active member of the Commonwealth Optical Munitions Panel.

In 1946-47, Briggs was seconded as Scientific Adviser to Dr H.V. Evatt at the first meeting of the US International Commission on Atomic Energy in New York and later in the same capacity as adviser to Paul Hasluck. He made this the occasion to see something of the development at MIT of a device for liquefying helium, which served as a basis for the establishment of The Division's research program in low temperature physics, now under the leadership of G.K. White. These were, I believe, the first such facilities in the southern hemisphere.

Being very research minded and recognising the danger of a national standards laboratory lapsing into mediocrity if it did not maintain an active scientific program, Briggs encouraged 'pure' physical research in parallel with developments for and services to science and industry through the maintenance of national physical standards. Under Briggs, the Division established an international reputation for its research on solar physics and solid state physics.

Having worked with George Briggs for most of my professional life, I cannot speak too highly of the leadership and inspiration he provided. He was an excellent and understanding mentor. Although a man of many parts, physics was always his principal interest. He took a leading role in the organisation of physics in Australia, first through the Section of Physical Science of the Royal Society of NSW of which he became the Secretary in 1927 (he joined the Society in 1919), then as Honorary Secretary/Treasurer from 1945, then President of the Australian Branch of the (British) Institute of Physics (1950). In this capacity in 1953 he initiated, with the support of Dr H. Lang, then Secretary of the Institute, the proposal that Australia form its own Institute of Physics. This proposal, when put to the vote of the Branch members, proved a little premature because of the reluctance of many to break away from the British body. The proposal was resubmitted in 1956 when, with the lapse of time and the unequivocal support of the British body, it was overwhelmingly adopted. Dr Briggs with Dr Lang and Dr Rogers (Treasurer of the Australian Branch) were made Honorary Fellows of the Australian Institute in recognition of the part they played in the formation of the A.I.P.
The Physicist

Dr Briggs was appointed to the National Standards Commission when it was established in 1930 to advise the Minister in regard to the establishment and maintenance of units and standards of physical measurement. Briggs played an important role in the formulation and implementation of this weights and measures legislation and served on the Commission until his retirement as Chief of the Division of Physics, NSL in 1958.

He was the representative of CSIRO on the UNESCO Conservation Committee and during 1953-55 Chairman of the UNESCO Australian Committee for Natural Science.

Report on the 19th Meeting of IUPAP

Anthony W. Thomas
Department of Physics, University of Adelaide

The 19th general meeting of the International Union of Pure and Applied Physics was held in Washington D.C. over the period September 29 to October 2, 1987. Australia's two representatives were Dr W. Blevin from CSIRO's Division of Applied Physics in Sydney, and myself. The theme of the meeting, which was held concurrently with the annual meeting of the AIP Corporate Associates, was 'Physics in a Technological World' - a theme at least as relevant to us as our American hosts. I shall deal first with the business of IUPAP and then, briefly, with the wealth of exciting science discussed.

Membership

The membership of IUPAP now numbers forty-five, of which two have observer status. (Saudi Arabia was admitted as an observer at this meeting.) Ordinary members must purchase at least one share, or unit, of which there are now 200. The cost is presently US$1,050, and it was agreed to increase this by US$50 per year in each of the next three years. Australia currently owns six shares, purchased from the diminishing funds of the Academy of Science. This entitles us to three votes — whenever voting is required. Since the level of cooperation is very high, this was not often necessary.

(There was some enthusiasm from countries like Japan and Italy, whose currencies are relatively strong against the US dollar, to increase the price per share rather more than 5% per year. However, in the face of much opposition, a compromise proposal was accepted which will enable voluntary contributions!)

Activities

The primary business of the Union is to encourage the development of all areas of physics through assistance in the organisation and sponsorship of international conferences. Indeed IUPAP has sponsored some 80 international meetings over the three years since the last general assembly. A vital part of its role is that it insures, as a condition of sponsorship, that host countries respect the free circulation of scientists. Provided visa applications are made at least three months before any conference, the Secretary General will intervene strongly whenever a visa has not been issued with two weeks to go.

Commission Reports and Elections

The business of IUPAP is conducted through its council and eighteen specialised commissions (C2 through C19). Each commission consists of a Chairman, Vice-Chairman, Secretary and ten ordinary members. Elections for each position (for a three-year term) are held during the general assembly. The retiring president of IUPAP was Professor A. Bromley of Yale University, and the emphasis on applications of physics at this meeting undoubtedly owed much to his influence. It is a shame that his recent ill-health will deprive us of his participation at the Bicentenary Congress of the AIP. His successor as president, Dr L. Kerwin, is president of the National Research Council of Canada. His election is a fitting reward for many years of service to the Union.

The six Australians elected (or re-elected) to various commissions are:

C2: SUNAMCO: Dr W.R. Blevin, CSIRO, Sydney.
C4: Cosmic Rays: Prof. J.R. Prescott, University of Adelaide.
C7: Acoustics: Dr N.H. Fletcher, CSIRO, A.C.T.
C9: Magnetism: Dr T.J. Hicks, Monash University.
C15: Atomic and Molecular Physics and Spectroscopy: Prof. J.F. Williams, University of Western Australia.
C16: Plasma Physics: Prof. S.M. Hamberger, A.U.L.

Written reports were presented to the general assembly from each of its commissions. These reports included a brief summary of the state of the field and of the conferences sponsored over the past three years. I shall only mention a few highlights.

- The C2 commission has released a very useful new booklet on units, nomenclature, symbols and so on. Copies are available for US$3 per copy from the Chairman of C2, Prof. R. Barber of the Department of Physics at the University of Manitoba. Every department and laboratory should have at least one copy.

- It was noted by the C4 commission that the next major Cosmic Ray Conference will be held in Adelaide.

- Following the recent excitement in superconductivity, it has been
decided to remove the word 'very' from the title of C5 which is now 'Low Temperature Physics'.

- The commission C6 which deals with publications has been placed on standby for the next three years — no members were elected at this assembly.

- Commission C7, Acoustics, was congratulated on its attention to the needs of developing countries.

- The Nuclear Physics Commission, C12, has been forced by the increasing coincidence of meetings to introduce fairly strict guidelines for the future. It is hoped to appoint some centre (possibly a national laboratory) to act as a collector and disseminator of conference information. In this way it is hoped to avoid too much overlap. The major international meetings on Nuclear Physics, and on Particles and Nuclei, will be held in years 1986 + 3n and 1987 + 3n (with n integer) respectively. It is suggested that smaller, satellite meetings (within an hour or two of the main site) could be held in co-operation with the major meetings.

- The new commission on Astrophysics, C19, has been very active over the past three years. There was some very spirited discussion of its role vis-a-vis C4 (Cosmic Rays), but no formal resolution was presented.

Presidential Address

In his presidential address, Prof. Bromley raised a number of important issues of relevance to us.

- He observed that three commissions have established medals. The weight of IUPAP behind these awards makes them quite substantial, even though the cost is very small. (Australia has already been a beneficiary of this policy with the award of the Shakti P. Duggal award by the C4 commission to Dr. J. Frotheroe of the University of Adelaide two years ago.) Prof. Bromley stressed the tremendous public relations benefits of such awards for physics as a whole, and recommended that other commissions should seriously consider the creation of similar awards.

- Again, on the important theme of public awareness, the various commissions were urged to consider arranging public lectures on physics by gifted speakers, as an integral part of all IUPAP meetings. (In my view this should also be applied to all scientific meetings within our country.)

- Prof. Bromley also emphasised a point made by the C13 commission on 'Physics for Development'. That is, one should not under-estimate the impact of international conferences on governments in developing countries (and we could very easily be placed in this category!). Such meetings can serve to emphasise the enormous, beneficial contributions of physics to society. In addition, properly handled, they can serve as a stimulus to governments to take worthwhile new initiatives. For example, a recent C13 conference in Brazil provided the opportunity for a ministerial announcement of a new national program of development in physics.

Australian Representation

To conclude the summary of IUPAP business I would like to make the following observations. Australian members of IUPAP commissions are clearly well respected and valued, and our present number (six members) is a fair share. However, we do not have a strong record regarding executive positions. For the next round we should seriously consider nominating one or two of our senior representatives for an appropriate executive position. In this regard it should be noted that a new regulation, passed at this assembly, calls for one of the Chairman or Vice-Chairman of each commission to be either an industrial physicist or a physicist working in applied physics.

Furthermore, taking Prof. Bromley's exhortation seriously, perhaps we should consider hosting more IUPAP conferences and even the general assembly itself.

Scientific Program

Let me next turn to the scientific program, which was truly marvellous. Any institution which takes physics seriously should purchase copies of the proceedings, 'Physics in a Technological World' (at US$27.50) when they become available in 1988 from the American Institute of Physics. I can do no more than mention the highlights.

Pierre Aigrain, a Senior Manager of Laboratoire Thomson (France), one of the three largest producers of consumer electronics in the world, spoke on the role of government in R&D. In view of our own government's recent actions with regard to CSIRO and university research, it was refreshing to hear an experienced, successful industrial scientist talking sense. The role of government, thought its institutions must be to do what it does well, namely maintain a broad base of basic research accessible to industry and to provide the trained, scientific manpower which industry can use.

The following motion (proposed by G. Harbecke (Vice-Chairman C8) and seconded by P. Aigrain) was unanimously approved by the general assembly.

The recent economic evolution including corporate mergers, acquisitions, and structural financial and policy changes can endanger the long-term research and development efforts in industrial institutions. This could also be detrimental to basic research institutions who should be allowed to continue to fulfill their mission. Since both pure and applied physics now appear to be much more important for the economic development and prosperity of our countries than at any time in the past, the recent economic changes are of great concern to the entire physics community.

Dr. H. Casimir (of group theory fame) talked about his experiences as a research manager with Philips. Again, he made the point that "a nation which does not do its share of fundamental research cannot absorb the rest!" More importantly for our industrialists, he felt that the same applied to industrial research laboratories. The rule of thumb for research support at Philips (in the Netherlands) is an expenditure of 1-1½% of its gross sales on its central laboratory. This is supplemented by another 5-6% spent at smaller, more applied engineering and development laboratories. (Conversations with other company representatives, including Bell, AT&T and GE confirm the general ignorance among business school graduates, particularly fresh MBAs, of the important role of R&D in their companies.)

Dr. J. Demuth of IBM reviewed the state of the art for the scanning tunneling microscope (STM), which he felt had ushered in a new era of micro-technology. This device has exceeded all expectations, and now offers views of surfaces with atomic resolution. The STM can be positioned within 0.5 nm of a surface and the surface
The physicist

scanned in 0.025 nm steps! One can thus monitor the flatness of surfaces to unprecedented accuracy, and follow the mechanism of epitaxy and growth. With modification the STM can be used under water. Furthermore, by using the tip of the STM one can artificially create surface bumps and depressions which offers atomic scale information storage.

Dr Alfred Cho of AT&T Bell Labs described some of the mechanisms for creating artificially structured materials. This included thin-film techniques, band-structure engineering (a bad description, because the work is done by the structure, and not by the atoms), and impressively, molecular beam epitaxy (MBE). By continually monitoring atomic beam deposition on a semiconductor it is possible to accurately deposit one or two atom layers over 8 cm wafers. Such materials have gone rise to increases in electron mobility of a factor of 300-1000!

Furthermore, it is possible to construct artificial quantum wells with variable band-gaps and tuned emission or absorption frequencies, e.g. for solid-state lasers.

Michael Fisher gave a masterly overview of the role of the theorist in understanding the properties of matter and its phase transitions. The three-state Potts model, as solved by Baxter at ANU, was mentioned, as was recent work by Polyakov and collaborators on the relationship between, and dual invariance, field theory and condensed matter physics. Horst Stormer (again AT&T Bell Labs) reviewed recent data on the Fractional Quantised Hall Effect -- including new experimental hints of even fractions for the first time.

Paul Chu of Houston University was eminently suited to discuss high-temperature superconductors, where his group has been amongst the world leaders. Superconductors at around 90 K can be made quite reliably -- indeed the general form A_Ba Cu_3 O_y generally works, if A is any of La, Y, Nd, Sm, Eu, Gd, Dy, Ho, Er, Tm, Yb, Lu. These superconductors all involve mixed phase samples and their instability is a major problem. Critical currents up to 10^5 A/cm2 at 77 K have been obtained in thin film samples at IBM. There are still many more questions about these materials unanswered than answered and the action is very hot. At the present time, General Electric sponsors its scientists working in this area to at least four meetings per year! There are hints from the group in Beijing of samples with (as yet un-reproducible) superconductivity at 260-360 K!

Prof. Yu Ossipyan of the Solid State Physics Institute in the USSR, reviewed possible future applications of high-temperature superconductors -- assuming the problems can be overcome. The possible improvements in power generation and transmission, in new motors and bearings, in transportation, instrument making and so on, are mindboggling. In electronics one could have improved SQUIDs, faster current transport, faster logic cells (30 GHz is now available, 1 THz seems likely soon) -- and applications not yet imagined.

Hans Frauenfelder, who holds the interesting title of Professor of Physics, Chemistry and Biophysics, explained the vital role of physics in biology -- and vice versa. Paul Lauterbur reviewed recent progress in medical imaging, explaining how nuclear methods (including NMR alias MRI) offer an alternative to the traditional methods of investigation of the structure and function of living things by 'avoiding the reduction of a beautiful living thing to a clear soup'. NMR can now eliminate the need for exploratory surgery in many cases (including knees), and by triggering on a heart beat one can study, for example, blood flows and muscle movement in the heart in real time.

Perhaps the most impressive talk of all was that by Dr Paul Fleury of AT&T Bell Labs, entitled 'Physics and the Information Age'. He stressed the central role of physics in networks, photonics and micro-electronics. No longer can quantum effects be ignored in modern technology. In the future, integrated circuits and solid state devices will necessarily be designed using quantum physics. The case with which Dr Fleury could talk of research instruments purchased in units of millions of dollars, was stunning. Research in his laboratories has led to tremendous advances in the properties of glass for optical transmission.

Although there was a plateau in the 'bit-rate-distance' field for 1990 and 1960, physicists have lowered the logarithm of the optical loss per km by four orders of magnitude over the past 20 years. We are now very near the theoretical lower limit.

It is not possible, in the space available, to summarise the other talks on the state of various areas of basic physics. Drs Furth, Kleppner, Van Hove and Appelquist, reviewed the state of plasma, atomic, high-energy nuclear and particle physics respectively.

The audience was left in no doubt that each of these fields is in a state of rapid and exciting development.

Let me conclude with some of the remarks made by Roland Schmitt from General Electric, who gave an after dinner speech entitled 'The Industrial Physics Rollercoaster'.

"Physics is behind most of today's technology. Nevertheless, we are too willing to move into the background and let the engineers take the credit for our creations. We must make greater efforts to explain to government, to industry, to the general public and to potential future physicists, how important physics is in our technological world."

Academic Standards Panel in Physics

The Australian Vice Chancellors Committee is to establish a series of Academic Standards Panels in major disciplines in universities, beginning in 1988 with the disciplines of history and physics. These disciplines were chosen because they represent major subject fields, one from the sciences, one from the humanities. Further panels are anticipated to be formed in 1989.

The AVCC believes it is vital that universities accept their traditional responsibility for the maintenance of academic standards. The role of the Academic Standards Panels will be to provide co-ordinated advice to university departments on standards in the discipline across the universities, so providing a mechanism by which assessment, particularly of honours students, might be compared between departments.

The panels will, in the course of about three years, visit each university department in a given discipline and will review matters related to the curriculum and assessment of performance. The initial priority will be with honours courses but advice on pass degree standards and coursework Masters may also be forthcoming. The panels will also consider annually the statistics of honours and pass gradings and will review some student work constituting part of the assessment process. Departments will provide samples of thesis, reports and examination papers and scripts for the Panel's use.

The Academic Standards Panel of the discipline of Physics will be convened by Professor Jim Piper of Macquarie University and five members drawn from the discipline across Australia.
What the Australian Institute of Physics means to you

Physics is an important science, a vital academic subject — and a profession central to Australia's development.

Since our beginnings in 1963, the Australian Institute of Physics has promoted the interests of physicists in a large number of ways:

- fostering a strong professional identity and fellowship among physicists — enabling you to meet with your colleagues on a regular basis.
- setting high standards of qualifications as a physicist.
- helping with the review and recognition of tertiary physics courses.
- expressing the views and interests of physicists to government bodies and other employers.

- promoting the value and interest of physics as a study subject.
- holding regular conferences and publishing the views of members along with other matters of interest.
- encouraging excellence in research and teaching with prizes and awards.
- encouraging outstanding students with awards and subsidies.

What you mean to the Australian Institute of Physics

Physicists with the concern and commitment to take an active interest in their profession are the lifeblood of the Institute.

As you'll see from our grades of membership, we welcome students, graduates, professional members, fellows, as well as associates and subscribers. The two latter grades cater specifically for people who do not qualify for full membership, but who have a demonstrable interest in physics.

Whatever your professional involvement or interest in physics, your participation is actively sought and welcomed. A broad cross-section of members makes for healthy discussion and a fresh approach, enabling the Institute to present a balanced and up-to-date viewpoint.

Grades of Membership

Student  For tertiary students majoring in physics. You will receive all mailings and notices, plus the Australian Physicist. Student members are eligible for Graduate Membership upon passing with a Physics Major.

Graduate  A 3-year pass degree with a physics major is required, from a university or recognised college. After 5 years in the intermediate grade, a graduate is eligible for elevation to the professional grade of Member.

Member  Our normal professional grade, to which most members belong, after they have had at least 5 years professional experience after graduation.

Fellow  Our elite grade. Most Fellows have around 15 years experience after graduation, usually a PhD and a number of well-regarded publications in appropriate journals.

NOTE: If you are overseas for the whole year, or unemployed, or if you are a full-time postgraduate student, your fee is halved.

How to become a member

If you are a student, or employed in a tertiary institution or government establishment, you'll usually have ready access to application forms. If not, please phone, or write to:

The Membership Registrar, Science Centre, Clarence Street, Sydney, NSW 2000.

Phone: (02) 29 7747

Fees at time of printing are:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Fee</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student</td>
<td>$11</td>
</tr>
<tr>
<td>Graduate</td>
<td>$45</td>
</tr>
<tr>
<td>Member</td>
<td>$70</td>
</tr>
<tr>
<td>Fellow</td>
<td>$95</td>
</tr>
<tr>
<td>Subscriber/Associate</td>
<td>$40</td>
</tr>
</tbody>
</table>
The Amplitude of Solar Cycle Number 22

Richard J. Thompson
IPS Radio and Space Services
P.O. Box 702, Darlinghurst, NSW 2010

Introduction

It is now apparent that the end of solar cycle number 21 was reached in September 1986 when the yearly smoothed sunspot number dropped to a minimum of 12.4. Since that time the new cycle, denoted cycle 22, has risen strongly and the sunspot number had climbed to 19.4 in February 1987. If this new cycle rises in the average manner of historical cycles, we will reach a maximum sunspot number late in 1990.

The prediction of the sunspot number of the next solar maximum is important. A successful prediction can provide insight into the mechanism by which the solar cycle is generated. The prediction of the amplitude is also important for a number of very practical purposes. For example, a large solar cycle with a high maximum sunspot number supports a wider spectrum of usable hf communication frequencies than a small one. Many of the users of the hf predictions provided by IPS Radio and Space Services require long-term predictions to plan their communication systems. A large error in the predicted maximum could result in considerable cost.

The crash of Skylab in July 1979 was a notable example of the result of an incorrect solar cycle prediction. Skylab was launched in May 1973 to an altitude calculated on the assumption that cycle 21 would be a small one. In fact the cycle was large, the second highest on record, and Skylab was subjected to more atmospheric drag than was anticipated. This caused the orbit to decay before the development of the Space Shuttle could support Skylab activities.

A large solar cycle has its disadvantages as well as its advantages. Solar flares are more frequent in a large cycle and these can cause fadesouts of some, or even all, hf communications. Known as short-wave fadeouts, these are important events for over-the-horizon radars such as Jindalee as well as for ordinary hf communications.

A large solar cycle also produces more frequent disturbances to the ionosphere and the geomagnetic field than a small cycle. These disturbances result from particles ejected from the sun during energetic events such as solar flares. If the particles reach the earth they induce currents in the magnetosphere. The effects of these currents on the ionosphere is known as an 'ionospheric storm'. The corresponding effect on the geomagnetic field is known as a 'geomagnetic storm'. Ionospheric/geomagnetic storms degrade hf communications, disrupt geophysical prospecting for minerals, produce current surges in powerlines and corrosion in pipelines, and are associated with anomalies in the operation of satellites. They are sometimes even associated with the loss of homing pigeons!

The Prediction of the Next Cycle

A wide variety of methods have been used to predict the amplitude of a cycle prior to the previous solar minimum. A description of the various techniques is given by Brown (1984a). They include the analysis of the time series of historical sunspot numbers to establish a power spectrum of periodicities. Once established, the series can be extrapolated to generate a prediction of the next cycle. Unfortunately, the solar cycle appears to be highly variable in its behaviour, perhaps even chaotic, and these techniques have had limited success in the past.

Another common technique is that of 'secular cycles' in which a long-term trend in solar activity is perceived and then extrapolated to the next cycle. An example is the Gleissberg cycle with a period of around 80 years, (Gleissberg 1942). Predictions based on the Gleissberg cycle have been indicating a decline in solar activity since the record sunspot maximum in 1957 on the assumption that this was the peak of the Gleissberg cycle. In the 30 years since that maximum we have seen a continuation of strong cycles with a slightly above average cycle (number 20) and then the second largest on record (cycle 21).

Other techniques which have been used include the correlation of solar activity with alignments of the planets or with the motion of the sun with respect to the centre of mass of the solar system. These techniques have not been very successful in the past and we certainly lack a physical understanding for any such correlations if they exist.

The only prediction methods which have general approval are the 'precursor' techniques. These operate on the notion that a solar cycle really begins some years before solar minimum and the first manifestation of the new cycle is the formation of stable large scale magnetic structures known as coronal holes. Coronal holes are sources of streams of high speed solar wind which produce a terrestrial ionospheric/geomagnetic disturbance whenever a stream reaches the earth. The stability of the coronal holes gives rise to a sequence of disturbances spaced by 27 days, the apparent rotation period of the sun. Such disturbances are known as 'recurrent' and their number, strength and stability in the declining phase of a cycle seem to be useful predictors of the strength of the following cycle.

The connection between recurrent geomagnetic disturbances in the declining phase of a cycle and the strength of the next solar cycle can be seen in Figure 1. This shows the variation of sunspot number since 1930 (dashed line and left scale) and also the number of geomagnetically disturbed days since 1932 (solid line and right scale). A day is considered to be geomagnetically disturbed if the daily planetary A index (Ap) was greater than 24. The level of disturbance appears to vary with
two components. Firstly, there is a component which is approximately in phase with the solar cycle. These disturbances show only a weak tendency to be recurrent. Secondly, there is a component which peaks in the declining phase of some, but not all, solar cycles. For example, two of the largest peaks in Figure 1 occurred in 1951-52 (just before cycle 19, the highest on record) and in 1973-74 (just before cycle 21 which was the second largest cycle on record). The disturbances in these peaks exhibited a very strong tendency for recurrence. Both peaks were characterised by ‘monster’ solar wind streams giving rise to two equally spaced disturbances during each solar rotation. These streams were long-lived, lasting for more than a year. In contrast, the declining phase prior to the relatively weak cycle 20 shows evidence of a very small peak of recurrent geomagnetic activity in 1963.

An interesting feature in Figure 1 is the large peak of disturbances visible in the declining phase of solar cycle 21 during the period 1982-1984. The disturbances during this time show a strong tendency to be recurrent but did not show the same general stability as the ‘monster’ streams of 1973-74. The peak was also strange in that it occurred quite soon after solar maximum as compared with the earlier recurrent peaks. Also, it followed a trough of magnetic disturbance around 1980. This year was quite unusual because, even though it was close to the maximum of the second largest cycle on record, it was a year of very low magnetic disturbance.

In spite of some unusual features it is interesting to predict the amplitude of cycle 22 on the basis of the 1982-1984 disturbance peak. This has been done by Thompson (1985) who predicted a sunspot maximum of 159 for cycle 22.

Other estimates using variants of the precursor technique have shown a fair scatter but all are above the long-term average cycle amplitude of slightly more than 100. Table 1 summarises some recent predictions.

<table>
<thead>
<tr>
<th>Author</th>
<th>Predicted sunspot number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brown (1984b)</td>
<td>120</td>
</tr>
<tr>
<td>Kane (1987)</td>
<td>185</td>
</tr>
<tr>
<td>Kataja (1984)</td>
<td>140</td>
</tr>
<tr>
<td>Sargent (1987)</td>
<td>118</td>
</tr>
<tr>
<td>Schatten (1984)</td>
<td>109</td>
</tr>
<tr>
<td>Schatten and Sofie (1987)</td>
<td>170</td>
</tr>
<tr>
<td>Thompson (1985)</td>
<td>159</td>
</tr>
</tbody>
</table>
The average sunspot number given by these predictions is 143. This is slightly above the value of 130 which has been adopted by IPS for its long term hf predictions.

**The Rise of Solar Cycle Number 22**

After solar minimum it is possible to predict the ensuing solar maximum purely from the rate of rise of the cycle, e.g. McNish and Lincoln (1949). Naturally, such predictions are more accurate, but less predictive, when there is a long elapsed time from solar minimum. We have now seen 11 months of the new cycle and have seen bursts of solar region growth in October 1986, April-May 1987 and in July-September 1987.

Figure 2 shows the regression between the rise in sunspot number in the first 11 months of a cycle and the ultimate peak sunspot number. The dots are the observed values for the 21 solar cycles for which we have reliable monthly sunspot data and the solid line is the least squares best fit line. The dashed vertical line is the value observed for the present cycle. It is very interesting to note that the present cycle has risen much faster than any of the previous cycles. However, at this early stage, the correlation of cycle rise and ultimate sunspot number is still very weak and the relationship is affected significantly by factors such as the shape of the cycle, the height of the minimum and perhaps the amplitude of the previous cycle (which might delay or advance solar minimum depending on its amplitude). With these limitations, the data in Figure 2 can be used to estimate the cycle amplitude and a value of $156 \pm 42$ is obtained. The uncertainty in this figure probably only entitles us to say that the cycle will be above average in amplitude, as has been predicted by the precursor techniques. However, within 6 to 12 months, this method should be capable of predicting the cycle amplitude with an accuracy of $\pm 20$ in sunspot number.

---

**References**

The Physicist

An Experimental Test of the Basis of Probability Theory

Cherie Sutherland McCusker and Brian McCusker
School of Physics, University of Sydney, Australia 2006

Introduction

The theory of probability underlies a great deal of modern science. In physics, for instance, the fundamental theory, quantum mechanics, deals only with probabilities. The Schrodinger wave function is itself the square root of a probability. Chemistry and biochemistry, in turn, lean heavily on quantum mechanics. In much psychology, sociology, and the social sciences, statistical methods are common. Even C.G. Jung, who was not fond of mathematics, used statistical analysis in his attempt to validate astrology. However, the theory of probability itself is based on an axiom. To many people, this axiom appears trivially obvious, just as does the parallel axiom in Euclidean geometry. But, as Riemann and Lobatchevsky showed over one hundred years ago, we can have viable geometries without Euclid's parallel axiom. And indeed, as the work of Einstein and his followers has shown, in the Universe at large it may well be that it is the non-Euclidean geometries that give the correct description. So, having seen one 'obvious' axiom overthrown, it is common sense to have a good look at others. This is what we do in this paper. We describe an experiment to test the validity of the axiom of probability theory. It is not an original experiment but, in part, is an exact copy of an experiment carried out by Dr Jane English and her co-workers. Our results confirm her findings. In easily repeatable circumstances the predictions of the axiom are grossly in error.

A Basic Axiom of Probability Theory

We will first give a non-mathematical statement of the axiom. Suppose we have a deck of 52 playing cards, and that we shuffle them thoroughly and then spread them face downwards on the table. If we nominate one particular card, say the Queen of Hearts, and then make a selection of one card from the face-downwards deck, the axiom says that the chance of drawing the Queen of Hearts is one in fifty-two and if we continue to make selections, the number of times the Queen appears will approximate more and more closely to the number of selections divided by fifty-two. If we use a Tarot deck, then the chance of getting a particular card is one in seventy-eight rather than one in fifty-two.

Mathematically, the axiom can be stated as follows. Suppose that we have a number of ‘elements’: these elements might be, for instance, the results of successive throws of a die. Each element will have some property. In the case mentioned, it is the number of the die face that is uppermost. When we have accumulated a large number of elements then the number of cases in which each property occurs will approximate closely to the measure of the property. In the case of the die throws this will be 1/6, if we assume that the die is true, that is, that all the faces are of equal size, that the die is of uniform density and so on. If we accumulate n elements and the number of times that the ith property occurs is ni, then the axiom states that \( \lim \frac{n}{\frac{1}{m}} = \infty \) where m is the measure of the property. It is called the relative frequency of the ith property. In the case of the die it will be 1/6 for all six properties. Alternative versions of the axiom exist. All, however, lead to the same prediction, namely that in the case of the die the relative frequency of occurrence of any one face will be 1/6, in the case of playing cards the relative frequency of occurrence of any one card will be 1/52; and in the case of Tarot cards it will be 1/78.

It will appear to most materialists (and to many others) that the axiom is obviously true. But it will not appear as such to some other sorts of people; for instance, practitioners of the Tarot. What Dr English did was to put it to experimental test.

The English Experiment

Jane English, who is both a physicist and a practitioner of Tarot, became interested in reconciling, if possible, these two very different symbolic systems for understanding and manipulating the Universe. As a Tarot practitioner she was in the habit of beginning each day by, first, meditating and then selecting a card from a face-downwards spread of a Tarot deck. This first selection was a selection for body, that is, she was interested in getting a feeling from the Tarot of the state of her body. She then made a second selection, this time for mind, then a third for spirit. She recorded these three selections each day in her journal. When she became interested in the comparison of Tarot and physics she had 1982 selections available for comparison with the predictions of the axiom. She made the comparison using a standard chi-squared test. She got a value of chi-squared of 127.3 for 77 degrees of freedom. From the tables quoted, this gives a probability of her result being in agreement with the predictions of the axiom of 0.03%; that is, not good agreement at all.

Moreover, she had two friends, also Tarot practitioners, who had carried out the same procedure for longer periods. One had accumulated 2395 selections and had a value of chi-squared of 132.4 giving a probability of being in agreement with the predictions of the axiom of only 10^-4 (that is, 1 in 10,000). The other had accumulated 2015 selections, had a chi-squared of 1161.0 and thus had a quite negligible probability of being in agreement with the predictions of the axiom (much less than one in ten thousand million).

It is worth noting that most of Jane’s readings and all of her friends’ readings had been accumulated before the idea of a statistical test occurred to her.
The Physicist

After making the test on her Tarot readings Jane carried out a ‘control’ test using a pack of cards which were blank on one side and numbered 1 to 78 on the other. She made 1982 selections. The selections were made without previous meditation and all in one period of a few hours. The value of chi squared was 85.8 giving a probability of being in agreement with the axiom of 47%. She also made 13 runs, totalling 24,183 selections, using an Apple computer to mimic the Tarot process. This gave a somewhat ambiguous result. Overall, the resulting distribution was not in disagreement with the predictions of the axiom. However, one run had a probability of only 0.05 of being in agreement with the predictions of the axiom.

The Present Experiment

One of us (B.McC) became aware of the Jane English experiment in late 1983. In mid-1985 we decided to repeat it, and maybe, extend it. We began work on it on Oct. 1, 1985. Like Dr. English, we had three participants, namely the two authors of this paper and Eden Sutherland, the fifteen year old son of Cherie Sutherland. Cherrie and Eden opted to carry out an exact copy of the Jane English experiment; Brian McCusker to carry out a slightly different experiment. This was to select, each day, one card from the major arcana of one deck and one card from the minor arcana of a different deck. Cherrie and Brian made their selections each morning immediately after meditating. They were able to complete the year without missing a day. Eden was less regular, to begin with, and only completed his 365 selections on May 25, 1987.

Eden’s selections give a value of chi squared of 141.3 (for 77 degrees of freedom) against the predictions of the axiom. This gives a probability of only $1.4 \times 10^{-1}$ for agreement with the axiom. Brian’s two selections give values of chi squared of 15.8 for 21 degrees of freedom (probability for agreement 0.79) and 54.5 for 55 degrees of freedom (probability for agreement 0.5). However, these last two trials were for only 365 selections each. Cherrie’s 1095 selections gave a value of chi squared of 282 (for 77 degrees of freedom). The probability of this being in agreement with the predictions of the axiom is of the order of $10^{-24}$, that is, one chance in one million, billion, billion!

Like Jane English, we made a ‘control’ experiment. This was to select each day a card from a deck of (52) playing cards. This selection was made casually but otherwise in similar conditions to the Tarot selection. Cherrie and Brian each made 365 selections and Eden 109 selections. No considerable deviations from the predictions of the axiom were found.

Thus the results of our experiment strongly support Dr. English’s results. Both of our trials that followed the Jane English procedure gave results strongly disagreeing with the predictions of the axiom.

Comparisons with Some Other Experiments

The results of many earlier experiments can be seen as supporting those of Dr English and ourselves. For instance, in 1934, Dr J.B. Rhine reported the results of a series of tests using a deck of cards of his own devising. The deck consisted of five sets (or suits) each of five cards. Each card bore one of five symbols: a star, rectangle, cross, circle, or wavy lines. The experiment involved a ‘subject’ and an ‘experimenter’. The deck was shuffled, cut and placed face downwards on the table. The subject then guessed to which suit the top card belonged. The top card was then removed by the experimenter, still face down, and stacked for later recording. The experimenter also recorded the guess. The procedure was then repeated for the next card until all 25 cards had been tested. Later the guesses were compared with the predictions of the axiom. This predicts that in a large number of trials the guess will be correct close to 20% of the time.

One of Rhine’s subjects in over 700 runs (that is in over 17,500 guesses) guessed correctly more than 32% of the time. Using the chi squared test this gives a value of chi squared of 1575 for one degree of freedom. If the axiom were true, this result is astronomically more improbable even than those already reported. The direct and simplest conclusion from Rhine’s experiment is that the axiom is untrue. Many similar experiments have since been reported.

It is well known that Dr. Rhine considered that this experiment proved the occurrence of clairvoyance. This, we believe, is a secondary conclusion which may or may not be correct. What the experiment shows primarily is that there is an enormous discrepancy between the experimental results and the predictions of the axiom.

This is borne out by other experiments reported in Rhine’s book and elsewhere. For instance, following a remark made by a young professional gambler, Rhine became interested in dice throwing. In his first test which involved 900 runs of 24 throws per run, he found that the probability of his results being consistent with the predictions of the axiom was less than $10^{-14}$. He attributed this result to ‘psychokinesis’. In other experiments, gross deviations from the predictions of the axiom have been attributed to clairvoyance, telepathy, precognitive telepathy, postcognitive telepathy, etc. While all these effects may occur, what we want to point out is that there is no need to make this large number of hypotheses. What all the results show primarily is that the predictions of the axiom are in error.

This interpretation is supported by the results of an experiment carried out by Robert Harvie, who attempted to duplicate parapsychological guessing experiments but with any possible ‘psi’ intervention eliminated. His method was to compare a table of ‘pseudo random’ numbers with two sets of random numbers, one set from Kendall and Smith’s tables and the other from the Rand corporation. In each case the two lists were compared number by number and the number of coincidences noted (that is, the number of cases when a 9 matched a 9, a 2 matched a 2 and so on). The expected number of coincidences, assuming the truth of the axiom, is $1/10^6$ the number of trials. In a total 49,600 trials he found that the probability of agreement with the axiom was only 0.0008.
Perhaps even more remarkable are the results of the attempts to produce the tables of 'random' numbers. G. Spencer Brown in his book *Probability and Scientific Inference* says (p.89) "Almost all long series, from Weldon's dice data to Rand's random digits, have been found to be significantly biased when tested. Those that have been subsequently published have had the bias removed before publication (our italics).

**A Discussion of the Experiments**

As noted above, in our two experiments five trials out of eleven gave results violently disagreeing with the predictions of the axiom. These five all were made using Tarot cards, after meditation, making only one set of three selections per day, and accumulating more than one thousand trials. These observations give us some idea of the necessary conditions for easily demonstrating the failure of the axiom.

Before detailing these conditions it is worth considering similar situations that have arisen in science before. For instance, classical physics was for long the backbone of science but we now know that it is a grossly incorrect description even of the material universe. Obviously, then, at least one of the axioms upon which it is based must be incorrect. If one wishes to demonstrate the inadequacy of classical physics one has a large number of experiments to choose from. A simple, cheap, straightforward way would be to observe the optical spectra from a sodium or mercury vapour lamp. Classical physics fails miserably in its attempt to account for these spectra. However, if one attempted to demonstrate the failure of classical physics by measuring the varying position of the planet Jupiter, one would need extremely expensive equipment and a very long observation time and even then one might not achieve the necessary accuracy.

So, one might expect a similar state of affairs in testing the axiom of probability theory. What Jane English has done is find a simple experiment that shows large discrepancies.

**A Connection with Recent Experiments in Quantum Mechanics**

The axiom of probability theory came out of the same intellectual climate as classical physics. The assumptions underlying both were realistic, materialistic, deterministic, and reductionist. As we mentioned above, classical physics failed catastrophically even to explain material phenomena. It was replaced over sixty years ago by quantum mechanics. This is a non-realistic theory (in the philosophical sense of the word 'realism'); it insists on the essential role of the observer.

This non-realism and other features of quantum mechanics disturbed many people, including Albert Einstein. In 1935, he and two collaborators, Boris Podolsky and Nathan Rosen, wrote a paper purporting to show that quantum mechanics is an incomplete theory. Two of his underlying assumptions in this paper were realism, that is the belief that a physical universe exists independent of any observer and, secondly, Einsteian locality. This is a belief that action at a distance does not occur and that no influence of any kind can propagate faster than the speed of light. However, recent elegant experiments in physics have shown that the predictions of Einstein's realistic theory are grossly in error and, on the other hand, the predictions of quantum mechanics are accurate.Aspect and his co-workers write that their results 'rule out the whole class of realistic local theories'.

The results of the Tarot experiments also strongly contradict predictions from the 19th century view of the universe. Like quantum mechanics, the Tarot experiments emphasize the importance of the observer in the universe. And, if the observer is important, then any accurate description of the universe must include a detailed study of the observer, that is, of ourselves. This crucial point has been completely overlooked by most psychologists. Fortunately, it has not been overlooked by some psychologists. Synchronistically, in the very year that Max Planck put forward his quantum hypothesis Sigmund Freud published *The Interpretation of Dreams*. Since then, psychology has progressed from Freudian to Jungian to Humanistic/Gestalt to Transpersonal. From 1977 to date a remarkable synthesis of this modern work with the older, mystical schools of psychology (Vogic, Buddhist, Zen, Christian, Jewish, Taoist, and Sufic) has been made by Ken Wilber. In this synthesis the universe is no longer seen as matter, with consciousness as a very occasional by-product of electrochemical interactions in a brain, but as consciousness structured in nine main levels, the lowest level of which is matter. In *The Atman Project* Wilber describes the levels and makes a comparison of the major schools in considerable and convincing detail. In *Up from Eden* he gives a transpersonal account of evolution — seeing it primarily as evolution in consciousness and thus avoiding the many pitfalls that have trapped generations of Darwinian and neo-Darwinian theorists. In *Eye to Eye*, along with much else, he has elucidated the deep structure of the scientific method and shown how it may be applied in all three main realms of consciousness, the empiric realm, the mental realm and the spiritual realm.

The results from the Tarot experiments and from the earlier experiments of J.B. Rhine and others fit beautifully into this picture. So do the quantum experiments of Clauser, Aspect, and others. However, the Tarot experiments have many advantages over the more physical experiments. The Tarot experiments are much less costly; they can be tried by very many more people; and they lend themselves to very considerable further development. They may turn out to be important for the exploration of higher levels of consciousness. We hope to deal with this more fully in a later paper.

**Doing it Yourself**

Unlike many experiments in modern science, this experiment readily lends itself to checking by the reader. This repeatability is considered by many to be one of the essentials of the scientific method. For readers who wish to make this check for themselves we offer the following suggestions.
The Physicist

AUSTRALIAN

a) If possible, work with a group of people. We notice that one person out of six failed to establish a deviation from the predictions of the axiom in one year.

b) Arrange for some of the group to follow the Jane English procedure exactly. This includes meditating for at least twenty minutes before making the selections and only making one set of three selections per day.

c) Preferably have a number of people already familiar with Tarot in the group.

d) Preferably, if the group is not balanced sexually, have more women than men.

e) Arrange for at least one member to be familiar with the chi squared test. An excellent popular account of this appears in Moroney's book *Facts from Figures* published by Pelican.

f) Preset the time for which the experiment is to run. If possible this should be at least one year.

g) Send us the results.

Finally, if you find it difficult or even impossible to believe in a breakdown of the axiom, remember the story of Galileo and the Cardinals. Galileo used the newly invented telescope to discover four moons revolving around the planet Jupiter. The Cardinals, following Aristotle, believed such moons to be impossible. Galileo invited them to look for themselves. The Cardinals refused, saying they had no need to waste time on such nonsense. The Cardinals were wrong.

Acknowledgements

We are grateful to Drs Jane English, Frances Vaughan, and Roger Walsh for their comments on our manuscript and their suggestion for its improvement.

REFERENCES


BRANCH SECRETARIES — ADDRESSES:

NSW Dr A.J.D. Farmer,
C.S.I.R.O., Applied Physics,
P.O. Box 218,
Lindfield, NSW 2070
Ph. (02) 467 6302

ACT Dr K.G.H. Baldwin,
Research School of Physical Sciences,
A.N.U.,
P.O. Box 4,
Canberra, ACT 2601
Ph. (062) 49 2769/2404 (W.H.)
95 1562 (A.H.)

SA Dr A.A. Pugatschew,
School of Physics,
South Australian Institute of Technology,
P.O. Box 1,
Ingle Farm, SA 5098
Ph. (08) 343 3057

VIC Dr K. Nugent,
School of Physics,
University of Melbourne,
Parkville, VIC 3052
Ph. (03) 344 5457

QLD Dr P.E. Monro,
Department of Physics,
University of Queensland,
St Lucia, QLD 4067
Ph. (07) 377 3413 (Messages on 337 3424)
379 6754 (A.H.)

WA Mr G. Hitchen,
School of Mathematical & Physical Sciences,
Murchison University,
WA 6150
Ph. (09) 332 2433

TAS Dr J.E. Humble,
Physics Department,
University of Tasmania,
P.O. Box 252C G.P.O.
Hobart, TAS 7001
Ph. (002) 20 2423
FAX: (002) 20 2186
letters to the editor

Indigation

Dear Editor,

I regret to say that the review by C.A. Hurst (1986) of my book (Mayants, 1984) is too superficial. The reviewer has not realised that the book is a single whole which renders basically a coherent exposition of two new, unique sciences: probabilistics (science of probability) and probabilistic physics (application of probabilities to physics). If the reviewer had read the book more carefully, he would not say that the way of presenting equilibrium classical statistical mechanics and quantum mechanics is banal, for it can be anything but that. That no concrete particle can have zero rest mass is not asserted, but strictly proven, and this fact cannot be disproved by reviewer's mere allegations. The book does not contain any 'standard physics' and, hence, does not have a superficial treatment of it either. The reviewer's question of the range of readers is answered in detail in the prefect (pp.xviii-xx) and in Henry Margenau's foreword, and the question would not arise if he had read these items. As to his opinion of the superiority of E.T. Jaynes' approach, I would be only too glad to welcome it myself if it could lead to a coherent construction of a science which would settle all current quantum-related issues and contradictions as easily as probabilistic physics does.


L. Mayants
Department of Physics and Astronomy
University of Massachusetts
Amherst, U.S.A.

Australian Journal of Physics

Dear Editor,

For many years the AIP has been active in resisting attempts by government to abandon publication of the Australian Journal of Physics. One of the ways in which the AIP is supported is through the sale of personal subscriptions with AIP membership fees.

I was, therefore, dismayed to receive, with my 1988 account, a curt statement 'because of admin. (sic) difficulties we cannot change, as in past years, offer reduced subscriptions to various journals'.

The implication of this is that reduced subscriptions are not available. It was only when I received a letter from the CSIRO Publishing Unit that I realised that this was not the case.

The continuation of the AIP is vital for physics in Australia. It has international acceptance as a journal of high quality and rigorous standards.

The executive should reverse this decision immediately. A more appropriate solution to the administrative problem is the inclusion of the journal subscription as part of the membership fee. The cost of a personal subscription is $50.00 per year, which, after deduction from income tax, is the cost of a lunch.

T.M. Sabine
School of Physical Sciences
NSW Institute of Technology
Broadway, NSW 2007

More on Creationism

Dear Editor,

Bickering about the standards of teacher training in Queensland and New Zealand is in danger of obscuring Barend Vlaardingerbroek's principal point (Aust. Phys., 24, 191) that creationism is dangerous. As a member of the national committee of Australian Skeptics, the only organised anti-creationist movement in Australia, I have witnessed the rise of this threatening phenomenon. To combat a belief system one must first understand it, so some comments on its nature are in order.

Creationism is the belief that the universe was created in six days by God about 6,000 years ago. Its adherents are invariably fundamentalists who believe that every word of the Bible is literally true and that the 6,000 year figure is implicit in the Bible. Creationists take particular exception to theories of human descent from lower life forms.

While personal beliefs remain sacrosanct, the problem arises when creationists misuse scientific arguments and logic in attempts to prove the cosmos is only 6,000 years old. Creationists fit the data to the hypothesis, rather than vice-versa. Such attempts are on the increase: geology, cosmology, thermodynamics, and the science of life are all under attack. Few scientists have bothered to respond to the amateurish arguments of the creationists (or 'creation scientists' as they term themselves), precisely because the arguments are so ludicrous. Yet that is to miss the point. Members of the public come to see only the creationist side of the argument, and not surprisingly often favour it. It is imperative that the scientific viewpoint be put over at an intelligible level, preferably in the mass media. There is no point in holding high-level academic discussions in low-circulation journals read only by scientists already hostile to creationism. Otherwise, once a significant fraction of the population is creationist, their votes will be won by the politicians of the day, with dangerous consequences for scientific truth.

Fortunately, the creationist arguments are so woefully ridden with errors that refuting them is easy; but media access presents a greater problem. All physicists with sympathetic media contacts should impress on them the importance of the problem, so as to raise the level of informed consciousness on the topic. Creationists should not go unchallenged on 'phone-ins.

The book 'Creationism: An Australian Perspective', by Queensland academics Ken Smith and Martin Bridgestock, summarises the arguments used by creationists in all fields of science and clearly details their errors. It provides a valuable inoculation, and is available from: Australian Skeptics, P.O. Box 575, Manly, NSW 2095, price $10.00 including P&P. I recommend it to all scientists and other concerned persons.

When argued against creationists in person an entirely different tack should be taken. Creationists are ultimately interested not in science, but in what the Bible says. With these people, the many inconsistencies which arise from a literal interpretation of the Bible should be highlighted. Which edition? Which translation? Finding inconsistencies is not difficult, and throws the burden of defence on to the creationists. Scientific argument, no matter how accurate, puts the scientist on the defensive and is better avoided until the upper hand is gained; creationists are adept at trite responses calling for elaborate counter-argument.

Creationism belongs in schools only in comparative religion courses. Wherever it masquerades as science it should be mercilessly exposed. It would say much for the AIP if it were to follow up the lead given at the 1986 ANZAAS conference with a briefing at the January bicentennial congress.

A.J.M. Garrett
School of Physics
University of Sydney
NSW 2006

Correction

On page 261 of volume 24 of the Australian Physicist (December 1987) the caption for the front cover referred to the Map Section of the MLA. This should have been the Map Section of the National Library of Australia (NLA). Apologies to all concerned.
University of Otago  
Dunedin – New Zealand

Chair of Physics

Applications are invited for appointment to a Chair in the Department of Physics. Applicants should have a substantial research record in some area or areas of physics, preferably in a field with some broad connection to those fields currently pursued in the department — atomic and laser physics, the physics of the magnetosphere and the earth's environment, thin film optics, energy physics, medical physics.

Professorial salaries are presently paid within the range $NZ68,000 — $NZ85,000 per annum.

Further particulars are available from the undersigned, PO Box 56, Dunedin, New Zealand.

Applications quoting reference number A87/85, close with the Registrar on 31 March 1988, or as soon as possible thereafter.

D.W. Girvan  
REGISTRAR

Selby RMIT  
Centenary Scholarship

The Selby Scientific Foundation, to honour the Centenary of the Royal Melbourne Institute of Technology, offers a Master by Research Scholarship to the value of $10,000 per year for two years.

The successful applicant will work in the field of High-Temperature Ceramic Superconductors.

This prestigious scholarship is designed to introduce a Physics Graduate student to the very important field of superconductivity.

For further information, contact:
Dr A.F. Moodie (F.A.A.) (Tel: 660 2434)
or, Dr I.K. Snook (Tel: 660 2143),
Department of Applied Physics, RMIT, 124 La Trobe Street, Melbourne, VIC. 3000.

Quality Management in the Testing Laboratory

NATA, the National Association of Testing Authorities, is now offering an intensive three-day training course in laboratory management. The course is structured around the application of quality management principals to the operation of testing, measurement, and calibration laboratories.

The courses will be conducted in Adelaide, Brisbane, Melbourne, Perth and Sydney during 1988, at a cost of $480 to non-members and $420 to members.

For further information, contact:
Mr Ian Waples, 
Manager, Promotion and Development, NATA, 688 Pacific Highway, Chatswood, NSW 2067. 
Telephone: (02) 411 4000.
book reviews

Introduction to Physical Mathematics

P.G. Harper & D.L. Weaire

This book is developed from a course given to first-year students at the Heriot-Watt University, Edinburgh. It is given in parallel with a pure mathematics calculus course and an introductory physics course and is meant to form a bridge between the two.

The book starts with the basic notions of the calculus and goes on to finish with vector calculus and partial differential equations. The treatment of each topic is brief, but practical questions of computation and the physical significance of results are emphasised, and as a consequence the exercises form an important part of the book.

One gets the impression that these days the old subject 'applied mathematics' is disappearing from the curriculum, or is searching for a new identity. I would recommend that applied mathematicians consider introducing courses such as the one on which this book is based, but with the extension that even more computer work is carried out through the exercises. Such a course, taken by all science students, would produce graduates with an appreciation of how to obtain practical results from mathematically posed problems, and with the scepticism that demands an answer to the question "is this result physically (or biologically) reasonable?" after each calculation.

This book would form an excellent basis for such a course. In the meantime, it should be in the physics library so that physics lecturers can refer their students to it.

R.H.J. McKellar
School of Physics
University of Melbourne

Mass Spectroscopy

H.E. Duckworth, R.C. Barber & V.S. Venkatasubramanian

This book is a revised and updated version of an earlier monograph by Duckworth on mass spectroscopy. The book covers the early development of mass spectroscopy from J.J. Thompson's classical experiments through to mass spectrometry in the upper atmosphere and space research, with fourteen chapters embracing all aspects of mass spectroscopy. The chapter devoted to the physics of magnetic and electrostatic ion optics is treated in sufficient detail to satisfy the student reader and specialist researcher as are those chapters on ion sources, positive ion detection and instruments. Indeed in the latter case the authors have even managed to include a description of Liebl's ion microprobe (also featured on the cover) with which this reviewer spent many happy hours playing some ten years ago. Several chapters are devoted to applications of mass spectroscopy in organic chemistry, solid state physics (including ion implantation), geology and cosmology. Small criticisms of the book are, firstly, the absence of the liquid metal ion source in chapter 3, which is perhaps one of the most widely used sources in ion microprobes and SIMS instruments today. Secondly, the techniques of secondary neutrals mass spectroscopy (SNMS) and multiphoton ionisation, both recent major advances in quantitative mass spectroscopy, also fail to rate a mention. However, this book should prove a valuable reference for the field of mass spectroscopy and its application in a diverse range of scientific disciplines.

R.H.J. McKellar
School of Physics
University of Melbourne

The Principles and Practice of Photochemical Machining and Photoetching

D.M. Allen
Adam Hilger Ltd., Bristol, 1986, xi+190pp., $59.50.

Photochemical machining (PCM) is an important industrial production technique which has been used for over 25 years for the fabrication of components such as colour television shadow masks, integrated circuit lead frames and magnetic recording heads. There has never been a comprehensive text dealing with this subject, so this monograph satisfies an important need.

The text deals exclusively with the photochemical machining of metals; the closely related topic of etching of semiconductor materials is not covered. This is probably appropriate in that plasma methods have supplanted wet chemical methods in the semiconductor industry in recent years, thus the technologies as practiced are now quite different. However, as plasma methods are available for etching some metal and composite materials, at least a brief discussion of plasma etching would have been a worthwhile addition to the text.

The treatment of the subject material is at a very practical level. While there is some discussion of etching mechanisms and an outline of the chemistry of photoresist materials, the emphasis is generally more on the 'how' rather than on the 'why'. As such, this book would be indispensable to anyone involved with micromachining of metal components and would be a worthwhile addition to the libraries of all laboratories with fine metal fabrication facilities.

I.C. Plumb
CSIRO Division of Applied Physics
Lindfield, NSW

The Neglect of Experiment

A. Franklin

This is an important book on a subject dear to my own heart. In our effort to teach all of physics in just four years we are often forced to present physics as a primarily theoretical subject. Experimental data rarely intrudes except to confirm the brilliance of the theoretical formulation. The sweat and blood, the consistency checks, the cross-checks, the late nights and the self-sacrifice required to get that data, almost never surfaces. The philosophers' questions of what it all means, for example Kuhn's view that "there can be no falsifying instances or crucial experiments", cannot be addressed in our regular courses.

Although it is too expensive for all but libraries, this book will serve as a way to salvage your self-respect. At least you can refer students to it. While dealing with issues in a philosophical manner in a few chapters (e.g. the Epistemology of Experiment in Chapter 6), the heart of this book is its discussion of three crucial experiments: the discoveries of parity violation, CP violation and the quantisation of charge in whole multiples of e. (Franklin's background in experimental high-energy physics shows in this choice, although perhaps unfortunately he did not participate in any of them.) For me the most fascinating account involves the discovery of parity violation in beta-decay in the 1920s by Chase, Cox and others. This discovery was lost in the struggle to resolve discrepancies with calculations.
The Physicist

by Mott of asymmetries in electron double scattering. It is fascinating to read the details of why this information was lost — including improvements in technology, a lack of theoretical awareness, etc.

The style is entertaining with a number of marvellous jokes: e.g. Mark Corse's quip that "four standard deviations is strong evidence, thirteen is absolute truth, and twenty-two is the word of God". There is the fact that Feynman bet Ramsey 50:1 that parity would be found to be conserved — and paid up! From the log-book of the Fitch-Cronin experiments, we see the pain of good experimental work in a June 6th entry: "The above is absolute garbage". We also see the advantage of the looser libel laws in the US when we read that whereas Fitch and Cronin had had a great reputation for "careful and correct work", "it is doubtful that the confirming results of Abashian's group would have achieved the same effect"!

There is a lot of important research into the meaning of what we do every day in this book. Your library should have some copies.

A.W. Thomas
Department of Physics
University of Adelaide

An Introduction to Equations of State: Theory and Applications
S. Eliezer, A. Ghaatik & H. Hora

This book presents a refreshing synthesis of many areas of physics, the appropriate unifying principle being the application of thermodynamics and statistical mechanics to a wide variety of systems. The first quarter of the book covers the more or less standard material on the thermodynamics of equations of state and the statistical mechanics of ideal Bose and Fermi systems. The treatment is at an introductory level but is presented in an original and stimulating way.

Ionization equilibrium is included in this survey, there is a chapter on the Debye-Hückel theory and following this a particularly full and interesting treatment of Thomas-Fermi models. This could have included applications in nuclear physics in addition to the atomic material.

As expected, the fascination of this book derives from the authors' aim of covering many of the properties of matter under extreme conditions both in the laboratory and in the universe at large. Given their many contributions to inertial confinement fusion, it is not surprising to find an authoritative treatment of pellet behaviour including nonlinear effects.

Turning now to astrophysics, the material on hydrodynamics in relation to shock waves is valuable in view of the recent interest in acceleration of particles through shock fronts. The applications in the book though are restricted to condensed matter physics. In spite of the ancillary resemblance of the diagrams on pages 233 and 244 (on pellet fusion) to the structure of neutron stars and the formation of supernovae respectively, the treatment of high density degenerate matter terminates with the white dwarf star.

In summary; Renewable Energy Resources is a valuable and detailed study of the scientific principles of what the late E.F. Schumacher called "technologies with a human face".

K.C. Hines
School of Physics
University of Melbourne

Renewable Energy Resources
J. Twidell & T. Weir

This is not another book on renewable energy for the enthusiast. Rather, it is a detailed technical book for the serious student of renewable energy, and for the practitioner.

The book has been written with formal teaching in mind, but can equally well serve as a quick reference guide to those in the business of designing and evaluating renewable energy technologies. It would be valuable for teachers of 2nd or 3rd year physics or engineering students wishing to cover the topic rigorously. The book would allow individual technologies to be covered, or the whole range.

The authors stress the multidisciplinary nature of renewable energies and encourage an interest in the environmental, life and agricultural sciences, in addition to physics and engineering. They also recommend a love of the outdoors for those interested in putting the theories to the test!

The fundamental principles of renewable energy sources — solar, wind, water, waves, tides, biomass and geothermal — are covered in detail, so that site specific resource estimation could be undertaken. Technologies for harnessing the various sources are also covered. These include solar water heaters, wind generators, photovoltaic cells and biogas digesters. The book finishes with a brief description of available and developing storage devices, from lead acid batteries to hydrogen and flywheels, which are so often a critical component of renewable energy systems.

No attempt is made to cover methods of assessing economic viability of renewable energy technology use. However, with the level of detail provided on the efficiency of resource capture, it should be a relatively simple matter to extend the calculations to site specific economic assessments, if required.

In summary, Renewable Energy Resources is a valuable and detailed study of the scientific principles of what the late E.F. Schumacher called "technologies with a human face".

M. Watt
NSW Department of Energy

Radio telescopes
W.N. Christiansen & J.A. Högblom
Cambridge Univ. Press, Cambridge, 1985, ix + 265pp., $49.00

The first edition of this classic, published in 1969, is probably a basic reference text for most practising radioastronomers today. However, the subject has advanced substantially since 1969, and this second edition attempts to reflect this.

The text is approximately evenly divided between filled apertures and arrays, and provides a solid theoretical basis for discussion and operation of any radio telescope likely to be encountered. Modern aperture synthesis lenses heavily on image processing techniques; in this area the text is weak, and one of the more recent textbooks, such as 'Interferometry and Synthesis in Radio Astronomy', by Thompson, Moran and Swenson, would be a useful complement.

Readers will be intrigued by the space devoted to early radio telescopes; these are of pedagogical and historic interest, but newly qualified astronomers may wish for more extensive treatment of recent and planned instruments.

This book is pitched at the level of graduate students and practising radioastronomers. It is, unfortunately, at $89, quite expensive.

M. Kasten
CSIRO Division of Radiophysics
Epping NSW
HUNTER TECHNOLOGY
It’s People Who Make Things Happen

★ TECHNOLOGY CENTRE

- ENTERPRISE DEVELOPMENT AREAS
  For start-up and existing technology-based companies

- CONFERENCE CENTRE
  Centre for 300 people plus training rooms

- BUSINESS SUPPORT SERVICES
  Secretarial, reception, accounting, publications

  MANAGER
  PAUL HEWITT

★ BUSINESS DEVELOPMENT

- INNOVATION ADVISORY SERVICE
  Recommending strategies for product commercialisation

- BUSINESS PLANNING
  To maximise a venture’s likelihood of success

- VENTURE MANAGEMENT
  Managing the implementation of business plans

  MANAGER
  GEOFF PINFOLD

★ COMPETITIVE INDUSTRY

- PLANNING SUSTAINED COMPETITIVENESS
  World competitiveness, product innovation, marketing

- CONSULTING SERVICES
  Value added management, quality, process technology

- TRAINING
  Training services to support competitiveness

  MANAGER
  NEVILLE WITTS

(049) 69 6922
<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mar 14-17</td>
<td>International Symposium on Non-equilibrium Solid Phases of Metals and Alloys, Kyoto. Y. Nakamura, Dept. of Metal Processing, Faculty of Engineering, Kyoto University, Kyoto 606, Japan.</td>
</tr>
<tr>
<td>Mar 14-Apr 8</td>
<td>Radiation Protection Course No. 11, Lucas Heights. The Principal, Australian School of Nuclear Technology, Lock Mail Bag No. 1, Menai, NSW 2234</td>
</tr>
<tr>
<td>Mar 22-25</td>
<td>Optics — ECOOSA '88, Birmingham. Meetings Officer IOP, 47 Belgravia Square, London, SW1X 8QX, UK.</td>
</tr>
<tr>
<td>Apr 4-8</td>
<td>International Workshop on Radiological Protection in Mining, Darwin. Dr J. Kvasnicka, Dept. of Mines &amp; Energy, GPO Box 2901, Darwin, NT 5794.</td>
</tr>
<tr>
<td>Apr 5-8</td>
<td>International Non-Ionizing Radiation Workshop, Melbourne. T. Boat, PO Box 4057, Melbourne, VIC, 3001.</td>
</tr>
<tr>
<td>Apr 6-9</td>
<td>8th General Conference of the Condensed Matter Division of EPS, Budapest. N. Kroo, Central Research Institute for Physics, POB 49, H-1525, Budapest, Hungary.</td>
</tr>
<tr>
<td>Apr 10-19</td>
<td>International Symposium and Workshop on Fusion Nuclear Technology, Tokyo. K. Miya, Nuclear Engineering Research Labs., The Univ. of Tokyo, Tokai-mura, Ibaraki Prefecture, 319-11, Japan.</td>
</tr>
<tr>
<td>Apr 25-May 20</td>
<td>Radioisotope Course for Graduates No. 34., Lucas Heights. The Principal, Australian School of Nuclear Technology, Lock Mail Bag No. 1, Menai, NSW 2234.</td>
</tr>
<tr>
<td>May</td>
<td>Int. Conference on Physics of Transition Metals, Kiev. Inst. of Metal Physics, Ukrainian Academy of Sciences, Vernadsky Str. 36, SU-252680, Kiev-142, USSR.</td>
</tr>
<tr>
<td>May 2-6</td>
<td>8th International Conference on Plasma Surface Interactions in Controlled Fusion Devices, West Germany. Ms M. Spittler-Wilden, KFA Jülich, POB 1913, D-5170 Jülich, West Germany.</td>
</tr>
<tr>
<td>June 20-24</td>
<td>Third Asia Pacific Physics Conference, Hong Kong. K. Young, 3rd Asia Pacific Phys. Conf., Dept. of Physics, The Chinese Univ. of Hong Kong, Shatin, Hong Kong.</td>
</tr>
<tr>
<td>Aug 8-12</td>
<td>5th Marcel Grossmann Meeting, Perth. Dr D. Blair, Physics Dept, The University of Western Australia, Perth, WA 6009</td>
</tr>
<tr>
<td>Aug 14-19</td>
<td>10th International Congress on Rheology, Sydney. Prof. R. Tanner, University of Sydney.</td>
</tr>
<tr>
<td>Aug 21-26</td>
<td>10th International Congress on Rheology, Sydney. Prof. R. Tanner, University of Sydney.</td>
</tr>
<tr>
<td>Aug 29-Sept 1</td>
<td>3rd Australian Archaeometry Conference, Adelaide Prof. John Prescott, University of Adelaide, SA 5001.</td>
</tr>
<tr>
<td>Oct 3-8</td>
<td>9th International Symposium on Exoelectron Emission, Related Phenomena and Applications, University of Wroclaw, Poland. Prof. J.A. Ramsey, Physics Dept, University of Newcastle, 2308.</td>
</tr>
</tbody>
</table>
"Rigidity" and "Damping" should be more than buzzwords

If your table bends and twists, your experiment is affected. Choosing the right optical table is critical, but there's too much talk about table "rigidity" and "damping" without meaningful performance specifications to back it up.

**Dynamic Response is the key.**
There are many kinds of rigidity. A table with "more rigidity" could ring like a bell if it lacks dynamic rigidity. And "more damping" can actually diminish a table's performance if it reduces the local rigidity, thermal stability, or long-term bowing resistance needed for precision work.

**The most important optical table specification.**
*Compliance* is the measure of the bending or twisting of a structure in response to a dynamic force. Acoustic and floor vibrations and mechanical resonances can undermine the most carefully set-up experiment. Only the optical table can assure the microrch stability of the equipment. Yet only Newport specifies the essential compliance parameter and minimizes it through proprietary design.

**Make an Informed decision.**
Newport tables are proven. For example, the 4' × 10' × 18" Research Series table top has a maximum compliance of 3 × 10⁻⁶ inch/lb. That kind of performance is 50–100 times better than that of tables claimed to be similar. It takes a continuing "ED" commitment to accomplish that.

We're proud to present our actual table performance data in our ads and in a 42-page section of our catalog. Your work deserves the best foundation — and it costs no more.

ALL YOUR LASER NEEDS

Newport Corporation

**QUENTRON OPTICS PTY. LIMITED**
Laser Court, 75A Angas Street, G.P.O. Box 2212, Adelaide, South Australia 5001
Telephone: (08) 223 6224 Telex: QTRON AA82809 Fax: (08) 223 5289
Unit 22-23, 36-38 East Street, Five Dock, N.S.W. 2046
Telephone: (02) 712 3111 Telex: QTRNSY AA122113 Fax: (02) 713 8046